DOCUMENT RESUME

ED 124 376 88 SE 018 328

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TITLE Photography Minicourse, Career Oriented Pre-Technical Physics. Preliminary Edition.
INSTITUTION Dallas Independent School District, Tex.
SPONS AGENCY Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.
PUB DATE 74
NOTE 91p.; Photographs and drawings may not reproduce well; For related documents, see SE 018 322-333 and SE 019 605-616

EDRS PRICE MF-$0.83 HC-$4.67 Plus Postage.
DESCRIPTORS Individualized Instruction; *Instructional Materials; *Photography; *Physics; *Program Guides; *Science Activities; Science Careers; Science Education; Science Materials; Secondary Education; Secondary School Science
IDENTIFIERS Elementary Secondary Education Act Title III; ESEA Title III

ABSTRACT

This minicourse was prepared for use with secondary physics students in the Dallas Independent School District and is one option in a physics program which provides for the selection of topics on the basis of student career needs and interests. This minicourse was designed to help students acquire a knowledge of some physics of photography and to develop some basic photographic skills. The minicourse was designed for independent student use with close teacher supervision and was developed as an ESEA Title III project. A rationale, behavioral objectives, student activities, and resource packages are included. Student activities and resource packages involve investigating careers in photography, comparing the camera and the eye, studying some properties of light, making a camera, and taking and developing pictures. (GS)

CAREER ORIENTED PRE-TECHNICAL PHYSICS

Photography Minicourse

1974

PRELIMINARY EDITION

dallas independent school district

CAREER ORIENTED PRE-TECHNICAL PHYSICS

Photography

Minicourse

ESEA Title III Project

1974

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This Mini Course is a result of hard work, dedication, and a comprehensive program of testing and improvement by members of the staff, college professors, teachers, and others.

The Mini Course contains classroom activities designed for use in the regular teaching program in the Dallas Independent School District. Through Mini Course activities, students work independently with close teacher supervision and aid. This work is a fine example of the excellent efforts for which the Dallas Independent School District is known. May I commend all of those who had a part in designing, testing, and improving this Mini Course.

I commend it to your use.

Sincerely yours,

Nolan Estes

Nolan Estes
General Superintendent

mfs

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CAREER ORIENTED PRE-TECHNICAL PHYSICS TITLE III ESEA PROJECT

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CAREER ORIENTED PRE-TECHNICAL PHYSICS

PHOTOGRAPHY MINICOURSE

RATIONALE (what this minicourse is about)

Confucius reportedly said, "A picture is worth a thousand words." Our environment is so filled with such a variety of pictures that it is hardly possible to imagine what it might be like to live in a picture-less society.

Photographs make up a large share of the many pictures which surround us. Consequently, photography is a basis for big business in America and photography has become one of America's most popular hobbies.

This minicourse is designed to help you to understand some technical physics of photography and to develop some basic photographic skills. Specifically, you will learn:

1) how black and white pictures are made
2) how the laws of reflection and refraction relate to simple photographic processes
3) how to identify the types, properties, and uses of lenses
4) how to take pictures by existing light, photoflash light, and photoflood light
5) how to develop film and to judge negatives for quality and for defects
6) how to make contact prints and enlargements

Developing and printing photographs has been mostly a male activity but women can engage in these activities as easily and as successfully as men. It is hoped that this simple fun-filled minicourse will interest more girls in the technical aspects of photography.

In addition to RATIONALE, this minicourse contains the following sections:

1) TERMINAL BEHAVIORAL OBJECTIVES (Specific things you are expected to learn from the minicourse).

2) ENABLING BEHAVIORAL OBJECTIVES (Learning "steps" which will enable you to eventually reach the terminal behavioral objectives).

3) ACTIVITIES (Specific things to do to help you learn).

4) RESOURCE PACKAGES (Instructions for carrying out the learning Activities, such as procedures, references, laboratory materials, etc.).

5) EVALUATION (Tests to help you learn and to determine whether or not you satisfactorily reach the terminal behavioral objectives):

   a) Self-test(s) with answers, to help you learn more.
   b) Final test, to help measure your overall achievement.

TERMINAL BEHAVIORAL OBJECTIVES:

Upon completion of this minicourse you will demonstrate your knowledge of photography and your photographic skills by:

a) listing four (4) photography-related vocations
b) selecting a suitable camera and suitable film for photographing a subject designated by your teacher
c) taking black and white pictures using existing light, photoflash, and floodlights
d) making at least five (5) contact prints and five (5) enlargements from film you have exposed and developed

ENABLING BEHAVIORAL OBJECTIVE #1:	ACTIVITY 1-1	RESOURCE PACKAGE 1-1
List a half-dozen photography-related vocations and demonstrate image formation with a ray trace diagram for a simple convex lens or a simple	Complete Resource Package 1-1.	"Careers in Photography"
	ACTIVITY 1-2	RESOURCE PACKAGE 1-2
	Complete Resource Package 1-2.	"Introduction to some Technical Physics of the Camera"

ENABLING BEHAVIORAL OBJECTIVE #2:	ACTIVITY 2-1	RESOURCE PACKAGE 2-1
Given a Photography Buying Guide, identify at least six (6) different types of cameras and list some advantages of each type.	Read and complete Resource Package 2-1.	"Choosing a Camera"
	ACTIVITY 2-2	
	Visit a camera store and see if you can list three (3) or more cameras NOT found in Resource Package 2-1.	
ENABLING BEHAVIORAL OBJECTIVE #3:	ACTIVITY 3-1	RESOURCE PACKAGE 3-1
Take acceptable pictures with available (existing) light, photoflash light, and photoflood light.	Read materials referenced in Resource Package 3-1.	"Readings-Lenses and Hand-Held Cameras"
	ACTIVITY 3-2	RESOURCE PACKAGE 3-2
	Study Resource Package 3-2.	"Picture Taking With Hand-Held Cameras"
	ACTIVITY 3-3	RESOURCE PACKAGE 3-3
	Read materials from Resource Package 3-3.	"Readings-Lighting"
	ACTIVITY 3-4	RESOURCE PACKAGE 3-4
	Complete Resource Package 3-4.	"Lighting"
ENABLING BEHAVIORAL OBJECTIVE #4:	ACTIVITY 4-1	RESOURCE PACKAGE 4-1
Develop film and make prints (both contact and enlarged).	Read selected material from Resource Package 4-1.	"Readings-Developing, Printing, and Enlarging"

ENABLING BEHAVIORAL OBJECTIVE #4:	ACTIVITY 4-2	RESOURCE PACKAGE 4-2
See page 3.	Read Resource Package 4-2 and perform Exercises 1, 2, and 3.	"Developing, Printing and Enlarging"
	ACTIVITY 4-3	RESOURCE PACKAGE 4-3
	Complete Resource Package 4-3.	"Cropping, Dodging, and Burning-in"
EVALUATION	ACTIVITY 5-1	
	Turn in your notebook to the teacher. Quantity and quality of material (such as log, negatives, prints, etc.) will be used to help measure the degree of accomplishment of the Terminal Behavioral Objectives.	

RESOURCE PACKAGE 1-1

CAREERS IN PHOTOGRAPHY

Photography relates to a wide variety of careers. Professional photographers often specialize in portraits, television and motion pictures, magazines and newspapers, commerce and business, or industry and research.

Advertising and book publishing are huge fields, wherein the related photography is usually done by free-lance photographers commissioned by an art director. Other photographic specializations include aerial and underwater photography; writing for photographic trade and technical journals; teaching photography-related courses in trade schools, community colleges, and 4-year colleges; and selling photography-related materials. Further, a knowledge of photography is of benefit to anyone who chooses acting or modeling as a career.

Investigation 1: Photography Careers and Occupations.

Read about photography-related careers and occupations in Hopke, Wm. E., The Encyclopedia of Careers and Vocational Guidance, Vol. 2, Revised Edition, Doubleday and Company, Inc., Garden City, New York, 1973. If this encyclopedia is not available, ask your teacher or librarian for a substitute reference. Respond to the following on a separate sheet of paper:

1) List four (4) photography-related vocations you might like and the training required for each.

For example:

	JOB	TRAINING REQUIRED
1)	Model	modeling school; etc.

2) List four (4) photography-related vocations you did not know about prior to this study.

3) Photography jobs are generally available to persons with training from (List those which apply):

a) high school
b) junior college
c) on-the-job apprenticeship
d) college-university courses
e) vocational school

4) Would you expect this field to offer part-time employment?

5) Are opportunities in this field about the same for men as for women?

6) Do qualified people of many ages work in this field?

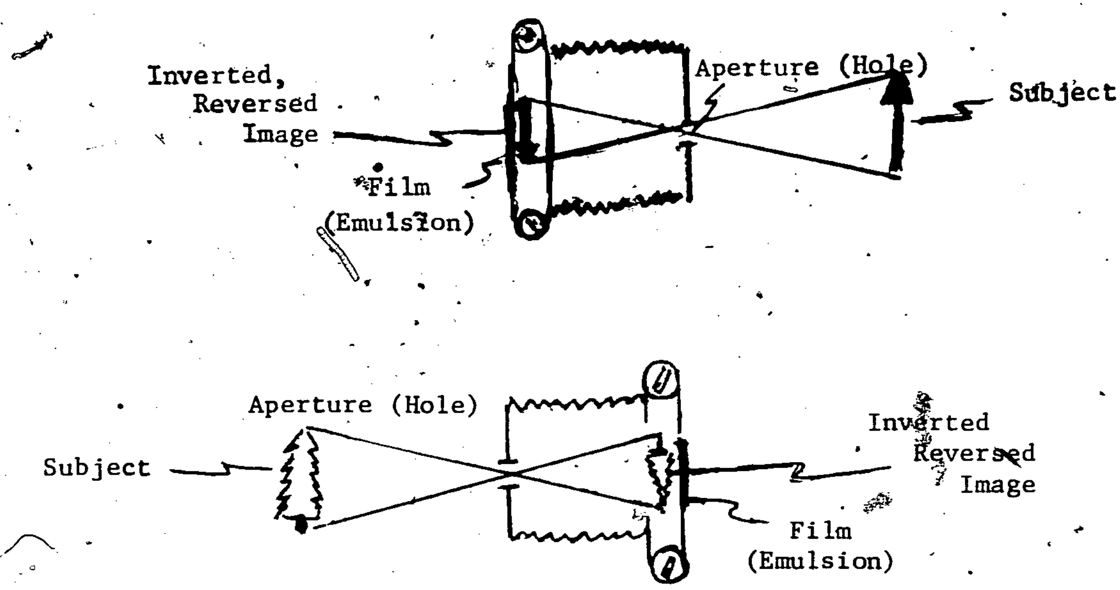
7) Is there a demand for qualified people in this field?

Investigation 2: Pictures In Your Environment

Make a list of the pictures and the photographs you can see from where you are at this moment. Restrict your body movements to head activity; i.e., don't flip and scan the pages in a book, etc. Write a brief description of your location and the number of pictures observed. Record the ratio of photographs to all other kinds of pictures. Turn this in for evaluation.

RESOURCE PACKAGE 1-2

INTRODUCTION TO SOME TECHNICAL PHYSICS OF THE CAMERA

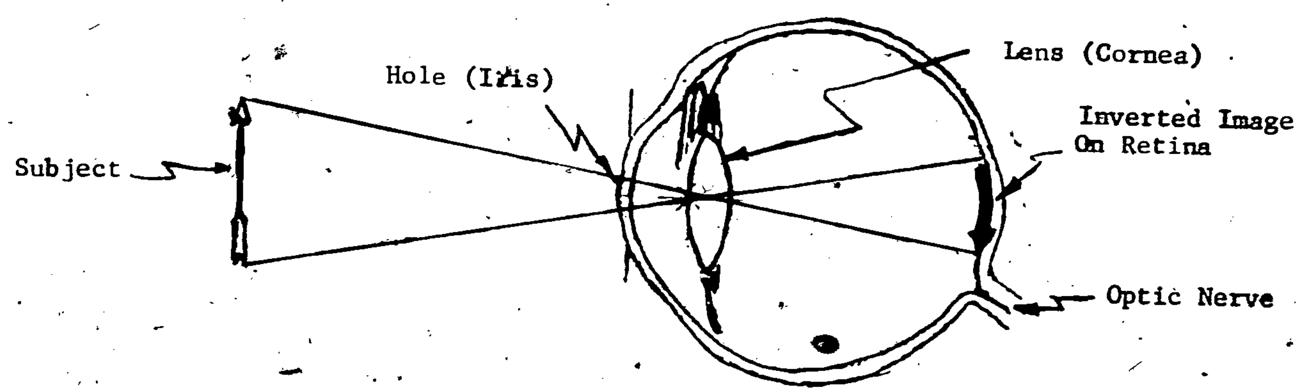


SIMPLE CAMERAS
Fig. 1

<u>The Simple Camera</u>. The camera in its elementary form is simply a box which is light-tight except for a very small hole in the center at one end. When such a box is properly placed before a subject, as

shown in Fig. 1, light reflected from the subject will pass through the tiny hole (aperture) and form an upside-down (inverted) reversed right-to-left image ("light picture") inside the box opposite the hole. If photographic film has been placed at the image position, the light will cause a chemical change in the film emulsion and "capture" the image on the film. A lens is usually placed near the tiny hole to focus the image on the film and to gather more light onto the film.

The Camera and the Eye. The camera and the eye are similar. The light-sensitive chemical emulsion on the film corresponds to the light-sensitive "nerve ends" in the retina (See Fig. 2). The upside-down reversed image is transmitted to the brain which "turns the image right-side up."

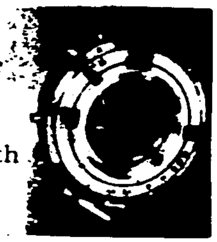


THE EYE
Fig. 2

The camera lens (sometimes a combination of lenses) acts like the lens of the eye, focusing the image clearly and sharply on the film surface. The diaphragm (adjustable hole) regulates the amount of light which enters the camera, just as the iris regulates the amount entering the eye through the pupil (hole formed by the iris). The shutter of a camera admits or excludes light, just as the eyelids do.

Camera Lenses and Light. The pinhole camera can take a good picture, but because the aperture is so small, a long time is required to pass enough light to expose (record the image upon) the film. If the subject moves during exposure, the resulting picture will likely be blurred. Of course, the hole could be enlarged to admit more light; but then the image would not be sharp (focused) and the picture would be useless for most purposes. To eliminate these problems, a camera is equipped with a lens. The diaphragm can then be opened to admit much more light than a pin hole, thereby recording an image upon the film in a relatively short time. At the same time, the lens will bend (refract) the light from the enlarged opening onto the film producing an image that is clear and sharp.

Because a lens permits the admission of more light in a shorter time then when only an aperture is used, a device to control the time interval is useful; hence, cameras have shutters which open and close at a definite speed or time interval. (See Fig. 3) This time interval is usually a fraction of a second, although some shutters may be kept open for several seconds, for minutes, or even longer to photograph under very special conditions. Most modern cameras, then, have devices which enable the photographer to vary the amount of light that enters the camera (diaphragm), to control the time during which light enters the camera (shutter), and to focus the light clearly and sharply onto the film (lens).



THE SHUTTER
Fig. 3

<u>Light and Some of Its Properties</u>. Photography represents a practical application of the physics of light. The branch of physics which deals with light is called <u>optics</u>. Without light we could not see, and without light there could be no photography. Therefore, it is important to consider the nature of light. One <u>model</u>

which explains some of the behavior of light is the wave model.* In this model light is assumed to be wave-like because it:

1) travels in a straight line
2) reflects (bounces back)
3) refracts (bends in passing at an angle from one medium into another medium)
4) interferes ("adds to" or "subtracts from" the effects of other light waves)
5) diffracts (bends in passing the edge of obstacles).

Because photography is a practical application of optics, the following general comments about light and lenses are presented less from a theortical view point and more from an applied technical viewpoint:

1) Light travels outward in all directions from a point source and its intensity (brightness) decreases inversely as the square of the distance from the source.

   a) In real camera situations, light sources are not true points. For example, flash lamps have reflector surfaces to prevent light from traveling outward in all directions.

   b) To decrease inversely as the square of the distance means that if you double the distance from the source the intensity decreases by a factor of 2^2 or 4! ...tripling the distance drops the intensity to 3^2 or 9, etc. So if you move a subject from position A to some position B, which is four times as far from the source as position A, the distance will be four times farther and the

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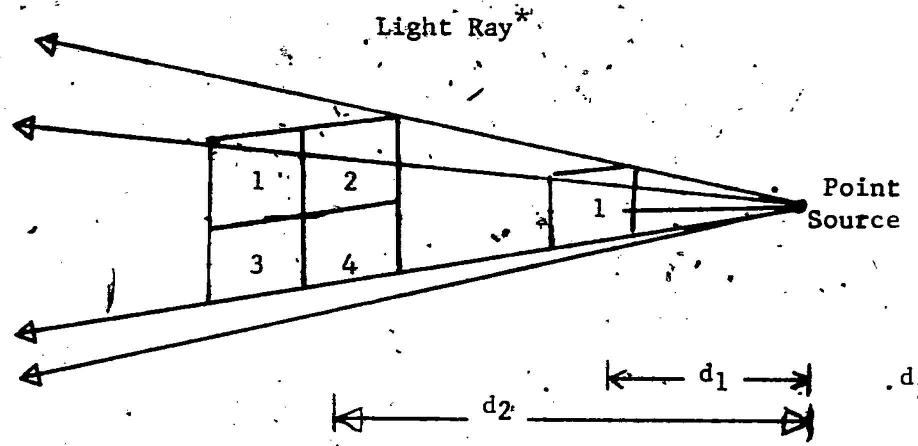
* A more universal model assumes light to be a dense localization of energy in motion, and this bundle of energy has both wave properties and particle properties. Under certain conditions light's wave-like nature is exhibited and under other conditions it shows its object-like nature.

light intensity will be 16 times smaller (will be 1/16 as bright at point B as at Point A). Perhaps the picture below will help explain this:



A Point Source

At distance d_1 all of the light which can shine on area 1 is the <u>same amount</u> of light which can shine on area 2 at distance d_2. But the area at d_2 (in the <u>shadow</u> of the area of d_1) is <u>four times greater than</u> area 1; therefore, the SAME AMOUNT OF LIGHT which shines on surface 1 must distribute itself over an area four times as large at surface 2! In other words, if four rays of light go through area 1, only one ray is available to go through an area of the same size at the distance d_2.

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* A "line of light" is called a <u>ray</u>. The branch of optics dealing with rays is called <u>geometric optics</u>.

2) Light can be transmitted by certain materials:

a) A window glass or a camera lens transmit so much light that one can see right through them. Such materials are said to be transparent.

b) A shower curtain or shower door transmits light, but not well enough that it can be clearly seen through. Such a material is said to be translucent.

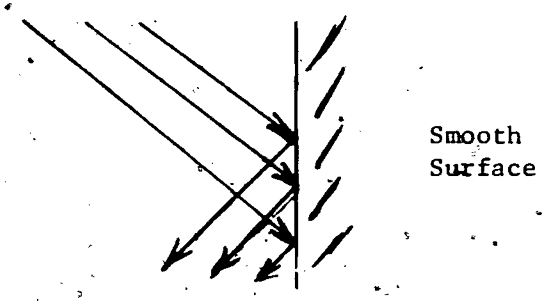
3) Some materials do not transmit light, such as a picture or a steel door. These materials are said to be opaque.

4) Some materials reflect or absorb incident light.

a) A black piece of soot, a lead pencil mark, or the dark lining of a camera will absorb light. Best absorbers have dark and rough surfaces.

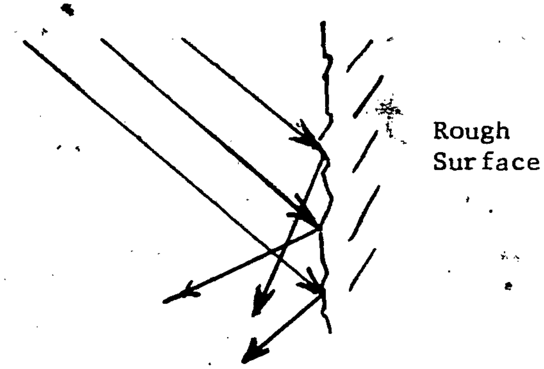
b) A mirror reflects incident light. Best reflectors have bright and smooth surfaces.

I) In technical physics, we speak of regular reflection:



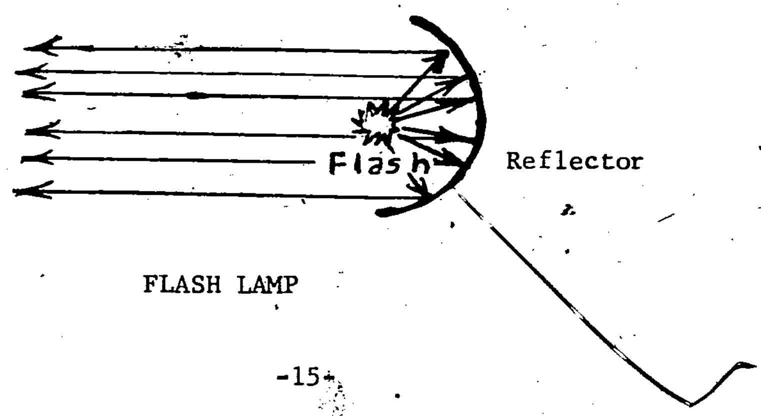
REGULAR REFLECTION

II) And sometimes we speak of <u>diffuse</u> reflection:



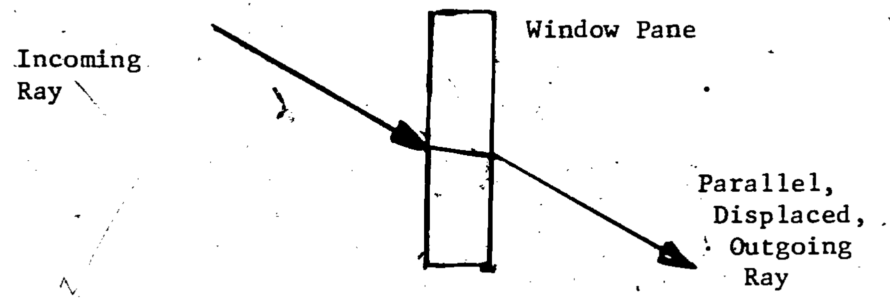
DIFFUSE DEFLECTION

III) And sometimes we use reflection as a means of "bending" light, as in a flash lamp:



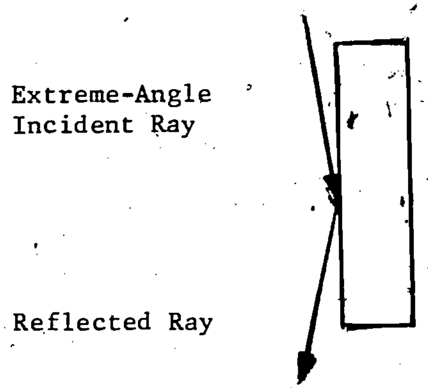
FLASH LAMP

5) <u>Refraction</u> through a window pane results in "displacing the light path sideways", but the displaced light stays along a line parallel to the incident ray.



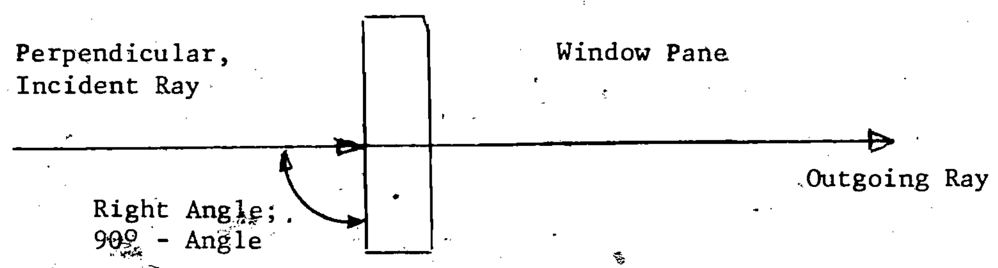
NO REFRACTION

6) But if a ray is incident upon the glass at too-extreme an angle, the ray will NOT be transmitted or refracted; it will be <u>totally</u> <u>reflected</u>:



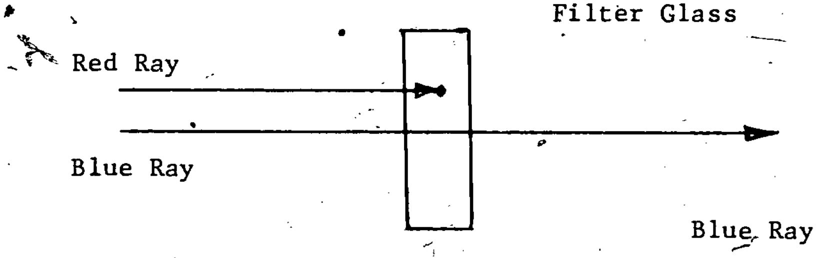
TOTAL REFLECTION

7) If the ray strikes the glass "head on" (at a right angle to its surface; perpendicular to its surface) no refraction occurs:



NO REFRACTION

8) Light can be selectively filtered during transmission by using certain filter materials for certain desired colors:

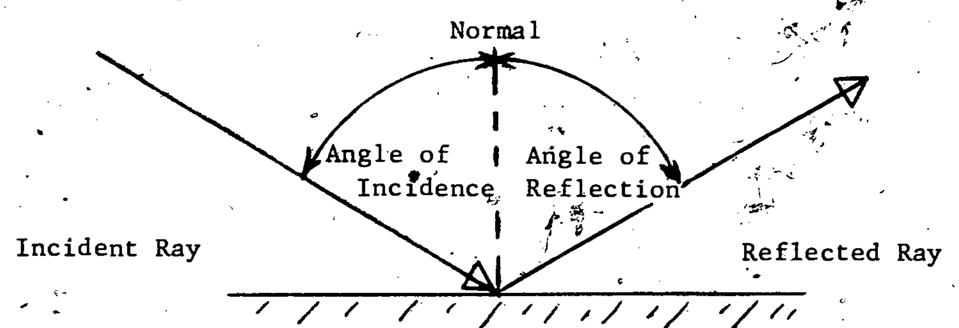


FILTERING

Reflection Rules. There are two simple reflection rules to consider. Study Fig. 4 and convince yourself of these:

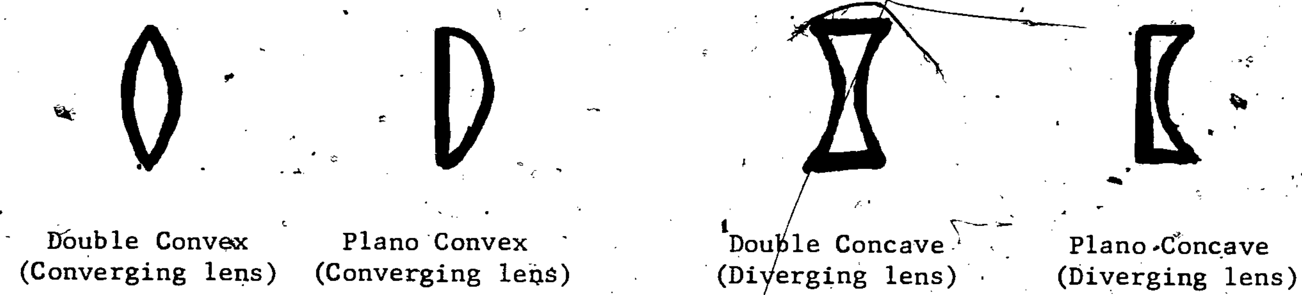
1) The incident ray, the reflected ray and the normal to the reflecting surface lie in the same plane. The word ray stands for the directed line segment (arrow) drawn in the direction of light wave travel. The normal is a line drawn perpendicular to (at right angles to; 90° from) the reflecting surface.

2) The angle of incidence is equal to the angle of reflection. Notice that both angles are measured from the NORMAL.

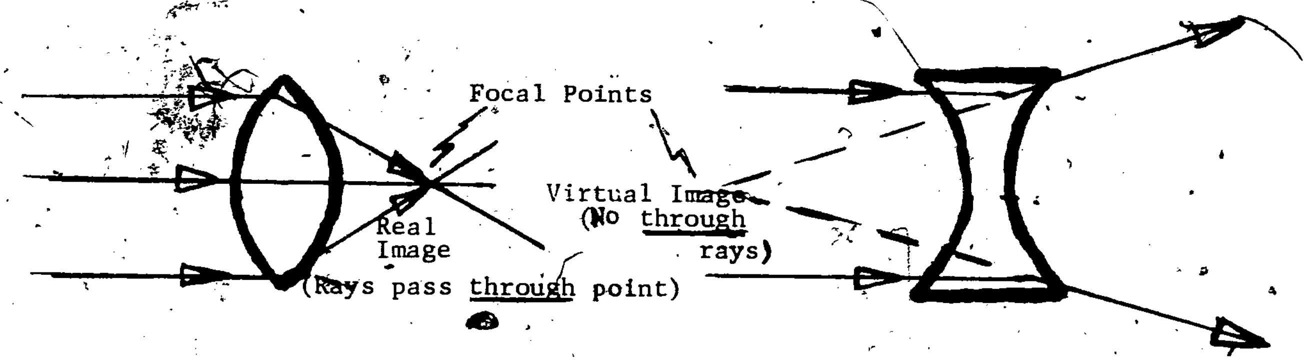


ANGLES AT A REFLECTING SURFACE
Fig. 4

__Refraction__. In passing through a lens, light is always bent (refracted) __toward__ the thickest part of the lens. See Fig. 5 for some types of lenses and see Fig. 6 for ray diagrams showing refraction by different types of lenses.



TYPES OF LENSES
Fig. 5



Light is bent toward the thick part of lens (converged by convex lens).

Light is bent toward the thick part of the lens (Diverged by concave lens).

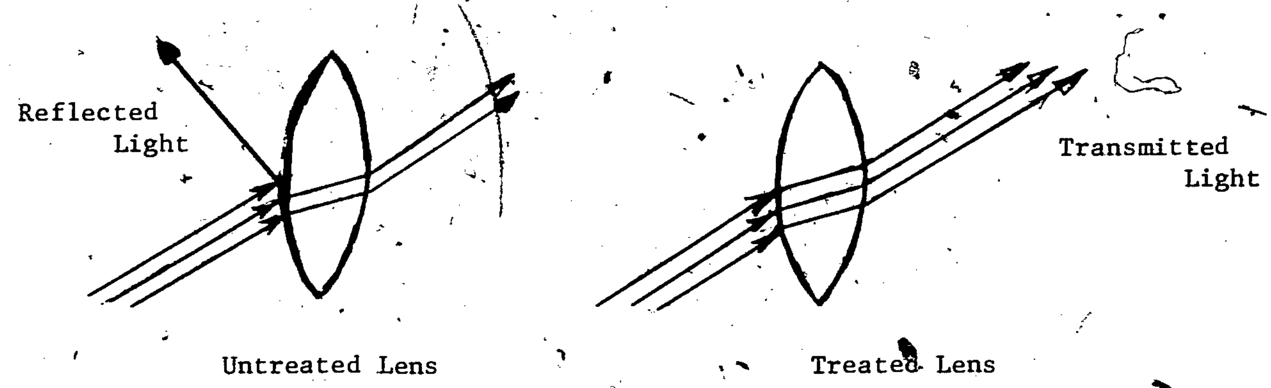
REFRACTION OF RAYS
Fig. 6

When light rays are bent by a lens, they can form images at what are called image points or focal points (or planes). These can be real images (the rays pass through the point and can be imaged on a screen at that point) or can be virtual images (the rays cannot be focused at the point, nor do they pass through the point. See Fig. 6 and notice the focal points.

Here are some lens-related technical tips which should help in photography:

1) To increase the optical (photographic) efficiency of a lens, it is helpful to reduce the light it reflects and increase the amount of light it transmits. This is done by coating the lens

with an anti-reflection compound:



2) If the object is at <u>infinity</u> (far enough away that light rays from it to the lens seem <u>parallel upon arrival at the lens</u>*), the point where the lens "intersects" the rays from the object is the <u>focal point</u>, and the complete image is formed on the <u>focal plane</u>. If the object is nearer than "infinity", the technical physics terms used are <u>image</u> point and <u>image</u> plane.

3) The distance from the focal point (plane) to the optical center of the lens, when the object is at infinity, is the <u>focal length</u> of the lens:

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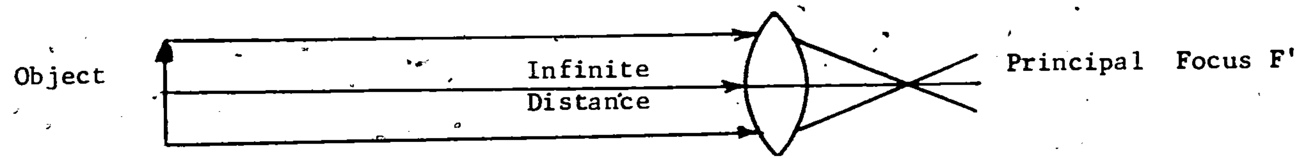
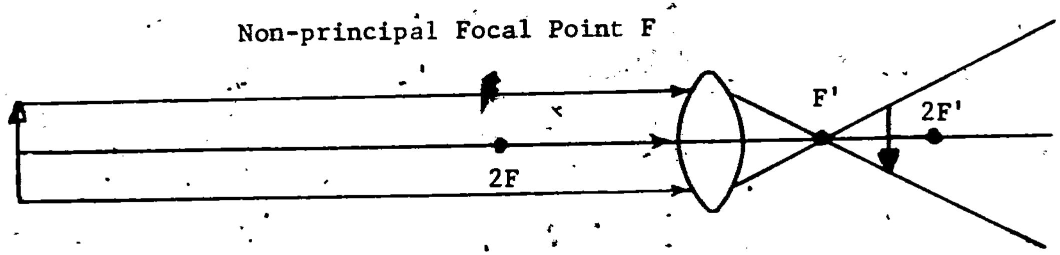
* For examples of parallel rays, see Fig. 6 and see <u>Case 1</u>. These rays are assumed to come from infinitely far away because they arrive at the lens as <u>parallel</u> rays. We would say the lenses focused on objects so far away are "focused at infinity". <u>Case 6</u>, page 22, is an example of <u>non-parallel</u> incident rays.

Converging Lenses. In order to better understand image formation in a simple camera using a single lens, study the following six (6) cases for images formed by converging lenses:

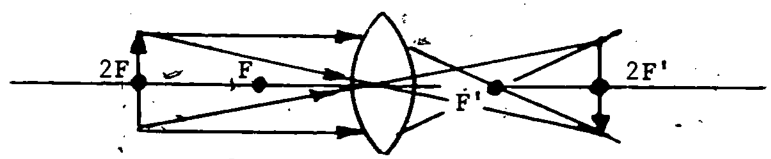
Case 1: Object is at an infinite distance (far, far away); the image formed will be a point at the focus:



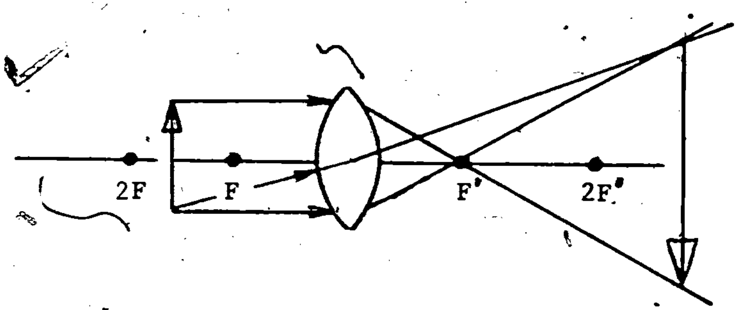
Case 2: Object is at a measurable distance beyond 2F (twice the focal length); the image will be real inverted, smaller than the object, and located between F' and 2F' (See diagram below.) Notice that the principal focal point is on the side opposite to the object; of course, because light can pass through a lens from both sides a non-principal focal point exists on the same side of the lens as the object.



Case 3: Object is at a distance exactly equal to twice the focal length; the image will be real, inverted, the same size as the object, and located at 2F'.

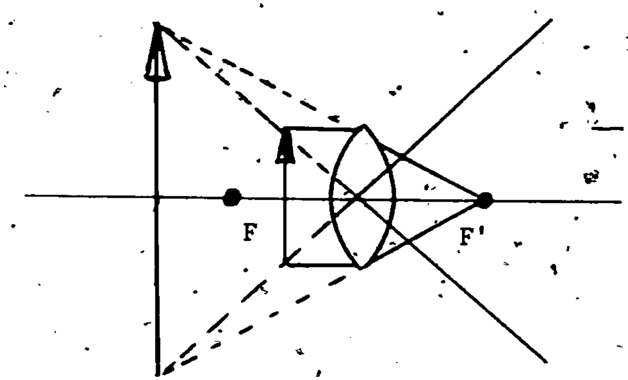


Case 4: Object is at a distance between one and two focal lengths; the image will be real, inverted, enlarged, and located beyond 2F'.

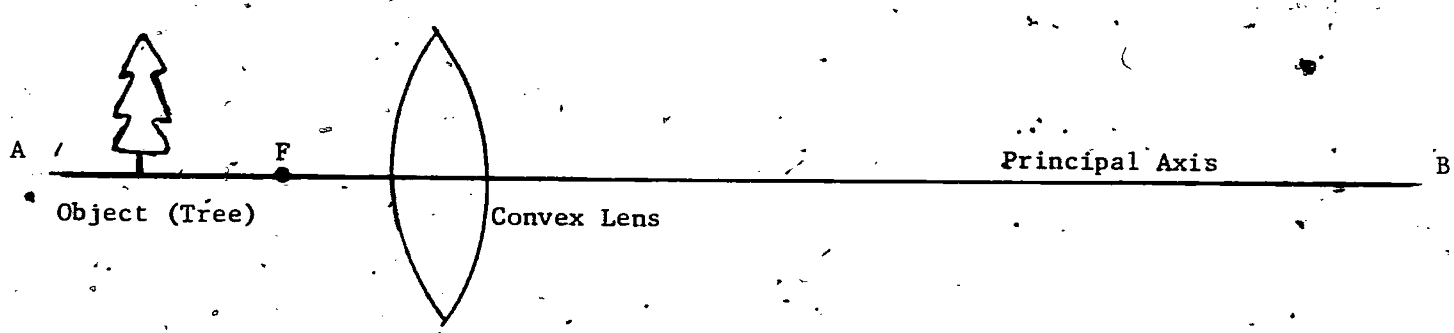


Case 5: Object is at the principal focus; no image is formed.

Case 6: Object is at a distance less than one focal length; the image will be virtual, erect, enlarged, and located on the same side of the lens as the object.



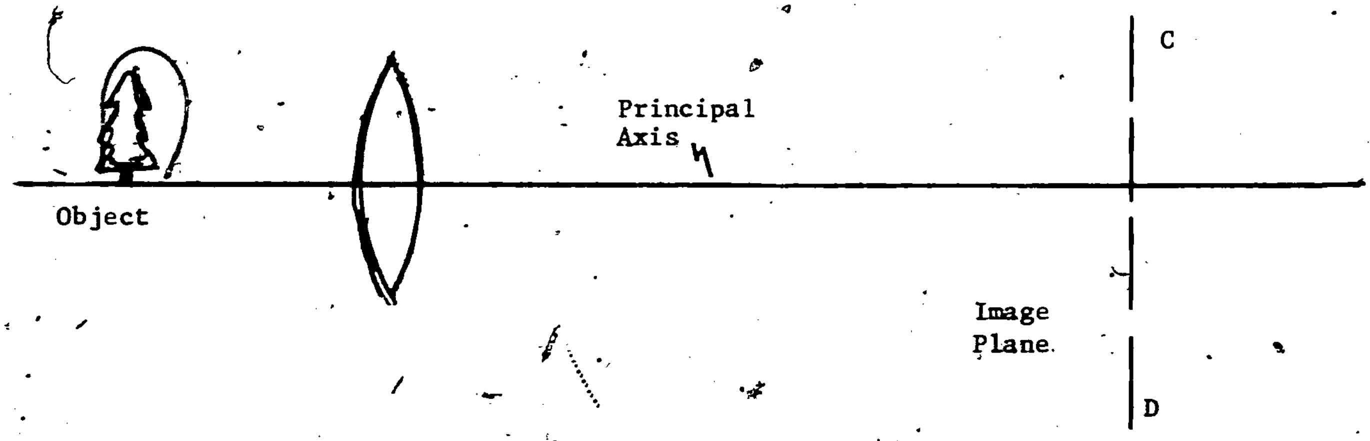
Convex Lens Tracing: Consider the thin convex lens and the object diagrammed below. Line AB passes through the geometric center of the short axis of the lens and is called its principal axis.



This convex lens will bend light which passes through it toward its thickest part; an image of the tree will be formed somewhere along the principal axis.

The image will lie on an image plane which is perpendicular to (at right angles to) the principal axis.*

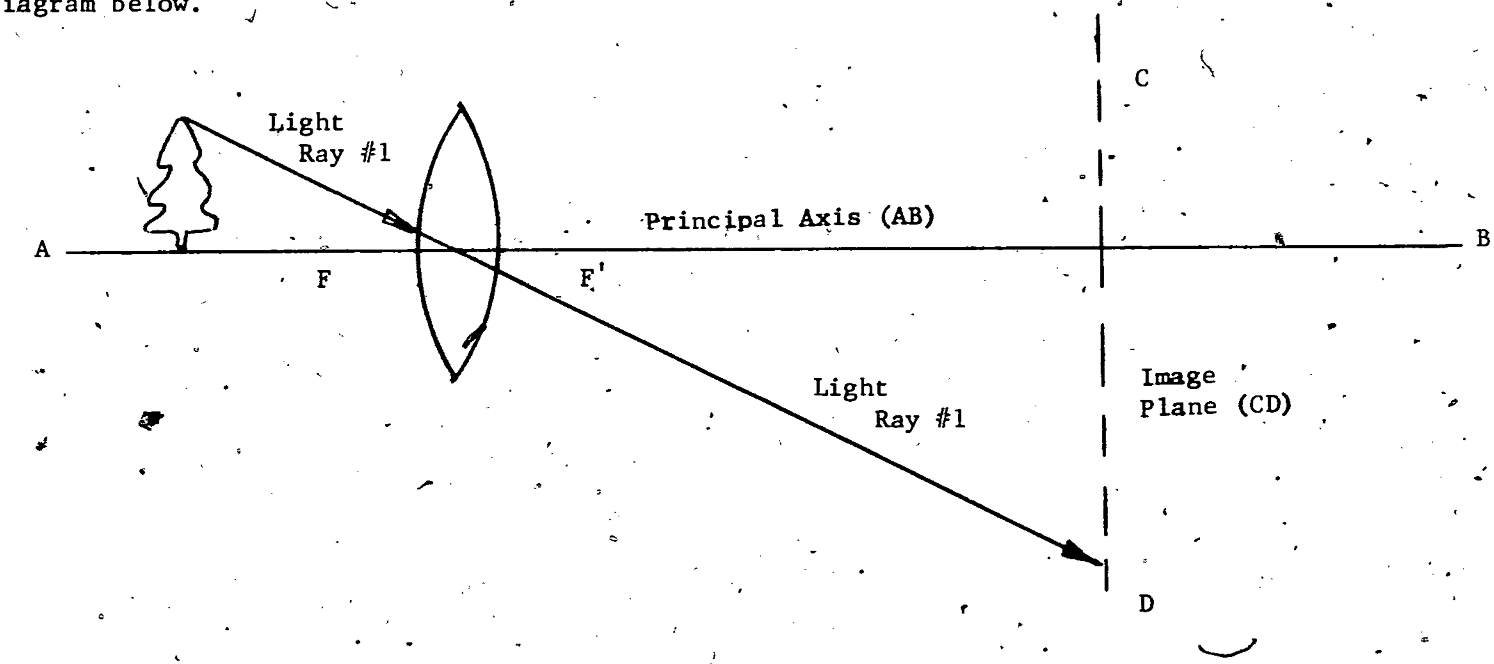
See the diagram below.



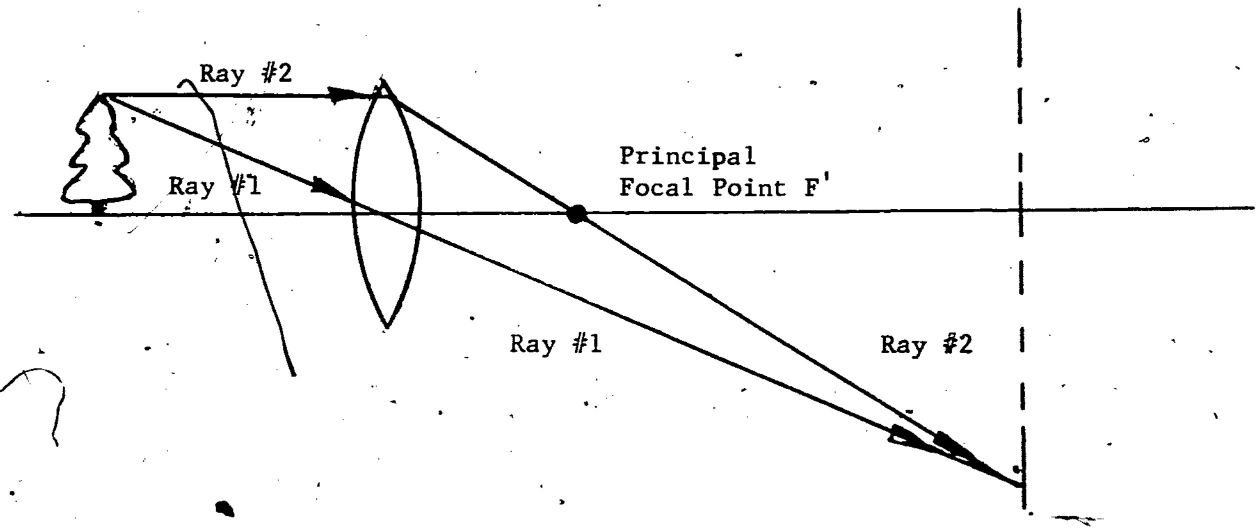
* You do not yet know where the image plane will lie; it has been placed arbitrarily at line CD for this example. When you learn how to ray trace, you will see that by drawing only two rays, the position of the image plane can be determined!

By using <u>ray tracing</u>, one can construct a <u>ray diagram</u> to show the position and placement of this <u>real image</u>. This lens will produce a real image because the <u>rays</u> will actually <u>pass through</u> the image plane. If a screen were placed at line CD, an image would be seen on the screen.

Using only two rays, we can sketch the position of this image. Ray #1 is drawn from the tip of the object <u>straight through</u> (non-refracted, not bent) the <u>lens center</u> to the <u>image plane</u>. See the diagram below.

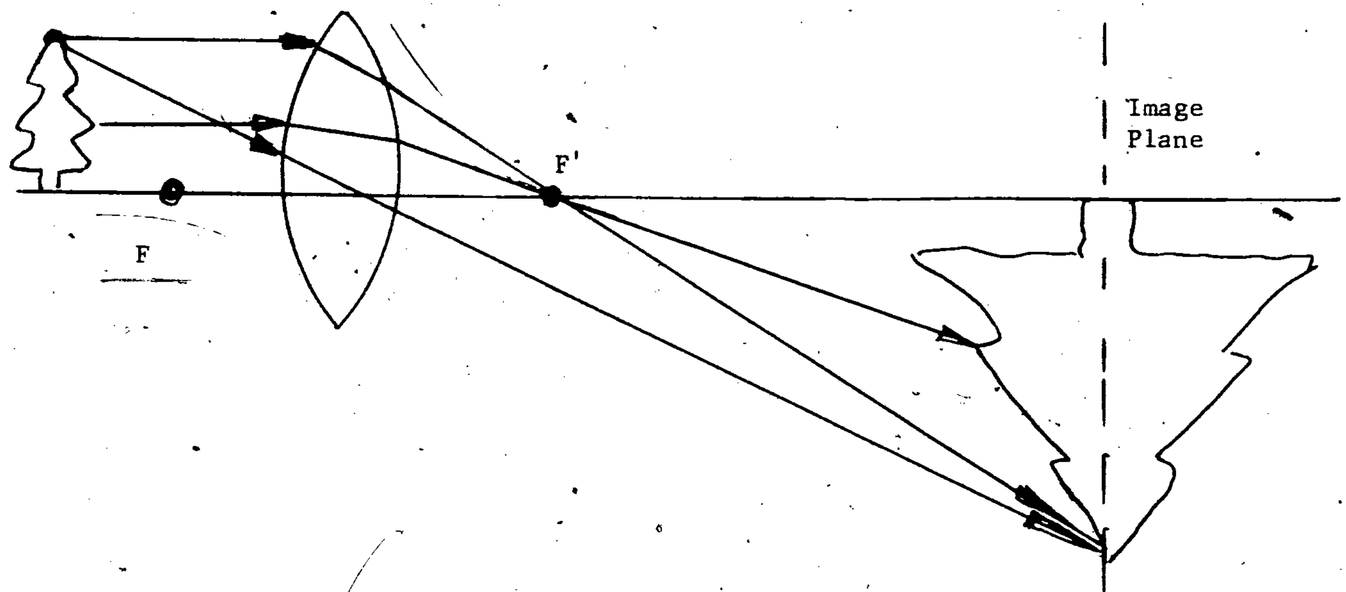


Ray #2 is next drawn from the same tip point to the lens, but along a line parallel to the principal axis. Upon passing through the lens, this parallel ray is bent (refracted) so that its continuation will meet the tip of ray #1. See the diagragm below.



The point where parallel ray #2 crosses the principal axis, on its way to the image plane, is the focal point of the lens.

If one were to ray trace from all points on the object to the lens, then on through the focal point, and then on <u>to the image plane</u>, the complete image would be formed.* See the diagram below.



Re-examine Case 4, page 23. Now, for the tree and lens diagrammed above:

a) What is the relative location of the object, in terms of focal length or focal point?

---

* In practice, tracing from all points on the object is not a simple task. But Ray #1, travelling straight through a lens center experiences no refraction, and Ray #2 (a parallel ray) always passes through the focal point enroute to the image plane. This ray from the tip of the object, determines the relative image size. It is unnecessary to ray trace from all points because one can obviously learn a great deal about the image with just these two rays!

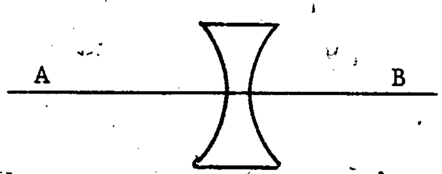
b) What is the relative location of the image, in terms of focal length or focal point?

c) Describe the image.

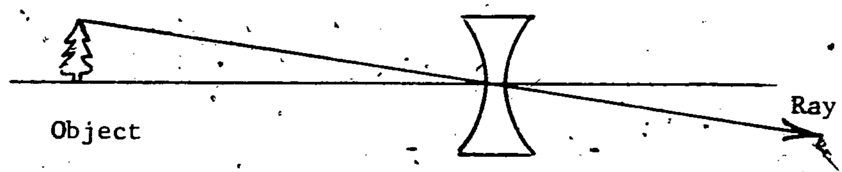
d) Restudy the figures on pages 23 and 24. Can you now better understand these ray diagrams?

If you are having trouble, get help from your instructor right now.

Ray Tracing Diverging Lenses. Diverging lenses have only a simple case because they produce ONLY virtual, erect, and smaller images. An examination of the ray diagrams below will show why.



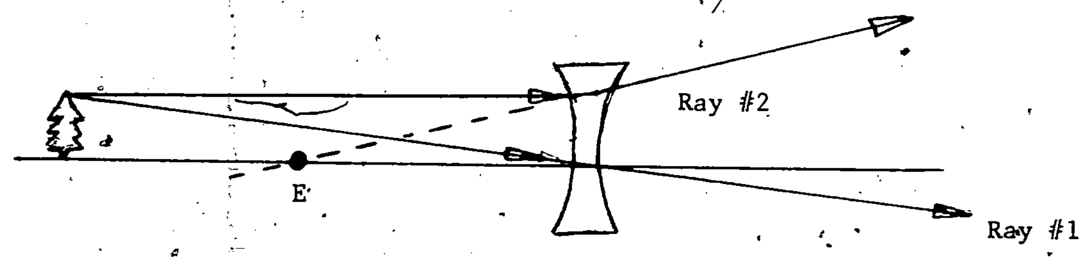
(a)



(b)

Diagram (a) shows a diverging lens with principal axis AB.

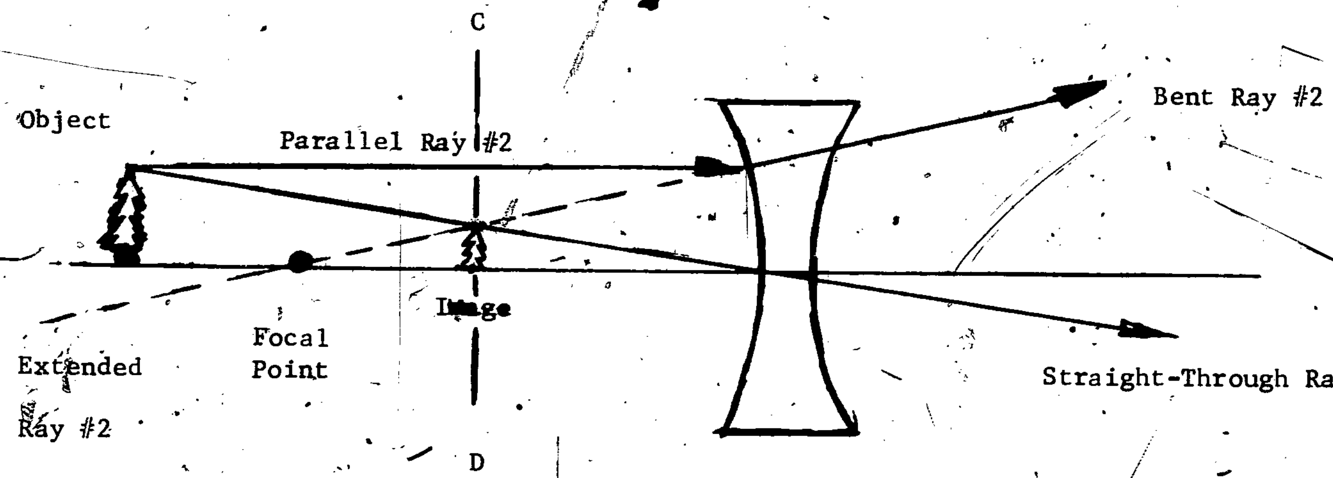
Diagram (b) shows ray #1 drawn from the object tip straight through the lens center.



(c)

Diagram (c) shows ray #2 drawn parallel from the same object tip, and bent outward into space (bent toward the thick part of the lens). Unlike the converging lens case, ray #2 <u>cannot</u> actually pass through the focal point on the principal axis; so we extend ray #2 <u>backward</u> from its outgoing direction (See the dotted line). This extension passes through the principal axis at the diverging lens' focal point (point E in the diagram).

The intersection of <u>ray #1</u> and the <u>extension of ray #2</u> form the image tip, and show us also where the image plane lies. See diagram (d) on page 31.



(d)

Notice that the image is smaller (<u>reduced</u>), is <u>virtual</u> (all the rays do not pass through the image and no focused image would appear at the image plane if a screen were placed there), and is <u>erect</u> (upright).

Expensive camera lenses are made up of a combination of converging and diverging lenses (the combination is called a <u>compound lens</u>) to obtain superior optical characteristics. Further study about lenses will be undertaken later, but you are ready to put what you have already learned into practice. Try your hand at the following investigations:

Investigation 1: Lens Magnification

Purpose: To show how a reading glass (single double-convex lens) of short focal length may be used as a simple magnifier.

Apparatus: One reading glass of 4" diameter, or similar kind of lens. Some photographic prints and negatives.

Introduction: A converging lens of short focal length is frequently used to magnify small objects. Such lenses are the basis of a reading glass, a simple magnifier, or the eye piece of a compound microscope or refracting telescope. The lens is positioned slightly less than one focal length away from the object, and the eye is placed close to the lens on the side opposite the object. This is a practical application of Case 6 for converging lenses; study the diagram again. Notice that the image is always virtual, erect, enlarged, and appears to be on the same side of the lens as the object.

Procedure: Use the lens to bring several photographic prints and negatives into sharp focus. Examine the prints and negatives for:

a) any portion slightly "out of focus"

b) any other defects

Conclusion: Put your findings in writing and turn these in to your teacher.

Investigation 2: Image Formation

Purpose: To study the image-forming characteristics of a converging lens, or combination of lenses.

Apparatus: A camera with variable focus.

Introduction: Converging lenses can produce both real and virtual images. In Investigation 1 you used a converging lens to produce a virtual image. Now you will use a converging lens (in a camera) to produce a real image. When you get your camera focused you will have an example of Case 2 for converging lenses.

Procedure: Take a camera of variable focus and practice focusing on various objects. When you get an object in good focus, ask the teacher to evaluate your ability to focus.*

Investigation 3: Ray-Trace Diagrams

Ask your teacher for some simplex convex and simple concave "lens-object" diagrams. You are to "ray trace" these thin lens diagrams; to label the diagrams as instructed; and to discuss the images formed in the terms prescribed by the teacher. If your classroom has a "ray box", or similar optical device, compare (match) your sketches to the patterns of the "ray box."

---

* Naturally, some cameras are easier to focus than others; some have automatic devices for this purpose. Your instructor will have you practice using several different kinds.

Investigation 4 (Optional):

See if you can relate the function of the choroid layer of the eye to the black interior of a camera. Write a simple description of the relationship and turn it in for evaluation. You may explain the function of other eye parts to your teacher or to your classmates for extra credit.

RESOURCE PACKAGE 1-3

SELECTED READINGS

1) How to Make Good Pictures, Revised Edition, Eastman Kodak Co., Rochester, New York, 1972.

2) McCoy, Robert A., Practical Photography, 3rd Edition, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1972:

Lenses	pages 19-44
Methods of Obtaining Correct Exposure	pages 48-60
Darkroom	pages 102-106

3) Mercer, John, An Introducture To Cinematography, Stipes Publishing Company, Champaign, Illinois, 1971.

*6) Schaum, Daniel, Schaum's Outline Series, Theory and Problems of COLLEGE PHYSICS, McGraw-Hill, New York, New York, 1961.

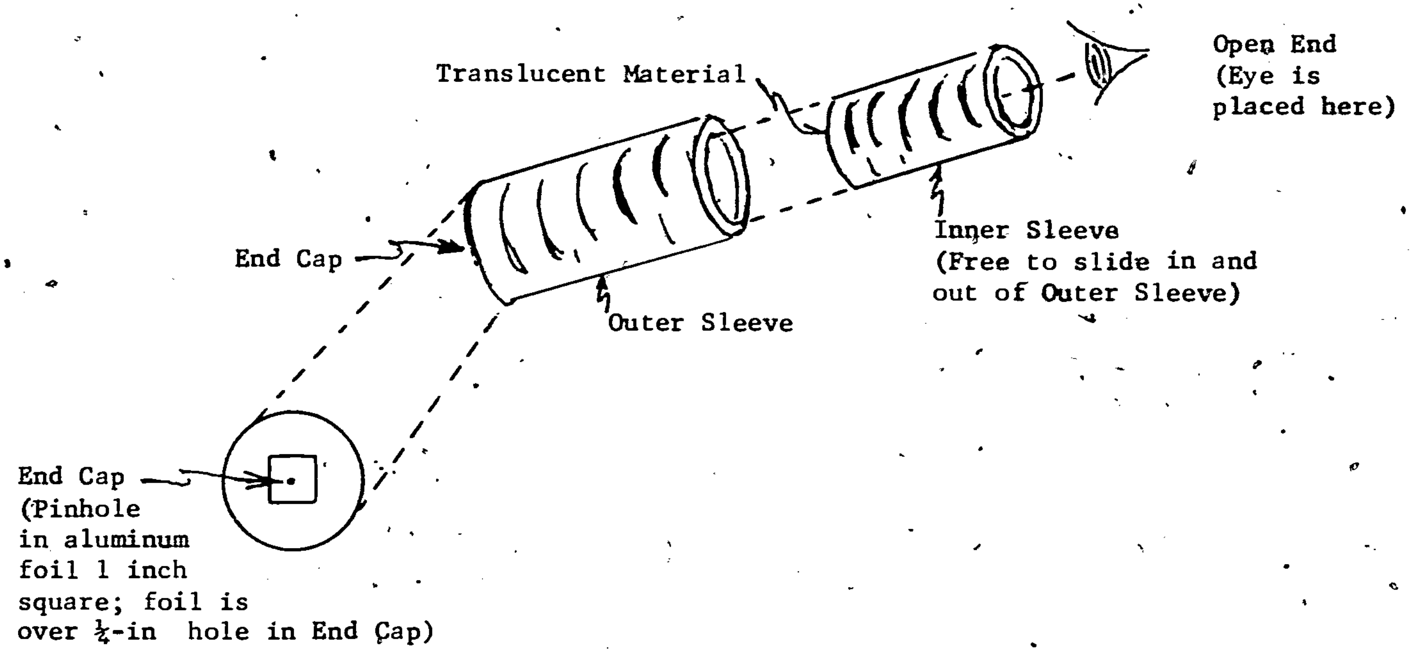
* A great reference for problem-solving; contains 625 solved problems, with clear explanations.

*RESOURCE PACKAGE 1-4 (Optional)

HOMEMADE CAMERAS

I. You will first examine some properties of a pinhole camera, a camera that has a <u>viewing screen</u> in place of photographic film. Later, you will place film in the camera and take a real picture.

You will need two cardboard tubes or containers, one of which can slide snugly inside the other. See Fig. 1.



PINHOLE CAMERA
Fig. 1

Attach a translucent material* (Make sure you know what "translucent" means!) over one end of the inner tube to serve as the viewing screen.

Next place a piece of aluminum foil over the ¼-inch opening in the end cap of the outer tube. (See Fig. 1) Pierce the center of the foil with a sewing needle. This will serve as the "eye" of the camera. In fancier cameras, this pinhole (aperture) is adjustable to control the amount of incoming light, and a lens is placed next to this aperture to focus the incoming light onto the photographic film. Notice that the ¼-inch opening is made in the light-tight cardboard end-piece of the outer tube, so that light passing through the needle-hole in the foil can reach the translucent screen.

Assemble the parts as shown in Fig. 1. Insert the inner sleeve into the outer one, translucent-screen end first.

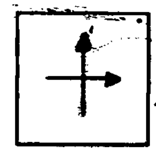
Now you are ready to examine the following properties of the pinhole camera:

A) The image. Point the camera toward a well-lighted wall on which you have placed a

---

* Waxed paper should work well; however, heavy weight tracing paper (#90 weight) is better because it is relatively inexpensive, is much more durable, and is available at any store stocking art supplies.

white cardboard marked with two black intersecting arrows as shown below.

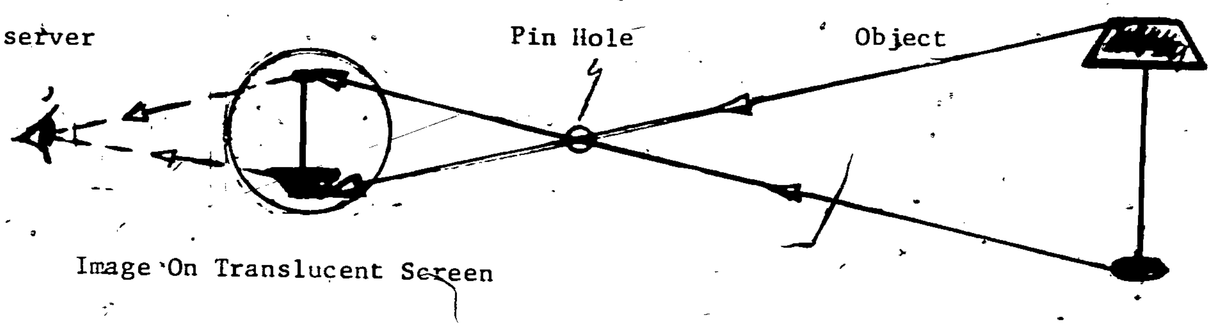


Begin with the screen close to the aperture (pinhole). Slowly separate the screen from the hole, while looking through the tube. You may have to use a hand to block out light from around your eye, and you must keep the tube pointed toward the "target" arrows.

Record in your notebook a description of what you see. For example:

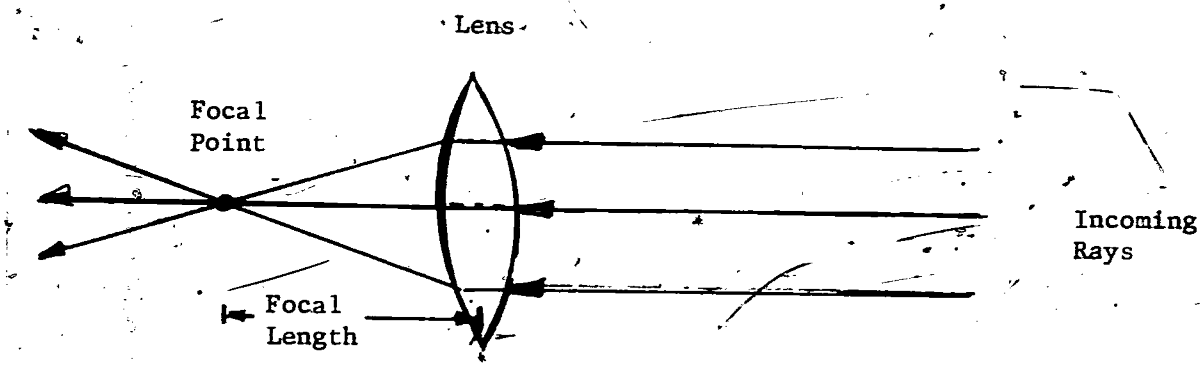
1) Is image size related to screen position?
2) Is image brightness related to screen position?
3) Is image sharpness related to screen position?
4) Is the image:
   a. upright or upside down?
   b. reversed left-side to right-side?

B) The Ray Trace. Examine the ray trace diagram below to better understand what happens in the pinhole camera.



II. (Optional Activity)

A lens is a <u>transparent</u>* material shaped to "bend" and thereby to focus light. Three effects of a lens placed in front of the pinhole may be observable: (1) a sharpened image, (2) greater "depth of field", and (3) a brightened image. The bending of light to a focus (focal point) is ray-diagrammed below:



Place a lens (shaped somewhat like the one above) over the end of a pinhole camera and repeat the observations of part I, section A. Again, record your observations in your notebook.

III. Now try taking a picture with your pinhole camera. Follow these steps and suggestions.

---

* Look up this word, if you don't recognize it.

A) Select a still subject with good lighting. Decide in advance on a vibration-free support for your camera, since exposure time will be relatively long.

B) While pinhole size is not critical, a No. 10 sewing needle pushed through foil about halfway up the needle shank yields approximately a 1/50-in hole diameter. This is a good size for film about six inches away. Scale your pinhole accordingly. Rotating the needle as it penetrates the foil will produce a neater hole.

C) A camera shutter can be devised using dark opaque paper hinged with a piece of tape over the pinhole.

D) Cover the eyehole light-tight.

E) Your "film" should not be that used in commercial cameras. Use "fast" photographic paper (Kodabromide Paper F, glossy no. 1 or no. 2, single weight, should do nicely.)

You can load your pinhole camera under a safelight (yellow or red darkroom light) or by using a candle two meters or so away.

Cut the photographic paper to fit over the translucent screen end of your camera, shiny side (emulsion side) facing the pinhole. Tape the film snugly in place (four corners will do) and then insert the inner tube (with "film") into the outer one (with pinhole).

Make sure the pinhole shutter is closed and that the eyepiece end is taped light-tight.

F) Expose the photographic paper by placing the camera on the pre-selected support. Avoid moving the camera as you open the "shutter." Leave the shutter open about two minutes for a subject in bright sunlight.

G) Record the shutter speed (exposure time), the camera location, the light conditions and the general subject.

Later on you will learn techniques of developing and printing film. For this time, it is probably better if your instructor develops and prints your photographic paper as a demonstration.

Later on you will be studying f-numbers and you will be read about f-numbers on exposure guides for regular cameras. The <u>relative aperture number</u> (called the <u>f-number</u>) of a lens is approximately the lens-to-film distance divided by the lens opening diameter. For example, if you made a pinhole 1/25 of an inch in diameter ("lens opening") and if your pinhole were six inches from the photographic paper, the f-number of your camera would be

$$\frac{6 \text{ inches}}{1/25 \text{ inch}} = f/150$$

What you have just computed for the pinhole camera can be done for a regular camera with lens.

The pinhole diameter of $\frac{1}{25}$ inch is the same as the <u>effective diameter</u> of a camera lens, and the 6-inch distance from the pinhole to the photographic paper is the same as the <u>focal length</u> of a camera's lens system. In other words, a general equation for f-number for a camera with a lens is:

$$\frac{\text{Focal length}}{\text{Effective lens diameter}} = \text{f-value}$$

Determine the approximate f-number of your pinhole camera. Submit this calculation to your instructor and discuss it with her/him.

RESOURCE PACKAGE 2-1

CHOOSING A CAMERA

Read "Choosing A Camera," pages 1-18, in Robert A. McCoy, Practical Photography, 3rd Edition, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1973, if this reference is available to you.

The remainder of this Resource Package is arranged as follows:

First, three general criteria are given for the classification of cameras. These criteria also provide a basis for the selection of a camera for personal or occupational use:

1) lens and shutter speeds
2) film size
3) focusing methods

Second, cameras are arbitrarily divided into the three groups: "simpler models", "more sophisticated models", and "polaroid models." Some of the advantages and disadvantages of each are discussed as a kind of further guide to prospective purchasers or users.

Lens and Shutter Speeds. Lens and shutter characteristics determine the picture-taking qualities of a camera. In general, the greater the range of possible shutter speeds and the greater the range of f-stops*, the better the camera.

---

* F-stop is the photographer's term for f-number (f-value). Shutter and lens characteristics combine to produce f-values; you will learn more about this later on.

Single lens cameras tend to produce images which are fuzzy around the edges. This edge fuzziness is called astigmatism and one way to correct for astigmatism is to use a compound lens.

The finest types of camera lens systems are called anastigmatic (without astigmatism). This means that a picture made with such a compound lens will show details clearly and sharply, not only in its central part but over its entire area. Since astigmatic lenses produce clear images, the image records (negatives) yield clear prints and permit big enlargements with fine definition (detail) throughout. These lenses also have the highly desirable quality of substantial speed. An f/6.3 anastigmatic lens is about six times as fast as the usual box camera "single" lens. An f/4 anastigmatic lens is twice as fast as an f/5.6, etc. A camera with a lens of the anastigmatic type is usually worth buying because it allows you to take good pictures under a wider range of conditions, such as motion of the subject, motion of the camera, intensity of light, etc.

Film Size. Film is available in a wide variety of sizes, types, speeds, and packagings. We will concern ourselves primarily with size. You will learn about the importance film speed in a later Resource Package. Packaging refers to film rolls, film cartridges, film sheets, etc. Film types refers to color film, infra-red film, transparency photography film, and the like.

In general, the larger the film sizes, the less "grainy" will be the negatives. In advanced photographic work "graininess" can be a critical consideration. You will study "graininess" more in a later Resource Package.

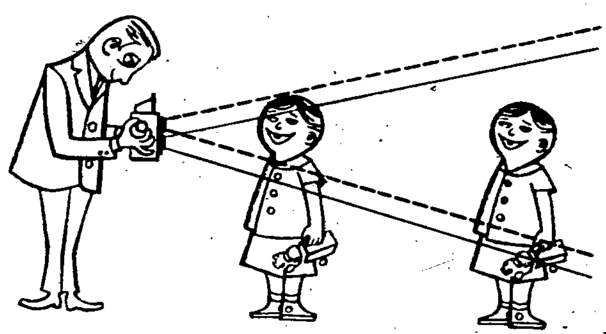
Focusing Methods. Two primary methods of focusing are the range finder method and the reflex method. Each has advantages and disadvantages, some of which are pointed out below.

The range finder method requires that the photographer focus on a subject by looking at it through a viewfinder. The basic disadvantage of this method is that a viewfinder view (the "viewing" optical line) is always offset from the lens view (the "lens-to-film" optical line).

The big advantage of the reflex method is that the photographer can see the subject exactly as the lens "sees" it. The "viewing" optical line and the "lens-to-film" optical line are identical.

Parallax is a word for the apparent shifting of the position of an object when viewed from different positions, as in the case of the viewfinder method of focusing. To observe the parallax phenomenon (effect) hold your pencil vertically at arms length in front of your face. Focus on the background (not on the pencil); alternately close one eye and then the other. Do you see the apparent shifting of position (apparent because you are holding the pencil fixed in place)?

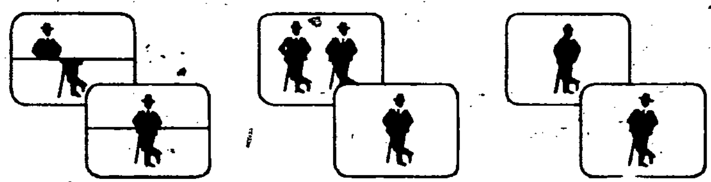
As mentioned earlier, a camera's viewfinder may not be in the same location as the lens. The lens thus focuses a picture which is slightly offset from the object seen in the viewfinder. This difference between what is seen by the photographer and what is "seen by the lens" (what the lens actually photographs) is what the photographer calls parallax. In the diagram below, this difference between the lens view and the finder view is shown with dotted lines. Particularly when taking close-ups, you must allow for parallax if using a camera which has no automatic parallax correction.



PARALLAX

In the more expensive and sophisticated cameras, optical systems are incorporated which compensate for viewfinder parallax and virtually eliminate it as a problem.

<u>More on Range Finder Focusing</u>. Most cameras (except very inexpensive ones) will have built-in range finders. The range finder is connected to the focusing mechanism of the lens, so that a good focus is set automatically. Three main types of range finders are pictured and described in the diagram below:



Split image

You view subject as horizontally cut in half. As you focus the lens, the two images align. When they unite in single unit, your subject is in focus.

Superimposed

These finders view subject as twins. As you focus lens, you superimpose one image over the other. When they become one image, subject is in focus.

Ground glass

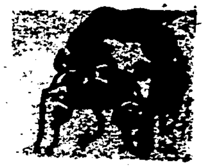
Simply focus lens until image is sharp on viewer. Then subject is in focus. This type used on twin-lens reflex and some kinds of single-lens reflex cameras.

THREE TYPES OF RANGE FINDERS

<u>More On Reflex Camera Focusing</u>. Reflex focusing incorporates a mirror system which projects the subject image with no parallax onto a <u>ground glass screen</u> viewfinder. The subject image the photographer sees is aligned exactly as the lens "sees" it, and focusing is accomplished by manipulating the

focusing mechanism until a clear, sharp, non-fuzzy image appears on the viewfinder screen. The diagram below shows both reflex and range finder types of camera viewing and focusing.

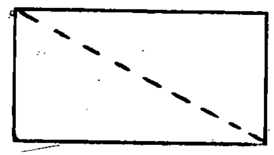
Reflex finder shows exactly what will be recorded on film.

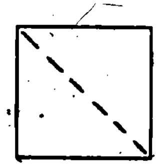


Viewing through an eye-level range finder.

TWO TYPES OF VIEWING AND FOCUSING

<u>More On Lenses</u>: Camera lenses gather light and then bend the light so that an image is formed on an area of film. Suppose we examine the film area itself; this area may be rectangular or square:


Rectangular
Film Area


Square
Film Area

The dotted lines are called the diagonals of the image areas.

As a practical "rule of thumb", it a lens has a focal length which is about the same as the length of the image-area diagonal it is called a <u>normal</u> lens. If the focal length is shorter than this diagonal, the lens is called a <u>wide-angle</u> lens. If the focal length is much longer than this image diagonal, the name <u>telephoto lens</u> is used.

Short focal length wide-angle lenses distort close objects more than normal lenses, but give a greater <u>depth of field</u> (show up objects in the picture's background better). Long focal length telephoto lenses give an apparent loss of depth of field and other distortions, but background detail can be brought out better than with a normal lens.

A shorter focal length lens concentrates much more light than a longer focal length lens. To concentrate more light, the long focal length telephoto lens has a much larger lens surface area. Because film must be exposed to a particular amount of light regardless of the focal length of the lens used, f-number calculations are used to assure this particular amount of light for any lens. Let's look again at the f-value formula:

$$\text{f-value} = \frac{\text{Focal length of lens}}{\text{Effective lens diameter}}$$

What this equation permits us to do is to set up different combinations of focal lengths and effective lens diameters which will focus the same amount of light. All that is required is that the combination yield the same formula ratio, or f-number. For example, these two combinations will result in the same film exposure (same amount of light on the film):

$$\text{f-1.4} = \frac{\text{27 mm focal length}}{\text{19.4 mm diameter}}$$

$$\text{f-1.4} = \frac{\text{19.5 mm}}{\text{13.9 mm}}$$

Another "rule of thumb": lenses having f-numbers of three (3) or greater are slow; fast lenses have f-numbers closer to one (1).

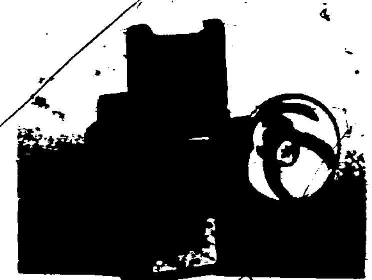
If you are wondering about the phrase "effective lens diameter" (Why wasn't it called simply "lens diameter"?), then you are asked to remember the diaphragm of the camera. The <u>iris diaphragm</u> is an adjustable aperture which can be used to effectively reduce the diameter of a lens opening. The lens can "see" only what the iris diaphragm permits it to see! Hence the term "effective lens diameter."

<u>Choosing the Right Camera</u>. Two factors generally determine the choice of a camera: (a) the use to which it will be put, and (b) the cost of the camera.

This next section section sets before you the characteristics of three groups of general types of cameras: "simpler models", "more sophisticated models" and "polaroid models". Also listed are some of the advantages, disadvantages, special applications, and some ideas of the kinds of photograph each takes best.

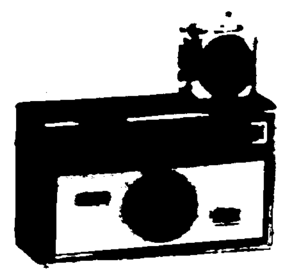
SIMPLER MODELS

1) <u>Simpler Box Camera Type</u>:



ADVANTAGES	DISADVANTAGES
Modest in price	Limited photographic use
Dependable camera for average conditions	Only good for pictures not requiring fine detail or much enlarging.
Flash available	
Nearly impossible to get a bad picture because of its simplicity	

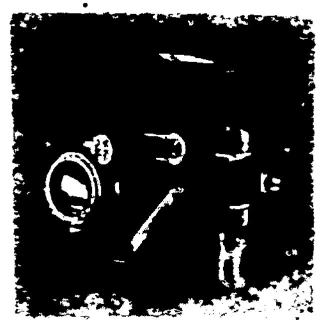
2) Instamatic Camera:



ADVANTAGES	DISADVANTAGES
Compact size	Limited photographic use, as in 1, above.
Drop-in cartridge-type film (easy loading)	
Dependable camera for average conditions	
Relatively modest price	

MORE SOPHISTICATED MODELS

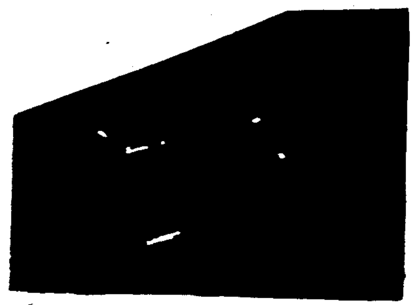
1) Bellows-Type Camera:



ADVANTAGES	DISADVANTAGES
Greater focusing range	Time required to open and close Bellows
Larger negatives; nice contact-print size	No interchangeable lenses
	Not many of the equipment options available that are necessary for technical kinds of photographic work

The typical folding camera is relatively light and compact. Most popular are the $2\frac{1}{4}$" x $3\frac{1}{4}$" sizes, many of which offer the option of 8, 12, or 16 exposures to a roll of film. Contact prints are large enough for a family album. In general, lenses are not interchangeable; however, slip-on lenses are available for taking close-up pictures. The better models of this type camera are equipped with excellent lenses.

2) <u>35 mm Camera</u>:



ADVANTAGES	DISADVANTAGES
Compactness	Enlargements usually necessary
Variable f-stops and shutter speeds	Retouching of film impractical
Transparencies of standard size and quality	Meticulous darkroom care needed
Interchangeable lenses	

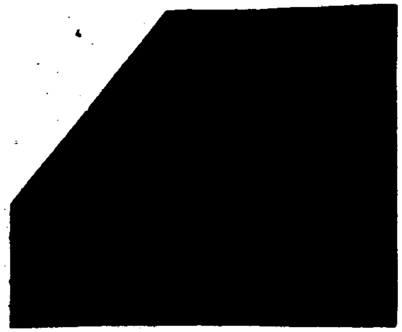
(continued)

ADVANTAGES	DISADVANTAGES
Depth of field visible at any stop	
Economical film cost	
Adaptability to special uses	
Large or small film loads	
Possible choice of range finder or reflex focusing available.	

Fast lenses, compactness and low film cost characterize these "mighty midgets of the Camera Kingdom." Normal film load is for 20 or 36 exposures, but bulk film loading is available too. Because a wide range of interchangeable lenses are available, these cameras are readily adapted to a wide variety of technical and artistic kinds of photography. Some of these cameras are compact enough to slip into a pocket, but most are carried in protective cases designed for fast shooting. Variable f-stops and shutter speeds permit photographing under a wide range of conditions.

3) Medium Format*

Single-Lens Reflex Camera:



ADVANTAGES	DISADVANTAGES
Eliminates viewfinder parallax	Reflex mirror shakes camera, requiring a tripod under certain conditions
Depth of field visible at any stop	Difficult focusing at smallest f-stops, unless equipped with preset lenses
Interchangeable lenses	No view of subject at instant of exposure
Adaptability	

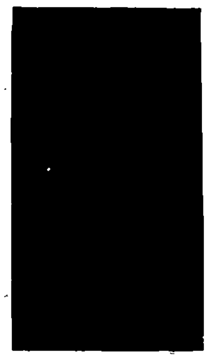
These are the only cameras discussed so far whose transparencies are large enough to be acceptable to commercial publications. Size and weight of medium format reflex cameras vary widely, principally according to film size. These cameras used to be designed mostly for waist-level viewing; however,

* Medium format refers to film size. It includes 2¼" x 2¼" (6 cm x 6 cm, called "6 by 6") and 2¼" x 2 3/4" (6 cm x 7 cm, called "6 by 7").

newest models offer both eye-level and waist-level viewing. Adaptability to different photographic conditions is accomplished with such options as polaroid backs, focusing prisms with grids and stops, sophisticated shutters for field flash, etc.

4) Medium Format

Twin-Lens Reflex Camera:



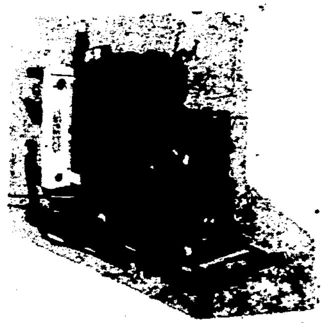
ADVANTAGES	DISADVANTAGES
Eye-level, waist-level, or open-frame image finding	Parallax at close distances
Square format: no turning for horizontal or vertical pictures	Depth of field cannot be observed directly
Image visible at instant of exposure	Image is perverted (mirror-reversed)

(continued)

ADVANTAGES	DISADVANTAGES
Contact prints large enough for relatively detailed inspection	

These cameras are popular because of the combination of direct ground-glass focusing and the ability to see the subject at the instant of exposure. Film is of a common size and is available almost everywhere in a variety of emulsions. For some models there are 35 mm adapter backs. Waist-level viewing makes low-level shots easier.

5) Press and View Camera:

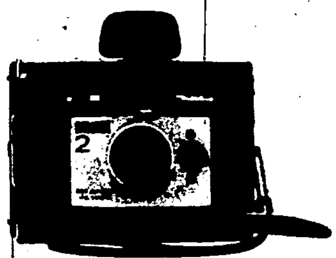


ADVANTAGES	DISADVANTAGES
Ground-glass focusing	Film costly
Interchangeable lenses	Bulky and heavy
Long bellows permit extreme close-ups	Many require a tripod
Distortion corrections	Relatively slow in operation
Ease of retouching negatives	Conventional film holder bulky; handier film packs more costly
Wide application to many types of photography	Viewed image is both inverted and perverted
Single sheet of film can be exposed and developed	May require a head cover outdoors to eliminate reflection off the ground glass screen during composing and focusing the picture

Both in and out of the studio, these cameras have maximum versatility and adaptability to the whole range of photographic work, except that they and their auxiliary equipment are heavy and bulky. The size and bulk of these cameras make them a real burden to carry; in fact, the larger ones can be used only on a tripod. They are the only type of camera with full distortion correction, and all have interchangeable lenses. Negatives are large, are easily handled in a darkroom, and are easy to retouch. Film cost may be discouraging to the non-professional. Their large transparencies are those most acceptable to high quality publications.

6) Polaroid Cameras:

POLAROID MODELS



ADVANTAGES	DISADVANTAGES
See what print looks like right away	Film costly
	No negatives
	Poorer quality prints
	No transparencies

These cameras have an emulsion which permits exposing and "printing" within a few seconds. You can see right away what kind of picture you have shot. The many styles of Polaroid cameras marketed today provide an adequate choice for "family kinds" of photography, as well as a limited usage for professional and skilled amateur work. Additional prints, cropping, enlarging, dodging, burning-in, etc., are operations which require a negative for economy and for high picture quality. Polaroid cameras produce <u>positives</u> (prints) only.

Project:

Visit some local photographic supply shops, peruse catalogues, etc., and come up with approximate prices of the cameras discussed in this Resource Package. Submit your findings to your teacher for evaluation.

RESOURCE PACKAGE 3-1

READINGS--LENSES AND HAND-HELD CAMERAS

1) Morgan, Willard D., and Lester, Henry M., Graphic Graflex Photography, 9th Edition, Morgan and Lester Publishers, New York, New York, 1952.

Your Lens	pages 37-52

2) Neblette, C. B., and others, Elementary Photography, 3rd Edition, The MacMillan Co., New York, New York, 1945.

About Lenses	pages 66-79
Picture Taking with Hand Camera	pages 80-97

RESOURCE PACKAGE 3-2

PICTURE TAKING WITH HAND-HELD CAMERAS

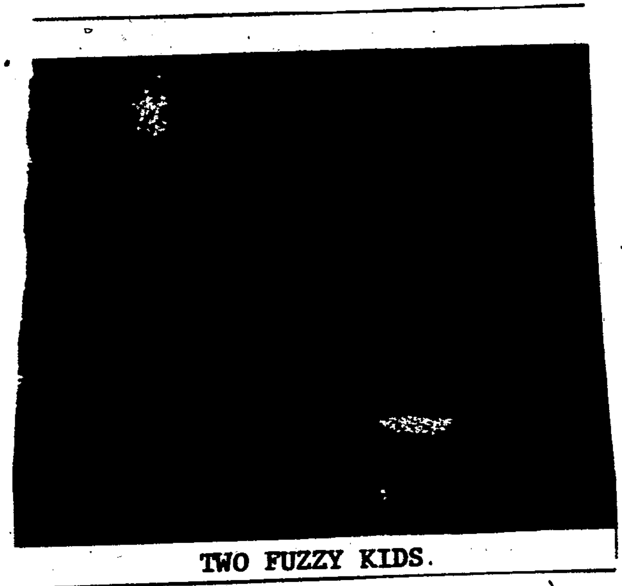


Fig. 1

Fig. 2

<u>A Steady Hand</u>. Holding the camera still* can mean the difference between the photographs in Fig. 1 and Fig. 2.

*Of course, choosing a faster shutter speed could offset the effects of a shaky hand!

Other Factors. What caused the fuzziness in the picture in Fig. 1? Even the best photographer makes mistakes, but if you get pictures like Fig. 1 and you have a steady hand, then perhaps you should get better acquainted with your camera. The picture in Fig. 1 is fuzzy because it was taken out of focus, and it is poorly composed because it lacked a parallax adjustment.

More on Focusing and Speed. Some lenses have a fixed focus (there is no lens adjustment). Everything beyond 3 to 4 feet from the camera will photograph clearly; nearer objects will be fuzzy. An adjustable focus lens usually has a camera-to-subject distance scale that is set manually. The print in Fig. 1 is fuzzy because the lens was not focused for the correct distance.

Lens speed refers to the light-passing ability of the lens. This is measured by f/numbers; the lower the number the faster the lens.

More on Lens Openings (Diaphragm). Behind the camera lens there is a hole called the lens opening, aperture, or lens diaphragm. This hole is adjustable, and its various sizes are measured in f/numbers. The diaphragm size must be co-ordinated with the shutter speed to insure that just the right amount of light strikes the film to insure proper exposure. Wider diaphragm openings require faster shutter speeds to avoid over-exposure, and smaller openings need slower speeds to avoid under-exposure. A light meter is a useful device to insure a proper combination of lens opening and shutter speed.

More on Shutter Speeds. The shutter opens to let light pass into the camera (It is the eyelid of the camera). The open time (shutter speed) is usually a fraction of a second, such as 1/50 or 1/100 second. Faster shutter speeds are used to stop the action of a moving subject and thus prevent blurred photographs. Slower shutter speeds permit the longer exposure times necessary when light is poor; a tripod or equivalent camera support should be used for slower shutter speeds to prevent blurred photographs due to camera movement while the shutter is open. Remember that shutter speeds must be co-ordinated with lens openings for proper exposures; under-exposures, for example, can be corrected by a wider lens opening or a slower shutter speed.

Depth of Field. A camera lens set for a focus of 10 feet may photograph fairly sharply everything from 8 feet to 12 feet from the camera. This range of focus is called depth of field. Small lens openings yield a greater depth of field; large lens openings yield a shallower depth of field. (See Fig. 3).

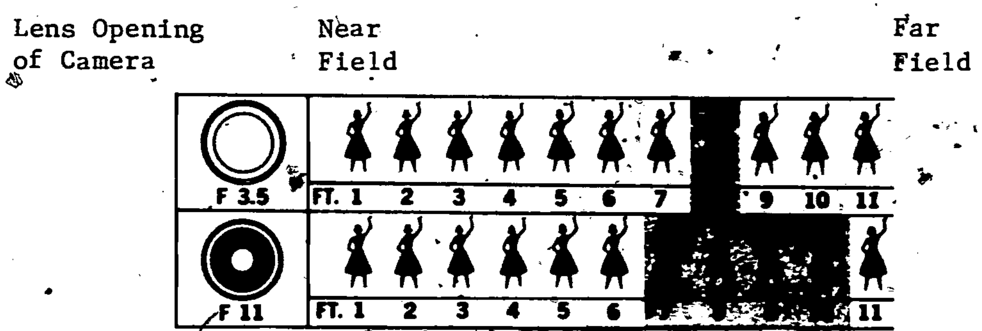


Fig. 3

Note the difference between depths of field at f/3.5 and f/11. (See shaded area)

RESOURCE PACKAGE 3-3

READINGS - PHOTOGRAPHIC ILLUMINATION

1) Basic Photography For The Graphic Arts, Morgan, Morgan & Morgan, Inc., Hastings-on-Hudson, New York, 1970.

2) How To Make Good Pictures, Rev. Ed., Eastman Kodak Company, Rochester, New York, 1972.

3) Flash Technique, 1st Edition, Eastman Kodak Co., Rochester, New York, 1954:

"Flash Techniques For Better Pictures"	pages 4-61

4) McCoy, Robert A., Practical Photography, 3rd Edition, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1972:

Flash	pages 61-71
Films	pages 75-88
Filters	pages 90-100

5) Studio Technique For Portrait Photography, 1st Edition, Eastman Kodak Co., Rochester, New York, 1961:

Basic Lighting	pages 2-3
Building and Lighting	pages 4-13
Lighting Ratio	pages 13-15
Highlight Brilliance	pages 16-19
The Three-Quarter Pose	pages 21-25
Corrective Techniques	pages 25-31
Portrait Background	pages 33-36

RESOURCE PACKAGE 3-4

LIGHTING

A good picture requires just the right amount of light. There are many different types of film and each type requires a different quantity of light for the same set of conditions. Most film comes with an exposure guide which explains the film's use under various conditions. Therefore, you will be expected to read the exposure guide on the film container before attempting to take pictures outdoors or indoors. This course is restricted to black-and-white photography for economy reasons. When you are on your own and are shooting color film, you must learn that it responds differently to sunlight, floodlight and flash than does black-and-white. You will be able to study these differences on your own, once you have become acquainted with black-and-white techniques.

Sunlight is the preferred source of light. But for taking pictures at night, indoors, or on a cloudy day you will need a flash or floodlight and fast film (film which requires less exposure time than slow film).

The Flash. A flash provides a convenient way to take pictures. Flash-shutter synchronization makes flash pictures easy to take. See Fig. 7 on following page).

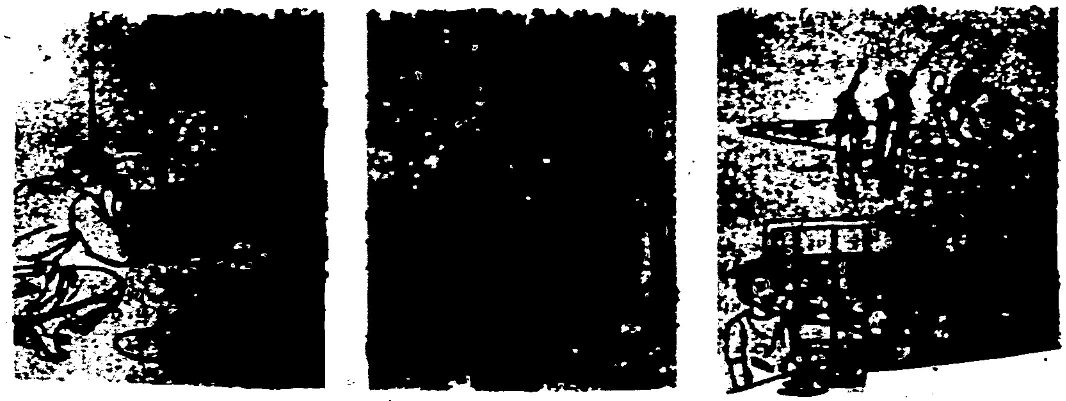
USING FLASH INDOORS
Fig. 7

Three flash techniques are:

a) Flash Off The Camera: By connecting the flash with an extension cord, it is easy to get interesting highlights and to avoid glare on eyeglasses. Place the extension light higher and to either the left or right of the camera position for a more natural picture. Or you can point the extension light toward the wall or ceiling to get a "bounce flash" result. See Fig. 8.

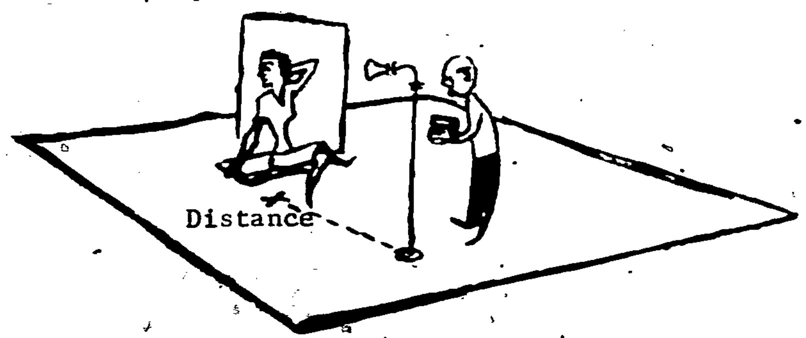
b) Multiple Flash: With one flash at the camera position and one or more at the end of an extension cord, you can get a more professional looking picture. Have one light illuminate the main areas of a subject's face while the others provide a pleasing highlight to the hair, as well as lighting the background and reducing back shadows.

c) <u>Daylight Fill-in Flash</u>: Outdoors, the sun may create shadows which record as featureless, black areas in pictures. Flash reduces these shadows. Indoors the flash is good for overcoming the uneven lighting on a subject near a window filled with incoming natural light. (See Fig. 8).



USING THE FLASH
Fig. 8

The Floodlights. Here are some helpful suggestions for use of floodlights with two classes of cameras:



EXPOSURE DEPENDS ON LAMP-TO-SUBJECT DISTANCE
Fig. 9

a) Non-Adjustable F-stop Cameras: Place the camera on a steady support for time exposures. Use Kodak Super - XX Film or equivalent at ½ second time exposure.

b) Adjustable F-stop Cameras: Place the camera on a steady support for time exposures. Use Kodak Super-XX Film at ½ second at f/16, or 1.25 second at f/4.5. Or, use Kodak Verichrome or Plus-X Film at 1 second at f/16.

For adjustable cameras, this table shows subject distance, lens setting, and shutter setting for Kodak Super-XX film:

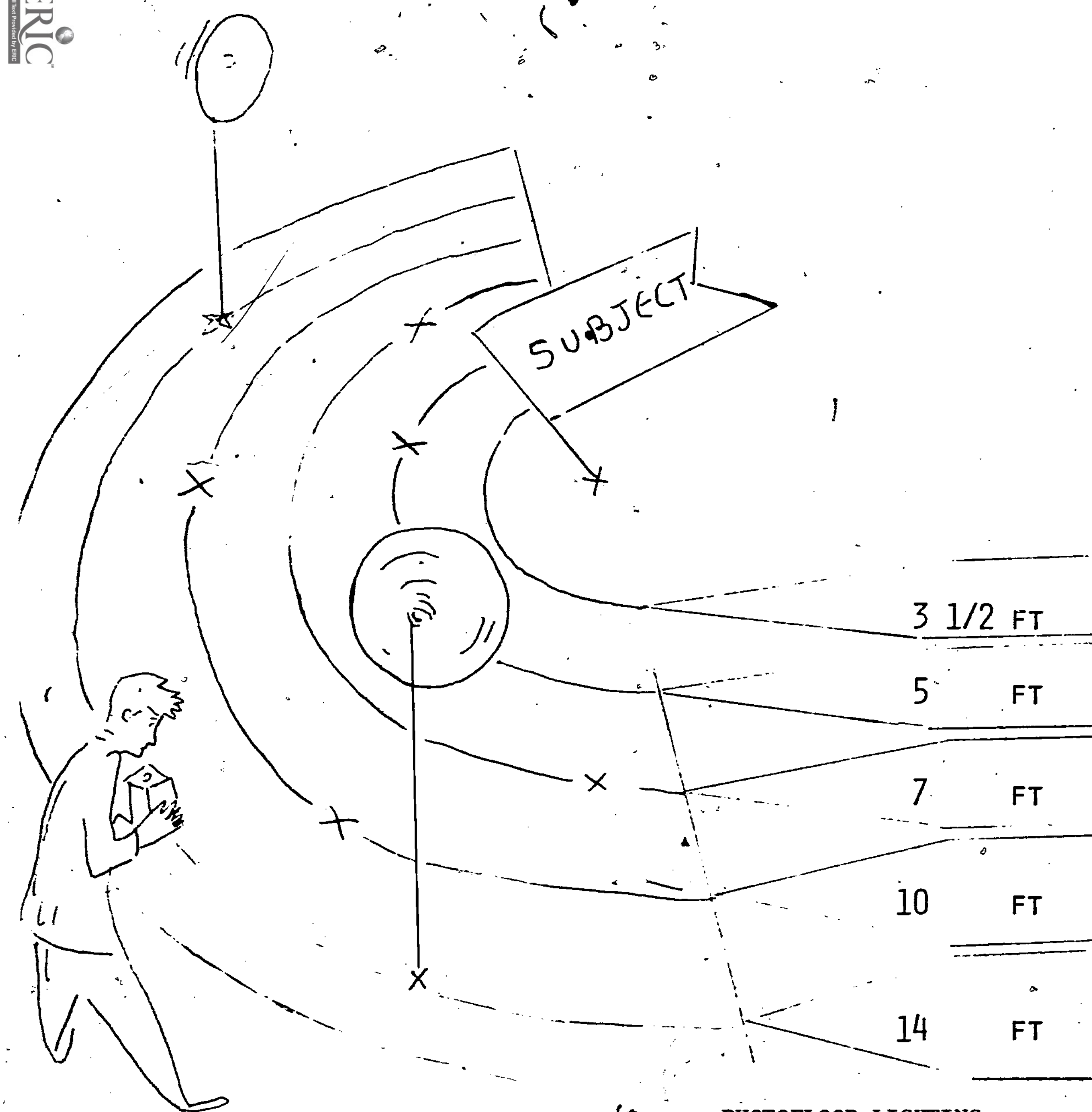
Floodlight Exposures For Adjustable Cameras With Kodak Super-XX Film		
When the distance from the modeling light to subject is	Set the lens opening at	Set the shutter time at
3½ feet	f/5.6 f/11	1/100 second 1/25 second
5 feet	f/4.5 f/8	1/100 second 1/25 second
7 feet	f/6.3 f/22	1/25 second 1/2 second
10 feet	f/4.5 f/16	1/25 second 1/2 second

The diagram in Fig. 10 can be used with the following lighting:

a) One #1 and #2 floodlamps in reflectors. Set both lamps at equal distances from the subject. The larger lamp is the <u>modeling</u> light; the smaller is the <u>fill-in</u> light.

b) Two #2 flood lamps in reflectors or two reflector-type floods. Place one lamp (modeling light) on one of the distance circles, and the other (fill-in light) on the next larger circle. Use the exposure given for the distance from the nearer light (modeling light) to the subject.

For a different effect try concealing a third lamp behind the subject; let it light the background or highlight some part of the subject. (This does not change the recommended exposure time.)



	Super-XX Film	Verichrome or Plus X
	Simple Camera Snapshots	
3 1/2 FT	1/25 at f/11	1/100 at f/4 1/25 at f/8
5 FT	1/50 at f/5.6 1/25 at f/8	1/50 at f/4 1/25 at f/5.6
7 FT	1/50 at f/4.5 1/25 at f/6.3	1/2 sec Simple Camera Time Exposure 1/25 at f/4.5
10 FT	1/2 Sec Simple Camera Time Exposure 1/25 at f/4.5	1 Sec Simple Camera Time Exposure 1 Sec at f/16
14 FT	1 Sec Simple Camera Time Exposure 1 Sec at f/16	2 Sec Simple Camera Time Exposure 2 Sec at f/16

PHOTOFLOOD LIGHTING
Fig. 10

Investigation 1. Take at least two pictures with available (existing) light. A log of each exposure must be kept in a notebook. Include the following:

(a) time of day

(b) exposure meter reading (or record of whatever other method you used to determine the camera setting)

(c) camera setting, shutter speed, and f-number

(d) type of film

Investigation 2. Take at least two pictures using photoflash. If you are using regular flash bulbs, look on the back of the packing box for exposure guide directions. Here is a guide for #5 or 25 (25 is the tungsten index, an indication of brightness of illumination) flash lamps in polished reflectors:

FLASH EXPOSURE GUIDE FOR #5 OR 25 LAMPS IN POLISHED REFLECTORS

Kodak Film	Tungsten Index	Reflector Size	Open Shutter or 1/25	1/50	1/100	1/200	1/300	1/400	1/500	1/800
Panatomic-X	25	4-5 inch	120	110	95	70	65	55	50	45
Verichrome	32	4-5 inch	140	125	110	80	70	60	55	50
Plus-X	40	4-5 inch	150	140	120	90	80	70	65	55
Super or the Press	50	4-5 inch	170	150	130	100	90	75	70	60
Super-XX	80	4-5 inch	220	200	170	130	110	95	90	80
Tri-X	160	4-5 inch	300	280	240	180	160	140	130	110
Super Panchro Press Type B	100	4-5 inch	240	220	190	140	130	110	100	90

To use the exposure guide, divide the guide number for the chosen shutter setting by the distance (in feet) from lamp to subject. The quotient is the lens opening at which to set the camera. Example: at a 10-ft distance using Plus-X film and a shutter of 1/300 sec, the guide number is 80. Therefore, divide 80 by 10 and get a lens opening of 8. These numbers are for average subject illumination. For light subjects, use one lens opening smaller than the guide indicates; for dark subjects, use one lens opening larger.

A log of the following data for each exposure must be kept in your notebook:

a) type of light used, type of camera used, and subject placement (a simple sketch of subject, subject distance, light placement, and camera placement)

b) Calculations showing how you used the exposure guide to compute the camera lens opening setting

c) the lens opening setting, the shutter speed, and the f-number used

d) type of film used

Investigation 3. Take at least two pictures using photoflood lights. In figuring your basic lighting plan, study Fig. 10. Again, a log of each exposure must be kept in the notebook. Record the following:

a) type of light, type of camera, subject placement (a simple sketch, as in Investigation 2)

b) camera lens, shutter speed, and f-number settings

c) type of film

Turn in your notebook to your teacher to be evaluated.

RESOURCE PACKAGE 4-1

READINGS-DEVELOPING, PRINTING, AND ENLARGING

1) Danils, Dan, Photography From A To Z, Amphoto American Photographic Book Publishing Co., Garden City, New York, 1968.

2) Epstein, S, and DeArmand, D. W., How To Develop, Print and Enlarge Pictures, 2nd. Ed., Amphoto American Photographic Book Publishing Company, Garland City, New York, 1970.

3) Foldes, Joseph, Practical Way To Perfect Enlargements, Amphoto American Photographic Book Publishing Company, Garden City, New York, 1954.

4) Kodak, B & W Photographic Papers, Morgan, Morgan & Morgan, Inc. Pub., Hastings-on-Hudson, New York, 1970.

5) McCoy, Robert A., Practical Photography, 3rd Edition, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1972:

Developing the Negative	pages 108-126
Contact Printing	pages 130-145
Enlarging	pages 148-164
Special Treatment of Negatives	pages 167-172
Special Treatment of Prints	pages 173-179
Some Principles of Art	pages 182-199
Portraiture	pages 213-230

6) Nibbelink, Don D., Bigger and Better--The Book of Enlarging, 1st Edition, John P. Smith Co., Inc. 1952, Garden City, New York, 1952:

Getting Ready To Print	pages 41-58
Painting With Light	pages 102-133

7) The Eighth Here's How, Amphoto American Photographic Book Publishing Company, Garden City, New York, 1973.

RESOURCE PACKAGE 4-2

DEVELOPING, PRINTING, AND ENLARGING

Taking pictures is only half the fun of photography. It is in the darkroom where the skills and deeper understandings of photography are really developed. For many people, this is the most fascinating part of photography. It is surprisingly simple to discover the secrets of "darkroom magic" as you learn to develop, to print, and to enlarge your own pictures!

Developing Film. You will start by learning to develop the film you exposed during the Investigations of Resource Package 3-1. In developing, follow these 7 basic steps.

LOADING FILM
Fig. 1

1) Load the film into the developing tank. In total darkness, remove the film from its paper backing and feed it into the tank grooves.

BE SURE:

a) the film does not "buckle" and touch itself

b) the tank cover is tight before going back into a lighted area.

See Fig. 1.

ADDING DEVELOPER
Fig. 2

TIMING AND STIRRING
Fig. 3

WASHING
Fig. 4

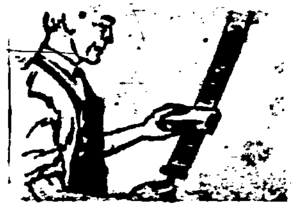
2) Pour in the developer. Do this as quickly as possible, so that the developer covers all parts of the film at nearly the same time. From this step on, you can work in full light. The length of time the film remains in the developer is given on the developer container. See Fig. 2.

3) Agitate (stir) for a short time. After agitating, pour the developer back into its bottle.

4) Repeat steps 2 & 3 with a short time stop. (About 8 slow counts in length.)

5) Now repeat steps 2 & 3 using a fixer solution. Leave the film in the fixer for about 15 minutes, unless you use rapid fix in which case follow the instructions for fixing time printed on the packaging label. See Fig. 3

6) Wash the film in running water. Let the water run freely over the film for approximately 30 minutes, with top of tank removed. This washing process is to stop the action of the chemicals on the film. See Fig. 4.



WIPING AND DRYING
Fig. 5

7) Wipe the water from the film. Use a sponge only if wash water sediment has spotted the film. Hang the film to dry. When the film is dry, it is ready for printing. See Fig. 5.

Contact Printing. Cut the developed film into the separate sections representing each of the different exposure settings. For example, if you exposed six (6) shots of 35 mm film before changing camera settings for the next six (6) shots, cut the 35 mm film into sections of six (6) negatives each. These exposed and developed sections are called negatives. Place a negative against a sheet of contact printing paper in a contact printer (either a print frame or a print box). See Fig. 6. The dull (emulsion) side of the negative should be placed against the shiny side of the contact paper. Shine a white light through the negative for a few seconds. This light forms an invisible image on the contact printing paper. The image becomes visible and permanent (a print) when this paper is put into the proper chemicals. All of this activity can be done under darkroom lights (dim yellow or red safelight). Next, put the exposed contact paper in the processing solutions in the 1 - 2 - 3 order of Fig. 7. First, move the paper back and forth in the

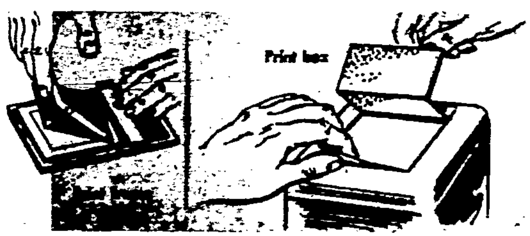


Fig. 6

CONTACT PRINT DEVELOPING
Fig. 7

developer tray for 45 to 60 seconds (until the picture appears as dark as you want it). Watch the picture "come to life" as it builds up in contrast. But be careful!...the print appears much darker and "more contrasted" in solution than it does after removal. <u>Second</u>, transfer the picture to the short stop tray for 30 seconds. This will neutralize the developer on the print. <u>Third</u>, place the picture in the fixer tray for about 5 minutes, agitating every few minutes for thorough fixing. Remember: Don't change this 1 - 2 - 3 sequence!...and don't contaminate the three tanks with your film <u>tongs</u> (film handling devices).

WASHING AND DRYING
Fig. 8

Now, wash and dry the prints as follows. <u>First</u>, place prints in lukewarm running water for about 45 minutes. Use a <u>print washer</u> or a <u>sink-plug</u> washer. <u>Second</u>, to dry the prints use a towel or a blotter book (For a real gloss, place the prints on a polished <u>ferro-type plate</u>). Place the blotter <u>between</u> the <u>dryer roller</u> and the <u>prints</u>. See Fig. 8. This avoids slipping and consequent crumpling of the print while the blotter absorbs surplus water. Then with surplus water removed let the prints dry overnight. (If there is an electric drier available, you can dry your prints in 5 or 10 minutes!)

<u>Enlarging</u>. Enlarging can bring out some fascinating features of your pictures. Photography can be an intensely personal and creative experience. And enlargements permit you to produce your very own special

effects. Furthermore, enlarging lets you create these special effects after pictures are recorded on film! As with printing, enlarging is fun and surprisingly easy.

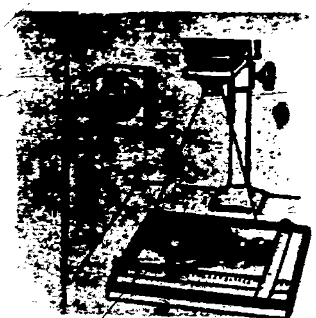
NEGATIVE CARRIER
Fig. 9

You will start by following these four simple steps:

1) Place the negative in the carrier, shiny side up (base side up). Slide the carrier into the enlarger slot. Use a soft camel-hair or antistatic brush to remove any dust. See Fig. 9

FRAMING AND FOCUSING
Fig. 10

2) Frame and focus the negative image on the easel, using a piece of white practice paper instead of enlarging paper. With the easel on the baseboard of the enlarger, turn the room lights out and the enlarger light on. Adjust the enlarger head so that a picture is framed on the white paper. Turn the focus knob to bring the image into sharp focus. See Fig. 10. It is a good idea to concentrate focusing on some fine detail of the picture. Make sure the picture is framed at the desired angle on the white practice paper.

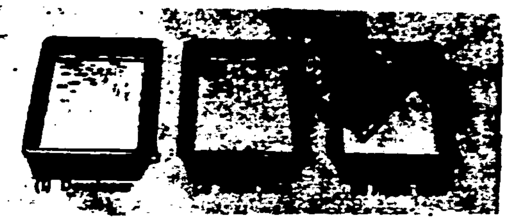


EXPOSING
Fig. 11

3) Turn the enlarger light off and replace the white practice paper with enlarging paper, glossy side up. Turn the enlarger light back on and shine it on the enlarging paper for about 5 to 10 seconds. Exact exposure time can be determined by using test strips (scrap pieces

of unexposed enlarging paper). See Fig. 11.

4) After exposure, put the enlarging paper in the processing solution in the same 1 - 2 - 3 order as for contact printing. See Fig. 12. Move the paper back and forth in <u>tray 1</u> for 45 to 60 seconds, until the picture appears as dark as you want it. Next, transfer the picture to the short stop <u>tray 2</u> for 30 seconds. This will neutralize the developer on the print. Then place the picture in the fixer <u>tray 3</u> for about 5 minutes, moving it every few minutes for thorough fixing. Now wash and dry the enlarged print by first placing it in running water for about 45 minutes. Use a print washer or a sink-plug washer. Dry the print using a towel or a blotter book. For a real gloss, place the print on a polished ferro-type plate. Place a blotter between the roller and the print. Dry the print overnight, or if you have an electric print dryer you can dry your print in less than 10 minutes.*



ENLARGEMENT DEVELOPING
Fig. 12

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* Ask your instructor about the Kodak film which dries after hanging only five (5) minutes and does not curl while hanging!

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Applications. Now that you have learned the techniques of exposing, developing, and printing film, perform the following exercises to test your skills and to provide a further basis for self and teacher evaluation.

Exercise 1. Expose and develop one roll of film. Record in your notebook the following data: (a) type of film, (b) kind of developer, (c) length of development time, (d) your evaluation of the negatives, and reasons therefor.

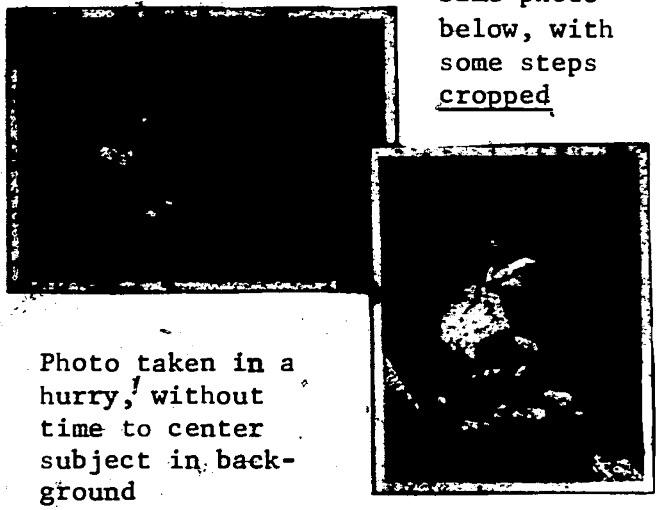
Exercise 2. Make at least two contact prints. Record in your notebook the following data: (a) type and number of contact paper, (b) kind of developer, (c) approximate time of exposure, (d) approximate time in print developer, (e) your evaluation of the prints, and reasons therefor.

Exercise 3. Make at least two enlargements. Record in your notebook the following data: (a) type and number of paper used (if variable contrast-paper, then so state), (b) kind of developer, (c) f/setting used for enlargement, (d) approximate time of exposure, (e) approximate time in developer, (f) your evaluation of the enlargements, and your reasons therefor.

Turn in your notebook for evaluation.

RESOURCE PACKAGE 4-3

CROPPING, DODGING, AND BURNING-IN



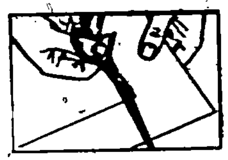
Same photo below, with some steps cropped

Photo taken in a hurry, without time to center subject in background

CROPPED PHOTO
Fig. 1

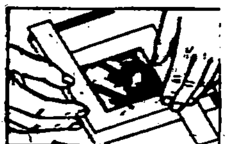
In making candid snapshots or in shooting fast-action pictures, there is not always enough time to compose the picture well. Cropping, dodging and burning-in are photo-processing techniques which center a viewer's attention on a particular subject of interest and eliminate unwanted details from a picture.

Cropping is essentially the removal of part of a print during the enlarging or printing process. See Fig. 1. One technique for cropping is to "look for a picture within a picture." As an aid, cut two L-shaped pieces of cardboard about ½-inch wide (See Fig. 2) and use these to isolate the "picture within a picture" before carrying out the printing process.



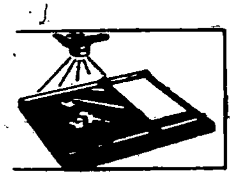
CUTTING L-SHAPES
Fig. 2

Carefully adjust the L-shapes to frame the exact section you want to enlarge. Then outline this area with a pencil.



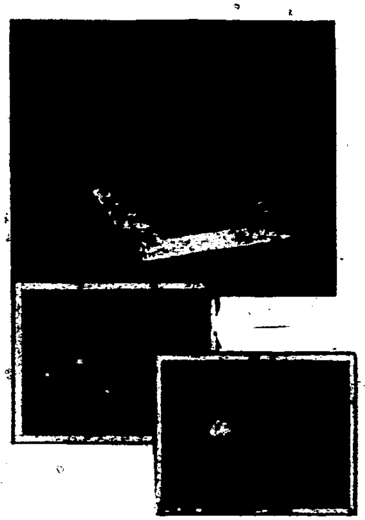
FINDING THE "PICTURE WITHIN A PICTURE"
Fig. 3

After you have decided on the print size, make the finished exposure and use the enlarging easel to frame the outlined area and consequent final print. (See Fig. 4)



FINAL PRINT
Fig. 4

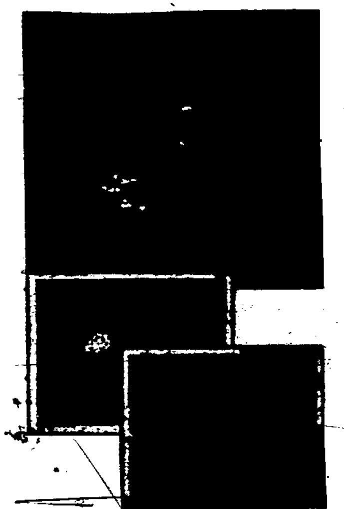
Cardboard Disc with Wire Handle



DODGING
Fig. 5

<u>Dodging</u>. A portion of a print may be too dark, such as that of the child on the left in Fig. 5. This area can be lightend during printing and the technique for this kind of lightening is called <u>dodging</u>. When making an enlargement you can lighten any part of the print by using a small cardboard disc on a wire handle (You can also use your hand instead of the disc, if the area to be "dodged" is large enough). During part of the exposure time, place the disc (hand) so that it casts a <u>shadow on the area you want lighter</u>. Since the shaded part of the picture gets less exposure to the enlarger light, it prints lighter. You can move the disc (hand) continuously to avoid sharp edges. The result should look like the child on the right in Fig. 5, who appears brighter than the steps in the background.

Burning-In. Burning-in is the opposite of dodging (lightening). If an area of a print is too light, it can be improved to bring out more detail by making the area darker. Fig. 6 shows the child on the left to be lighter than the background steps. Cut a hole in a sheet of cardboard. During part of the exposure time, hold the cardboard between the lamp and the easel so that light shines through hole onto the area you want darker. This gives the area more exposure, and it results in a darker print over that area. Move the cardboard continuously in small circular movements to avoid sharp edges. The result will be like the darker child on the right in Fig. 6.



BURNING-IN
Fig. 6.

Evaluation. You will be given a negative by your teacher, from which you are to make at least two (2) enlargements and one (1) straight contact print. Then crop, dodge, and burn-in as you feel inclined. Turn in the three prints (2 enlargements and 1 straight contact) to your teacher for evaluation. Also turn in some prints from the same negative showing cropping, dodging, and burning-in.

Now that you have developed a proficiency in photographic skills and a working knowledge of cameras you will likely enjoy very much the many popular newstand magazines like "Popular Photography", Ziff-Davis Publishers, New York, New York.