DOCUMENT RESUME

ED 226 226 CE 035 155

TITLE Investigative Photography, 16-1. Military Curriculum Materials for Vocational and Technical Education.
INSTITUTION Army Military Police School, Fort McClellan, AL.; Ohio State Univ., Columbus. National Center for Research in Vocational Education.
SPONS AGENCY Office of Education (DHEW), Washington, D.C.
PUB DATE Mar 75
NOTE 243p.
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051)

EDRS PRICE MF01/PC10 Plus Postage.
DESCRIPTORS Color; *Equipment Utilization; Investigations; *Light; Military Personnel; Military Training; Optics; *Photochemical Reactions; *Photographic Equipment; *Photography; Postsecondary Education; Secondary Education; *Technical Education
IDENTIFIERS *Crime Detection; *Investigative Photography; Military Curriculum Project

ABSTRACT

This military-developed text consists of nine lessons dealing with investigative photography. Covered in the individual lessons are the following topics: light (light as the basis of photography, the behavior of light, the composition of white light, light transmission, reflection and absorption, illumination, and pinholes and light); camera lenses and optics (types of lenses, lens defects, lens focal length, aperture setting and light control, lens angles, image size, the circle of confusion, and lens focusing characteristics); cameras; films (black and white films, color film, diffusion transfer reversal system materials, and film selection); principles of exposure (basic outdoor exposure, interchanging the stop and shutter speed, light meters, exposure with artificial light, filter effects, filter types, and film factors); photographic chemistry and processing (film development, negative developing solutions, the effects of developer and negative density, developer life, processing the negative, negative processing problems, printing paper and printing, and processing the print); copy and small object photography (photographing small objects and fingerprints); and crime scene photography (photographing crime scenes and articles of evidence). Each lesson has an objective, suggestions for study, a reading assignment, review exercises, and answers to the exercises. A course exam is also included, but no answers are available. (MN)

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

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- Developing educational programs and products
- Evaluating individual program needs and outcomes
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FOR FURTHER INFORMATION ABOUT
Military Curriculum Materials
WRITE OR CALL
Program Information Office
The National Center for Research in Vocational Education
The Ohio State University
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THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION

Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

Agriculture	Food Service
Aviation	Health
Building & Construction Trades	Heating & Air Conditioning
Clerical Occupations	Machine Shop
Communications	Management & Supervision
Drafting	Meteorology & Navigation
Electronics	Photography
Engine Mechanics	Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
217/782-0759

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INVESTIGATIVE PHOTOGRAPHY

Table of Contents

Developed by:
United States Army

Development and Review Dates
March 1975

Occupational Area:
Photography

Cost: Print Pages
224

Availability:
Military Curriculum Project, The Center for Vocational Education, 1960 Kenny Rd., Columbus, OH 43210

Suggested Background:
None

Target Audiences:
Grades 10-adult

Organization of Materials:
Lesson assignment booklet containing objectives, readings, review exercises, and solutions; course examination

Type of Instruction:
Individualized, self-paced

Type of Materials:			No. of Pages:	Average Completion Time:
Investigative Photography				
Lesson 1	–	Light	18	Flexible
Lesson 2	–	Camera Lenses–Optics	28	Flexible
Lesson 3	–	Cameras	22	Flexible
Lesson 4	–	Films	22	Flexible
Lesson 5	–	Principles	40	Flexible
Lesson 6	–	Photographic Chemistry and Processing	31	Flexible
Lesson 8	–	Copy and Small Object Photography	25	Flexible
Lesson 9	–	Crime Scene Photography	25	Flexible
Examination			15	

Supplementary Materials Required:
None

Expires July 1, 1978

Course Description

This course is designed to provide theory information to students concerning basic photography and some of the procedures of investigative photography. The course consists of nine lessons, Lesson 7 was deleted because it deals with specific military equipment.

Lesson 1	—	*Light* gives an introduction to light as the basis of photography, defines the terms used about light, and discusses the behavior of light, the composition of white light, light transmission, reflection and absorption, illumination, and pinholes and light
Lesson 2	—	*Camera Lenses-Optics* gives an introduction to lenses, defines the terms used about lenses, and discusses types of single lenses, aberrations and other defects of lenses, lens focal length and focal plane, aperture setting and light control, lens angles, image size, the circle of confusion, and lens focusing characteristics.
Lesson 3	—	*Cameras* gives an introduction to cameras, defines the terms used about cameras, and discusses a variety of cameras and focusing mechanisms.
Lesson 4	—	*Films* gives an introduction to films, defines the terms used in films, and discusses black and white film characteristics, color film, diffusion transfer reversal system materials, and selection of film.
Lesson 5	—	*Principles of Exposure* gives an introduction to exposure, defines the terms used about exposure, and discusses basic outdoor exposure, interchanging the stop and the shutter speed, light meters, exposure with artificial light, filter effects, filter types, and film factors.
Lesson 6	—	*Photographic Chemistry and Processing* introduces development and discusses negative developing solutions, the effects of developer and negative density, developer life, processing the negative, negative processing problems, printing paper and printing, and processing the print.
Lesson 8	—	*Copy and Small Object Photography* discusses copying, small object photography, and photographing fingerprints.
Lesson 9	—	*Crime Scene Photography* gives hints on how to photograph specific crime scenes and articles of evidence.

Each lesson has an objective, suggestions for study, a reading assignment, review exercises and answers to the exercises. The course was designed for student self-study and evaluation in a laboratory or on-the-job learning situation. A course exam is included but no answers are available The first five lessons can be used in any basic photography course. The last two lessons can be used in career units on photography.

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UNITED STATES ARMY MILITARY POLICE SCHOOL

Ft. McClellan, Alabama
36201

LESSON ASSIGNMENT BOOKLET

LESSON ASSIGNMENT BOOKLET

SUBCOURSE NO. 4-12 I

INVESTIGATIVE PHOTOGRAPHY

MARCH 1975
REPRINT

16-1

ARMY CORRESPONDENCE COURSE OF
THE U. S. ARMY MILITARY POLICE SCHOOL

SUBCOURSE NO. 4-12 I, INVESTIGATIVE PHOTOGRAPHY

Photography is a field of activity with a variety of meanings to different people. To some it is a technical science dealing with chemistry, and the physics of light and optics. Others think of it as a graphic expressional art subject to changes in texture, moods of lighting, and changing tone of grays or variable colors. To most it is the Sunday snapshot of the wife and children. To the criminal investigator photography is an extension of his investigative technique, an aid in relating and establishing the facts in a case, and a tool used to communicate recorded information to others.

In order for the investigator to master the use of this valuable tool and use it properly, he must become familiar with some of the peculiarities of photography. An understanding of photo chemistry, light, and optics must be developed by the investigator. He must learn to capture the facts as they actually exist, avoiding an involvement in creating "art" which could distort the true facts. This understanding is needed because the picture taken must be of a quality and type which can be used in an investigative report and presented in court. It is an objective graphic method of communication which illustrates to others what the investigator discovered during his investigation.

The objective of this subcourse is to convey to the student the information which will enable him to make use of photography as an investigative tool. It is not intended to make an investigator a photographer, but it is intended to give him enough information to produce photographic results which are acceptable to supplement the investigative report and to be entered into court proceedings as evidence.

This subcourse consists of nine (9) lessons and an examination as follows:

Lesson 1. Light.

Lesson 2. Camera Lenses-Optics.

Lesson 3. Cameras.

Lesson 4. Films.

March 1975 Reprint

THIS SUBCOURSE SHOULD BE COMPLETED AND RETURNED FOR GRADING WITHIN SIX MONTHS.

Lesson 5. Principles of Exposure

Lesson 6. Photographic Chemistry and Processing

Lesson 7. Two Army Cameras

Lesson 8. Copy and Small Object Photography

Lesson 9. Crime Scene Photography

Examination

Twenty-five credit hours are allowed for the successful completion of this subcourse.

You will grade your own lessons using the lesson solutions inclosed in your subcourse packet. Follow these simple A, B, C's in studying all lessons for this subcourse.

A. Study the "Text Assignment" for the lesson.

B. After thorough study, complete each of the "Requirements," circling or marking your answers in the exercise booklet itself. You may either complete all requirements before grading or grade your own requirements one at a time, whichever you choose. If you grade your requirements one at a time, be sure that you do not check the next exercise solution before completion of the exercise. If you do, you will deny yourself the opportunity to develop your own solution to the exercise since you will already know the answer. How can you tell how well you are learning the material if you look at the answers in advance?

C. If you incorrectly answer an exercise, look up the text reference listed on the solution sheet. Study this reference and compare it to all the possible exercise solutions. Be sure that you understand why the school's solution is best. If you cannot understand this, you may write us for further assistance. This will correct erroneous thinking on your part and reinforce the learning process. By following this procedure, you will be in the best position to successfully complete the examination. Remember, the more you study and the more you understand the exercises, the better will be your examination grade.

When you have completed all lessons to your satisfaction, you may commence work on your examination which has been forwarded to you along with your subcourse booklet.

Text Furnished. Attached Memoranda.

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LESSON ASSIGNMENT SHEET

SUBCOURSE NO. 4-12 I	Investigative Photography.
LESSON 1	Light.
CREDIT HOURS	1.
TEXT ASSIGNMENT	Attached Memorandum.
MATERIALS REQUIRED	None.
LESSON OBJECTIVE	To provide you with a knowledge of light as it applies to photography.
SUGGESTIONS	None.

ATTACHED MEMORANDUM

This attached memorandum includes information extracted from resident instructional material of the United States Army Military Police School, and TM 11-401-1. In case of conflict between the attached memorandum and other publications, the material contained in the attached memorandum will apply to this lesson assignment.

1. INTRODUCTION. Light is the basis of photography, therefore it is fitting that we begin with a study of light. It is important to understand some properties of light, for a picture is not a direct duplication of the subject, but of the light which is reflected from it. With a basic understanding of light's behavior, the photographer is able to utilize different light sources, photographic lenses, and light sensitive films. The photographer must learn to think in terms of light. Without the correct amount of light, there will be no image or the image will be an unacceptable one. The investigative photographer must be aware that simply by varying the light source, the entire composition and mood of the photograph can be changed. Again, the investigative photographer must produce a photograph which is objective, reporting facts with the picture, without distortion of truth.

2. TERMS. The definitions given in this paragraph are not necessarily the most important terms in the lesson. Additional terms and definitions will be found throughout the lesson and those given below may be listed only in the interest of clarification.

a. MILLIMICRON or MU - A unit length equal to one millionth of a millimeter.

b. FREQUENCY - The number of repetitions of a periodic process in a unit of time.

c. OPAQUE - Not transparent or translucent.

d. TRANSLUCENT - Admitting and diffusing light, resulting in that objects beyond cannot be clearly distinguished.

e. PERPENDICULAR - A line at right angles to the plane of another line or surface; exactly vertical or upright.

f. ANGLE OF INCIDENCE - Angle at which light arrives at a surface (Figure 8).

g. ANGLE OF REFRACTION - The deflection from a straight path of a light ray in passing obliquely from one medium to another (Figure 8).

h. ANGLE OF DEVIATION - Difference between angle of incidence ray and the path of the refracted ray (Figure 8).

i. EMERGENT RAY - The path of a light ray after leaving one medium and entering another, i.e., from glass to air (Figure 8).

j. CANDLE POWER - A standard for measuring the brilliance of illumination. The higher the candle power, the brighter the illumination.

k. EMULSION - A light sensitive layer of silver salt suspended in gelatin, spread over a permanent support such as film, glass, or paper.

l. MONOCHROMATIC - A single color.

3. BEHAVIOR OF LIGHT. Early in the twentieth century the scientist Max Planck developed a theory that any radiating body will give off energy in small particles, which he called quanta. Einstein demonstrated, with mathematics, that quanta (also called photons) have a frequency (see 3a(2)) and can be measured. A knowledge of these properties of light aids the photographer in different ways under various conditions.

a. Classification of Light. Light, as a form of radiant energy, is classified according to wave length and frequency.

(1) A wave length is the measurement of light from crest to crest (Figure 1). It was discovered that wave lengths are different for each color and that their wave lengths are very small. For example, the wave length of yellow light is about a forty thousandth of an inch (0.00006 cm).

(2) The frequency of light is the counting of these small wave lengths as they pass a specific point in one second. The light which is visible to the human eye has a wave length from 400 to 700 millimicrons.

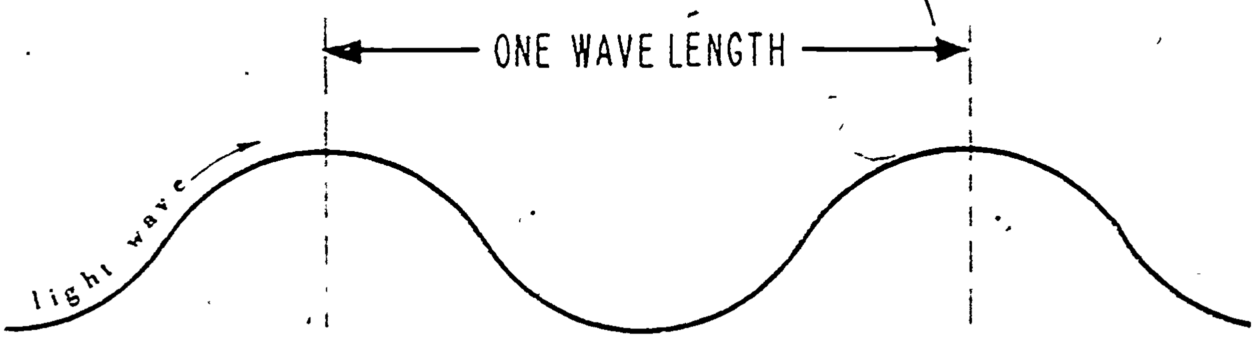

Fig 1. Light Wave Length

b. Light Rays and Waves. Light is described as having a wave motion character and a ray character (see Figure 2). Both of these actions occur simultaneously and they are actually just different ways of looking at the same light behavior. However, these two views of light aid in the discussion of how light will affect an object. For most practical purposes in photography, light rays are said to travel in a straight line. When an object blocks some of the light rays, a shadow is cast and this shadow will give the object shape. Shadows are important in that they give a picture depth and mood.

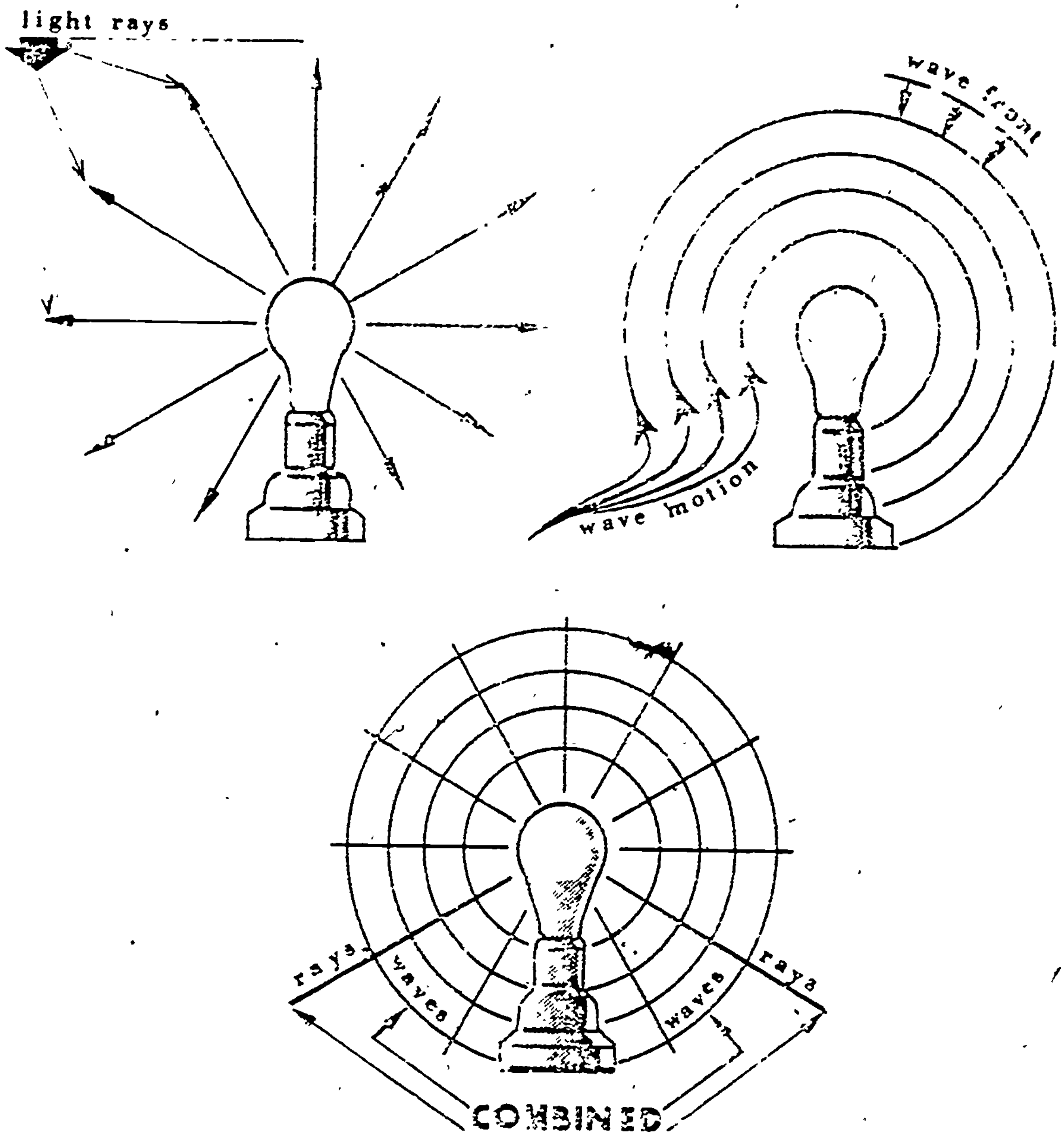

Fig 2. Light Rays and Waves

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c. The Visible Spectrum (Figure 3). The electromagnetic spectrum includes the entire range of wavelengths and frequencies of electromagnetic radiation. It extends from gamma rays to the longest radio waves and includes what the human eye sees as visible light. The visible spectrum is a very small part of the electromagnetic spectrum. Each of the varying wavelengths of visible light has its own typical color. Visible light wavelengths are from 400 millimicrons to 700 millimicrons.

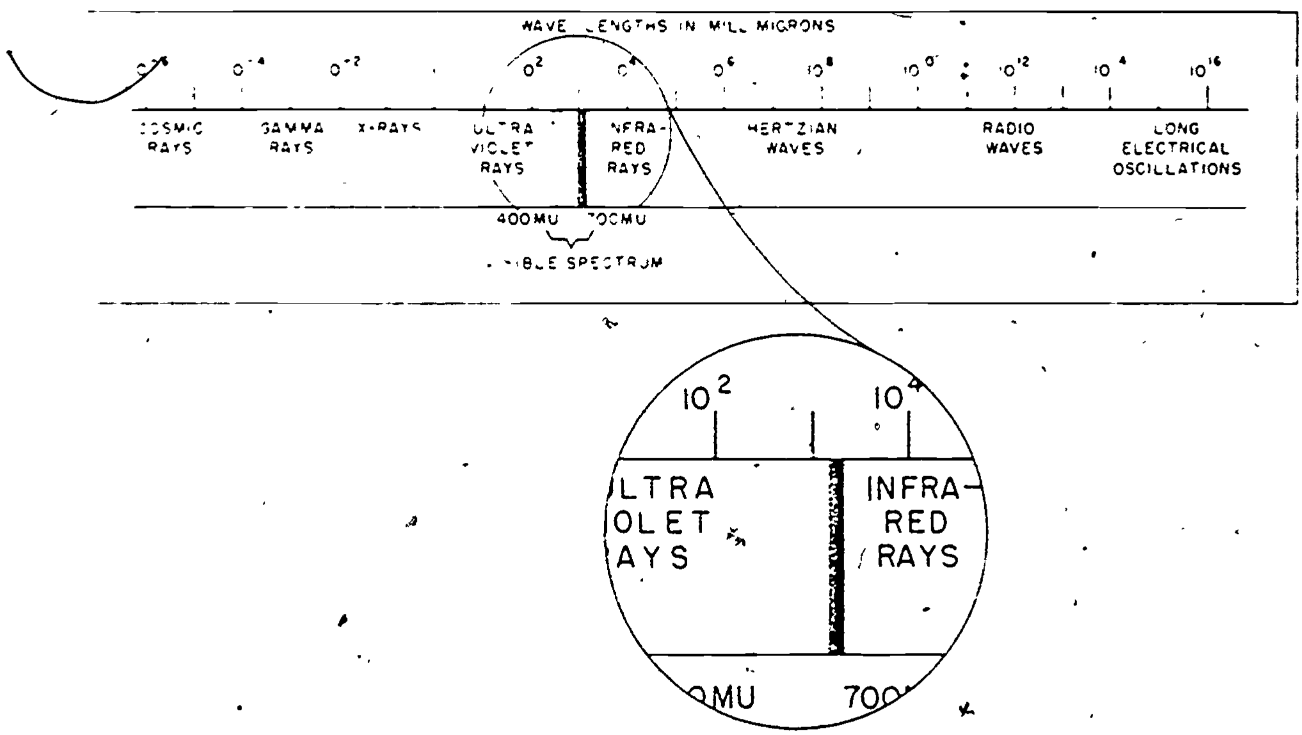

Fig 3. The Electromagnetic Spectrum

4. COMPOSITION OF WHITE LIGHT. White light is composed of all visible light wavelengths in the visible spectrum. Sunlight is white light and is an ideal or equal blending of all the wavelengths of the visible spectrum. If any of these wavelengths are missing, even in part, we have another color instead of white light.

a. Dispersion of light is the process of passing white light through a prism or material with similar properties, separating the light into its color components. The light that emerges will be split into a band of colored light (see Figures 3 and 4). The amount of dispersion will vary in accordance with the type of glass used. For example, a prism of dense glass will disperse light rays to a greater degree than a prism of less density.

b. Color Wavelength. Each color of the spectrum represents light movement at different frequencies or wavelength (violet at 400 millimicrons and red at 700 millimicrons). The shorter the colors wavelength the more it will be bent as it passes through a transparent substance. This behavior of light is called refraction (paragraph 6). Therefore, red light waves, being the longest, will be bent the least. The action of refraction helps to explain dispersion of white light. As light enters the prism the frequencies are bent independently into its color parts.

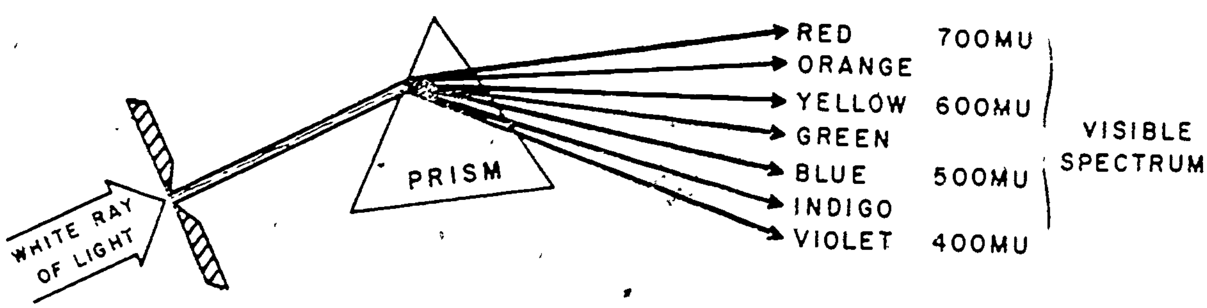

Fig 4. Dispersion of Light by a Prism

c. Sir Isaac Newton's experiments with prisms showed that ordinary white light, when passed through a prism, contained all visible colors. He proved this point when he passed a band of colors produced by one prism through a second prism, with a lens in between (Figure 5). The lens and prisms were spaced so that the second prism brought the separated colors together again to form white light.

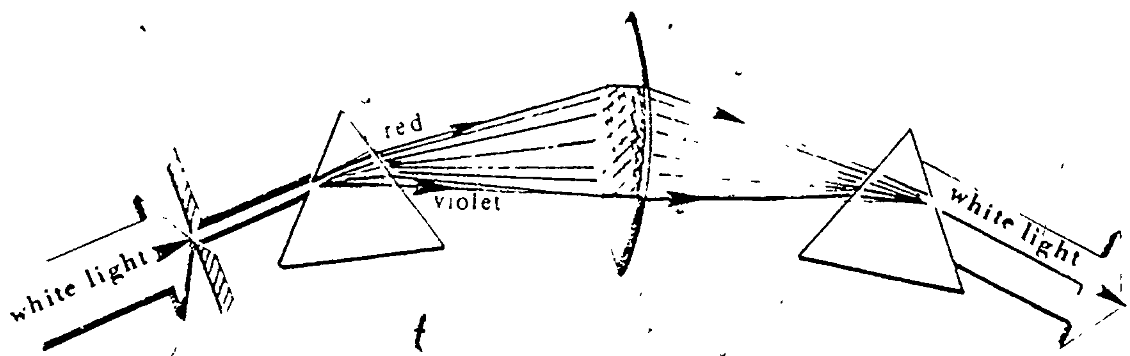

Fig 5. Newton's Experiment Showing Composition of White Light

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5. LIGHT TRANSMISSION, REFLECTION AND ABSORPTION. Light rays traveling in a straight line will be transmitted through, reflected, or absorbed, or a combination of these actions will occur, when they encounter any substance. The type of action which will take place will depend on whether the substance, or medium, is transparent, translucent, or opaque (Figure 6).

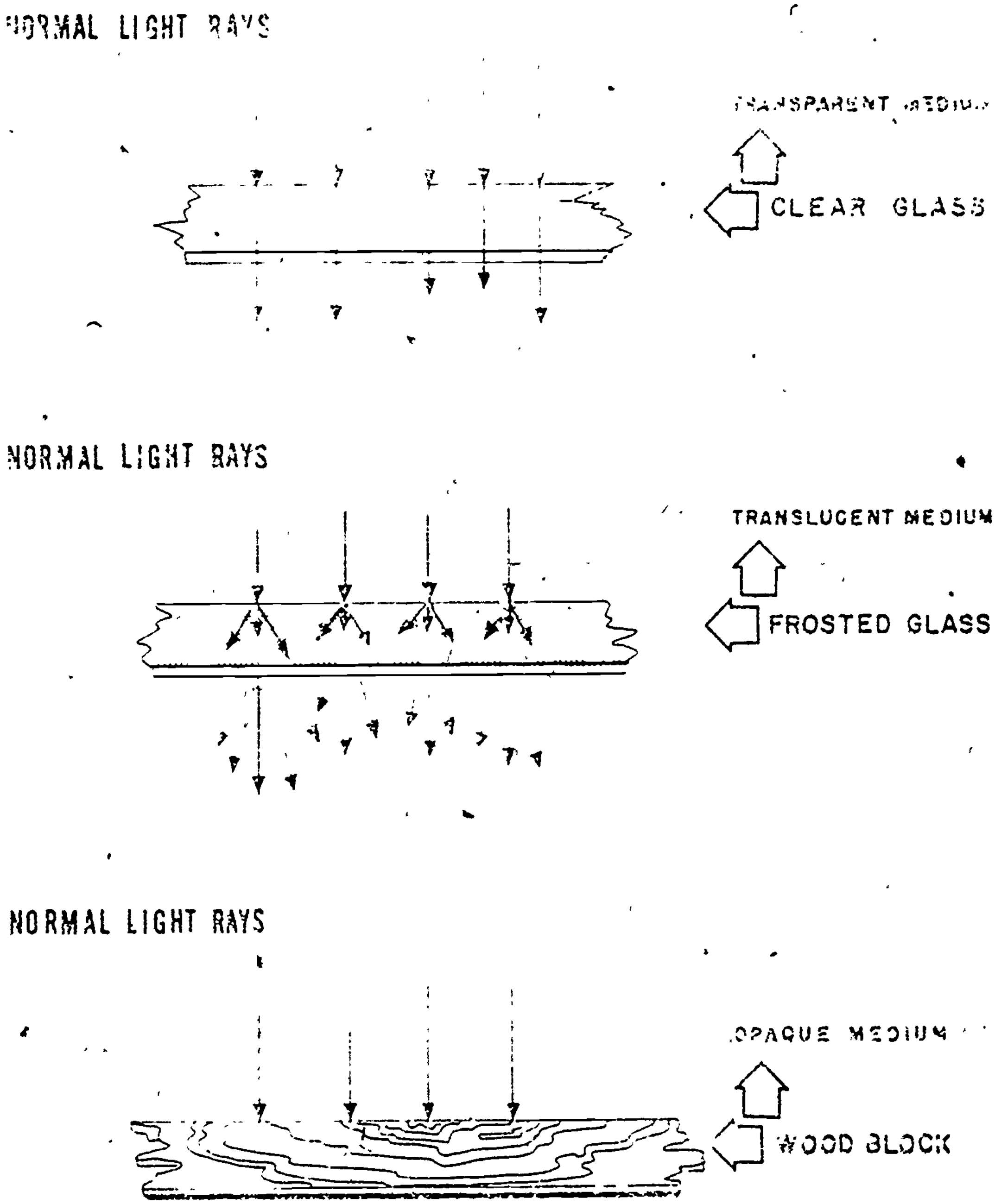

Figure 6. Light Transmission, Reflection, and Absorption.

a. Transmission. Transmission of light is said to occur when light passes through a medium (i.e., glass, a transparent medium, or frosted glass, a translucent medium).

b. Reflection. Light rays that are not transmitted through or absorbed by an object are said to be reflected. Light rays striking the surface of a medium are called incident rays. The point where the light rays and object come in contact is termed the point of incidence. Light reflected from an object falls into two groups - specular and diffused.

(1) Specular Light. Specular light travels in one direction. The incident light ray striking a perfectly smooth surface will rebound at exactly the same angle at which it strikes the object. (See Figure 7.)

(2) Diffused Light. Diffused light is light that is scattered in several directions when its rays hit an uneven surface. The incident ray will be reflected off the surface at various angles (Figure 7). Most objects that are photographed will reflect both specular and diffused light.

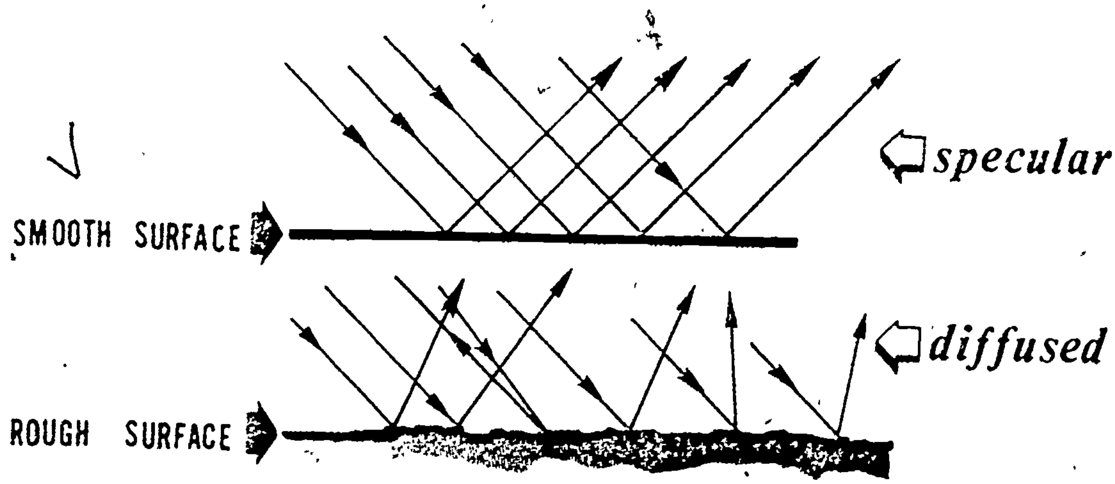

Fig 7. Reflected Light

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c. Absorption. Light will normally be absorbed to some degree no matter what type of surface is encountered. The color of an object is largely a matter of absorption and reflection. When white light falls on an object that absorbs some of the wave lengths and reflects or transmits others, the object appears to have color. The wave length that is reflected or transmitted determines the color of the object. For example, a red object appears red because it reflects or transmits only the red wave lengths. The other wave lengths, which produce green and blue, are absorbed by the object.

6. REFRACTION. Refraction is the bending, or deflection, of light rays when they pass at an angle from one transparent medium to a second transparent medium of a different density (i.e., air to glass, or air to water, etc.).

a. Law of Refraction. If a light ray falls perpendicular, or normally, upon a surface between two mediums of different density, the ray is not bent. If the light strikes the surface at an angle, the light ray will be bent. The direction in which the light is bent is dependent upon the density of each medium the light is traveling through. For discussion purposes, the mediums which light will be traveling through are air and glass, although the law of refraction applies as well to other mediums. A light ray, in passing from a medium of lesser density (air) to one of greater density (glass), is bent toward the normal or perpendicular. In passing from a medium of greater density to one of lesser density, the ray will be bent away from the normal. (See Figure 8.)

b. The greater the angle of incidence and the greater the differences in densities of two mediums, the greater will be the angle of refraction.

c. Index of Refraction. Light travels through substances of different densities at varying speeds. For example, the speed of light traveling in glass is approximately 120,000 miles per second, whereas light traveling through air is approximately 186,000 miles per second. The ratio between the speed of light in one medium to its speed in another medium is known as the index of refraction. A practical use of this knowledge is in the determination of the angle of refraction of lenses made of various types of glass and used for varying purposes.

7. ILLUMINATION. The intensity of illumination on an object will depend upon the strength of the light source and the distance from the source to the object.

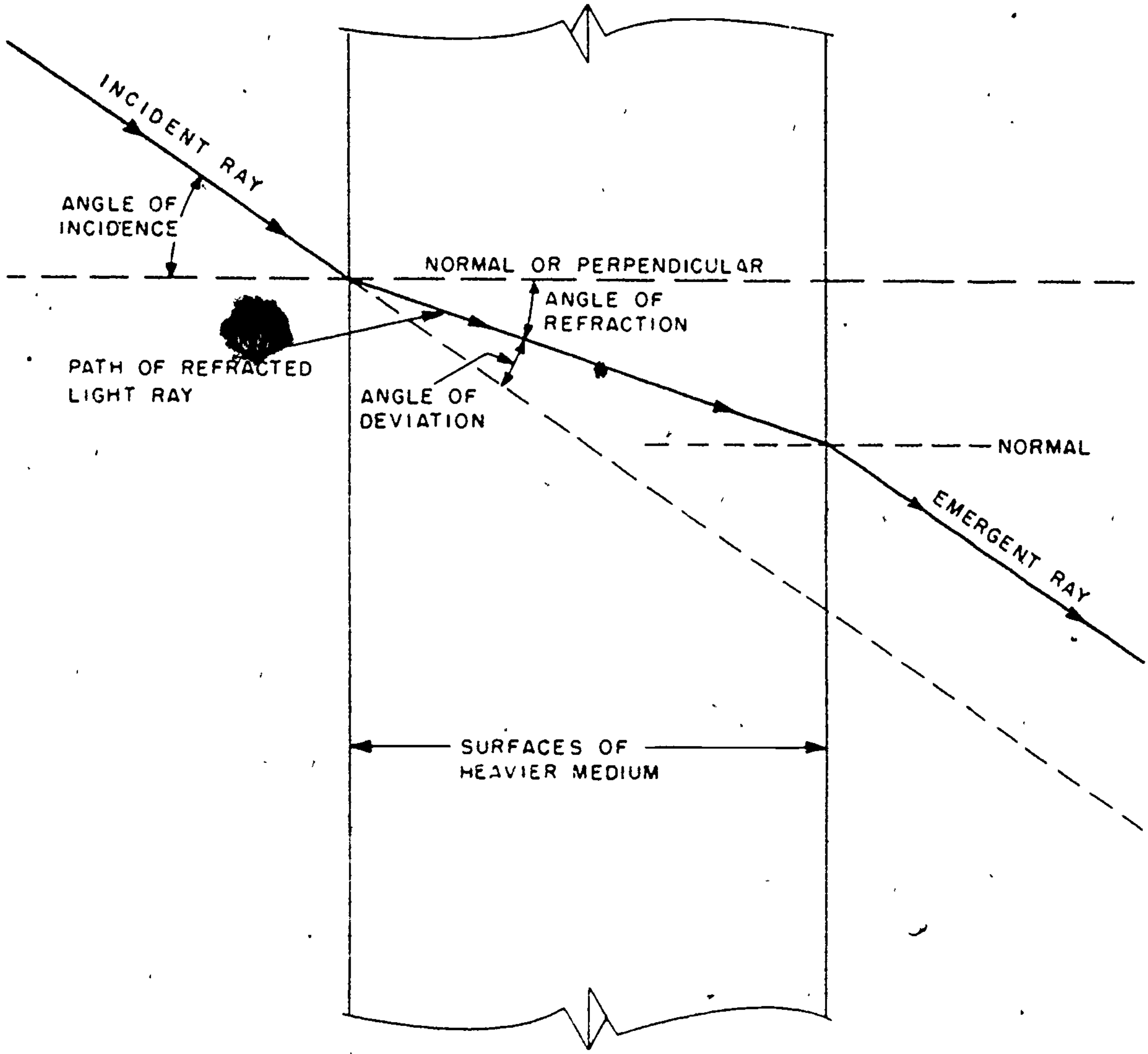

Fig 8. Terminology in Refraction

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a. Inverse Square Law of Light. Light intensity diminishes inversely with the square of the distance from the light source to an object. Light from a point source (i.e., light bulb) will spread out in a room both horizontally and vertically. When the distance from the source is doubled, the area over which it must spread is increased four times. In Figure 9, a card is placed 1 foot, 2 feet, 3 feet, and 4 feet from a light source. When the card is placed 1 foot from the light source, the intensity of illumination is equal to the candlepower of the light source; when the card is moved to a point 2 feet from the light source, the intensity is one fourth as bright; when the card is moved to a point 3 feet from the light source, the intensity is one-ninth as bright; and when the card is moved to a point 4 feet from the light source, the intensity is one-sixteenth as bright. As the object is moved closer to the light source the process reverses and the object appears brighter (see Figure 9).

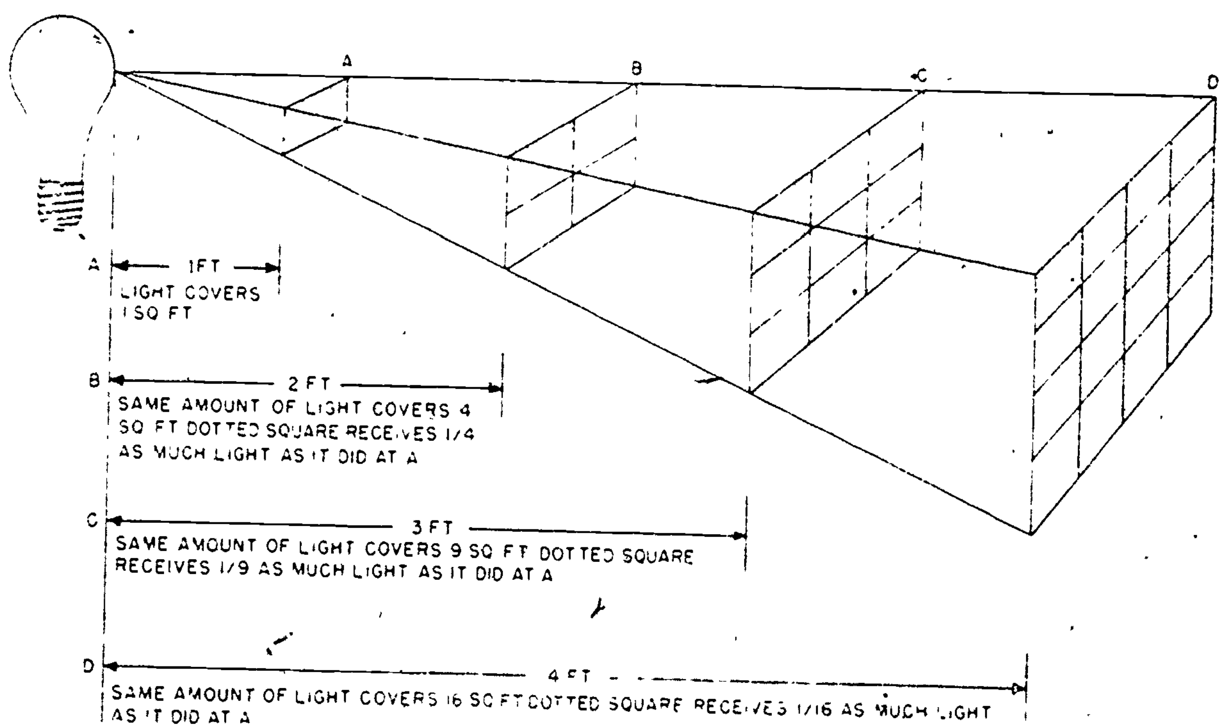

Fig 9. Inverse Square Law

b. Brightness represents the quantity of light reflected from a surface that has been illuminated. The amount of light reflected depends on the nature of the surface. The glossier the surface, the more specular the reflection; the more matte (dull) the surface, the more diffuse the reflection. Tones, from white to black, also play a part in the degree of reflectivity of the surface. Therefore, a very glossy white surface will approximate the effect of a mirror; a diffuse white surface, like a blotter, is not subject to specular reflection and gives a scattered light. Normally, surfaces are a compromise between the two extremes. The distance from a camera to the subject has no effect on brightness. If the camera were moved away from a surface to be photographed, subject brightness will remain about the same.

c. The relationship of brightness extremes and the relationship of brightness areas to shadow areas are factors that must be considered, translated into values, and reproduced in a corresponding scale of shades on a light sensitive emulsion. Because photographic emulsions lack the extreme sensitivity of the human eye and the ability to be selective, the photographer must control the ratio of brightness extremes of a subject. He achieves this through judicious use of subject selection, control of light intensity, control of light direction, control of the direction of shadows, and control of the amount of reflected light. The photographer must aim for reduced brightness extremes, so that the light-sensitive emulsion can effectively reproduce conditions without sacrificing subject detail or reducing the range of shading of the subject as it appears in the finished photographic print.

8. A PINHOLE AND LIGHT.

a. The behavior of light through a pinhole has long been known. In earlier times it was called a "camera obscura." The camera obscura was a light-tight inclosure with a small hole in one side. The light rays entered the inclosure through this small hole and produced a picture, on the wall opposite the hole, of the object outside.

b. As light travels through space, it will travel in a straight line. Because of this fact the passage of light reflected from and through a pinhole will cause the reflected light to form an inverted image (Figure 10).

c. A drawback on using this type of apparatus for practical photography is that the image formed is not a bright one. The pinhole must be small in order to get a relatively sharp image. For this reason, long exposures are necessary to produce an acceptable image. However, if several separate images (Figure 10) could be placed upon each other the image would require less exposure time. Figure 10 illustrates how this could be accomplished through the use of prisms, which introduces the employment of optics in photography.

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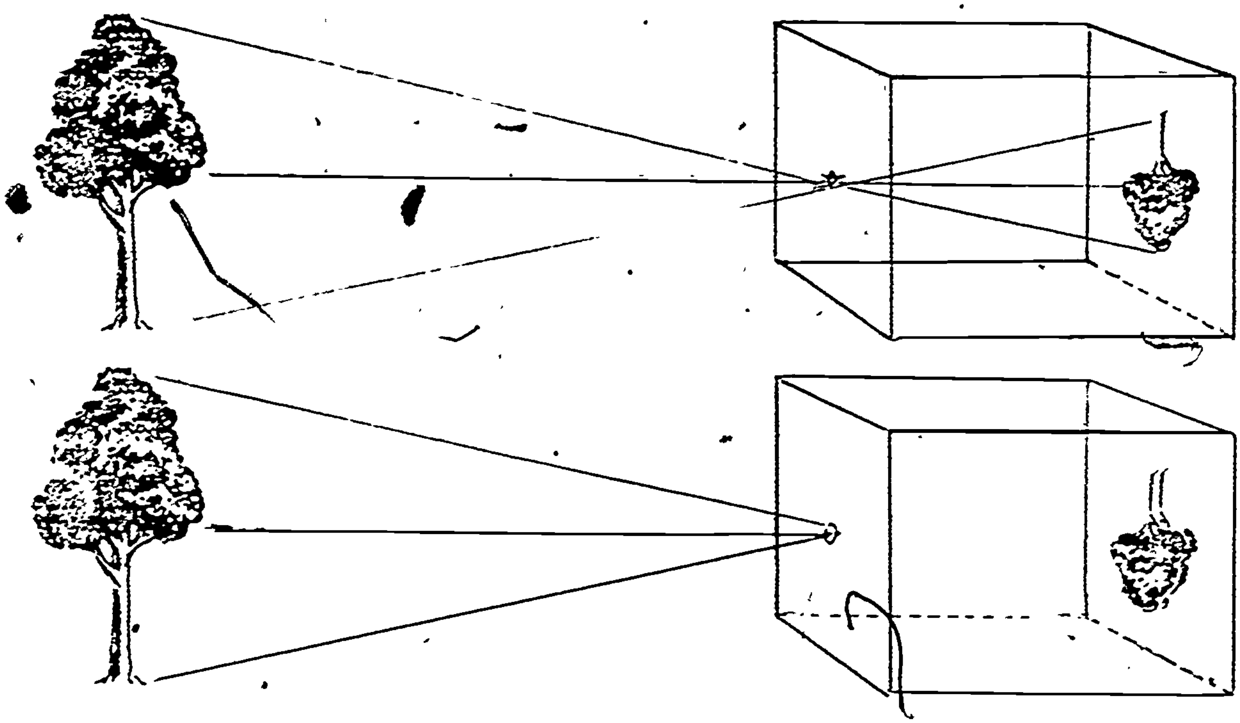
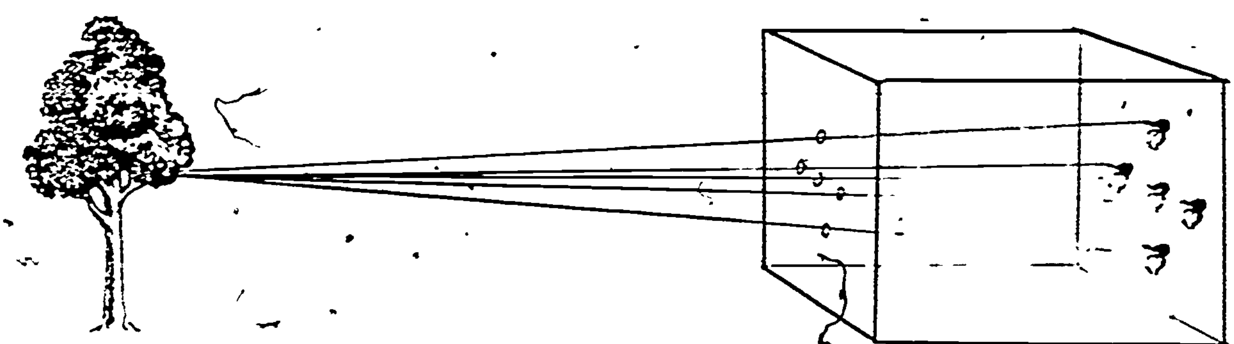
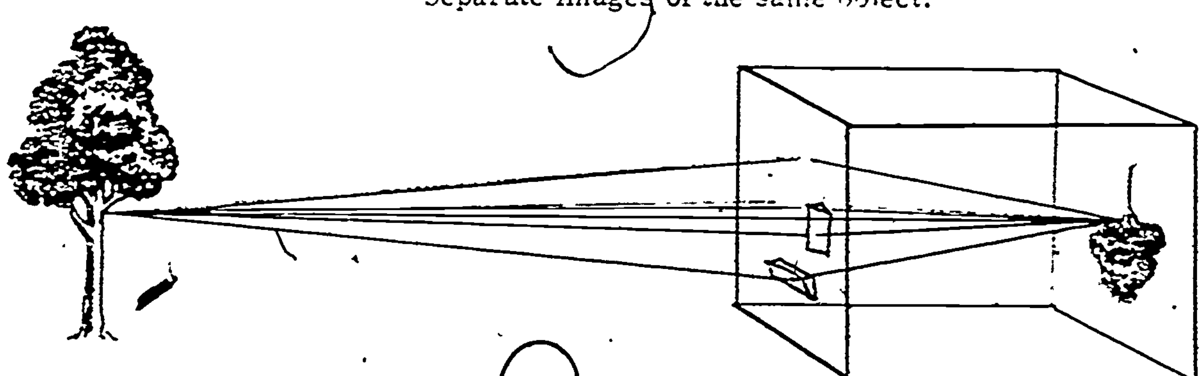


Images produced by large and small pinholes.



Separate images of the same object.



Separate images made to coincide.

Fig 10.

EXERCISES

REQUIREMENT. The following exercises are multiple choice. There are four alternatives to each exercise. You are to select the one alternative that is correct and indicate your choice by circling the correct response directly on the exercise booklet.

1. Light is classified according to

   a. color and speed.

   b. frequency and color.

   c. wave length and frequency.

   d. speed and relativity.

2. Visible light wave lengths are from

   a. 100 to 400 millimicrons.

   b. 400 to 700 millimicrons.

   c. 700 to 1000 millimicrons.

   d. 1000 to 1300 millimicrons.

3. The process by which white light passing through a prism is separated into its color components is called

   a. dispersion.

   b. refraction.

   c. disintegration.

   d. separation.

4. The shorter a color's wave length, the more it will be

a. bent when passing through a transparent substance.

b. scattered in an infinite number of directions.

c. concentrated upon a single spot or in a single ray.

d. separated into its primary and secondary color.

5. The light rays striking the surface of a medium are called

a. X rays.

b. transparent rays.

c. visible rays.

d. incident rays.

6. The direction in which light is bent, when passing through different mediums, is dependent upon the

a. speed of light.

b. density of the medium.

c. wave length of the light.

d. frequency of the light.

7. The ratio between the speed of light in one medium to its speed in another medium is known as the

a. Inverse Square Law.

b. Theory of Relativity.

c. Planck's Theorem.

d. Index of Refraction.

8. According to the Inverse Square Law of light, when the distance from the light source is doubled, the area over which it must spread is increased

a. two times.

b. four times.

c. one time.

d. eight times.

9. A matte, or dull, surface reflection would be said to be

a. diffuse.

b. specular.

c. refracted.

d. dense.

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P

10. The light from a pinhole will form

a. a halo effect.

b. a photographic emulsion.

c. an inverted image.

d. an emergent ray.

LESSON ASSIGNMENT SHEET

SUBCOURSE NO. 4-12 I	Investigative Photography.
LESSON 2	Camera Lenses - Optics.
CREDIT HOURS	2.
TEXT ASSIGNMENT	Attached Memorandum.
MATERIALS REQUIRED	None.
LESSON OBJECTIVE	To provide you with the general and specific information to enable you to understand and use camera optics.
SUGGESTIONS	None.

ATTACHED MEMORANDUM

This attached memorandum includes information extracted from resident instructional material of the United States Army Military Police School and TM 11-401-1. In case of conflict between the attached memorandum and other publications, the material contained in the attached memorandum will apply to this lesson assignment.

1. INTRODUCTION. A camera optic, or lens, is a spherical and symmetrical piece of polished glass that refracts light rays so that a clear, sharp image is projected on the rear wall of a camera.

a. The purpose of the camera lens is to gather light, by refracting the light rays, to produce an image which is sharp, clear and without distortion.

b. In Lesson 1 it was shown that a simple pinhole will produce an image on the opposite wall of a light tight box. Also, if one were to place prisms at various locations, a brighter image would result by imposing one image over the other. The photographic optic is, in fact, prisms placed in different arrangements to bend the light and produce the sharp, clear, undistorted image which will be acceptable as a photograph.

2. TERMS. The definitions given in this section are not necessarily the most important terms in the lesson. Additional terms and definitions will be found throughout the lesson, and those given below may be listed only in the interest of clarification.

a. Refraction - The deflection from a straight path of a light ray in passing obliquely from one medium to another (para 1).

b. Concave - Hollowed or rounded inward (para 3).

c. Convex - Curved or rounded like the exterior of a circle (para 3).

d. Converge - To come together and unite in a common focus.

e. Astigmatism - The inability of a lens to focus both horizontal and vertical lines sharply at the same time (para 4).

f. Coma - A spherical aberration in which the image of a point source is a comet-shaped blur.

g. Aberration - An optical defect which causes imperfect images (para 4).

h. Curvature of Field - Distortion caused by the curvature of a concave lens (para 4).

i. Newtons Rings - Irregular light and dark bands which appear between the surfaces of positive and negative lenses when they are pressed together (para 4).

j. Flare - Stray light which causes bright spots on exposed film (para 4).

k. Aperture - The lens opening that regulates the amount of light entering the lens (para 6).

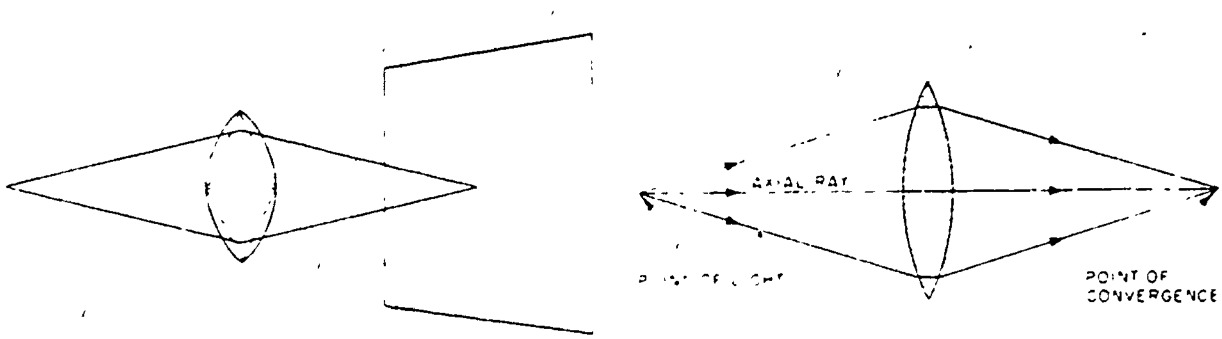
l. Diaphragm - An adjustable aperture which controls the amount of light passing through a lens (para 6).

m. Infinity - A distance setting on a camera focusing scale, beyond which all objects are in focus.

n. Exposure - The time that a given amount of light requires to create an image on sensitized material.

3. TYPES OF SINGLE LENSES. Single lenses are divided into two groups; positive and negative.

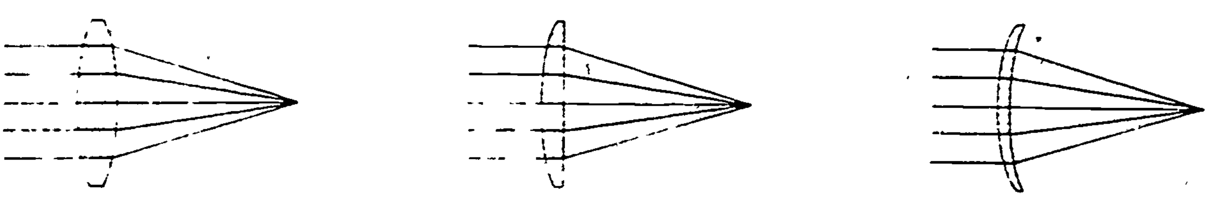
a. Positive lenses are basically two prisms placed base to base (Figure 1). These lenses form a distinguishable image, because they refract the light rays so that they converge after passing through the lens. "Positive lenses form real images because light rays passing through such lens converge. Lenses in this class are also termed convex, convergent, or collective. The most common positive lens is the double-convex which will cause light rays, from either side of the lens surface, to converge (Figure 2). Two other positive lens types are the plano-convex and the convexo-concave (Figure 2). The plano-convex has one curved surface and one flat surface while the convexo-concave has two curved surfaces, one convex and the other concave.



Rays bent by a double prism.

Paths of light rays through a convergent lens.

Figure 1.



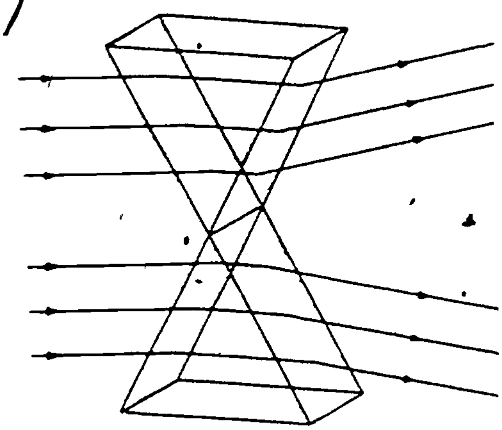
Double-Convex

Plano-Convex

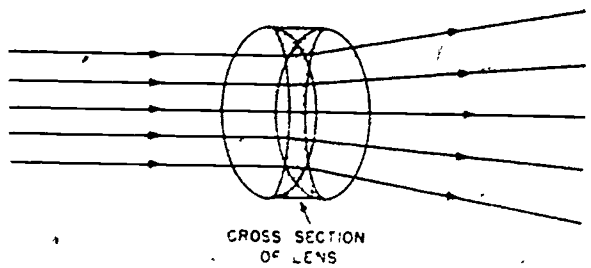
Convexo-Concave

Figure 2. Types of Simple Lenses.

b. A simple negative lens is two prisms placed apex to apex (Figure 3). The negative lens forms only near images (vertical images), because, as the light rays pass through them, they are spread. These lenses are called concave, divergent, or dispersive. Negative lenses are usually not used alone but they form a part of a compound lens to correct for errors or distortion in a compound lens. These lenses are thinner in the center than at the edges and take three forms (Figure 4); the double-concave, plano-concave and concavo-convex.

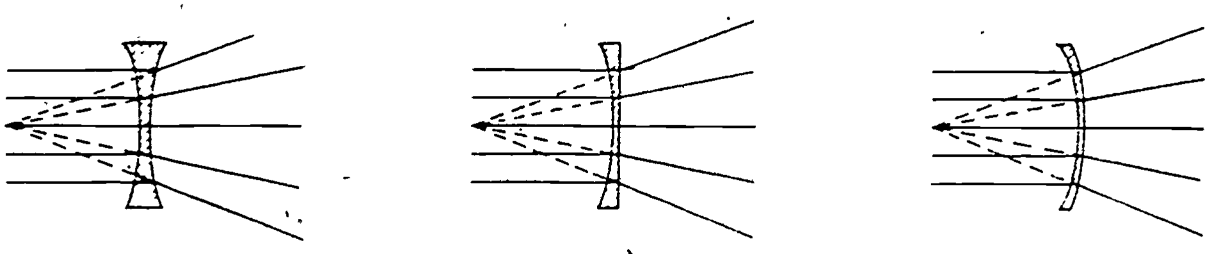


Deviation of rays by two prisms, apex to apex.



Deviation of rays by a divergent lens.

Figure 3.



Types of Single Lenses.

Figure 4.

4. ABERRATIONS AND OTHER DEFECTS OF LENSES.

a. The early lensed cameras, and some present day inexpensive cameras, have difficulty producing an image free of all defects. The cameras used in investigative photography must be of high quality and free of these defects. The camera lenses used by the Army are usually corrected lenses. However, a brief discussion of uncorrected lenses will provide some insight into the fact that these defects in optics do affect image-object relationships.

b. The perfect lens is one that will project an object in exact detail to form the photographic image. The simple lens cannot perform this task, because there are usually uncorrected defects in the optic. These optical defects are called lens aberrations.

c. An aberration is an optical imperfection responsible for image distortion. It can be avoided by combining several lenses and by eliminating marginal rays refracted through the outer edges of the lens. There are six general types of aberrations: spherical aberrations, chromatic aberrations, astigmatism, coma, curvature of field and distortion. The camera lens will normally be designed to compensate for these defects, however, the photographer must select with care the lens or camera he will use to insure it is a corrected lens or the camera is equipped with a corrected lens.

d. Other optical defects affecting a lens, which are usually corrected when the lens is designed, are Newton's rings, light loss, and flare. Although light loss and flare are usually corrected during manufacture, they can occur if the lens is misused.

(1) Lens Coatings. Most corrected lenses will be coated with a substance which will reduce one type of flare (optical flare) and which will also increase the optic's ability to transmit light, thus reducing light loss. However, this coating can be damaged. Damage to the lens coating can result from improper cleaning, excessive cleaning, and improper storage. The camera lens should be stored in a dry, moderate temperature and kept out of direct sunlight. Proper storage will help to reduce the amount of lens cleaning required. A good rule to follow is to clean the lens as little as possible.

(2) Another lens problem which can be detected and reduced is mechanical flare. Mechanical flare is caused by stray light reflections creating bright spots on the film. These spots are usually caused by shiny surfaces on the lens shade or lens mount, and can be detected by careful inspection. They occur through normal wear on the camera finish causing the shiny metal surface to be exposed. The surface can be easily repaired by a camera repairman. Do not attempt to repair it yourself.

(3) Lens Shades. Lens shades are rectangular, cylindrical or cone-shaped devices placed on the front of the lens to shield it from stray light. The length of a lens shade is based directly on the angle of view of the lens (See Figure 5). By using the proper lens shade, optical flare can be reduced, and other stray light eliminated.

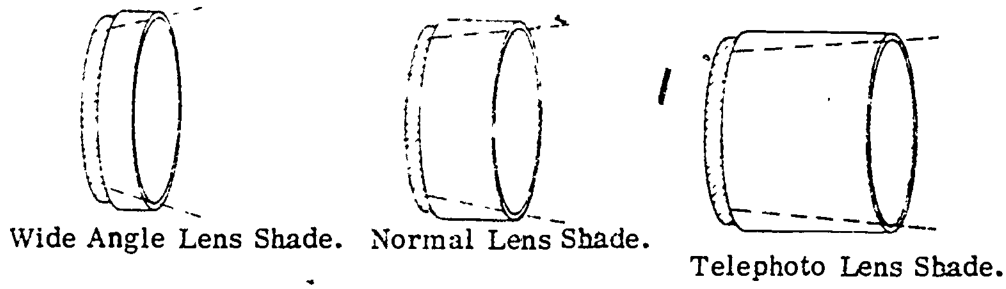
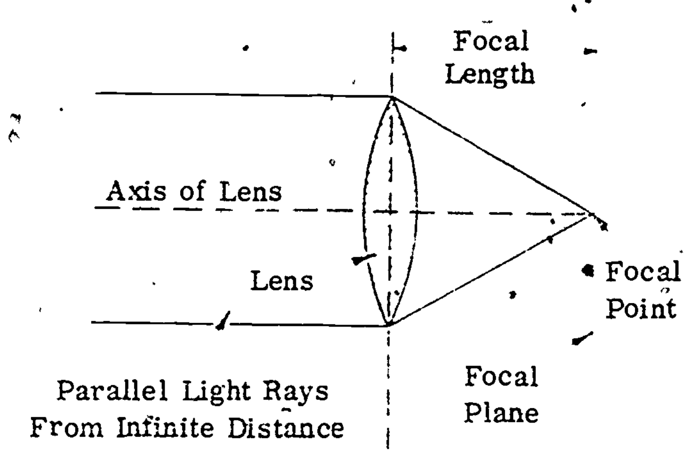


Figure 5.

5. THE LENS FOCAL LENGTH AND THE FOCAL PLANE. The focal length of the lens controls the image brightness, speed of the lens, and the image size at the focal plane.

a. The focal plane of a lens is the point, and plane, where the lens' projected image is clear and sharp. (See Figure 6.) This plane is sometimes called the film plane, as the film is located at this point to capture the image.



Focal length and Focal plane.

Figure 6.

b. The focal length (Figure 6) is the distance from the optical center of the lens to its focal plane, when the lens is focused at infinity. The focal length is a fixed value of the lens and it cannot be varied by the photographer.

c. The focal length determines the size of the image at the focal plane. The longer the focal length, the larger the image. A short focal length produces a smaller image with a greater depth of field (Figure 7). As the picture area is affected by these lens characteristics, the scene's perspective is also influenced. This, then, may affect the true representation of the actual subject or scene.

d. Speed of the Lens. Lens speed is the maximum amount of light that the lens will transmit to its focal plane. The amount of light reaching the focal plane is affected by the diameter of the lens, the number of optical elements in the lens, the number of reflecting surfaces, and the focal length of the lens.

(1) The speed of the lens is determined by the largest lens diameter (called the maximum effective aperture) and the focal length of the lens. It is based on the inverse square law (see para 7, Sec a, Lesson 1), and it is the ratio of the diameter of the lens to its focal length (Figure 8). To find the speed of the lens, divide the diameter of the lens into the focal length. In figure 7 the lens diameter is two inches and the focal length is eight inches which when divided is four. The lens speed is then said to be four and written f/4. The same would be true of a four inch focal length with a one inch lens diameter.

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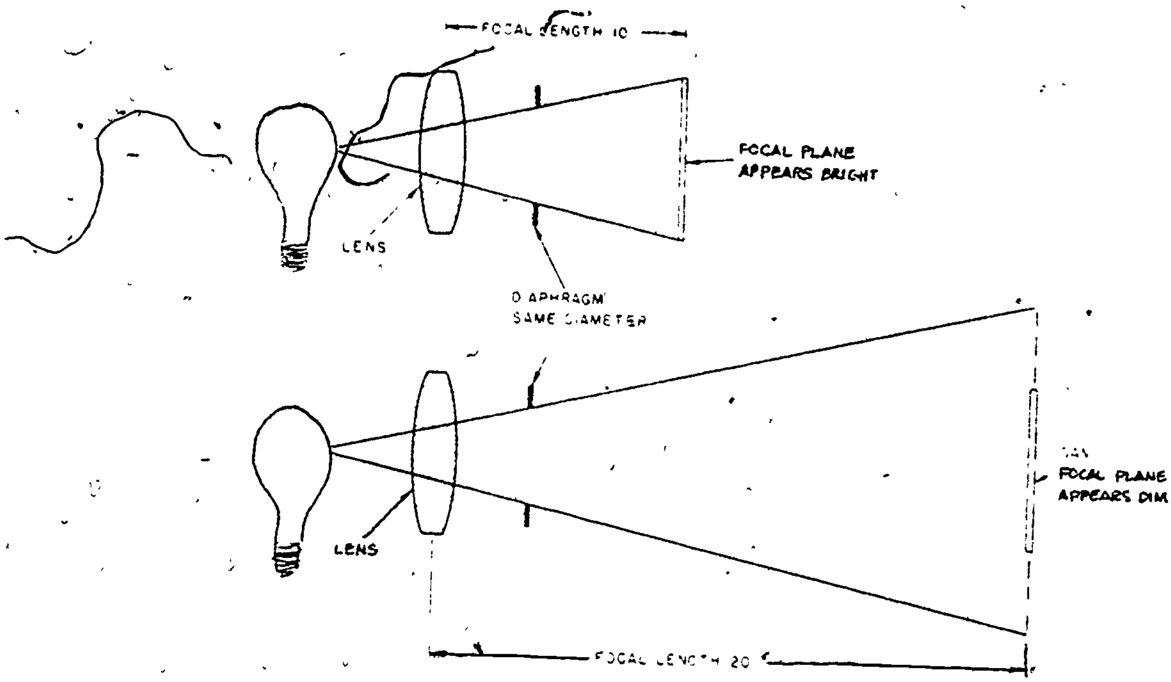
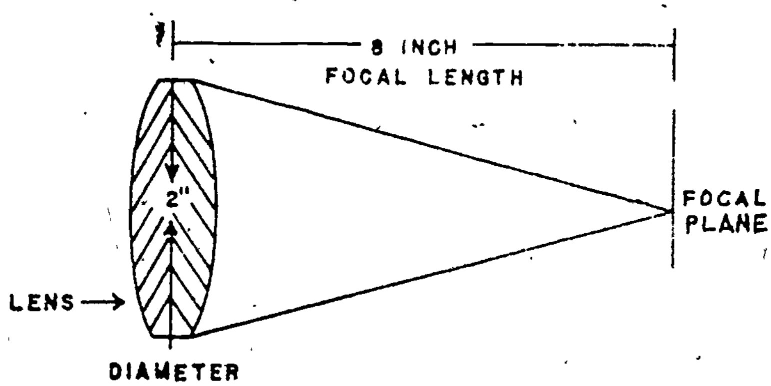


Relationship of focal length and light source.

Figure 7. Relationship of Focal length, light brightness and image size. This figure shows that, by moving the focal length back from the same diameter lens, the light is less bright, but that the image size is increased.



$$\frac{\text{FOCAL LENGTH}}{\text{LENS DIAMETER}} = \text{F/NUMBER} \qquad \frac{8}{2} = 4 \text{ OR F/}$$

Figure 8. Lens Speed.

(2) When one is dealing with lens speed it must be realized that the smaller the f/number, or the more equal the relationship of the focal length to the lens diameter is, the brighter the image will be at the focal plane. Therefore, a f/1 lens speed is brighter than a f/4. In photo terms **the f/1 lens** is faster.

(3) A practical application of the use of a fast lens is when the light level of a scene is low and only available light can be used, i.e., a night club scene. The lens speed, along with other light controls, helps to regulate our use of light in photography. In short, the faster the lens, the lesser the amount of light needed to reproduce an image.

6. APERTURE SETTING - A LIGHT CONTROL. The aperture is another one of the control devices used to regulate the amount of light reaching the focal plane.

a. The varying of the aperture setting is simply a matter of stopping, or allowing various amounts of light to reach the focal plane without a change in the focal length. This is done by using as much of the lens surface as possible, or using very little of the lens surface, to transmit light.

b. The mechanism used to regulate how much of the lens surface is used is called diaphragm. Because this diaphragm works under the same principle as the iris of the human eye it has been further termed an iris diaphragm (Figure 9).

c. To standardize how much light will reach the focal plane at the various diaphragm openings the f/value system was developed so that a common marking would produce the same photographic result in a wide variety of cameras (Figure 10). The standard full stop f/value system is shown in Figure 11. Lenses manufactured in the United States are calibrated in the Universal F/stop scale. Not all of the stops in the entire scale are found on any one lens; however, the ratio of light reaching the focal plane by each smaller f/stop is the same. Consider the amount of light transmitted by the largest stop (stop 1) as one unit. The next smaller stop will transmit one half that amount of light (of stop 1). The next smaller stop (stop 3) will transmit one-half of the amount of light as stop 2, or one quarter the amount of light as stop 1.

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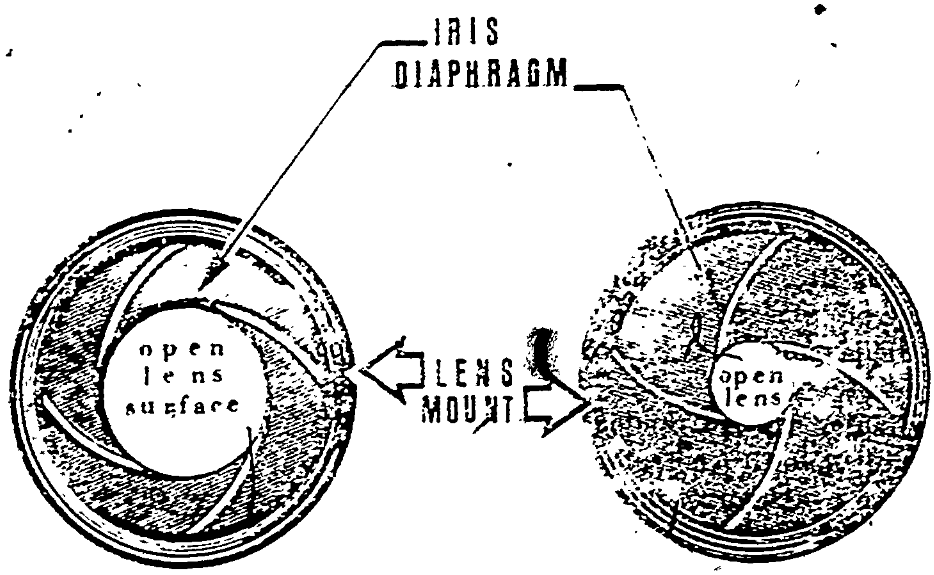
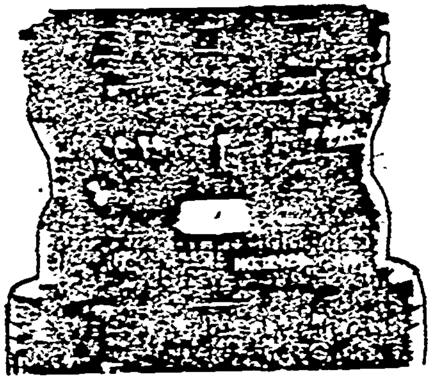
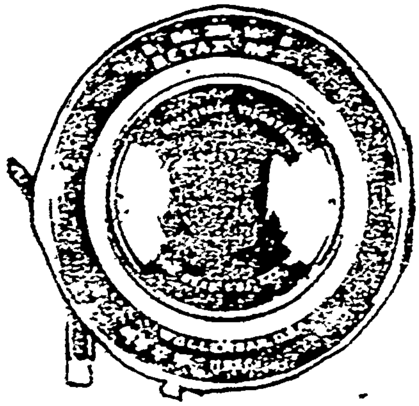


Lens aperture at f/4 *Lens aperture at f/16*

Figure 9. Diaphragm or electric surface. Figure illustrates two different lens' settings - f/4 and f/16 of the same size lens.



f/stop scale on a barrel mounted lens.



f/stop scale on a shutter housing.

Figure 10. Example of two different lenses both showing an f/stop scale.

f numbers, or diaphragm scale sequence	Units of light passed by the lens in a given time (as the lens is closed down)	Units of light passed by the lens in a given time (as the lens is opened wider)
1.4	1	2048
2	1/2	1024
2.8	1/4	512
4	1/8	256
5.6	1/16	128
8	1/32	64
11	1/64	32
16	1/128	16
22	1/256	8
32	1/512	4
45	1/1024	2
64	1/2048	1

Figure 11. Standard Full f/stop Scale.

7. LENS ANGLES.

a. Angle of field is the largest angle at which light entering a lens will produce, at its focal plane, an acceptable image.

(1) A normal or standard lens has approximately the same angle of field as the human eye; a wide-angle lens has a wider angle of field and the long focal length and telephoto lenses have a much narrower angle of field (Figure 12).

(2) The angle of field has a definite effect on the size of the negative that can be used with a particular lens, since the film may be larger than the area of light the lens will transmit.

b. Angle of View. The angle of view of a photographic lens determines actual coverage when used with a camera of a certain film size. The angle of view can be changed by varying the focal length of the lens, film size, and the subject distance.

(1) With a normal lens, the focal length is equal to the diagonal of the negative size used. When a normal focal length lens is used with a negative having a shorter diagonal than the focal length of the lens, the result is a narrow angle of view. If the same lens is used with a larger negative, the angle of view is greater. The larger the negative to be covered by a lens of a given focal length, the greater the angle of view.

(2) If the focal length is equal to the diagonal of the negative, the angle of view decreases as the subject distance is shortened.

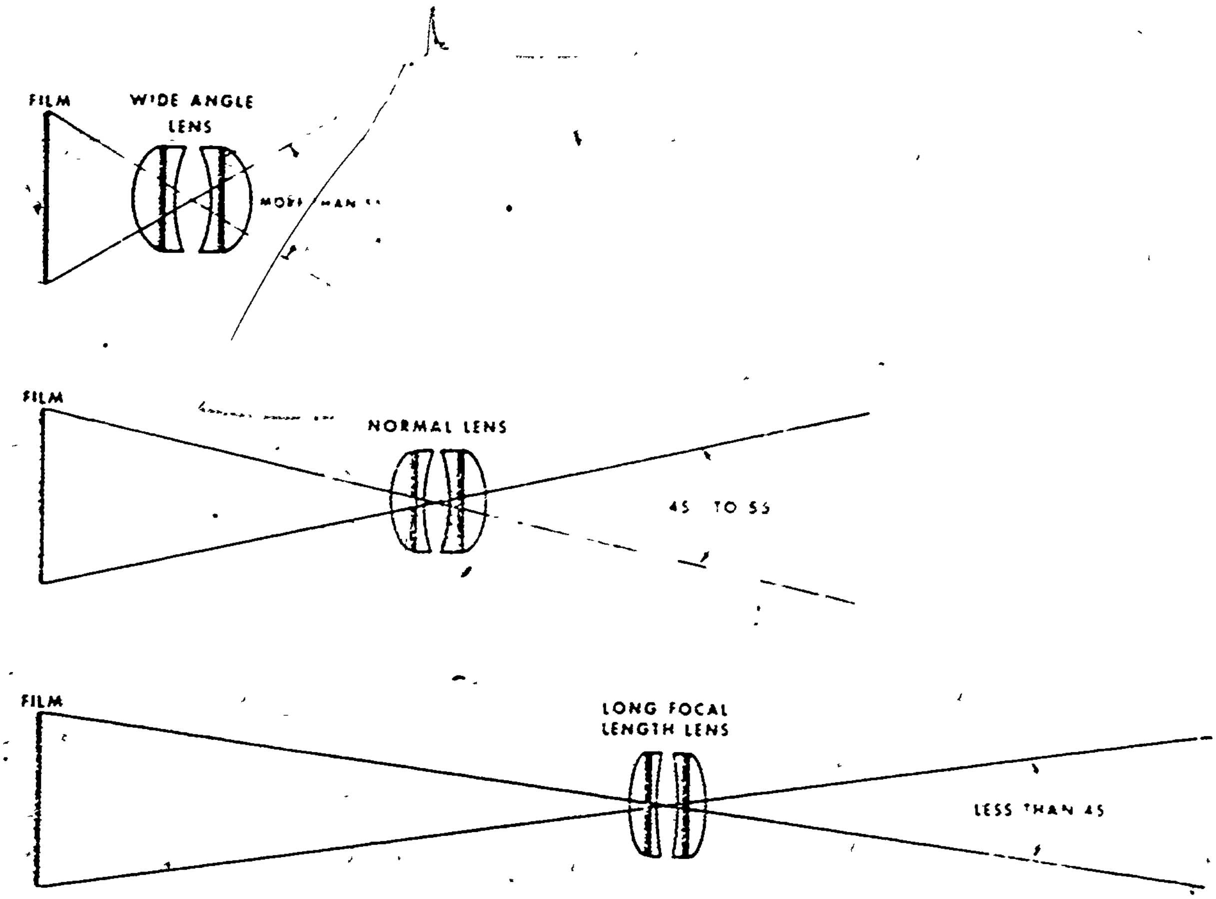
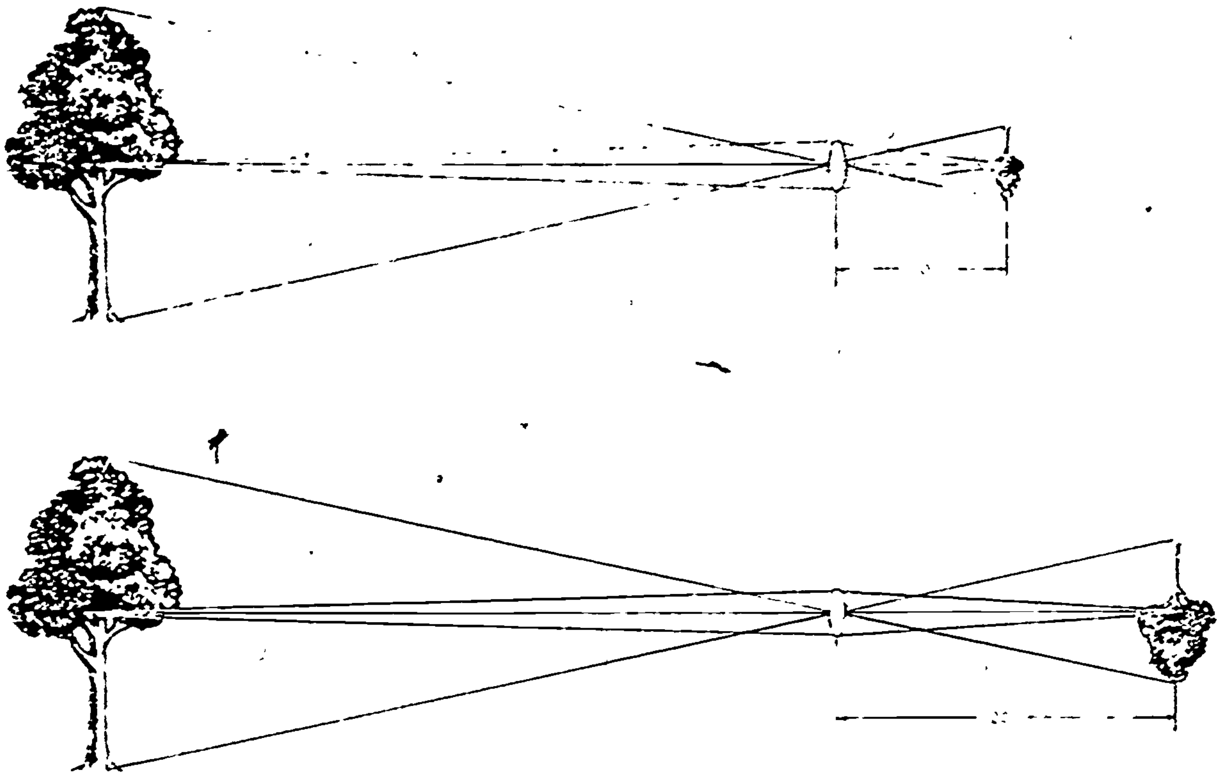


Figure 12. Angle of view for various focal length lenses.

(3) Since the manufacturers usually produce lenses for specific negative sizes, they also prepare tables giving angles of view of commonly used lenses. Some manufacturers also list angle of view for vertical and horizontal measurements of film. For example, one might read for a five-inch focal length lens; diagonal sixty-five degrees, horizontal fifty-three degrees, and vertical forty-four degrees.

8. IMAGE SIZE.

a. If the subject distance remains constant, the focal length of a lens controls the size of an image on the film. A short focal length lens has a wide angle of view and produces, without changing the negative size, a smaller image than a long focal-length lens. When two lenses of different focal lengths are used with the same film size, the lens with the longer focal length includes less of the subject area. However, any subject detail in that area appears larger than it would if photographed with a shorter focal length lens.



Size of image in relation to focal length.

Figure 13. Lens to subject distance is the same, only the focal length of the lens is different, thus affecting image size.

b. The focal length of the lens most frequently used with a particular camera should be approximately the same length as the diagonal measurement of the negative size. Use of the correct lens causes the proportions of objects to be recorded as normal. Figure 13 indicates the diagonal measurement of the more common negative sizes:

Negative sizes		Diagonals	
Millimeters	Inches	Millimeters	Inches
24x36	1x1½	43	1.8
60x60	2¼x2¼	85	3.4
60x90	2¼x3¼	108	4.3
100x125	4x5	160	6.4
130x180	5x7	220	8.7
200x250	8x10	288	12.8
264x336	11x14	426	17.75

Figure 14. Diagonals of Common Negative Sizes.

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9. CIRCLE OF CONFUSION. The photograph is an accumulation of many individual points that are the reflections of points originating from the subject.

a. Light rays produce a "cone" of light. The top or apex of this cone originates at a point on the subject with the base of the cone at the lens. Once through the lens the cone is reversed and with the base still at the lens the cone point is reproduced at the focal plane which represents the subject. An infinite number of these cones combine to produce the photographic image.

b. These cones do not form perfect points, but are actually minute circles of light and they are termed circles of confusion. The circle of confusion of a photograph is the diameter of the point formed by a particular lens.

c. When the circles of confusion are small enough, they are considered acceptable and are said to be in focus, and inversely, when they are too large then the subject is out of focus.

d. Several factors aid in controlling circles of confusion such as lens focus, aperture and the printing of the negative.

(1) Focus is the point where light rays converge to form an image. By the movement of the lens, the image is brought into focus. When the lens is not adjusted correctly so that the focal plane is at the point of cone convergence, the image will be blurred. This blur is caused by the overlapping of enlarged circles of confusion. This can be overcome by moving the distance between the lens and the focal plane to form the smallest possible circles of confusion.

(2) The aperture setting on the camera lens will affect the size of the circles of confusion. A small aperture opening reduces the amount of light reaching the film and that too narrows the light rays passing through the lens. The narrow rays create smaller circles of confusion.

(3) The type of finished print desired should be considered when dealing with circles of confusion. If the negative is to be contact printed, small circles of confusion are not as important as when the negative is to be used to make enlarged prints (see Lesson 6, Processing). When making an enlargement the circles of confusion in the negative are projected onto the print. They are therefore magnified. The larger the print required, the more magnification the circles of confusion receive. If a small circle of confusion is not obtained in the negative, this enlargement will blur the finished print.

e. A standard size of circles of confusion has been established as 1 1000 of the focal length of the lens for larger cameras (4 x 5 negative size) and 1/2000 of the focal length of the lens for miniature cameras (35mm negative size).

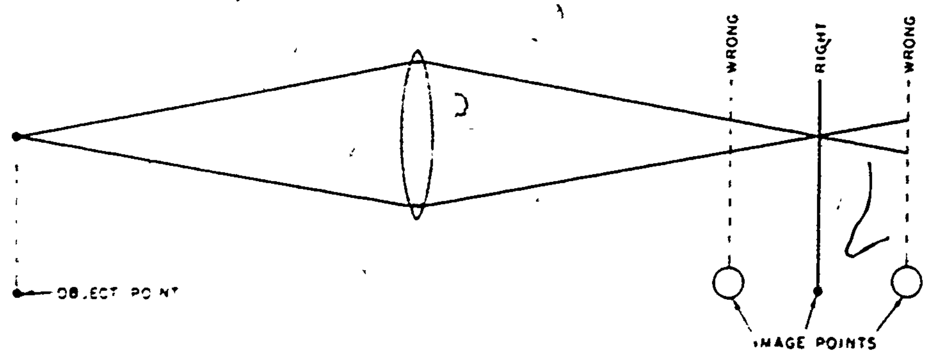

Figure 15. Image points nearer to and farther from focal point.

10. LENS FOCUSING CHARACTERISTICS. In order to obtain an acceptable finished product in a photograph, the image must be distinct. In discussing the circle of confusion, a standard was set for the size of object point reproduction at the focal plane. To reach this standard, lens traits of the lens should be considered which will obtain a distinct image.

a. Most general use cameras will have the lens and focal plane in a fixed position, except for a movement forward or rearward of the lens. The ability of the lens to critically focus on several objects is somewhat limited in this instance. When the lens is focused on a distant object it will form a sharp image relatively close to the lens; whereas, when this same lens is focused on a near object the lens will form a sharp image farther back from the lens. Therefore, the lens will not have both the near and far objects in sharp focus at the same plane. The lens must be moved farther away from the focal plane if the near object is to be in sharp focus, and closer to the focal plane to place the distant object in sharp focus.

(1) Figure 16 illustrates as a sharp image at points A, B, and C. Point B is at the film plane and therefore in sharp focus.

(2) This limitation in the lens may not be critical when other factors concerning the objective of the photograph are considered i.e., object distance, lighting, object depth, etc.

b. The lens does have the ability to focus on several objects at the same time, however this may be accomplished by a degree of loss of other desirable picture qualities e.g., image size, critical sharpness, etc. To obtain acceptable focus of several subjects, application of lens depth of field and hyperfocal distance must be accomplished.

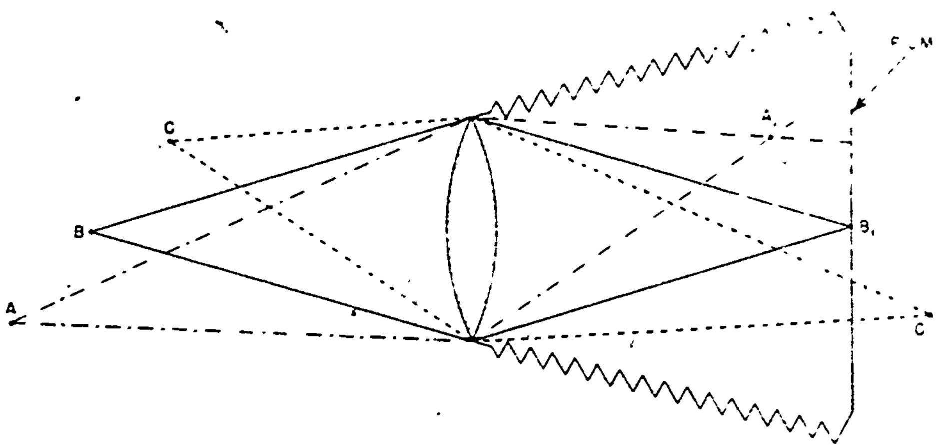

Figure 16. Focusing for one object.

(1) Depth of field is the distance between the nearest point of acceptable sharp focus and the farthest point of acceptable sharp focus (Figure 17). Because most subjects have depth to them it is important to have areas of acceptable focus rather than a single vertical plane in sharp focus. The amount of distances involved in depth of field depends on the focal length of the lens, the lens aperture setting and the distance the subject is from the lens.

(a) The depth of field will be increased as the focal length of the lens becomes shorter. Therefore, if there were no other controls for depth of field than focal length, one could obtain a greater depth of field with a shorter focal length lens.

(b) Depth of field also increases as the lens aperture is closed down to a smaller aperture opening. In paragraph 9d(2), it was discussed that the circle of confusion becomes smaller as the aperture is closed down. Related to this fact is the increase in depth of field. Any time a photographer desires to have several objects in focus at various subject planes, the center of lens should be used. This is because lesser refraction will be needed. However, when this is done, remember, less light reaches the film and therefore a compensation may need to be made by adding more light to the subject or focal plane in order to get a correct exposure.

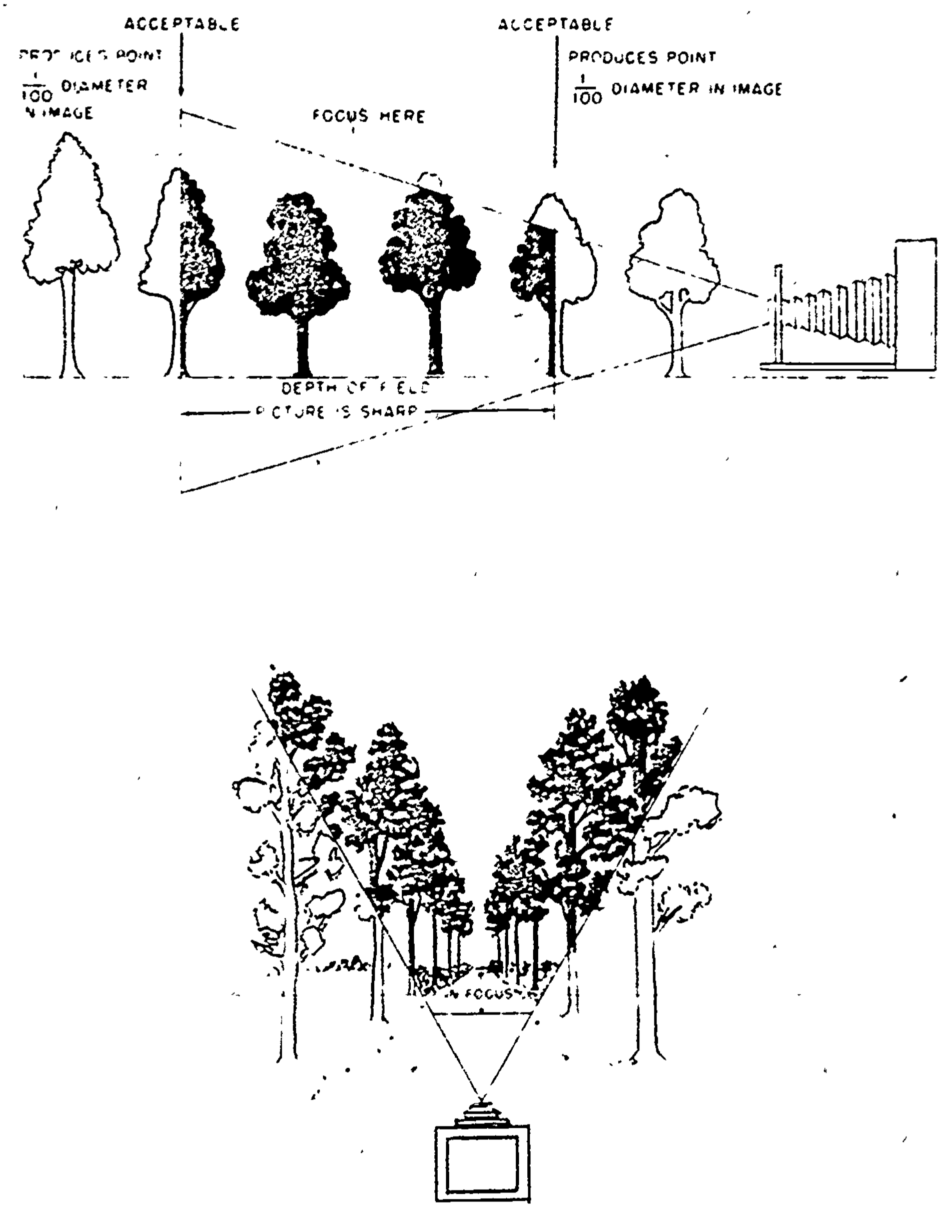

Figure 17. Depth of Field.

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(c) In photographing an object which is near the lens, the depth of field is shortened. In reverse, as the distance between the object and lens is increased, so too is the depth of field increased. And, once again this may well be at the expense of other photographic qualities. Figure 18 demonstrates this process of object-lens distance.

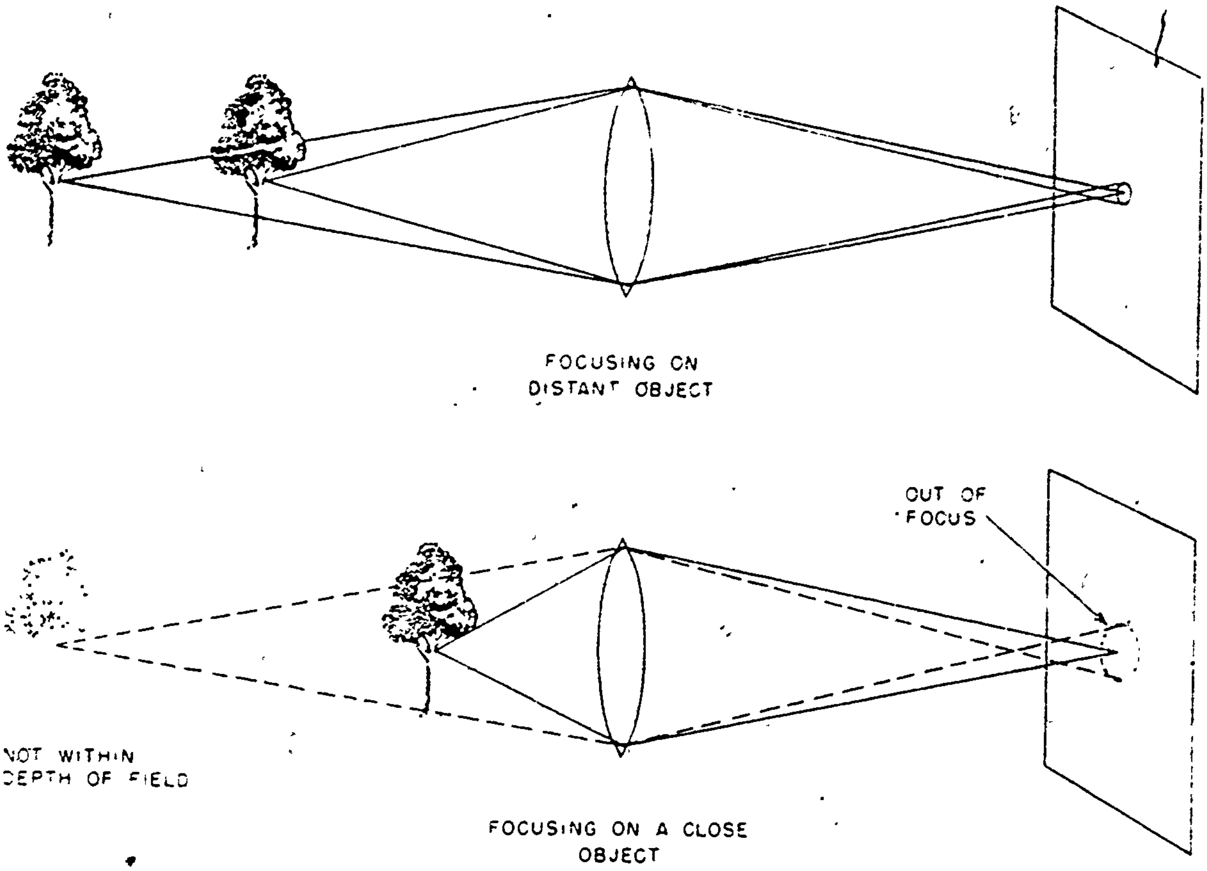

Figure 18. Effect of Subject Distance on Depth of Field.

(d) From the discussion concerning depth of field it should be apparent that whenever the photographer is using his lens at a large aperture opening and/or the closer his subject is to the lens, the more critical becomes the problem of acceptable focus. Accurate lens focus is essential when a sharp image is required in these two situations and it becomes even more important when the negative is to be enlarged and/or when the negative size is small.

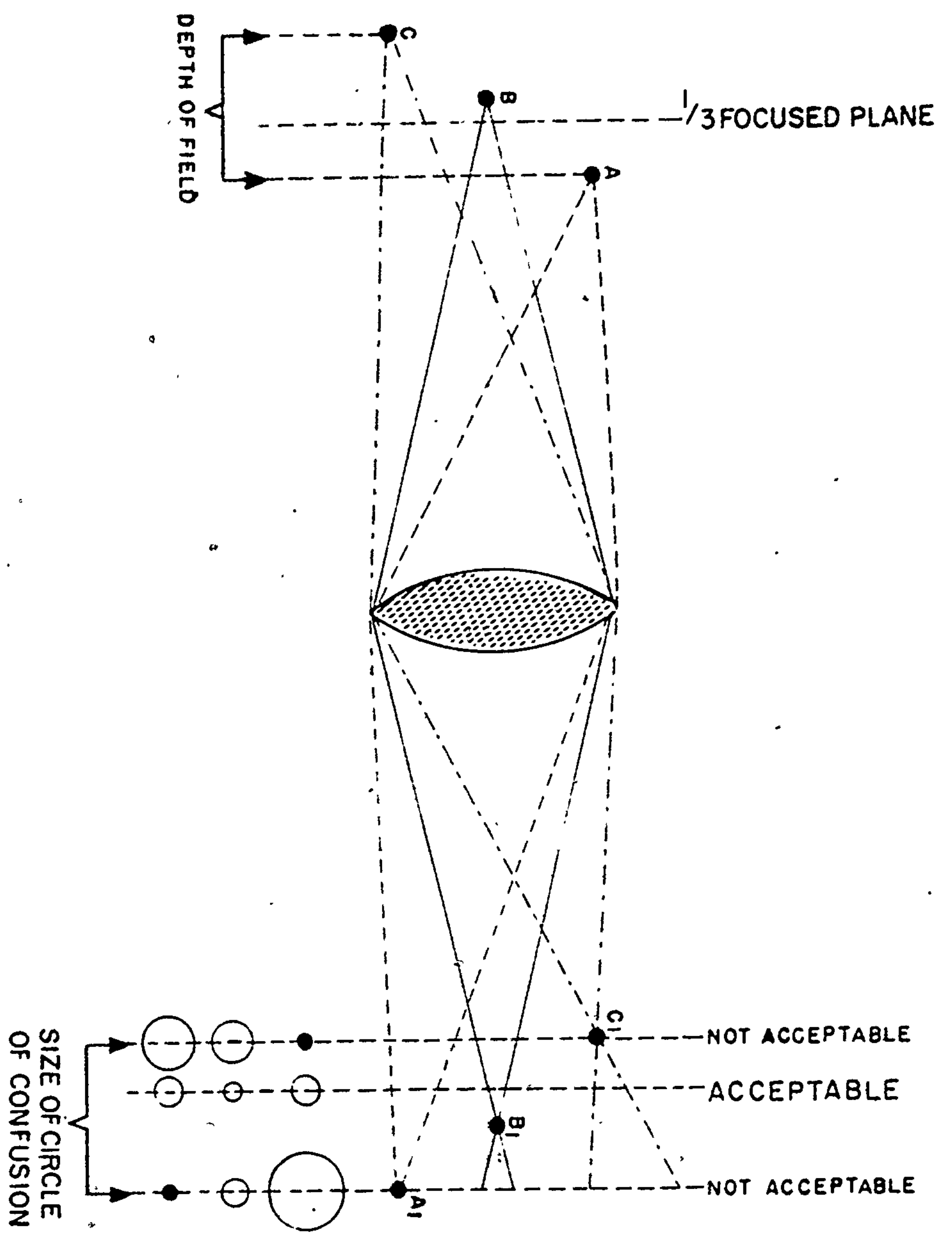

Figure 19.

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(e) Generally, when photographing a subject which requires a maximum depth of field, it is best to focus on a point one-third of the distance into the depth of field, in other words one-third the distance between the nearest point wanted in sharp focus and the farthest point wanted in sharp focus. Figure 19 illustrates how the circles of confusion are affected when focused at one-third the distance into the depth of field range. The "Best" line is the plane on which the circle of confusion is minimized for each of the three subjects A, B, and C.

(2) Hyperfocal distance is the nearest point in usable focus, when a lens is focused on an object at infinity.

(a) When a lens is focused at its hyperfocal point, the depth of field extends from one-half of the lens hyperfocal distance to infinity. This setting provides maximum depth of field for any f/number of that lens.

(b) The hyperfocal distance is dependent upon focal length of the lens, the lens stop, and the allowable circle of confusion. This dependence is similar to that of depth of field only reversed. For example, the longer focal length the greater the hyperfocal distance, the smaller the lens aperture, the shorter the hyperfocal distance, etc. Figure 20 is an example of the relationship between hyperfocal distance and depth of field.

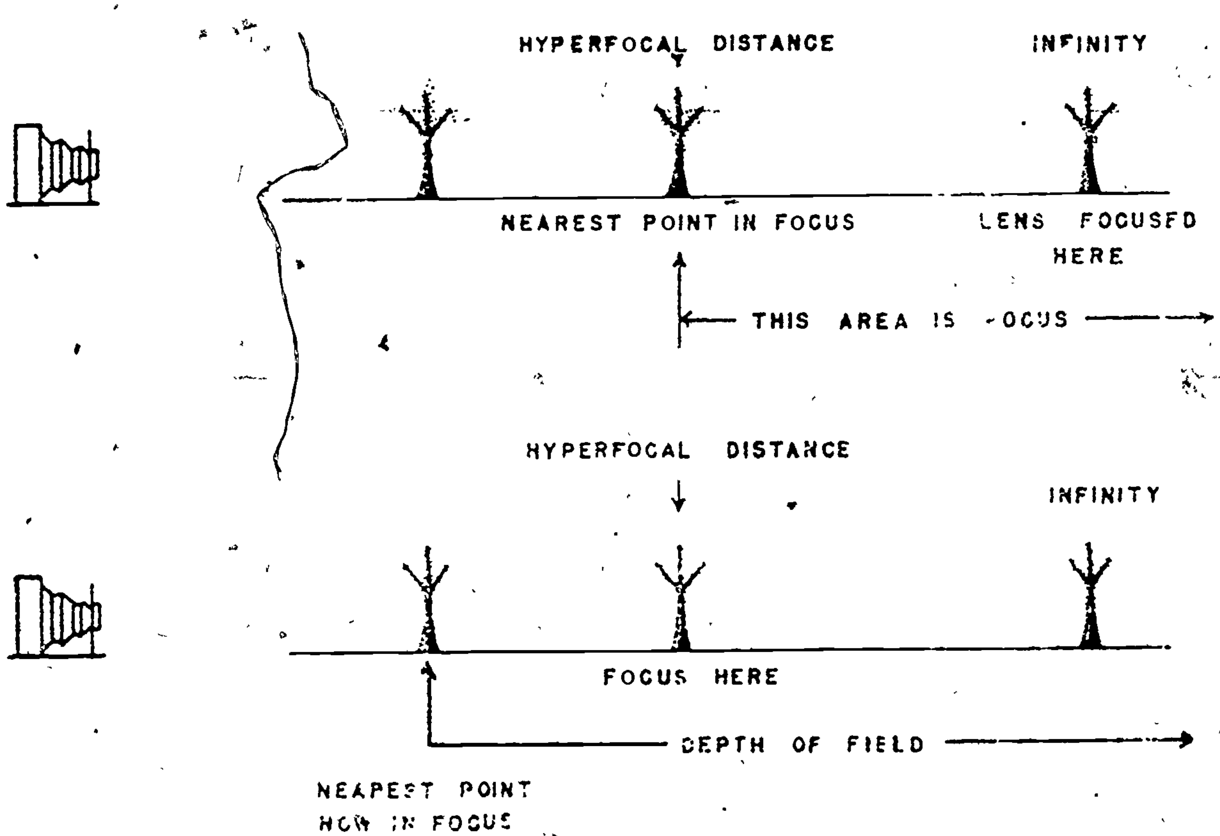

Figure 20. Hyperfocal Distance.

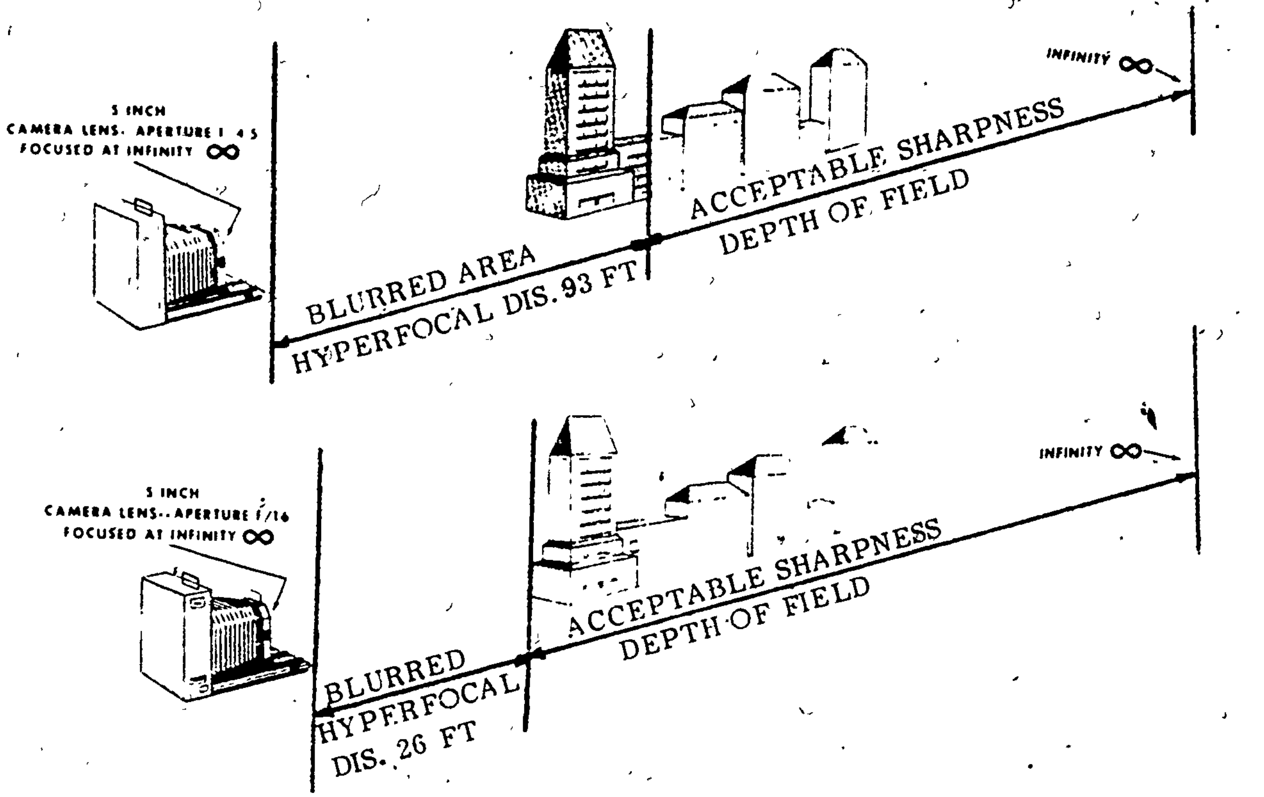

Figure 21. Lens aperture and its relationship to hyperfocal distance and depth of field.

(3) Determining Depth of Field and Hyperfocal Distance. There are two different methods usually available to the photographer for locating depth of field or hyperfocal distances: Either by depth of field indicators or mathematically.

(a) Some cameras have depth of field indicators (scale) which show the approximate depth of field at various distances when using different lens f/stops. A depth of field scale is therefore especially useful when the range of acceptable sharpness needs to be known. Figure 22 illustrates such a scale.

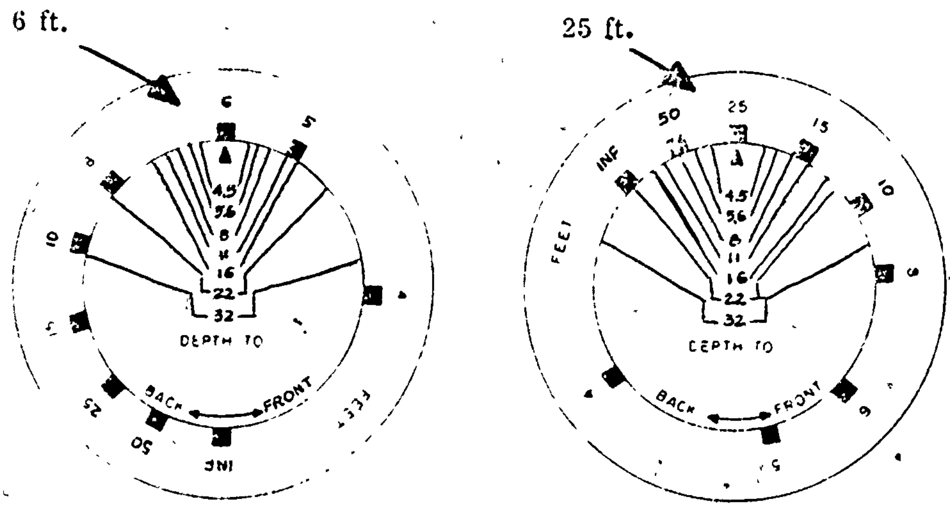

Figure 22. A type of depth of field indicator.

Using this scale focused at six feet with an aperture of f/4.5, the depth of field would be five and three quarters feet to six and one quarter feet. If it were required to have everything from five feet to ten feet in focus at the six foot setting, the aperture would be set at f/22. As the subject of focus is moved away from the lens to twenty-five feet, the depth of field at f/22 has increased and includes subjects from twelve feet to infinity. To find the hyperfocal distance for this lens using the same scale, one would adjust the focusing mechanism so that the aperture intended for use would be opposite the scale's infinity mark and the lens would then be focused at its hyperfocal distance.

(b) The depth of field indication is the most commonly used method of determining depth of field and hyperfocal distance. However, in rare situations there may be a need to calculate both the depth of field and hyperfocal distance. The following formulas would then be used:

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$$\text{Hyperfocal Distance} = \frac{F2}{fC}$$

Where the hyperfocal distance is in inches

F = focal length of lens in inches
C = circle of confusion in fraction of an inch
f = lens aperture setting

Depth of Field

near point

$$\frac{\text{hyperfocal distance x distance focused on}}{\text{hyperfocal distance + distance focused on}} = \frac{HD}{H+D}$$

far point

$$\frac{\text{hyperfocal distance x distance focused on}}{\text{hyperfocal distance - distance focused on}} = \frac{HD}{H-D}.$$

depth of field = far point - near point

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EXERCISES

REQUIREMENT. The following exercises are multiple choice. There are four alternatives to each exercise. You are to select the one alternative that is correct and indicate your choice by circling the correct response directly on the exercise booklet.

1. Positive lenses form distinguishable images by refracting light rays so that they

a. divide.

b. spread.

c. crest.

d. converge.

2. Errors or distortion in a compound lens are called

a. scratches.

b. aberrations.

c. fogging.

d. bands.

3. Which of the following is NOT a general type of lens aberration?

a. Coma.

b. Curvature of field.

c. Astigmatism.

d. Conical aberration.

4. Lens coatings

   a. reduce light loss.

   b. increase flare.

   c. keep out moisture.

   d. increase reflection.

5. The focal length of the lens will NOT control which one of the following:

   a. Image brightness.

   b. Image focus.

   c. Speed of the lens.

   d. Image size.

6. The spot at which a lens projected image is clear and sharp is called the

   a. focal center.

   b. focal axis.

   c. focal point.

   d. focal length.

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7. The longer a lens' focal length is, the

   a. clearer the image.

   b. larger the image.

   c. smaller the image.

   d. dimmer the image.

8. The speed of a lens is the ratio of the diameter of the lens to its

   a. focal length.

   b. focal plane.

   c. aperture.

   d. image size.

9. Each lens has a known "lens speed" which refers to

   a. maximum aperture of the lens.

   b. minimum aperture of the lens.

   c. comparative focal length of the lens.

   d. relative effective aperture of the lens.

10. A practical application of the use of a fast lens would be at a

a. racetrack.

b. football game.

c. nightclub.

d. dragstrip.

11. The amount of light passing through a lens is controlled by the aperture, or diaphragm. As succeedingly smaller apertures are used, the amount of light passing through the lens is

a. doubled.

b. reduced one-fourth.

c. increased one-fourth.

d. reduced one-half.

12. A blurred focus is caused by enlarged circles of confusion which

a. refract the light.

b. overlap one another.

c. change the focal length.

d. cause astigmatism.

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13. When focusing on an object closer than infinity, a certain area, which extends from a point in front of the object to a point beyond the object, will be in sharp focus. This area is described as

a. hyperfocal distance.

b. focusing zone.

c. reciprocity effect.

d. depth of field.

14. Depth of field will be increased as the focal length of the lens becomes

a. longer.

b. wider.

c. faster.

d. shorter.

15. Hyperfocal distance is the nearest point in usable focus, when a lens is focused on

a. the circle of confusion.

b. an object at infinity.

c. the axis of the focal plane.

d. a nearby object.

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LESSON ASSIGNMENT SHEET

SUBCOURSE NO. 4-12 I	Investigative Photography.
LESSON 3	Cameras.
CREDIT HOURS	1.
TEXT ASSIGNMENT	Attached Memorandum.
MATERIALS REQUIRED	None.
LESSON OBJECTIVE	To provide you with general knowledge of the various types of cameras and their mechanics.
SUGGESTIONS	None.

ATTACHED MEMORANDUM

This attached memorandum includes information extracted from resident instructional material of the United States Army Military Police School, and TM 11-401-1. In case of conflict between the attached memorandum and other publications, the material contained in the attached memorandum will apply to this lesson assignment.

1. INTRODUCTION. In making reference to "the camera" several photographic features are included. Two of these features have been discussed; the lens and the iris diaphragm. The camera body itself provides two general functions - one, of providing a light tight box, and, second, of providing a structure on which various other features are positioned. In this lesson the types of cameras, shutters, and focusing mechanisms will be discussed.

2. TERMS. The definitions given in this section are not necessarily the most important terms in the lesson. Additional terms and definitions will be found throughout the lesson, and those given below may be listed only in the interest of clarification.

a. Bellows. The part of some cameras which is capable of being expanded.

b. Curtain Aperture. The slit in a focal plane shutter permitting light to reach the film.

c. Macrophotography. The photography of objects which are too small for the conventional camera and too large for the field of a microscope. Very short focal-length lenses and long bellows extension are generally used in this type of photography.

3. CAMERAS IN GENERAL. There are a great variety of cameras in existence. Generally, this is because of the various uses to which cameras can be put, and the variety and quality of individual camera features.

a. Box Cameras. A simple and inexpensive camera is the box camera. The box camera (Figure 1) consists of a housing with a lens at one end and a film-winding mechanism at the other end (focal plane). The lens position and aperture setting are arranged so that all objects from about eight feet to infinity are in reasonable focus. It has a fixed aperture of f/11 or f/16, a simple view finder (para 5), and a spring shutter mechanism (para 7) that provides usually one shutter speed of either 1/25 or 1/50 of a second. It is an excellent tool for beginners. Some police departments issue patrolmen this type of camera for general use on items they may feel are significant during the course of their daily activities.

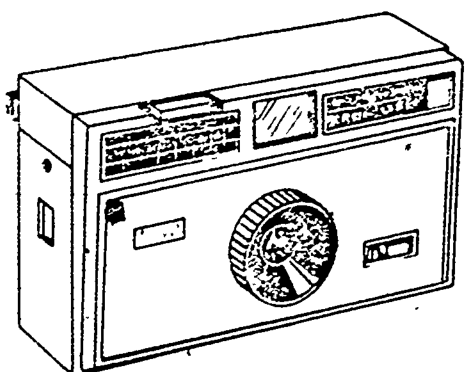

Figure 1. Box Camera

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b. Folding Cameras (Figure 2) have a bellows and are so constructed that the lens snaps into a fixed position when the camera is opened. Focusing, shutter speed, and aperture are adjustable.

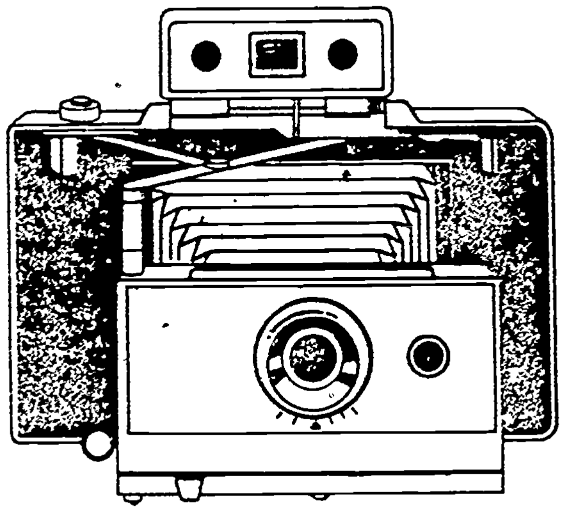

Figure 2. Folding Camera.

c. Press and Hand Cameras are used in commercial and news photography. They are sturdy and practical and they are useful in a wide range of photographic work. As a rule, the bellows of these cameras can extend from two to three times their normal length. With this feature the photographer can increase the distance between the lens and the film to record very small objects. This type of camera is ideally suited for reproduction and small object photography. Other desirable features include a between-the-lens-shutter, a focal plane shutter, or both (para 7). Their high quality lenses provide aperture settings from f2.8 to f4.5. They can utilize a variety of film sizes from 2-1/4 by 3-1/4 inches to 4 by 5 inches. The lens can be moved up, down, and sideways. The press-type camera shown in Figure 3 is equipped with a coupled range finder (para 5) and synchronized flash attachments and it has handled the bulk of US Army still photography since World War I. This type of camera is issued to most CID units.

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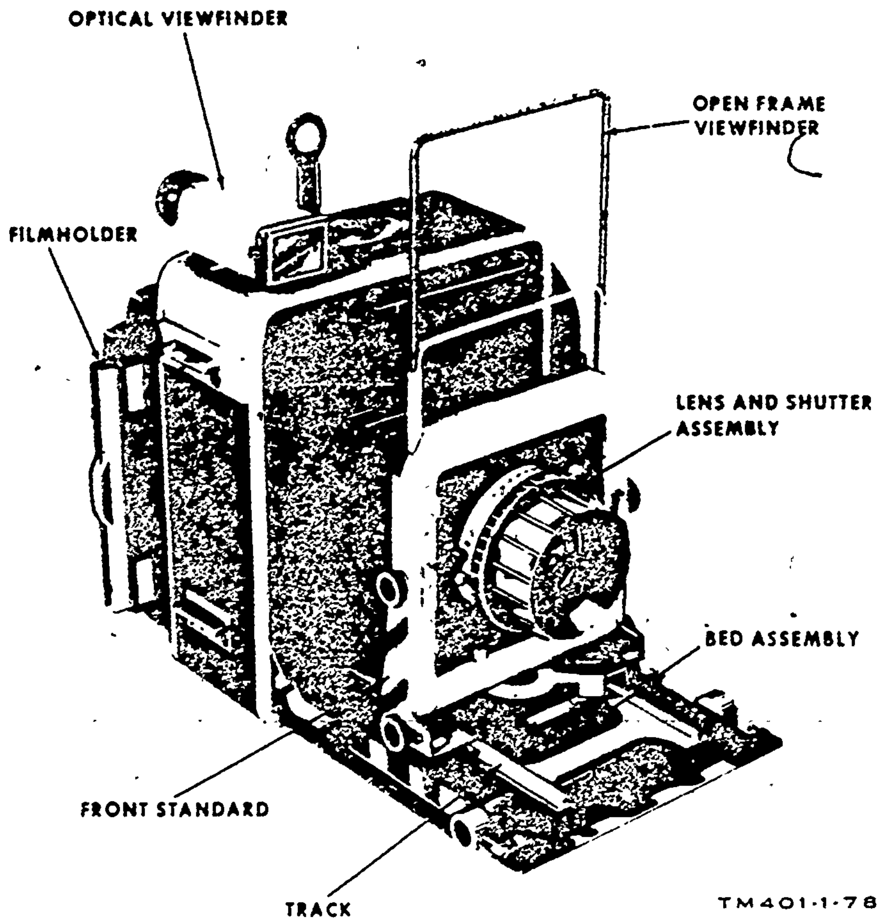

Figure 3. Press type camera.

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d. The view camera and studio cameras (Figure 4) are essentially larger versions of press and hand cameras. They have removable lenses, can be focused by moving either the front or rear of the camera, and are equipped with long bellows. The back of these cameras can be moved or swung both horizontally or vertically. Studio cameras are used primarily for portraiture, copy work, small object photography, and other indoor photography. The view camera is used for architectural, group, and general outdoor photography. Both cameras are used by the Army.

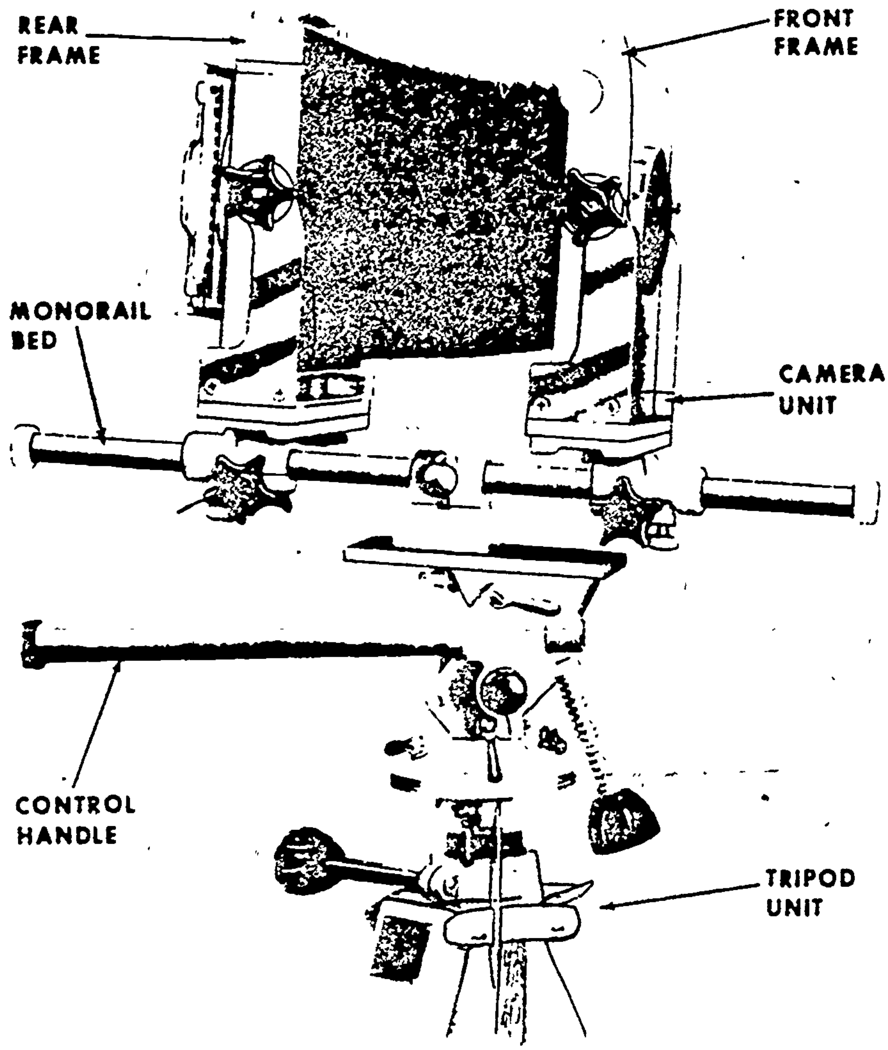

Figure 4. View Camera.

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e. Miniature cameras are precision instruments designed for small size films. The best known is the 35mm Rangefinder camera. The quality miniature camera has an optical and mechanical standard which exceeds that of larger cameras. Minute inaccuracies, not noticeable with larger negatives, could make the miniature negative worthless. Many of these cameras are designed to accept a variety of lenses. Most also have a focal plane shutter with shutter speeds up to 1/1,000 of a second. The camera is so designed as to provide a lightweight instrument for difficult photo coverage.

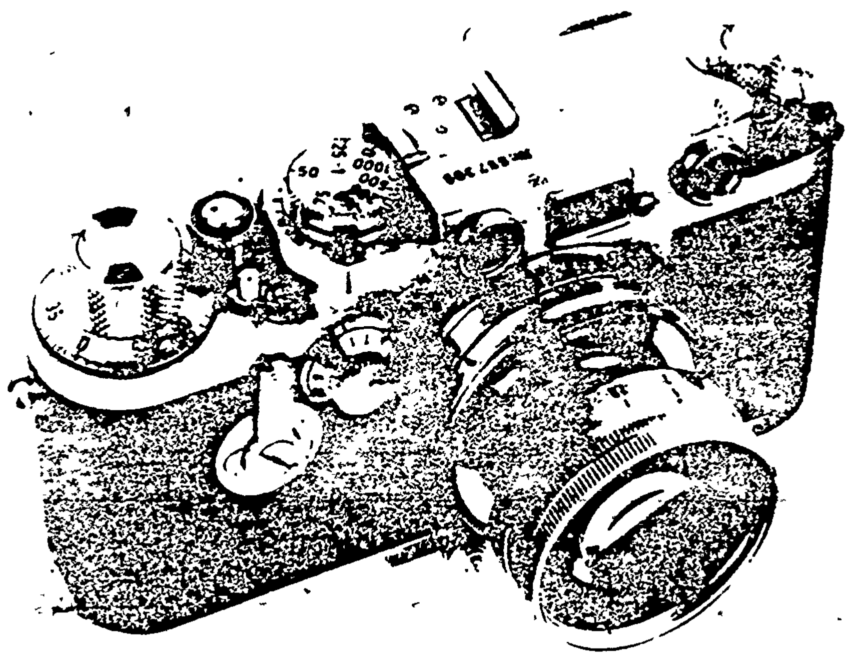

Figure 5. 35mm Camera.

f. The reflex camera is characterized by its particular type of focus. The subject image is transmitted through a lens onto a mirror which reflects the image up to a focusing and composing surface called a ground glass (para 5). There are two types of reflex cameras; the single lens reflex and the twin lens reflex.

(1) The 35mm single lens reflex employs a movable mirror which is located in the path of the light rays transmitted by the picture taking or recording lens. A fraction of a second before the shutter is released, the mirror is flipped out of the light path. After exposure, the mirror returns to the viewing and

focusing position. This type of camera is helpful to the photographer because whatever appears in the viewfinder will appear on the negative. This is important when different focal length lenses are used and it also aids in focusing and preventing parallax (para 6). These single lens features are available in many 35mm cameras.

(2) The twin lens reflex employs two separate lenses (Figure 6). One lens is used for focusing and composing and the second, usually mounted under the first, transmits the light to the focal plane for recording. Normally this camera will not utilize interchangeable lenses. The camera in Figure 6 produces a 2-1/4 by 2-1/4 inch negative, has permanently fixed lenses, and an automatic parallax adjustment.

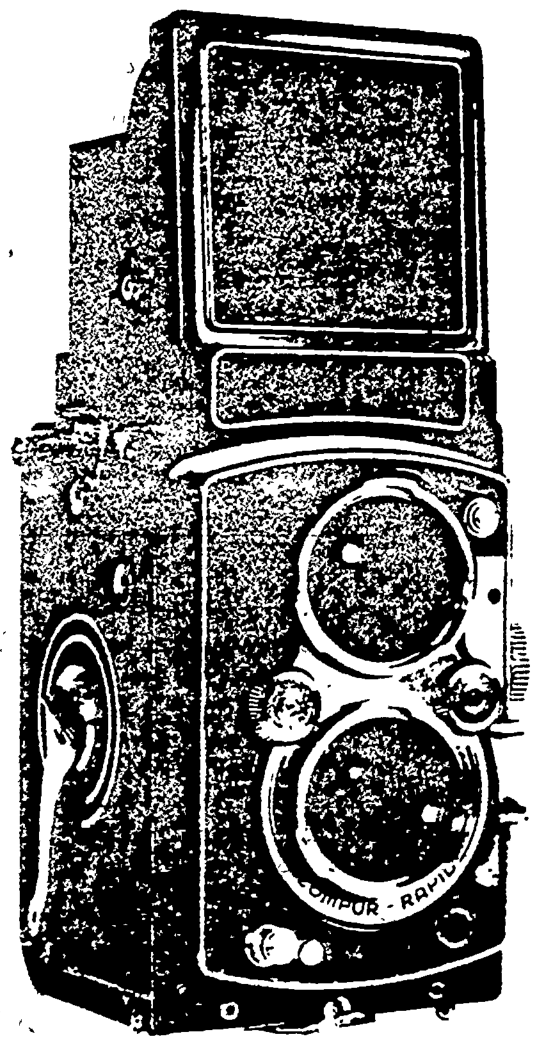

Figure 6. Example of a Twin Lens Reflex Camera.

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g. Although there are a great number of other cameras, most of them follow the design features discussed above. All of these cameras have a useful place in the various phases of police work. The value of any particuiar camera depends mainly on the intended reasons for taking the picture and the skill of the operator.

4. CAMERA LENS FOCUS. For cameras, other than fixed focus cameras, the camera lens is usually focused by moving the lens nearer to or farther away from the film plane (focal plane). A few cameras (i.e., view camera) can adjust either the lens or the film plane for focusing. So that the lens may be focused, it is mounted on a stand that is separated from the camera body by a collapsible bellows, or the lens mount is threaded to allow it to move. With either method the movement permitted is a precision movement. Lens focusing is facilitated by such camera features as distance scales, depth of field indicators and tables, rangefinders, and ground glass focusing.

a. A simple distance scale is normally provided with most focusable cameras. The scale is located either on the camera body or on the lens mount.

(1) The Vernier scale (Figure 7) illustrates a typical camera body distance scale. One part of the scale is attached to the camera body, and the other position is on a sliding track. To focus for a given distance, the focusing knob is turned until the subject distance lines-up with the body scale. The closest distance in focus in the figure is eight feet.

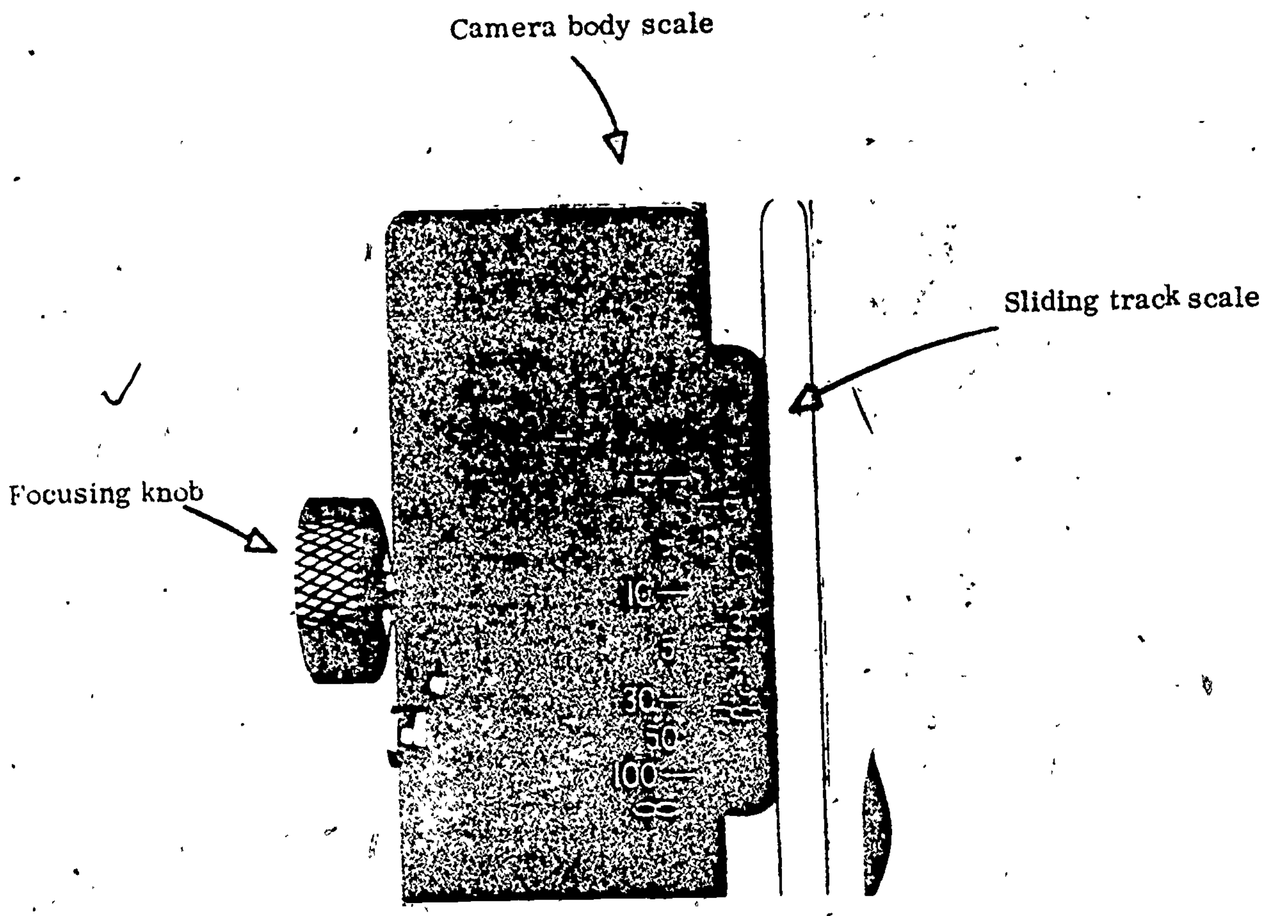

Figure 7. Vernier distance scale.

A slightly different scale is the semivernier focusing scale (Figure 8). It is operated in the same manner as the vernier scale with the exception of the arrow lining up with the desired focused distance.

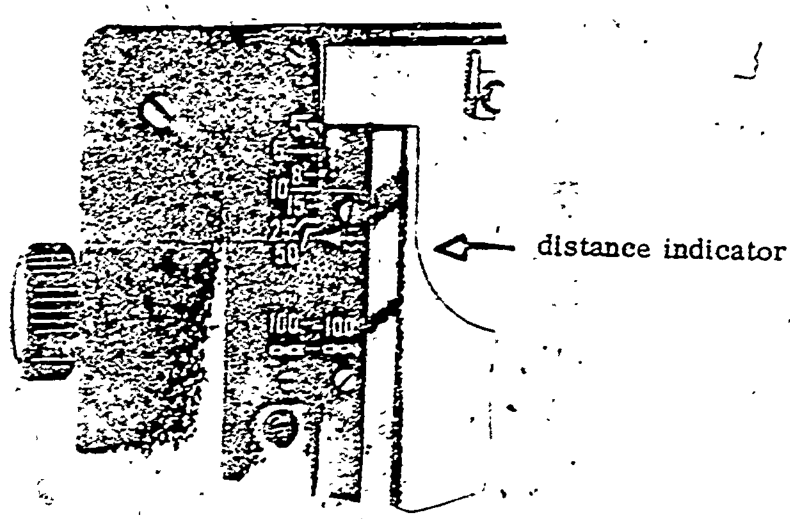

Figure 8. Semivernier distance scale.

(2) When the distance scale is engraved directly on the lens mount, as is the case of most 35mm cameras, the scale consists of a distance scale and adjoining depth of field scale. Figure 9 shows the two related scales of a four inch lens on a 70mm camera. The scales permit the photographer to determine the depth of field of the lens for any given aperture at any given focusing distance. By referring to this scale and the lens aperture, one can establish the depth of field on the adjacent distance scale. For example, when matching aperture setting f/16 with the distance scales infinity mark (see Figure 9), then moving down the distance scale to the distance indicator across from f/16 setting, the depth of field is found to be from about sixteen feet to infinity. All objects within this range will be in focus.

(3) When a lens is focused on an object at infinity, the nearest object in sharp focus is said to be at the hyperfocal distance (Lesson 2). By focusing the lens at the hyperfocal distance, everything from 1/2 the hyperfocal distance to infinity will be in sharp focus.

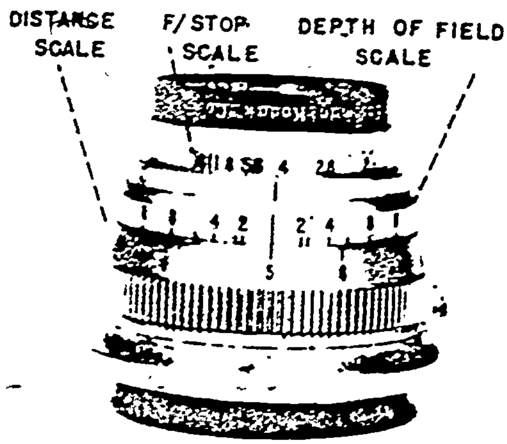

Figure 9. Distance Scale, 35mm Camera.

b. Depth of field and depth of field scales have been discussed in Lesson 2. However, not all cameras have these scales. Depth of field is an important concept which is easily applied. It is therefore helpful to the photographer to work out a depth of field table to indicate the maximum depth of field for a given distance setting. This table can then be attached to the back of the camera for immediate reference.

c. The modern rangefinder serves the primary purpose of determining the distance from the lens to the subject. A coupled rangefinder will also focus the lens at the same time. A rangefinder aids the photographer in obtaining a more precise focus. Basically, a rangefinder measures the angle of convergence between two beams of light from the same point. These two beams are then transmitted by the distance separation lenses in the rangefinder. A movable mirror, or prism, changes the direction of one beam of light and brings it into alignment with the other light beam. The movable mirror in the rangefinder is mechanically coupled to the lens so that the lens is focused when the two beams are brought together within the eyepiece. In some cameras, with interchangeable lenses, the same rangefinder may be automatically coupled to any lens and need not be adjusted. Operating the rangefinder is fairly simple.

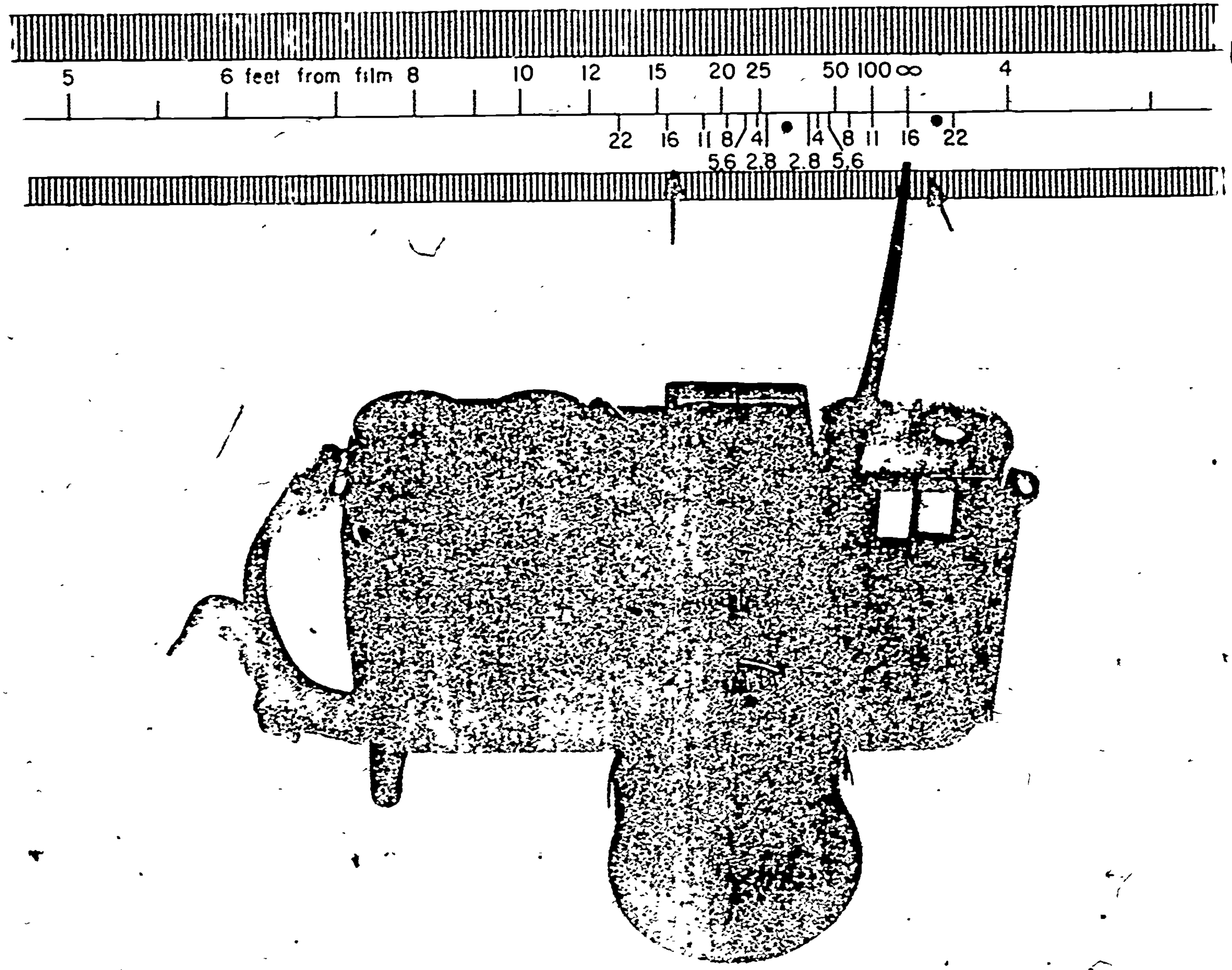

Figure 10. Distance and depth of field scale on 70mm camera lens.

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(1) Look through the eyepiece, and move the camera until the desired subject is centered.

(2) A smaller and brighter section is located at the approximate center of the eyepiece. The smaller area contains the image reflected by the movable mirror as well as the image that is passed directly through the upper stationary mirror.

(3) By turning the focusing mechanism, the reflected image is shifted until the two images appear to be one. The subject is then in focus. A double image indicates out-of-focus and a single image indicates correct focus.

(4) Figure 11 demonstrates a rangefinder with the two images which would be superimposed on one another. Another type is the split image rangefinder. Figure 11 shows an image as seen in the eyepiece. Again, when the image is one, the coupled lens is in focus.

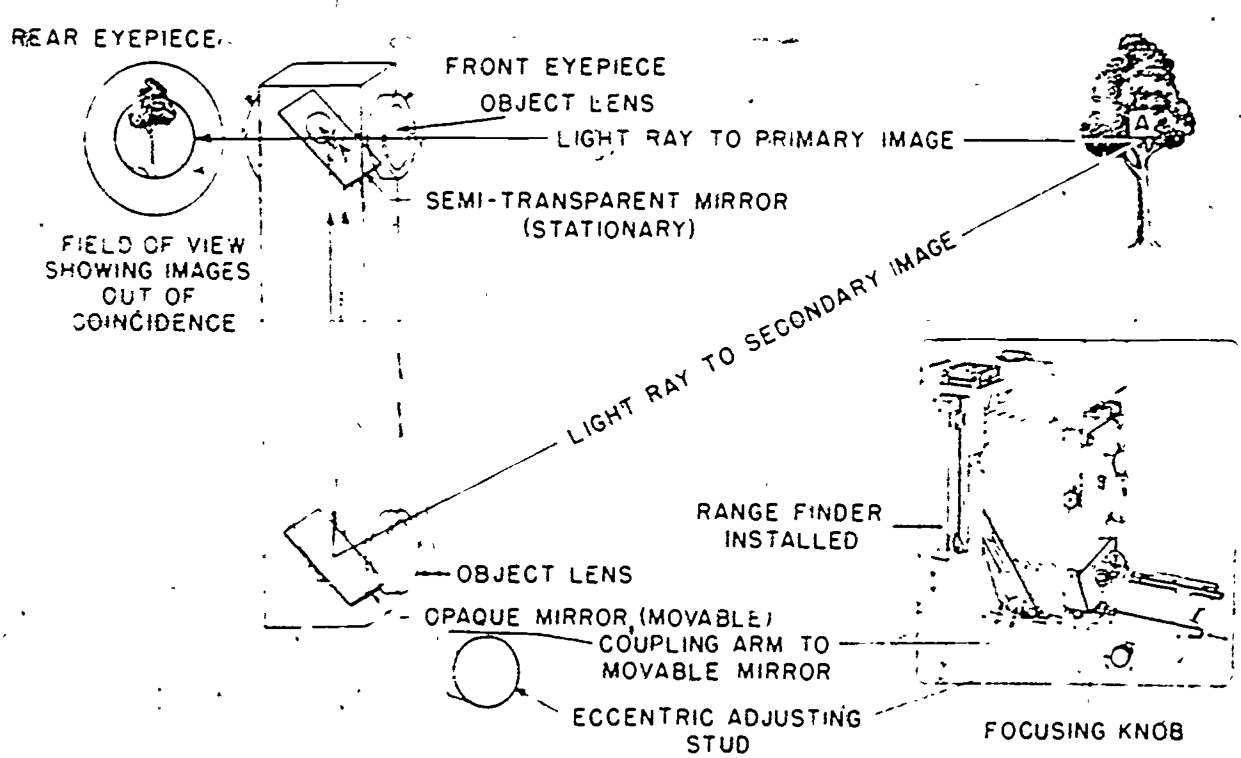

Figure 11. A Type of Rangefinder.

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Figure 12. Split Image Rangefinder; Eyepiece View.

d. Ground glass focusing is the most precise type of camera focusing system. Ground glass is a piece of glass located at the focal plane of the camera. The image is transmitted through the lens and formed on the glass, with the movement of the lens or focal plane bringing the image into sharp focus.

(1) When a ground glass is used on the larger cameras, it is preferable to place the camera on a tripod. The lens is then set at its maximum aperture for focusing. The lens is focused, and, if desired, the aperture which will be utilized for the exposure can be set and the depth of field determined.

(2) With the larger cameras, this operation is impractical when speed is required to get the picture. Usually on these cameras other focusing features are provided. However, these cameras are excellent for close-up, reproduction, and macrophotography.

(3) The most common type of cameras using some form of ground glass are the 35mm single lens reflex cameras.

5. VIEWING THE SUBJECT. The primary function of the camera viewfinder is to give a visual image of what the film will record. It permits the photographer to view the subject for composition and shows what will be recorded on the finished print.

a. The more advanced type of viewfinder, or rangefinder, is a combination of these two camera features (range/view). This arrangement allows the photographer to view and focus the picture through one device. When these two functions are separate, the photographer must shift from rangefinder to viewfinder in order to take the picture.

b. The camera with ground glass focusing is also the most dependable viewfinder. What the photographer sees on the ground glass is the identical image that will be recorded on the film. This insures that the picture will contain all required subjects. Examples of cameras using this system are the view camera (Figure 4) and the reflex camera (Figure 6).

c. A tubular viewfinder is a small optical viewing instrument usually mounted on or in the camera body near the rangefinder. It provides a means for determining the picture area the film will record. The camera pictured in Figure 3 has a tubular viewfinder (also see Figure 13). Miniature cameras employ a similar design and they are usually enclosed within the camera body. The viewfinder is positioned close to the same axis as the taking lens and thus has less of a parallax problem (para 6).

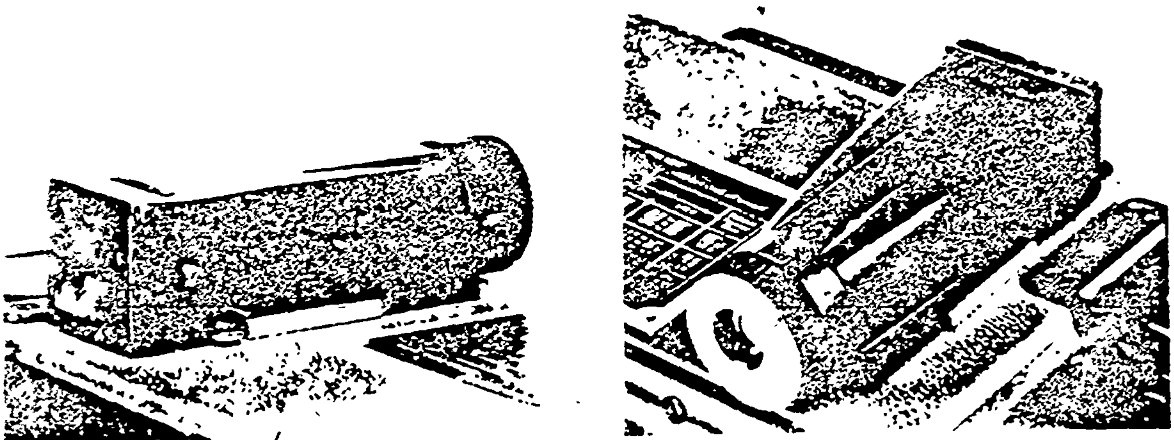

Figure 13. Tubular Viewfinder.

d. A wire frame viewfinder, sometimes called a sports viewfinder, is usually found on a press type camera (Figure 3). It consists of a rear peepsight and a front wire frame. When the peepsight is brought close to the eye, the photographer has a full-sized view of the subject bordered by the wire frame.

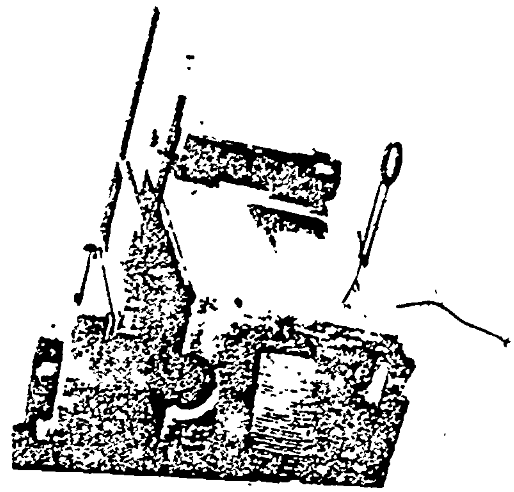

Figure 14. Sports Viewfinder.

6. PARALLAX. In simple terms, parallax is the difference in the angle of view between what the camera lens transmits to the film and what the photographer sees through the viewfinder. If a viewfinder is directly above the lens only, vertical parallax correction is necessary. If the viewfinder is not in either the same horizontal or vertical plane as the camera lens, correction in both directions may be necessary. The closer the subject is to the lens the more critical the problem of parallax becomes. Some cameras automatically correct for parallax. Others have devices which must be manually operated. The photographer must be thoroughly familiar with his camera equipment because when this equipment requires a parallax correction, and it is not corrected, he will possibly lose a vital portion of the subject.

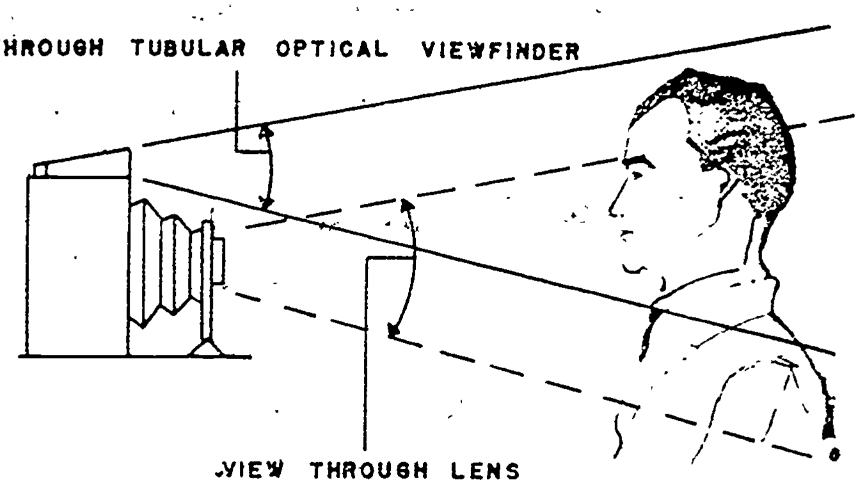

Figure 15. Parallax.
Although the viewfinder indicates the whole head will be included in the picture, the lens will not record this view because of parallax.

7. CAMERA SHUTTERS. The camera shutter is an adjustable mechanism that regulates the amount of light reaching the film by varying the length of time light is allowed to pass through the lens.

a. Shutter speed refers to the time that the shutter is opened, allowing light to reach the film. Shutter speed is related to lens aperture setting (discussed in Lesson 2), and to film speed, which will be discussed in detail in Lesson 5.

b. There are two different types of camera shutters - between-the-lens and focal plane shutters.

(1) The between-the-lens shutter is located between the lens elements, and it consists of thin blades activated by springs. When the shutter dial is set for a given speed, the springs are activated; when released the blades open to the desired aperture and then close. Figure 16 shows a lens which contains this type of shutter. These shutters help to keep the image free of distortion, when photographing fast moving objects. The advantage of the between-the-lens shutter is that its placement in the lens helps to eliminate distortion. Also, the shutter speed can be easily synchronized for flash pictures. However, as a consequence of the shutter placement, the versatility of the camera is limited, in respect to lens interchangeability, and very fast shutter speeds are lost. Normally, the fastest shutter speed is 1/500 of a second. Although interchangeability and faster lens speeds are available, these qualities are quite expensive.

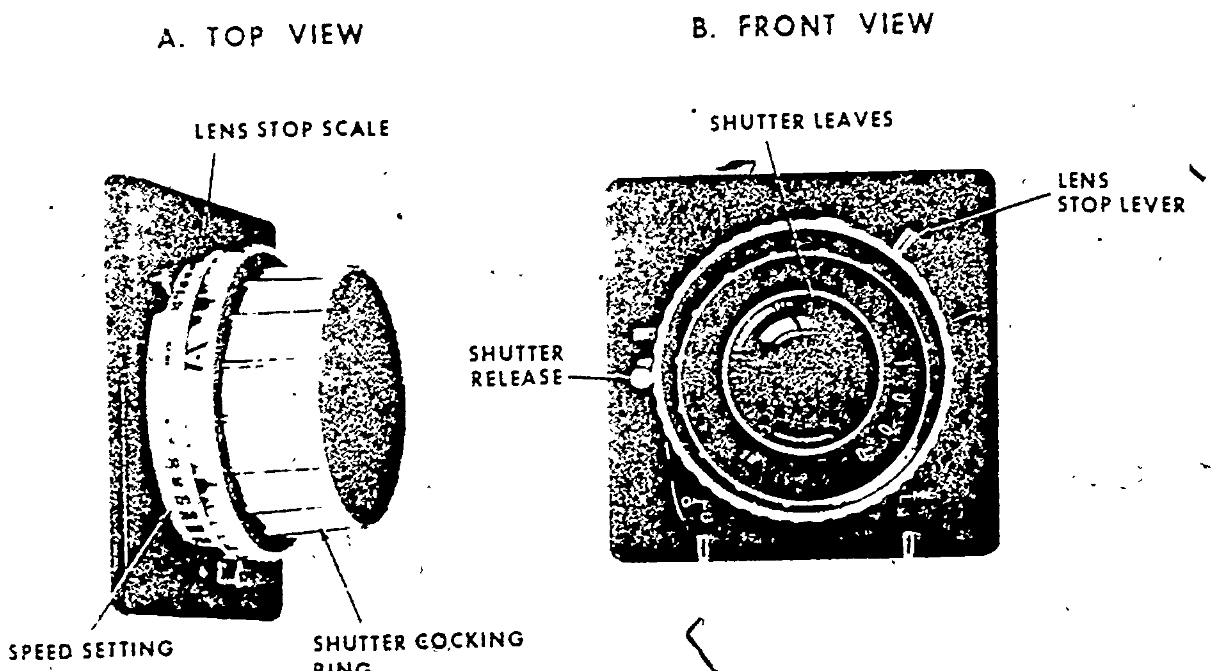

Figure 16. A lens containing a between-the-lens shutter.

(2) Focal plane shutters, also known as curtain shutters, consist of a lightproof curtain with different sized rectangular slits, or adjustable metal slits. The size of the slit determines the shutter speed of the exposure. The focal plane shutter exposes the film a portion at a time as the slit passes over the unexposed film. Figure 17 shows the curtain with its various sized slits and an adjustable curtain.

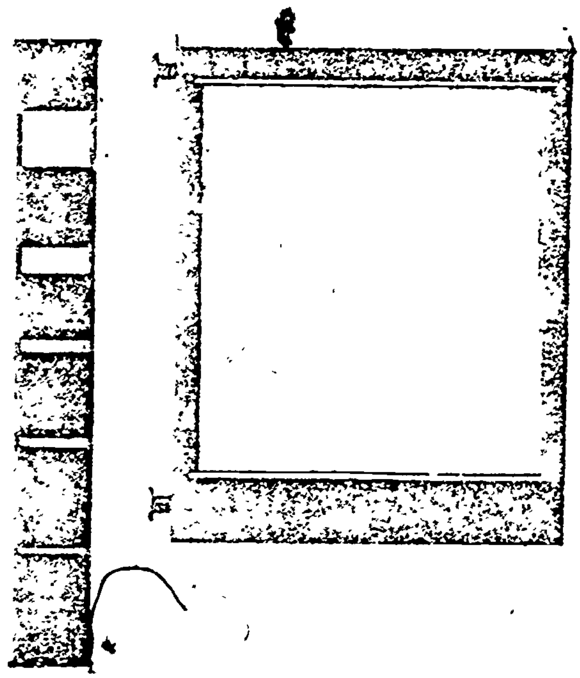

Figure 17. Focal Plane Shutter Curtains.

The advantages of the focal plane shutters are that they allow for lens interchangeability and usually have shutter speeds up to 1/1,000 of a second. Compared to the between-the-lens shutter, the focal plane shutter contributes to positional distortions. These distortions are most apparent when a larger negative is used. As the film is exposed in sections, a fast moving subject may be stretched out making it appear longer than it actually is. The distortion created by the focal plane shutter can be minimized by using a smaller negative size (35mm v. 4 x 5), and using the smallest lens aperture possible.

EXERCISES

REQUIREMENT. The following exercises are multiple choice. There are four alternatives to each exercise. You are to select the one alternative that is correct and indicate your choice by circling the correct response directly on the exercise booklet.

1. A simple box type camera normally has a fixed aperture of

   a. f 2.8 or F4.

   b. f5.6 or F8.

   c. f 11 or F 16.

   d. f22 or F32.

2. A Vernier scale measures

   a. camera/subject distance.

   b. film weight.

   c. shutter speed.

   d. aperture width.

3. In a rangefinder camera, when two separate beams of light are brought together within the eyepiece to form one image,

   a. the lens is out of focus.

   b. the image is refracted.

   c. the image is diffuse.

   d. the lens is in focus.

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4. The most precise type of camera focusing apparatus is

   a. an iris diaphragm.

   b. a split focal plane.

   c. ground glass.

   d. the Vernier scale.

5. The most common type of camera, using some form of ground glass, is

   a. Press camera.

   b. 35mm rangefinder camera.

   c. Single lens reflex camera.

   d. Twin lens reflex camera.

6. The primary function of a viewfinder is to give

   a. a distance reading.

   b. a visual image.

   c. a color scheme.

   d. a depth of field reading.

7. The difference between what the camera lens transmits to the film and what the photographer sees through the viewfinder is known as

a. flare.

b. parallax.

c. astigmatism.

d. correction.

8. The time that a shutter is opened, allowing light to reach the film is known as

a. parallax.

b. lens speed.

c. diaphragm speed.

d. shutter speed.

9. Between-the-lens shutters help to eliminate

a. Newton's Rings.

b. distortion.

c. flare.

d. refraction.

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10. An advantage of focal plane shutters is

   a. freedom from positional distortion.

   b. shutter speeds down to 1/2 of a second.

   c. the ability to catch infrared rays.

   d. shutter speeds up to 1/1,000 of a second.

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LESSON ASSIGNMENT SHEET

SUBCOURSE NO. 4-12 I	Investigative Photography.
LESSON 4	Films.
CREDIT HOURS	3.
TEXT ASSIGNMENT	Attached Memorandum.
MATERIALS REQUIRED	None.
LESSON OBJECTIVE	To familiarize you with the different types of film and with their individual characteristics.
SUGGESTIONS	None.

ATTACHED MEMORANDUM

This attached memorandum includes information extracted from resident instructional material of the United States Army Military Police School and TM 11-401-1. In case of conflict between the attached memorandum and other publications, the material contained in the attached memorandum will apply to this lesson assignment.

1. INTRODUCTION. In the first lesson it was stated that light is the basis of photography. In our discussion thus far, the control of light has involved the lens, the aperture setting of the lens, and the camera shutter. The film used is also a means of control that can be exercised over light. The film's sensitivity to light is the basis for how much light will be required to produce an acceptable negative. Therefore, by varying the film's sensitivity, the amount of light required is either increased or decreased. When the film's sensitivity is changed, other film characteristics are also changed.

2. TERMS. The definitions given in this section are not necessarily the most important terms in the lesson. Additional terms and definitions will be found throughout the lesson, and those given below may be listed only in the interest of clarification.

a. Color - A sensation produced in the eye by a particular wavelength of visible light.

March 1975
REPRINT

b. Acetate Base - A nonflammable film base (para 3).

c. Silver Halides - A metallic silver compound that darkens on exposure to light.

d. Antihalation Backing - An opaque coating on the back of film to prevent light reflection from the back of the film base (para 3a(4)).

e. Emulsion - A light-sensitive layer of silver salts, suspended in gelatin, which is spread on a permanent support such as acetate (para 3).

f. Color Sensitivity - The response of a photographic emulsion to light.

g. Density - The degree of blackening of the silver in an emulsion.

h. Latent Image - The invisible image formed in an emulsion by exposure to light.

i. Exposure - The time that a given amount of light requires to create an image of the desired density on an emulsion.

j. Contact Print - A photographic print made by placing a sensitized emulsion in direct contact with a negative and passing light through the negative.

3. BLACK AND WHITE FILM CHARACTERISTICS. Once into the subject of films, one is naturally carried into the realm of chemistry. For, from its beginning to its end result, films involve a chemical process.

a. The chemistry of film emulsions makes possible the permanent recording of an event. A chemical process is utilized whereby silver halides are physically changed by exposure to light. Generally, the film consists of several layers; the base support, the emulsion itself, a protective coating and non-curl antihalation backing (Figure 1).

(1) The film base is commonly made of cellulose acetate which supports the light sensitive film emulsion and is coated with a non-curl antihalation backing.

(2) The emulsion layer is composed of a gelatin, which contains minute suspended crystals, which are generally grains of light-sensitive silver halides. The type of processing these grains have received, i.e., their type, size, etc., determines the film's photographic characteristics.

(3) The protective coating is an overcoating of hard gelatin which helps prevent scratching and abrasions.

(4) The backing of the film base has two functions: first, a non-curl function - simply to control film curling - and, second, the antihalation function, which reduces, or prevents, light from reflecting haphazardly into the emulsion layer.

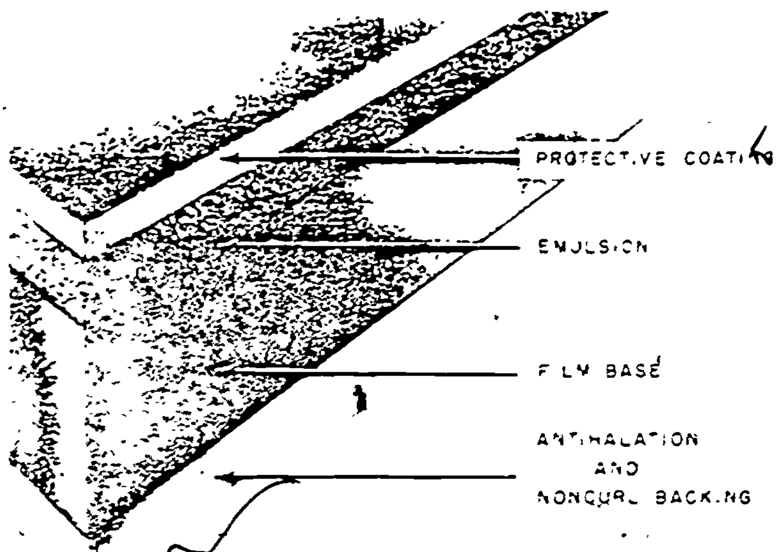

Figure 1. A cross section of a typical film structure.

b. Unexposed film is the raw material of the photographic process. By properly applying its principal characteristics, the finished product will prove to be a valuable aid to the investigator. The principal characteristics of the film emulsion are its sensitivity to colors, contrast, latitude, grain, resolving powers and acutance (see para 3b(5)), and speed.

(1) Color Sensitivity. All photographic emulsions are sensitive to the colors of blue, violet, and ultraviolet. The film's sensitivity to other colors is obtained by adding dyes to the emulsion during manufacture.

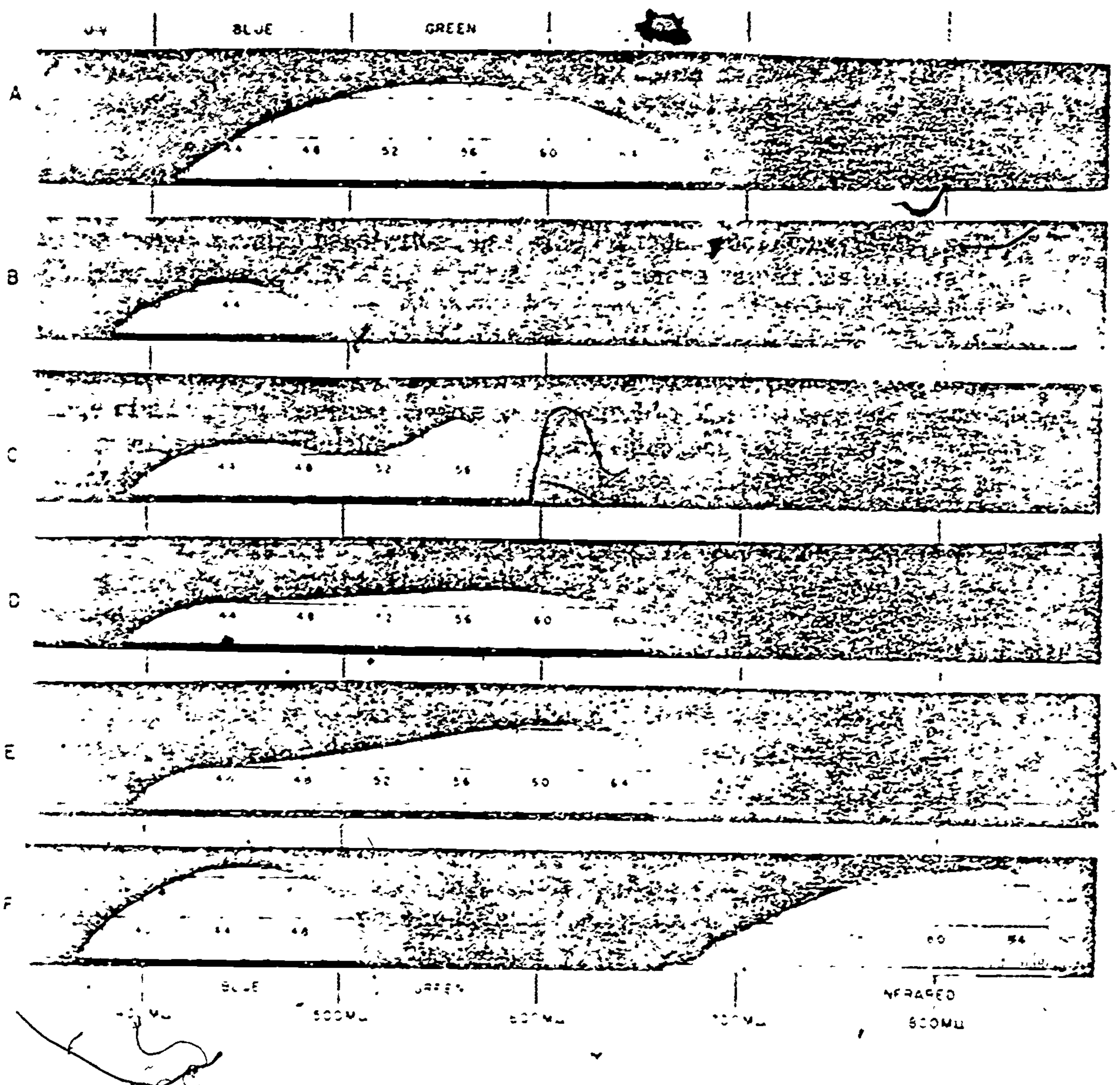

Figure 2. Spectrograms showing color sensitivity of various films.

Figure 2 demonstrates, visually, the sensitivity of various major film types to color. Spectrogram A is the approximate color sensitivity of the human eye.

(a) Nonchromatic Emulsions. This film type is sensitive to ultraviolet and blue-violet colors only (Figure 2, Spectrogram B). This film may be used when natural color rendition is not important. For example, nonchromatic film is used to copy black and white originals and to photograph colorless subjects when extreme contrast is needed.

(b) Orthochromatic Emulsions. This film type is sensitive to blues and greens, but not to reds. Reds are recorded on film as dark tones, while greens and blues record as light tones when printed. Orthochromatic film sensitivity is indicated in Figure 2 in Spectrograph C.

(c) Panchromatic Emulsions. This film is sensitive to all colors. These emulsions are subdivided according to their degree of sensitivity to each color. Films having a fairly even balance of all colors are designated panchromatic type B (Figure 2, Spectrogram D). Film types having a higher sensitivity are known as type C. (Figure 2, Spectrogram E.) Because panchromatic films produce the most natural recording of colors, it is the most commonly used in investigative photography.

(d) Infrared Emulsions. These film emulsions are sensitive to blues and infrared radiation, which is beyond the human eye's sensitivity. (Figure 2, Spectrogram F.) Because of the infrared's longer wavelength, it is useful in penetrating haze. In investigative photography, it is useful in the laboratory analysis of questionable documents, in the discovery of old or faded tattoos or areas where small objects are hidden under skin, and in the construction of camera traps.

(2). Contrast. Contrast is the difference between the bright and dark areas in a photograph. It will depend on the difference in the density of metallic silver in the film emulsion. Bright areas on the subject reflect a greater amount of light, which causes the negative to become dense. These dense areas are called highlights. Darker areas reflect little light and affect fewer silver halides and are therefore less dense and leave only a slight tonal mark on the negative. This area is called shadow area. Various brightnesses between the light and dark areas also register on the negative as corresponding densities, called intermediate tones. Normal contrast is represented by a full range of densities including highlights, intermediate tones, and shadows. High contrast is the recording of highlights and shadow areas only, with little or no intermediate graduation. There is a wide, or sharp, difference between the two areas. Low contrast shows very little difference between highlights and shadow areas and is sometimes termed "muddy". Emulsions are manufactured with varying degrees of inherent contrast. Process (high contrast) film records a short range of tones, such as black and white, and is used to copy line drawings. Normal contrast film is used to record a wider range of tones, as found in a portrait or landscape. In other words, the selection of film is governed by the contrast of the subject and the photographic rendition desired.

(3) Latitude. The ability of an emulsion to record a varying range of brightness values is called latitude. An emulsion capable of producing a long range of brightness values has wide latitude, and, conversely, an emulsion producing only a short range of brightness values has little latitude. The latitude of the average panchromatic film of normal contrast is about 1 to 130. This means that a highlight 130 times as bright as a shadow can be recorded without impairing any intermediate gradations (tones). The brightness range of an average scene, however, is about 1 to 32. Consequently, variations of exposure above and below normal will still produce normal negatives. The extent to which exposure can deviate from the normal, and still produce an acceptable image, is called exposure latitude.

(4) Grain. Ordinarily, microscopic silver grains that make up the negative image are not visible in the negative or contact print. However, a granular or speckled effect usually appears when a negative is viewed under a microscope or when a big enlargement is made. With further magnification, graininess increases. Grain in an emulsion depends on the size of the silver halide crystals before development and on the clumping of the silver grains during development. (See Lesson 6.)

(5) Resolving Power and Acutance. Photographers consider both resolving power and acutance. Since both of these characteristics are not inherent in all films, the photographer must study his results to find the type of emulsion that meets his particular requirements.

(a) Resolving power is the capability of an emulsion to reproduce fine subject details.

(b) Acutance is the degree to which an emulsion can record a sharp division between image area details of differing contrast. It is of greater importance as it is responsible for the visual impressions of image sharpness.

(6) Film Speed - Sensitivity to Light Intensity. Film speed expresses the amount of light required to produce a satisfactory negative with a given emulsion. Film speed is only one of six different film characteristics. however, it is important that this characteristic be fully understood. The film speed has a direct relationship to exposure. Film is rated with an American Standards Association (ASA) guide number. This guide number (ASA number) is used to indicate the amount of light needed to record an image. The higher the ASA number is, the less light required to make an acceptable negative, i.e.,

ASA 400 would require much less light than ASA 25, all other factors being the same. This number is referred to as the speed of the film. Film speed is divided into three groups - slow, medium, and high speeds.

(a) Films rated up to 160 are called slow speed films. A slow speed film contains smaller grains of silver halides and they are less sensitive to light. They therefore require more exposure (see Lesson 6). Because of their fine grain, they are best employed when the prime concern in the finished product is wide tonal separation, greater latitude and greater resolving power and acutance. Larger enlargements are also possible without loss of desirable film characteristics.

(b) A medium speed film has an ASA rating of between 200 and 400. These films require less exposure time than slower speed and therefore they lose some of the desirable film characteristics.

(c) A high speed film has an ASA number higher than 400. A high speed film contains large grains of silver halides and requires a very short exposure under normal lighting conditions. Due to the larger grain size, these films are far less desirable when enlargements, image detail and quality are required in the finished product. This film speed may be the only answer when a photograph must be taken inconspicuously and with very little available light, e.g., surveillances at night or in bars.

4. COLOR FILM. Color photography is related in many areas to black and white photography and an investigator who has a good foundation in the basic principles of black and white photography can work into color without much trouble.

a. In simplified form, color film is made up of several layers. Each layer has a purpose. The top layer is sensitive to blue light, next is a yellow filter, then a layer sensitive to green and finally a layer sensitive to red. All this is then supported by the film base.

b. Because of its complexity, color film loses some of the flexibility that one finds in black and white photography. However, it adds a real life dimension, i.e., color.

(1) In black and white photography the problem of exposure is in allowing the correct amount of light to reach the film and form an acceptable negative. Color has this problem, plus the problem of the type, or color, of the light. Some color films are more sensitive than others to a particular color. Various forms of artificial light are not pure forms of white light, i.e.,

they give off more rays of a certain color wavelength, e.g., daylight fluorescents are bluish.

(2) The determination of a correct exposure is more critical with color film. With black and white film the exposure can be incorrect by one or two f/stops and the negative may still be usable. This is not the case with color, however, for if it is one f/stop off the correct exposure, there will be nothing usable.

(3) Shadow areas are important in black and white photography as they give form, texture, and contrast to the photograph. In color work form, texture, and contrast are determined by colors. In order to see colors, light must be present. It is therefore an acceptable practice to provide light in the shadow areas.

c. With color photography the choice of color transparencies or color negatives is available to the photographer. Films with their suffixes containing "chrome" provide transparencies. Those which contain "color" provide color negatives.

(1) The reversal-type (chrome) films are first treated as any other negative, then they are re-exposed to white light and redeveloped. This procedure produces a positive image and, when mounted, the finished transparency (slide).

(2) The negative type (color) films are processed similar to black and white film in that you first process a negative and then print the negative.

5. DIFFUSION TRANSFER REVERSAL SYSTEM MATERIALS. The diffusion transfer reversal system, commonly called the Polaroid system, is a photographic process that produces an immediate photographic print. One film of this type produces a finished print, another produces both a negative and a print, and a third produces a transparency. This material is used extensively by commercial interests, and the military has accepted it for use when production speed is essential.

a. <u>The Materials of the Composite Film Process</u>. A Polaroid picture is made from a composite film that contains, within itself, all the materials necessary for making a positive picture, including the light-sensitive negative, the printing paper, and the chemical reagents.

(1) Negative Material. The negative material consists of a base coated with a gelatin emulsion that has suspended layers of silver halide crystals.

(2) Positive Paper. The positive paper, which is not light sensitive, is the base on which the final positive print will appear.

(3) Reagent Pod. The metal foil pod that lies between the negative and the positive material is filled with a viscous, jelly-like compound. This compound is the chemical reagent that transforms the latent image into a visible photograph.

b. The Process in Operation.

(1) The automatic developing process begins when the photographer advances the film, after exposure, to the next frame or removes the packet from the film holder (applicable for cut film cameras employing special film backs). As the film is advanced, the exposed negative and the positive paper strip are joined between two steel rollers. The foil pod, which is located at the head of the paper, is forced through the rollers in such a way that the jelly-like liquid is spread evenly between negative and positive material, forming a .0003-thick layer.

(2) The thin layer of chemical substance develops the exposed silver halide grains of the negative. The unexposed silver halide grains are converted to solubles, but are not fixed out as in conventional processes. Instead, the soluble silver complexes diffuse across the thin layer of the processing reagent and are transferred to the positive paper.

(3) Upon transfer, the silver precipitates as metallic silver and forms the positive image. Both reactions occur almost simultaneously. The positive image is in the process of forming while negative development is taking place.

c. Types of Film. Each commercial (Polaroid) film type is assigned a number that relates the film to a specific camera model and to a particular pictorial result.

(1) Film in the 30 series produces eight black-and-white 2-1/2- by 3-1/4-inch prints. There is no final negative.

(2) Film in the 40 series produces eight black-and-white 3-1/4- by 4-1/4-inch prints. There is no final negative.

(3) Film type 46 produces 2-1/4- by 2-1/4-inch transparencies. These transparencies are ready for projection a few minutes after exposure.

(4) Film types 52, 53, and 57 (film packets) are used in a special 4- by 5-inch film holder and produce a 4- by 5-inch black-and-white positive paper print. Types 53 and 57 packets use an acetate base negative that can be reprocessed into a conventional negative.

d. Development Process. Diffusion transfer reversal system films require a development period ranging from 10 seconds to 2 minutes. Instructions in each film package must be followed closely to obtain best results.

(1) Development starts with the pulling of the tab, or removal of the packet when using the special film holder (Polaroid Land Film Holder No. 500). The tab should be pulled out straight, swiftly, and firmly.

(2) The length of time during which the image is subjected to the development action of the reagent will have some effect on contrast. Extended development will increase contrast and shortened development will reduce contrast.

(3) Temperature will also have an effect on the development action of all films. For example, cold weather slows down the developing capability of the reagent. Therefore, the photographer, when operating in extremely cold climates, should carry the camera inside his jacket. Normal body heat will keep the pods of reagent from freezing.

e. Print Coating. Black-and-white photographs made with diffusion transfer reversal films require a print coating (provided with the film) to preserve delicate highlight renderings and to retain tonal values. This coating must be applied as soon as possible after development. Proceed as follows:

(1) Use a flat, clean surface as an operating base.

(2) Apply the coating material in firm, straight overlapping strokes, making sure that the image is completely covered.

(3) Dry the prints. Ordinarily, prints will dry within minutes; in humid weather, however, the drying process may require more than 5 minutes.

f. Print Defects. The table in Figure 3 can be used as a trouble-shooting guide when using diffusion transfer reversal system material. It shows a number of common faults and their probable causes.

Print defect	Probable source of trouble
Total blank; black	Exposure did not reach film. Check all operations; make sure that the shutter is cocked and the tab is pulled.
Total blank; white	Overexposure to light, could be caused by badly damaged or outdated developer pod.
Print too light	Overexposure.
Print too dark	Underexposure.
Black area at end of print	Tab pulled only part way.
Streaks across print	Hesitant tab pulling
Developer smear	Caused by developer sticking to print instead of negative. Could be due to hesitant print removal, or severe over or underdevelopment. To remove spots, rub them firmly with coating material.
Partial development	Usually caused by damaged developer pod, or use of old, outdated film.
White spots, repeated regularly across film.	Dirt or dried developer reagent on steel rollers. Keep rollers clean.
Flat, muddy toned prints	Underdevelopment
Fading highlight	Due to improper coating; failure to coat; or bad storage conditions.
Streaky fading	Print not fully and evenly coated
Edges fogged	Light leaked in at the edges of negative roll.
Brown stains	Developing reagent left on face of print. Prints should always be coated immediately.

Figure 3. Print Defects.

6. SELECTION OF FILM. The primary reason for the great number and variety of film emulsions is to provide any photographer with the material best suited for specific photographic goals. Therefore, the investigative photographer must choose the emulsion which has the greatest number of favorable performance factors in order to accomplish his investigative needs.

a. Manufacturer's Information. An important informational guide for film selection is the information provided by the manufacturer. This is also true for equipment and accessories.

b. Black and White Film. Black and white film is generally the most versatile. It provides the highest film speeds, the easiest processing and is generally accepted into court proceedings without difficulty. It is also less expensive in both film and processing costs. Obviously it is best used when color and instant picture availability are not of primary importance. The table in Figure 4 provides a general guide for the suitability of film materials in black and white.

Subject classification	Chief requirements	Most suitable type of negative materials
Black and white	Panchromatism	Commercial panchromatic
Copies:		
Line—black-white	High contrast	Press orthochromatic
Line—color	High contrast, color sensitivity	Process panchromatic
Copies:		
Halftone—black-white	Medium contrast	Commercial panchromatic Commercial ortho.
Color	Medium contrast	Commercial ortho
	Color sensitivity	Commercial panchromatic
Duplicates:		
By means of intermediate negative or positive.	Medium contrast negligible graininess.	Commercial panchromatic
Lantern slides	Extremely fine-grain, good contrast	Fine-grain panchromatic
		Lantern slide plates, normal and contrast.
Medical photography:		
Surface lesions	Panchromatic materials	Fine-grain panchromatic
Surgery, etc.		Commercial panchromatic
	Speed in artificial light	Fast panchromatic
Action outdoors	Speed for full exposure at high shutter speeds.	Fast panchromatic
Indoors or extremely poor lighting.	Speed in artificial light	Fast panchromatic
Architecture:		
Exteriors	Texture rendition	Fine-grain panchromatic
Interiors or night	Latitude, speed	Fast panchromatic
News:		
Candid	High speed	Fast panchromatic
Photoflash		Fast orthochromatic
Portraiture:		
Children	Low contrast, high speed	Fine-grain panchromatic
Men	Ortho materials strengthen character.	Fast orthochromatic
Women	Pan materials, smooth skin texture and contours.	Fine-grain panchromatic
Landscapes:		
Cloudscapes	Panchromatism, use of filters	All panchromatic materials
Marine views	Same	Same
Snowscapes	Same	Same
Still life:		
Small object photography	Texture, modeling	Fine-grain panchromatic
Color separation:		
Negatives	Balanced rendering by red, green, and blue light.	Fast panchromatic

Figure 4. Negative Material for Special Use.

c. Color Photography. Color photography, in law enforcement, has become more important in recent years. When color photography was first used in legal proceedings it was held as inflammatory and generally not admitted into these proceedings. Today this situation is changing and color, with its added aspects of reality, is fast becoming accepted.

(1) If picture projection is important, color slides should be used... However, the color negative process is usually the best method to use in investigative work. The color negative can be processed as either color prints or black and white prints without much difficulty. And in some cases, it may be best to make both color and black and white prints when they are to be used in any legal proceedings. Then, if color is ruled inflammatory, the black and white prints can be used in their place.

(2) Color is not relevant to all investigations, but when it will assist in development of the elements of proof it should be used. For example, in a murder case a great deal of blood was pooled on an automobile garage floor, and bloody footprints were found nearby. When the bloody pool and footprints were photographed in black and white, the blood pool looked like any other grease or oil spot on the garage floor, and, because of the porous texture of the cement floor, the footprint did not appear very clear. When these items were photographed in color, there was no doubt as to what they were.

(a) Color is recommended for personal identification. When it is reasonably available, color polaroid may be best suited for this purpose because it requires a minimum set up time, equipment, and processing. Color is excellent for identification because it produces hair and skin color plus bringing out possible identifying marks which would not be observed in black and white.

(b) When arson is suspected, color photography or movies, of the burning fire record the various colors of smoke and flames. The colors can then be analyzed and a determination of cause made.

(c) In assault and bodily injury cases where it is difficult to adequately describe the extent of personal injuries (e.g.; swelling, discolorations dislocations, etc.) color can accurately convey this information.

(d) In an autopsy when a medical doctor needs to point out important findings which have minute shading differences in the colors of body tissues, etc.

(e) In narcotic addiction, identification where skin tone is changed due to needle marks.

(3) To some individuals, color may seem the best for all investigative work, but it must be remembered that color is more limiting than black and white, is a more involved process, and involves greater expense. The processing of color transparencies may be accomplished in most CI detachments, and color negative material will be processed by most Signal Corps photographic laboratories, when they are available.

(4) The table in Figure 5 lists some common color films, note the film speeds, and the different type of film for two different light sources.

This list of common color films is for your general information only, commercial names are descriptive and do not constitute endorsement. Before using a film that you are not thoroughly familiar with, carefully read all data packaged with the film.

Light	Product	Film	Speed	Sizes	Process
Daylight	Positive transparency	Agfachrome Professional	65	Sheet	Agfa 75 F
		Agfachrome CT 18	65	35 mm, roll	Agfa 68 F
		Anscochrome	32	35 mm, roll, sheet	AR-1
		Ektachrome	50	roll, sheet	E2/E3
		Ektachrome Aero Type		roll	E2/E3
		Ektachrome Infrared Aero	10	75 ft roll 9×9 in.	E2/E3
		Ektachrome Professional	50	roll	E2/E3
		Ektachrome X	64	35 mm, roll	E2/E3
		High Speed Ektachrome	160	35 mm, roll	E2/E3
		Kodachrome II	25	35 mm, roll	K-12
		Kodachrome X	64	35 mm, roll	K-12
		Super Anscochrome	100	35 mm, roll, sheet	AR-1
Daylight	Negative	Agfacolor Negative	40	35 mm, roll, sheet	Agfa N set
		Gevacolor N5	40	35 mm, roll, sheet	Gevacolor
		Ektacolor CPS	100	roll, sheet	C-22
		Kodacolor X	64	35 mm, roll	C-22
Tungsten	Positive transparency	Agfachrome CK20	65	35 mm, roll, sheet	Agfa 68 F
		Agfachrome Professional	65	sheet	Agfa 75 F
(3,200 K)		Anscochrome	25	sheet	AR-1
(3,200 K)		Ektachrome Sheet Type B	10	sheet	E-1
(3,200 K)		High Speed Ektachrome B	125	35 mm	E2/E3
(3,200 K)		Super Anscochrome	100	35 mm, roll	AR-1
(3,400 K)		Ektachrome Sheet Type B	32	sheet	E2/E3
(3,400 K)		Kodachrome II Type A	40	35 mm	K-12
(3,400 K)		Kodachrome Professional Type A	16	35 mm	K-12
(flash)		Ektachrome Roll Type F	25	35 mm, roll	E2/E3
(flash)		Kodachrome F	15	35 mm, roll	K-12
Tungsten	Negative	Agfacolor Negative	40	35 mm, roll, sheet	Agfa N set
		Gevacolor N 3	40	35 mm, roll, sheet	Gevacolor
(3,200 K)		Ektacolor L	16	sheet	C-22
(flash)		Ektacolor S	25	sheet	C-22
(flash)		Kodacolor X	4[illegible]	35 mm, roll	C-22

With No. 12 filter

Figure 5. Common Color Film.

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d. Diffusion Transfer Reversal System Materials. Selection of Polaroid films for investigative work is generally not recommended. It does have a place but this is limited.

(1) With Polaroid equipment, the photographer can tell almost instantly whether his equipment is functioning correctly or not. It also provides him with photographs which may be needed immediately.

(2) Polaroid is, however, limited and expensive. The film speeds available are low compared to other film materials and the films which have the higher ASA do not provide a negative. This is an important fact when several copies are required. The films that provide a negative have a much slower film speed and are the most expensive. Also, processing equipment must be available at the crime scene in order to properly produce a good Polaroid negative.

4-12 l; 4-15

EXERCISES

REQUIREMENT. The following exercises are multiple choice. There are four alternatives to each exercise. You are to select the one alternative that is correct and indicate your choice by circling the correct response directly on the exercise booklet.

1. In the chemistry of film emulsions, exposure to light physically changes

   a. copper bromides.

   b. gold nitrates.

   c. silver halides.

   d. crystal sulfates.

2. A film's protective coating helps prevent

   a. curling.

   b. fading.

   c. halation.

   d. scratching.

3. The function of the antihalation backing is to reduce or prevent

   a. reflection by stray light.

   b. the emulsion layers from separating.

   c. the blurring of the image.

   d. none of the above.

4. Although black and white films are sensitive to colors, the colors are reproduced as varying shades of gray. The sensitivity of black and white film to certain colors is controlled by the

a. addition of pulverized silver to the emulsion.

b. staining dyes incorporated into the film base.

c. addition of various dyes to the emulsion.

d. addition of a filter layer in certain film emulsions.

5. All photographic emulsions are sensitive to the colors of

a. blue, green and red.

b. blue, violet, and ultraviolet.

c. green, red and infrared.

d. yellow, orange and green.

6. A film type which is sensitive to ultraviolet and blue-violet <u>only</u> is called

a. orthochromatic.

b. nonchromatic.

c. panchromatic.

d. infrared.

4-12 I; 4-17

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7. Due to the ability of the manufacturer to control the sensitivity of black and white film to certain colors, orthochromatic films are not affected by exposure to

a. yellow-green light.

b. blue light.

c. red light.

d. green light.

8. The film type which produces the most natural recording of colors is

a. panchromatic.

b. monochromatic.

c. ultrachromatic.

d. infrachromatic.

9. The difference in the density of the metallic silver in a film emulsion is known as

a. shadow.

b. brightness.

c. contrast.

d. highlight.

1-12 1; 4-18

10. Latitude is the ability of an emulsion to record a varying range of

a. reds and greens.

b. shadow areas.

c. panchromatic areas.

d. brightness values.

11. Which of the following ASA numbers would require the least amount of light, all other conditions being the same, to produce an acceptable negative?

a. 25.

b. 64.

c. 125.

d. ASA numbers are not correlated to light conditions.

12. Films rated up to ASA 160 are called

a. slow speed films.

b. fast speed films.

c. panchromatic.

d. monochromatic.

4-12 f; 4-19

13. Which of the following is NOT a characteristic of high speed film?

a. ASA number higher than 400.

b. Contains large grains of silver halides.

c. Not very desirable for enlargements.

d. The silver halides are far less sensitive to light.

14. The exposure time for color film

a. may be incorrect by more than two f/stops without spoiling the negative.

b. is less critical than with black and white film.

c. may be off by one f/stop without rendering the negative unusable.

d. is more sensitive than with black and white film.

15. Composite (Polaroid) film contains

a. extremely large silver halide crystals.

b. four different emulsions.

c. particles that are very sensitive to green.

d. all the materials necessary to make a positive picture.

4-12 I; 4-20

16. Polaroid film in the 40 series produces

a. 8 black and white 2-1/2 by 3-1/4 inch prints.

b. 8 black and white 3-1/4 by 4-1/4 inch prints.

c. 8, 2-1/4 by 2-1/4 inch transparencies.

d. 8, 4 by 5 inch transparencies.

17. The probable source of streaks across a Polaroid print would be

a. developer sticking to print instead of negative.

b. old, outdated film.

c. hesitant tab pulling.

d. dirt on the steel rollers.

18. Which of the following is NOT true of black and white films?

a. Generally the most versatile.

b. Highest film speeds.

c. Accepted into court proceedings.

d. Most expensive.

4-12 I; 4-21

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19. The film which would probably be used for a daylight, positive transparency would be

a. Kodacolor X.

b. Ektachrome.

c. Extocolor CPS.

d. Kodachrome II, Type A.

20. Polaroid film is useful, in some instances, to the investigative photographer because of

a. high film speeds.

b. low cost.

c. compactness.

d. quick production.

4-12 I; 4-22

LESSON ASSIGNMENT SHEET

SUBCOURSE NO. 4-12 I	Investigative Photography.
LESSON 5	Principles of Exposure.
CREDIT HOURS	4.
TEXT ASSIGNMENT	Attached Memorandum.
MATERIALS REQUIRED	None.
LESSON OBJECTIVE	To provide you with the working knowledge of equipment and exposure factors of films, cameras, filters, and lighting to obtain a correctly exposed negative.
SUGGESTIONS	None.

ATTACHED MEMORANDUM

This attached memorandum includes information extracted from resident instructional material of the United States Army Military Police School and TM 11-401-1 and TM 11-401-2. In case of conflict between the attached memorandum and other publications, the material contained in the attached memorandum will apply to this lesson assignment.

1. INTRODUCTION. Exposure refers to the amount of light that reaches the film. In the early days of photography, or today, when using the simple and inexpensive box camera, exposure was a simple procedure that sometimes depended on just plain old luck. You waited until a sunny day came along, pushed a button, and chances are you would get a good snapshot of the family and friends. Today, however, with the more complete and expensive camera equipment and the various types of film exposure, it is not quite so simple. The discussion thus far has involved some of the elements of correct exposure. In the quest for the control of light, to get a correct exposure and an acceptable print, all these elements must work together. The film speed, lens aperture setting, the lens' shutter speed and the type and amount of light available or introduced, must be in agreement in order to achieve a correct exposure.

2. TERMS. The definitions found in this section are not necessarily the most important terms in the lesson. Additional terms and definitions will be found throughout the lesson, and those given below may be listed only in the interest of clarification.

a. Shutter Speed - The period of time during which the shutter is open to permit light rays to reach the film.

b. Exposure - The product, and time and intensity, of illumination acting upon photographic material.

c. Underexposure - Too little light, producing a loss of tonal separation and detail in the shadow areas of a picture.

d. Overexposure - Too much light, producing a dense negative with poor tone separation in the lighter parts of this picture.

e. Panning - To move camera so as to keep an object in the picture

f. Lumens - A unit for measuring the amount of light produced by an artificial flash.

3. BASIC OUTDOOR EXPOSURE. A basic exposure for an outdoor scene is based on an average lighting situation for that scene. To a photographer, an average scene means that the scene is nearly equal, in the distribution of lights and darks, when the subject is lighted from the front by normal sunlight. From this, there has developed a procedure used to estimate exposure.

a. The usual starting point for exposure is to have the film speed (ASA) in agreement with the camera shutter speed. The film speed was first determined by the selection of the best film to accomplish a certain objective. The shutter is then set on the same number as ASA. For example, if the film ASA is 125, the shutter should be set on 1/125; or, for ASA of 25, the shutter should be 1/25. If the camera shutter does not have the exact number, set it on the closest number. For the rest of this discussion the example film will have an ASA of 100 and therefore a shutter speed of 1/100 of a second.

b. The next step is to determine the type of lighting and its effect on reflections from the subject and its relationship to the lens aperture setting. To evaluate lighting and subject, four typical classes have been set up. These classes are common throughout photographic literature, and, in most cases, are used in the film manufacturer's information sheets supplied with the film as an aid in determining exposure.

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(1) Daylight illumination is divided into the classes of bright sun, hazy sun, cloudy bright, and cloudy dull (Figure 1).

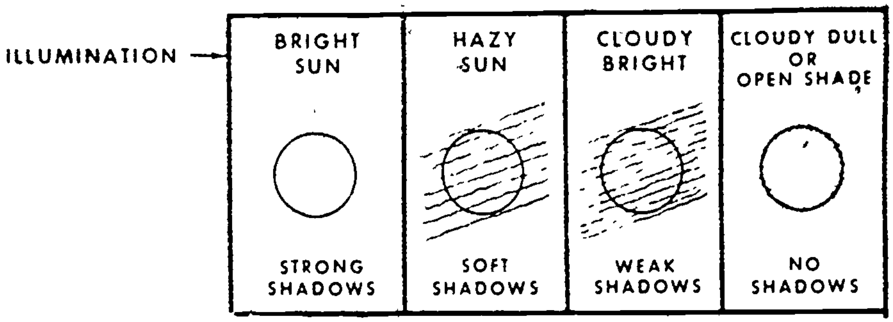

Figure 1. Classes of Illumination.

(a) Bright Sun. On a bright, sunny day, the sky is clear, bright, and free of large cloud masses or atmospheric haze. Any shadows cast by the sun on this type of day are sharply defined. Normally, this type of daylight illumination provides ideal photographic conditions.

(b) Hazy Sun. On a hazy, sunny day, the sun is partially obscured by a thin haze. Since the light intensity is about one-half the light intensity of bright sun, the lens aperture should be one stop larger than the setting for bright sun. On a hazy, sunny day, the edges of shadows are slightly diffused or soft and are less clearly defined than those in bright sun. This type of lighting is preferred when the photographic mission requires slightly diffused light.

(c) Cloudy Bright. On a cloudy, bright day, the sun is largely obscured by clouds or haze. The sun is in evidence, but the shadow areas are not apparent. This daylight condition exists when the light is bright--even glaring--and it seems there should be shadows but there are few, if any.

(d) Cloudy Dull. On a cloudy, dull day the sun is completely obscured by heavy layers of clouds or dense haze. On this type of day, light is extensively diffused and it is difficult to determine the exact location of the sun. Since there are no shadows, there is no contrast and subjects appear flat.

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(2) In subject brightness (type of subject and its reflective ability) the four classes are: brilliant, bright, average, and dark. In the discussion below, average brightness is treated first to permit comparison with the other classes (Figure 2).

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Brilliant	Bright	Average	Dark
Beach Scenes Snow Scenes Marine Scenes	White Buildings Light Clothing	Buildings Street Scenes People	Dark clothing Dark subjects

Figure 2.

(a) Average Subject. An average subject is one that reflects approximately 18 percent of the light striking it and absorbs the remainder. Included in this category are people in medium-colored clothing, most buildings, landscapes with trees, street scenes, and interior views.

(b) Dark Subject. A dark subject reflects only about 9 percent of the light striking it and absorbs the remainder. Because it is only one-half as bright as an average subject, it requires twice the exposure required for an average subject. Included in this category are vehicles and weapons, people in dark-toned clothing, and a barren rocky island in a stormy area.

(c) Bright Subject. A bright subject is one that reflects twice as much light as an average subject; consequently, it absorbs a much smaller percentage of light. A bright subject requires much less exposure than an average subject--generally one lens stop less than for an average subject. Typical subjects in this category are a fair-skinned and light-haired person, people in light clothing, and light-colored buildings.

(d) Brilliant Subject. A brilliant subject reflects about four times as much light as an average subject and absorbs very little light. A brilliant subject requires much less exposure than an average subject---generally two lens stops less than for an average subject. Typical subjects in this category are a landscape covered by snow, people in light-colored clothing on a white and sandy beach, a white sailboat against a blue sky and white buildings of a desert village.

(3) This information, on illumination and subject, has been accumulated through extensive research and experience. This is also true of the aperture settings which are found in the Daylight Exposure Chart shown in Figure 3. In this figure, the relationship between the illumination, subject, and aperture is demonstrated.

DAYLIGHT EXPOSURE CHART				
ILLUMINATION → / SUBJECT ↓	BRIGHT SUN — STRONG SHADOWS	HAZY SUN — SOFT SHADOWS	CLOUDY BRIGHT — WEAK SHADOWS	CLOUDY DULL OR OPEN SHADE — NO SHADOWS
	LENS APERTURE SETTING			
BRILLIANT BEACH SCENES, SNOW SCENES, MARINE SCENES	f/32	f/22	f/16	f/11
BRIGHT WHITE BUILDINGS, LIGHT CLOTHING	f/22	f/16	f/11	f/8
AVERAGE BUILDINGS, STREET SCENES, PEOPLE	f/16	f/11	f/8	f/5.6
DARK DARK CLOTHING, DARK SUBJECTS	f/11	f/8	f/5.6	f/4.5

NOTE

1 Camera shutter speeds and film speed as follows

A S A film speed rating 25 use shutter speed 1/25

A S A film speed rating 50 use shutter speed 1/50

A S A film speed rating 100 use shutter speed 1/100

2 Side-lighted subjects require one additional lens stop

Back-lighted subjects require two additional lens stops

Figure 3. Daylight Exposure Chart.

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(4) The next step is to judge the illumination, look at the subject, and determine which class each one is in; then find the corresponding aperture which is in agreement with the two. For example, it is a bright, sunny day and the subject is an average street scene. The exposure chart is then referred to; moving down the bright sun column to the average subject the lens aperture setting is discovered to be f/16. If the sun were largely obscured by clouds a few minutes later, it might be determined to be cloudy bright. The aperture would then be f/8 for the same street scene.

c. With the second step, the four parts of an exposure are in agreement. In the case of the example, the film speed was ASA 100, the shutter speed 1/100 of a second and the lens aperture f/16. The basic exposure of an average subject is shutter speed the same as ASA, at f/16.

d. The Daylight Exposure Chart is to be used merely as a guide which can serve as a starting point to determine correct film exposure. From this starting point, other situations that affect the exposure can be considered and adjustments made. Some of these situations which should be considered are:

(1) Position of the Sun. The angle at which the sun's rays enter the atmosphere affects it's color and intensity. This angle will depend on one's geographic location (latitude, the hour of the day, and the season of the year). When the sun is close to the horizon at sunrise or sunset the intensity of all wavelengths is not only less but there is also a greater loss of blues. Films are generally more sensitive to blues and therefore the exposure should be increased by a half or a full f/stop.

(2) Shade and Shadows. Because exposure must be sufficient to record important details in shadows, the degrees of darkness and physical extent of these shadows must be considered. To obtain details in a shadow area, use a wider lens opening than the one selected for a scene entirely in sunlight. Most closeups have larger and more important shadow areas, and therefore require an increase in exposure of one stop. In general, the more distant the center of interest of a picture, the smaller and less important the shadow area. In photographing a subject out of doors, for example, a close-up must show detail in the darkest and smallest parts. At a greater distance, these details cannot be distinguished or photographed individually. At an even greater distance, large details are indistinguishable and further exposure adjustments are required. Exposure must be based on existing light conditions if details within the shadow areas are to be brought out in the photograph. This is especially important when long focal lengths or telephoto lenses are used to obtain coverage of distant terrain details. Generally, whether close or distant, exposure for shadow areas of a scene is identical.

(a) Since most subjects fall into the nearby group, it is safe to consider a scene as nearby when not sure of which type of exposure to select.

(b) A semidistant view, which includes large shadow areas with important details and resembles a close-up in shadow importance, requires the same lens setting as a close-up.

(c) Long distance scenes do not usually have dark shadows, because atmospheric haze lightens the areas.

(d) A general procedure in photography is that the film is exposed for shadow areas and developed for the highlight areas.

(3) Cloudy Dull and Heavy Shade. If light from about half the sky strikes a subject, the situation is known as cloudy dull, or open shade, and requires an increase of three lens stops. If a subject is shielded not only from the sun, but also from most of the sky, it is in heavy shade, or closed shade, and an increase of four or more stops is needed. Examples of subjects in heavy shade are scenes in narrow streets and among tall buildings where, at a given angle, the sun is unable to penetrate.

(4) Direction of Lighting - Front, Side, and Back Lighting. The direction from which sunlight strikes a subject also has a bearing on exposure. A subject is brightest when the sun is behind the photographer as he faces the area to be recorded. This is called front lighting (Figure 4).

(a) Side lighting illuminates the subject from the right or left side (Figure 4).

(b) Back lighting illuminates the back of the subject and the photographer faces into the sun (Figure 4).

(c) To determine what type of lighting is involved, it must be remembered that it is in relation to the subject and not the camera or photographer.

(d) In investigative photography, details in shadow areas are more important than any artistic lighting effect. With this requirement in mind, side lighting requires a one stop increase over front lighting, and back lighting requires two stops more than front lighting.

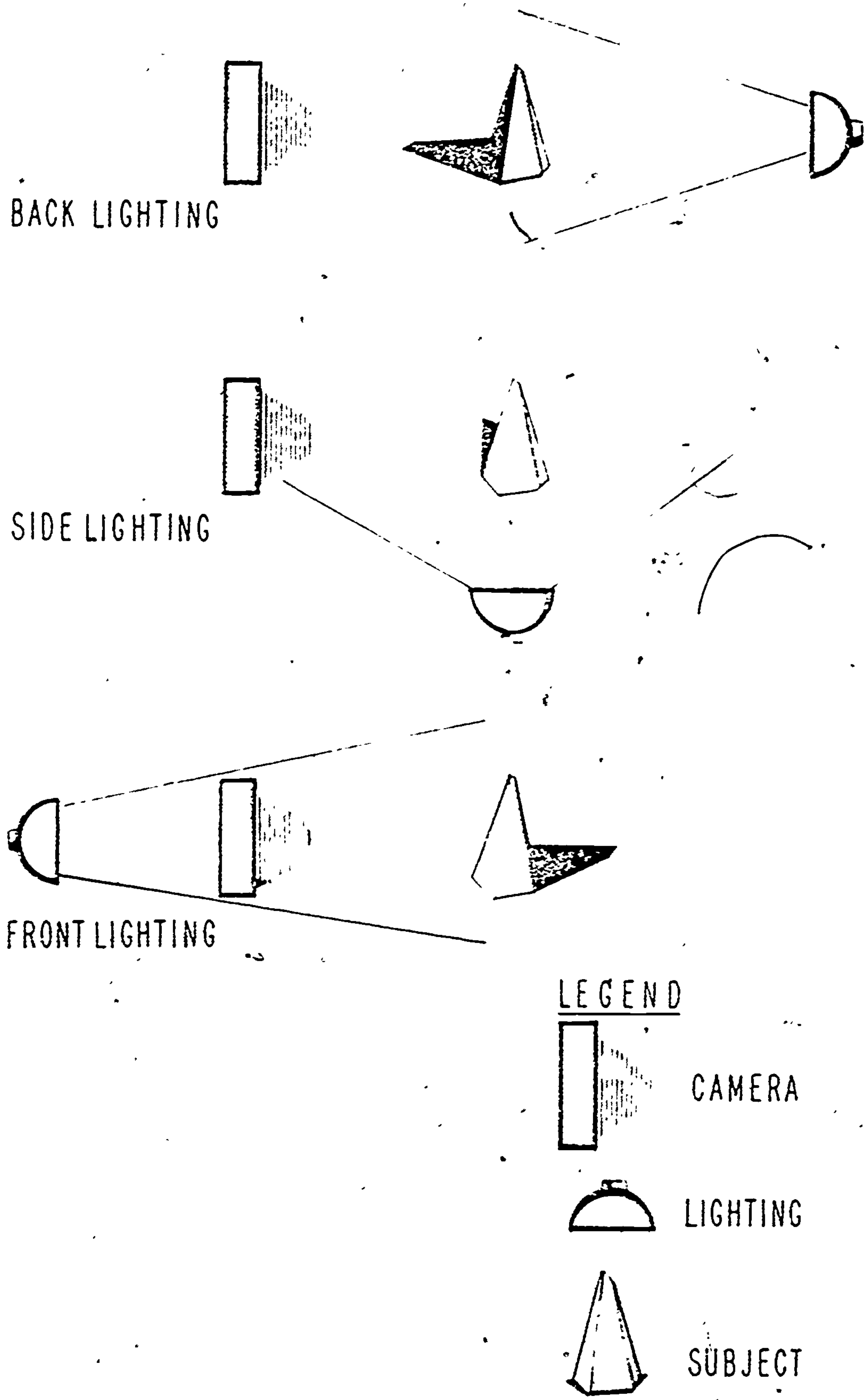


Figure 1 . Direction of lighting.

(e) The figures above apply only to subjects in bright or hazy sunlight, and not to subjects photographed on cloudy and overcast days. When daylight is sufficiently diffused and there are no noticeable shadows, the intensity of light falling on the subject is the major consideration.

(5) Effects on the Basic Exposure. Using the above information, some examples can best illustrate how basic exposure is affected.

(a) The selected film speed is ASA 200, therefore the shutter speed is 1/200. The illumination is a hazy sun with a bright subject. The aperture is found on the Daylight exposure chart to be f/16. At this point other factors are now considered. In this case there is back lighting of the subject. This calls for an increase in exposure of two stops. The exposure would then be shutter 1/200 of a second and lens aperture f/8.

(b) The selected film speed is ASA 25 - the shutter speed will then be 1/25. The illumination is bright sun average subject. Referring to the chart, the aperture is f/16. The picture requires shadow detail and it is considered a nearby scene. The exposure would be f/5.6.

4. INTERCHANGING THE F/STOP AND THE SHUTTER SPEED. In finding the correct exposure thus far, the camera's shutter speed has been limited to the ASA of the film being used, and the aperture setting has been determined by available illumination. The reason for limiting these related functions is to first find the correct exposure--the correct amount and duration (time) of light reaching the film to produce an acceptable negative. Once the correct exposure is determined, it may be necessary to use a different shutter speed or lens aperture setting. For example, the correct exposure is determined to be shutter speed 1/100 at f16, however, this aperture setting does not provide the required depth of field--f/32 is the only aperture that can provide the required depth of field. Can the picture be taken at f/32 aperture? Yes, it can, provided the shutter speed is changed to again agree with the aperture opening. The film still needs the same amount of light and as long as the combination of shutter speed and aperture setting provides that amount of light, the exposure will be correct. An important fact to remember is that once the correct exposure is determined, any adjustment of one of these two exposure factors demands an adjustment of the other factor. In the example above, the shutter speed would be reduced to 1/25 of a second for the f/32 aperture.

a. As the aperture is increased by one f/stop, twice as much light is allowed to reach the film as before. When it is reduced (decreased) by one f/stop, one-half as much light will reach the film. The shutter speed has the same relationship to light as the aperture. As the shutter speed is increased by one speed, one-half as much light is allowed to reach the film. In reverse, as the shutter speed is decreased by one speed, twice as much light is allowed to reach the film.

b. Once the correct exposure is determined, it remains constant (the same). Each time the aperture is changed, a corresponding change must be made for shutter speed to allow the same amount of light to reach the film. The aperture is increased by one f/stop--the amount of light on the film is twice the original amount, the shutter speed is therefore reduced, cutting the amount of light by one-half and the amount of light reaching the film is again the original amount, and the correct exposure. The relationship between the aperture setting and the shutter speed is that when the aperture setting is increased, a corresponding increase must be made in the shutter speed. In relation to light, the aperture allows more light in and the shutter is adjusted correspondingly, by admitting less light due to the faster speed of the shutter.

c. Assume that you have determined that the basic exposure is 1/100 second at f/11. However, with a rapidly moving subject, such as an automobile, you want to use a shutter speed of 1/400 second. Since changing the shutter setting from 1/100 second to 1/400 second reduces the amount of light reaching the film to 1/4, you must compensate by adjusting the lens aperture to assure a four times increase of the light permitted to reach the film. The f/stop that transmits four times as much light as f/11 is f/5.6. Therefore, a balanced exposure of 1/400 second at f/5.6 gives the same amount of light as the basic exposure of 1/100 second at f/11.

d. Whenever the correct exposure has been determined, other combinations of shutter speed and aperture setting can be easily found. The one combination which is usually selected will be the one which fulfills the requirements for the desired results.

5. SUBJECT MOVEMENT AND EXPOSURE. The main factors, which should be considered in action photography, are speed of the subject, angle and direction of the subject in relation to the camera, distance from the subject to the camera, and the focal length of the camera lens.

a. Speed of Subject. In some action photographs, the shutter speed must be calculated to insure that the recorded image retains a slight degree of motion. For example, the partial blurring of an individual's arm as he is throwing a ball shows that action is occurring. In this case, calculate the exposure for the most rapid movement, and then allow for the degree of movement to be retained. When it is necessary to prevent blur, the shutter speed must be so fast that subject movement during the exposure will not be apparent.

b. Direction and Angle of Moving Objects. Exposure time is affected by the direction of motion with respect to the camera axis. A subject moving directly across the field of view requires a faster shutter speed than one moving toward or away from the camera. When the direction of motion is at a 90° angle to the camera axis, the shutter speed must be faster than when the motion is at 45° to the camera axis.

c. Distance. The closer the moving object is to the camera, the faster must be the shutter speed required to arrest the movement. It is preferable to select the camera position and point of focus in advance if the type and path of the action are known factors, if this is at all possible. Proceed as follows:

(1) Select and focus on the spot where the action will be photographed. If there is no time to prefocus, judge the distance.

(2) To compute the exposure, use an exposure meter (para 6) to take a reading on an object lighted similarly to the subject being photographed.

(3) Then use the chart in Figure 5 to determine the shutter speed needed to stop the action.

(4) When the action starts, follow the action by panning the camera. To do this, follow the moving subject through the finder until the subject reaches the prefocused area.

(5) Trip the shutter when the subject is in the prefocused area.

d. Lighting Conditions. Light direction and resulting shadows are factors in determining the correct exposure for a given subject.

(1) A uniformly illuminated object, regardless of details or composition, will not provide the same disturbing emphasis of broken lines as the moving subject that accentuates shadow details created by sidelighting. Study carefully the subject matter to be recorded if motion is a part of the photographic problem.

(2) Whenever there is ample light, the selection of a high shutter speed is no problem. With poor lighting conditions, use a high speed film and a relatively large lens aperture.

e. Focal Length of Lens. The closer the photographer is to the subject to be photographed, the more critical the movement of exposure. Long focal length lenses may be used to move the action closer to the viewing position. However, the longer the focal length of the camera lens, the more critical the shutter speed to arrest the action.

f. Guides to Shutter Speeds for Subjects in Motion. The tables in Figure 5 can be used as guides in recording motion. For stopping action, with a small camera, the table gives approximate shutter speeds adaptable to various types of subjects moving at indicated rates of speed. The Press-Type camera tables gives approximate shutter speeds adaptable to various types of subjects. It is based on a circle of confusion of 1/200 of an inch, with a five-inch lens and a four by five-inch film size.

Approximate subject speed (miles per hour)	Camera to subject distance (feet)	Direction of motion					
		Two-inch lenses			Four-inch lenses		
		Movement of subject matter					
		Toward camera (second)	At 45° angle to camera (second)	At 90° angle to camera (second)	Toward camera (second)	At 45° angle to camera (second)	At 90° angle to camera (second)
5 to 10	25	1/50	1/75	1/100	1/75	1/100	1/150
	50	1/35	1/50	1/75	1/50	1/75	1/100
	100	1/20	1/35	1/50	1/35	1/50	1/75
10 to 20	25	1/100	1/150	1/200	1/125	1/200	1/300
	50	1/50	1/75	1/125	1/75	1/125	1/200
	100	1/35	1/50	1/100	1/50	1/75	1/100
20 to 30	25	1/125	1/200	1/300	1/200	1/300	1/500
	50	1/75	1/125	1/200	1/125	1/200	1/300
	100	1/50	1/75	1/125	1/75	1/125	1/200
30 to 45	50 to 100	1/200	1/350	1/600	1/300	1/500	1/800
45 to 100	100 and over	1/300	1/500	1/750	1/400	1/750	1/1,000

Figure 5. Shutter Speeds of Miniature and Small Cameras.

Approximate subject speed (miles per hour)	Camera-to-subject distance (feet)	Movement toward camera	Movement at 45° angle to camera	Movement at 90° angle to camera
5 to 10	25	1/100	1/200	1/400
	50	1/50	1/100	1/200
	100	1/25	1/50	1/100
[illegible] to [illegible]	25	1/200	1/400	1/800
	50	1/100	1/200	1/400
	100	1/50	1/100	1/200
[illegible] and faster	25	1/400	1/800	
	50	1/200	1/400	1/800
	100	1/100	1/200	1/400

Figure 6. Shutter Speeds of Press-Type Cameras.

6. LIGHT METERS; AN EXPOSURE MECHANISM. A light meter or exposure meter can be a very reliable aid in determining correct exposure. Again, this aid, though more reliable than the exposure chart, is mainly used as a guide. The final interpretation of lighting and camera factors, and picture requirements for the best exposure is the decision of the photographer.

a. Generally, light meters have photoelectric cells which convert light into an electrical charge which moves a needle on a calibrated scale. The more light there is, the more electrical energy is converted, and the farther the needle will be moved. The photographer adjusts for the films ASA, gets a light reading from the needle, turns a few dials, and the dials, when in alignment, give him a selection of several shutter and aperture combinations. There are two types of light meters. Reflected meters and Incident meters.

b. The reflected light meter measures the amount of light that is reflected from a subject. When light readings are taken with this type of meter, the photoelectric cells are pointed towards the subject.

c. The incident light meter measures the amount of light falling on a particular subject.

d. Light meters are most commonly desired for reflected light readings and this is the most frequently used type of meter (Figure 7). When using this meter on distant scenes, it is best to slant the meter slightly away from the sky as the sky is normally the brightest part of an average picture and it will affect the exposure reading. The type of photograph desired is determined before measuring the scene's light value. If shadow detail is important, measure the shadow area carefully. If the highlights are to be emphasized, the exposure reading should be of the highlights only. To try to obtain detail in each of these areas, both are measured and a compromise exposure setting is used.

e. The incident light meter is used near the subject, as in the reflective type, however, the photoelectric cells are pointed toward the camera lens when a reading is taken. This meter is very useful when there is weak illumination. It is also useful to obtain a uniform negative density for an average subject and scene. When there is an extended brightness range of the subject area, it should not be used.

f. Aids are sometimes used to obtain a useful exposure reading. Two common methods are - a gray card and a palm reading.

(1) The gray card is a neutral medium card, a foot and a half square, which is placed near the subject. A light meter reading is taken of the light reflected from the card. The purpose behind using the gray card is to get a consistent reading. Through experience, the photographer can determine which exposure is best for his purpose.

(2) A palm reading is obtained by using the palm of one's hand three or four inches from the meter, to get an exposure reading. Again, this reading is used to achieve consistency. The reading helps with negative development and the color sensitive meter. However, it is naturally more useful when skin tones are important.

g. Procedures for using the exposure meter are as follows·

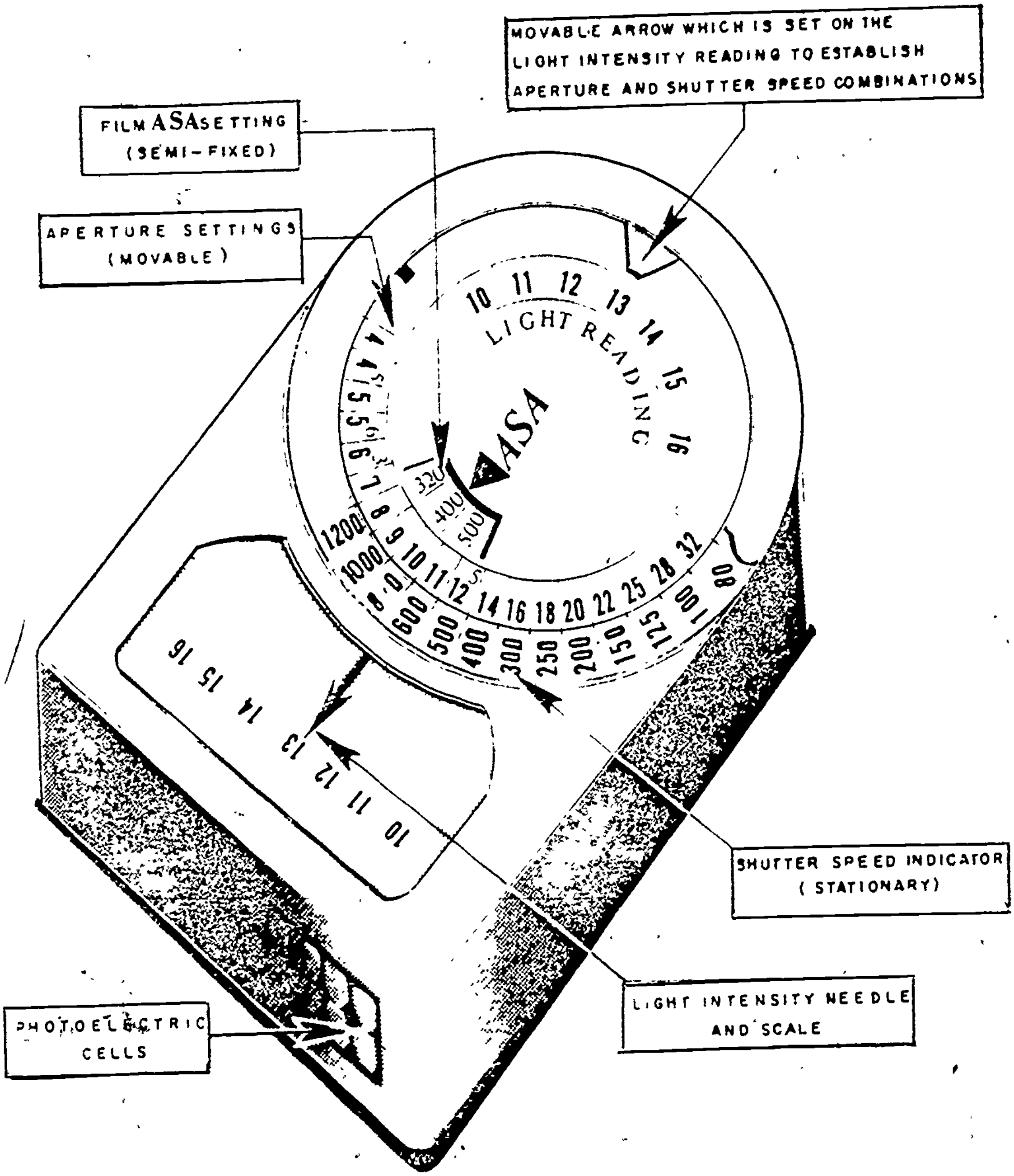
(1) Set the ASA film index number on the light meter (see Figure 3, ASA is set on 400). This setting will remain the same until a different film is used.

(2) Take a meter reading of the subject, keeping in mind the many factors discussed above. The reading in Figure 7 is 13.

(3) Set the moveable dial to correspond with the light value reading, as it is indicated by the light intensity needle. In Figure 7, the arrow is set at 13.

(4) You are now ready to read the aperture and shutter settings. Most exposure meters will give more combinations than any one camera may have, however all the combinations will give the same exposure results. The choice is the photographer's and depends on the picture results needed.

h. An exposure meter should be shielded from shock, strong magnetic influences, dampness, extreme heat, and sunlight. Never point a reflective meter directly at the sun.



1. SET EXPOSURE METER FOR THE FILM'S ASA NUMBER
2. TAKE LIGHT READING FROM SUBJECT
3. LINE UP THE MOVABLE ARROW ON THE METER WITH THE CORRECT LIGHT READING
4. DETERMINE WHICH COMBINATION IS NEEDED FOR THE REQUIRED EXPOSURE APPERTURE SETTINGS AND SHUTTER SPEEDS ARE ADJACENT TO ONE ANOTHER, (E.G. IN THE ILLUSTRATION 1/250 IS ADJACENT TO F/18)

Figure 7.

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7. EXPOSURE WITH ARTIFICIAL LIGHT - PHOTOFLOOD. Assuming a long enough exposure, almost any light intensity can be used to produce an image on a sensitive emulsion. However, dimly illuminated subjects often require an exposure too long to be practical. Accordingly, artificial light gives the photographer pictorial control. He can place light on different parts of a scene to achieve a variety of lighting. Special lamps have been developed for such purposes.

a. Flood Lamps. Flood lamps resemble home service lamps, but their filaments are designed to give more light of a bluer characteristic per watt than home service lamps. Sizes are designated by the numbers 1, 2, and 4, and relative light output is roughly proportional to the numbers. The letter B, sometimes used with the lamp number, indicates a blue glass lamp that adds the effect of daylight in color photography. The letter R, used with the lamp number, indicates a built-in reflector.

b. Determining Exposure. Floodlighting is usually below sunlight in intensity and requires the use of larger lens apertures or longer shutter exposures. Only flashlamps at close range approximate the intensity of sunlight. In addition, illumination from a lamp is inversely proportional to the square of the lamp-to-subject distance (inverse square law). When the distance between a lamp and a subject is doubled, only one-fourth as much light reaches the subject. When the distance between the light and the subject is tripled, only one-ninth as much light reaches the subject. Illumination also varies with lamp wattage, the efficiency of the reflector, the angle at which light strikes the subject, the use of diffusers, if any, and the actinic quality of the light.

(1) Lens settings for simple two-lamp setups, with lamp types and distances specified, can be determined quite easily. Approximate lens settings are given in computers and usually on film instruction sheets.

(2) More complicated lighting setups require the use of an exposure meter or test exposures. Once a photographer has become familiar with certain lamp setups, however, he can, through experience, duplicate camera and lens adjustments to obtain a particular pictorial effect.

8. EXPOSURE WITH ARTIFICIAL LIGHT - PHOTOFLASH.

a. Photoflash is the more common type of artificial light used in investigative photography. Although the following is a discussion of flash photography, keep in mind that floodlamps can be used in place of flashbulbs. The principal differences between flood and flash, and thus the advantages or disadvantages of one over the other, are that the:

(1) Light from a flashbulb shines for but a brief moment.

(2) A new flashbulb must be used for each exposure. The one true exception to this fact, the electronic flash, will be discussed later in this lesson. The four-in-one flash cubes are not an exception to this fact because they are really four separate flashbulbs built as one unit.

(3) Flashbulbs are more portable than floodlamps. Even though using flashbulbs requires a larger number of bulbs, the small size and weight of the bulbs and auxiliary equipment make flash equipment easier to carry. Also, floodlamps usually need to get power from commercial powerlines, whereas flashbulbs operate on batteries.

b. There are several varieties of flashbulbs. However, they are all similar in construction. There are, generally, four common types of bases - screw, bayonet, pinless, and glass (Figure 8). The type of lamp base used will depend on the type of socket found in the lampholder. The size of the bulb will depend on the size of the reflector.

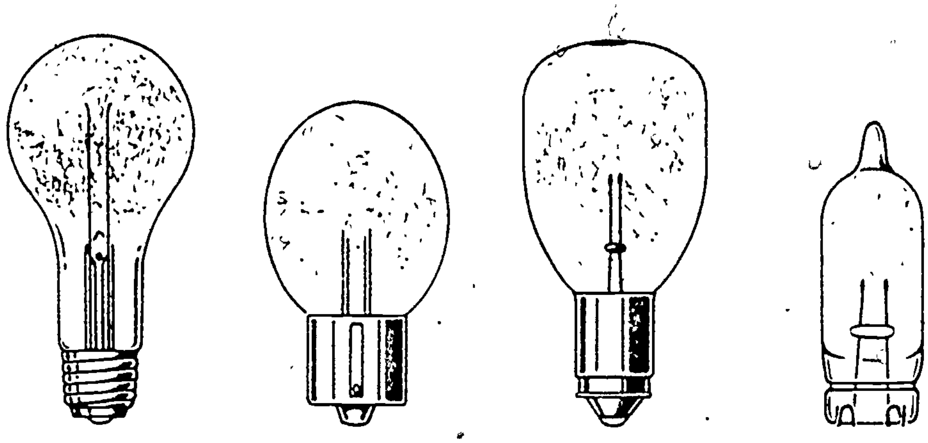

Figure 8. Flashbulb Bases.

(1) The effectiveness of a flash lamp is dependent to a large degree on efficiency of the reflector. The center of the flashbulb should be at the focal point of the reflector. If the bulb is not centered, the efficiency is reduced. Because reflectors vary a great deal in their efficiency, the information provided by the manufacturer is important.

(2) The light from a flashbulb is produced by burning metal. Wires connect the contacts on the flashbulb base to a primer (Figure 9). Electric current passing through the primer causes the primer to explode and

ignite the wire filling. The burning wire filling produces the light. The filling is a metal such as magnesium that will burn with a brilliant white light. Actually the color is reddish, but this is not visibly noticeable. The filling may be fine, loosely packed wire or a crumpled foil. Burning the wire filling requires oxygen, so the flashbulb is not evacuated as a household lamp is; the flashbulb contains oxygen. If, due to some fault in the lamp, there is not enough oxygen, there will be no flash. Many flashbulbs have a blue spot (actually a cobalt salt) on the glass that turns pink when there is not enough oxygen. DO NOT USE THE BULB when the blue spot has turned pink. The burning metal produces heat and explosive force as well as light. For safety, the glass is heat resistant and coated with a plastic to prevent the glass from breaking and scattering pieces. Even though modern flashbulbs have this safety feature, DO NOT FIRE BARE BULBS near other people. The lamp that you are using might be defective. It's not likely, but why take any chance when there are clear plastic covers for all types of reflectors that give added safety protection. Also, a handkerchief or other diffusing cover will provide protection and reduce the harshness of the light when you are photographing up close.

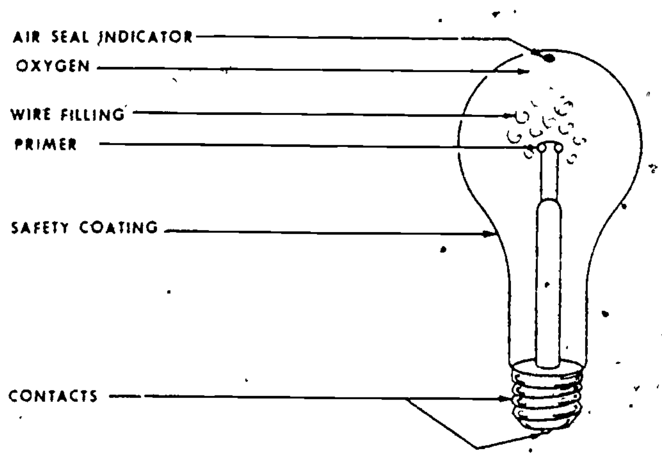

Figure 9. Flashbulb Construction.

c. Brilliance and Time Vary From Bulb to Bulb. To you the flash of a flashbulb may last just a moment, but when compared to the speed of your shutter the duration of the flash may be a very short or a very long time. Since the shutter must be open during the flash, you must consider the shutter action with the timing of the flash when selecting a flashbulb. Each flashbulb manufacturer prints data concerning brilliance and time about its own flashbulbs. The data may be printed in words, charts, or graphs and is usually packaged with the bulbs. Figure 10 is a typical graph of the flash of a flashbulb.

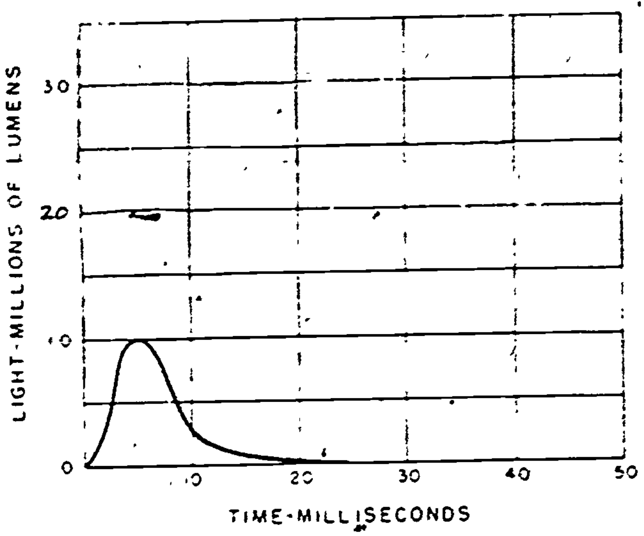

Figure 10. Typical Time-Intensity Curve.

(1) Let's look at the operation of the flash shown by the time-intensity curve in Figure 10. The vertical height shows the brightness in lumens. The horizontal scale shows the number of milliseconds (thousandths of a second), after the flash is triggered. For the first few milliseconds no light is emitted because it takes this long to fire the primer and ignite the filler. From 3 to 7 milliseconds the flash gets brighter because the burning is spreading through the filler. After a peak brightness at 7 milliseconds the brightness decreases as the filler is burned up. Different types of lamps have different time-intensity curves.

(2) The area under the curve indicates the amount of light available for exposure of the film; however, if the shutter opens too late or closes too soon some of the light will not be used. Look at the curve in Figure 10. A shutter speed of 1/200 second is 5 milliseconds, and if this shutter opens when the flash is triggered, the shutter will close before any light is available. At a shutter speed of 1/50 second (20 milliseconds) this same shutter closes before the peak of the flash, and less than half the light is used. Thus, the shutter must open and close at the proper time to get the most effective use of the flash.

(3) Timing is not the only difference between bulbs. Peak brightness, total light, and the shape of the time-intensity curve also vary with type of flashbulb.

d. There are many different types of flashbulbs.

(1) Class S lamps take a long time to fire and reach their peak brightness, and they produce a very brilliant light (Figure 11). Class S bulbs are best used with slow shutter speeds to illuminate large, open areas.

(2) Class M lamps are medium firing. They are faster than S lamps, but generally have a lower light output. This is the most common class of lamp used with synchronized, between-the-lens shutters (Figure 12).

(3) Class FP bulbs are about as fast as class M lamps in reaching their peak, but they remain at their peak for a long time. The fairly flat, long peak of Class FP flashbulbs assure even exposure with focal plane shutters. A focal plane shutter does not expose all of the film format at the same time, so the light intensity must remain constant as the shutter moves across the film plane to give the same exposure to all parts of the film (Figure 13).

(4) The newest development in flash photography is the flash-cube. This is a cube containing four miniature flashlamps, each with its own reflector. The cube rotates after each exposure, permitting you to take a series of four exposures without changing lamps (Figure 14). The lamps can be used only with cameras designed for them or in special adapters for other cameras.

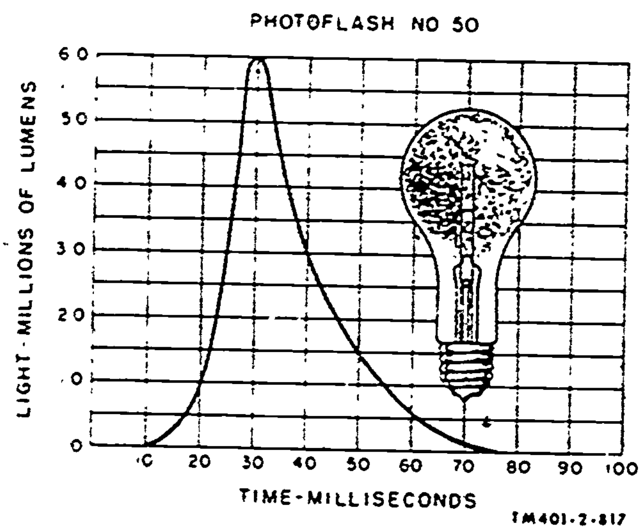

Figure 11. Class S flashbulb curve.

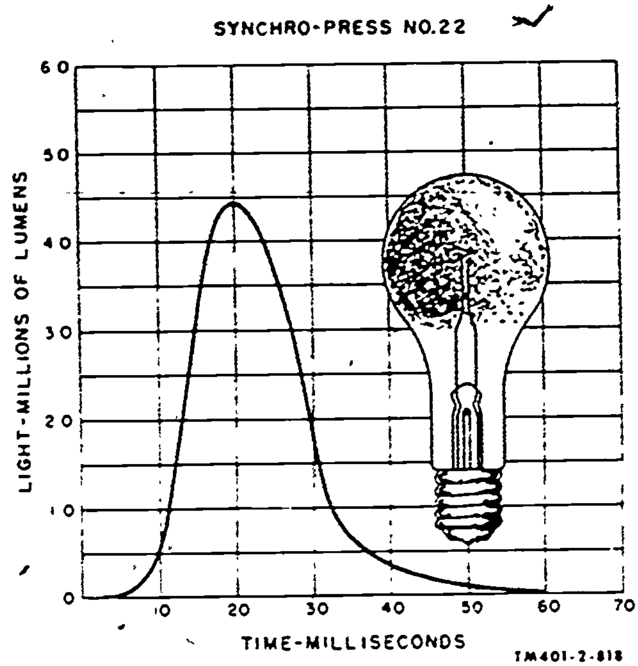

Figure 12. Class M flashbulb curve.

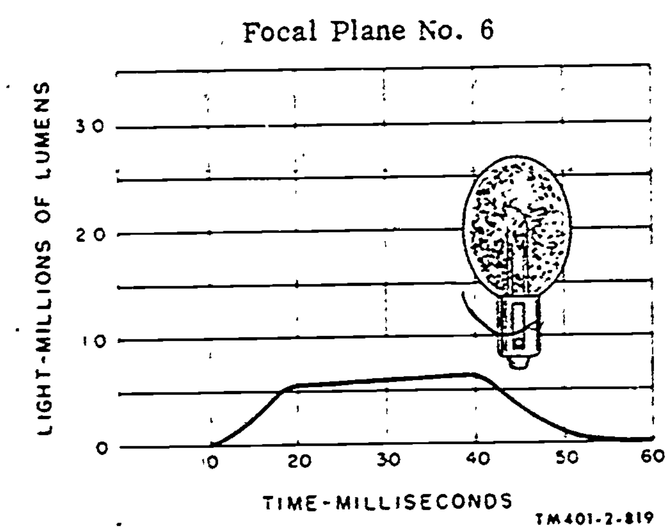

Figure 13. Class FP flashbulb curve

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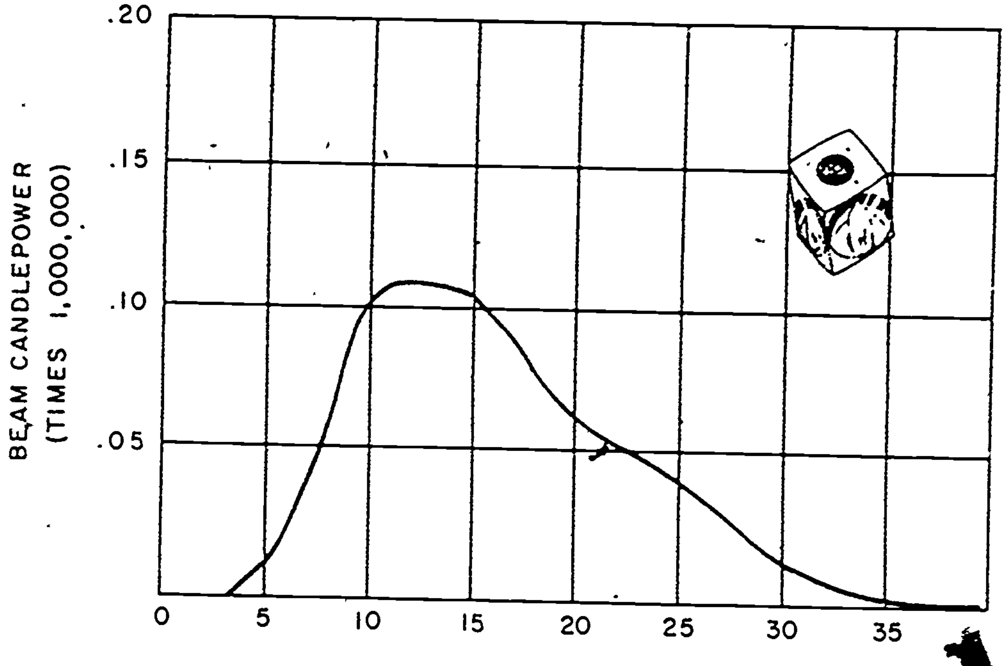

Figure 14. Flashcube curve.

d. An electronic flashlamp, also called a speed-lamp or repeating flash unit, produces light in the same manner as a fluorescent lamp.

(1). The reaction of an electronic flash unit is so quick that the flash is over in less time than it takes to open most shutters. Thus, X synchronization is often required. In X synchronization, the flash is delayed until the shutter is fully open, whereas in other types of synchronization you delay the shutter.

(2) Because electronic flash units are fast operating, shutter speed has almost no effect, and rapid photographs are possible. At very slow shutter speeds the shutter may not open fast enough, but this presents no problem with X synchronization. And for the shutter to cut off any of the flash its speed has to be 1/1,000 second or faster.

e. Guide Number Determines F/Stop. Exposure time is normally the duration of the flash and you control the amount of exposure by adjusting the lens opening. To make your calculation of the required f/stop easy, manufacturers of lamps print guide numbers for their lamps. Specific guide number data is packaged with the flashbulbs, and an example of the type of data is shown in the chart below. Figure 15 also lists some common flashbulb guide numbers.

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Film	Guide numbers in 2" to 3" polished reflector				
	F X or M 1/30th or slower	M Sync only			
		1/60	1/125	1/250	1/500
All Weather Pan	160	130	110	80	65
Kodacolor	70	55	48	34	28
Kodacolor-X	110	90	80	55	45
Panatomic-X	90	70	60	44	36
Plus-X	180	140	120	90	70
Verichrome Pan	160	130	110	80	65
Versapan	160	130	110	80	65

Figure 15. Sample Flashbulb Guide Numbers.

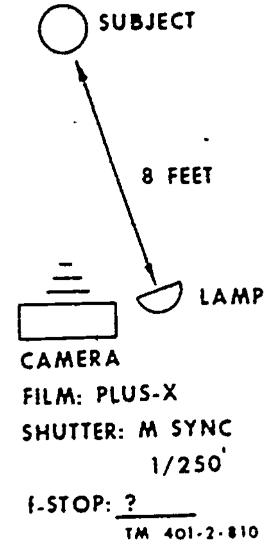

Figure 16. Problem to Determine f/stop.

(1) The required f/stop is determined by dividing the guide number by the lamp-to-subject distance. For instance, if the subject is 5 feet from the lamp and the guide number is 40, the f/stop is 40/5 or 8 (actually f/8). Work the problem in Figure 16 using chart in Figure 15.

(2) The answer to the problem in figure 16 is f/11 (90/8 = 11.25).

(3) The guide numbers stated by a manufacturer for a given lamp are based on subjects of average brightness, a particular reflector, and a given film speed. For dark subjects (people with dark colored clothing, brown or black objects), and for open areas, open an additional 1/2 or 1 f/stop. For light subjects (white clothing or light colored objects) and a closed-in area (near walls or low ceilings) close down 1/2 to 1 f/stop. A diffuse type of reflector requires one additional stop more than a polished reflector.

(4) Manufacturers' data generally state the guide number for many film speeds, and it is not difficult to determine the guide number for any ASA value if you know the guide number for one ASA value. To find the (new) guide number for a (new) ASA value; multiply the old (known) guide number by the square root of the quotient of the new ASA value divided by the old ASA value as shown by the following formula:

$$\text{New guide number} = \text{old guide number} \sqrt{\frac{\text{new ASA value}}{\text{old ASA value}}}$$

For example, if the guide number for an ASA of 100 is 50, then the guide number for an ASA of 200 is

$$50\sqrt{\frac{200}{100}}$$

$$50\sqrt{\frac{200}{100}} = 50\sqrt{2} - 50 \times 1.4 = 70.$$

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9. LIGHTING EFFECTS AND EXPOSURE. Artificial light, both photoflood and photoflash, can be used in different ways. Although photoflash is still the main point of interest, many of these techniques also apply to photoflood.

a. Open Aperture for Diffuse or Bounce Flash. Except when the flash is mounted on the camera, flash lighting generally is very harsh with strong highlights. To soften the lighting and make it more natural you can use diffusing or bounce techniques.

(1) To diffuse the flash you can use a diffusing reflector, a diffusing shield, or ~~simply~~ place a standard man's cotton handkerchief over the flash. A diffusing reflector has a rough surface, while the polished reflector has a smooth mirror finish. The diffusing shield is a piece of translucent plastic that fits over the front of the reflector.

(2) Each of the above mentioned diffusing devices reduces the intensity of the light by about one-half; thus, you must open the lens one additional stop.

(3) You must also open the lens for bounce flash. Bounce flash is the technique of reflecting the light off a wall, ceiling, or other surface to get a diffused or more natural lighting of the subject. To determine the lens opening with bounce flash, use the distance that the light travels to the subject. That is, the distance from the lamp to where the light hits the wall plus the distance from where the light hits the wall to the subject (Figure 16).

b. Flash-on-Camera Gives Flat Lighting. Mounting the flash on the camera is a convenience that gives the photographer freedom of movement and ability to make exposures quickly with assurance of fairly good lighting. However, do not limit the quality of your photographs by becoming lazy and using flash-on-camera techniques exclusively.

(1) Flash-on-camera gives flat lighting. There are no shadows in the picture because the flash illuminates almost every area that can be seen by the camera. Shadows give depth to the picture and body to the subject. Without shadows the photograph loses some of its ability to produce the optical illusion of the three dimensions, and consequently it appears flat.

(2) Because illumination decreases with the square of the distance, flash-on-camera is likely to result in overexposure of near objects and underexposure of far objects.

(3) Flash-on-camera is best used as a secondary or fill-in light to bring out the details in shadows created by a key light that is off to one side.

c. Flash Off to One Side Gives Form. Lighting the subject from one side produces shadows that the camera records, and these shadows create the illusion of depth, form, and texture. The light should not be directly to one side of the subject but somewhere between head on and to one side. Even holding the flash at arms length to one side of the camera will improve the quality of the photograph.

(1) Another advantage of having the light off to one side is that it will give a more even illumination of deep scenes. If you place the light off to one side, the distance from the light to the front of the scene is about the same as the distance from the light to the back of the scene. When the scene is very deep use more than one light.

(2) Flash can also be used as separation light, to light the background, or to silhouette the subject.

(3) The disadvantage of side lighting is the loss of detail in shadow areas, but you can overcome this by using multiple flash.

d. Multiple Flash. Flash off to one side (key lighting) gives form and texture to the photograph; flash on the camera (fill-in lighting) brings out shadow details; and lighting the background or back of the subject (separation lighting) separates the subject and the background giving depth to the picture. You can take advantage of all these forms of lighting in one photograph by using many flashbulbs in a synchronized multiple flash.

e. Lighting Ratio. The lighting ratio is the ratio of the illumination of the highlights to the illumination of shadows. The lowest possible ratio (1:1) means that the highlights and shadows are lighted to the same extent. At 2:1 the highlights have twice the light of the shadows; at 3:1, three times the amount; and so on (Figure 18).

(1) A lighting ratio of 1:1 is used principally for copying or where any shadow is undesirable. To get a 1:1 ratio requires a careful balancing of lights so that there are no shadows and so that the lighting is the same throughout.

(2) A lighting ratio of 2:1 results in faint shadows with high detail in the shadows. The bright shadows of a 2:1 ratio retain color purity in color film, permit good rendition of mechanical objects, and reduce the burned out

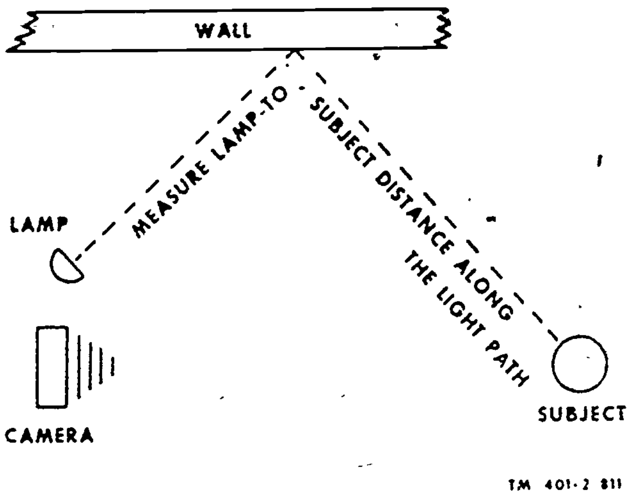

Figure 17. Lamp to Subject Distance.

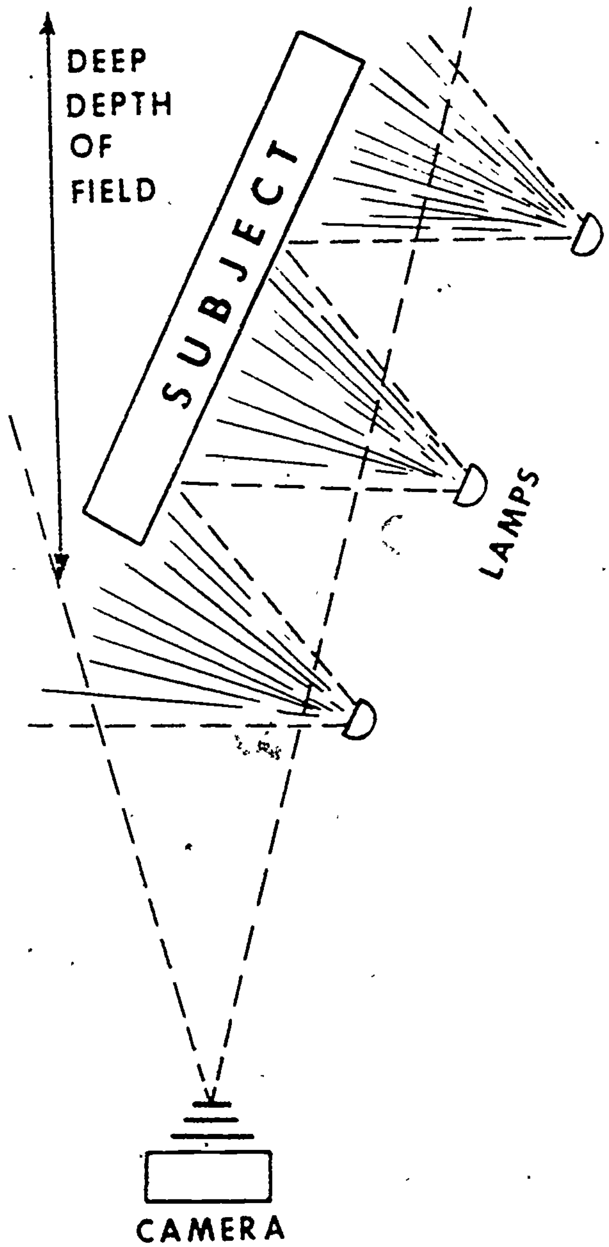

Figure 18. Lighting Great Depths.

effect of highly reflective highlights. The 2:1 ratio is obtained by using equal lights from key and fill-in lights. Even though they are of equal intensity, the highlights will be brighter because they receive light from both lamps, whereas the shadow areas are illuminated only by the fill-in light.

(3) A 3:1 lighting ratio is the result of having the key light supply twice the illumination of the fill-in light (Figure 17). The shadow areas are very noticeable without too much loss in shadow details. The 3:1 ratio is good for most black and white pictures, especially activity shots and portraits.

(4) As the lighting ratio increases, the shadow area gets effectively darker and darker, and, depending on the latitude of the film, the shadow details are soon lost completely. The higher ratios are used for dramatic effects.

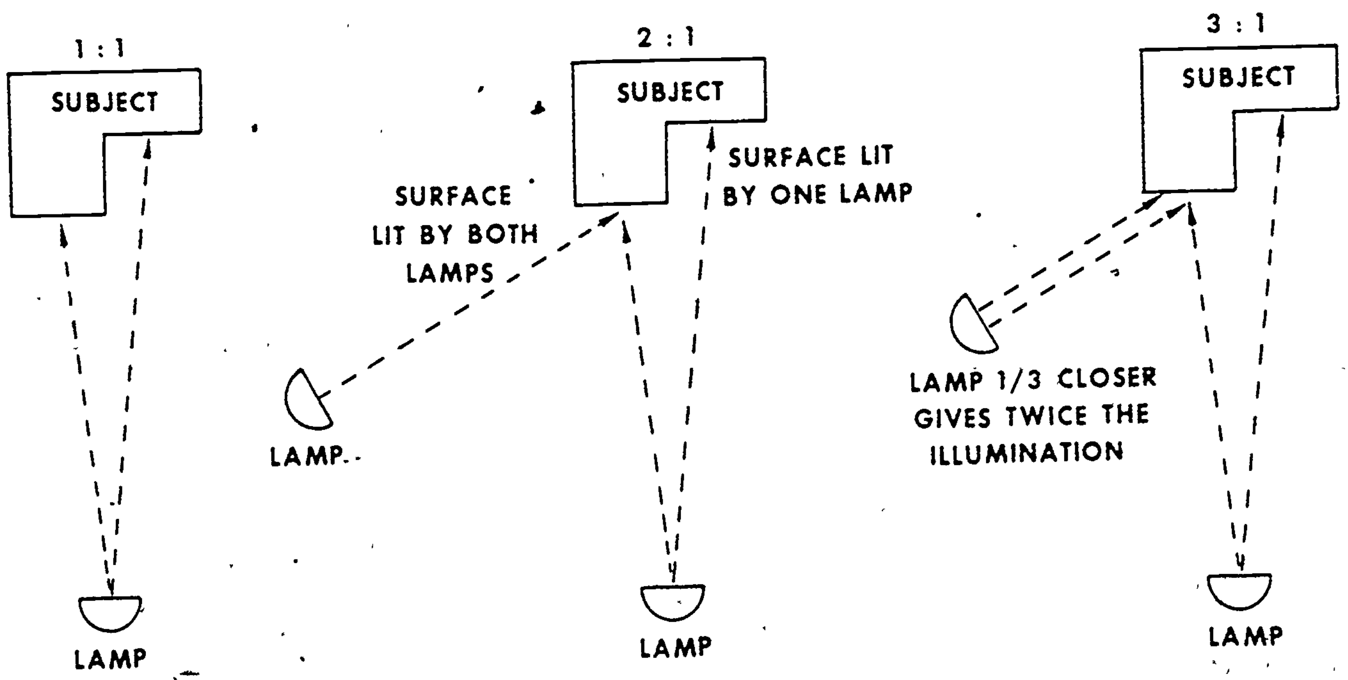

Figure 19. Lighting ratios.

f. Use of Flash in Daylight. Night and indoor shots are not the only situations when you use flashbulbs. You might use them to replace one or more photoflood lamps. Perhaps you might use photofloods for fill-in and separation light, while using the flash as a main light to reduce the strain on the subject caused by the bright lights. You can use flashbulbs in sunlight to lower contrast, increase shadow detail, and add brilliance. On dull, overcast days you might get flat, uninteresting pictures, but if you use a flash it can add sparkle, form, depth, and sharpness to a photograph taken on a dull day. On a bright, clear day the sun creates deep, dark shadows. A flash can lighten the shadows, bring out details in the shadows, and reduce the overall contrast to remove the cutting sharpness of a bright day.

(1) On bright, sunny days use the sun as the key light and the flash as a fill-in light.

(2) Use Sun as Fill-In on Dull Day. On dull, overcast days use existing light as a fill-in light and flash as the key light. Set your exposure for the type of daylight, and then position your flash to simulate the sun.

(3) Use Flash to Balance Sun. When you photograph indoors where the bright daylight is visible through a door or a window, and when you photograph in deep shade where bright patches of sunlight are visible, the extreme variation of lighting may be too much for the film. These situations are easily handled by the human eye, but the resulting photograph is so dark in the shade areas and so white in the sunlit areas that the details of both are lost. To overcome this effect and get an indoor-outdoor balance, you can use a flash to lighten the shady area. Set the exposure as though the entire scene were receiving the same light as the sunlit areas, and position the flashbulb according to the formula. You may need more than one lamp to get even lighting throughout the entire indoor or shaded area.

10. FILTER EFFECTS. In Lesson 1, we learned that white light (sunlight) is composed of all colors of the spectrum, and that each color has its own characteristic wavelength. When a colored glass filter is placed in a beam of white light, the color composition of the light is altered. According to its color, a filter will absorb some wavelengths and transmit others.

a. Of all the colors of the spectrum, three are designated as primary colors, red, blue, and green. The remaining colors are combinations of these three colors and are called secondary colors. The secondary colors are found in the area of the spectrum where the wavelength of two primary colors merge. For example, green has a wavelength of 500-600 millimicrons (see Lesson 1, para 3a (2)); and red's wavelength is 600-700 millimicrons (mn). Yellow is made of green and red, and has a wavelength of 600 mn. As the wavelength of green becomes longer it merges with the shortest wavelength of red. The overlap of the two wavelengths produce the secondary color - yellow.

b. Each color has a complementary color, and when combined they will produce white light. For example, yellow is the complementary color of blue. Yellow is composed of red and green. By the addition of blue, all primary colors are present and the product is white light. To facilitate determining complementary colors, a color wheel can be used (Figure 20). The colors on the upper portion of the wheel represent the red end of the spectrum and are warm colors. Those on the bottom portion represent the blue end of the spectrum and are cold colors. To find a complementary color, select the primary color first. The complementary color is directly opposite on the other portion of the wheel. For example, the complementary color of red is blue green (Figure 20).

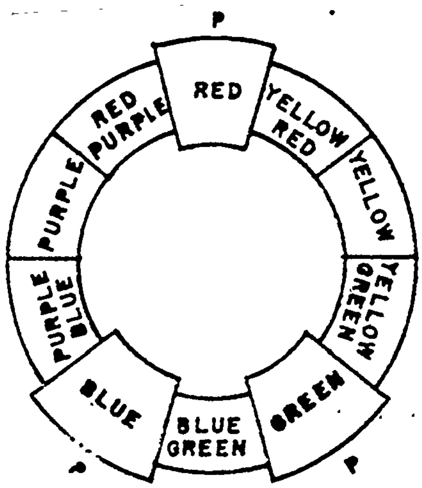

Figure 20. Color Wheel.

c. When a filter is placed over a lens it does two things. It lightens its own color and darkens its complementary colors. Because a filter selectively absorbs certain colors, it appears colored. A red filter appears red because it absorbs blue and green and transmits red. A blue filter absorbs red and green, and a green filter absorbs blue and red. A filter which absorbs only blue appears yellow because it transmits red and green. Absorption means that the filter will not pass that particular color. Thus a red filter will not pass blue or green. If a red object is photographed with a red filter any objects in the scene which are blue or green will be darkened and the red object will be lightened in the final print. The reds will be darker on the negative since the red light is all that is being transmitted.

11. FILTER TYPES. For general photographic purposes, there are two classifications of filter. They are correction filters and contrast filters.

a. Correction Filters are used to correct the color-sensitivity balance of black and white films. The human eye is more sensitive to green and yellow than are film emulsions. The film emulsion is more sensitive to blue. To render colors in their relative brightness, as seen by the human eye, a filter is used to change the sensitivity of the film, making it more responsive to yellows and greens. Usually correction filters are yellow.

b. Most photographers use filters to create contrast. Although two colors may be different, if their brightness value is the same they will reproduce as almost the same shade of gray in a black and white print. To create the needed contrast, a contrast filter is used. A classic example is a red apple and the green leaves of its stem. Red and green reproduce as almost the same shade of gray. Either of two filters can be used to create contrast between them. A red filter will darken the leaves and lighten the apple and a green filter will do just the opposite. There are four basic filters used for contrast:

(1) Red (A).

(2) Orange (G).

(3) Yellow (K-2).

(4) Green (X-1).

c. There are certain procedures that can be of help in determining proper filter selection. The subject should be examined to determine how various colors should be photographed to show texture or pattern, or how to create contrast between two or more colors. Some color shades are obvious enough to indicate the correct selection. In some instances viewing the subject through the filter will enable you to make the correct determination. To simplify filter selection the following chart may be used.

d. Not all filters can be used with all films. However, it is safe to say that any filter can be used with panchromatic film (see Lesson 4, para 3), since it is sensitive to all colors. Manufacturers instructions for films should be referred to for correct determination of filter use.

COLOR OF SUBJECT	LIGHTER	DARKER
RED	A or G	C 5*
GREEN	X-1 or C 5	C5 or A
BLUE	C 5	A or G
YELLOW	K-2, G or A	C 5
ORANGE	G or A	C 5

**The C5 filter is blue*

Figure 21. Color chart.

12. FILM FACTORS. Since a filter absorbs some of the colors contained in white light, it is obvious that some of the intensity of the light is lost as well. Therefore, some compensation must be made in exposure. The amount of compensation is determined by the color and shade of the filter. The amount of correction is given for each filter by the filter's factor.

a. The filter factor is a number that indicates the number of times the exposure must be increased to equal the amount of light that would reach the film if the filter were not used. For example, a yellow K-2 filter has a factor of 2. This means the exposure must be increased twice. This can be accomplished by opening up one f/stop or doubling the exposure time. If the basic exposure was 1/50 second at f/8 without the filter, the exposure with the filter could be either 1/50 second at f/5.6, or 1/25 second at f/8. Listed below are the exposure increase factors for the most often used filters, for Plus-X Panchromatic film.

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FILTER	COLOR	EXPOSURE FACTOR	NUMBER OF F/STOP CHANGES OUTDOORS
A	*RED*	8	3F/ STOP
X — 1	*GREEN*	4	2F/ STOP
G	*ORANGE*	3	1-1/2F/ STOP
K — 2	*YELLOW*	2	1 F/ STOP

Figure 22. Filter Factor Table.

EXERCISES

REQUIREMENT. The following exercises are multiple choice. There are four alternatives to each exercise. You are to select the one alternative that is correct and indicate your choice by circling the correct response directly on the exercise booklet.

1. The usual starting point for exposure is to have

   a. the film speed in agreement with the shutter speed.

   b. the shutter speed in agreement with the lens aperture.

   c. the lens aperture in agreement with the focal length.

   d. the focal length in agreement with the film speed.

2. Which of the following is not a classification of daylight illumination?

   a. Bright sun.

   b. Hazy sun.

   c. Cloudy bright.

   d. Hazy dull.

3. The four classes of subject brightness are

   a. white, yellow, red, black.

   b. brilliant, bright, average, dark.

   c. bright, average, dull, dark.

   d. brilliant, bright, shadow, dark.

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4. The amount of light reflected from a dark subject is about

a. 9%.

b. 11%.

c. 13%.

d. 15%.

5. Joe is taking a picture of an accident. The scene is a downtown street, at noon, on a cloudy day. Many bystanders will be in his picture. The bystanders cast weak shadows. His lens aperture, using Figure 3 (The Daylight Exposure Chart), should be

a. f 5/6.

b. f/8.

c. f/11.

d. f/16.

6. At what time of the day is there the greatest loss of blues in the rays of the sun?

a. 7 a.m.

b. 9 a.m.

c. 11 a.m.

d. 1 p.m.

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7. If light from about half the sky strikes a subject, the situation is known as cloudy dull, or open shade, and requires an increase

a. in focal length.

b. of six lens stops.

c. of three lens stops.

d. of one lens stop.

8. The amount of light that is admitted as the aperture is increased by one f/stop is

a. one-quarter as much.

b. one-half as much.

c. twice as much.

d. the same, since there is no connection.

9. How much light will be allowed to reach the film if the shutter speed is decreased by one speed?

a. One quarter as much.

b. One half as much.

c. Twice as much.

d. Shutter speed does not affect the amount of light.

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10. Of the following, which direction of motion requires the fastest shutter speed?

a. Toward the camera.

b. Stopped 15 feet from the camera.

c. Away from the camera.

d. Across the field of view in front of the camera.

11. Which of the following distances, away from a camera, would require the fastest shutter speed to stop the motion of a racehorse?

a. 10 feet.

b. 20 feet.

c. 30 feet.

d. Shutter speed is not a factor here.

12. Two factors in determining the correct exposure for a given subject are.

a. light direction and resulting shadows.

b. focusing distance and film type.

c. type of viewfinder used and film ASA number.

d. shadow areas and camera focal length.

13. A means of correcting for poor illumination is

a. to move closer to the subject.

b. use of a relatively large lens aperture.

c. use of a lower ASA film.

d. a higher shutter speed.

14. Light meters are normally powered by

a. transistors in the meter body.

b. the heat contained in light, which is converted to electrical energy.

c. pin cell batteries in the meter body.

d. light energy, which is converted into mechanical power.

15. Step one in taking a light meter reading is to set the

a. f/stop scale.

b. ASA index number.

c. shutter speed scale.

d. foot-candle scale.

16. The letter which indicates a floodlamp that adds the effect of daylight to color photography is

a. B.

b. R.

c. D.

d. C.

17. Floodlighting usually acquires the use of larger lens apertures because

a. it compensates for harsh bluishness of the light.

b. it is usually below sunlight in intensity.

c. artificial lighting changes focal length.

d. floodlighting causes more shadows.

18. The effectiveness of a flash lamp is dependent to a large degree on

a. the power available.

b. the type of base used.

c. the efficiency of the reflector.

d. the size of the bulb.

19. The class of flashbulb which is normally used with focal plane shutter cameras is

a. S.

b. FP.

c. M.

d. B.

20. Answer the following problem using Figure 16. Flash subject distance is 15 feet. Kodacolor film is being used. The shutter speed is M synchronized at 1/125 of a second. What is the correct f/stop?

a. 1.4.

b. 2.

c. 3.2.

d. 4.

21. A problem with flash-on-camera techniques is the

a. absence of blue light.

b. inability to adjust the lens aperture.

c. the underexposure of near objects.

d. lack of shadows.

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22. Yellow light and blue light, when combined will produce

a. green light.

b. black light.

c. white light.

d. blue light since it is primary.

23. A filter

a. lightens its own color.

b. lightens into complementary color.

c. darkens its own color.

d. darkens its own color and its complementary color.

24. A correction filter is used to

a. change focal length.

b. bring out blues that are not normally seen.

c. create contrast.

d. change a film's color sensitivity.

25. If a filter factor is 4, it requires

a. a decrease of 4 x the original exposure.

b. a decrease of 2 f/stops.

c. an increase of 2 x the original exposure.

d. an increase of 2 f/stops.

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LESSON ASSIGNMENT SHEET

SUBCOURSE NO. 4-12 I	Investigative Photography.
LESSON 6	Photographic Chemistry and Processing.
CREDIT HOURS	4.
TEXT ASSIGNMENT	Attached Memorandum.
MATERIALS REQUIRED	None.
LESSON OBJECTIVE	To provide you with general and specific information necessary for you to understand and put into practical use the various processes and materials involved in photographic development and processing.
SUGGESTIONS	None.

ATTACHED MEMORANDUM

This attached memorandum includes information extracted from resident instructional material of the United States Army Military Police School and TM 11-401-1. In case of conflict between the attached memorandum and other publications, the material contained in the attached memorandum will apply to this lesson assignment.

1. INTRODUCTION. Most individuals, at one time or another, have loaded a camera, taken some snapshots and removed the film for "development" at the local drug store. They usually do not know what is involved in the developing process, but they do know that they will receive their snap shots back in a more meaningful form--a picture. However, at the point of removing the film for development a long and complex process has only started. Actually, the word "development", as used above can be divided into two separate phases; development of the film into a negative and the printing of the negative.

2. NEGATIVE DEVELOPING SOLUTIONS. The development of a negative is a chemical process which entails five different steps in the following order: actual development, a rinse bath, a fixing bath, washing, and drying.

a. Before discussing these processes, there are some general factors which must be pointed out.

(1) When working with photographic chemicals and light sensitive materials, cleanliness is a must. Work areas must be clean and free of extraneous objects. If this is not done the negative may be worthless before it ever gets into the developing solution.

(2) Chemicals, whether they are for negative development or printing, are set up from left to right. This standard procedure was established to avoid mistakes in processing. Also, when using these chemicals do not go back to the previous solution in the chain. This may destroy the negative and it will definitely affect the chemicals themselves.

b. The developing solution is the first chemical solution to be used. This solution is composed of many different chemicals which have various functions. There are also a variety of developers which act differently on the film, i.e., they produce different results. The different solutions generally include a reducer, a solvent, an accelerator, a preservative and a restrainer. These chemicals are obtainable separately in powder form and then mixed with water, or as a ready-mixed solution.

(1) Reducer. The basic ingredient in the development solution is the reducer. When a sensitized emulsion is exposed to light, the silver halides forming the latent image are so weakened by the action of light that they can be reduced to metallic silver. This reduction produces a visible image. In this reduction process, a chemical compound, the reducing agent, combines with oxygen and reacts with the exposed silver halides in the film emulsion. If used alone, however, this reducing agent will have very little or no effect on the silver halides, since it has a low rate of oxidation. Therefore, an accelerator must be added to the developer.

(2) Solvent. The solvent softens and swells the emulsion and allows the chemicals in the solution to penetrate.

(3) Accelerator. An accelerator, or alkali, is used to increase the rate of oxidation of the reducing agent. This accelerator energizes the reducer by increasing its rate of oxidation, softens the gelatin of the film emulsion, and speeds up solution penetration. However, a solution containing only a reducer and an accelerator will oxidize quickly and act too rapidly. Therefore, it becomes necessary to add a restrainer to the developer to prevent chemical fog (a veil of silver deposited throughout the entire emulsion), and rapid deterioration of the solution.

(4) Preservative. All organic development agents, in an alkali state, have a strong chemical attraction with oxygen. Therefore, it is necessary to add a preservative to the developing solution to prevent excessive oxidation. A preservative prolongs the usefulness of the solution and prevents the formation of colored oxidation products which cause stains.

(5) Restrainer. Because the reducer and an accelerator oxidize in solution, a restrainer is added to slow down the deterioration process.

c. The next step in the development process is the rinse bath, sometimes called short stop or stop bath. When a negative is removed from the developing solution, the emulsion is soft and small amounts of developer remain in the emulsion and on its surface. If the developer is not removed, it will continue its development action and cause stains. To remove surplus developer, the negative or print is placed in a rinse bath. There are three general types of rinse baths: water, acid, and hardening. Each has its specific purpose and should be used accordingly.

(1) Water Rinse Bath. As a rinse, water helps to retard continued development by removing excess amounts of developer from the film and helps to prevent some contamination of the fixing solution. However, if it is used alone it will dilute the fixer. In many cases it is not used or it is used in combination with the acid bath. The water is first used to rinse the negative and then the acid bath is used.

(2) Acid Bath. An acid rinse is more effective than water as it neutralizes the chemical action of the developer and also lengthens the usefulness of the fixer.

(3) Hardening Rinse Bath. A hardening bath is used only when development is done in high temperatures or under tropical conditions. Under ordinary conditions the hardener in the fixing solution is sufficient and the procedure is not used.

d. The fixing solution is usually the last chemical solution used in developing the negative. When film development is completed, the emulsion contains a metallic silver image and a residue of unchanged silver halides.

(1) The metallic silver image is that portion of the emulsion affected by camera exposure. Subsequent chemical treatment of the latent image by the developer compounds brings forth the image.

(2) The unchanged silver halides are that portion of the emulsion not affected by camera exposure. If subjected to exposure by light during development, these unchanged silver halides immediately react to the exposure, decompose, and destroy the image. Therefore, it is necessary to fix the image.

(3) The primary purpose of fixation is to convert insoluble silver halides into a soluble form.

(4) The fixer, like the developer, is made up of many different chemicals and comes either as separate ingredients or in a pre-mixed form. These ingredients include the fixer, neutralizer, preservative, and hardener.

(5) All fixing baths contain a silver halide solvent, called a fixer or fixing agent. The chemical most widely used for this purpose is sodium thiosulfate, more commonly called a hypo. Sodium thiosulfate changes the silver halides to a compound that is soluble in water. Fixation makes unwanted silver halides soluble. This conversion from solid to liquid continues until all unchanged silver halides have been transformed. The two phases of fixation are--

(a) The gradual spreading of the thiosulfate into the gelatin of the emulsion layer.

(b) The chemical reaction of the chemical with the unchanged silver halides, thereby producing soluble products.

(6) Acid or Neutralizer. The pores of an emulsion retain a considerable amount of developer, which will continue its activity if allowed to remain. To prevent interaction between the preservative and the hardener, acetic acid is added to the fixing bath. It stops development and prevents staining, while neutralizing the alkalinity of the developer.

(7) Preservatives. When enough acid is added to the fixing bath to neutralize the alkalinity of any remaining developer, the hypo is decomposed into free sulphurous acid. This makes the bath unusable. To prevent decomposition of the fixing bath, sodium sulfite is added to the solution to serve as a preservative. Sodium Sulfite combines with the sulphur to form a new hypo, prevents discoloration of the solution, and aids in the elimination of stains.

(8) Hardener. Emulsions become soft and swollen during development, and undesirable effects, such as frilling and scratching, may occur if processing is continued without hardening the emulsion. The most common practice is to include a hardening agent in the fixing bath, so that the emulsion can be fixed and hardened at the same time. The most common hardening agent is potassium alum.

e. Washing the negative involves the last solution to be used, which is normally plain water. Washing completes the movement of all unwanted material out of the emulsion, disposes of hypo and other minute residue so that the negative will not be subject to chemical decomposition or staining.

f. After the negative is washed, it must be dried before printing. Drying involves hanging the negative in a location which has a good circulation of warm, dry, dust-free air. Surplus moisture should be removed from the negative before or as it is hanging. This moisture may cause spots on the film's surface. These spots can be removed by photographic sponges, which must be kept clean of chemicals, and dirt, that could damage the negatives. Also available is a wetting solution into which the negative can be dipped and which helps to prevent water spots from forming. Drying time for a negative depends on the condition of the air.

3. EFFECTS OF DEVELOPER AND NEGATIVE DENSITY. To this point, control of light has been a key factor in getting a good negative. Now, at the point of development, the time of development and type of developer become control elements in getting a good negative.

a. Time of Negative Development. The time of development is usually determined by the type of film and the type of developer used.

(1). For normal development, instructions are usually supplied by the film manufacturer and developer manufacturer. A sample type of film instructions for development is shown in Figure 1.

(2) The time required, or speed, of the developing action is determined by the developer and the type of film. Figure 1 shows that brand A developer takes less time than brand D. A similar table, as in Figure 1, will be inclosed with the developer only instead of brand of developer it will be brand or type of film.

(3) Time has an effect on different parts of the negative. In the lesson on exposure it was stated that one should expose the film for the shadow area and develop for the highlights. The reason for this is that, in the initial phase of development, the developer affects the density of the shadows and the highlights to approximately the same degree. As the developing action continues, however, highlight area of the negative become more dense. Therefore, if exposure is made for shadow areas, development time can be shortened, thus compensating for overexposing the highlights. Experience is the best guide here, and it cannot be accomplished in extreme high light and shadow subjects (see Figure 2).

BRAND NAME OF PACKAGED DEVELOPER	DEVELOPMENT TIME IN MINUTES					
	TANK			TRAY		
	65 F	*68F	70F	65F	*68F	70F
A	$5\frac{1}{2}$	5	$4\frac{1}{2}$	6	$5\frac{1}{2}$	5
B	6	$5\frac{1}{2}$	5	$6\frac{1}{2}$	6	$5\frac{1}{2}$
C	7	$6\frac{1}{2}$	6	8	$7\frac{1}{2}$	7
D	10	8	6	12	10	8

** Normal development is at* **68F**
For additional information see the developer instructions.

Figure 1. Sample Film Manufacturer's-Developer's Instructions.

b. The Type of Developer. There are several types of developers, and each one provides different qualities of development. In selecting a developer, consider the type of film, the conditions under which it is exposed, and the results desired. Accordingly, select a slow working developer for negatives requiring a low or medium degree of development, and an active developer to obtain a high degree of development. For example, surveillance photographs taken under poor lighting conditions require a very vigorous developer to bring out as much of the image as possible, while autopsy negatives, for example, usually call for a much less active developer.

c. Negative Grain and Developers. During development, the silver grains have a tendency to group together (cluster). This tendency is lessened when a fine-grain developer is used. A negative of fine-grain is important when enlargements are to be made to extreme sizes - ten times original size or more. The tendency of clustering also increases as the developer temperature increases from the normal 68° F.

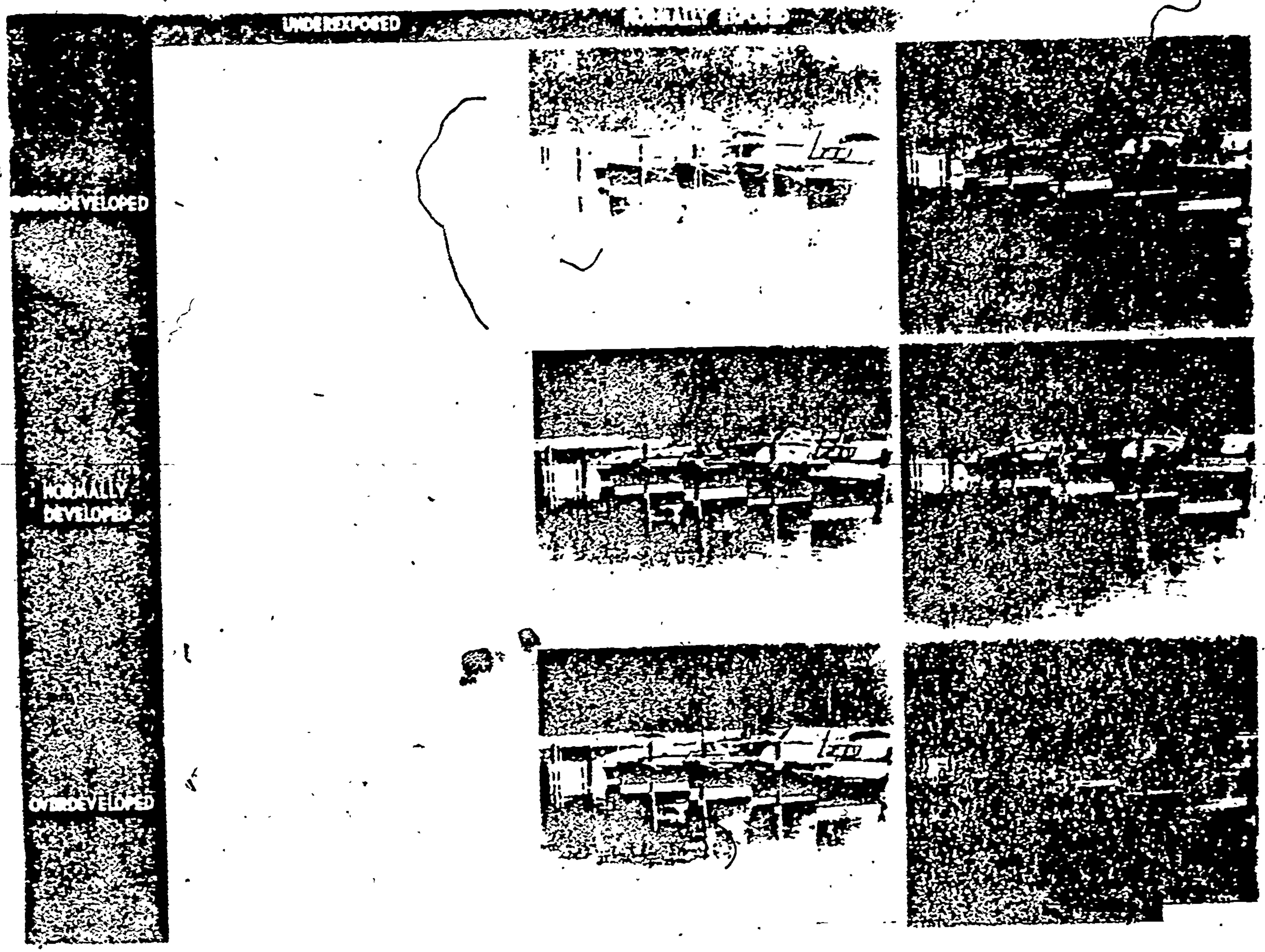

Figure 2. The Effect of Variations of Exposure and Development on the Negatives.

d. Negative Density. Negative density is defined as the degree of blackening of a silver deposit in a film emulsion in relation to the light incident upon it. The density of a negative is determined by the exposure and the development. A dark negative is a dense negative and a light negative is called a thin negative. In Figure 2 the negatives on the far left are thin negatives and the negatives on the far right are dense negatives. The type of negative desired in investigative photography is one that is normally exposed and normally developed (Figure 2).

e. Figure 2 shows a set of nine negatives which illustrate the effects of underexposure, and overexposure, as well as underdevelopment and overdevelopment. Reading from left to right, the portions of the illustration show the effect of exposure. Reading downward they show the effect of development.

(1) (a) The center negative will produce the best print, because it has received normal exposure and development.

(b) The three negatives to the left have been underexposed, and the three to the right have been overexposed.

(c) The top row of negatives has been underdeveloped, and the bottom row has been overdeveloped.

(2) The three underexposed negatives lack detail in the shadows, and an increase in development time does not produce an appreciable increase in shadow detail. Little can be done to improve the underexposed negative.

(3) The three normally exposed negatives have good shadow detail. Even though the top underdeveloped negative seems flat and lacks the contrast of the center negative, it differs from the flat negatives of the underexposed group in shadow detail. The bottom negative, which has lost detail in the highlight areas and has too much contrast, is overdeveloped.

(4) The three negatives on the right are overexposed. Although the top negative is flat and dense, detail can be seen over most of the negative. The normally developed and overdeveloped negatives are so dense that almost no details are visible.

(5) Underexposure is indicated when the shadows lack detail, and overexposure when the highlights are dense. Underdevelopment is shown when there is good shadow detail, but the negative is flat. Too much contrast means overdevelopment.

(6) The developing time, and therefore density, is affected by the temperature of the solution. The normal temperature for development is 68° Fahrenheit (20° centigrade). If any solution is above 70°F, the film emulsion swells excessively, becomes soft, and is easily damaged in processing. A positive effort should be made to keep all solutions for negatives and prints at 68°F.

4. DEVELOPER LIFE. As the developer is used, byproducts from the film accumulate and affect the developing solution by slowing it down. The development of additional film is retarded. Therefore, to obtain the degree of development produced by a fresh solution, the development time may have to be increased or fresh developer used and the old developer discarded. Again manufacturers' instructions contained with the developer will usually indicate how much film a developer can work under certain circumstances, e.g., method of development, age, etc. The problem of developer life is only a problem when a great deal of film is being processed or when developer is mixed, used, and then stored to be used again over a long period of time.

a. <u>Exhaustion of Developer</u>. A developer is exhausted when its developing power has been depleted. With exhaustion, the development time cannot be increased to compensate for its inability to develop the film.

(1) One cause of developer exhaustion is oxidation. When air reacts with several chemicals in a solution, there is a loss of developer activity.

(2) Developers also become exhausted when the solution becomes contaminated with fixing solution.

b. <u>Effects of Exhaustion</u>. When a developer becomes exhausted, there is a loss of ability to render shadow detail and an increase in the tendency to stain. Loss of shadow detail may be partially offset by increasing developing time.

(1) In tank development, (see para 6b(2) and 6c(2)), and especially with developers of low activity, a replenisher must be used to counteract loss of detail. Exhaustion is indicated when there is a general flattening of contrast and a drop in density.

(2) Loss of activity is not usually encountered in tray development, (see para 6b(1) and 6c(1)), because the solution is discarded before the effects of exhaustion appear.

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c. Replenisher. A developer is replenished when its developing power is almost completely restored by the addition of certain chemicals.

(1) In the simplest method of replenishment, fresh replenisher solution is added to the used developer. When properly used, there is little or no increase in developing time.

(2) In replenishment, it is always necessary to follow the directions given on developer containers. The quantity of replenishment solution and the changes in developing time vary with the type of developer.

5. PROCESSING THE NEGATIVE. There are two different methods of handling film development either by tray or tank. These handling methods will vary with the type of film being developed - either roll or sheet film.

a. Handling Film. Film handling is complicated by the fact that the emulsion is sensitive to light. Once the protective cover, paper, dark slide, etc. is removed from the film, it must be protected from light until the fixing process is well under way. The procedures which are to be followed while you are in the dark must be worked out in advance to reduce the difficulties of working without light. With advance planning, the film can be protected from scratches, abrasion marks, and uneven development. During processing, the film emulsion becomes swollen and softens as a result of immersion in, and the action of, the chemical solutions. Special care is necessary to protect them from damage as they are transported from one chemical solution into another, and while the film is subject to treatment by a specific solution. Some guides to follow are:

(1) Anyone inexperienced in a particular developing procedure should practice the procedure prior to working with important negatives.

(2) Film must be handled carefully at all times. It should be handled along film edges keeping fingers off the film's surface.

(3) Work areas must be kept clean. Areas should be free of dust, dirt, extra solutions, and extraneous objects.

(4) The solutions must be checked for proper temperature and correct amounts before going dark. The correct amount of solution should be enough to completely cover the negative.

(5) All equipment needed for development must be handy and in the proper place.

b. Processing Sheet Film. Sheet film has a sturdy base and it is less flexible than roll film. It is one piece of film, usually cut in the common sizes of four by five inches or eight by ten inches. It is used only in professional types of cameras.

(1) Processing Sheet Film in Tray. To insure good negative uniformity in the processing of sheet film, proceed as follows:

(a) Use four trays slightly larger than the film. Arrange the solutions in the following orders:

1. Preliminary water bath,

2. Developer,

3. Stop bath, and

4. Fixing bath.

(b) Pour at least 1/2 inch of solution into each tray.

(c) Bring solutions to the proper temperature. Arrange the holders containing the exposed films in a convenient position, turn off the lights, and remove films from their holders.

(d) Guard against dirt and fingerprints, especially when handling panchromatic film in total darkness.

(e) Immerse the exposed films, one at a time, emulsion side up, in the tray of water. Each film must be completely covered with water before the next film is placed over it.

(f) When all the films are in the tray, draw one film carefully from the bottom and place it on the top. Handle the film only at the extreme edges, and do not let a corner or an edge of any sheet of film dig into the film emulsion below it. Repeat this replacement from bottom to top until individual film sheets have been leafed through twice. This will prevent films from sticking together, and will dislodge any air bubbles that may have formed.

(g) Start the timer, and transfer films quickly, one sheet at a time, from the bottom of the pile into the developer tray. Continue rotation of the films from the bottom to the top throughout the development period.

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(h) At the end of the correct developing time, transfer the films, one at a time, to the acid stop bath. Then, leaf through the pile twice. Keep track of the order in which the films were placed in the developer, so they can be put into the stop bath in the same order. Failure to do so will result in overdevelopment of some films.

(i) Transfer the sheets of film, one at a time, to the fixing bath. Continue replacement from bottom to top until the negatives are completely fixed.

(j) Wash the negatives thoroughly in running water for 30 minutes by continuing the rotation method or by placing the negatives in developing hangers and using a washing tank.

(k) After the washing is completed, swab the negatives carefully to remove loose particles or deposits. Then attach a clip to one corner of each negative and hang the negatives in a drying cabinet. Excess surface moisture is best removed with a viscose sponge.

(2) Processing Sheet Film in Tank. In a tank, films are much less subject to scratching or other mechanical damage, and solutions are less exposed to the action of air. Solutions in a tank last longer and can be used for processing a greater number of films than solutions in a tray. To process sheet film in a tank, proceed as follows:

(a) Use at least three tanks— one for the developer, one for the acid stop bath, and one for the fixing bath.

(b) Bring the solutions to the correct temperature, and set the timer for the appropriate development time.

(c) Arrange sheet film holders and film developing hangers so that they are easily accessible. Then turn off the light.

(d) Remove the films from the holders and load them into the hangers.

(e) Start the timer and lower the hangers into the developer.

(f) Agitate the hangers vertically under the solution for about 5 seconds, striking the tops of the hangers sharply against the top of the tank once or twice to dislodge air bells clinging to the film.

(g) Leave the hangers undisturbed for 1 minute. Then, lift them clear of the solution, drain for 1 or 2 seconds, and replace them in the solution. Repeat this procedure at 1-minute intervals, alternating the bottom corners from which the solution is permitted to drain.

(h) At the end of the development time, lift the hangers from the developer, drain them, and transfer them to the stop bath. Lift and drain the hangers several times in this bath.

(i) Transfer the hangers to the fixing tank, and agitate them vertically under the surface of the solution for about 30 seconds. Lift and drain them at 2-minute intervals until fixing is completed. Fixing time is usually twice the clearing time of the film. The room lights may be turned on after the first 2 minutes.

(j) Wash the negatives thoroughly in running water for 30 minutes.

(k) Remove the hangers from the wash water.

(l) Take the film out of the hanger, and swab it carefully to remove dirt or any form of deposits.

(m) Attach a film clip to one corner of the film and hang it in a drying cabinet. Eliminate excess surface moisture with a chamois or viscose sponge.

c. Processing Roll Film. Unlike sheet film, roll film is very flexible and of different widths and lengths. The length of roll film makes it difficult to handle. It is easiest to process single rolls of film in a small tank. In addition, results are better, and the possibilities of film damage are minimized. Small tanks, designed for small size roll films, are similar to those used for larger size roll films. They are constructed so that all operations, excluding the loading, can be carried out in light.

(1) Use a small tank with a lighttight cover.

(2) Turn out darkroom lights and load the film into the reel.

(3) Place the loaded reel in the tank and replace the lighttight cover.

(4) Turn on darkroom lights and pour in developer.

(5) Normally, agitate the solution by twisting or shaking the tank. In some tanks, however, it is necessary to rotate the reel within the tank.

(6) At the end of the development time, pour the developer solution from the tank through the appropriate opening.

(7) Fill the tank with an acid stop bath solution. Do this several times to rinse the film.

(8) After the film has been rinsed, pour the fixing solution into the tank and agitate the film continuously for about 30 seconds. Continue this agitation at intervals during the fixing.

(9) Wash the film by removing the cover and allowing a stream of water to run through the tank or by removing the film reel to a washing tank.

(10) Swab the film under water to remove grit.

(11) Hang the film and remove water drops.

6. NEGATIVE PROCESSING PROBLEMS. Photographic films are subject to damage before, during, and after processing. At any time during the procedures a negative can be made useless. The following are some of the most frequent causes of negative problems.

a. Abrasions. Abrasions are fine lines or streaks that occur when a sharp or rough object rubs against the emulsion surface before development. Abrasions are also caused by grit or rough spots in the camera, by twisting the roll to tighten the film on the spool, or by touching the film before development.

b. Air Bells. Air bells are small air bubbles that adhere to the film surface and prevent the processing solution from acting on the film. Air bells on a film during development will leave small clear spots; air bells on the film during fixing will produce many spots.

(1) To avoid air bells, immerse the film in the solution slowly, so that air bubbles are not carried below the surface of the solution.

(2) To dislodge any air bells that have formed, tap the film hanger or reel against the side or bottom of the tank after the film is immersed.

c. Streaks. Streaks of varying densities are often caused by uneven development.

(1) If the film is not placed in the developer evenly, development will start in some areas before others are even wet. Sharp edges will result from this uneven immersion of the film in the developer.

(2) Diffuse or indefinite boundaries are usually caused by lack of agitation, or by uneven stopping of development by the fixing bath or acid stop bath.

(3) Under some conditions, streaks may be caused by excessive or improper agitation. It is always best to follow the agitation procedure recommended for the processing method used.

d. Reticulation. Reticulation of the emulsion is a network of lines having a grainy, leather-like appearance. This action occurs when film is subjected to sudden temperature changes in transferal from one solution to another.

e. Dust and Dirt. Dust and dirt coming into contact with the soft sticky surface of the film will adhere and become embedded as the film dries. It is then impossible to remove it, even by rewashing the film. Avoid this difficulty by drying film in a clean room or cabinet that is supplied with a stream of filtered air.

f. Drying Marks. Drying marks are usually formed by water drops that remain on the film during drying. Such marks may be surrounded by a line of low density.

(1) Avoid dry marks by first moving the film from the developing clip or hanger to a dry clip; then remove the surface drops with a moist chamois or viscose sponge.

(2) If the developing hanger is used, do not shake it or disturb it after the film has started to dry. This shaking action may cause water drops from the hanger to fall on the film and cause drying marks.

g. Fogging. Fogging of photographic material, which results from faulty development or overage film, is the reduction of unexposed silver halides. It causes a general lowering of contrast by veiling the shadow areas and borders of the negative. Solvent fog occurs when sulfite, ammonia, hypo, or a combination of these act on an emulsion and permit the developing agent to reduce the dissolved silver halides to yellow colloidal metallic silver.

h. Agitation. Agitation of the tray, tank, or film is necessary to bring fresh solution to the emulsion. When developing negatives in a tray, agitate the solution constantly. When developing negatives in a small tank, agitate the solution intermittently (at intervals of once a minute, or less). With no agitation, objectionable streaks may appear on a negative from the convection currents set up by the products of development, or the negative may be underdeveloped because of no agitation.

7. SOME INFORMATION ON PRINTING PAPER. Paper is an ideal support for sensitized emulsions, because it reflects light and is flexible, economical, and durable. Most paper emulsions are used to produce positive prints from photographic negatives. Printing paper emulsions are particularly thin to increase the reflectivity of the finished print and to make it extremely flexible. There are three types of printing paper emulsions: bromide, chloride, and chlorobromide. The main difference among these types is speed and latitude. Surfaces are either matte or glossy.

a. The Chemistry of Paper Emulsions. When light strikes the minute silver halides embedded in the gelatin layer of a paper emulsion, a physical change takes place, creating the latent image. Subsequent chemical development makes the invisible latent image visible.

b. The Anatomy of Photographic Paper. Photographic positive papers (Figure 3) are composed of the following layers: paper base, baryta layer, and an emulsion.

(1) Base. The base must be chemically pure to insure that it will not interfere with the chemical processes to which the emulsion is subjected. Accordingly, the paper base must meet the highest standards with respect to quality and purity. Paper is available with either a single or double weight base.

(2) Baryta Layer. Although paper has a high degree of natural reflectivity, the quality of a photographic print can be increased if the reflectivity is increased. This is accomplished by adding, to the paper, a gelatin layer containing baryta crystals.

(3) Emulsion. The emulsion layer, which contains minute silver halides suspended within a gelatin medium is thin. Printing paper emulsions need only reproduce the tonal range of a negative while film emulsions must have the capability of interpreting brightness, shadows, colors, and related details of a given scene or subject. Accordingly, printing paper emulsions are of a much simpler structure than film emulsions.

c. Development Papers. Development papers (photographic printing papers) have a gelatin surface that contains light-sensitive silver halides. Following exposure, the papers are subjected to a precise chemical development process.

(1) Chloride Papers. Chloride papers, which have a slow speed emulsion containing silver chloride, are fine grain and produce deep blacks. Because of low sensitivity to light, they are used for contact printing. Chloride papers are made in different contrasts, ranging from soft (low contrast) to hard (high contrast).

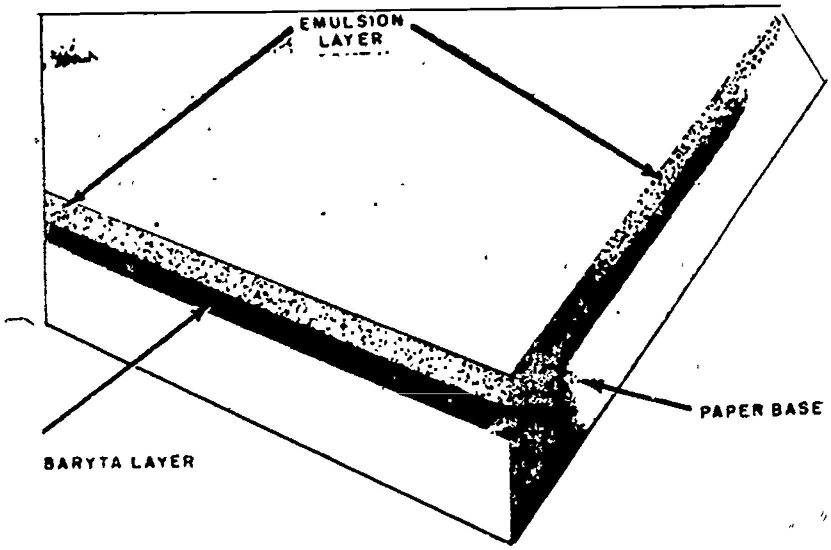

Figure 3. Cross Section of Photographic Printing Paper

(2) Bromide Papers. Bromide papers, which have a faster emulsion speed than chloride papers, achieve sensitivity through the use of silver bromide halides. They produce blacks that are warmer than those of chloride papers. Because of the relatively high sensitivity to light, these emulsions are particularly suitable for projection printing. Papers are available in a great range of contrasts to correct inadequacies in negative contrast.

(3) Chlorobromide Papers. Chlorobromide paper emulsions, which contain both silver chloride and silver bromide halides, produce pleasing warm blacks. Emulsion speed lies between that of chloride and bromide papers. Chlorobromide papers are produced in a wide range of contrasts and are used for both contact and projection printing.

d. Variable Contrast Paper. Variable contrast paper combines the complete scale of contrast ranges in one paper. This versatility is achieved with a special chlorobromide emulsion that produces varying contrast responses upon exposure to different colored lights. The photographer, instead of using different grades of paper, places one of a series of colored filters over the projection printer lens to achieve a specific contrast response. Up to ten filters are available to permit the widest possible contrast. They range from light yellow, for low contrast, to deep blue, for high contrast.

e. Types and Contrasts of Photographic Papers Used in the Army. Photographic papers used in the military service are designated by type, subtype, and contrast. The type (Figure 4) specifies if the emulsion is designated for contact or projection printing, and whether the paper is in graded contrasts or variable contrast. The subtype (Figure 4) refers to the thickness of the base stock, the surface finish, and whether or not the base is water resistant.

Types of Photographic Papers

Type	Description
I	Contact, graded contrast
II	Projection, graded contrast
III	Contact, variable contrast
IV	Projection, variable contrast

Subtypes of Photographic Papers

Subtype	Description
A	Single weight, glossy
B	Double weight, glossy
C	Single weight, semimatte
D	Double weight, semimatte
E	Single weight,semiglossy, water-resistant base.
F	Lightweight, semimatte, flexible.

Figure 4. Types and Subtypes of Photographic Papers.

8. PRINTING. Printing is the process whereby the negative is used to make the positive. In this process light is transmitted through the negative to produce a like positive image on light sensitive material. This process is comparable to much of what has already been discussed. Generally, printing involves selection of light sensitive material, exposure, development, stop bath, fixing, washing, and drying.

a. Generally, the chemicals involved for processing paper are the same as for film. Chemicals are set up from left to right, and all solutions should be at the normal temperature of 68°F. The same problems that occur with film solution can occur in developing the positive print, e.g., developer exhaustion and contamination.

b. Handling. Light sensitive paper does not have to be handled as carefully as photographic film, but it is important to keep your hands away from the emulsion side of the paper.

(1) Printing is not done in complete darkness since, usually, a safelight is used. The safelight may be a red or amber light of no more than ten watts. However, a yellow-green safelight designed for photography use is recommended. When determining the correct exposure it is best not to view the print under safelight conditions as the light is deceptive and, it is difficult to judge proper exposure.

(2) Printing paper curls slightly toward the emulsion, thus, by looking at the edges, the emulsion side may be determined.

(3) Make sure that you do not handle the sensitive side of the paper too often. The natural oil present on your skin, or the traces of chemical deposits that adhere to your skin, can cause spots to appear on the paper after it has been processed. Hands should be clean and dry when handling fresh paper.

(4) A good basic arrangement of materials would be fresh paper on the left on a clean dry surface, printer or enlarger, timer, developer, tongs, stop bath, tongs, fixer, and washing tray on the far right. If tongs are not used, the left hand should be used for the developer and the right for the fixing solution.

(5) After the paper is completely submerged in any one of the processing solutions, it should be agitated rapidly to insure complete coverage by the processing solution and the removal of air bubbles.

c. There are two types of printing methods - contact printing and projection printing.

(1) Contact Printing. As its name implies, a contact print is made by placing a sheet of photographic paper in direct contact with a negative. Contact between the two surfaces are made negative emulsion to paper emulsion. When white light is directed toward the negative, the negative image controls the amount of light transmitted to the paper. The dense areas of the negative bar the passage of light, while the clear, or low density, areas permit light to pass freely. The image formed on the sensitized coating of the paper is, therefore, a reverse of the negative. In reality, this makes it a positive that approximates the true black-and-white relationships of the subject.

(a) Printing Frames. A printing frame is a simple device. It looks much like a picture frame with fitted clear glass front and a wooden or plastic back. The back is usually padded with felt and held in place by spring-clamps or a screw device which also prevents any paper or film movement. To ready the frame, it is turned so that the back is up, facing the individual. The film is then placed on top of the clean glass, emulsion side up, and the paper is next emulsion down, the back is put in place and the entire frame turned over. It is then ready for exposure.

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(b) Contact Printer or Printing Box, Figure 5. A printer is simple and efficient. It is actually a box, with a plate glass across the top. A hinged cover clamps down over the glass and holds the negative and paper in tight, uniform contact. As this hinged cover is pressed into position, a light or set of lights inside the box is automatically switched on to provide the exposure light. The lights are switched off when the pressure cover or plate is lifted. Inside the printer is a low-power ruby lamp that remains lighted throughout printing operations. This lamp will aid you in positioning and judging the negative.

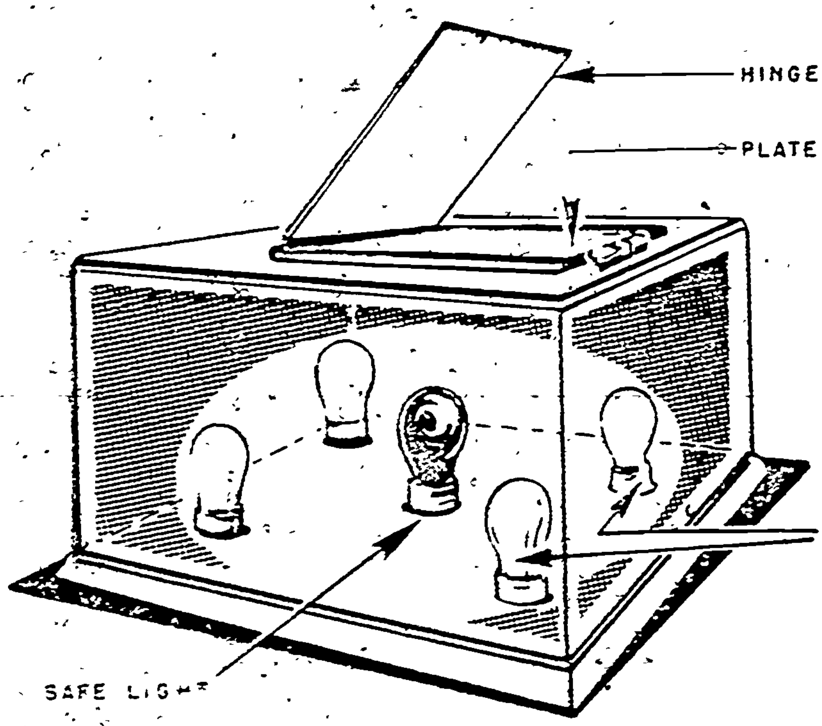

Figure 5.

(2) Projection Printing (Enlarging). Enlarging, as it is commonly called, is quite different from contact printing. In enlarging, the negative image is projected onto a photographic paper, such as a color slide is projected on a screen. The equipment used in enlarging all follows similar principles used in working with a camera. The image is brought into focus on a sheet of paper (no focusing can be accomplished in contact printing) which is anywhere from a few inches to several feet from the enlarging lens. In general, projection printing is a highly elastic, adaptable and versatile process in which great skill and control can be exercised. The many different types and models of projection printing equipment have five basic characteristics in common. All of them have a light source, a negative holder, a lens, a bellows, and a paper board or easel. Any enlarger is, essentially, a camera in reverse, because it projects rather than receives the image.

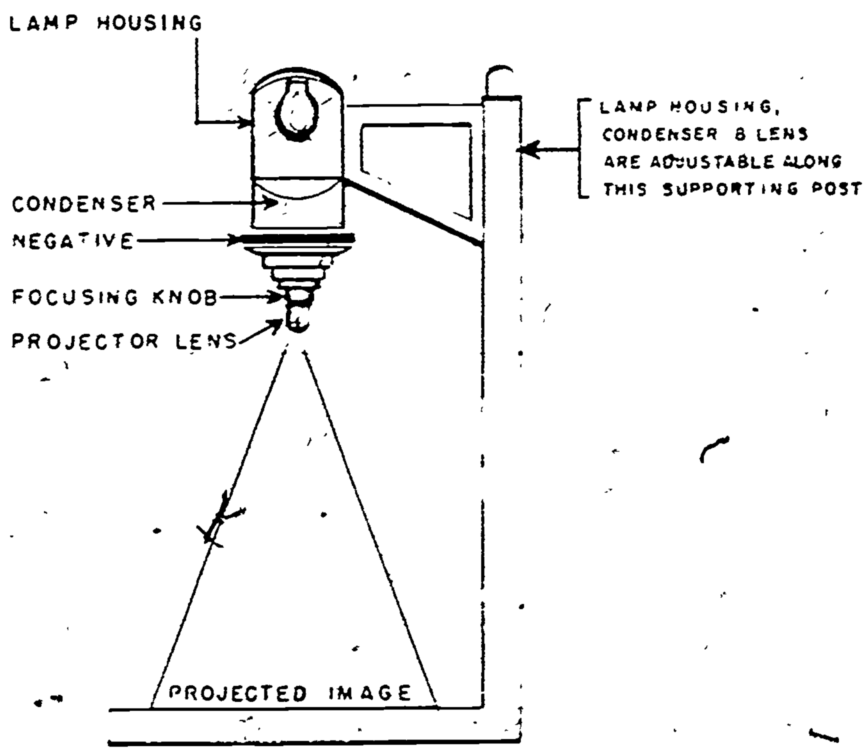

Figure 6. Enlarger.

9. PRINT QUALITY. An important factor in print quality is having a good negative to begin with. If the negative is poor little may be done in printing to improve it. With a good negative, a good print is the result of proper print exposure, full development, correct solutions and solution temperatures, and the right grade of paper.

10. PRINT EXPOSURE. The processing of a print begins with exposure of the paper and then into development following similar procedures as in film development.

a. Proper Exposure. The proper exposure in printing is much the same as with film, and involves control of light. With the contact printer, exposure is controlled by a timer and the number of lights in the printer. Projection printers control light by time and by aperture setting of the lens.

b. To arrive at the correct exposure test strips are a good method. If you are contact printing a four by five negative, the printing paper selected is cut into small strips, e. g., one inch by four inches. Several strips are then exposed at different times, (e. g., three, five, seven, and nine seconds). These strips are then placed in the developer for the full development time, usually one and a half to two minutes. After the strips have been fixed for about two minutes, they are brought out into normal light and checked for correct exposure. If none of the exposures are correct, adjustments in the exposure time can be made from the best of the strips.

c. The strip method can also be used in projection printing. A starting point for lens aperture can be f/8. Again several strips are cut from an eight by ten sheet of paper (8, 10, or 12 strips). A starting exposure is then decided, say five seconds. Five-sixths of the printing paper is covered with a piece of cardboard, the enlarger is turned on and the cardboard moved down the strip exposing one-sixth of the test strip each time at five second intervals. The test strip would then have six different test sections ranging from five seconds to thirty seconds. Again, after fixing the test strip it is taken into normal light, studied, and the necessary adjustments made for the proper exposure.

d. When test strips are used, the strip should be made to cover the widest range of contrasts in the negative.

e. Adjustment should be made in exposure time not in the time the strip is developed. Development time should remain constant throughout the testing and the final print.

11. PROCESSING THE PRINT. Both contact printing and projection printing are processed the same once the exposure is made. Projection printing is the most common type of printing, and therefore it will be discussed here.

a. The work area is set up as described in paragraph 8b(4). Temperatures are checked to insure all solutions are at 68°F. The area, enlarger, and negative are checked for cleanliness.

b. The negative is placed in the enlarger with emulsion side down. The enlarger is now set for focusing. With only the safelight on, the enlarger's lens is set on its maximum aperture and the projection lamp turned on. The enlarger head is adjusted so that the desirable image size is obtained on the easels and the lens is then focused on a white sheet of paper (the paper is an aid to focusing). Once focused, the aperture is shut down to a recommended aperture of f. 5. The enlarger is then turned off and printing paper, emulsion side up, is placed in the easel. Test exposures are then made.

c. After exposure, the print is slipped into the developer, emulsion side up. Make sure that the entire print is immersed at once and that no air bubbles cling to the surface. Agitate the paper as development gets under way and watch the appearance of the image. A normal print should develop gradually-shadows first, then half tones, and finally highlights. Development should be for the full recommended development time. After full development the print is moved to the stop bath and then to the fixer. The size and weight of the printing paper governs this procedure.

d. Prints are now washed in clear water at 68°F. There are several ways to wash the print.

(1) <u>Washing in Trays.</u> There are three methods used to wash negatives and prints in trays.

(a) In the simplest method, prints are placed in a tray of water and the water is changed every 5 minutes. This changing of water is repeated at least six times.

(b) In the second method, a continuous stream of water runs into the tray for a minimum of 30 minutes.

(c) In the third method, a device is attached to the edge of the tray to siphon water from the bottom of the tray while fresh water enters on top. This action continues for a minimum of 30 minutes.

(d). Regardless of the method used, always separate the prints to insure that fresh water will reach all areas. **Note** that single-weight paper should be washed a minimum of 30 minutes and double-weight paper a minimum of 1 hour.

(2) Washing in Tanks. Negatives that have been processed in a tank can also be washed in the same or a similar tank. Fresh water is directed into the tank, and the negatives are suspended in the tank by metal or plastic frames.

e. Drying of Prints. The method used in the drying of prints depends upon the type of paper used, the urgency of the job, and the use for which the prints are intended.

(1) Matte and semimatte surfaced papers are placed face down on cheesecloth stretchers after the surface moisture has been squeegeed or blotted out. Normally, the prints should dry within the hour.

(2) In a second system, the prints are placed between strips of blotting paper and cardboards. The blotting paper and cardboards are then rolled together tightly with print emulsions facing outward, to minimize curling. This is a slower procedure, but it reverses the natural tendency of dry prints to curl.

EXERCISES

REQUIREMENT. The following exercises are multiple choice. There are four alternatives to each exercise. You are to select the one alternative that is correct and indicate your choice by circling the correct response directly on the exercise booklet.

1. The correct order for the steps in development of negatives is

   a. fixing, development, washing, rinse, and drying.

   b. development, washing, rinsing, fixing, drying.

   c. development, rinsing, fixing, washing and drying.

   d. development, fixing, washing, rinsing, drying.

2. The ingredient which prevents chemical fog and rapid deterioration of the developing solution is called a/an

   a. Restrainer.

   b. Solvent.

   c. Reducer.

   d. Accelerator.

3. The three types of rinse baths are

   a. water, acid, and softening.

   b. water, alkaline, and acid.

   c. acid, alkaline, and chemical.

   d. water, acid, and hardening.

4. Water, when used alone as a rinse, will

a. cause fogging.

b. leave streaks.

c. dilute the fixer.

d. lengthen the usefulness of the fixer.

5. The chemical most widely used as a fixing agent is

a. sodium biosulfate.

b. sodium thiosulfate.

c. ammonium biosulfate.

d. ammonium thiosulfate.

6. The most common hardening agent is

a. ammonium alum.

b. sodium alum.

c. calcium alum.

d. potassium alum.

7. Using the sample film manufacturers development instructions (Figure 1), what would be the development time in a tray, of brand C at 65°F?

a. 6-1/2.

b. 7.

c. 7-1/2.

d. 8.

4-12 I; 6-26

8. The degree of blackening of a silver deposit in a film emulsion in relation to the light incident upon it is known as

a. negative density.

b. silver halide diffusion.

c. incident blackening.

d. grain dispersion.

9. In Figure 2, the center negative on the right side has been

a. underexposed/underdeveloped.

b. overexposed/normally developed.

c. normally exposed/normally developed.

d. overexposed/overdeveloped.

10. Normal development temperature is

a. 78° F.

b. 75° F.

c. 68° F.

d. 65° F.

11. When processing sheet films, negatives should be washed in running water for approximately

a. 30 minutes.

b. 10 minutes.

c. 2 minutes.

d. 30 seconds.

4-12.1; 6-27

12. In processing sheet film in a tank, three tanks are needed for

a. the developer, the preservative, and the fixing bath.

b. the developer, the acid stop bath, and fixing bath.

c. the developer, the acid stop bath, the hardener.

d. the water bath, the acid stop bath, the fixing bath.

13. Small air bubbles that adhere to the film surface and prevent the processing solution from acting on the film are called

a. reticulation.

b. air bells.

c. drying spots.

d. clusters.

14. Reticulation is caused by/when

a. dirt and dust adhering to the film's surface.

b. air bubbles are not dislodged.

c. film is not placed in the developer evenly.

d. sudden temperature changes in transferal from solution to solution.

15. The three types of printing paper emulsions are

a. bromide, chloride, and chlorobromide.

b. baloid, chloride, and sulfide.

c. chloride, sulfide, and chlorobaliod.

d. chloride, chlorosulfide, bromide.

16. The process whereby a negative is used to make a positive is known as

a. variable contrast.

b. negative emulsion.

c. printing.

d. developing.

17. Printing is not done

a. on variable contrast papers.

b. at temperatures over 65°F.

c. in total darkness.

d. without a baryta emulsion.

18. The recommended safelight, when printing, is

a. blue-white.

b. infrared.

c. violet.

d. yellow-green.

19. All of the following are items of equipment used in projection printing except a

a. light source.

b. glass plate.

c. bellows.

d. negative holder.

4-12 I; 6-29

20. Projection printers control light by time and by

    a. aperture setting of the lens.

    b. colored filters.

    c. emulsion sensitivity.

    d. the type of contact paper.

21. Test strips should be made to cover the widest range of

    a. colors.

    b. emulsions.

    c. papers.

    d. contrasts.

22. When using test strips, development time should

    a. be lengthened for each strip.

    b. double.

    c. remain constant.

    d. be shortened.

23. In projection printing, negatives are

    a. not needed.

    b. placed in the enlarger emulsion side down.

    c. at least three feet from the printing paper.

    d. placed in the enlarger emulsion side up.

4-12 I; 6-30

24. The recommended aperture for projection printing is

a. f 2.8.

b. f 4.

c. f 8.

d. f 16.

25. A normal print would develop in which of the following manners?

a. Shadows first, then half tones, and finally highlights.

b. Highlights first, then half tones, and finally shadows.

c. Reds first, then blues, and finally yellows.

d. Prints do not develop.

4-12 I; 6-31

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MODIFICATIONS

Chapter 7 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

LESSON ASSIGNMENT SHEET

SUBCOURSE NO. 4-12 I	Investigative Photography.
LESSON 8	Copy and Small Object Photography.
CREDIT HOURS	3.
TEXT ASSIGNMENT	Attached Memorandum.
MATERIALS REQUIRED	None.
LESSON OBJECTIVES	To familiarize you, the student, with the knowledge and techniques of copying, small-object photography, fingerprints, and document photography, so that you may utilize them in investigative photography.
SUGGESTIONS	None.

ATTACHED MEMORANDUM

This attached memorandum includes information extracted from resident instructional material of the United States Army Military Police School, TM 11-401-1, and TM 11-401-11. In case of conflict between the attached memorandum and other publications, the material contained in the attached memorandum will apply to this lesson assignment.

1. INTRODUCTION. As an investigator, utilizing photography in your work, you will find that a knowledge of copying techniques will be very useful, and in many cases necessary, in preparing photographic evidence. The same holds true with the other topics this lesson will deal with. In all probability, you will frequently run into small objects of evidence which must be photographed, and you must know how to properly handle them. Fingerprints and documents may be of extreme importance in a case, and this lesson is designed to give you the most important and useful elements of knowledge to utilize when dealing with them. This lesson, by no means, contains all the knowledge that has been collected on these subjects, however, it should give you a good grounding in the fundamentals and enable you to use them in your work.

2. Copying. Investigators today are finding that a knowledge of copying techniques, as well as a knowledge of general photography, is valuable in their work. Photographic copying provides accurate reproduction of photographic prints, drawings, sketches, manuscripts, typed and printed materials and similar objects. Most cameras can be used in copying; and those with ground glass focusing and double extension bellows are ideal for this work. There are several general rules that must be followed, and a little more care must be taken in exposure, but with a little practice, copying can be easily accomplished.

a. There are a number of terms unique to copying that you should be familiar with before continuing the lesson.

(1) To Copy. To reproduce photographically, subjects such as drawings, printings, photographs, letters or book pages.

(2) Original. The material to be copied.

(3) Line Original. Material which contains only two tones, dark and light. Usually printed matter, such as this page.

(4) Continuous-Tone Originals. Material which contains many shades of gray or color between the lightest and darkest tones, such as Figure 4.

(5) Reproduction. The photograph obtained by copying.

(6) Reflex Copying. A means of reproducing, without a camera, line originals or continuous-tone originals, if poor quality is acceptable, by direct contact with sensitized paper.

b. Equipment.

(1) A camera is necessary for copy work. If possible, the copy camera should be able to utilize a large film size (4 x 5, 8 x 10), be able to focus very close to the original, and be rigidly mounted. If a view, or studio camera, is available, it should be given preference over other types for general copy work. However, when necessary, other types of cameras (i.e., 35mm) may be used with attachments such as extension tubes (hollow tubes which, when placed between the lens and camera body, allow closer than normal photographs to be taken). Ground glass focusing and a long bellows extension are desirable.

(2) Lens. The lens you use should be anastigmatic (a corrected lens that sharply focuses both horizontal and vertical lines simultaneously) and of medium speed. The focal length should be longer than the diagonal of the film to allow for a good working distance and greater definition in the corners of the negative. To achieve fine detail you should use a small aperture.

(3) Filters. You can either increase or decrease the contrast in a copy of multi-colored original by filtering. With line copy it is usually desirable to have as much separation of the tones as possible; in other words, a very sharp contrast. On the other hand, you may want to reduce the contrast in line copy in order to filter out unwanted marks that may appear in the original. Also, you can eliminate stains by filtering and can make lettering more readable by making the letter either lighter or darker than the background.

(a) The general rules for adjusting contrast of a multi-colored original are as follows. To lighten an area, use a filter of the same color. To darken an area, use a filter of the complementary color (see Lesson 5 for further information on filters). To eliminate stains, use a filter of the same color as the stain, but slightly darker.

(b) Filters absorb light, thus the basic exposure must be increased to compensate for this light loss. (An exception to this rule is single-lens reflex cameras.) The manufacturer's filter factor ratings indicate the number of times the exposure must be increased to compensate for light loss due to the use of a filter.

(4) Film. The proper film choice will aid the filters' work and may eliminate the need for a filter. Different types of film are used for line and continuous-tone copy. High contrast film, along with high contrast developer, is used to get maximum separation of the tones in line copy. Generally, use monochromatic process film to copy black and white line copy, and use process pan and process ortho films for colored line copy originals. Use commercial film to produce shades of gray in continuous-tone copy. Do not interchange the two groups of film.

(5) Scale. The copy may be smaller, the same size, or larger than the original depending on the reasons for copying. Scale is expressed as a ratio of one dimension of the original to the same dimension of the copy. A scale of 3:1 means the original is three times larger than the copy, a ratio of 1:1 says the original and copy are the same size, and a scale of 1:2 means the original is smaller than the copy by one-half. An 8 x 10 original copied to a scale of 2:1 produces a copy print that is 4 x 5.

(6) Copy Stands and Mounting. Copy stands generally consist of a metal post, a wood baseboard, and an arm to support a camera parallel to the base. Some stands are equipped with adjustable lights for illuminating subject originals. Mount the original on a copyboard or easel parallel to the film plane, centered with the optical axis of the lens, upside down and flat. The original must be parallel with the film to prevent distortion due to perspective (keystoning). The original is upside down to aid in focusing, and should be flat to prevent distortion and shadows caused by bumps and wrinkles.

(7) Lighting. Natural lighting (the sun or house lamps) are poor for copy work because of a lack of uniformity. If you have to copy outdoors find an open shady area to work in. When using natural light try to place the original so that it gets light from both sides, or use reflectors so the original is illuminated as uniformly as possible. For indoor copy work, use two photoflood lamps in reflectors on both sides of the camera. Place the lights so there is a 45 degree angle between the light and the original and between the light and the camera (see Fig. 1).

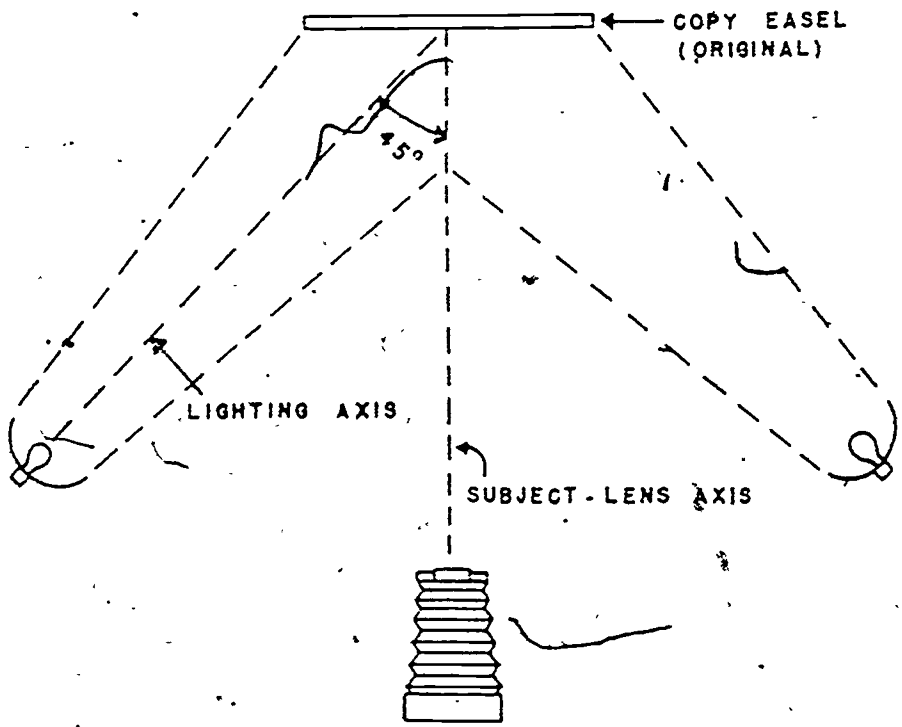


Figure 1. 45 Degree (Flat) Lighting

For originals with a textured surface, reduce the angle. Eliminate bright light reflections (hot spots) by moving the lights or the reflecting surfaces, polarizing the light, or using shields.

c. Techniques for Making the Copy.

(1) Now that all the equipment and materials are in place, focus the camera by observing the image on the ground glass viewing screen. Also look for possible defects such as hot spots, or distortion. Next, determine the exposure.

(2) Obtaining correct exposure.

(a) Exposure is best determined by developing a trial film which has been exposed 1/4, 1/2, 1, 2, and 4 times the estimated exposure. If time does not permit you to make and develop a trial negative, then make three separate exposures. One exposure should be the estimated correct exposure, one three stops underexposed, and one three stops overexposed. One of the three should produce a good copy. When a photoelectric exposure meter is used for determining copy exposures, the most consistent results are obtained by measuring the illumination on the original, either directly with an incident light meter, or indirectly with a reflection type meter.

(b) When the original to lens distance is less than 10 times the focal length of the lens, as it is most of the time in copy photography, you must multiply (increase) the basic exposure by the bellows extension factor (MF: multiplying factor). One method of calculating the bellows extension factor is to measure the bellows extension (BE), (distance from lens to focal plane), and divide by the focal length (FL) of the lens and square the results. This is stated as the formula

$$MF = \frac{BE^2}{FL}$$

For example:

$$MF = \frac{(10'')^2}{(5'')} = \frac{100}{25} = 4$$

$$MF = 4$$

The basic exposure must be increased four times.

(c) The following simple chart may be used to compensate for bellows extension light loss with a known MF value, or to compensate for light loss due to the use of filters, when the filter factor is known. It should be memorized and remembered for use with all small object and copy photography.

MF or Filter Factor	2	4	8	16	32	64
F Stop Compensation	1	2	3	4	5	6

d. Summary of General Techniques:

(1) Select the camera and lens.

(2) Select the filter and film.

(3) Mount the original flat and parallel to the film plane.

(4) Adjust the lights for uniform illumination of the original.

(5) Focus the camera.

(6) Determine the basic exposure and multiply it by the filter factor and bellows extension factor.

(7) Process the film and make prints.

e. Restrictions on Copying. It is unlawful to reproduce copyrighted material without the written permission of the copyright owner. Any such material that is authorized for reproduction must have a copyright notice included on the reproduction.

(1) Federal law prohibits the copying of U.S. and foreign government obligations such as currency, bonds, notes or the like. Also included are canceled and uncanceled US stamps. US government departmental identification cards, badges or insignia; military or naval documents marked secret, confidential, or restricted; certificates of citizenship, naturalization or arrival, etc.

(2) This is only a brief summary of existing photographic restrictions. Legal advice should be obtained before reproducing any of the above mentioned or similar materials.

3. SMALL OBJECTS PHOTOGRAPHY. Investigative photography can be divided into three categories: Crime scene photography, document photography, and small object photography. Depending on the circumstances of a particular investigation, any one of the three may be of importance in preserving or presenting evidence, but the one that is most challenging is small objects photography. The small items of evidence collected during an investigation (e.g. cigarette butts, etc.) are usually important in establishing the elements of proof in an offense. They present some problems, because of their size, which the proper utilization of photographic techniques can easily overcome. When the actual subjects are not available for court use, photographs can take their place. Small details can be magnified and fragile evidence can be preserved. In addition, photographic evidence greatly aids reviewing authorities in reaching fair and just decisions, which must be based on documentation.

a. For our purposes, an object can be considered small if it is less than 24 inches in its longest dimension. In addition to appearing in the crime scene series of photographs establishing their location, all small, portable items of evidence should be taken to the laboratory where they can be photographed under the most favorable circumstances. Close-up photographs of perishable items, such as footprints, and evidence that will oxidize and change color, such as bloodstains, must be made as soon as possible at the scene of the crime. Some objects may require more than one photograph in order to show trace evidence on all surfaces. A ruler should be included in the photograph to indicate the dimensions of the object in question.

b. <u>Lighting Effects and How to Obtain Them.</u> By the proper placement of lights, the photographer can create and control shadows and highlights on his subject, and emphasize or subdue portions or features of the subject. There are two general types of lighting equipment, floodlights and spotlights.

(1) Floodlights, as their name implies, flood the subject with a broad, even light. They are used to establish the illumination level, and the overall lighting of the subject. Light is controlled by the use of "barn doors" (panels placed to the side of the lights) and diffusion screens. (Figure 2).

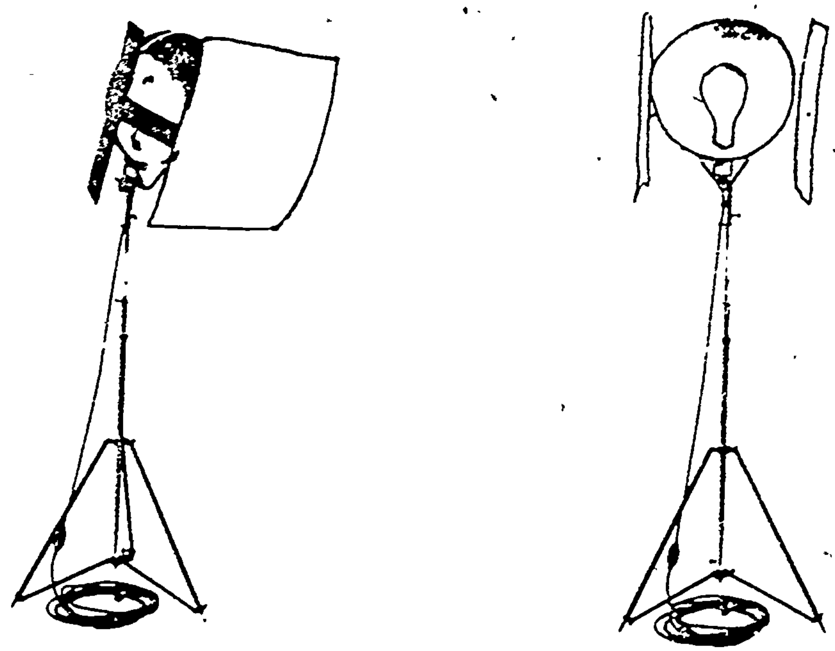


Figure 2. Floodlight Set

(2) Spotlights are used to create highlights and shadows, and to separate the subject and background. They give a rather harsh, strong light, and create sharp-edged shadows. (Figure 3.)

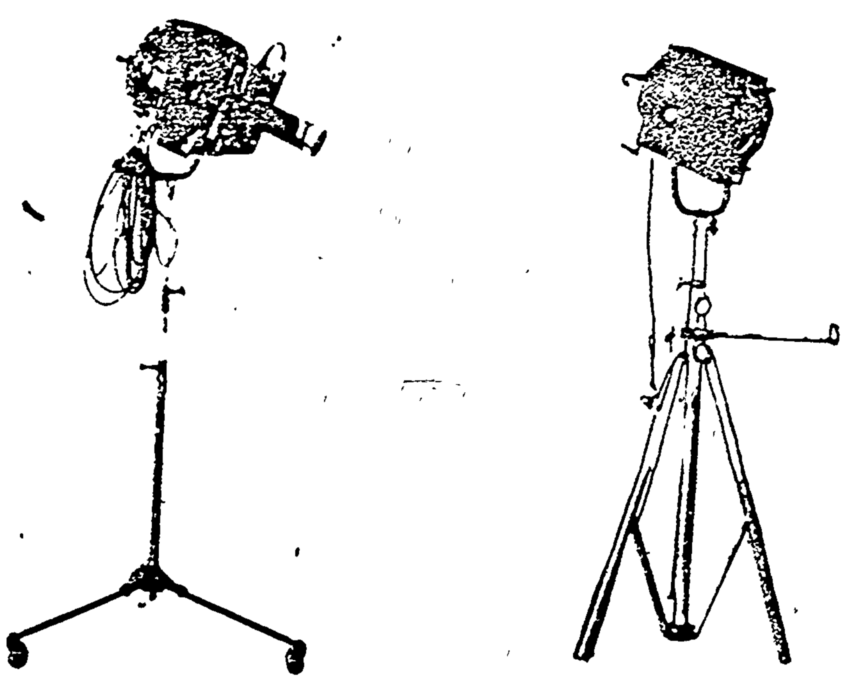


Figure 3. Spotlight Types.

(3) Reflectors are also used in lighting. They provide studio photography with the equivalent to bounce light in photoflash. Reflectors provide a soft, weak light, and are used almost exclusively for full light.

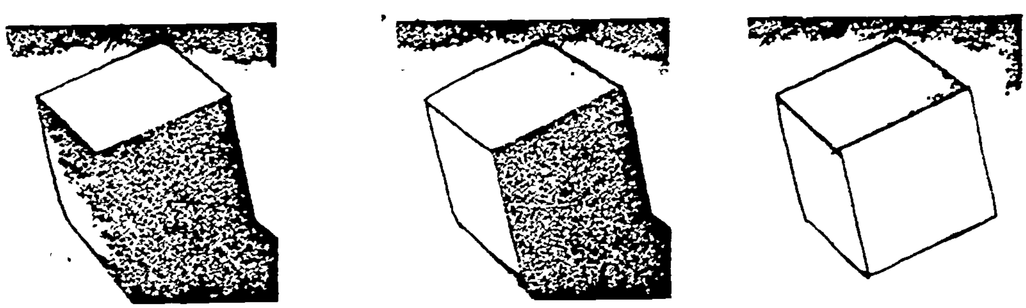
(4) To photograph small objects, the main light is most often a spotlight, with floodlights used for fills.

c. Photographing Rectangular Objects. There are three steps in lighting a rectangular subject (see Figures 4 and 5).

(1) The first is to place the main light. It should be behind and to the side of the subject, and the light should strike its surface at an angle of about 40 to 60 degrees. This main light illuminates the top of the subject and provides a deep, dominant shadow. In almost every instance this light will be a spotlight.

(2) The second step is to place a fill light on the same side as the main light. This light is to lighten the shadow on that side of the subject. It should be table height so it does not cast a second shadow.

(3) The final step is the addition of a third light, also at table height, to lighten the shadow detail in front of the subject. The fill lights should be 1/3 to 1/4 as bright as the main light, to give a lighting ratio of 3 or 4 to 1.



Step 1	Step 2	Step 3
Main Light	Side Light	Front Fill

Figure 4. Light Control.

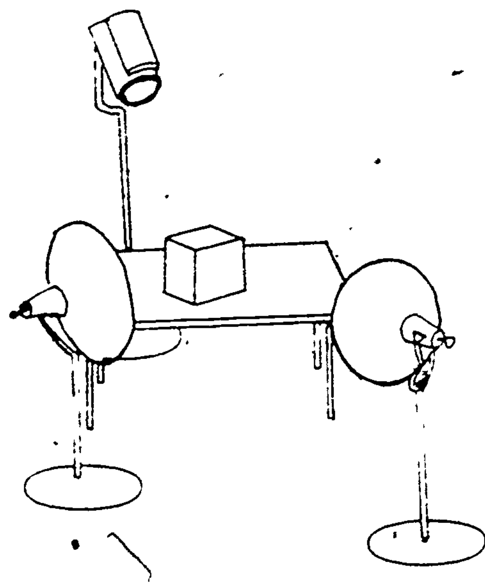


Figure 5. 3-Light Set-Up for Rectangular Subjects

d. Photographing Spherical Objects (See Figures 6 and 7). Basic lighting for a spherical object utilizes four lights. Three spotlights give the object roundness, and a weak floodlight is used as a fill.

(1) The main light is placed high to the rear and left of the subject, at an angle of about 60 degrees. This illuminates the top and left portion of the subject.

(2) The second spot is placed to the right rear of the subject at table height. This illuminates the right side and a portion of the bottom of the subject.

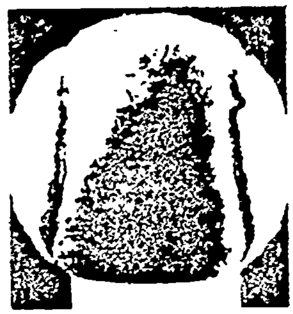
(3) The third spot is placed low and to the left rear of the subject. It illuminates the bottom left side, and gives a highlight in the area illuminated by the main light. This gives the subject the appearance of roundness.

(4) The floodlight is placed in front, near the camera, to soften the shadow on the front of the subject.

Step 1
Main Light

Step 2
Right fill (Backlight)

Step 3
Left fill (Backlight)



Step 4
Front fill (Weak floodlight)

Figure 6. Light Control

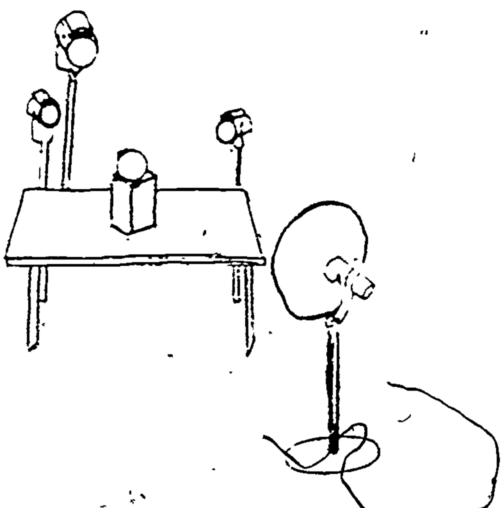


Figure 7. 4-Light Set-Up for Spherical Objects

e. Photographing Shiny Objects. One of the problems involved in small object photography is the elimination of undesirable reflection when photographing an object with a highly-polished surface. This is often solved by the use of a tent. The subject is placed on a suitable stand which is covered with a material contrasting in color to the object. It is surrounded by a four-sided screen that has neither top nor bottom, and made, generally, of white paper. The lights are arranged outside the tent. The light reaching the subject is softly diffused, and reflections are eliminated. The highlights are subdued, and shadows softened. Normally a floodlight is used. Exposure is made through a small hole cut in the screen.

f. Preservation of Texture. The texture of an object is often of importance in its reproduction. Rough textures, such as sandpaper or coarse materials, can be emphasized by adding a spotlight, toward to one side. This is usually in addition to the normal lighting arrangement. The closer the texture light is to being parallel to the surface of the object, the more the texture is emphasized. Smooth surface objects are enhanced by adding highlights along the edges of the object, and on any separate planes of the object.

g. The Camera. If possible, you should select a large format (press or studio type camera, using a large size film (4 x 5, 8 x 10). The camera should have ground glass focusing a long adjustable bellows extension, and be rigidly mounted. Front and back focusing is also desirable.

h. The Technique of Small Objects Photography.

(1) Select a suitable camera, having all the extra adjustments that will be necessary to copy most small objects.

(2) Select the film to be used. Most panchromatic and color films are suitable. A good exposure meter will also be a great aid in arriving at the basic exposure.

(3) Position the camera. Perspective is very important, as it can destroy the whole sense of reality and be very misleading. Too high a camera angle may cause a "Keystoning" effect. Observe your subject very carefully in the ground glass.

(4) Lighting can greatly influence the final result. A full range of tones and distinct separation of the planes is essential. The set should be illuminated by fairly flat lighting to eliminate hard shadows, but not so flat as to "kill" the shape of the subject. Some side lighting may be required to give form and shape to the object. In other words, the lighting should be controlled to produce dark or light

areas as required. In order to obtain maximum depth of field, a small aperture should be used. The proper use of light is the key to making effective photographs of small objects. It creates shadows, highlights, mood, and shows the shape, texture, and color of the object in question.

(5) Focus the camera very carefully. Working very close to the subject requires critical focusing. When photographing at near or same size, focusing cannot be done by moving the camera lens. The camera back, the whole camera, or the subject must be moved.

(6) Determine the basic exposure and multiply it by the bellows extension factor and the filter factor, if one is to be utilized. Developing a trial negative, if time permits, is the best method of obtaining correct exposure.

4. PHOTOGRAPHING FINGERPRINTS. The subject that is probably most often photographed by an investigator is a fingerprint. In many instances, the fingerprint is the most convincing evidence establishing the fact that the subject was at the scene. Without photography much of the value of fingerprints would be lost. Some fingerprints are on objects which are fixed and cannot be taken to court; others are too faint to be seen clearly by the naked eye. They can be easily destroyed by weather and careless handling. These difficulties are easily overcome by photography. Since fingerprints are so delicate, they should be photographed as soon as they are found. The procedures discussed here are equally applicable to palm prints, footprints, and fabric prints or impressions.

a. There are three types of fingerprints, classified according to their visibility.

(1) Visible Prints. Clearly visible prints are usually found on hard, smooth-surfaced materials, such as glass, or metals, and can be photographed without special preparation of the print. This class also includes prints found in soft substances such as putty or wax.

(2) Faint Prints. These prints can be seen by the naked eye, but have indistinct patterns. They must be specially prepared (usually with fingerprint powder) so that the pattern is clear and has enough contrast to allow photographing.

(3) Almost Invisible Prints. These are prints found in dust, or on materials which do not allow development with fingerprint powder. Sometimes they can be brought out by crosslighting, or by treatment by iodine fumes or chemicals. Once treated, these prints fade quickly.

b. Equipment and Materials. The equipment used for photographing a fingerprint will depend on the conditions under which the print is found.

(1) The KE-12(2) (Speed Graphic) (See Lesson 7), with double bellows extension is preferable for fingerprint photography. The double bellows provides for 1:1 image size in the negative. For a 1:1 photograph the distance from the film to the center of the lens must be twice the focal length of the lens used, and the distance from the center of the lens to the print must also be two focal lengths. Or, in other words, the distance from the film to the print will be four times the focal length with the lens positioned midway between. The camera bed should be marked, at this point, showing the proper position of the front standard assembly at double extension. As has been indicated, a 1:1 ratio, or larger, requires a double bellows extension. The bellows compensating factor (M.F. multiplying factor) must be considered when computing the exposure settings. A double bellows extension reduces the light intensity striking the film plane by 1/4 the intensity of the light passing through the lens.

$$MF = \frac{(\text{Bellows Extension (BE)})}{(\text{Focal Length (FL)})}$$

(see paragraph 3b(2)(c) in this lesson.)

(2) Filters. Color filters may be used to control contrast when the prints are found on colored backgrounds, or when colored fingerprint powders are used. To select the proper filter, examine the subject through the filter. If the contrast is improved, then that filter can be used.

(3) Fingerprint Powders. Dusting the fingerprint with a powder is the most universally-used means of developing a print. The color of the powder used is determined by the color of the material on which the print is found. The powder should contrast with the background; those most often used are black, white or gray, brown or red, and fluorescent. If the fingerprint covers an area containing several colors, and contrast cannot be obtained with ordinary powders, use a fluorescent type powder, and photograph the print with ultra-violet light. Aluminum powder can be used on glass or shiny metal because of its exceptional clinging qualities.

(a) Black Fingerprints on Light Surfaces. When black or dark powder is used to develop a fingerprint on a light surface few problems are presented, since this is the same as photographing line copy. Care should be taken that hot spots are not created by your lighting.

(b) Light Fingerprints on a Dark Background. This type of print creates a special problem. The image produced in the final print is reversed. That is, the ridges, of the print, are shown as white rather than black. To change the print back into its proper relationship, an intermediary negative is made. Arrange the negative and a sheet of unexposed film so that the notches correspond, place the negative and film sheet on a contact printer, emulsion side down, with the negative on the bottom. With a 10-watt lamp, the exposure will be approximately one second. The resulting negative is called a transparency or reversal negative, and will produce a photographic print of black fingerprints on a white surface.

(c) Fingerprints on Glass. Either of two methods may be employed in photographing fingerprints on glass. If dark powder is used, place the glass on a light, non-reflective, paper background. The rest of the procedure is the same as other photography. If a light powder is used, place the glass on a piece of black velvet, and photograph it in the normal manner. If the print is on a bottle, a paper background can be rolled up and inserted into the bottle, or the bottle may be filled with a dark liquid, such as ink. Be sure the contents of the bottle has no material value as evidence. Bottles, and other glass objects with curved surfaces, are sometimes difficult to light since they are highly reflective. In some cases, the light may be reflected onto the bottle surface by white paper or cardboard, rather than directing the lamp directly onto the subject. If the glass is translucent, rather than transparent, it may be possible to photograph the fingerprint by placing the light behind the glass, and photographing the print by transmitted light.

7 c. Photographing Fingerprints at a Crime Scene. When fingerprints are found at the scene of a crime, they should be photographed as soon as possible. The object containing the print should be photographed from medium distance, showing the entire object and some of the surrounding area. This enables later identification of the object in the overall view of the crime scene. In those rare instances when fingerprints are to be lifted by tape, they should be photographed before the tape is placed over the print. If photographs are made of the fingerprint on the lifting tape, the negative should be placed in the printer upside down. The image has been reversed from left to right on the tape, and it must be returned to its proper relationship so it can be classified.

5. DOCUMENT PHOTOGRAPHY. Document photography employs the same basic equipment and set-up as copy photographing. In addition, ultraviolet and infrared are used as well. The main difference in document photography and copy photography is that copying merely reproduces the subject as seen, while document photography relates to an effort to detect or clarify writing or markings on paper that is no longer visible due to age, exposure to weather, fire or water, or alteration. Document photography is divided into two general classes: documents that have obviously been altered by erasure or other visible alteration; and those that appear normal but which are suspected of being altered, but in which the alteration is not visible to the naked eye.

a. Film Selection. Correct film selection is the key to successful document photography. The contrast of the writing or marks on the document determine the film to be used. Faint details require the use of a high-contrast film. If detail is required in both the paper and ink, a moderate film is required, since a high-contrast film would block out the detail on one or the other. It is often necessary to experiment with several films before the correct selection is found. The choice of paper is also made on the same basis as the film selection. The film must be properly exposed. In some instances, several photographs may be required of one document, as in the case of a document that has printed matter and signatures in several colors of ink and pencil. More than one exposure would be needed to bring everything out clearly.

b. Mechanical Erasures. These are the easiest to detect, but present some of the most difficult problems. If the writing appears to have been completely removed, there is little possibility of restoring it. It should be examined under a magnifying glass, using a concentrated beam of light. By moving the lamp at various angles, it may be possible to detect some trace of writing. If so, place the document in the copy easel, and arrange your light at the same angle as the original examination light. Usually, a high-contrast film is required, which will exaggerate the traces so they are readable. Side-lighting is most often the best arrangement, since it reveals the texture of the erased area. If no detail is revealed by reflected light, place the document over a light and examine it by transmitted light. Examine both sides in this manner. Examination through filters is also sometimes helpful. If visible light examination reveals no traces, examine the document by ultra-violet radiation. Traces of the ink or pencil may be detected, or the traces may not be sympathetic to the radiation and will be seen against the fluorescence of the paper. If ultra-violet reveals nothing, photograph the document with infrared. It may reveal traces that do not react to ultra-violet.

c. Chemical Erasures. The examination of these documents is basically the same with chemical erasures as for mechanical erasures, but more often than not ultra-violet is the best method. Most papers have a natural fluorescence that is easily disturbed by chemicals. The effect is quite noticeable under ultra-violet radiation. In other instances the ink may fluoresce to a greater degree than the paper, or it may not fluoresce at all. In either instance, the effect can be photographed. Sometimes reflected ultra-violet will reveal alteration not shown by fluorescence. The exposures by ultra-violet will be in minutes rather than seconds, as would be the case with ordinary light.

d. Obliterated Writing. If the writing in question has been obliterated by overwriting, or scratched out, it is sometimes possible to restore the original writing. If the over-marks are made in a different color than the original writing, a filter of the same color as the overwriting may absorb the color and reveal the underwriting. View the obliteration through the filter and examine the effect. A medium contrast film should be used. If heavy pressure was used in the original writing, it may be possible to photograph the indentations which remain obliterated. Cross-lighting is usually used, and a medium contrast film. If these methods fail, try infrared. The ink may be transparent to infrared and allow the underwriting to be photographed. In some instances, ultra violet may be used as there may be a difference in the intensity or color of the fluorescence. If the obliteration is made by pasting paper over the writing, as, for example two papers that were stuck together accidentally, and pulled apart, leaving part of the paper stuck to the writing, wetting the paper may reveal the writing. Apply a chemical such as benzine, or lighter fluid, to the area on the reverse side. The writing will appear for a few seconds and then disappear as the fluid evaporates. Be prepared to photograph as soon as the writing appears.

(1) Masking. Masking is a photographic process which often permits separating the individual information from obliterated areas. If a negative, and a positive made from the negative are superimposed, all the information will disappear. However, if the positive is made from a second negative which differ in some respect from the first, then some information can be made to disappear selectively while other information is retained.

(2) It is necessary to make two negatives at the same magnification and that these negatives differ as much as possible in the ratio of image strength between the writing to be deciphered and that which is causing confusion. A film positive is made by contact from the negative containing the weaker image of the wanted information (or the stronger image of the unwanted value) and processed so that the superimposition with the other negative will obliterate the unwanted information. A print made by exposing through the superimposed films will produce a greatly clarified picture of the information desired.

e. Photographing Impressions. The impressions left upon a pad of paper by writing on an upper sheet which has been removed will sometimes provide a legible copy of the message written on the missing page. By directing a beam of light from the side (almost parallel to the plane of the paper), the indentations can be brought into relief and the writing revealed. No special treatment of the paper is necessary. This should be done in a darkened room so that only the grazing light illuminates the paper. Handle the pad very carefully before photographing it. Never put the suspect paper under any pressure, as this would tend to smooth out the indentations and make it more difficult to photograph.

f. Charred Documents. The writing on charred documents can often be deciphered and photographed using infrared light. Naturally the degree of "restoration" depends on the degree of charring. Those papers that have been completely burned cannot be photographed successfully. In some instances, charred documents are photographed by placing the paper under a large sheet of glass, and arranging one light at an angle off to one side, so that the ink residue reflects the light. Both methods should be tried. Infrared may also be useful in photographing charred fabrics or leather, such as money bags, names inscribed on wallets, etc. Since these materials will usually be quite brittle and fragile, they must be handled with extreme care.

EXERCISES

The following exercises are multiple choice. There are four alternatives to each exercise. You are to select the one alternative that is correct and indicate your choice by circling the correct response directly on the exercise booklet.

1. The type of light generally used to separate the subject from its background would be a

   a. floodlight.

   b. spotlight.

   c. reflector.

   d. floodlight with barn doors.

2. In figuring exposures, when the original to lens distance is less than 10 times the focal length of the lens, you must

   a. add the basic exposure number to the bellows extension factor.

   b. multiply the basic exposure by the bellows extension factor.

   c. divide the basic exposure by the bellows extension factor.

   d. multiply the exposure by the distance of the films focal plane.

3. When mounting an original on a copyboard, all of the following steps would be taken EXCEPT.

   a. the original should be parallel to the film plane.

   b. the original should be perfectly flat on the copyboard.

   c. the original should be centered with the optical axis of the lens.

   d. the original should be mounted right side up on the copyboard.

1-12 I; 8-19

4. Glare is generally eliminated when photographing a very shiny surface by the use of

a. a tent.

b. reflectors.

c. barn doors.

d. bounce light.

5. An investigator might find it necessary, prior to photographing a fingerprint, to use iodine fumes to bring out

a. visible prints.

b. faint prints.

c. almost-invisible prints.

d. latent prints.

6. For a 1:1 photograph, the distance from the film to the center of the lens must be

a. the same as the focal length of the lens.

b. one half the focal length of the lens.

c. twice the focal length of the lens.

d. four times the focal length of the lens.

4-12 I; 8-20

13. Of the following, which item is not preferable in a copy camera?

a. Close focusing capability.

b. Small film size.

c. Rigidly mounted.

d. Ground glass focusing.

14. Writing on charred documents can often be deciphered and photographed by

a. using filters.

b. the masking technique.

c. using infrared light.

d. treatment with benzine or lighter fluid, which will bring the writing out for a short time.

15. Normally, in photographing small objects, the main light is

a. a floodlight, with two spotlights to bring out details.

b. a spotlight with floodlights used for fill lighting.

c. spotlights, with reflectors, used if there is excessive glare.

d. two floodlights, with barn doors attached to direct the light.

4-12 I; 8-23

16. To photograph rectangular objects, the main light should be placed

a. directly to the front of the subject.

b. to the front right of the subject.

c. above and to the rear of the subject.

d. behind and to the side of the subject.

17. An 8 x 10 original produces a copy print that is 2 x 2-1/2 when the scale is

a. 4:1.

b. 1:4.

c. 2:1.

d. 1:2.

18. To bring out faint detail, on a document that is being photographed, you would generally use

a. a high-contrast film.

b. a medium-contrast film plus a high shutter speed.

c. a low-contrast film.

d. any type of film because a red filter will provide the needed contrast.

4-12 I; 8-24

19. Generally, the best method for examining chemical erasures is

a. infrared light.

b. ultra-violet light.

c. treatment with iodine.

d. oblique lighting.

20. To darken an area, which is to be copied

a. use a filter of the same color.

b. increase your aperture setting by four stops.

c. use a filter of the complementary color.

d. decrease your shutter speed to 1/25 of a second.

1-12 I; 8-23

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LESSON ASSIGNMENT SHEET

SUBCOURSE NO. 4-12 I	Investigative Photography.
LESSON 9	Crime Scene Photography.
CREDIT HOURS	4.
TEXT ASSIGNMENT	Attached Memorandum.
MATERIALS REQUIRED	None.
LESSON OBJECTIVE	To provide you with the information needed to enable you to photograph specific crimes at their scene.
SUGGESTIONS	None.

ATTACHED MEMORANDUM

This attached memorandum includes information extracted from resident instructional material of the United States Army Military Police School. In case of conflict between the attached memorandum and other publications, the material contained in the attached memorandum will apply to this lesson assignment.

1. INTRODUCTION. Photography is an essential tool for the law enforcement investigator. ~~As a tool, it enables~~ him to record the visible, and, in many cases, the invisible evidence of a crime. The photographic evidence can then be stored indefinitely and retrieved when needed. In short, there is no other process which can ferret, record, remember, and recall criminal evidence as well as photography. This lesson is designed to give you general information to enable you to photograph specific crimes at their scene.

2. CRIME SCENE PHOTOGRAPHY. The basic function of a crime scene photograph is to provide the investigator with information that will assist him in solving the crime. In cases involving violence, the location of objects in the scene may be vital in establishing exactly what took place. A permanent record of such a crime scene is considered indispensable to a successful presentation of the case in court. The photographs must be taken before the scene is disturbed, and articles of evidence removed. The photographer's aim should be to record a maximum of useful information in a series of photographs which will enable the viewer to understand where and how the crime was committed.

The term "crime scene" refers not only to the immediate locality in which the crime took place, but also to adjacent areas where important acts took place immediately before or after the commission of the crime. The photographs, along with establishing points of proof, may prove useful later in interrogating suspects and interviewing witnesses. They also will provide the court with a graphic illustration of the scene, enabling it to better evaluate evidence.

a. Photographing the Scene. To insure complete photographic coverage of the crime scene, a pattern should be established for photographing the area. This pattern should be worked clockwise in a spiral, starting at a point at the perimeter of the scene, and working toward the center. Usually, the first photograph is of the entrance into the area. The second photograph should include a portion of the area taken in the first photograph. Because of this overlapping coverage, the scene can be viewed with the assurance that no portion of the area has been excluded, and the relationship of objects in each photograph is established. The overall crime scene photographs will be long shots, in most cases. When items of importance are discovered they should be photographed from a distance close enough to identify the object, but still show enough of the surroundings to establish its location in the overall crime scene photographs. It can be later photographed, at close range, to reveal identifying marks, or other evidence, such as blood stains, fingerprints, or hair or fibers. The number of photographs required to provide complete coverage of the scene will be determined by the nature of the crime and the location. However, no less than four photographs are necessary to adequately show the interior of a room. If there is doubt as to whether a photograph should be taken, it is best to take it. It is far better to have too many photographs than too few.

b. Lighting. The type of lighting necessary for crime scene photography will be determined by the scene itself, so no specific rules can be made, other than following the lighting techniques found in other lessons. Also, there are several generalizations that apply to crime scene photography. The scene should be well lighted, revealing all the detail of the object or area. Dramatic lighting with deep shadows is not desirable, unless the shadows play a role in the crime. When photoflash is used, care should be taken not to place the flashlamp too close to the subject, since this will "burn" the subject with too much light, and the detail will be lost.

c. Perspective. An evidence photograph should appear natural to the observer, with sizes, distances, and relationships appearing in their proper perspective. This perspective is determined by the position of the camera when the photograph was taken. As a rule of thumb, it can be said that the camera should be at a witness eye level, or about 5 feet from the floor. Other positions will be used from time to time, but the general scenes and medium-distance photographs should be from that height. The camera should be placed to show a natural line of vision, such as an observer would see, avoiding trick shots, and placed so that objects in the scene do not appear distorted or unnatural by being too close to the lens.

d. Verification of Photographs. In addition to identifying a photograph for the court, it is also necessary to verify the materiality and truthfulness of the subject or scene portrayed. If the perspective is distorted because of the nature of the crime scene's shape or physical limitations, or by wide angle or telephoto lenses, the distortion must be explained. If a filter is used to create contrast or reveal evidence, it must be explained, the camera position must be given, and the other technical information regarding that individual photograph. This is especially true when using infrared or ultraviolet. This is best accomplished with a mimeographed form that is pasted on the back of the print. This is called a data card, and should be made for each negative and print, and should contain a complete technical history of each negative and print (e.g., f/stop, film, developing time, etc.). The information on the data card must be verified as well as the print itself. Care must be taken not to express any opinion in this form, such as the nature of the offense, since this may affect its admissibility in court. The same information should be filed with each negative.

e. Marking the Photograph. This subject is divided into two categories. In the first category, marks may be used to identify a photograph, or objects depicted in the photograph. These marks will probably have to be explained to the satisfaction of the court before the print will be accepted. The second category is marks or objects placed in the scene and photographed as part of the scene. These marks or objects must be verified as to their proper positioning, and must be necessary in the identification of some object.

(1) Markings on a Photograph. It is permissible to place a mark on a photograph to identify the print before it is submitted in evidence. After it is accepted, it will be marked as an exhibit by the court. The technical information shown on the reverse of the print must be verified at this time. It is permissible to place marks on the face of a print to identify certain objects, if necessary, and explainable.

(2) Markings Placed in the Crime Scene. In some instances it is permissible to place an identifying marker in the crime scene. These markers should be used with discretion and restraint. Care must be taken not to obscure

important evidence by the marker, and the marker must be clearly visible and identifiable. An example of this type marking is a stake showing the location of an item of evidence that is too small to be seen in an overall view of the scene. If a marker is used to indicate or establish size, a ruler calibrated in inches or millimeters should be used. The ruler should bear the photographer's initials so it can be identified if it is required to be presented in court for verification.

f. Marking the Negative. The only marking permissible on a negative is an identification number. This, normally, would consist of the case number and the number of the negative. Negative numbers run in sequence in the order in which they were taken. This number is placed on the border of the negative. Nothing should be placed in the image area of the negative. The negative, after exposure, is handled in the same manner as any other item of evidence, and the chain of custody is the same. When motion picture film or color film is commercially processed, a statement called a processor's affidavit should be obtained. This states that the film was normally processed, and returned to the sender neither altered nor edited. The chain of custody is maintained by transmitting the film through registered mail, with return receipts requested. It is suggested that the processor be listed as a witness in the case report.

g. Data Board. Occasionally, a photograph will be taken of a scene in which nothing appears that will indicate left and right in the negative. To prevent the accidental reverse printing of the negative, a data board is included in the scene when it is photographed. The data board can be a black board, or even a simple 3 x 5 card, with the time, date, location and photographer's initials written on it. The data board assists in identifying and verifying the photograph. It is important that no opinion be expressed on the data board, for example, the word Murder, or Suicide. Since the facts of the case are not established at the time the scene is photographed, opinion would indicate that the investigator had already formed conclusions. This could render the photographs inadmissible as evidence.

h. Presentation of Prints. A photograph to be used as evidence in court may be made to suit one of two purposes. If a print is for distribution to the various members of the court, 8 x 10 inches is a convenient size. It is large enough to show details of the subject, and not so large to be difficult to handle. If the print is to be used as a display exhibit, it should be larger in size, 16" X 20" being a commonly used size. Display exhibits are used to illustrate points, or explain the scene depicted. Display prints should be mounted on stiff cardboard. When an enlargement is made of a portion of a negative, a contact print should be submitted with it, to show the relationship of the enlarged area to the entire scene shown in the negative.

3. PHOTOGRAPHING SPECIFIC CRIMES. Given below are suggestions for photographing the more common types of crime. These are by no means comprehensive. Each crime will have individual features which should be photographed. Keep in mind the nature of the offense and try to show clearly those features which aid in establishing the elements of the offense.

a. Burglary and Vandalism. From a photographic viewpoint, burglary and vandalism can be treated alike. The following are examples of subject matter, in recommended order, to photograph in a typical burglary or vandalism.

(1) General views of the exterior of the building in which the crime has taken place.

(2) The point of break or entry. These should be photographed in such a manner that marks of force will be shown clearly.

(3) Point of exit.

(4) Conditions of rooms.

(5) Articles left at the scene (e.g., burglar's tools).

(6) Trace evidence, such as burned matches and cigarette butts.

(7) Tool marks and impressions of shoes or tires.

(8) Fingerprints and footprints as well as articles on which these prints may be found.

(9) The area from which valuable articles were removed, such as from a safe, desk, etc.

(10) It is recommended that investigators be particularly careful about leaving articles such as cigarette butts or matches at the scene, since they could be confused with similar trace evidence left by the intruder.

b. Photographing Deceased Victims. In many instances, the victim's body will reveal as much information as the crime scene. The photographs of the victim will differ with each case, but there are certain factors that are peculiar to certain offenses. The photographing of the victim is done in two phases:

Those taken at the scene. and those taken at the morgue. The presence of the investigator during the examination of the victim, and in some instances the autopsy, is vital, if the evidence is to be preserved. Due to the large number of possible offenses and wide variety of evidence that may be found, only a general outline of the more common incidents will be given. These basic photographs are a guide, and can be expanded or altered to match the situation.

(1) Homicide. Homicide photographs should set the scene, and provide information concerning the manner of death. The crime scene should be photographed from every direction with plenty of closeups to aid in reconstructing the crime.

(a) In an indoor scene, these pictures might include:

1. The room or area in which the body was found.

2. The adjoining rooms, exterior of the house or surrounding area, visibility at various points, footprints, or impressions of tire prints.

3. Evidence of struggle, such as overturned furniture, bloodstains, etc.

4. Signs of activity prior to the occurrence, such as the telephone receiver off the hook or wires cut, TV and lights turned on, drinking glasses or liquor bottles, etc. In general, articles apparently in use immediately prior to commission of crime or which appear to have been disturbed from their customary position, should be photographed.

5. Unusual signs, such as marks of conflict on a suspect's person or clothing; trails of bloodstains, footprints on paper or in blood; handkerchiefs or garments bearing laundry marks and other potential clue material.

(b) In an outdoor scene, look for such items as shoe or tire impressions, discarded cigarettes, burned matches, broken branches or shrubbery, signs of objects being dragged; and photograph them immediately lest they be disturbed.

(c) To locate the body in the scene and its position in relation to other articles in the room, take at least two photographs of the body at right angles to each other. Point the camera down from the normal position of a standing observer. Other pictures might include closeups of wounds, the location of the instrument of death, and other special aspects or conditions of the body.

(d) Additional photographs of the body may later be taken at the morgue under the direction of the autopsy surgeon. These may include teeth marks on the lips and the tongue, bruises or scratches on the body, post-lividity marks, and marks on the legs or arms indicating that the victim had been bound. While many of these may be observed at the scene, they are more easily photographed at the morgue. In addition to the body, the victim's clothing should also be examined.

(2) Hangings. In many cases of hanging, doubt exists as to whether it is murder, suicide, or accidental. The original position of the body, is, therefore, of importance. Often the body is cut down or moved in an effort to render first aid. This means that the photographs will be somewhat different than those taken when the body is undisturbed. These two circumstances will be discussed separately.

(a) Undisturbed Scenes. 'Views of the overall scene are taken first. Overall views of the body should be taken from torso height, and should include the rope. Closeup photographs are taken of the head and neck showing how and where the end of the rope is secured. Since most suicides do not have their feet clear of the floor (many are found sitting or in a semi-prone position) any space between the victim's feet and the floor should be photographed. Any object which appears to have been kicked from under the victim's feet should also be photographed.

(b) Disturbed Scenes. When the body has been removed from its original position little can be done to photograph the scene. Overall views of the room are made. If the rope is still secured, the method of securing it should be photographed, as should any signs of disturbance. Closeup photographs of the depth and location of the groove, made by the rope, should be taken, including black or blue marks or scratches. Color film is well suited for these photographs, especially when the face is discolored. Black and white photos should also be taken, as color may be ruled inflammatory and not admissible. But color will best preserve evidence of discoloration of the body.

(3) Drownings. In drowning cases, the body is usually the sole object of interest. The scene is of little importance since the body will not normally be found in the same area where the death took place. The main question is, did the deceased actually die of drowning or was he thrown into the water after dying from some other cause? The photographic operation should be directed toward those facts which will help to resolve this question and the victim's body will most likely provide the answers. Color film is extremely useful here since many of the significant clues may be matters of discoloration. Photograph the whole body, both from the position of a standing observer and from the ground level. The latter view will show any distention of the body.

Closeups should include any foam about the mouth; the position of the mouth, whether open or closed; wounds, peculiar markings, bruises, or unusual discolorations; articles grasped in the hand; and any rope or wire bindings. Many of these shots can be made at the morgue before autopsy.

(4) Accidental Electrocution or Lightning Deaths. In addition to the usual photos, special attention should be given to those aspects of the scene which show how the electrical contact was made. Examples are the accessibility of lighting fixtures; wires lying in water; electrical hazards, such as frayed insulation or exposed wires.

c. Explosions. Explosions may be accidental or intentional; if the latter, it is the job of the investigator to determine if it were directed toward a person or property. The investigator must be very careful because the key evidence may be as subtle as a small piece of string. Usually such offenses are committed indoors. The following items are potential objects to be photographed:

(1) Nature of Explosive Device. The detonator of a home-made bomb may leave items strewn about the scene, such as: parts of the container, fragments of a box, pieces of string or paper; metal parts such as pieces of pipe, tape, wire, batteries, and parts of clock mechanisms.

(2) Undetonated Portions of Explosives. These may be found at a considerable distance from the point of explosion.

(3) Traces of Liquid Explosives. Stains or splashes on clothing, draperies, or walls; particles of wax or paraffin.

(4) Point of Origin. The exact spot at which the bomb exploded is important. Also, the window or other opening through which the bomb may have been thrown.

(5) Condition of Utilities Equipment. If it appears that the source of power for the detonation was derived from a doorbell, telephone, or gas equipment, photographs should be made of such items, also of household appliances and similar pieces of equipment. Also photograph such items if in places where they would not normally be placed. Faulty gas lines, open gas valves, and ruptured pipes or fittings should also be photographed.

(6) Evidence from Suspect. Indications of the use of explosives may be found on the person of a suspect or in his lodgings or vehicle. Thus, photographs should be made of acid burns, discolorations, or injuries on a suspect's person and of explosive components, binding materials, insulation materials, etc.

d. Arson. Arson is one of the more difficult offenses to prove, since much of the evidence is consumed by fire. Photography is one of the major scientific aids used in investigations of this type. It is a lengthy operation, starting with the investigator's arrival at the scene and continuing, perhaps, for several days after the fire. This is a type of investigation that is well suited to the use of motion pictures, as well as still photography. The photographing of a fire is divided into three phases: photographing the fire in progress; immediately after the fire; and after action when damage photographs are taken.

(1) During the Fire. Photographs of the fire while it is in progress are valuable for a number of purposes. They should include the following:

(a) The area of origin.

(b) The speed, direction, and manner of the spreading of the fire.

(c) Progressive stages of the fire from various angles, as significant changes take place.

(d) The arrangement of windows and doors.

(e) Photographs of spectators should be taken every 15 minutes or so, since the arsonist will often return to the scene of the fire. Look for individuals who appear in more than one photograph.

(f) This phase of the photography is best accomplished by a motion picture camera. The color of the smoke and steam, location, size and color of the flames as well as their intensity, are all valuable in determining the use of an accelerant. A time log should be maintained, recording the time each sequence was taken. Naturally, color film is the preferred film since it provides better identification of colors. The photographs of the spectators may be a valuable lead, especially if there has been a series of fires in the vicinity. Local civilian firemen and arson investigators should be invited to view these films since they may be familiar with possible suspects. If it is possible, photographs should be taken inside the structure during the fire. These should include windows and doors, closets and file cabinets where records are stored. Incendiary devices should be photographed carefully, as should any item that could be used in starting the fire. These items relate to the most difficult element of proof, intent. Empty cans or liquid containers, paper, or rags, combustible liquids, candles, matches, etc., should all be carefully photographed. Photographs should also be taken of prospective devices that have been tampered with, such as sprinkler systems that have been turned off, open gas jets or pipes, or electrical systems that have been altered to create a danger. If the fire is uncontrollable, this evidence may be consumed and lost for the investigator's evaluation.

(2) After the Fire. When it is safe to enter the building, it should be photographed completely. The same attention should be given to the details considered in photographing the interior during the fire. In addition the area that was burning can now be entered and photographed. It is important that this be accomplished before the firemen enter the area, since they may collapse dangerous walls or chimneys to protect the public. This, of course, destroys any evidence that is there. Special attention should be given to arrangements of the items in various rooms. Arson is often used to conceal another crime. Particular attention should be given to documents and records that are purposely exposed, doors, windows, transoms, and ventilators that are open and provide cross-drafts. Electric clocks should be photographed to show the time of power failure. Views of burned areas should be taken with special attention to their probable points of origin. The firemen are a good source of information to determine these areas. The path of a fire can sometimes be traced by the effects of the fire. The alligator pattern of charring caused by the fire often can be used to trace the fire to its origin. The deep charring of the wood, and the small checks of the pattern, should be photographed. Cross- or side-lighting is best to reveal the detail of the charring. The exposure should be increased by one or two f/stops since the charred wood absorbs a great amount of light. The pattern at the point of origin is smaller and deeper than the rest of the area. The pattern is also smaller and deeper at points where flammable liquids were used.

(3) After-Action Photographs. After-action photographs include complete exterior coverage of the structure and the surrounding area. They also include any evidence that may be uncovered during cleanup operations. These require coordination with the fire department and the personnel employed in the cleaning detail. They should be briefed as to what may be of interest to you. If evidence is located, they should be instructed not to move it until you have arrived to photograph it. In addition to the photographs of the structure and such evidence as may be found, a photographic copy of the blueprints of the structure is also valuable in reconstructing the scene. In conjunction with the blueprint, overall photographs of the interior can be used to indicate the location of various rooms inside the building, by marking their location on the print with a grease pencil.

e. Sex Offenses. This type of crime is photographed in three phases: the victim; the victim's clothing; and the scene of the assault. The offense of rape will be used as an example of this type crime. This is one of the more difficult crimes to prove, thus, photographs are of prime importance. Since resistance to the act is important, bruises and discolorations on the body of the victim are vital evidence. In addition to these marks, the condition of the specifically-affected parts, and the presence of foreign hairs, fibers, and biological stains all add to the evidence that the act did in fact take place. Foreign matter adhering to the victim's clothing may, through laboratory analysis, verify the victim's identification of the scene. This type photography lends itself well to the use of color film. Permission should be obtained in writing from the victim, or her parents or guardian in the case of a minor, before the photographs are taken. It is recommended that the victim's physician be present when the photographs are made.

(1) Photographing the Scene. The scene of the crime should be photographed to show its relationship to neighboring roads or houses, to show that the victim's cries could not be heard, or that the scene would not normally be one used for a social meeting. A closeup of the scene should show disturbances in the ground, or in shrubbery or foliage; items of clothing or personal items such as a purse, comb, lipstick, buttons, as well as footprints or tiretracks are other items to photograph. Indoor scenes may have broken or disarranged furniture or other signs of a struggle, and there may be signs of forced entry, such as a cut window screen, a broken window, or tool marks on a door.

(2) Photographing the Suspect. An examination of the suspect by a physician and the investigator may reveal evidence linking the suspect with the scene or the act. These items should be photographed. They are basically the same items that would be noted on the victim: bruises, scratches, foreign matter in the clothing, semen stains, etc.

f. Crimes Involving Firearms. Firearms as a weapon, having the advantage of distance, can make the work of the photographers very difficult. The photographer should work with a firearms expert and the photographs should be made to conform with his views on how the evidence should be shown. It will be a definite aid if the trajectory of a bullet can be shown. One technique for vividly showing the path of a bullet is to stretch a white cord from the body of the victim to the apparent point of the discharge of the weapon. The scene should be photographed both with and without the cord, so that an overlay can be made, if it is desirable to show in the picture the path of the bullet.

(1) Indoor Scenes. Marks made by bullets on impact with a wall or other solid object should be photographed from the assumed point of fire, as well as closeup.

(2) Outdoor Scenes. If the crime took place outdoors, the possibility of long trajectories or ricochet of bullets exists. Since the position of the person discharging the weapon is often unknown and difficult to determine, photographs taken from the body position along the estimated direction of fire become very important.

g. Accidental Deaths. An accidental death is photographed in the same manner as a homicide. Photographs should be taken of anything that tends to prove or illustrate how and why the accident occurred. Special care should be taken to include photographs of any safety devices which were used, properly or improperly, or not used at all. Many times these photographs can be used as the basis for prevention programs.

h. Surveillance Photography. The purpose of a surveillance is to provide the investigator with information or evidence. One of the best methods of recording this information or evidence is a photograph. Surveillance photography is the same as ordinary photography except that the photographer must maintain secrecy. This means that the photographs must be taken from a distance with a telephoto lens, or with a concealed camera. The application of photography during a surveillance will depend on the nature of the surveillance and the purpose. Some of the more common applications are outlined in the following examples.

(1) Camera Position. On a fixed surveillance, or when the camera is positioned at a suspected meeting pl ace of the suspect, the prime considerations are concealment and the field of view. The camera must be positioned where it cannot be observed but still have a clear view of the area. It is best to take first an overall view of the scene to establish the location, and then use a lens of long enough focal length to make recognizable photographs of the suspect(s). If motion pictures are used the first few feet of film should be taken of the data board, and if a clock is located in the scene's area the clock should be photographed at the beginning and end of each scene. This establishes the time the photographs were made. The data board is photographed on each roll of film. Notes should be maintained on the exposure, film type, etc., and the names, time of arrival or departure of the persons of interest who are photographed. Vehicles or other objects of interest should also be recorded if photographed. Cases in which this type surveillance photography is used are narcotics

purchases, blackmarket operations, thefts from parked automobiles, or when the meeting of two or more persons must be proven to establish their presence at a certain area or that they are acquainted.

(2) Moving Surveillance. A moving surveillance provides the greatest problems in photography, since the investigator is often in the open, and must take the photographs with a minimum of concealment. It is best to operate in teams, one man driving and the other acting as his assistant, taking the photographs and operating the radio, taking notes, etc. If a foot surveillance is required, the problem is increased since two men together are more obvious than one. If the suspect's destination is known, it is best to set up a pre-selected position and take the pictures when the suspect arrives.

(3) Surveillance Leading to Apprehension. In some types of offenses the surveillance leads to an immediate apprehension, such as a narcotics sale. In cases of this nature the photographer must not only photograph the purchase, but the apprehension as well. When the investigator makes the apprehension he will grasp the suspect's hands to prevent him from dropping or throwing the narcotic away. This action must be photographed, as well as the evidence still in the suspect's hand if possible. The evidence taken from the suspect's person, should also be photographed, such as syringes, hypodermic needles, etc. In this type offense, if an apprehension is made after a forced entry and surprising the suspects while they are using narcotics, the first photographs are taken as soon as entry is gained. This is to record the suspect's positions and actions. Any evidence revealed during the search of the suspects and the room they are in must also be photographed, as and where it is found, and later at the photo lab for identification and record.

i. Disorders. Although not usually the responsibility of criminal investigators, disorders and riots may be of some interest from a criminal standpoint if they occur on a military reservation, or involve a military operation. Motion pictures taken of the participants allow identification of persons involved, and study of the actions of various groups within the mob. If criminal actions are observed the motion picture film is excellent evidence. Intelligence personnel may also have an interest or responsibility in the case, and should be invited to view the films.

4. ARTICLES OF EVIDENCE. In addition to appearing in the overall crime scene photograph to establish their location, all portable items of evidence should be taken to the laboratory where they can be photographed under the most favorable circumstances (see Lesson 8, Copy and Small Object Photography). Closeup photographs of perishable items, such as footprints, and evidence that will oxidize and change color, such as bloodstains, must be made at the scene of the crime as quickly as possible.

a. It is very important for the investigator to label, in some manner, every item of evidence he accepts, not only to prevent a possible mix-up of evidence but for his own personal protection. All small items should be placed in containers and the containers labeled with a case number. It is also recommended that the photographer give a signed receipt containing a description of all items passed on to him, and to demand a similar receipt when he passes an item on to another party. Thus, the continuity of handling can be preserved. It is advisable to observe some characteristic peculiar to the particular piece of evidence so that he can positively identify it later as the material he received and photographed.

b. Important items of evidence, such as tools, weapons, and contraband, and items which may deteriorate or change with time should be photographed individually. Some objects may require more than one photograph in order to show trace evidence on all surfaces. This provides a permanent record of the original appearance of the object, provides a supplement for the case report, and protects the valuable evidence from unnecessary handling.

c. Photography of Blood. Blood oxidizes and turns brown. Frequently the crime laboratory will remove the blood from a weapon to analyze it, and there have been cases where a defense attorney has objected to a weapon being offered in evidence after it has been cleaned. Thus the photographer must work fast when photographing any evidence containing blood.

(1) Blood, per se, is easy to photograph. Color film should be used, especially with old, dried blood which may not record satisfactorily in black and white photography. Bloodstains are frequently found where the background of similar color makes it more difficult to photograph. There are several methods which can be used.

(2) The object in photographing blood is to capture as much contrast between the bloodstain and its surroundings as possible. A red filter may lighten the blood more than its surroundings, and a blue filter may darken the blood more than its background. A very low grazing light, especially when dealing with fabrics, will sometimes record bloodstains because of the difference in reflectivity between the blood and the nap of the fabric. Also, fresh blood, and sometimes oxidized blood, will fluoresce when illuminated with ultraviolet light.

d. Footprints and Tire Impressions. Imprints of shoes and tires are often found at a crime scene. Although these are usually reproduced by plaster casting, they should be photographed first. Place the camera on a tripod with the film plane parallel to the ground. In the case of footprints, include a ruler beside the print and adjust the camera to obtain as large an image as possible. In the case of tire prints, select a length of track for best tread pattern, especially areas which reveal defects, such as cuts, which may help identify an individual tire.

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e. Dusty Shoe Prints. Occasionally, dusty shoe prints are found on a newly waxed floor or on paper strewn on the floor. These may be visible to the naked eye by use of crosslighting. Another method is to use a sticky material to which the dust will adhere, and which will lift the print from the floor.

5. PHOTOGRAPHIC EVIDENCE. While most of the rules pertaining to photographic evidence are based on civilian court decisions, they apply to military courts and boards as well. They deal with the admission of the photograph as evidence, and the weight to be given various types of evidence depicted in individual photographs. The photograph offered in evidence should be a faithful representation of the subject matter. It should not mislead the viewer in any important aspect. It should be free of distortion, in lines or shapes, and tone relationships should be accurate. Important subject matter should be in sharp focus. There are two types of evidence photographs; those which represent objects of evidence, or a scene, and serve in place of the object, or a verbal description of it; and those which actually prove a point in issue, such as bullet comparisons, document alterations or fingerprints. To be admissible in evidence, the object portrayed must itself be admissible. The admissibility of photographs which prove a point in issue is decided by the court, based on the point in question, and the degree of effectiveness with which the photograph accomplishes this purpose.

a. The use of photographic evidence is mentioned in several portions of the Manual for Courts-Martial, United States, 1969 (Revised), as follows:

(1) Para 138c. Real Evidence. Physical objects such as clothing, jewelry, weapons, and marks on wounds on a person's body, may be received or exhibited if they are relevant to an issue in the case. Evidence of this kind is called real evidence. If an item of real evidence which has been introduced in the case is not to be attached to the record of trial because of the impossibility or impracticality of doing so or for some other reason, the item should be clearly and accurately described for the record by testimony, photographs, or other means so that it may be considered properly upon review of the case.

(2) Para 54d. . . . . When a document, such as an original record, which must, or should be, returned to the source from which it was obtained, is received in evidence or marked for identification, a suitable copy or extract copy thereof will be substituted for the document and it will then be returned. Similar action may be taken to substitute an accurate description or photograph for an item of real evidence which must be returned to its source or is too bulky for inclusion in the record of trial.

(3) Para 144e. Maps and Photographs. Maps, photographs, X-rays, sketches and similar projections of localities, objects, persons, and other matter are admissible when verified by any person, whether or not he made or took them, who is personally acquainted with the locality, object, person, or other thing thereby represented or pictured and is able from his own personal knowledge or observation to state that they actually represent the appearance of the subject matter in question. Such writings are also admissible when they come within either the official record or business entry exception to the hearsay rule.

b. These portions of the manual outline the basic prerequisites for evidence photographs in military courts. Essentially, the photograph must be clear, sharp, free of distortion, identifiable, and material and relevant to the issue(s) of the case.

EXERCISES

REQUIREMENT. The following exercises are multiple choice. There are four alternatives to each exercise. You are to select the one alternative that is correct and indicate your choice by circling the correct response directly on the exercise booklet.

1. Which of the following is NOT a prime function of Investigative Photography?

   a. Provides a permanent record.

   b. Determines guilt or innocence.

   c. Assists in the solving of crimes.

   d. Provides a graphic illustration of the scene.

2. The information on a data card should include

   a. location, time/date, and initials.

   b. location, time/date, offense, and initials.

   c. location, case number, time/date, offense, and initials.

   d. case number, offense, and initials.

3. Which of the following is NOT a factor in initially photographing a crime scene?

   a. Items photographed should show enough of the surroundings to establish location.

   b. At least four photographs of the overall scene should be taken.

   c. The first photograph is usually of the entrance to the area.

   d. The overall photographs will generally be closeups.

4. To insure complete coverage of a scene, a pattern should be established. This pattern should start at a point on the perimeter and move

a. clockwise in a spiral.

b. counterclockwise in a spiral.

c. from the interior to the exterior of the scene.

d. from right to left, getting each corner.

5. After a fire, in which arson is suspected, you may be able to trace the fire to its origin because

a. the alligator pattern of charring is not as light absorbent as the surrounding areas.

b. the checks of the charring pattern will be larger than the surrounding areas.

c. the pattern of charring at the point of origin is smaller and deeper than the rest of the area.

d. the point of origin will be blacker than the rest of the area.

6. Proper perspective means that the camera should be

a. as close to the object as possible to get as close to actual size as possible.

b. at a witness' eye level.

c. parallel to the floor.

d. about 3 feet from the floor.

7. To best show the alligator pattern of charred wood you would use

a. flat lighting.

b. diffused lighting.

c. one to two stops less exposure.

d. one to two stops more exposure.

8. All of the following are TRUE statements concerning photographs which are used as evidence EXCEPT

a. negatives should be handled as any other piece of evidence and the chain of custody is the same.

b. the processor of the film should be listed as a witness in the case report.

c. negatives used as evidence cannot be altered or retouched in any way, except for an identification number.

d. prints used in a criminal case cannot be enlarged or changed in any way.

9. A rape victim has been hospitalized. You have been directed to take photographs of her injuries, for which she will have to be photographed in the nude. Before taking the photographs you should obtain written permission from

a. the victim's husband.

b. the attending physician.

c. the victim, or parent, or guardian in the case of a minor.

d. the Staff Judge Advocate.

4-12 I; 9-19

10. Which of the following is a TRUE statement concerning objects or markers placed in and photographed as part of a crime scene?

a. It will make the photograph inadmissible as evidence.

b. All objects must be included on a Chain-of-Custody form, DA 19-31.

c. They must be necessary for the identification of some object.

d. They need not be verified as to their proper positioning.

11. On a fixed surveillance, the prime considerations are

a. the types of lenses used.

b. concealment and the field of view.

c. concealment and the exposure factors.

d. exposure factors and film type.

12. When an enlargement is made of a portion of a negative, for court use,

a. it must be supported by testimony to be entered as evidence.

b. a contact print should be submitted with it.

c. it must be 16 x 20 inches in size.

d. it may be submitted without any additional support or explanation.

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13. In narcotics investigations, any evidence revealed during a search of a person, or room

a. can be photographed only after the suspect has been advised of his rights.

b. must be photographed when and where it was found.

c. can only be photographed, and used as evidence, after it has been determined to actually be contraband.

d. should only be photographed in the photo lab under ideal conditions, as a statement from the investigator will verify when and where it was found.

14. Upon arriving at the scene of a burglary, the first photographs you would normally take would be of

a. the exterior of the building or site.

b. marks left by tools.

c. trace evidence, since the investigators might leave their own traces.

d. articles left at the scene.

15. Color photographs of a victim of hanging should be taken, since color

a. presents a more vivid portrayal than black and white, increasing chances for a conviction of the suspect.

b. provides a better record of body discolorations than black and white, and is better evidence in court.

c. shows more detail than black and white photos, adding to their value as evidence in court, and allows the pathologist to add testimony not included in his report.

d. provides proof of the pathologist's autopsy findings and demonstrates tissue damage.

4-12.1; 9-21

16. A data card is

a. placed in the scene to identify each individual photograph.

b. a complete technical history of a print or negative.

c. used to verify the materiality and relevancy of each photograph.

d. used to identify the photographs and the location of the scene.

17. Photographs of a victim should be taken

a. only at the morgue, since a doctor must be present.

b. only at the scene, since any photographs taken after the body is moved would not be valid.

c. at both the scene and the morgue.

d. only after the victim is officially declared dead.

18. When photographing a homicide victim, to locate the body in the scene and its position in relation to other articles, you should

a. include a ruler in the photograph.

b. photograph the body from all four sides.

c. take at least two photographs of the body at right angles to one another.

d. get as far above the body as is possible by using a chair, for example.

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19. During pretrial investigation of a homicide, you are asked how photographs of the scene made by another photographer, who has been transferred, can be identified. You would reply that

a. the data card on each print can identify that particular photograph.

b. a deposition left by the actual photographer must be used in the pretrial investigation.

c. anyone familiar with the scene can identify them.

d. identification is required, and the photographer must be recalled.

20. The first photograph of an undisturbed victim of hanging would be

a. of the overall scene, including the body.

b. of the rope marks on the victim's neck.

c. under clinical conditions at the morgue, with a doctor to supervise.

d. of the body, with someone standing next to it to show perspective.

21. Of the four choices given below, the most important element of photographing the scene of sex crimes, is the photographing of the

a. victim at the scene while the details are still vivid.

b. victim's clothing with infrared to detect semen stains.

c. victim's injuries as soon as medical personnel allow.

d. scene of the crime showing terrain, bushes, buildings, etc.

4-12 I; 9-23

22. Photographs are taken of a victim of drowning. Foul play is suspected. The items of primary interest would be

a. the scene where the body was located, showing it being removed from the water.

b. the type terrain in which the body was found.

c. the contents of the victim's pockets.

d. the victim's mouth, body discoloration, bruises and other marks on your ...

23. All of the following statements are TRUE concerning individual photographs of important items of evidence, EXCEPT

a. they are admissible only if the original item is unavailable.

b. they provide a permanent record of the original appearance.

c. they provide supplements for the case report.

d. they protect valuable evidence from unnecessary handling.

24. When photographing during a fire, in which arson is suspected, you would try to photograph

I. any items which could have been used in starting the fire.
II. protective devices which may have been tampered with.
III. spectators.
IV. the arrangement of doors and windows.

a. IV only.

b. I and II.

c. I, II, and IV.

d. all of the above.

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25. You want to photograph bloodstains on a pair of pants. One method of accomplishing this would be to

a. use iodine fumes to bring the stain out.

b. use a low grazing light.

c. use the maximum aperture your camera will allow.

d. place lights at a 45° angle to bring out the stain.

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LESSON SOLUTION SHEET

ARMY CORRESPONDENCE COURSE OF
THE US ARMY MILITARY POLICE SCHOOL

SUBCOURSE NO. 4-12 I — Investigative Photography

SOLUTIONS

(All references, enclosed in parentheses, are to the attached memorandum.)

LESSON 1

1. c (para 3a)
2. b (para 3c)
3. a (para 4a)
4. a (para 4b)
5. d (para 5b)
6. b (para 6a)
7. d (para 6c)
8. b (para 7a)
9. a (para 7b)
10. c (para 8b)

LESSON 2

1. d (para 3a)
2. b (para 3b, 4b, 4c)
3. d (para 4c)
4. a (para 4d(1))
5. b (para 5)
6. c (para 5a)
7. b (para 5c)
8. a (para 5d(1))
9. a (para 5d(1))
10. c para 5d(3))
11. d (para 6c)
12. b (para 9d(1))
13. d (para 10b(1)(a))
14. d (para 10b(2))
15. b (para 10b(1))

LESSON 3

1. c (para 3a)
2. a (para 4a(1))
3. d (para 4c)
4. c (para 4d)
5. c (para 4d(3))
6. b (para 5)
7. b (para 6)
8. d (para 7a)
9. b (para 7b(1))
10. d (para 7b(2))

LESSON 4

1. c (para 3a)
2. d (para 3a(3))
3. a (para 3a(4))
4. c (para 3b(1))
5. b (para 3b(1))
6. b (para 3b(1)(a))
7. c (para 3b(1)(b))
8. a (para 3b(1)(c))
9. c (para 3b(2))
10. d (para 3b(3))
11. c (para 3b(6))
12. a (para 3b(6)(a))
13. d (para 3b(6)(c))
14. d (para 4b(2))
15. d (para 5a)
16. b (para 5c(2))
17. c (Figure 3)
18. d (para 6b)
19. b (Figure 5)
20. d (para 6d(1))

March 1975
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LESSON 5

1. a (para 3a)
2. d (para 3b(1))
3. b (para 3b(2))
4. a (para 3b(2)(b))
5. b (Figure 3)
6. a (para 3d(1))
7. c (para 3d(3))
8. c (para [illegible])
9. c (para 4a)
10. d (para 5b)
11. a (para 5c)
12. a (para 5d)
13. b (para 5d(2))
14. d (para 6a)
15. b (para 6g(1))
16. a (para 7a)
17. b (para 7b)
18. c (para 8b(1))
19. b (para 8d(3))
20. c (para 8e(1))
21. d (para 9b(1))
22. c (para 10b)
23. a (para 10c)
24. d (para 11a)
25. d (para 12a)

LESSON 6

1. c (para 2)
2. a (para 2b(3)-(5))
3. d (para 2c)
4. c (para 2c(1), (2))
5. b (para 2d(5))
6. d (para 2d(8))
7. d (Figure 1)
8. a (para 3d)
9. b (Figure 2, para 3e)
10. c (para 3e(6))
11. a (para 5b(1)(j))
12. b (para 5b(2)(a))
13. b (para 6b)
14. d (para 6d)
15. a (para 7)
16. c (para 8)
17. c (para 8b(1))
18. d (para 8b(1))
19. b (para 8c(2))
20. a (para 10a)
21. d (para 10d)
22. c (para 10e)
23. b (para 11b)
24. c (para 11b)
25. a (para 11c)

LESSON 7

1. b (para 3f)
2. a (para 4)
3. c (para 3)
4. d (para 5)
5. a (para 7c(3))
6. b (para 4b)
7. d (para 8a(1)(e))
8. b (para 8a(3))
9. a (para 8b)
10. c (para 8a(1)(d)

LESSON 8

1. b (para 3b(2))
2. b (para 2c(2)(b))
3. d (para 2b(6))
4. a (para 3e)
5. c (para 4a(3))
6. c (para 4b(1))
7. c (para 2b(7))
8. a (para 4b(3))
9. d (para 4b(3)(b))
10. a (para 2e(1))
11. c (para 3a)
12. d (para 2c(2)(a))
13. b (para 2b(1))
14. c (para 5f)
15. b (para 3b(4))
16. d (para 3c(1))
17. a (para 2b(5))
18. a (para 5a)
19. b (para 5c)
20. c (para 2b(3)(a))

LESSON 9

1. b (para 2)
2. a (para 2d)
3. d (para 2a)
4. a (para 2a)
5. c (para 3d(2))
6. b (para 2c)
7. d (para 3d(2))
8. d (para 2f)
9. c (para 3e)
10. c (para 2e(2))
11. b (para 3h(1))
12. b (para 2h)
13. b (para 3h(3))
14. a (para 4a)
15. b (para 3b(2)(b))
16. b (para 2d)
17. c (para 3b)
18. c (para 3b(1)(c))
19. c (para 5a(3))
20. a (para 3b(2))
21. d (para 3e(1))
22. d (para 3b(3))
23. a (para 4a)
24. d (para 3d(1)(a)-(f))
25. b (para 4c(2))

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ARMY CORRESPONDENCE COURSE OF
THE U. S. ARMY MILITARY POLICE SCHOOL

EXAMINATION

SUBCOURSE NO. 4-12 I	Investigative Photography.
CREDIT HOURS	2.
TEXT ASSIGNMENT	All texts and references previously used.
MATERIALS REQUIRED	None.
EXAMINATION OBJECTIVE	To test your knowledge of material covered in the previous lessons.
SUGGESTIONS	Review text assignments and solutions to previous lessons before answering questions. Use answer sheet provided.

16-1

March 1975
REPRINT

EXERCISES

REQUIREMENT. The following exercises are multiple choice. There are four alternatives to each exercise. You are to select the one alternative that is correct and indicate your choice by placing a cross (x) in the space provided on the answer sheet.

1. When an enlargement is made of a portion of a negative, for court use, you should also submit

a. a contact print.

b. the chain of custody statement.

c. an explanation of the scene.

d. all available technical information about the negative.

2. An accelerator increases the rate of oxidation of the

a. solvent.

b. reducer.

c. fixer.

d. restrainer.

3. To best show the alligator pattern of charred wood at the point of origin of a fire, you would most likely use

a. flat lighting.

b. 2 f/stops overexposure.

c. flood lights placed at 45°.

d. diffused or refracted lighting.

4. The reflection of light from [illegible] would [illegible] classed as

a. specular.

b. refractive.

c. diffuse.

d. dense.

5. All of the following are characteristics of a film emulsion EXCEPT

a. contrast.

b. grain.

c. acutance.

d. halation.

6. The trajectory of a bullet may be shown by stretching a white cord from point of impact to the apparent point of discharge and photographing it. You would also

a. record the azimuth and distance factors.

b. pose someone, with a weapon, at the point of discharge.

c. take a close-up of the cord so that it may later be readily identified.

d. photograph the scene without the cord.

7. In copying, a 1:1 image size requires that the distance from the film to the print be

a. the same as the focal length of the lens used.

b. twice the focal length of the lens used.

c. four times the focal length of the lens used.

d. eight times the focal length of the lens used.

8. If development time is extended, in the diffusion reversal system,

a. contrast is increased.

b. the print will be blurred.

c. contrast is decreased.

d. the final print will not be any good.

9. Positive lenses are thicker at the center than at the edges and cause light rays to

a. disperse.

b. converge.

c. divide.

d. coincide.

10. You are photographing a homicide. Your method of photographing the scene would most likely be

a. to photograph the body first, since an autopsy must be quickly performed, then the scene and evidence.

b. to start at the entrance to the scene, work in a special, clockwise manner, taking overlapping shots, and photographing the victim last.

c. to photograph fragile evidence first, then the victim, then the overall shots of the entire scene; each shot overlapping the others.

d. to photograph as soon as the scene itself was processed, and make the photographs in an overlapping, circular manner.

11. A special problem is created when photographing light fingerprints on a dark background. The problem is that

a. light powders will not cling to light fingerprints.

b. the image produced in the final print is reversed.

c. you must use filters to eliminate glare, caused by your lights.

d. a reversal film, rather than a regular process film, must be used.

12. When a distance scale is engraved directly on a lens mount, as on most 35mm cameras, there is usually, also, an adjoining

a. speed scale.

b. bellows distance scale.

c. Vernier scale.

d. depth of field scale.

13. The shutter fast speed control on the KS-15(1) controls speed from

a. 1 to 1/25 of a second.

b. 1/50 to 1/500 of a second.

c. 1/100 to 1/500 of a second.

d. 1/25 to 1/1000 of a second.

14. The difference in the density of metallic silver in a film emulsion is known as

a. shadow.

b. brightness.

c. contrast.

d. highlight.

15. You are using a filter whose factor is 2, on a range finder camera. You must

a. decrease the original exposure by 2.

b. decrease the aperture by 1 f/stop.

c. increase the original exposure by 2.

d. increase the aperture by 1 f/stop.

16. A negative should only be marked with

a. photographer's initials and identification number.

b. time/date taken and photographer's initials.

c. identification number.

d. a grease pencil to identify items of interest in the image area.

17. The correct order for the steps in the development process is

a. fixing, development, washing, rinsing, and drying.

b. development, rinsing, fixing, washing, and drying.

c. development, washing, rinsing, fixing, and drying.

d. development, fixing, washing, rinsing, drying.

18. The photographing of objects which are too small for a conventional lens and too large for a microscope is called

a. macrophotography.

b. microphotography.

c. close-up photography.

d. telephoto photography.

19. You find a document at the scene of a crime on which, you feel, chemical erasures may have been made. The best method for examining this document would be

a. treatment with infrared light.

b. oblique or flat lighting.

c. to use ultra-violet light.

d. treatment with iodine or benzine.

20. To prevent interaction between the preservative and the hardener, in the development process, you would add

a. soluble silver halides.

b. potassium alum.

c. sodium sulfate.

d. acetic acid.

21. Depth of field is the distance between the nearest point of acceptable sharp focus and

a. infinity.

b. the film plane.

c. the farthest point of sharp focus.

d. the hyperfocal distance.

22. For general copy work, of non-textured surfaces, the illumination used is usually 45° lighting. This calls for

a. two spotlights, with barn doors, on both sides of the camera.

b. two flood lamps, in reflectors, on both sides of the camera.

c. one spotlight at a 45° angle to the main surface of the object being copied.

d. one flood lamp and two reflectors placed at 45° angles.

23. Black and white films reproduce colors as shades of gray. Sensitivity to colors other than blue, violet, and ultra-violet, is obtained by the

a. addition of pulverized silver to the emulsion.

b. staining dyes incorporated into the film base.

c. addition of various dyes to the emulsion during manufacture.

d. addition of a filter layer in certain film emulsions.

24. If an aperture is increased by one f/stop, twice as much light is admitted as before. If shutter speed is increased by one speed

a. one-half as much light is admitted.

b. twice as much light is admitted.

c. the aperture must also be increased by one f/stop.

d. there will be no change.

25. Film emulsions which are sensitive to all colors are termed

a. monochromatic.

b. orthochromatic.

c. panchromatic.

d. monchromatic.

26. On the KS-15(1) camera, the amount of light which reaches the film is determined by the

a. interval between the two lens curtains.

b. focal plane/camera lens distance.

c. optical diaphragm.

d. lens focal length.

27. In small object photography, to obtain maximum depth of field, you would use

a. the bellows extension factor to compute your settings.

b. 45^{o} flat lighting, wherever practicable.

c. the smallest practicable lens aperture.

d. the camera at as high an angle position as possible.

28. Since the light intensity of a hazy sun is less than that of bright sun, the lens aperture setting for hazy sun should be

a. one stop smaller than the setting for bright sun.

b. one stop larger than the setting for bright sun.

c. two stops smaller than the setting for bright sun.

d. two stops larger than the setting for bright sun.

29. When light is passed through a prism and separated into its color components it is

a. dispersed.

b. disintegrated.

c. separated.

d. refracted.

30. A lenses "speed" is the ratio of the diameter of the lens to its

a. focal plane.

b. aperture.

c. image size.

d. focal length.

31. You are called to the scene of a fire in which arson is suspected. When you arrive, the fire has reached its peak of intensity. The first pictures you take would be

a. overall views to show the condition of the structure.

b. in sequence to show the path of the fire through the building.

c. with infrared to penetrate the smoke and steam.

d. color motion pictures to show color of the smoke and flame.

32. On the KE-12(2) camera, there is a mounting bracket attached to the upper right portion of the outer side of the camera body. This bracket is for mounting the

a. polaroid adapter.

b. filmholder.

c. optical view finder.

d. flashgun.

33. When photographing rectangular small objects, the fill lights should be

a. 1/3 to 1/4 as bright as the main light.

b. 1 to 1/2 as bright as the main light.

c. the same brightness as the main light.

d. twice as bright as the main light.

34. In processing film, the type of film used and the type of developer used will usually determine

a. development time.

b. exposure time.

c. developer life.

d. chemical decomposition.

35. The difference in the angle of view between what the camera lens transmits to the film and what the photographer sees through the view finder is known as

a. flare.

b. parallax.

c. astigmatism.

d. correction.

36. At a distance of 22 feet, light from a point source, according to the Inverse Square Law, the area over which the light would spread would be

a. 11 square feet.

b. 22 square yards.

c. 222 square feet.

d. 484 square feet.

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37. Light is generally controlled, in lenses, by an aperture. As the size of the aperture is succeedingly diminished, the amount of light passing through the lens is

a. one-half as much for each succeeding stop.

b. one-quarter as much for each succeeding stop.

c. doubled for each succeeding stop.

d. four times as much for each succeeding stop.

38. The main criteria for placing objects or marks in a crime scene and photographing them is that

a. they must be included on DA 91-60, Chain of Evidence Form.

b. they should not be too visible as this would detract from the object in question.

c. you must obtain permission from the ranking individual at the scene.

d. it must be necessary in the identification of some object.

39. Focal length determines the

a. size of the image at the focal plane.

b. amount of light which reaches the focal point.

c. maximum effective aperture of the lens.

d. distance to the hyperfocal point.

40. Floodlighting usually requires an increase in the size of the lens aperture because

a. it compensates for the brightened bluishness of the light.

b. it is usually below sunlight in intensity.

c. artificial lighting changes the film speed.

d. floodlighting causes more shadows.

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