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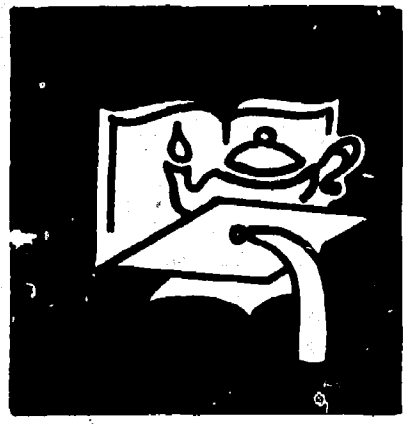
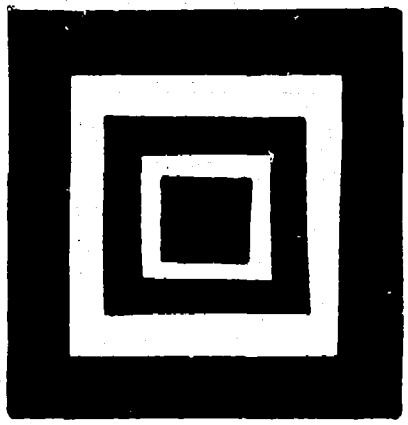
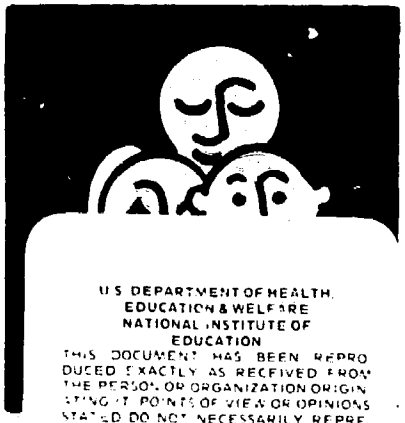
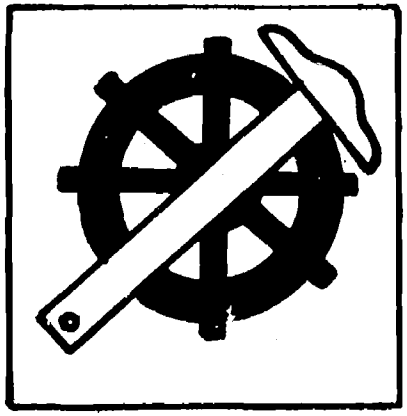
ABSTRACT

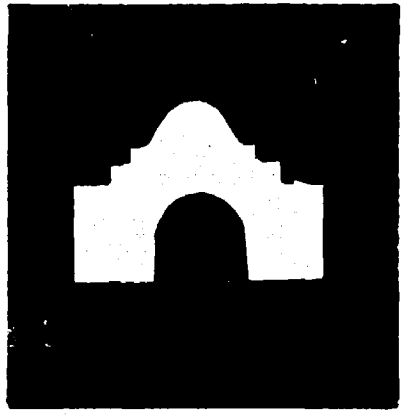
The guide provides both subject matter and career preparation assistance for physics teachers. It is arranged in vertical columns relating curriculum concepts in physics to curriculum performance objectives, career concepts and career performance objectives, suggested teaching methods, and resource materials. Career information is included on 46 physics-related occupations. Space is provided for teacher's notes which will be useful when the guide is revised. The appendix includes useful formulas, audio-visual source information, career source information, selected references, and periodicals for career information. (EA)

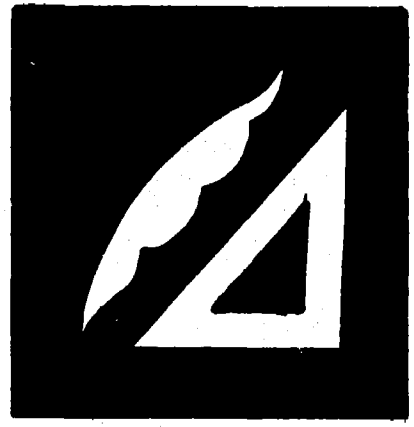












Career - Curriculum Guide

CAREER EDUCATION CENTER

HARLANDALE INDEPENDENT SCHOOL DISTRICT
3706 ROOSEVELT
SAN ANTONIO, TEXAS 78214

PHYSICS 1

CAREER EDUCATION CENTER

MR. CHARLES N. BOGGESS, SUPERINTENDENT

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SAN ANTONIO, TEXAS

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CURRICULUM GUIDE

PHYSICS I

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A C K N O W L E D G E M E N T S

Appreciation is expressed to the following teachers who contributed to the research and development of this curriculum guide.

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FOREWORD

"...a book cannot tell you how to be creative. It may cause you to see something differently, or to do something you have not done before, or to understand better what you have been doing all along. At best, a book can only start you off on a way of your own and be a resource to you as you go ahead. It can do little, compared to what you yourself must do."

--Evelyn Wenzel

from "The Come-Alive Classroom" by Cook, Caldwell & Christensen

Dear Teacher:

This curriculum guide has been prepared to help you as you endeavor to fulfill your teaching responsibilities. Please feel free, as you use it, to add your comments, suggestions and constructive criticism in the appropriate column as these will be needed when the guide is revised at the end of the school year. Also any additional resource materials which you think would be beneficial and should be included can be added at your discretion. If I can be of any assistance during the school year, please feel free to contact me at any time.

Mr. Angelo Russo
Science Consultant
Career Education Center
924-8272 or 922-3841

Preface

Meaningful existence is the goal of life in today's world. Living takes on meaning when it produces a sense of self-satisfaction. The primary task of education must be to provide each individual with skills necessary to reach his goal.

When children enter school, they bring with them natural inquisitiveness concerning the world around them. Normal curiosity can be the nucleus which links reality to formal training if it is properly developed. A sense of continuity must be established which places education in the correct perspective. Communities must become classrooms and teachers resource persons. Skills such as listening, problem solving, following directions, independent thinking and rational judgement then can merge into daily living procedures.

In classrooms especially designed to form a bridge between school and the world of work, experiences must be developed. On campus performance in job tasks and skills, following a planned sequence of onsite visitation, will fuse information into reality. Practical relationships developed with those outside the formal school setting will provide an invaluable carry-over of learned skills.

Search for a rewarding life vocation is never easy. Without preparation it becomes a game of chance. With a deliberate, sequential, and planned program of development, decisions can be made based upon informed and educated judgements.

A full range career education program, K-12, will offer opportunities for participants to enter employment immediately upon completion of training, post secondary vocational-technical education, and/or a four-year college career preparatory program.

C. N. Boggess

C. N. Boggess, Superintendent
Harlandale Independent School District

The Career Education Project has been conducted in compliance with the Civil Rights Act of 1964 and is funded by a grant from the U. S. Office of Education and the Texas Education Agency.

Philosophy

It is becoming increasingly apparent that a thorough familiarity with basic scientific principles is necessary to live as an informed citizen in today's highly technological society and those who lack this understanding and appreciation will no doubt contribute little to future scientific progress. One of our primary objectives is to provide all students with not only knowledge in the conceptual domain but also in the affective and psychomotor as well, for we believe in the total development of each child to his fullest potential.

Preparation for life must be as broad as possible so as to allow the individual to possess the necessary information upon which to base his life's decisions. A critical decision, and one not to be taken lightly, is the selection of a life's work. We are attempting, for the first time, to provide not only subject matter preparation but career preparation as well. To be well-versed in a subject and know little about it's usefulness, application and significance is to be ill-equipped for modern living.

Hopefully as the students climb our conceptual ladder in the academic realm they will simultaneously be preparing themselves for a specific career or occupation. Upon graduation from the high school, a clear and definite plan for future endeavors will have already been formulated and the means for the fulfillment of those plans will be evident. Whether they are going to college, a technical school or directly entering the world of work, success will be virtually assured.

The textbook adopted by the Harlandale Independent School District is entitled Modern Physics by Dull, Metcalfe, and Williams. Two laboratory manuals are used in conjunction with the text. One is entitled Laboratory Experiments in Physics by Williams, Metcalfe, Trinklein, and Lefler; the other is entitled Scientific Experiments in Physics by Robert L. Lehrman.

PHYSICS

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
INTRODUCTION -definition of physics -brief history of physics -noted physicists of the past and present	The student should be able to: 1. State orally, to the satisfaction of the teacher, an acceptable definition of physics. 2. Name at least three ancient beliefs which have been proven false by the science of physics. 3. List at least five noted physicists of the past and give the contribution of each one. 4. Write a brief paragraph discussing the importance of physics today.	CONCEPT: There are many occupations in the area of physics for those who have the interest and ability. OBJECTIVE: The student should be able to list at least ten occupations related to the study of physics.	**PHYSICS RELATED OCCUPATIONS** 1. Mathematician 2. Navigator 3. Civil Engineer 4. Astronomer 5. Automotive Mechanic 6. Nuclear Physicist 7. Machinist 8. Architectural Designer 9. Physics Teacher 10. Biophysicist 11. Electrical Engineer 12. Radio-T.V. Service 13. Systems Engineer 14. Optical Laboratory Technician 15. Flight Engineer

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students look up a definition of physics in any source. Use their definitions as a springboard for a class discussion at the next meeting. 2. Construct a time line on the class bulletin board and place the names of noted physicists along with their major contributions in their proper sequence. A class discussion should follow. 3. Have the students compare, in a short paper, Galileo with Aristotle in their approaches to physics. 4. Show and discuss the filmstrip entitled Physics which is available from the Harlandale Audio-Visual Center. **CAREER:** 1. Have the students prepare a written report on at least one career related to the science of physics. 2. Have the students interview at least one person who is engaged in an occupation related to the study of physics.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: Mi-9 Physics CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles Encyclopedia Of Careers	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-matter and it's properties -volume, weight, mass, inertia and density -energy	The student should be able to: 1. Define matter, to the satisfaction of the teacher, and give at least ten examples. 2. Explain orally, what is meant by volume and discribe how it can be measured. 3. Differentiate correctly, in a short statement, between weight and mass. 4. List at least three examples of inertia. 5. Define accurately what is meant by energy and name at least five forms of energy.	CONCEPT: The concept of energy and matter is the primary concern of the theoretical physicist. OBJECTIVE: The student should be able to list at least two activities of a theoretical physicist.	THEORETICAL PHYSICIST 1. Almost three-fifths of all physicists are engaged in research. Some conduct research to increase scientific knowledge with little regard to its practical applications. These scientists are known as theoretical physicists. They attempt to describe in mathematical terms interactions between matter and energy. For example, they try to identify and measure the tiny particles which may exist within the nucleus of an atom or use such devices as accelerators, spectometers and lasers in studying matter or energy relationships. 2. A bachelor's degree with a major in physics in the minimum requirement for those wishing to become physicists. Graduate training is helpful for advancement into higher-level positions and a Ph.D. is generally required for responsible positions in research and development. 3. Depending on specialty and experience, graduates having the Ph.D. degree generally started at about $15,000 a year, although some were paid considerably less in 1970. 4. Opportunities for physicists are expected to be favorable through the 1970's. Rapid growth is expected in this field and many new physicists will be needed.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate the measurement of mass using an equal-arm and an inertial balance. 2. Demonstrate the determination of the volume of a solid by displacement in water. 3. Have the students perform any of the following exercises in their lab manuals entitled Laboratory Experiments in Physics: a) #1 Measuring Length b) #2 Measuring Mass c) #5 Mass Density 4. Show and discuss the film entitled Matter and Energy available from the Harlandale Audio-Visual Center. 5. Discuss and demonstrate, using available materials, the conversion of energy from one form to another. **CAREER:** 1. Invite a physics professor from a local college to class to discuss employment opportunities in this field. 2. Have interested students listen to the magnetic tape entitled Physicists which is available from the Harlandale Audio-Visual Center. 3. Have interested students write to the American Institute of Physics for further career information.	CURRICULUM: ESC REGION 20: Films: #2269 Frames of Reference #2265 Inertia HARLANDALE AUDIO-VISUAL CENTER: Film: 16-557 Matter and Energy Filmstrip: A-80 Classification of Matter CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-287 Physicists SCHOOL LIBRARY OR COUNSELOR'S OFFICE: Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Institute of Physics 335 East 45th Street New York, New York 10017	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-measurement in physics -MKS, CGS, and FPS -metric system and conversions	The student should be able to: 1. Name the five types of units that can express all physical measurements. 2. Construct a table of the three systems of measurement and give the basic units in each system. 3. When presented with ten measurements in the English system, convert them, with 90% accuracy, to the metric system.	CONCEPT: One of the fundamental aspects of physics is that of measurement. A physics technician must be thoroughly familiar with the three systems used in physics. OBJECTIVE: The student should be able to list at least two advantages or disadvantages of being a physics technician.	PHYSICS TECHNICIAN 1. The technician works along with the physicist using all the tools of the trade-slide rule, math tables, and oscilloscope instruments that measure everything from radiation to weight. Most physics technicians work in the electronics and aerospace industries as well as in telecommunications and transporation. The government, particularly in defense missile and aircraft manufacturing, is the second largest employer of technicians. 2. Education for this field may be obtained in a technical institute or it may be acquired at the same time as his training while working for a company. Direct application to establishments employing technicians may be fruitful for those wishing to enter this field. 3. Beginning salaries range from $5400 to $8,400 a year. Experienced technician's can earn as much as $11,400 annually. 4. The outlook for technician is expected to be fairly good in the near future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Discuss the three systems of measurement and illustrate each with available devices in the lab. 2. Prepare a class exhibit of graduated cylinders, beakers and flasks each filled to a marked capacity. Also display a mass of one kilogram along with other submultiples thereof. 3. Show and discuss the filmstrip entitled The Metric System available from the Harlandale Audio-Visual Center. 4. Show and discuss any of the films dealing with measurement which are available from ESC Region 20. 5. Using a spring balance, demonstrate the conversion of readings to dynes and newtons. CAREER: 1. Invite a physics technician to class to discuss his training and his work. 2. Have interested students write a report on the occupation of physics technician using the SRA Occupational Brief available from the school library or counselor's office. 3. Have interested students write to the National Council of Technical Schools for further career information.	CURRICULUM: ESC REGION 20: Films: #4794 Adventures in Science-The Size of Things #2258 Measuring Large Distances #8565 Measuring Short Distances #8571 Measurement #8263 Measurement in Physical Science #8564 Short Time Intervals HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: AA-63 The Metric System CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #312 Physics Technicians Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: National Council of Technical Schools 1507 M Street NW Washington, D.C. 20005	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-significant figures -scientific notation -scalar and vector quantities -displacement	The student should be able to: 1. List and use correctly all of the rules for adding, subtracting, multiplying, and dividing significant figures. 2. State, in a short statement, two advantages of scientific notation over ordinary notation. 3. Distinguish orally between a scalar quantity and a vector quantity. 4. Solve correctly, both graphically and by calculation, at least ten problems involving vectors.	CONCEPT: Mathematicians must have a knowledge of significant figures and scientific notation. OBJECTIVE: The student should be able to list at least two reasons why he or she would or would not choose mathematics as his life's work.	MATHEMATICIAN 1. Mathematics can be divided into two broad areas: pure mathematics and applied mathematics. Pure mathematics seeks basic truth without considering any applications of knowledge while applied mathematics uses methods to get practical results and to solve concrete problems. At one time most mathematicians were teachers. Today about 20,000 or more work for business, industry and government. Generally mathematicians provide information needed to make wise decisions. The mathematician studies a problem, analyzes it and then converts it to a mathematical model to be solved. 2. A student interested in mathematics as a career should study chemistry, physics, writing, and speech. He or she should enjoy math courses and have a logical mind capable of reasoning effectively. A master's degree is very desirable; a doctor's degree is preferred. 3. Salaries of mathematicians in business and industry are usually higher than those in other kinds of employment. The average salary in 1968 was $16,800 for those in industry. Mathematicians working for non-profit organizations earned a median salary of $18,000 a year. 4. There will probably continue to be a strong demand for mathematicians in the near future as new applications of mathematics come to light.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using data from lab exercises 1, 2, 4 and 5, illustrate the use and manipulation of significant figures. 2. Drill the students orally in the use of scientific notation. 3. Show and discuss the film entitled Change of Scale which is available from ESC Region 20. 4. Demonstrate the addition of vectors using the force table. 5. As a review exercise, handout a mimeographed sheet so the students can refamiliarize themselves with the trigonometric functions. CAREER: 1. Invite one of the math teachers to class to discuss some of the occupational opportunities in the area of mathematics. 2. Have interested students listen to the magnetic tape entitled Mathematicians which is available from the Harlandale Audio-Visual Center. 3. Have interested students write to the American Mathematical Society for further career information.	CURRICULUM: ESC REGION 20: Film: #8566 Change of Scale CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-303 Mathematicians SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #258 Mathematicians Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Mathematical Society P.O. Box 6248 Providence, Rhode Island 02904	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
FORCES -force vectors -composition of forces -resultant and equilibrant	**The student should be able to:** 1. Solve correctly, graphically and mathematically, at least ten force vector problems. 2. Define, to the satisfaction of the teacher, such terms as: a. force b. resultant force c. equilibrant force d. force vector 3. Describe, in a short paragraph, the method used to find the magnitude of three or more forces acting simultaneously on the same point.	CONCEPT: **Building contractors must be familiar with forces and how they may affect their construction.** OBJECTIVE: **The student should be able to list at least two reasons why he would or would not enjoy being a building contractor.**	BUILDING CONTRACTOR 1. The building contractor prepares to bid on a job after he has carefully studied the plans and specifications that describe the materials and construction methods for a project. If his bid is accepted, the contractor signs an agreement to complete the structure with given specifications for a certain price and usually by a specified date. The contractor then is ready to buy materials, hire labor, and contact sub-contractors for some of the work. He then plans the progress of the work and organizes time schedules for the various trade workers. 2. There are no standard educational requirements for becoming a building contractor but the prospective contractor would be wise to get as much formal education and experience as possible before starting out on his own. A young man with technical school or college training may start out as an estimator, material buyer or salesman for a construction company. 3. In general, an experienced contractor should average between $10,000 and $30,000 a year, plus a share of the profits if he is an owner. 4. The future looks bright for the building construction industry.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do laboratory exercise #6 entitled Composition of Forces in Laboratory Experiments in Physics. 2. Show and discuss any of the following films from ESC Region 20: a) Forces b) Vector Kinematics 3. Have the students do laboratory experiment #6 entitled Force Vectors in their lab manuals. (Scientific Experiment in Physics) 4. Assign, on a mimeographed handout, at least fifteen force-vector problems and have students illustrate the solution of each at the chalkboard. CAREER: 1. Invite a local building contractor to class to discuss his occupation. 2. Have interested students listen to any of the occupational tapes dealing with the construction industry which are available from the Harlandale Audio-Visual Center. 3. Have interested students write to the Associated General Contractors of America for further career information.	CURRICULUM: ESC REGION 20: Films: #8575 Forces #4712 A Million To One #8567 Vector Kinematics CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tapes: MT-327 Construction Laborer MT-327 Cement Mason MT-326 Bricklayer MT-331 Plasterers MT-331 Plumbers and Pipefitters MT-332 Roofers SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #231 Building Contractors Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Associated General Contractors of America 20th and E Streets, NW Washington, D.C. 20036	

RICULUM NCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-resolution of forces -parallel forces	The student should be able to: 1. Define, to the satisfaction of the teacher, the following terms: a. composition of forces b. resolution of forces c. moment arm d. couple e. torque f. pivot 2. Solve correctly, using force diagrams and appropriate calculations, at least ten problems involving the resolution of forces.	CONCEPT: A civil engineer is frequently concerned with the resolution of forces in his work. OBJECTIVE: The student should be able to describe, in a short paragraph, the work of a civil engineer.	CIVIL ENGINEER 1. In 1971 there were about 200,000 civil engineers working in the United States. A civil engineer usually works in one of the branches of civil engineering. These branches include structural engineering (design of large buildings, bridges, dams, and tunnels); construction engineering (actual completion of these projects); transportation engineering (the design and construction of highways, airports, railroads); hydraulics engineering (flood control, irrigation and water systems); and environmental engineering (clean water, sewage systems, soil and air pollution). 2. Anyone considering civil engineering as a career should do well in mathematics, mechanics, physics and chemistry. A high degree of intelligence, and a sense of practicality are also important. A bachelor's degree is needed for most engineering positions. Almost 40% of civil engineers go on to complete the work for a master's degree. 3. The average beginning salary for engineers with a bachelor's degree ranged between $10,000 and $11,500 in 1971. Those with a master's degree and no experience usually average about $12,000 more a year. 4. The outlook for prospective civil engineers in the immediate future is rather good.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Demonstrate and discuss the methods used in the resolution of forces.

2. Have the students do laboratory exercise #7 entitled Resolution of Forces. (Laboratory Experiments in Physics)

3. Have the students do the lab exercise entitled The Simple Crane.

4. Demonstrate parallel forces using a meter stick, spring balances and assorted masses.

5. Have the students do lab exercise #8 entitled Parallel Forces in their lab manuals. (Laboratory Experiments in Physics)

6. Handout a mimeographed sheet with at least 15 problems on it dealing with the resolution of forces. Have selected students solve them at the chalkboard.

CAREER:

1. Invite a local civil engineer to class to discuss his training and his work.

2. Have interested students listen to the recorded tapes entitled Engineering or Civil Engineer which are available from the Harlandale Audio-Visual Center.

3. Have interested students write to the American Society of Civil Engineers for further career information.

CURRICULUM:

HARLANDALE AUDIO-VISUAL CENTER:
Filmstrip: K-70 Vectors-Directed Quantities

CAREER:

HARLANDALE AUDIO-VISUAL CENTER:
Magnetic Tape: MT-295 Engineering
MT-312 Engineering Science
Cassette Tape: Cas T-54 Civil Engineer

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:
SRA Occupational Brief #2
Civil Engineer

Occupational Outlook Handbook

Dictionary Of Occupational Titles

WRITE TO:

American Society of Civil Engineers
345 East 47th Street
New York, New York 10017

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-center of gravity -friction -stable equilibrium	**The student should be able to:** **1. Explain accurately, in a short statement, what is meant by the center of gravity of an object.** **2. Describe how one can find the center of gravity of an irregularly shaped plane object.** **3. Solve correctly, at least five problems involving the center of gravity and five dealing with the coefficient of friction.** **4. Define friction and list at least three ways in which it may be helpful.**	CONCEPT: **The concepts of frictions and equilibrium are important to the highway engineer.** OBJECTIVE: **The student should be able to list at least two activities of a highway engineer.**	HIGHWAY ENGINEER 1. Approximately 16,500 engineers in the United States are employed in highway engineering. A very small number of them are women. These highway engineers plan, locate and supervise the building of highways and other related structures. Highway engineers may engage in activities which overlap those in other fields therefore a thorough knowledge of engineering is required. 2. The minimum requirement for entrance into this profession is the bachelors of science degree. This course of study usually takes four or five years depending on the college or university. Graduate degrees in this field usually mean higher salaries and positions of greater responsibility. 3. Highway engineers can expect to earn any where from $10,000 to $16,000 a year depending on the degrees attained and the number of years experience. 4. The outlook for highway engineers is especially favorable and there always seems to be positions available for capable persons in this field.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students attempt to balance a meter stick and a baseball bat and discuss the results of their attempt. 2. Using a meter stick, spring balances and masses, show how the location of the center of gravity varies the supporting forces. 3. Demonstrate the experimental method for finding the center of gravity by plumb line intersection. 4. Have the students do exercise #10 entitled the Coefficient of Friction in Laboratory Experiments in Physics. 5. Assign as a class exercise, at least ten problems dealing with friction. 6. Show and discuss the film entitled Force of Gravity or the filmstrip entitled Gravity both of which are available from the Harlandale Audio-Visual Center. CAREER: 1. Invite a highway engineer to class to discuss his work. 2. Have interested students listen to the magnetic tape entitled Engineering which is available from the Harlandale Audio-Visual Center. 3. Have interested students write to the Federal Highway Administration for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Film: 16-411 Force of Gravity Filmstrip: C-90 Gravity CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-295 Engineering SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #389 Highway Engineers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Personnel and Training Division Federal Highway Administration Washington, D.C. 20591	

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
MOTION **-definition of motion** **-speed and velocity**	**The student should be able to:** **1. Define, to the satisfaction of the teacher, what is meant by motion.** **2. Distinguish accurately between speed and velocity.** **3. Solve correctly, either graphically or mathematically, at least 10 problems dealing with speed and velocity.**	CONCEPT: **Relationship of speed and velocity to the work of an aerospace engineer** OBJECTIVE: **The student should be able to discuss, in a brief paragraph, what it would be like to an aerospace engineer.**	AEROSPACE ENGINEER **1.** The term "aerospace engineer" is a very broad one that covers a wide range of engineering specialties. It is also one of the basic engineering professions. Each engineering job requires different abilities and the kind of work an aerospace engineer does depends on what kind of company he works for. Spacecraft and missile engineers, for example, must solve different problems from those met by aircraft engineers. Specifically it is the aerodynamics engineer who is concerned with the speed, range, payload and stability of any flight system. **2.** A prospective engineer should have a great aptitude for mathematics and should enjoy solving problems. A bachelor's degree is the minimal requirement for entry into this field. Most high-level jobs in research or teaching require graduate training of varying degrees. **3.** Graduates with no experience usually start at about $9,000 a year. After five years or so of work in a speciality, the engineer can expect to earn between $9,500 and $12,000 a year. Those in supervisory positions can earn up to $20,000 a year. **4. A continuing demand for aerospace engineers in all fields is expected.**

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: **1. Show and discuss any of the following films available from ESC Region 20 or the Harlandale Audio-Visual Center:** **a) Moving With the Center of Mass** **b) Straight Line Kinematics** **c) Laws of Motion** **2. Have the students write a short paragraph on the topic "Acceleration Is a Change of a Change."** **3. As a homework assignment, have the students practice solving speed and velocity problems.** CAREER: 1. Invite an aerospace engineer to class to discuss opportunities in this field. 2. Have interested students write to the American Institute of Aeronautics and Astronautics for further career information. 3. Have interested students do a research report using the SRA Occupational Brief entitled Aerospace Engineers.	CURRICULUM: ESC REGION 20: Films: #2271 Elastic Collisions and Stored Energy #2272 Moving With the Center of Mass #2259 Straight Line Kinematics HARLANDALE AUDIO-VISUAL CENTER: Film: 16-327 Laws of Motion Filmstrip: K-65 Laws of Motion CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: Types of Engineering SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #201 Aerospace Engineers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, New York 10019	

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-uniformly accelerated motion -Newton's law of motion -momentum	The student should be able to: 1. Describe, in a short statement, what is meant by uniformly accelerated motion and explain why a unit of time is used twice in a unit of acceleration. 2. State accurately, each of Newton's laws of motion and write the equation which expresses the relationship of force to mass and acceleration. 3. Solve correctly, at least 10 problems involving accelerated or decelerated motion. 4. Define correctly what is meant by momentum.	CONCEPT: Relationship of motion and momentum to the work of a flight engineer OBJECTIVE: The student should be able to describe, briefly but accurately, the work of a flight engineer.	FLIGHT ENGINEER 1. A flight engineer keeps track of more than one hundred instrument dials in the plane cockpit, performs pre-take off inspections and helps the pilots in providing hazard-free transportation. When the flight is over, the engineer insures that the mechanics correct any problems that arose during the trip. Then he makes a post flight inspection, turns in his log, and checks for his next assignment. 2. Most scheduled airlines prefer their flight engineers to have a commercial pilot's license. They must, in addition, be certified by the FAA and must pass a rigid physical examination every year. Flight engineers must have a high school education; young men with two or more years of college are preferred. 3. Flight engineers can expect to earn about $700 - $800 a month to start. The salary figures can climb to as high as $3,150 a month as qualifications and experience increase. The average earnings for a flight engineer in 1969 was about $22,000 a year. 4. The airline industry anticipates a shortage of flight crew members in the near future. Those who are interested and willing to work hard to qualify will find a variety of openings available.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Beginning with definitions of velocity, displacement and acceleration, write the mathematical concepts and derive the various relationships. Emphasize the more important and most used equations that result and apply these equations to falling bodies.

2. Demonstrate Galileo's experiment involving uniform acceleration using a long inclined plane.

3. Have the students do any of the following experiments:

   a) Air Track For a Constant Velocity
   b) Air Track For Acceleration
   c) Turntable Timer for "g"
   d) Pendulum Timer for "g"

4. Have the students do any of the following lab exercises in their lab manuals: (Laboratory Experiments in Physics)

   a) #11 - Momentum
   b) #12 - Acceleration
   c) #14 - The Pendulum

5. Demonstrate the law of conservation of momentum using:

   a) a dart gun and suspended block
   b) a two-dimensional air table

CAREER:

1. Invite a local flight engineer to class to discuss his occupation.

2. Have interested students interview a flight engineer at the local airport and write a report on their findings.

3. Have interested students listen to the tape entitled Flight Engineer which is available from the Harlandale Audio-Visual Center.

CURRICULUM:

ESC REGION 20:
Films: #2298 Angular Momentum-A Vector Quantity
#8578 Collisions of Hard Spheres
#2266 Free Fall and Projectile Motion-Falling Bodies
#8576 Inertial Mass

HARLANDALE AUDIO-VISUAL CENTER:
Film: 16-69 Galileo's Laws of Falling Bodies
Filmstrips: K-64 Conservation of Momentum
C-100 Newton's Laws of Motion

CAREER:

HARLANDALE AUDIO-VISUAL CENTER:
Magnetic Tape: Flight Engineer

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:
SRA Occupational Brief #305
Flight Engineers

Occupational Outlook Handbook

WRITE TO:

Federal Aviation Administration
800 Independence Avenue SW
Washington, D.C. 20590

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-unbalanced forces -universal gravitation -circular and rotary motion -centripetal force -simple harmonic motion	The student should be able to: 1. List the two factors on which the magnitude of gravitational attraction depends. 2. Define, briefly but accurately, the following terms: a. circular motion b. centripetal force c. rotary motion d. orbiting velocity e. escape velocity f. displacement g. amplitude h. period i. frequency 3. Solve correctly, at least fifteen problems dealing with centripetal force and simple harmonic motion.	CONCEPT: Gravity in terms of g-forces is experienced frequently by test pilots. OBJECTIVE: The student should be able to list two reasons why he would or would not like to become a test pilot.	TEST PILOT 1. Although there are not many test pilots, their job is a very critical one. All airplane manufacturers employ several highly competent men to test new planes. They combine their engineering background with their ability to fly in testing new models of planes to make sure they perform as expected. 2. All pilots and copilots must be licensed by the FAA before they can do any commercial flying. An applicant who is 18 years old and has 200 hours of flying time can apply for a commercial airplane pilot's license. With this license and a strong engineering background, a test pilot will have little difficulty finding a position. 3. Salaries of pilots and copilots average about $25,000 a year in domestic organizations and $29,000 a year in international operations. Salaries for test pilots vary according to training and experience. 4. The outlook for this field is favorable and all signs point to increased expansion of the airline industry.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Describe and discuss the Cavendish experiment. 2. Photograph a bouncing tennis ball using a stroboscope. 3. Show and discuss the film entitled Laws of Motions which is available from Encyclopedia Britannica Films, Inc. 4. Have the students perform lab experiment #13 entitled Centripetal Force in Laboratory Experiments in Physics. 5. Demonstrate and discuss gyroscopic motion using a bicycle wheel and rotating stool. 6. Show and discuss the film entitled Periodic Motion available from ESC Region 20. CAREER: 1. Invite a pilot to class to discuss his training and his his work. 2. Have interested students interview a pilot at the airport and write a report on their findings. 3. Have interested students listen to the tapes about this occupation which are available from the Harlandale Audio-Visual Center.	CURRICULUM: ESC REGION 20: Films: #4708 Apollo Re-entry Simulation #8531 Apollo in Perspective #2267 Deflecting Forces #8577 Elliptic Orbits #2268 Periodic Motion #2270 Universal Gravitation HARLANDALE AUDIO-VISUAL CENTER: Film: 16-411 Force of Gravity Filmstrip: C-90 Gravity CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: Pilots-Copilots Cassette Tape: Cas T-39 Commercial Pilot SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #31 Airline Pilots Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Air Line Pilots Association International 1329 E Street NW Washington, D.C. 20004	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
WORK, POWER AND MACHINES -meaning of work -formula for determining work W=Fs -units of work;	The student should be able to: 1. Define accurately what a physicist means when he uses the term work. 2. Solve correctly at least 10 work problems assigned by the teacher. 3. Name the units in both the metric system and the English system which are used to express the magnitude of work done.	CONCEPT: Power trucks are used a great deal in industry to reduce and speed up work. OBJECTIVE: The student should be able to write a brief paragraph describing the work of a power truck operator.	POWER TRUCK OPERATOR 1. A power truck is a small-wheeled vehicle which runs on large storage batteries or a gasoline engine and carries heavy loads for short distances. A major advantage is that a stack of boxes or other items can be moved from place to place without having to be loaded and unloaded each time. This is because of platforms called pallets on which the load is placed. One of the largest employers of power truck operators is the metals industry but the qualified operator can work in just about any kind of plant, factory or warehouse. 2. The two primary qualifications of a power truck operator are coordination and the ability to judge distance. The standard procedure for learning to be a power truck operator is through on-the-job training. 3. Salaries of power truck operators vary not only according to the kind of company but also according to it's location. Among union workers the average salary appeared to be $2.50 to $3.00 an hour. 4. Chances for finding work in this occupation appear to be good throughout the next ten years. Advancement is limited in this occupation and only those with the necessary educational requirements will be offered promotions.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using a spring balance, lift a wood block from the floor. Then pull the block horizontally on the surface of a table. Compare the readings of the balance and discuss these with the class. 2. Using the chalkboard, define work, power and energy and derive the equations for all three of these concepts. 3. Show and discuss the film entitled Energy and Work which is available from the ESC Region 20. 4. Handout a mimeographed sheet of problems dealing with work. As students solve these, have them placed on the blackboard along with an explanation of the solution. CAREER: 1. Invite a power truck operator to class to talk about his job. 2. Have interested students read SRA Occupational Brief #344 entitled Power Truck Operator. 3. Have interested students write to the Material Handling Institute for further career information.	CURRICULUM: ESC REGION 20: Film: #2273 Energy and Work CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #344 Power Truck Operator Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: The Material Handling Institute, Incorporated 250 Gateway Towers Pittsburgh, Pennsylvania 15222	

RICULUM NCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-definition of power -units of power -potential and kinetic energy P.E. = mgh KE = $\frac{1}{2}$ mv^2	The student should be able to: 1. Define orally what is meant by power and give the units used to express it in all three measurement systems. 2. Solve correctly, at least ten problems involving power, kilowatts and horsepower. 3. Distinguish clearly, in a short statement, between potential energy and kinetic energy. 4. Solve correctly, at least five problems dealing with both potential energy and kinetic energy.	CONCEPT: Modern power plants employ many stationary engineers to insure their safe and efficient operation. OBJECTIVE: The student should be able to list at least three duties or responsibilities of a stationary engineer.	STATIONARY ENGINEER 1. In 1970, about 200,000 stationary engineers were employed in power stations, factories, breweries, steel mills and a variety of other establishments. Stationary engineers must detect and identify any trouble by watching and listening to machinery and by reading meters and gauges. They must regulate their machines using valves, levers, switches and other instruments and frequently repair equipment if its fails to perform. 2. Many stationary engineers start as helpers and acquire their skills informally through on-the-job training. Most establishments prefer, however, a formal apprenticeship because of the increasing complexity of many machines and systems. High school graduates are preferred by most employers and those selected usually remain an apprentice for 3 or 4 years. Many areas have licensing requirments in addition to the apprenticeship programs. 3. In 1969-70, the average earnings for stationary engineers was $4.14 an hour. Salaries ranged from $2.84 an hour in Oklahoma to $4.98 an hour in Chicago. 4. Employment in this area is expected to show little or no change through the 1970's. Nevertheless, several thousand job openings will arise annually because of the need to replace workers who retire, die or transfer to other occupations.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate a pendulum bob and engage the class in a discussion of energy transformation as the bob swings. 2. Have the students do experiment #16 entitled Conservation of Energy in Laboratory Experiments in Physics. 3. Show and discuss the film entitled Matter and Energy which is available from the Harlandale Audio-Visual Center. 4. Drill the students, using problems run off on mimeographed sheets, on the solution of problems dealing with potential energy, kinetic energy and power. CAREER: 1. Invite a stationary engineer to class to talk about his work. 2. Have interested students read the SRA Occupational Brief entitled Stationary Engineer which is available from the school library or counselor's office. 3. Have interested students write to the International Union of Operating Engineers for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Film: 16-557 Matter and Energy CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-330 Operating Engineers SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #177 Stationary Engineer Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: International Union of Operating Engineers 1125 Seventeenth Street NW Washington, D.C. 20036	

RICULUM NCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
MACHINES -use of machines -six simple machines -lever, pulley, wheel and axle, inclined plane, wedge and screw -mechanical advantage	The student should be able to: 1. List at least four functions of machines and give an example of each. 2. Name orally the six simple machines and give at least two examples of each. 3. Define and distinguish between ideal mechanical advantage and actual mechanical advantage. 4. Solve correctly at least five problems dealing with each of the six simple machines.	CONCEPT: Relationship of machines to the work of an industrial machinery repairman OBJECTIVE: The student should be able to list at least three duties or activities of an industrial machinery repairman.	INDUSTRIAL MACHINERY REPAIRMAN 1. Practically every industry has a need for machinery repairmen. Of the 175,000 repairman working in 1968, most worked in food products, chemicals, metal products, transportation, paper and textiles. Primarily the repairman's job is to keep machinery working efficiently. Often he must dismantle, inspect and replace parts as well as install new equipment when necessary. His work varies a great deal and is dependent upon the industry in which he is employed. 2. The most important attribute for this job is a curiosity about how things work as well as high degree of mechanical aptitude. The best way to qualify for a job as an industrial machinery repairman is to enter a formal apprenticeship program which usually lasts about four years. This combines classroom instruction with on-the-job training. Most employers prefer high school graduates in selecting candidates for their apprenticeship programs. 3. In 1967-68, the average hourly wages for industrial machinery repairmen ranged from $2.65 to $4.22 depending on the location and size of the plant. Almost two-thirds earned $3.40 or more an hour. 4. The outlook for this occupation should be quite favorable due to a wider use of machinery and a greater sophistication of industrial machinery.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students observe and examine the kitchen in their home and list all of the devices they find there that are applications of one or more of the machines studied in this chapter. 2. Have the students visit the auto mechanics or machine shop and examine the various devices used there for exerting large forces with little effort. 3. Have interested students create colored posters illustrating the six simple machines and display them around the room. 4. In a drill exercise, have the students practice solving problems involving the six simple machines, their mechanical advantages, and their efficiency. CAREER: 1. Invite a machinery repairman to class to discuss his work. 2. Have interested students do a research report using the SRA Occupational Brief entitled Industrial Machinery Repairman which is available from the school library or counselor's office. 3. Have interested students write to the International Association of Machinists for further career information.	CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-339 Industrial Machinery Repairman MT-337 Machinists SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #152 Industrial Machinery Repairman Occupational Outlook Handbook Dictionary Of Occupational Titles Encyclopedia Of Careers WRITE TO: International Association of Machinists 1300 Connecticut Avenue Washington, D.C. 20036	

ICULUM CEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-friction -efficiency of machines -compound machines	The student should be able to: 1. Describe briefly, in a short statement, the two ways the efficiency of a machine may be calculated. 2. Solve correctly, at least ten problems involving the efficiency of the six simple machines. 3. Name at least twenty compound machines which are commonly used at school or in the home.	CONCEPT: A millwright is a skilled worker whose chief concern is heavy machinery. OBJECTIVE: The student should be able to discuss, in a short paragraph, the occupation of millwright.	MILLWRIGHT 1. The specific duties and responsibilities of a millwright depend on the kind and size of organization he works for. Primarily he is involved with unloading and placing new machinery on a previously prepared foundation, assembling any remaining parts, and installing electric motors, shafts, and belts. He uses a great variety of tools and instruments in his work and often is involved with the dismantling, moving and reassembling of older equipment. 2. The two primary routes for entering this occupation are apprenticeship and on-the-job training. Apprenticeship programs usually are 4 years in duration and include a planned curriculum of classroom instruction as well as on-the-job training. The classroom instruction include shop mathematics, blueprint reading, hydraulics, electricity and safety. A person interested in being a millwright can apply directly to the company of his choice or to a local union which has the names of companies with apprenticeship programs. 3. The current average salary for millwrights is about $3.97 an hour plus a cost-of-living allowance. 4. More millwrights will be needed to install and maintain the new mechanized and automated equipment constantly being developed. The outlook for this occupation is quite favorable.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have the students do experiment #15 entitled Efficiency of Machines in their lab manuals. (Laboratory Experiments in Physics) 2. Have the students practice solving work problems involving friction at the chalkboard. 3. Have the students attempt to design a basic compound machine to perform some task. A prize could be awarded to the best design. CAREER: 1. Invite a local millwright to class to discuss his training and his occupation. 2. Have interested students listen to the tape entitled Millwrights which is available from the Harlandale Audio-Visual Center. 3. Have interested students write to the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America for further career information.	CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-341 Millwrights SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #222 Millwrights Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: International Union, United Automobile, Aerospace and Agricultural Implement Workers of America 8000 East Jefferson Detroit, Michigan 48214	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-gears and wheels -differential pulleys -cams	The student should be able to: 1. List at least five machines whose proper operation is dependent on gears. 2. Solve correctly at least ten problems dealing with gears. 3. Define, briefly but accurately, the following terms: a. cam b. differential pulley c. worm wheel d. reciprocating motion 4. Draw a diagram illustrating how a cam changes rotary motion into reciprocating motion.	CONCEPT: Gears, wheels, differential pulleys and cams all are in the domain of the automotive mechanic. OBJECTIVE: The student should be able to list at least two advantages and two disadvantages of being an automotive mechanic.	AUTOMOTIVE MECHANIC 1. Automotive mechanics overhaul and repair engines, correct transmission troubles, perform brake service, repair frames and axles, remedy electrical failures and perform other duties as required. Experienced mechanics may also be called upon to estimate the cost of repair jobs for customers and make out bills listing charges for the work involved. 2. It is advisable to have at least two years of regular high school before entering a technical school for training. The most common way to learn this trade is through on-the-job training but many learn the trade through apprenticeship programs. Most mechanics get jobs by applying directly to the employer or by answering newspaper advertisements. 3. In 1968, the average salary earned by mechanics working for automobile dealers was between $3.45 and $4.60 an hour. The highest paid mechanics are the automatic transmission specialists and frame men. A specialist can earn up to $14,000 a year or more. 4. About 9,000 new auto mechanics are needed each year to replace those who leave the occupation. The outlook is for a steady increase in the number of mechanics being hired.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
URRICULUM: • Have the students collect and bring in as many assorted cams, gears and wheels as possible for a class display. • Have the students practice solving problems, at the chalkboard dealing with gears and gear ratios. • Have interested students compete in a poster contest to see who can create the most original one concerning machines. CAREER: 1. Have interested students interview an auto mechanic and write a brief description of what they learned. 2. Have interested students listen to either of the tapes dealing with this occupation which are available from the Harlandale Audio-Visual Center. 3. Have interested students write to the Automobile Manufacturers Association for further career information.	CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tapes: Auto Body Repairman Auto Mechanics Cassette Tape: Cas T-49 Auto Mechanic SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #85 Automotive Mechanics Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Automobile Manufacturers Association, Incorporated 320 New Center Building Detroit, Michigan 48202	

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-kinetic theory -solids -cohesion and adhesion -tensile strength -stress and strain	The student should be able to: 1. List in writing, the three basic aspects of the kinetic theory of matter. 2. Solve correctly at least five problems involving mass density and weight density. 3. Define correctly, in a short statement, the following terms: a. cohesion b. adhesion c. tensile strength d. ductility e. malleability f. elastricity 4. Solve correctly at least ten problems dealing with tensile strength, stress and strain.	CONCEPT: Tensile strength, ductility, and malleability are some of the concepts which are important to the metallurgical engineer. OBJECTIVE: The student should be able to list at least two reasons why he or she would or would not like to be a metallurgical engineer.	METALLURGICAL ENGINEER 1. Metallurgical engineers engage in a wide range of activities from attempting to develop a method of separating a metal from an ore to analyzing some weakness in a metal. The kind of work they do depends upon whether they are in research, in production or in the sales aspect of the organization and they may work in a plant, in an office or in a laboratory. 2. A college degree is the minimum requirement for becoming a metallurgical engineer. with graduate training becoming increasingly important. Basic courses in mathematics, chemistry, physics, mechanics and English are an integral part of the college program. Although about 800 metallurgical engineers graduate every year, the industry needs four times that number. 3. Salaries for metallurgical engineers average any where from $9,900 to $11,300 depending on education and experience. 4. Employment in this branch of engineering is expected to grow rapidly through the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate molecular motion with the aid of a molecular vibration tube. 2. Demonstrate and discuss the melting points of solids. 3. Have the students do experiment #17 entitled The Size of a Molecule in Laboratory Experiments in Physics. 4. Using polished glass plates, demonstrate and discuss cohesion and adhesion. 5. Have the students do experiment #20 entitled Hooke's Law in their lab manuals. (Laboratory Experiments in Physics) 6. Have the students solve several problems dealing with density and elasticity. CAREER: 1. Invite a metallurgical engineer to class to discuss his occupation. 2. Have interested students do a research report on this occupation using the SRA Occupational Brief entitled Metallurgical Engineers. 3. Have interested students write to the Metallurgical Society of AIME for further career information.	CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #206 Metallurgical Engineer Occupational Outlook Handbook Dictionary Of Occupational Titles Encyclopedia Of Careers WRITE TO: The Metallurgical Society of AIME 345 East 47th Street New York, New York 10017	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-liquids -cohesion and adhesion -surface tension -capillarity -Pascal's principle -hydraulics -buoyancy	The student should be able to: 1. Define accurately the following terms: a. liquid b. cohesion c. adhesion d. surfaces tension e. capillarity f. buoyancy g. specific gravity 2. State correctly, Pascal's law; Archimedes principle. 3. List at least two devices which are used to measure liquid pressure. 4. Solve correctly, at least 15 problems dealing with liquids and liquid pressure.	CONCEPT: Relationship of liquids and pressure to the work of ship designer OBJECTIVE: The student should be able to list at least three activities of ship designer.	SHIP DESIGNER 1. There are now more than 11,000 ship designers in the United States. The designer draws up plans for a new ship making certain that the design contains living accommodations and space for equipment, fuel and cargo. The hull must be able to move easily through the water and it must be sturdy enough to stand up to the blows of huge waves. Also it must be designed to operate economically. Two kinds of specialists engage in this complicated occupation - the naval architect and the marine engineer. 2. There are only four schools in the United States accredited to award degrees in this field. Subjects included in the curriculum are physics, hydraulics, materials testing, metallurgy and electrical theory, and advanced mathematics. The beginning naval architect or marine engineer usually does such things as drawing layouts and making calculations. As he gains experience, he is given more responsibility. 3. Salaries for ship designers begin at about $7,200 and may go as high as $20,000 a year. Top-level workers sometimes earn as high as $25,000 annually. 4. The future looks bright for those contemplating ship building as a career.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Using available laboratory equipment, demonstrate and explain Brownian motion, surface tension and capillarity. 2. Show and discuss the film entitled Buoyancy which is available from the ESC Region 20. 3. Show and discuss the filmstrip entitled Archimedes Principle which is available from the Harlandale Audio-Visual Center. 4. Have the students practice solving in class several problems dealing with the mechanics of liquids. CAREER: 1. Have interested students read the SRA Occupational Brief entitled Ship Designers which is available from the school library or counselor's office. 2. Have interested students write to the American Society of Naval Engineers for further career information.	CURRICULUM: ESC REGION 20: Films: #8032 Boats-Buoyancy, Stability, Propulsion #8679 Buoyancy HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: 16-10 Archimedes' Principle CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #259 Ship Designers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Society of Naval Engineers 1012 Fourteenth Street, NW Washington, D.C. 20005	

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-gases -ideal gas -standard temperature and pressure -atmospheric pressure -mercurial and aneroid barometers -Boyle's law	The student should be able to: 1. Use correctly, in a sentence, the following terms: a. ideal gas b. S.T.P. c. air pressure 2. Solve correctly, at least ten problems involving gases and air pressure. 3. Compare, in a short paragraph, an aneroid barometer with mercurial barometer. 4. State correctly, Boyle's law.	CONCEPT: Atmospheric pressure is an important concept for the meteorologist. OBJECTIVE: The student should be able to list at least three reasons why he or she would or would not consider meteorology as a career.	METEOROLOGIST 1. The meteorologist interprets atmospheric conditions to forecast immediate and long range changes in weather. He analyzes charts and data, such as barometric pressure, temperature, humidity, wind velocity, and areas of precipitation, to make forecasts. The meteorologist also conducts research into long range forecasting, severe weather phenomena, solar heating, and other problems as well as predicts movements of fronts, precipitation, and pressure areas. 2. The minimum requirement is a four-year course leading to a bachelor's degree in meteorology. Graduate training is usually necessary for positions other than beginning analyses and forecasting. Many colleges and universities offer full course in meteorology. A complete list can be obtained from the American Meteorological Society. 3. Salaries for meteorologists ranged from $6,387 to $25,000 depending on education and experience. The median salary for all meteorologists in 1966 was $11,700 annually. 4. This is a growing field and opportunities are presently increasing.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: • Discuss and demonstrate mercurial and aneroid barometers to the class. • Perform a demonstration experiment of Boyle's law and have the class record the data and graph the results. • Show and discuss the film entitled Behavior of Gases which is available from ESC Region 20. • Have students practice solving gas problems until proficiency is reached. • Show and discuss the film entitled The Law of Gases which is available from the Harlandale Audio-Visual Center.	CURRICULUM: ESC REGION 20: Film: #8570 Behavior of Gases HARLANDALE AUDIO-VISUAL CENTER: Film: 16-92 The Law of Gases CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-305 Meteorologists SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #256 Meteorologists Occupational Outlook Handbook Dictionary Of Occupational Titles	
CAREER: 1. Invite a local weatherman to class to talk about his job. 2. Have interested students go to the local TV station and interview one of the meteorologists there. 3. Have interested students read the SRA Occupational Brief entitled Meteorologists which is available from the school library or counselor's office. 4. Have interested students write to the American Meteorological Society for further career information.	WRITE TO: American Meteorological Society 45 Beacon Street Boston, Massachusetts 02108	

RICULUM NCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-fluids in motion -Bernoulli's principle and its application -airplane lift	The student should be able to: 1. Define accurately, in a short statement, the following terms: a. fluid b. lift c. drag d. viscosity 2. Explain, in his own words, why a spinning baseball travels in a slightly curved path. 3. State Bernoullis principal and list at least two applications of this principal. 4. Discuss, in a short paragraph, how lift is produced during the flight of an airplane.	CONCEPT: Relationship of Bernoullis principle to the airline industry and the occupation of airline dispatcher OBJECTIVE: The student should be able to discuss, in a short paper, the work of an airline dispatcher.	AIRLINE DISPATCHER 1. These workers are sometimes called flight superintendents and are employed primarily at large airports. They coordinate all scheduled flights of an airline and supervise these flights to be sure that all FAA and safety regulations are observed. They are also responsible for canceling flights and for changing any plans of operation. 2. Dispatchers are not hired directly. They move up slowly through the ranks. Assistant dispatcher job openings are usually filled by promoting a dispatch clerk, radio operator, or an air traffic controller. These workers can become licensed dispatchers after a period of on-the-job training. 3. Beginning dispatchers earn between $700 and $845 a month to start. After approximately ten years of service, their salaries usually range from $1,000 to $1,485 a month. 4. The airline industry is expecting increasing growth in the future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Compare viscosities by dropping a ball through various liquid media. 2. Demonstrate and discuss Bernoulli's principle using such things as a ping-pong ball in a funnel, a spool in a card, etc. 3. Show and discuss the film entitled Airplanes - Principles of Flight available from ESC Region 20. 4. Have students engage in a paper airplane contest using paper models of their own design. CAREER: 1. Invite an airline dispatcher to class to discuss his work. 2. Have interested students interview an airline dispatcher at the airport and write a report on his findings. 3. Have interested students listen to the tape entitled Airplane Dispatcher which is available from the Harlandale Audio-Visual Center.	CURRICULUM: ESC REGION 20: Film: #4010 Airplanes-Principles of Flight CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-347 Airplane Dispatcher SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #266 Airline Dispatcher Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Air Line Dispatchers Association 929 West Broad Street Falls Church, Virginia 22046	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-thermal expansion -heat and temperature -linear coefficient of expansion -liquid and gaseous expansion -temperature scales -Charle's law	The student should be able to: 1. List at least three sources of heat and give an example to illustrate each source. 2. Distinguish, in a short paragraph, between heat and temperature. 3. Solve correctly, at least ten problems dealing with heat and with the expansion of materials. 4. Convert correctly, at least 20 Fahrenheit readings to the centigrade and Kelvin scales. 5. State accurately, Charle's law and solve at least 10 problems related to it.	CONCEPT: Relationship of heat to the work of a thermodynamics physicist OBJECTIVE: The student should be able to list at least three duties or activities of a heat physicist.	HEAT PHYSICIST 1. The heat physicist conducts research into the nature and properties of heat and its conversion into energy. He performs experiments involving the measurement, development, transmission, and the effects of heat. The thermodynamics physicist studies the effects of low and high temperatures on the physical properties of matter as well as examines the relationship between the amount of heat expended and the energy involved. 2. Persons who are interested in physics as a career should have above-average intelligence, ability in mathematics and keen powers of observation. Graduate training is usually required for top-level positions in teaching and research. About one-third of all physicists have received the Ph.D. degree. 3. Salary levels for physicists range from $8,000 for those with a bachelor's degree to between $12,000 and $20,000 annually for those with the doctorate degree. 4. The outlook for physicists is excellent for the next ten years or so.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate and discuss thermal expansion with the use of thermoscopes. 2. Have the students do any of the following experiments in their lab manuals: (Laboratory Experiments in Physics) a) #22 Coefficient of Linear Expansion b) #23 Charles' Law 3. Have the students practice solving, in a class exercise, several problems dealing with temperature conversions and thermal expansion. 4. Demonstrate and discuss the relationship between pressure and absolute temperature using sealed pressure containers. 5. Show and discuss any of the following filmstrips: a) Heat and Temperature - Molecular Energy b) The New World of Low Temperature CAREER: 1. Invite a physicist from a local college to class to discuss opportunities in his field. 2. Have interested students write to the American Institute of Physics for further career information. 3. Have interested students listen to the tape entitled Physicist which is available from the Harlandale Audio-Visual Center.	CURRICULUM: ESC REGION 20: Film: #8541 Gas Pressure and Molecular Collisions HARLANDALE AUDIO-VISUAL CENTER: Filmstrips: K-53 Heat and Temperature-Molecular Energy K-52 The New World of Low Temperature CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-287 Physicist SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #75 Physicists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Institute of Physics 335 East 45th Street New York, New York 10017	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-heat capacity and specific heat -fusion -solidification -vaporization and boiling -liquefaction of gases	The student should be able to: 1. Define, briefly but accurately, the following terms: a. specific heat b. fusion c. heat capacity d. heat of fusion e. heat of vaporization f. calorie g. BTU 2. Solve correctly, at least fifteen problems dealing with specific heat, calories and BTU's. 3. Explain, in his own words, the process of distillation.	CONCEPT: High temperatures and boiling are fundamental to the work of a chemical engineer. OBJECTIVE: The student should be able to list at least three activities of a chemical engineer.	CHEMICAL ENGINEER 1. A chemical engineer designs chemical-plant equipment and devises manufacturing processes for products such as gasoline, synthetic rubber, plastics, detergents, cement, paper and many others. He plans the layout of the equipment and oversees workers engaged in constructing and improving it. He also determines the most effective arrangement of operations and supervises subordinates. 2. Most positions in this occupation expect a person to have at least a bachelor's degree in engineering. A master's degree is preferable as well as such personal qualities as good judgement, determination and the ability to work well with others. 3. Salaries for chemical engineers with a bachelor's degree were about 9,970 in 1970. Graduates with a master's degree and no experience started at about $12,000 while those with doctorates began at about $15,000 a year. 4. Opportunities for chemical engineers should be favorable throughout the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate the specific heats of various substances via the melting of paraffin. 2. Show and discuss either the film entitled The Nature of Heat or the filmstrip entitled How We Measure Heat both of which are available from the Harlandale Audio-Visual Center. 3. Have the students perform any of the following experiments in their lab manuals: (Laboratory Experiments in Physics) a) #24 Specific Heat b) #26 Heat of Fusion c) #28 Heat of Vaporization 4. Demonstrate evaporation rates using various liquids. 5. Have the students, in a drill type class exercise, practice solving problems involving specific heat and heat capacity. CAREER: 1. Invite a chemical engineer to class to talk about his work. 2. Have interested students read the SRA Occupational Brief entitled Chemical Engineer which is available from the school library or counselor's office. 3. Have interested students write to the American Chemical Society for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Film: 16-107 The Nature of Heat Filmstrip: K-51 How We Measure Heat CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief Chemical Engineer Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Chemical Society 1155 Sixteenth Street, N.W. Washington, D.C. 20006	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-heat and work -laws of thermodynamics -gas turbines, jet engines and rockets -heat pump	The student should be able to: 1. Solve correctly at least ten problems involving the interconversion of heat and work. 2. State correctly the first and second laws of thermodynamics. 3. Define or discuss, in a short statement, each of the following terms: a. turbojet b. turbine c. rocket d. internal combustion engine e. external combustion engine 4. Describe, in a brief paper, how a heat pump works.	CONCEPT: Relationship of jet engines and turbines to the work of a jet mechanic OBJECTIVE: The student should be able to discuss, in a brief paper, the work of a jet mechanic.	JET MECHANIC 1. A jet engine mechanic is either an "airframe mechanic" (works on the plane's fuselage, landing gear, and control surfaces such as the rudder and ailerons) or a "powerplant mechanic (works on the plane's engine). The powerplant mechanic examines the engine, makes necessary adjustments or installs new parts. On occasion, he may replace an entire engine. 2. One can enter this trade by beginning as a trainee or apprentice or by graduating from an FAA approved mechanics school. Most of these schools have 18-24 month programs. After graduation one must have at least 18 months experience before qualifying for the necessary license. 3. Mechanics working for scheduled domestic and international airlines averaged between $800 and $1,100 a month in 1970. 4. The number of aircraft mechanics working for scheduled airlines is expected to increase rapidly through the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have a class discussion dealing with the interrelationship between heat energy and mechanical energy. Present the equation for the conversion from heat to work. 2. Demonstrate a steam engine and develop the laws of thermodynamics around this engine. 3. Show and discuss the filmstrip entitled Distributing Heat and Energy available from the Harlandale Audio-Visual Center. 4. Have the students prepare a written research report on the general nature of entropy. 5. Have the students practice solving problems involving thermodynamics as assigned by the teacher. CAREER: 1. Invite a jet mechanic to class to discuss his training and his work. 2. Have interested students listen to the tape entitled Aircraft Mechanic which is available from the Harlandale Audio-Visual Center. 3. Have interested students go to the airport and interview an airplane mechanic. 4. Have interested students write to the Air Transport Association for further career information.	CURRICULUM: ESC REGION 20: Film: #8537 Gemini Rendezvous Missions #8526 Gemini-The Twins #2172 Science in Space HARLANDALE AUDIO-VISUAL CENTER: Filmstrips: C-24 Fuels and Heat C-22 Distributing Heat and Energy CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-347 Aircraft Mechanic SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #151 Airplane Mechanics Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Air Transport Association of America 1300 Connecticut Avenue, NW Washington, D.C. 20036	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
WAVE MOTION AND SOUND -transverse and longitudinal waves -wave characteristics -sound transmission -speed of sound	The student should be able to: 1. Distinguish, in a short paragraph, between transverse and longitudinal waves. 2. Define accurately, in a short statement, each of the following terms: a. amplitude b. compression c. frequency d. rarefaction e. wavelength f. crest g. trough 3. Solve correctly, at least 15 problems dealing with the frequency and speed of sound.	CONCEPT: The concept of sound, its production and transmission, is an integral part of the work of a disc jockey. OBJECTIVE: The student should be able to list at least two advantages and two disadvantages of being a disc jockey.	DISC JOCKEY 1. Disc jockeys do much more than sit and play records. Usually they will read commercials, interview celebrities, complete a program log (a list of records and commericals he has played) and prepare for the next day's program. Disc jockey's who work for small stations may also go out and sell air time to advertisers, write commericals, edit news reports and answer letters from listeners. 2. This occupation requires persons who are quick-witted, agreeable and have the ability to hold an audience's interest. It is becoming difficult nowadays to get a job as a disc jockey without a degree. A number of colleges offer programs in this field. It is also desirable to have a FCC radio operator's license. 3. The salary of disc jockey's depends on his experience as well as the size of the radio station. Established disc jockeys in larger cities usually earn from $600 to $900 a week, some earn as much as $75,000 to $10,000 or more a year. 4. The prospects for disc jockeys in broadcasting will continue to be favorable in the near future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate and discuss wave characteristics using a ripple tank and a slinky spring. 2. Show and discuss the filmstrip entitled Wave Motion - A Key to Modern Science which is available from the Harlandale Audio-Visual Center. 3. Have the students perform laboratory experiment #29 entitled Speed of Sound in Laboratory Experiments in Physics. 4. Demonstrate the Kundt tube experiment. 5. Assign at least 15 problems on waves and the velocity of sound. Have the students show their solutions on the chalkboard. 6. Using available film loops, show and discuss interference of waves. CAREER: 1. Invite a local disc jockey to class to discuss his training and his work. 2. Have interested students go to a local radio station to interview a disc jockey there. 3. Have interested students listen to the tape entitled Radio-TV Announcer which is available from the Harlandale Audio-Visual Center.	CURRICULUM: ESC REGION 20: Films: #2264 Simple Waves #4836 Sounds and How They Travel #6011 Sound Waves in Air #3669 Vibrations HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: K-66 Wave Motion-A Key to Modern Science CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-349 Radio-TV Announcer Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Society of Disc Jockeys 448 West 51st St. New York, New York 10019	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-intensity and loudness -decibels -the ear as a receiver	The student should be able to: 1. Describe, in a short statement, the distinction between the intensity and loudness of sound. 2. Label correctly, a schematic diagram of the ear and list the function of each part. 3. State orally the difference between frequency and pitch.	CONCEPT: Sound intensity and loudness are important to the speech and hearing clinician. OBJECTIVE: The student should be able to list at least two reasons why he or she would or would not like to be a speech and hearing clinician.	SPEECH AND HEARING CLINICIAN 1. Today there are about 18,000 speech and hearing clinicians in the United States. Speech and language therapy is closely related to hearing therapy since the inability to hear sounds correctly is often responsible for speech problems. The exact duties of the clinician vary with the problem at hand and after investigating the particular situation, he will lay out a plan of therapy. 2. Patience is essential in this occupation as treatment and progress sometimes move slowly. A bachelor's degree is required in this field and graduate training is desirable. Certification in speech pathology and audiology can be granted from the American Speech and Hearing Association after meeting established standards. 3. The average salary in schools in 1968 was approximately $8,900 a year. In colleges and universities the median salaries ranged from $8,300 to $15,000 annually. 4. Prospects in this field are excellent as the need for clinicians for exceeds the supply.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Illustrate and discuss the production of sound via tuning forks, strings, hacksaw blade, etc. 2. Show and discuss either of the following films which are available from the Harlandale Audio-Visual Center: a) Sound Waves and Their Sources b) The Ears and Hearing 3. Assign at least ten problems involving sound intensity and have selected students show and explain their solutions at the blackboard. CAREER: 1. Invite a local speech and hearing clinician to class to discuss his or her work. 2. Have interested students interview the speech and hearing clinician employed by the school district. 3. Have interested students write to the American Speech and Hearing Association for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Films: 16-149 Sound Waves and Their Sources 16-182 The Ears and Hearing CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-300 Speech Pathologist and Audiologist SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #148 Speech and Hearing Clinicians Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Speech and Hearing Association 9030 Old Georgetown Road Washington, D.C. 20014	

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-Doppler effect -inaudible sounds -resonance and interference	The student should be able to: 1. Explain orally what is meant by the Doppler effect. 2. Define accurately, in a short statement, each of the following terms: a. infrasonic b. ultrasonic c. threshold of hearing d. constructive interference e. destructive interference f. resonator 3. List all of the conditions necessary to produce resonance.	CONCEPT: Sound production and transmission are the primary concern of a sound man in communications. OBJECTIVE: The student should be able to write a brief paragraph describing the work of a sound man in broadcasting.	SOUND MAN 1. The sound man in a theatre, studio or at a radio-TV station analyzes the script and operates a sound-mixing board to control the output of voices, music and previously taped sound effect's during performances. He works with producing personnel to determine microphone placement, special sound effects, cues and the accustical characteristics of the theatre. The sound man listens to the overall effect on a monitor and makes necessary adjustments if necessary. 2. A high school diploma is the minimum requirement for jobs in the field of broadcasting and a college degree is desirable. Those beginning in small stations usually begin as assistant technicians and move to larger stations as they gain experience. A Radio-Telephone First Class Operator's License is required by any person who operates or adjusts broadcasting transmitters in radio and TV stations. 3. The average salary for technicians in this field from $9,000 to $13,000 annually depending on the size and location of the station. 4. Employment opportunities in this field are expected to remain fairly steady in the next decade.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate and discuss resonance with harmonic resonaters and a closed tube. 2. Have the students perform experiment #29 entitled Resonance in their lab manuals. (Laboratory Experiments in Physics) 3. Have the students solve assigned problems dealing with wavelength and frequency and show their solutions at the chalkboard. CAREER: 1. Invite a broadcast technician from a local TV station to come to class to discuss his occupation. 2. Have interested students read the SRA Occupational Brief entitled Broadcast Technicians which is available from the school library or counselor's office. 3. Have interested students write to the American Communications Association for further career information.	CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-349 Broadcast Technicians SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #302 Broadcast Technicians Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Communications Association One Park Row New York, New York 10038	

RRICULUM NCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-sound and music -scales -pitch	The student should be able to: 1. Distinguish clearly, in a short paragraph, between sound and music. 2. Describe or discuss briefly, in a written paper each of the following: a. diatonic scale b. chromatic scale c. tempered scale 3. State orally the difference between a physicists' idea of pitch and a musicians idea of pitch.	CONCEPT: Relationship of music and its production to the work of a music teacher OBJECTIVE: The student should be able to write a one page paper telling what it would be like to be a music teacher.	MUSIC TEACHER 1. Music teachers generally are college teachers, secondary school teachers or private teachers who conduct classes at home or in the home of their students. Methods of teaching today use highly motivational techniques such as the utilization of computers and school programs geared to introducing students to many instruments simultaneously. 2. Music teachers must satisfy the requirements for a teaching career as well as the requirements for performing such as sight reading; ability to perform from memory or by ear; understanding of musical interpretation; and participation in a performing group. In addition, a music teacher must be endowed with a great deal of patience and understanding. 3. Salaries of music teachers are determined by the salary schedule for all teachers in a particular organization. However, music teachers frequently supplement their income by giving private lessons or taking church positions. 4. The number of music teachers has been more than sufficient in recent years and will probably continue to be in the near future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Show and discuss the film entitled Discovering the Sound and Movement of Music available from ESC Region 20. 2. Have the students from band demonstrate the various musical instruments and observe the sound characteristics using a microphone and oscilloscope. CAREER: 1. Invite the school music teacher to class to discuss his or her career. 2. Have interested students listen to the tape entitled Musicians and Music Teachers which is available from the Harlandale Audio-Visual Center. 3. Have interested students write to the American Music Conference for further career information.	CURRICULUM: ESC REGION 20: Film: #8487 Discovering the Sound and Movement of Music CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: Musicians and Music Teachers SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #384 Instrumental Music Teachers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Music Conference 3505 East Kilgore Road Kalamazoo, Michigan 49002	

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-harmony and discord -fundamental tones -sound quality -string and wind instruments	The student should be able to: 1. Define, briefly but accurately, the following terms: a. major chord b. octave c. fundamental d. harmony e. first harmonic f. second harmonic g. third harmonic 2. List at least three wind instruments and three string instruments. 3. State and explain the four laws of strings.	CONCEPT: Production of musical instruments is very dependent upon the physical attributes of sound and its equality. OBJECTIVE: The student should be able to list at least two reasons why he or she would or would not enjoy working in the musical instrument manufacturing industry.	MUSICAL INSTRUMENT MANUFACTURING WORKERS 1. Factories today produce all kinds of musical instruments using production lines, special machinery and individual handwork. Procedures vary widely according to the type of instrument, the materials used or the number of components involved. A piano, for example, may have more than 9,000 parts. 2. A wide variety of jobs exists in musical instrument manufacturing and the qualifications also vary widely. Jobs are available for skilled and unskilled workers as well as for professional people who supervise others. Those best qualified for this field have good mechanical ability, a high degree of manual dexterity and some knowledge of the physics of sound. 3. Workers on the production line average about $2.50 to $3.50 an hour while those with skills earn considerably more. 4. The sale of musical instruments is expected to continue to climb upward in the 1970's thereby providing many more opportunities in this industry.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Use a sonometer to illustrate the four laws of strings. 2. Show and discuss the film entitled The Science of Musical Sounds which is available from the Harlandale Audio-Visual Center. 3. Have the students solve at least ten problems dealing with the laws of strings and sound tube production. CAREER: 1. Have interested students read the SRA Occupational Brief entitled Musical Instrument Manufacturing Workers which is available from the school library or counselor's office. 2. Have interested students write to the National Association of Music Merchants for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Film: 16-252 The Science of Musical Sounds CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #229 Musical Instrument Manufacturing Workers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: National Association of Music Merchants 222 West Adams Street Chicago, Illinois 60606	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
ILLUMINATION -sources of light -light waves -quantum theory -luminous and illuminated objects -shadows -photometry	**The student should be able to:** 1. Name the two general sources of light and give at least two examples of each. 2. List at least three properties of light waves. 3. Define, in a short statement in the following terms: a. luminous b. illuminated c. umbra d. penumbra e. relection f. refraction g. transparent h. translucent i. opaque 4. Solve correctly at least twenty problems in photometry.	CONCEPT: Relationship of the sources of light and shadows to the work of a lighting technician OBJECTIVE: **The student should be able to list at least two duties or responsibilities of a lighting technician.**	LIGHTING TECHNICIAN 1. The lighting technician positions and operates lighting equipment for television broadcasts and confers with the program director to determine the desired lighting effects. He is responsible for the proper use of spot, flood, incandescent and mercury vapor lights as well as reflectors and other equipment. Frequently he makes adjustments and repairs to his equipment and supervises or directs other technicians. 2. A good way to acquire the knowledge necessary to become a lighting technician is to attend a technical school or college-level institution providing courses in electronics. This training will be a distinct advantage for those who hope to advance to supervisory positions or more specialized jobs in large stations and networks. 3. In 1970, salaries for technicians in this field average from $154 to $270 a week depending on such factors as the size of the station and the experience of the individual. Salaries are sometimes supplemented by working overtime. 4. Only a slight increase in the number of technicians is expected in the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

URRICULUM:

- Redemonstrate ripple tank experiments to illustrate wave characteristics.

- Demonstrate the photoelectric cell, filters, etc., to illustrate the Planck-Einstein Quantum Theory of Light.

- Show the PSSC film (0201) entitled Introduction to Optics available from:

  PSSC Films
  Modern Learning Aids
  1212 Avenue of the Americas
  New York, New York 10019

- Have the students perform experiment #31 entitled Photometry in Laboratory Experiments in Physics.

- Have the students practice solving problems in photometry at the blackboard.

CAREER:

1. Invite a lighting technician from a local TV station to class to discuss his work.

2. Have interested students do a research report on this occupation using the Occupational Outlook Handbook.

CURRICULUM:

ESC REGION 20:
Films: #2282 Electromagnetic Waves
#8585 Interference of Photons
#8239 Light-Illumination and Its Measurement
#8243 Light-Wave and Quantum Theories
#8584 Photons
#8573 Pressure of Light

HARLANDALE AUDIO-VISUAL CENTER:
Films: 16-189 Light Waves and Their Uses
16-538 Light Waves and Quantum Theories
Filmstrip: K-71 Physical Optics-Light Waves

CAREER:

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:

Occupational Outlook Handbook

Dictionary Of Occupational Titles

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-speed of light -laws of reflection and refraction -index of refraction -critical angle -lenses	The student should be able to: 1. Explain, in his own words, how Michelson determined the speed of light in air. 2. When presented with ray diagrams of reflection and refraction complete all of them correctly. 3. State correctly the three laws of refraction. 4. Define accurately, in a written statement, the following terms: a. critical angle b. index of refraction c. principal axis d. principal focus e. virtual image f. focal length g. optical center h. converging lens i. deverging lens	CONCEPT: Relationship of the laws of reflection and refraction to the work of an optometrist OBJECTIVE: The student should be able to list at least three reasons why he or she would or would not consider optometry as a career.	OPTOMETRIST 1. The optometrist examines a person's eyes to determine visual efficiency and if some abnormality is present, he prescribes corrective procedures. He improves and corrects vision using lenses, prisms, exercises and visual training. Any visual pathological disorders he discovers are usually referred to a medical practitioner. Some optometrists are engaged in basic research or teaching. 2. A total of six years of college training are required as well as successful completion of a licensing examination. Upon graduation the student is granted a doctor of optometry (O.D.) degree. Additional graduate training is required for those wishing to enter teaching or research. An internship is also required of all optometrists while they are in college. 3. Earning of $15,000 or more a year are not uncommon for optometrists and a well-managed practice can net in the neighborhood of $40,000 a year. 4. A slight increase of opportunities in this field is expected during the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Show and discuss the film entitled Speed of Light which is available from ESC Region 20. 2. Using laser apparatus, demonstrate the laws of reflection and refraction. 3. Have the students perform the following experiments in their lab manuals: (Laboratory Experiments in Physics) a) #32 Plane Mirrors b) #33 Concave Mirrors c) #34 Index of Refraction of Glass d) #36 Converging Lenses e) #37 Focal Length of a Lens f) #38 Lens Magnification 4. Show and discuss the filmstrip entitled The Story of Lenses available from the Harlandale Audio-Visual Center. 5. Have the students practice solving problems, at the chalkboard, dealing with reflection, refraction, and lenses. CAREER: 1. Invite an optometrist to class to talk about his occupation. 2. Have interested students go to an optometrist and interview him about his career. 3. Have interested students listen to the tape entitled Optometrists which is available from the Harlandale Audio-Visual Center. 4. Have interested students write to the American Optometric Association for further career information.	CURRICULUM: ESC REGION 20: Films: #3594 Charting the Universe-With Optical and Radio Telescopes #4734 Frontiers in Space-Exploring the Universe With Telescopes #3572 Introduction to Optics #8240 Light-Lenses and Optical Instruments #8241 Light-Reflection #8242 Light-Refraction #8574 Speed of Light HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: The Story of Lenses CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-298 Optometrists SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #34 Optometrists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Optometric Association 7000 Chippewa Street St. Louis, Missouri 63119	

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-the eye and image formation -comparison of the eye and camera	The student should be able to: 1. Draw a schematic drawing of the eye, label all of the parts and give the function of each. 2. Compare, in a written paper, the eye and the camera. 3. Define, in a short written statement, the following terms: a. myopia b. hyperopia c. astigmatism 4. Explain orally the lens system and image formation of a compound microscope and astronomical telescope.	CONCEPT: Relationship of the eye and vision to the work of an ophthalmologist OBJECTIVE: The student should be able to write a brief paragraph describing what it would be like to be an ophtalmologist.	OPHTHALMOLOGISTS 1. Most ophthalmologists are in private practice but some join hospital staffs while others are teaching or working for the government. An ophthalmologist thoroughly examines a patient's eyes and writes a prescription for glasses if necessary. Some disorders require exercises, medical applications or even surgery. 2. A prospective ophthalmologist should plan on four years of college in addition to medical school and one or two years of internship. After this internship an ophthalmologist must devote three or four years of residency in a hospital usually an ophthalmologist is about thirty years old before he begins to practice. 3. Ophthalmologists who enter private practice usually earn more money than those who are salaried. After working in this field and gaining some experience, he may earn between $25,000 and $50,000 a year. 4. Many more doctors are needed in this field in the future. Opportunities should be quite favorable in the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Have a class discussion on the topic "Is What We See Actually Reality." 2. Have the students examine their own eyes using an eye chart. 3. Have the students perform any of the following experiments in their lab manuals: (Laboratory Experiments in Physics) a) #39 The Compound Microscope b) #40 The Refracting Telescope 4. Show and discuss the film entitled Eyes and Vision available from ESC Region 20. CAREER: 1. Invite an ophthalmologist to class to talk about his work. 2. Have interested students read the SRA Occupational Brief entitled Ophthalmologists which is available from the school library or counselor's office. 3. Have interested students write to the American Association of Ophthalmology for further career information.	CURRICULUM: ESC REGION 20: Film: #4731 Eyes and Vision CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #146 Ophthalmologists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Association of Ophthalmology 1100 Seventeenth Street, NW Washington, D.C. 20036	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-color of light -complementary and primary colors -pigments -color printing and photography -spectroscope -Fraunhofer lines -polarization	The student should be able to: 1. List the primary colors and alongside each name its complement. 2. Describe, in a short paragraph, the operation of a spectroscope in measuring and photographing spectra. 3. Indicate orally the origin of the Fraunhofer lines. 4. Explain, using a schematic diagram, how light is polarized.	CONCEPT: Relationship of colors and pigments to the work of a commercial artist OBJECTIVE: The student should be able to discuss, in a short essay, what it would be like to be a commercial artist.	COMMERCIAL DESIGNER 1. This commercial designer devises and paints color schemes on designed wallpaper samples and lays out wallpaper designs. He also mixes pigments to obtain paints of various colors and shadings. He also determines the accuracy of the location and alignment of designs on original prints using a T-square, compass, ruler and triangle. Finally he paints the designs on a positive plate with an artists brush to block out any light during the photographic process. 2. A commercial art course usually takes two or three years after which the student receives a certificate. Some art schools, especially those connected with colleges, grant a bachelor of fine arts degree. A person's artistic talent and creative ability are perhaps the most important qualifications. 3. Salaries for those in commercial art with some experience ranged from $100 to $180 a week. Some with a great deal of experience and talent have earned from $15,000 to $30,000 a year. 4. Future opportunities for commercial artists and designers will be good throughout the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Demonstrate and discuss color using Newton's wheel.
2. Have a student volunteer to prepare a special report on color photography methods and present it to the class.
3. Demonstrate the spectra of gaseous discharge tubes using a spectrometer.
4. Show and discuss interference and diffraction of light using the Laser Apparatus Set.
5. Have the students do either of the following experiments in their lab manuals: (Laboratory Experiments in Physics)
   a) #43 Wavelength by Diffraction
   b) #44 Polarization of Light
6. Demonstrate polarization using polarized lenses.

CAREER:

1. Invite a commercial designer or artist to class to talk about his career.
2. Have interested students listen to the cassette tape entitled Commercial Artist which is available from the school library or counselor's office.
3. Have interested students write to the American Institute of Graphic Arts for further career information.

CURRICULUM:

ESC REGION 20:
Films: #3473 Discovering Color
#8678 The Laser-A Light Fantastic
#8627 Light and Color
#8770 Understanding Color-Color by Addition

HARLANDALE AUDIO-VISUAL CENTER:
Filmstrip: K-90 Polarized Light

CAREER:

HARLANDALE AUDIO-VISUAL CENTER:
Cassette Tape: Cas T-42 Commercial Artist

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:
SRA Occupational Brief #65
Commercial Artist

Occupational Outlook Handbook

Dictionary Of Occupational Titles

WRITE TO:

American Institute of Graphic Arts
1059 Third Avenue
New York, New York 10021

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
ELECTROSTATICS -static electricity -conductors and insulators -potential difference -capacitance	The student should be able to: 1. Discuss, in a short written paper, the production of static electricity and the law which governs the attraction and repulsion of charged bodies. 2. Define accurately, in a short statement, the following terms: a. conductor b. insulator c. electric field d. potential difference e. capacitance f. dielectric constant g. farad 3. Solve correctly, at least five problems dealing with electrostatic charges, potential difference and capacitance.	CONCEPT: Relationship of electrical charges to the work of an electrical engineer OBJECTIVE: The student should be able to list at least two reasons why he or she would or would not choose electrical engineering as a career.	ELECTRICAL ENGINEER 1. Electrical engineers are responsible for the production, control and use of electrical energy. Generally this field is divided into two broad areas: power and electronics. Power electrical engineers are concerned with large amounts of energy required to meet the demands of large cities and industries. Those in the electronics field are concerned with small amounts of electrical energy for communications, computers and other devices. 2. Electrical engineers usually take a four or five year college course followed by a master's or doctor's program. Graduate training is essential for top-level positions in research and teaching. After about four years of experience an engineer can take the prescribed two-day examination in order to obtain his license as a professional engineer. 3. Starting salaries for engineering graduates with no experience was about $10,500 annually in 1970. Those beginning with a master's earned about $1,200 a year more. 4. Employment opportunities for engineering graduates are expected to increase steadily through the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate and discuss static electricity using a Wimshurt machine, Van de Graf generator and rods rubbed with fur or fabric. 2. Have the students perform experiment #45 entitled Static Electricity in Laboratory Experiments in Physics. 3. Demonstrate and discuss Faraday's ice pail experiment. 4. Demonstrate various capacitors and show the effects of various potential differences. 5. Have the students build capacitors and bring them to class. Explain to the class the construction and use of commercial capacitors. 6. Have the students practice solving problems dealing with electrostatics and capacitance including networks. CAREER: 1. Invite an electrical engineer to class to discuss his career. 2. Have interested students listen to the tape entitled Types of Engineering which is available from the Harlandale Audio-Visual Center. 3. Have interested write to the Institute of Electrical and Electronics Engineers for further career information.	CURRICULUM: ESC REGION 20: Films: #2278 Coulomb Force Constant #2276 Electric Fields #4713 Electric Lines of Force #2280 Electrical Potential Energy and Potential Difference, Pt. 1 HARLANDALE AUDIO-VISUAL CENTER: Filmstrips: C-96 Producing Small Amounts of Electricity K-67 Electric Fields CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: Types of Engineering SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #3 Electrical Engineers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Institute of Electrical and Electronics Engineers 345 East 47th Street New York, New York 10017	

RICULUM NCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
DIRECT CURRENT -electrical symbols -sources of current -cells and batteries	The student should be able to: 1. When presented with a list of twenty electrical symbols, correctly state the meaning of each. 2. List at least five basic sources of continuous current. 3. Match correctly, each of the following terms with their definitions: a. electric current b. resistance c. primary cell d. storage cell e. electrolyte f. electromotive series g. battery h. electrode	CONCEPT: Relationship of current and its flow to the work of a cable splicer and lineman OBJECTIVE: The student should be able to discuss, in a short paragraph, the work of a cable splicer and lineman.	CABLE SPLICER AND LINEMAN 1. This job includes putting wires and cables in place; laying, maintaining and repairing lines and other related operations. Linemen also connect many pairs of wires to form a continuous line between the cable terminals of each customer and the central office. After completing the wire work, the splicer seals it in a special case. Occasionally, he fills the sheathing of the wire with gas under pressure to retard moisture damage. 2. Cable splicers and linemen usually learn their skills on the job. They are supervised during all phases of their instruction to insure that they are doing their work correctly and safely. It usually takes the lineman about six years to become fully trained and skilled. 3. In 1965, the average salary for cable splicers was $3.39 an hour. It was $2.64 an hour for linemen. 4. Hundreds of job openings are expected in the 1970's to replace workers leaving the field for one reason or another.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Duplicate Volta's experiment using a penny and a dime separated by a saliva-moistened paper towel. 2. Make a copper-zinc cell and demonstrate it to the class. 3. Make and demonstrate a thermocouple explaining how it operates. 4. Have the students perform experiment #46 entitled Electrochemical Cells in Laboratory Experiments in Physics. 5. Show and discuss any of the films available from ESC Region 20 or the Harlandale Audio-Visual Center. CAREER: 1. Have a lineman or cable splicer come to class to discuss his work. 2. Have interested students listen to the tape entitled Linemen-Cable Splicers. 3. Have interested students write to the local telephone company for further career information.	CURRICULUM: ESC REGION 20: Film: #2274 Conservation of Energy #8583 EMF #8925 Electrical Sources #8117 Electricity From Chemicals #4162 Electricity-Principles of Safety #8548 Electrochemical Cells HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: Mi-3 Electricity CAREER: HARLANDALE AUDIO-VISUAL CENTER: Record w/filmstrip: BB-66 The Electric Current BB-68 Electrical Work, Energy and Power Magnetic Tape: Lineman-Cable Splicers SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #28 Linemen and Cable Splicers Occupational Outlook Handbook WRITE TO: American Telephone and Telegraph Company 195 Broadway New York, New York 10007	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-Ohm's law -series and parallel circuits -resistance and heat -Joule's law	The student should be able to: 1. State orally, Ohm's law and use it to solve correctly at least twenty problems dealing with resistance, current, and voltage. 2. Solve correctly, at least ten problems involving series and parallel circuits. 3. State correctly, Joule's law. 4. Define in a short statement, the following terms: a. overload b. short circuit c. fuse d. power	CONCEPT: Relationship of electrical power and circuits to the work in the alarm systems industry OBJECTIVE: The student should be able to list at least two reasons why he or she would like to be an alarm system worker.	ALARM SYSTEM WORKERS 1. There are three general groups of employees who work in this field, installers, operators, and runners. Installers place the protective devices in appropriate locations and perform major repairs on systems. Operators keep watch on the dials and indicators and receive alarms. Runners are in patrol cars and check buildings where an alarm has rung. 2. In this field educational requirements are not the most important consideration. For installers, employers generally want men with some experience or training in electrical work. Operators and runners are usually men, but women are often considered. The best way to get a job is to apply directly to the personnel office of the company one wishes to work for. 3. Starting wages for all three groups of alarm system workers was about $2.50 an hour in 1970. These workers can advance to as high as $5.00 an hour after gaining experience. 4. The demand for qualified alarm system personnel will increase substantially in the near future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
URRICULUM: • Demonstrate and discuss series and parallel circuits using light bulbs appropriately arranged. • Exhibit and discuss various types of resistances: carbon, metal, rheostats, and potentiometers. • Have the students perform the following lab experiments in their lab manuals: (Laboratory Experiments in Physics) a) #47 Combination of Cells - Internal Resistance b) #49 Measurement of Resistance - Wheatstone Bridge c) #52 Simple Networks d) #50 Effect of Temperature on Resistance e) #54 Electric Equivalent of Heat • Show and discuss the film or filmstrip entitled Series and Parallel Circuits available from the Harlandale Audio-Visual Center. CAREER: 1. Invite a guard or watchman to class to talk about his job. 2. Have interested students read the SRA Occupational Brief entitled Guards, Watchmen, and Alarm System Workers. 3. Have interested students write to the Independent Watchmen's Association for further career information.	CURRICULUM: ESC REGION 20: Film: #2275 Coulombs Law #8926 Fundamentals of Electricity HARLANDALE AUDIO-VISUAL CENTER: Film: 16-486 Series and Parallel Circuits Filmstrip: C-26 Series and Parallel Circuits Record w/filmstrip: BB-67 Ohm's Law of Electrical Resistance CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #297 Guards, Watchmen, and Alarm System Workers Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Independent Watchmen's Association 30 East 20th Street New York, New York 10003	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-electrolysis of water -electroplating -Faraday's first and second law	The student should be able to: 1. Describe accurately, in a short paper, what occurs at the cathode and at the anode during the electrolysis of water. 2. Solve correctly at least ten problems dealing with the heating and chemical effects of electricity. 3. Describe accurately, in a brief paper, what occurs during the electroplating of one metal on the surface of another. 4. State briefly but accurately, Faraday's first and second law.	CONCEPT: Relationship of electrical energy to the occupation of electroplater OBJECTIVE: The student should be able to write a short one page paper explaining why he or she would or would not enjoy electroplating as an occupation.	ELECTROPLATER 1. An electroplater covers objects with coatings of metal by dipping these objects in to a plating solution in which an electric current is flowing. This deposits the plating metal on the objects and makes them not only more attractive but also more durable. The electroplater is responsible for preparing all necessary solutions, adjusting the current flow and checking the length of time required for the entire process. 2. There are no minimum educational requirements for entering this field. Most firms, however, prefer to hire high school graduates who have at least average physical strength, good eyesight, patience and a concern for detail. Those interested in this type of work should apply directly to the local plating company for employment. 3. Salaries for electroplaters in 1968 ranged from $1.75 to $3.50 an hour depending on experiences. 4. Increased job opportunities are expected for electroplaters during the 1970's and 1980's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate and discuss the electrolysis of water. 2. Set up a small electroplating cell. Electroplate a key or coin with copper. Show that the cell can remove the plating by reversing the polarity and use varying amounts of current to show its effect. 3. Demonstrate the electrolysis of a NaCl solution and identify the products. 4. Have the students perform experiment #55 entitled Electrochemical Equivalent of Copper in their lab manuals. (Laboratory Experiments in Physics) 5. Show and discuss the filmstrip entitled Electrochemistry-Linking of Two Sciences available from the Harlandale Audio-Visual Center. CAREER: 1. Invite an electroplater to class to talk about his job. 2. Have interested students read the Occupational Brief entitled Electroplaters which is available from the school library or counselor's office. 3. Have interested students write to the American Electroplaters Society for further career information.	CURRICULUM: ESC REGION 20: Film: #8580 Counting Electrical Charges in Motion #2279 Elementary Charges and Transfer of Kinetic Energy HARLANDALE AUDIO-VISUAL CENTER: Filmstrip: K-61 Electrochemistry-Linking of Two Sciences CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #311 Electroplaters Occupational Outlook Handbook WRITE TO: American Electroplaters' Society 56 Melmore Gardens East Orange, New Jersey 07017	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
MAGNETISM -magnetic substances -domain theory -magnetic poles and fields -induced magnetism -electromagnetism	The student should be able to: 1. Use correctly, in a written sentence, each of the following terms: a. ferromagnetic b. domain c. magnetic field d. diagmagnetic e. angle of declination f. electromagnet g. flux density 2. Discuss, in a short paper, the domain theory of magnetism. 3. Describe, in a short paragraph, an experiment which illustrates induced magnetism. 4. List at least four uses of electromagnetism.	CONCEPT: Relationship of magnetism and magnetic fields to the work of a geophysicist OBJECTIVE: The student should be able to list at least three activities of a geophysicist.	GEOPHYSICIST 1. The geophysicist studies the physical aspects of the earth. He investigates and measures seismic, gravitational, electrical, thermal and magnetic forces which affect the earth. He may also study the physical properties of the atmosphere, help locate petroleum and mineral deposits, investigate the origin of earthquakes and help establish water supply and flood-control programs. 2. Those planning on becoming geophysicists should contemplate graduate work after receiving the bachelor's degree. A doctorate degree is usually required for high-level research positions and for top-level teaching jobs. 3. Salaries for geophysicist start from about $7,000 a year for those with a bachelor's degree to as high as $12,000 with a Ph.D. 4. The demand for geophysicist is expected to grow during the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Exhibit and discuss common applications of magnetism such as magnetic toys, compasses, door catches, etc. 2. Show and discuss the film entitled Domains and Hysteresis in Ferromagnetic Materials which is available from Bell Telephone. 3. Demonstrate and discuss magnetic field concepts using magnets, paper and iron filings. 4. Have the students perform experiment #56 entitled Magnetic Field About a Conductor. 5. Demonstrate and discuss Oersted's and Faraday's electromagnetic induction experiments. 6. Show and discuss the filmstrip entitled Modern Theories of Magnetism available from the Harlandale Audio-Visual Center. CAREER: 1. Invite a geophysicist from a local college to class to talk about his career. 2. Have interested students listen to the tape entitled Geophysicists which is available from the school library or counselor's office. 3. Have interested students write to the American Geological Institute for further career information.	CURRICULUM: ESC REGION 20: Film: #4714 Electrons In a Uniform Magnetic Field #3581 A Magnet Laboratory HARLANDALE AUDIO-VISUAL CENTER: Film: 16-410 Magnetic Force Filmstrip: K-68 Modern Theories of Magnetism CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-304 Geophysicist: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #331 Geophysicists Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: American Geological Institute 1444 N Street, NW Washington, D.C. 20005	

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-meters -galvanometer -voltmeters - ammeters -ohmmeters	The student should be able to: 1. Explain, in a short statement, why an ammeter must be a low-resistance instrument and a voltmeter must be a high-resistance instrument. 2. Solve correctly, at least ten problems involving meters. 3. Draw at least three circuits showing how various meters would be arranged in order to make appropriate measurements.	CONCEPT: Relationship of meters to the work of an instrument maker OBJECTIVE: The student should be able to list at least two reasons why he or she would or would not enjoy being an instrument maker.	INSTRUMENT MAKER 1. Many scientific discoveries have resulted from the development of new and improved instruments. Instrument makers work with engineers and scientists in the development of new kinds of research and testing devices. These instruments are used for measuring heat, time, fluid flow, level pressure, temperature and other important variables. Many of the men engaged in this work are quite skilled in the construction of electronic parts. 2. Some technical schools and institutes offer courses in instrument making. Many instrument makers first become machinists and after one or two years of experience, they are usually qualified to be instrument makers. 3. In 1967 beginning salaries for instrument makers ranged from $3.50 an hour to $5.00 an hour. 4. The employment outlook for instrument makers in the near future is excellent.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Demonstrate the meter effect by using a coil of wire. Develop the mathematical relations for turning a coil and a magnet into a meter. 2. Demonstrate the various types of meters to the class and explain their uses. Develop the equations for voltmeters, ammeters and ohm meters. 3. Show and discuss the film entitled Measurement of Electricity or the filmstrip entitled Direct-Current Measuring Instruments available from the Harlandale Audio-Visual Center. 4. Have the students practice solving problems involving meters and select students to demonstrate their solutions at the blackboard. CAREER: 1. Have interested students do a research report using the SRA Occupational Brief entitled Instrument Maker which is available from the school library or counselor's office. 2. Have interested students write to the Instrument Society of American for further career information.	CURRICULUM: HARLANDALE AUDIO-VISUAL CENTER: Film: 16-101 Measurement of Electricity Record w/filmstrip: BB-69 Direct-Current Measuring Instruments CAREER: SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #27 Instrument Maker Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Instrument Society of America 530 William Penn Place Pittsburgh, Pennsylvania 15219	

RICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-generators -motors -inductance	The student should be able to: 1. List the primary components of an electric generator and give the function of each. 2. Explain, in a short statement and using a schematic diagram, the motor rule. 3. Solve correctly at least ten problems dealing with motors and generators. 4. Define correctly in a short statement, mutual inductance and self-inductance.	CONCEPT: Relationship of generators and motors to the work of a home appliance serviceman OBJECTIVE: The student should be able to write a one page paper about the work of a home appliance serviceman.	HOME APPLIANCE SERVICEMAN 1. This worker installs, maintains and repairs the many mechanical and electrical devices which are found in the home. He can work on such large machines as driers, refrigerators and freezers or small machines like shavers, mixers and toasters. For each kind of serviceman there are two categories - fieldmen and benchmen. Fieldmen drive to the customer's location and works while the benchmen repair the devices which are brought into the shop. 2. Some employers will hire home appliance servicemen without a high school diploma, but those having the diploma will be in a position to be hired, will receive better pay and will have a greater chance for advancement. Many distributors train their own men on the job while others hire men who have had some technical school training in this area. 3. Salaries in 1968 for home appliance servicemen ranged from $2.18 an hour to as much as $4.22 an hour depending on training and experience. 4. There is currently a shortage of appliance servicemen in the United States due to a lack of adequate training facilities and an increase in appliance sales.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Have a student volunteer, as a special extra-credit assignment, prepare a report on Faraday and present it to the class orally.

2. Demonstrate and discuss the operation of a St. Louis motor.

3. Have the students design and build their own electric motors and demonstrate them to the class.

4. Show and discuss the film entitled Electromagnetic Induction available from ESC Region 20 or the filmstrip entitled How AC and DC Motors Work available from the Harlandale Audio-Visual Center.

5. Have the students perform experiment #58 entitled Electromagnetic Induction in their lab manuals. (Laboratory Experiments in Physics)

CAREER:

1. Invite an appliance serviceman to class to discuss his occupation.

2. Have interested students listen to the tape entitled Appliance Servicemen which is available from the Harlandale Audio-Visual Center.

3. Have interested students write to the Association of Home Appliance Manufacturers for further career information.

CURRICULUM:

ESC REGION 20:
Films: #4161 Electricity-How It Is Generated
#8119 Electromagnetic Induction

HARLANDALE AUDIO-VISUAL CENTER:
Filmstrips: C-25 Home Electrical Appliances
C-23 Elements of Electrical Appliances
K-76 How AC and DC Motors Work

CAREER:

HARLANDALE AUDIO-VISUAL CENTER:
Magnetic Tape: MT-338 Appliance Servicemen

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:
SRA Occupational Brief #333
Home Appliance Servicemen

Occupational Outlook Handbook

Dictionary Of Occupational Titles

WRITE TO:

Association of Home Appliance Manufacturers
20 North Wacker Drive
Chicago, Illinois 60606

RRICULUM ONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-transformers -electric power transmission	The student should be able to: 1. Distinguish, by means of a diagram and a short explanation, between a step-up and a step-down transformer. 2. Solve correctly at least five problems involving current flow and windings in transformers. 3. Draw a schematic diagram illustrating the generation and transmission of electrical power from its source to the consumer.	CONCEPT: Transformers are frequently used in the work of a telephone installer. OBJECTIVE: The student should be able to discuss, in a short paper, the work of a telephone installer.	TELEPHONE INSTALLER 1. The telephone installer is responsible for repairing, installing and testing equipment for the local telephone company. He acts also as a skilled craftsman, public relations representative and salesman. He works both indoors and outdoors, occasionally being required to climb a pole to complete an installation. He usually works forty hours a week, except in emergencies when he may work several hours overtime. 2. All telephone installers are required to possess a high school diploma before being hired. The telephone company gives all applicants an aptitude test and looks for such personal qualifications as neatness, intelligence, mechanical ability and electrical aptitude. 3. Salaries for telephone installers averaged about $3.54 an hour in 1965 with pay raises being given periodically until the maximum is reached. 4. There will always be a need for installers and repairmen to handle this very important work.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Construct and discuss the operation of a transformer. Explain that power input will be greater than power output. 2. Have a class discussion on the various uses of transformers and electric power generation. 3. If possible, take the class on a field trip to a power generating plant. CAREER: 1. Invite a telephone installer to class to discuss his work. 2. Have interested students visit the local telephone company to interview an installer there. 3. Have interested students read the SRA Occupational Brief entitled Telephone Installers which is available from the school library or counselor's office.	CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-352 Telephone Equipment Installer SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #359 Telephone Installer Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Communications Workers of America 1925 K Street, NW Washington, D.C. 20006	

URRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-alternating current circuits -impedance and resonance -vacuum tubes and their curcuits -rectifiers, mixers, amplifiers and oscillators -transistors	The student should be able to: 1. Explain briefly the relationship between an alternating current and voltage which is in phase. 2. Solve correctly, at least 10 problems involving alternating circuits. 3. Define accurately each of the following terms: a. parallel resonance b. series resonance c. impedance 4. List the function of each of the following types of vacuum tubes: a. rectifier b. mixer c. detector d. amplifier e. wave shaper	CONCEPT: Relationship of alternating current vacuum tubes and transistors to the work of a radio-TV serviceman. OBJECTIVE: The student should be able to write a one page paper explaining what it would be like to be a radio-TV serviceman.	RADIO-TV SERVICEMAN 1. The primary duty of the radio and TV serviceman is to diagnose any difficulties and repair these as quickly as possible. Also included in his work is the installation of televisions and tv aerials. The serviceman often tests circuits, does minor soldering and replaces various tubes and components. 2. Technical schools offer programs in radio and TV repair. These courses usually take nine months of full time work or eighteen months of part-time training. Some employers, such as appliance dealers and department stores, will train workers on the job as well as give them classroom instruction. 3. A beginning radio-TV serviceman can expect from $70.00 to $100.00 a week. Those with more training skill, and experience can earn $160. a week or more. 4. Employment opportunities in this field are expected to increase rapidly throughout the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Discuss the difference between AC and DC. Using an oscilloscope, demonstrate the sine-wave produced by a transformer. 2. Demonstrate tuning a radio to illustrate resonance. 3. Have a class discussion on transistors, radios, stereos, etc. Utilize advanced radio-TV students and equipment from the electronics shop. 4. Have the students perform experiment #61 entitled Series Resonance and #64 entitled Triode Characteristics in their lab manuals. (Laboratory Experiments in Physics) 5. Have the students solve as many problems as possible involving AC circuits. CAREER: 1. Have interested students visit a local radio-TV repair shop and interview those working there. 2. Have interested students write to the International Brotherhood of Electrical Workers for further career information. 3. Invite a local radio-TV repairman to class to talk about his occupation.	CAREER: HARLANDALE AUDIO-VISUAL CENTER: Magnetic Tape: MT-341 Radio-TV Technician SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #346 Radio-TV Technicians Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: International Brotherhood of Electrical Workers 1200 Fifteenth Street, NW Washington, D.C. 20005	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-transmitters and receivers -television receiver -color transmission -radar	The student should be able to: 1. Name the two major sections of a radio transmitter. 2. List at least two important characteristics or properties of a receiver. 3. Explain, briefly but accurately, how a color television works. 4. Write the correct definition of radar.	CONCEPT: Relationship of transmitters and receivers to the work in the electronics industry OBJECTIVE: The student should be able to describe, in a paragraph, the work of an assembler in the electronics industry.	ASSEMBLERS (ELECTRONICS INDUSTRY) 1. In this industry there are many different kinds of assemblers since products vary in use, function, size and form. Primarily these workers insert or attach component parts in their correct positions by welding, soldering, screwing and bolting. Usually an assemblers job is just one small part in a long process. In 1967, there were more than one million people employed in electronics manufacturing. 2. Usually a high school diploma is required before employment. Beginning positions as semi skilled assemblers do not require special training but skilled assemblers should have some basic knowledge of electronics theory and some experience with equipment and electrical circuits. Many cities have night schools which offer classes in electronics. 3. Beginning salaries for assemblers range from $1.60 an hour to $1.95 an hour depending on the job. Some workers who are in testing and inspecting jobs earn about $3.00 an hour. 4. Increased opportunities are expected in this field in the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS
CURRICULUM: 1. Show and discuss the film entitled Communication - Story of Its Development available from ESC Region 20. 2. Demonstrate and explain to the class the operation of a color television set. 3. Have the class take a field trip to a local television station and write a report on their activities. 4. If possible take the class to the local airport control tower to observe their radar operations. CAREER: 1. Have interested students listen to the tape entitled Electronic Assembler which is available from the Harlandale Audio-Visual Center. 2. Have interested students read and report on the SRA Occupational Brief entitled Assemblers in the Electronics Industry which is available from the school library or counselor's office. 3. Have interested students write to the Electronic Industries Association for further career information.	CURRICULUM: ESC REGION 20: Films: #4124 Communication-Story of Its Development #8537 Gemini Rendezvous Missions CAREER: HARLANDALE AUDIO-VISUAL CENTER: Cassette Tape: Cas T-49 Electronic Assembler SCHOOL LIBRARY OR COUNSELOR'S OFFICE: SRA Occupational Brief #314 Assemblers in the Electronics Industry Occupational Outlook Handbook Dictionary Of Occupational Titles WRITE TO: Electronic Industries Association 2001 Eye Street NW Washington, D.C. 20006	

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
ATOMIC STRUCTURE -atoms and molecules -atomic mass and atomic number -discovery of the electron, proton and neutron	The student should be able to: 1. Describe, briefly but accurately, the experiment of Rutherford which showed that the nucleus is positively charged. 2. Discuss orally the ideas of Thomson, Rutherford and Bohr concerning the structure of the atom. 3. Define, accurately, in a short statement, the following terms: a. Angstrom b. atomic mass c. atomic number d. electron shell e. orbital f. nucleon	CONCEPT: The nuclear engineer must be very knowledgeable in the area of atomic structure. OBJECTIVE: The student should be able to write a short paper describing the occupation of a nuclear engineer.	NUCLEAR ENGINEER 1. Of the 175,000 persons employed in the field of atomic energy, about 2,000 are classified as nuclear engineers. Nuclear engineers design plans, devise tools and solve heating, cooling and ventilating problems in regard to projects involving sources of neutrons and radiation. Most nuclear engineers work in research and development companies contracted by the AEC and the National Aeronautics and Space Adminstration. 2. A minimum of four to five years of college is required for qualification as an engineer. Nuclear engineers must have completed undergraduate work and have a B.S. degree before entering this field. On-the-job training is important in this field because it is relatively new and has a rapidly changing technology. 3. Nuclear engineers in the atomic energy field can earn starting salaries ranging from $8,000 to $10,000 a year. With some experience, most engineers can earn between $12,000 and $18,000 annually. 4. There apparently will be an ever increasing demand for nuclear engineers in the near future.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Have the students prepare oral reports on such men as Rutherford, Thomson, or Bohr.

2. Demonstrate and discuss Millikan's oil drop experiment and have the class determine the charge on the electron.

3. Show and discuss the PSSC film (0416) entitled The Rutherford Atom available from:

   PSSC Films
   Modern Learning Aids
   1212 Avenue of the Americas
   New York, New York 10019

   This film is also available from ESC Region 20.

CAREER:

1. Have interested students do a research report dealing with the occupation of nuclear engineer using the Occupational Outlook Handbook and the Dictionary of Occupational Titles.

2. Have interested students write to the American Nuclear Society for further career information.

CURRICULUM:

ESC REGION 20:
Films: #2327 The Mass of Atoms, Part 1
#2328 The Mass of Atoms, Part 2
#8582 Mass of the Electron
#2285 Matter Waves
#2277 Milliken Experiment
#6012 Rutherford Atom

CAREER:

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:

Occupational Outlook Handbook

Dictionary Of Occupational Titles

WRITE TO:

American Nuclear Society
244 East Ogden Avenue
Hinsdale, Illinois 60521

RRICULUM NCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-isotopes -bonding -chemical and physical changes	The student should be able to: 1. Define accurately what is meant by an isotope and list at least three important uses of isotopes. 2. Illustrate, using atomic diagrams, the difference between ionic bonding and covalent bonding. 3. Differentiate, using examples, between a chemical change and a physical change.	CONCEPT: Isotopes and chemical bonding are important concepts for the physical chemist. OBJECTIVE: The student should be able to describe, in a short paragraph, the duties and activities of a physical chemist.	PHYSICAL CHEMIST 1. The physical chemist conducts research into the relationships between chemical and physical properties of organic and inorganic compounds. He often induces change in the composition of substances using thermal, light and electrical energy and chemical catalysts. He also develops techniques for the use of instruments that measure heat, light and electricity. 2. A bachelor's degree with a major in physical chemistry is usually the minimum requirement for work in this field. Chemists having the master's degree or the Ph.D. are qualified for higher level positions in teaching and research. 3. The average starting salary for chemists in 1970 was about $9,000 in private industry. Inexperienced graduates with a master's degree earned about $11,000 a year whereas those having the Ph.D. earned about $15,000 annually. 4. The employment outlook for physical chemists is expected to be favorable through the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Have a student, as an extra-credit assignment, prepare a brief oral report on isotopes, bonding and the origins of the Periodic Table.

2. Show and discuss any of the following filmstrips available from the Harlandale Audio-Visual Center:

   a) Covalent Bonds - Covalent Substances
   b) Orbitals - Ions and Molecules
   c) Electron Arrangements and Chemical Bonds

3. Show and discuss the film entitled Elements, Compounds and Mixtures available from FSSC Films.

Curriculum:

HARLANDALE AUDIO-VISUAL CENTER:
Filmstrips: M-56 Electron Bonds-
M-57 Molecule-Atom and Valence
M-65 Electron Arrangements and Chemical Bonds

Career:

HARLANDALE AUDIO-VISUAL CENTER:
Magnetic Tape: Chemists

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:
VGI Occupational Brief #65
Chemists
Occupational Outlook Handbook
Dictionary of Occupational Titles

WRITE TO:

American Institute of Chemists
60 East 42nd Street
New York, New York 10017

CAREER:

1. Invite a physical-chemist to class to discuss his training and his work.

2. Have interested students write to the American Institute of Chemists for further career information.

3. Have interested students listen to the tape entitled Chemists which is available from the Harlandale Audio-Visual Center.

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-radioactivity and nuclear energy -characteristics of radioactive elements -alpha, beta and gamma particles	The student should be able to: 1. Name the scientist who first discovered radioactivity and describe briefly how it was done. 2. List at least five characteristics or properties of radioactive elements. 3. Compare, in a brief written paragraph, the composition and charge of alpha and beta particles. 4. Discuss briefly how gamma rays are produced and why they are important.	CONCEPT: Radiation is a primary concern and tool of the radiologist. OBJECTIVE: The student should be able to write a brief paper describing what it would be like to be a radiologist.	RADIOLOGIST 1. In 1971 there were approximately 9000 radiologists in the United States, a small number of them being women. The radiologist is first of all, a doctor, but his work is much more technical. A radiologist may either enter diagnostic radiology, therapeutic radiology or nuclear medicine and become a specialist in one of these areas. 2. A radiologist must obtain an undergraduate degree, followed by four years of medical school. After receiving his M.D. degree, they must spend one year as an intern and three years in a hospital as a resident. Upon completion of the residency, the radiologist must pass examinations before he can be licensed. 3. Professional incomes in this area are not easy to estimate but it is not unusual for a radiologist to earn about $40,000 a year. 4. Radiology is a fast-growing field and opportunities should be very good for those who qualify.

SUGGESTED TEACHING METHODS

CURRICULUM:

1. Ask for a student to volunteer, for extra credit, to prepare a brief oral report on the history of radioactivity. After the report, have a class discussion concerning the problems involved in the control of nuclear weapons, radioactive fallout, together with all the political and social problems.

2. Show and discuss any of the following films available from ESC Region 20:

   a) Corridor of the Atom
   b) Radioactivity

3. Demonstrate the use of a Geiger counter in the detection of radioactivity.

CAREER:

1. Invite a radiologist to class to speak about opportunities in this field.

2. Have interested students read and report on the SRA Occupational Brief entitled Radiologists which is available from the school library or counselor's office.

3. Have interested students write to the American College of Radiology for further career information.

RESOURCE MATERIALS

CURRICULUM:

ESC REGION 20:
Films: #2320 Corridor of the Atom
#2257 Long Time Intervals
#2036 Radioactivity

HAMLADALE AUDIO-VISUAL CENTER:
Filmstrip: K-69 Electro-Magnetic Radiation

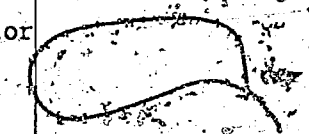
CAREER:

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:
SRA Occupational Brief #379 Radiologists
Occupational Outlook Handbook
Dictionary Of Occupational Titles

WRITE TO:

American College of Radiology
20 North Wacker Drive
Chicago, Illinois

TEACHER'S COMMENTS

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-detection of radioactivity -types of nuclear reactions -nuclear decomposition -nuclear disintegration -fission -fusion	The student should be able to: 1. Define or describe, briefly but accurately, the following terms: a. linear accelerator b. synchrotron c. fission d. fusion e. half life f. transmutation 2. State accurately the function of a moderator. 3. Describe, in a short paragraph, what is meant by a chain reaction and explain why the fission of $_{92}U^{235}$ produces a chain reaction.	CONCEPT: Relationship of radiation to the work of a health physicist  OBJECTIVE: The student should be able to discuss, in a brief written paragraph, why he or she would or would not like to be a health physicist.	HEALTH PHYSICIST 1. Health physicists are sometimes known as radiation physicists and are responsible for detecting radiation and applying safety standards to control exposure to it. In 1970, about 1,100 health physicists were employed in radiation protection work, research or teaching. These workers establish standards of inspection and determine procedures for protecting employees and eliminating radiological hazards. 2. Health physicists should have at least a bachelor's degree in physics and a year or more of graduate work in health physics. 3. Professional workers employed at AEC installations averaged about $15,000 a year in 1970 and other white collar workers earned an average of nearly $7,300 annually. 4. Total employment in the atomic energy field is expected to increase somewhat during the 1970's.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Discuss, using the chalkboard, nuclear reactions, nuclear decompositions and nuclear disintegrations.

2. Show and discuss any of the following films available from ESC Region 20:

   a) The Day Tomorrow Began
   b) Storms Over the U.S.
   c) The Mighty Atom

3. Show and discuss the film entitled Nuclear Reactors for Research available from North American Rockwell Corp., 12214 Lakewood Boulevard, Downey, California.

CAREER:

1. Invite a health physicist to class to talk about his work.

2. Have interested students do a research report about the occupation of health physicist using the Occupational Outlook Handbook.

3. Have interested students write to the U.S. Atomic Energy Commission for further career information.

CURRICULUM:

ESC REGION 20:

Films: #2319 The Day Tomorrow Began
#2403 Storms Over the U.S.
#2321 The Mighty Atom

CAREER:

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:

Occupational Outlook Handbook

Dictionary of Occupational Titles

WRITE TO:

U.S. Atomic Energy Commission
Washington, D.C. 20545

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-particle accelerators -cyclotron -synchrotron -betatron -linear accelerator	The student should be able to: 1. Write nuclear equations for the radioactive decompostion of the following: a. $_{90}Th^{234}$ b. $_{92}U^{234}$ c. $_{84}Po^{210}$ 2. Describe, in a written statement, how particles are accelerated in a cyclotron and a linear accelerator. 3. Solve correctly at least five problems in atomic physics.	CONCEPT: Relationship of the different types of accelerators to the work of an accelerator operator OBJECTIVE: The student should be able to describe, in a brief paragraph, the work of an accelerator operator.	ACCELERATOR OPERATOR 1. Accelerator operators set up and coordinate all of the activities involved in the operation of particle accelerators. They adjust the controls according to instructions from the scientist in charge and set up target materials to be bombarded. They are frequently asked to assist in the maintenance of the equipment used in atomic research. 2. A high school education that includes courses in mathematics and physics is the usual minimum requirement necessary to qualify for on-the-job training. This training usually includes operating, repairing and safety procedures. 3. In 1970 blue-collar workers employed by contractors at AEC laboratories and other installations averaged about $4.11 an hour. 4. As commercial activities in atomic energy expand and as new applications of this energy form are developed total employment in this industry is expected to increase.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Using transparencies or the chalkboard, describe particle accelerators and their contribution to modern nuclear and atomic theory.

2. Have the students collect as many pictures of the various types of accelerators as possible and prepare a bulletin board display.

3. Show and discuss the film entitled Atomic Energy available from the U.S. Atomic Energy Commission, P.O. Box E, Oak Ridge, Tennessee.

4. Have the students practice solving problems in atomic physics at the chalkboard and explain their solutions to the class.

CAREER:

1. Have interested students do a research report on the occupations in the field of atomic energy using the Occupational Outlook Handbook and the Encyclopedia of Careers.

2. Have interested students write to the U.S. Atomic Energy Commission for further career information.

CAREER:

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:

Occupational Outlook Handbook

Dictionary Of Occupational Titles

Encyclopedia Of Careers

WRITE TO:

U.S. Atomic Energy Commission
Washington, D.C. 20545

CURRICULUM CONCEPT	CURRICULUM PERFORMANCE OBJECTIVE	CAREER CONCEPT AND CAREER PERFORMANCE OBJECTIVE	CAREER INFORMATION
-chain reactions -electric power from reactors -cosmic rays	The student should be able to: 1. Draw a diagram and explain briefly the fissions of $_{94}Pu^{239}$ and $_{92}U^{235}$. 2. Define or discuss briefly all of the following terms: a. critical mass b. control rod c. H-bomb d. cosmic rays e. Geiger counter f. breeder reactor	CONCEPT: Relationship of fission and fusion reactions to the work of a decontamination man OBJECTIVE: The student should be able to describe, in a brief paper, the work of a decontamination man.	DECONTAMINATION MAN 1. These workers in the field of atomic energy have the primary duty of decontaminating equipment, plant areas, and materials exposed to radioactive contaminants. They use radiation-detection instruments to locate the radiation and eliminate it by using special equipment, detergents and chemicals. They then verify the effectiveness of the decontamination. 2. Decontamination men are generally high school graduates who qualify for on-the-job training. Usually this training takes several months. 3. Salarys for these workers averaged about $4.11 an hour in 1970 as compared to $3.55 an hour in other manufacturing industries. 4. Many factors indicate a long-term expansion in this field including increased expenditures for research and development of atomic energy. Opportunities, therefore, should be quite favorable in the coming decades.

SUGGESTED TEACHING METHODS	RESOURCE MATERIALS	TEACHER'S COMMENTS

CURRICULUM:

1. Using transparencies, describe and discuss chain reactions, their use and control.

2. Using diagrams of electric power reactors, discuss their construction and operation.

3. Have a class panel discussion on the pros and cons of nuclear electric power.

4. Show and discuss the film entitled The Strange Case of Cosmic Rays available from the local Bell Telephone business office.

CAREER:

1. Have interested students do a research paper on the occupation of contamination man using the Occupational Outlook Handbook which is available from the school library or counselor's office.

2. Have interested students write to the U.S. Atomic Energy Commission for further career information.

CAREER:

SCHOOL LIBRARY OR COUNSELOR'S OFFICE:

Occupational Outlook Handbook

Dictionary Of Occupational Titles

Encyclopedia Of Careers

WRITE TO:

U.S. Atomic Energy Commission
Washington, D.C. 20545

APPENDIX

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Adventure in Science - The Size of Things	16mm	Film Associate of California	11 min.	C
Airplanes - Principles of Flight	16mm	Coronet Films	11 min.	C
Apollo in Perspective	16mm	National Aeronautics and Space Adm.	14 min.	C
Apollo Re-entry Simulation	16mm	National Aeronautics and Space Adm.	11 min.	C
Archimedes Principle	16mm	Encyclopedia Britanncia Films	6 min.	B/W
Behavior of Gases	16mm	Modern Learning Aids	15 min.	B/W
Boats - Buoyancy, Stability, Propulsion	16mm	Coronet Films	14 min.	C
Buoyancy	16mm	Film Associate of California	16 min.	C
Buoyancy	16mm	Modern Learning Aids	28 min.	C
Change of Scale	16mm	Modern Learning Aids	23 min.	C
Charting the Universe - With Optical and Radio Telescopes	16mm	Encyclopedia Britannica Films	13 min.	C
Classification of Matter	FS	Encyclopedia Britannica Films		C
Collisions of Hard Spheres	16mm	Modern Learning Aids	19 min.	B/W
Communication - Story of Its Development	16mm	Coronet Films	11 min.	C
Conservation of Energy	16mm	Modern Learning Aids	27 min.	B/W
Conservation of Momentum	FS	Popular Science		C
Coulomb's Law	16mm	Modern Learning Aids	30 min.	B/W
Coulomb Force Constant	16mm	Modern Learning Aids	34 min.	B/W

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Counting Electrical Charges in Motion	16mm	Modern Learning Aids	22 min.	B/W
Day Tomorrow Began, The	16mm	USAHL	30 min.	C
Deflecting Forces	16mm	Modern Learning Aids	30 min.	B/W
Discovering Color	16mm	Film Associate of California	15 min.	C
Discovering the Sound and Movement of Music	16mm	Film Associate of California	15 min.	C
Distributing Heat and Energy	FS	Encyclopedia Britannica Films		C
EMF	16mm	Modern Learning Aids	20 min.	B/W
Elastic Collisons and Stored Energy	16mm	Modern Learning Aids	27 min.	B/W
Electric Fields	FS	Popular Science		C
Electric Fields	16mm	Modern Learning Aids	25 min.	B/W
Electric Lines of Force	16mm	Modern Learning Aids	7 min.	B/W
Electrical Potential Energy and Potential Difference Part I	16mm	Modern Learning Aids	27 min.	B/W
Electrical Sources	16mm	Sterling Educational Films	13 min.	C
Electricity	FS	McGraw-Hill Textfilms		C
Electricity From Chemicals	16mm	Coronet Films	14 min.	C
Electricity - How It Is Generated	16mm	Coronet Films	11 min.	C
Electricity - Principles of Safety	16mm	Coronet Films	11 min.	C
Electrochemical Cells	16mm	Modern Learning Aids	22 min.	C
Electrochemistry - Linking of Two Sciences	FS	Popular Science		C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Electromagnetic Induction	16mm	Coronet Films	14 min.	C
Electro-Magnetic Radiation	FS	Popular Science		C
Electromagnetic Waves	16mm	Modern Learning Aids	33 min.	B/W
Electrons In a Unifdrm Magnetic Field	16mm	Modern Learning Aids	10 min.	B/W
Elements of Electrical Appliances	FS	Encyclopedia Britannica Films		C
Elementary Charges and Transfer of Kinetic Energy	16mm	Modern Learning Aids	34 min.	B/W
Elliptic Orbits	16mm	Modern Learning Aids	19 min.	B/W
Energy and Work	16mm	Modern Learning Aids	28 min.	B/W
Eyes and Vision	16mm	Encyclopedia Britannica Films	10 min.	B/W
Force of Gravity	16mm	McGraw-Hill Textfilms	23 min.	B/W
Forces	16mm	Modern Learning Aids	23 min.	B/W
Frames of Reference	16mm	Modern Learning Aids	28 min.	B/W
Free Fall and Projectile Motion - Falling Bodies	16mm	Modern Learning Aids	27 min.	B/W
Frontiers In Space - Exploring the Universe With Telescopes	16mm	Encyclopedia Britannica Films	11 min.	B/W
Fuels and Heat	FS	Encyclopedia Britannica Films		C
Fundamentals of Electricity	16mm	Sterling Educational Films	13 min.	C
Galileo's Laws of Falling Bodies	16mm	Encyclopedia Britannica Films	6 min.	B/W
Gas Pressure and Molecular Collisions	16mm	Modern Learning Aids	21 min.	B/W

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Gemini Rendezvous Missions	16mm	National Aeronautics and Space Adm.	13 min.	C
Gemini - The Twins	16mm	National Aeronautics and Space Adm.	14 min.	C
Gravity	FS	Elementary Science		C
Guardian of the Atom	16mm	U S National Audiovisual Center	29 min.	C
H-Bomb Over the U.S.	16mm	Brandon Films	10 min.	C
Heat and Temperature - Molecular Energy	FS	Popular Science		C
Home Electrical Appliances	FS	Encyclopedia Britannica Films		C
How AC and DC Motors Work	FS	Popular Science		C
How We measure Heat	FS	Popular Science		C
Inertia	16mm	Modern Learning Aids	26 min.	B/W
Inertial Mass	16mm	Modern Learning Aids	19 min.	B/W
Interference of Photons	16mm	Modern Learning Aids	13 min.	B/W
Introduction to Optics	16mm	Modern Lehrning Aids	23 min.	C
Laser, The - A Light Fantastic	16mm	Film Associate of California	21 min.	C
Laws of Cases, The	16mm	Coronet Films	11 min.	B/W
Laws of Motion	FS	Popular Science		C
Laws of Motion	16mm	Popular Science	12 min.	B/W
Light and Color	16mm	Encyclopedia Britannica Films	14 min.	C
Light - Illumination and Its Measurement	16mm	Coronet Films	14 min.	C

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Light - Lenses and Optical Instruments	16mm	Coronet Films	14 min.	C
Light - Reflection	16mm	Coronet Films	14 min.	C
Light - Refraction	16mm	Coronet Films	14 min.	C
Light - Wave and Quantum Theories	16mm	Coronet Films	14 min.	C
Light Waves and Their Uses	16mm	Encyclopedia Britannica Films	11 min.	B/W
Long Time Intervals	16mm	Modern Learning Aids	25 min.	B/W
Magnet Laboratory, A	16mm	Modern Learning Aids	20 min.	B/W
Magnetic Force	16mm	Modern Learning Aids	29 min.	B/W
Mass of Atoms, The Part I	16mm	Modern Learning Aids	27 min.	B/W
Mass of Atoms, The Part II	16mm	Modern Learning Aids	20 min.	B/W
Matter and Energy	FS	Coronet Films	14 min.	C
Matter Waves	16mm	Modern Learning Aids	28 min.	B/W
Measurement	16mm	Modern Learning Aids	21 min.	B/W
Measurement In Physical Science	16mm	Coronet Films	14 min.	C
Measurement of Electricty	16mm	Coronet Films	12 min.	B/W
Measuring Large Distances	16mm	Modern Learning Aids	29 min.	B/W
Measuring Short Distances	16mm	Modern Learning Aids	20 min.	B/W
Mighty Atom, The	16mm	McGraw-Hill Textfilms	25 min.	C
Millikan Experiment	16mm	Modern Learning Aids	30 min.	B/W

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Million To One, A	16mm	Modern Learning Aids	5 min.	B/W
Modern Theories of Magnetism	FS	Popular Science		C
Moving With The Center of Mass	16mm	Modern Learning Aids	26 min.	B/W
Nature of Heat, The	16mm	Coronet Films	11 min.	B/W
Newton's Law of Motion	FS	Jam Handy		C
New World of Low-Temperature, The	FS	Popular Science		C
Periodic Motion	16mm	Modern Learning Aids	33 min.	B/W
Polarized Light	FS	Popular Science		C
Photons	16mm	Modern Learning Aids	19 min.	B/W
Physical Optics - Light Waves	FS	Popular Science		C
Physics	FS	XXX		
Pressure of Light	16mm	Modern Learning Aids	23 min.	B/W
Producing Small Amounts of Electricity	FS	Jam Handy		C
Radioactivity	16mm	McGraw-Hill Textfilms	13 min.	C
Rutherford Atom	16mm	Modern Learning Aids	40 min.	B/W
Science In Space	16mm	McGraw-Hill Textfilms	27 min.	C
Science of Musical Sounds, The	16mm	Chas. Pacey (Academy Films)	11 min.	C
Series and Parallel Circuits	FS	Encyclopedia Britannica Films		C
Short Time Intervals	16mm	Modern Learning Aids	21 min.	B/W

AUDIO-VISUAL SOURCE INFORMATION

TITLE	TYPE	SOURCE	TIME	COLOR OR B/W
Simple Waves	16mm	Modern Learning Aids	27 min.	B/W
Sounds and How They Travel	16mm	Academy Films	11 min.	C
Sound Waves and Their Sources	16mm	Encyclopedia Britannica Films	11 min.	B/W
Sound Waves In Air	16mm	Modern Learning Aids	35 min.	B/W
Speed of Light	16mm	Modern Learning Aids	21 min.	B/W
Story of Lenses, The	FS	Popular Science		C
Straight Line Kinematics	16mm	Modern Learning Aids	34 min.	B/W
Understanding Color - Color by Addition	16mm	Academy Films	14 min.	C
Universal Gravitation	16mm	Modern Learning Aids	31 min.	B/W
Vectors - Directed Quantities	FS	Popular Science		C
Vetors Kinematics	16mm	Modern Learning Aids	16 min.	B/W
Vibrations	16mm	Encyclopedia Britannica Films	14 min.	B/W
Wave Motion - A Key to Modern Science	FS	Popular Science		C
What Is Electricity	16mm	Encyclopedia Britannica Films	13 min.	B/W

SOME USEFUL FORMULAS

1. Resolution of Force of Gravity

   Object Resting on Inclined Plane

   $$W : W_p = l : h$$

   W is weight of object; W_p is force tending to pull object down plane; l is length of plane; h is height of plane.

2. Coefficient of Friction

   $$u = \frac{F}{N}$$

   u is coefficient of friction; F is force of friction; N is force normal to surface.

3. Speed

   $$\text{Average Speed} = \frac{\text{distance traveled}}{\text{elapsed time}}$$

4. Velocity

   $$V_{av} = \frac{s}{t}$$

   Vav is average velocity; s is displacement; t is elapsed time.

5. Acceleration

   $$a = \frac{V_f - V_i}{t}$$

   a is acceleration; V_f is final velocity; V_i is initial velocity; t is elapsed time.

6. Accelerated Motion

   $$s = V_i t + \tfrac{1}{2}at^2 \quad \text{or} \quad s = V_i t + \tfrac{1}{2}gt^2$$

   s is displacement; V_i is initial velocity; t is elapsed time; a is acceleration or g is acceleration of gravity.

7. Newton's Second Law of Motion

   $$F = ma$$

   F is force; m is mass; a is acceleration.

8. Force and Acceleration on Bodies of Known Weight

   $$F = \frac{wa}{g}$$

   F is force; w is weight; a is acceleration; g is acceleration of gravity.

9. Weight and Mass

   $$w = mg$$

   w is weight; m is mass; g is acceleration of gravity.

10. Impulse and Change of Momentum

    $$Ft = mv_f - mv_i$$

    F is force; t is elapsed time; the product Ft is impulse; m is mass; v_f is final velocity; v_i is initial velocity; the product mv is momentum.

SOME USEFUL FORMULAS

11. Law of Universal Gravitation

$$F = G\frac{m_1 m_2}{s^2}$$

F is force of attration; G is gravitational constant; ml and m2 are masses of bodies; s is distance between their centers.

12. Centripetal Force

$$\text{Centripetal Force} = \frac{mv^2}{r}$$

m is mass; v is velocity; r is radius of path.

13. Orbiting Velocity

$$v = \sqrt{rg}$$

v is orbiting velocity; g is acceleration of gravity at distance r from center of the earth.

14. Pendulum

$$T : T' = \sqrt{l} : \sqrt{l'}$$

T is period of first pendulum; T' is period of second pendulum; l is lenght of first pendulum; l' is length of second pendulum.

15. Pendulum

$$T = 2\pi\sqrt{\frac{l}{g}}$$

T is period; l is length; g is acceleration of gravity.

16. Work

$$W = Fs$$

W is work; F is force; s is distance.

17. Power

$$P = \frac{W}{t}$$

P is power; W is work; t is time.

18. Potential Energy

$$P.E. = mgh \text{ or } P.E. = wh$$

P.E. is potential energy; m is mass; g is acceleration of gravity; h is vertical distance; w is weight.

19. Kinetic Energy

$$K.E. = \tfrac{1}{2}mv^2 \text{ or } K.E. = \frac{1}{2}\frac{wv^2}{g}$$

K.E. is kinetic energy; m is mass; v is velocity; w is weight; g is acceleration of gravity.

20. Relationship between Mass and Energy

$$E = mc^2$$

E is energy; m is mass; c is velocity of light.

21. Variation of Mass with Velocity

$$m = \frac{m_0}{\sqrt{1 - (v^2/c^2)}}$$

m is mass at velocity v; m_0 is rest mass; c is velocity of light.

22. Ideal Mechanical Advantage

$$IMA = \frac{S_e}{S_r}$$

IMA is ideal mechanical advantage; S_e is effort force distance; S_r is resistance force distance.