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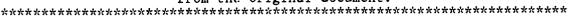   Industrial Education
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ABSTRACT
        This Idaho secondary education curriculum guide
provides lists of tasks, performance objectives, and enabling
objectives for instruction intended to impart entry-level employment
skills in industrial technology. The first list is a general job
competencies task profile, followed by a sheet on which teachers can
evaluate students' general job competencies. The remaining eight
lists are on the following topics: employability skills, force, work,
rate, resistance, energy, power, and force transformers. Each task
describes an occupational activity that will result in a finished
process or product. (CML)

Curriculum Guide for
PRINCIPLES OF TECHNOLOGY
Units 1-7

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VOCATIONAL TECHNICAL EDUCATION

STATE DIVISION OF
VOCATIONAL EDUCATION

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Curriculum Guide for

PRINCIPLES OF TECHNOLOGY

Units 1-7

Compiled by:
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Industrial Technology

Idaho Division of Vocational Education
March 1992

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GENERAL JOB COMPETENCIES

Directions: Evaluate the trainee using the rating scale below and check the appropriate number to indicate the degree of competency achieved. The numerical ratings of 3, 2, 1, and 0 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on level of student performance for each of the tasks listed below. The written test score line is provided for optional teacher use. It may not be applicable in all cases. "NA" is an appropriate entry in such instances.

Rating Scale:

0   **No Exposure** - no information nor practice provided during training program, complete training required.

1   **Exposure Only** - general information provided with no practice time, close supervision needed an additional training required.

2   **Moderately Skilled** - has performed independently during training program, limited additional training may be required.

3   **Skilled** - can perform independently with no additional training.

01.0   <u>DEMONSTRATE EMPLOYABILITY SKILLS AND HABITS</u>
         The student will be able to:
0 1 2 3
□□□□ 01.01 Identify employment opportunities.
□□□□ 01.02 Apply employment-seeking skills.
□□□□ 01.03 Interpret employment capabilities.
□□□□ 01.04 Demonstrate appropriate work behavior.
□□□□ 01.05 Maintain a business like image.
□□□□ 01.06 Maintain working relationships with others.
□□□□ 01.07 Communicate on-the-job.
□□□□ 01.08 Adapt to change.
□□□□ 01.09 Demonstrate a knowledge of business operation.

EMPLOYABILITY SKILLS OVERVIEW

This is one of a series of modules which comprise the Idaho Curriculum Guide Principles of Technology. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that vocational programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

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MODULE 0 - EMPLOYABILITY SKILLS

00.01 TASK: <u>IDENTIFY EMPLOYMENT OPPORTUNITIES</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Given the information resources of a library, obtain and compile the information needed to seek a job.

ENABLING OBJECTIVES:

1.   Identify the requirements for a job.

2.   Investigate educational opportunities.

3.   Investigate occupational opportunities.

4.   Locate resources for finding employment.

5.   Confer with prospective employers.

6.   Identify job trends.

00.02 TASK: <u>APPLY EMPLOYMENT-SEEKING SKILLS</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Given appropriate information, locate a job opportunity, prepare and take an interview for it, complete the required tests, forms and applications, and evaluate a response to the job opportunity.

ENABLING OBJECTIVES:

1.   Locate a job opening.

2.   Complete a resume.

3.   Prepare for an interview.

4.   Participate in an interview.

5.   Complete tests required.

6.   Complete forms required.

7.   Complete an application letter.

8.   Complete a follow-up letter.

9.   Complete an acceptance letter.

10.   Evaluate a job offer.

11.   Evaluate a job rejection.

00.03 TASK: <u>INTERPRET EMPLOYMENT CAPABILITIES</u>
LEVEL
E **PERFORMANCE OBJECTIVE:** Given the assignment to explain how your capabilities make you employable, demonstrate how to match skills and experience to a job being sought.

ENABLING OBJECTIVES:

1. Match an interest to job area.

2. Match aptitudes to job area.

3. Verify abilities.

4. Identify immediate work goal.

5. Develop a career plan.

00.04 TASK: <u>DEMONSTRATE APPROPRIATE WORK BEHAVIOR</u>
LEVEL
E **PERFORMANCE OBJECTIVE:** Given the responsibility of an employee in a new job, demonstrate knowledge of appropriate behavior in the workplace.

ENABLING OBJECTIVES:

1. Exhibit dependability.

2. Demonstrate punctuality.

3. Follow rules and regulations.

4. Explain the consequences of dishonesty.

5. Complete assignments accurately and on time.

6. Control emotions.

7. Take responsibility for decisions and actions.

8. Take pride in work and be a loyal worker.

9. Learn to handle pressures and tensions.

10. Demonstrate ability to set priorities.

11. Demonstrate problem-solving skills.

00.05   TASK: <u>MAINTAIN A BUSINESS-LIKE IMAGE</u>
LEVEL
  E   PERFORMANCE OBJECTIVE: Given a responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of the actions and behaviors which will project a business-like image.

ENABLING OBJECTIVES:

1.   Participate in the institution's orientation.

2.   Demonstrate knowledge of company or agency products and services.

3.   Identify the requirements for a job.

4.   Investigate educational opportunities.

5.   Investigate occupational opportunities.

6.   Locate resources for finding employment.

7.   Confer with prospective employers.

8.   Identify job trends.

00.06   TASK: <u>MAINTAIN WORKING RELATIONSHIPS WITH OTHERS</u>
LEVEL
  E   PERFORMANCE OBJECTIVE: Given the responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of how to successfully work with others.

ENABLING OBJECTIVES:

1.   Work productively with others.

2.   Show empathy, respect, and support for others.

3.   Demonstrate procedures and assist others when necessary.

4.   Recognize problems and work toward their solution.

5.   Minimize the occurrence of problems.

6.   Channel emotional reactions in positive ways.

00.07   TASK: <u>COMMUNICATE ON-THE-JOB</u>
LEVEL
   E   PERFORMANCE OBJECTIVE: Given the responsibility to perform the duties of a new
          job, with a new employer, demonstrate a knowledge of how to communicate on-the-job.

          ENABLING OBJECTIVES:

          1.   Read and comprehend written communications.

          2.   Use correct grammar.

          3.   Speak clearly when addressing others.

          4.   Use job-related terminology.

          5.   Listen attentively.

          6.   Write legibly.

          7.   Use telephone etiquette.

          8.   Follow written and oral directions.

          9.   Ask questions.

          10.   Locate information needed to complete the task.

          11.   Prepare written communication.

          12.   Demonstrate keyboarding skills.

          13.   Demonstrate computer skill.

00.08 TASK: <u>ADAPT TO CHANGE</u>

LEVEL

E **PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of how to adapt to change.

ENABLING OBJECTIVES:

1. Recognize the need to change.

2. Demonstrate a willingness to learn.

3. Demonstrate flexibility.

4. Participate in continuing education.

5. Seek challenge in the workplace.

6. Adjust goals and plans when necessary.

00.09 TASK: <u>DEMONSTRATE A KNOWLEDGE OF BUSINESS OPERATION</u>

LEVEL

E **PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of the role of that business, its employees, and the free enterprise system.

ENABLING OBJECTIVES:

1. Explain the role of business in the enterprise system.

2. List the responsibilities of employees.

3. Identify the responsibilities of managers and employers.

4. Discuss the opportunities for business ownership or management.

5. Describe the planning required to start a business.

6. Discuss the importance of business meetings.

TASK LIST

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SYSTEMS

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01.01   TASK: APPLY PRINCIPLES OF FORCE IN MECHANICAL SYSTEMS
LEVEL
E   PERFORMANCE OBJECTIVE: Given the appropriate information, materials and
       equipment, demonstrate the application of force in mechanical systems.

ENABLING OBJECTIVES:

1.   Define the concept of force in one or two sentences.

2.   Identify a common device that's used to measure force.

3.   Name the units of force used in System International (SI) and the English
       measuring system.

4.   Describe what happens when forces on an object are balanced.

5.   Describe what happens when forces on an object are unbalanced.

6.   Briefly define the following: scalar, vector, weight, mass and torque.

7.   Use scale diagrams to determine the resultant force on an object when two or
       more forces act on it.

8.   Describe torque's relationship to clockwise and counterclockwise movement.

9.   Solve torque problems, given force and lever arm information.

10.   Describe a situation where technicians measure and apply forces in a mechanical
       system.

11.   Distinguish between a scalar and a vector quantity.

12.   Produce a scale drawing of a given vector at a given angle from a reference
       system.

13.   Determine the actual magnitude and direction of a vector from its given scale
       drawing.

14.   Add vectors that act in the same direction.

15.   Add vectors that act in opposite directions.

16.   Add vectors that act at any angle each with other.

17. Substitute in the formula for torque ($T = F \times L$) and calculate a torque, given values for the force (F) and the lever arm (L).

18. Identify five types of mechanical stress that occur around the home or in a factory.

19. Measure the effects of forces pulling on a spring.

20. Plot on a graph the relationship between the force applied to a spring and the resulting change in length of the spring.

21. Measure forces--in newtons or pounds--by using appropriate scales.

22. Suspend a weight from two cords. Measure the tension (force) in each cord.

23. Make a scale drawing (vector diagram) that illustrates the force in each rope.

24. Use the vector diagram to determine the resultant force.

01.02 TASK: <u>DEMONSTRATE THE PRINCIPLES OF PRESSURE IN FLUID SYSTEMS</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Given appropriate information, materials and equipment, demonstrate the application of pressure in fluid systems.

ENABLING OBJECTIVES:

1.   Differentiate between hydraulic and pneumatic systems.

2.   Find the density of a substance, given its mass and volume.

3.   Determine the specific gravity of a substance, given its density and the density of water.

4.   Define buoyant force in one or two sentences.

5.   Define pressure. Identify it as a vector or scalar quantity.

6.   Explain where atmospheric pressure comes from. State the sea level standard value for atmospheric pressure in the appropriate system of measure.

7.   Find pressure, force or area, using the formula, $p = {}^F/_A$, given any two of the quantities in the formula.

8.   Describe the difference between absolute and gage pressure.

9.   Explain how pressure in a fluid depends on depth of fluid.

10.   Solve for one quantity, given the other two, in the following equation:
$p = Pw \times h$.

11.   Describe how fluid pressure is a forcelike quantity.

12.   Given a fluid system with two connected reservoirs, describe fluid levels in each reservoir that will cause fluid motion between reservoirs, or that will cause no motion.

13.   Explain how manometers are used to measure pressures.

14.   Describe how a technician might have to measure and/or control pressure in a fluid system.

15.   Given two of three quantities in an equation, solve the equation for the third quantity.

16.   Substitute numerical values in equations for density and fluid pressure, and solve the equation for the unknown quantity.

17.   Measure the specific gravity of a liquid with a hydrometer.

18. Measure pressures above atmospheric pressure with a manometer and a mechanical pressure gage.

19. Measure pressures below atmospheric pressure with a manometer and a mechanical pressure gage.

20. Calculate the absolute pressure, given the gage and atmospheric pressure.

01.03 TASK: <u>DEMONSTRATE THE PRINCIPLE OF VOLTAGE IN ELECTRICAL</u>
<u>SYSTEMS</u>

LEVEL
E   PERFORMANCE OBJECTIVE: Given the appropriate information, materials and
equipment demonstrate the application of voltage in electrical systems.

ENABLING OBJECTIVES:

1.   Differentiate between AC and DC current.

2.   Identify the most common source of DC voltage.

3.   Describe the sequence for connecting a DC circuit in series so that voltages will
add.

4.   Identify three components of a circuit, including a source, conductor and load
(*light bulb*), and give their symbols.

5.   Describe how frequency and hertz relate to AC current.

6.   Briefly describe how voltage can be considered a "*forcelike*" quantity.

7.   Name at least three types of voltmeters.

8.   Briefly describe a situation that requires a technician to measure voltage.

9.   Draw a line graph to represent given information (numbers).

10.   Use a line graph to extract certain information.

11.   Connect voltage sources to increase total voltage.

12.   Use a voltmeter to measure voltages by selecting the proper settings for the
function switch and range switch.

13.   Connect batteries, predict total voltage and verify by measurement with a
multimeter.

14.   Read schematic drawings of simple circuits.

15.   Connect simple circuits. Measure voltage rise and voltage drop.

16.   Examine a circuit. Draw a schematic diagram of the circuit.

01.04   TASK: <u>APPLY TEMPERATURE PRINCIPLES IN THERMAL SYSTEMS</u>
LEVEL
  E   PERFORMANCE OBJECTIVE: Given appropriate information, materials and
       equipment, demonstrate the application of temperature principles in thermal systems.

       ENABLING OBJECTIVES:

       1.   Identify the direction of movement of heat energy in a thermal system when
             temperature information is known.

       2.   Name and describe the "forcelike" quantity in a thermal system.

       3.   Define temperature in one or two sentences.

       4.   Describe the relationship between heat energy and molecular motion, including
             how heat energy moves through a system.

       5.   Given Celsius or Fahrenheit temperatures and the formula for conversion, find
             the equivalent temperature on the alternate scale.

       6.   Summarize in a few sentences when the degree symbol (°) should follow or
             precede the "F" of "C" abbreviation.

       7.   Describe how a thermocouple thermometer measures temperature.

       8.   Briefly describe a situation that requires a technician to control temperature.

       9.   Use a formula to calculate the Fahrenheit temperature, given the Celsius
             temperature.

       10.   Use a formula to calculate the Celsius temperature, given the Fahrenheit
             temperature.

       11.   Calibrate a liquid-in-glass thermometer to indicate the temperature in degrees
             (Celsius for degrees Fahrenheit).

       12.   Use a liquid-in-glass thermometer to measure temperatures.

       13.   Draw a thermocouple circuit. Briefly explain how a thermocouple works.

       14.   Set up a thermocouple circuit for temperature measurement.

       15.   Measure Celsius temperature with a thermocouple to within plus or minus (+) 2
             C°.

       16.   If you know the voltage reading of a thermocouple, use the thermocouple
             calibration table to find the temperature.

MODULE 2 - WORK

02.01 TASK: SOLVE WORK PROBLEMS IN MECHANICAL SYSTEMS
LEVEL
  E PERFORMANCE OBJECTIVE: Given the necessary materials and equipment, solve work problems in mechanical systems.

ENABLING OBJECTIVES:

1. Define work done by a force in a mechanical system.

2. Explain the relationship between work done on a object, force applied and the distance an object moves.

3. Identify the effects of work done by a force in a mechanical system.

4. Solve work problems, given force and distance information in English and SI units.

5. Explain how efficiency relates to input work and output work for a mechanical system.

6. Define work done by a torque in a mechanical system.

7. Define radian measure of angles.

8. Explain the relationship between work done on an object, torque applied and the angle (in radians) through which the object moves.

9. Identify the effects of work done by a torque in a mechanical system.

10. Solve work problems, given torque and angle information in English and SI units.

11. Identify workplace applications where work in mechanical systems occurs.

12. Given an angle in degrees, find its value in radians.

13. Given an angle in revolutions, find its value in radians.

14. Solve mechanical work problems.

15. Determine the work done by a force that acts on a pulley

16. Determine the work done by a force that acts on a load.

17. Show by calculation that the work done by a pulley on a load is less than the work done by the force acting on the pulley.

18. Calculate the efficiency of a pulley system.

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02.02 TASK: <u>DEMONSTRATE THE APPLICATION OF WORK DONE BY A WINCH</u>

LEVEL

E   PERFORMANCE OBJECTIVE: Provided with the appropriate equipment demonstrate the work done by a winch.

ENABLING OBJECTIVES:

1.   Determine the work done by a torque that acts on a winch.

2.   Determine the work done by a torque that acts on a load.

3.   Show by calculation that the work done by a winch on a load is less than the work done by a torque acting on the winch.

4.   Calculate the efficiency of a winch.

02.03   TASK: <u>APPLY THE PRINCIPLES OF WORK DONE IN FLUID SYSTEMS</u>

LEVEL

E   PERFORMANCE OBJECTIVE: Given the necessary materials and equipment, apply the principles of work done in fluid systems.

ENABLING OBJECTIVES:

1.   Describe how open and closed fluid systems are different.

2.   Describe what is meant by work done in a fluid system.

3.   Explain the relationship between work and pressure in a fluid system, as given in the equation,

WORK = CONSTANT PRESSURE X FLUID VOLUME MOVED.

4.   Explain the relationship between work and pressure in a fluid system, as given in the equation,

WORK = PRESSURE DIFFERENCE X VOLUME MOVED.

5.   Solve work problems (given pressure and volume information) in English and SI units.

6.   Identify the effects of work done on a fluid.

7.   Identify workplace applications where work occurs in fluid systems.

02.04 TASK: <u>APPLY MATH SKILLS NEEDED TO CALCULATE WORK DONE IN MECHANICAL FLUID SYSTEMS</u>

LEVEL
E **PERFORMANCE OBJECTIVE:** Provided with the proper materials, solve related math problems associated with work being done in mechanical and fluid systems.

ENABLING OBJECTIVES:

1. Given the equation for linear work, W - F X D, rearrange the equation. Solve for *force* (F) or distance (D).

2. Given the equation for rotational work, $W = T X \theta$, rearrange the equation. Solve for torque (T) or rotational angle (θ).

3. Given the equation for fluid work, $W = p X (V)$, rearrange the equation. Solve for pressure (p) or volume moved (V).

4. Substitute appropriate numerical values and units in work equations. Solve the equations.

02.05 ASK: <u>DEMONSTRATE THROUGH APPLICATION THE WORK DONE BY A PISTON</u>

LEVEL
E **PERFORMANCE OBJECTIVE:** Given the appropriate supplies and equipment, calculate the work done by a piston.

ENABLING OBJECTIVES:

1. Calculate the mechanical work done on a piston by a force that moves the piston.

2. Calculate the fluid work done by a piston on a gas that's compressed by the piston.

3. Measure the mechanical and fluid work done by a piston that compresses gas in a cylinder.

02.06 TASK: <u>CALCULATE THE WORK DONE BY A WATER PUMP</u>

LEVEL

E   **PERFORMANCE OBJECTIVE:** Given the necessary pieces of equipment, measure the work done by a water pump.

ENABLING OBJECTIVES:

1.   Measure the pump work required to lift a given volume of water to a given height, using the mechanical work formula:

    WORK = CONSTANT PRESSURE X FLUID VOLUME MOVED.

2.   Measure the pump work required to lift a given volume of water a given height, using the fluid work formula:

    WORK = PRESSURE DIFFERENCE X VOLUME MOVED FROM HIGH PRESSURE TO LOW PRESSURE

3.   Determine the efficiency of a water pump by comparing fluid work done by the pump to the electrical work done on the pump.

02.07 TASK: <u>SOLVE PROBLEMS RELATING TO WORK DONE IN ELECTRICAL SYSTEMS</u>

LEVEL

E   **PERFORMANCE OBJECTIVE:** Given the appropriate materials and equipment, solve problems showing work done in electrical systems.

ENABLING OBJECTIVES:

1.   Describe work in electrical systems in terms of the equation,

    WORK = VOLTAGE X ELECTRICAL CHARGE MOVED.

2.   Identify a basic unit of electrical charge as the coulomb.

3.   Identify a coulomb as the charge that 6,250,000,000,000,000,000 electrons (6.25×10^{18}) have.

4.   Solve electrical work problems, given voltage and charge information.

5.   Identify the effects of work done in electrical systems.

6.   Identify workplace applications where work in electrical systems occurs.

7.   Explain how efficiency relates to input work and output work in an electrical system.

8.   Read the voltage indicated on the scale of a multimeter when the meter range and function are specified.

9.   Solve electrical work problems, given voltage and charge information.

02.08 TASK: <u>DETERMINE THE WORK DONE BY MOTORS AND SOLENOIDS</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Provide $\cdot$ with the necessary tools and materials determine the work done by motors and solenoids.

ENABLING OBJECTIVES:

1.   Give a general definition of a motor.

2.   Determine the electrical energy used by a motor in a measured period of time. Identify this as "Work Input."

3.   Determine the useful work done by a motor. Identify this as "Work Output."

4.   Calculate the efficiency of a motor.

5.   Identify the main parts of a solenoid.
6.   Describe how the solenoid works.

7.   List five devices or applications that use solenoids.

8.   Set up a lab experiment to measure the pulling force and the holding force exerted on a solenoid plunger for different voltages applied across the solenoid.

9.   Identify the mechanical and electrical work involved in the operation of a solenoid.

03.01 TASK: MEASURE RATE IN MECHANICAL SYSTEMS

LEVEL

E   **PERFORMANCE OBJECTIVE:** Given the necessary information, materials and equipment measure rate in mechanical systems.

ENABLING OBJECTIVES:

1.   Distinguish between linear motion and rotational motion.

2.   Use the equation, $v = \ell/t$ to describe a linear rate or speed (v) as the distance (ℓ) an object travels along a line in a unit of time (t).

3.   Use the equation, $v_{av} = d/t$ to calculate average speed for non-uniform motion over a distance, d, in time, t.

4.   Describe linear acceleration (a) as linear speed (v) per unit time (t) by using the equation, $a = \dfrac{v_f - v_i}{t}$.

5.   Rearrange the equation for constant linear speed, $v = \ell/t$. Isolate linear displacement (ℓ) or elapsed time (t).

6.   Rearrange the equation for constant rotational speed, $\omega = \theta/t$. Isolate angular displacement (θ) or elapsed time (t).

7.   Rearrange the equation for constant linear acceleration, given the equation, $a = \dfrac{v_f - v_i}{t}$. Isolate the final linear speed (v_f).

8.   Describe an angular rate or speed (ω) as angular distance (θ) traveled per unit of time (t) by using the equation, $\omega = \theta/t$.

9.   Use the equation, $a = \dfrac{w_f - w_i}{t}$ to describe an angular acceleration (a) as angular speed (ω) per unit time (t).

10.   Calculate linear and angular rates by using the correct rate equations.

11.   Identify workplace applications where technicians measure or control rate in mechanical systems.

12.   Measure rates in mechanical systems.

13.   Rearrange the equation for constant angular acceleration, given the equation, $\alpha = \dfrac{w_f - w_i}{t}$. Isolate the final linear speed (ω_f).

14.   Substitute correct numerical values and units in rate equations. Solve the equations for a numerical value with appropriate units.

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03.02 TASK: MEASURE RATES ON CONVEYOR BELTS
LEVEL
E   PERFORMANCE OBJECTIVE: Provide the appropriate materials and equipment measure rates on conveyor belts.

ENABLING OBJECTIVES:

1.   Measure the linear rate (speed) of objects moving on a conveyor belt.

2.   Measure the production rate of objects coming off a conveyor belt.

3.   Determine the angular rate (rpm) of a conveyor belt.

03.03 TASK: MEASURE ANGULAR RATE WITH A STROBOSCOPE
LEVEL
E   PERFORMANCE OBJECTIVE: Given a stroboscope, correctly measure angular rate of rotation operating tools and pieces of equipment.

ENABLING OBJECTIVES:

1.   Measure the angular rate of high-speed rotating objects with a stroboscope.

2.   Express angular rate in revolutions per minute (rpm) or radians per second.

03.04   TASK: <u>DEMONSTRATE THE APPLIED PRINCIPLES OF RATE IN FLUID SYSTEMS</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Provided with the necessary materials and equipment, demonstrate the application of rate in fluid systems.

ENABLING OBJECTIVES:

1.   Describe a volume-flow rate (Q_v) as volume of fluid (V) moved per unit time (t), or $Q_v = V/t$.

2.   Describe a mass-flow rate (Q_m) as mass of fluid (m) moved per unit time (t), or $Q_m = m/t$.

3.   Explain the meaning of the fluid rate equations. Use them to find an unknown.

4.   Measure rates in fluid systems.

5.   Identify workplace applications where technicians measure or control rate in fluid systems.

6.   Use power-of-ten notation, where appropriate, to express large numbers in fluid rate problems. Multiply and divide numbers in power-of-ten notation.

7.   Given the equation for volume-flow rate, $Q_v = V/t$, rearrange the equation to isolate V or t. Solve for volume-flow rate (Q_v), volume (V), or elapsed time (t).

8.   Given the equation for mass-flow rate, $Q_m = m/t$, rearrange the equation to isolate m or t. Solve for mass-flow rate (Q_m), mass (m) or elapsed time (t).

9.   Substitute appropriate numerical values and units in fluid rate equations. Solve the equations for the unknown variable.

03.05   TASK: <u>MEASURE LIQUID-FLOW RATE IN A CHANNEL</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Given measuring devices, measure liquid-flow rate in a channel.

ENABLING OBJECTIVES:

1.   Measure the linear-flow rate of water in a channel.

2.   Calculate the volume-flow rate in a channel, given the dimensions of the channel and its linear-flow rate.

3.   Describe the function of a wire.

4.   Compare measurements of flow rate in a channel to flow rate measurements made with the help of a calibrated container and a stopwatch.

03.06   TASK: <u>MEASURE GAS-FLOW RATES WITH AN ORIFICE</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Given an orifice and calibration chart, measure gas-flow rates.

ENABLING OBJECTIVES:

1.   Measure gas volume moved and time of movement to determine gas-flow rate through a pipe.

2.   Identify how pressure difference across an orifice plate in a pipe changes as the gas-flow rate increases or decreases.

3.   Explain how an orifice plate and a calibration chart are used to find gas-flow rates in a pipe.

03.07 TASK: DEMONSTRATE THE PRINCIPLE OF RATE IN ELECTRICAL SYSTEMS
LEVEL
  E   **PERFORMANCE OBJECTIVE:** Given the appropriate materials, supplies and equipment, demonstrate the principle of rate in electrical systems.

ENABLING OBJECTIVES:

1. Describe charge-flow rate (I) as quantity of charge moved (q) per unit time (t), or $I = q/t$.

2. Explain the meaning of rate in electrical systems. Use rate equations to find an unknown.

3. Distinguish between DC and AC current.

4. Distinguish between frequency and period.

5. Determine period and peak-to-peak voltage of the signal when given a waveform display and control settings on an oscilloscope.

6. Determine frequency and peak-to-peak voltage of the signal when given a waveform display and control settings on an oscilloscope.

7. Substitute numerical values and units in electrical rate equations. Solve for unknown.

8. Measure rates in electrical systems.

9. Use a volt-ohm-milliammeter (VOM) to measure DC current.

10. Use a digital multimeter (DMM) to measure DC current.

11. State the proper safety procedures to follow when using DMMs and VOMs.

12. Identify workplace applications where technicians measure and/or control rate in electrical systems.

13. Use an oscilloscope to measure the period and amplitude of an electrical signal.

14. Use an oscilloscope to determine the frequency of an electrical signal.

15. Use a function generator to provide a specified electrical waveform (signal).

03.08 TASK: <u>DEMONSTRATE THE PRINCIPLES OF RATE IN THERMAL SYSTEMS</u>
LEVEL
  E   PERFORMANCE OBJECTIVE: Given the necessary equipment and demonstrate skills
        needed to apply the principles of rate in thermal systems.

ENABLING OBJECTIVES:

1.   Describe the heat-flow rate (Q_H) as heat energy (H) moved per unit time (t), or
           $Q_H = {}^H/t$.

2.   Define rate units for thermal systems, using both English and SI measure.

3.   Define heat capacity and specific heat.

4.   Explain the meaning of the equation for thermal system rate. Use this equation
           to find an unknown value.

5.   Explain the difference between sensible and latent heat.

6.   Express a numerical value and unit, such 3.4×10^3 meters, in prefix notation (3.4
           millimeters).

7.   Rearrange the equation for heat-flow rate $Q_H = {}^H/t$. Solve for heat energy (H) or
           elapsed time (t).

8.   Rearrange the equation for heat-flow rate caused by a temperature difference
           across a substance, $Q_H = \underline{KA\Delta T}$. Solve for thermal conductivity (k), area of the
           substance ℓ

           (A) temperature difference across the material (ΔT) or the material thickness (ℓ).

9.   Substitute appropriate numerical values and units in rate equations. Solve the
           equations.

10.   Measure heat rate in a thermal system.

11.   Identify workplace applications where technicians measure and control rate in
           thermal systems.

03.09   TASK: <u>DEMONSTRATE PROPER USE OF TERM COUPLE DEVICES IN</u>
                 <u>MEASURING HEAT-FLOW RATE</u>

LEVEL
  E   PERFORMANCE OBJECTIVE: Set up the proper lab equipment and conduct lab
         experiments to demonstrate proper use of term couple devices in measuring heat-flow
         rate.

         ENABLING OBJECTIVES:

         1.   Determine temperature with a thermocouple and thermocouple tables without
               using a controlled-reference junction.

         2.   Explain the meaning of the term "steady state" as it applies to a thermal system.

         3.   Determine the heating rate of a DC electric heater (in calories per second) if
               voltage and current are known.

         4.   Determine the heat-flow rate out of a container during a steady-state condition if
               the input heat rate is known.

         5.   Describe how the heat-flow rate across two faces of an object depends on:

               a.   thermal conductivity of the material in the object.

               b.   surface area of the faces.

               c.   temperature difference between the two faces.

               d.   material thickness between the two faces.

         6.   Set up a lab experiment to measure the effect of thermal conductivity and surface
               area on heat-flow rate.

         7.   Use the formula, $O_H = \dfrac{KA \Delta T}{\ell}$ to calculate heat-flow rate through a given object.

04.01 TASK: <u>APPLY PRINCIPLES OF RESISTANCE IN MECHANICAL SYSTEMS</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Given the appropriate information, materials and equipment, demonstrate the application of resistance in mechanical systems.

ENABLING OBJECTIVES:

1.   Describe what's meant by resistance in general.

2.   Explain how resistance in each energy system relates to the unifying principle of a "force" divided by a rate.

3.   Identify correct SI and English units for resistance in each energy system.

4.   Identify good and bad effects of resistance in each energy system.

5.   Identify workplace applications where technicians measure or control resistance.

6.   Measure resistance in mechanical system.

7.   Identify sources of resistance in mechanical systems.

8.   Distinguish between static and kinetic friction.

9.   Describe kinetic friction as a resistance between moving surfaces.

10.   Explain the relationship between frictional force (f), the coefficient of friction (μ) and the force pressing two surfaces together (N).

11.   Use the equation, $f = \mu N$, to calculate an unknown.

12.   Show that a drag obeys the unifying principle of a "force" divided by a rate.

13.   Describe ways to reduce or increase friction in mechanical systems.

14.   Measure frictional forces in real applications.

15.   Identify workplace applications where technicians measure and control resistance in mechanical systems.

16.   Rearrange the equation for the coefficient of friction, $\mu = {}^{f}/_{N}$. Isolate the frictional (f) or the normal (N) pressing the two surfaces together.

17.   Restate the equation $\mu = {}^{f}/_{N}$ with proper subscripts for conditions of static and kinetic friction.

18.   Substitute appropriate numerical values and units in resistance equations. Solve the equations for a numerical value with the proper units.

04.02 TASK: <u>DEMONSTRATE THE PRINCIPLES OF FRICTION</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Given the appropriate supplies and materials, demonstrate through application the principles of friction.

ENABLING OBJECTIVES:

1.   Measure the pulling needed to move an object horizontally over a given surface at constant speed when surface textures are varied.

2.   Measure the pulling required to move a weighted object across a given surface, at constant speed, with and without surface lubrication.

3.   Measure the drag on two or three objects of different shapes.

4.   Prepare a graph that shows how drag depends on airflow speed for each of the objects.

04.03   TASK: <u>APPLY THE BASIC PRINCIPLES OF RESISTANCE IN FLUID AND AIR SYSTEMS</u>

LEVEL
E   PERFORMANCE OBJECTIVE: Provided with appropriate materials, apply the principles of resistance in fluid and air systems.

ENABLING OBJECTIVES:

1.   Describe resistance in fluid systems.

2.   Distinguish between streamlined and turbulent flow.

3.   Identify sources of resistance for a fluid moving through a pipe.

4.   Describe dragforce as resistance to objects moving through fluids.

5.   Identify the effects of resistance in a fluid flowing through a pipe.

6.   Compare resistance in a fluid system to resistance in a mechanical system.

7.   Show that fluid resistance obeys the unifying principle of a "*force*" divided by a rate in the equation, $R_F = {^{\Delta P}}/{Qv}$.

8.   Use the equation, $R_F = {^{\Delta P}}/{Qv}$ to find an unknown.

9.   Explain how fluid resistance in a pipe depends on (1) pipe area, (2) pipe length and (3) type of fluid.

10.   Describe how to reduce fluid resistance in a system.

11.   Measure fluid resistance in the lab. Express it in appropriate units.

12.   Identify workplace applications where fluid resistance is important.

13.   Isolate the change in pressure (Δp) or the volume-flow rate (Qv) when given the equation for fluid resistance $R_F = {^{\Delta P}}/{Qv}$.

14.   Substitute appropriate numerical values and units in fluid resistance equations. Solve the equations for a numerical value with proper units.

15.   Measure volume-flow rate of water that flows through a tube using a rotameter.

16.   Determine the pressure drop (pressure difference) across sections of tube.

17.   Graph pressure difference versus flow rate of air through tubes of different lengths and different cross-sectional areas. Relate the graphs to fluid resistance of the different tubes.

18. Measure the pressure drop across filter sections in air ducts.

19. Measure the pressure difference across a set of standard restrictor plates. Develop a calibration curve of pressure difference versus restriction.

20. Show that increased contamination of filters causes increased resistance to airflow and decreases flow rate.

21. Rearrange the equation for drag resistance, $R_D = {}^F/v$. Isolate the drag (F) or the speed of the object (v) moving in a fluid.

04.04 TASK: <u>APPLY BASIC ELECTRONIC PRINCIPLES TO SOLVE RESISTANCE</u>
<u>PROBLEMS IN ELECTRICAL SYSTEMS</u>

LEVEL
E   PERFORMANCE OBJECTIVE: Given the appropriate information, materials and equipment, demonstrate the basic electronic principles used to solve resistance problems in electrical systems.

ENABLING OBJECTIVES:

1.   Describe resistance in electrical systems.

2.   Show that electrical resistance can be understood in terms of the unifying principle of a "force" divided by a rate.

3.   Use a graph to explain the relationship between resistance, voltage and current (Ohm's law).

4.   Use the equation, $R_E = \Delta V / I$, to solve for an unknown.

5.   Show how resistance in a wire depends on (1) the length of the wire, (2) cross-sectional area of wire, and (3) the material the wire is made of.

6.   Define resistivity.

7.   Explain how wire resistance in electrical systems is similar to pipe resistance in fluid systems.

8.   Find total resistance of two or more resistors in parallel hookups and in series hookups.

9.   Distinguish between conductors, semiconductors and insulators.

10.   Measure resistance in electrical systems.

11.   Identify workplace applications where technicians measure and control resistance in electrical systems.

12.   Isolate the change in voltage (ΔV), or the current (I) by rearranging Ohm's law given in the form, $R_E = \Delta V / I$.

13.   Isolate the resistivity (p), the length of the wire (ℓ), or the cross-sectional area (A), by rearranging the equation $R_E = p\ell / A$.

14.   Find the resistance of a resistor using a table of resistor color codes.

15.   Substitute correct numerical values and units in resistance equations. Solve the equations for a numerical value with the proper units.

16.   Measure voltages and current in a series circuit.

17. Find the resistance of a resistor in a series circuit without measuring its resistance directly.

18. Find the total resistance of a series circuit.

19. Draw schematic and pictorial diagrams of circuits.

20. Compare the accuracy of resistance by color code to actual readings made with a DMM.

21. Measure voltage and current in a parallel circuit.

22. Calculate total resistance of several parallel resistors without directly measuring the resistance.

23. Find the total resistance in a parallel circuit containing resistances.

24. Draw pictorial and schematic diagrams of circuits.

25. Use a volt-ohm-milliammeter (VOM) to measure resistor resistance.

04.05   TASK: <u>APPLY THE PRINCIPLES OF RESISTANCE IN THERMAL SYSTEMS</u>
LEVEL
   E   PERFORMANCE OBJECTIVE: Given the necessary materials and equipment, apply the
         principles of resistance in thermal systems.

         ENABLING OBJECTIVES:

         1.   Describe resistance in a thermal system.

         2.   Identify the effects of resistance in a thermal system.

         3.   Define thermal conductivity.

         4.   Explain the relationship between resistance, temperature difference and heat-flow
                 rate.

         5.   Show that thermal resistance obeys the unifying principle of a "force" divided by
                 a rate.

         6.   Use the equation, $R_T = \dfrac{\Delta T}{Q_H}$, to find an unknown.

         7.   Use the equation, $R_T = \dfrac{\ell}{kA}$, to find an unknown.

         8.   Explain the meaning of the R-factor as a measure of relative thermal resistance
                 of insulation.

         9.   Measure thermal resistance in the lab.

         10.   Identify what can be done to reduce--or increase--thermal resistance.

         11.   Identify workplace applications where technicians measure and control resistance
                 in thermal systems.

         12.   Rearrange the basic equation for thermal resistance, $R_T = \Delta T/Q_H$, to isolate
                 the temperature difference (ΔT) or the heat-flow rate Q_H.

         13.   Isolate the material thickness (ℓ), thermal conductivity (K) or or the area (A), by
                 rearranging the equation for thermal resistance, $R_T = \ell/kA$.

         14.   Substitute correct numerical values and units in resistance equations.   Solve
                 equations for a numerical value with the proper units

         15.   Find the temperature difference across a piece of insulation through which heat
                 energy is flowing.

         16.   Find the thermal resistance of a piece of insulation.

         17.   Determine the effectiveness of thermal insulation on hot-water pipes.

         18.   Find the thermal resistance of pipe insulation.

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MODULE 5 - ENERGY

05.01 TASK: <u>APPLY ENERGY PRINCIPLES IN A MECHANICAL SYSTEM</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Given the appropriate information, materials and pieces of equipment, demonstrate the application of energy in mechanical systems.

ENABLING OBJECTIVES:

1.   Describe the nature of energy in mechanical systems.

2.   Describe what's meant by "potential energy."

3.   Describe what's meant by "kinetic energy."

4.   Describe the relationship between potential energy, kinetic energy and heat energy in the conservation-of-energy law.

5.   Describe the relationship between work and energy.

6.   Identify appropriate SI and English units for energy in mechanical systems.

7.   Measure energy in mechanical systems.

8.   Identify workplace applications where technicians measure or control energy.

9.   Distinguish between gravitational potential energy and elastic potential energy.

10.   Calculate gravitational potential energy. Use the formula, $E_p = \omega h$.

11.   Calculate elastic potential energy. Use the formula, $E_p = \frac{1}{2} \kappa d^2$.

12.   Calculate a spring constant. Use the formula $k = {}^F\!/d$.

13.   Measure potential energy (E_p).

14.   Identify workplace applications where technicians measure and control potential energy.

15.   Rearrange the equation for gravitational potential energy, $E_p = mgh$, to solve for mass (m), gravitational constant (g), or height (h).

16.   Rearrange the equation, $E_p = \frac{1}{2} \kappa d^2$, to solve for a spring constant (k) or the distance (d) a spring extends or compresses.

17. Rearrange the equation for a spring constant, $k = F/d$ to solve for force (F) applied to the spring, or the distance (d) the spring extends or compresses.

18. Substitute correct numerical values and units in energy equations. Solve the equations for a numerical value with the proper units.

19. Use a stroboscope to measure the speed of a rotating flywheel.

20. Use a formula to calculate the kinetic energy of a rotating flywheel.

21. Set up an experiment to measure the kinetic energy of a rotating flywheel.

05.02 TASK: <u>DEMONSTRATE THE PRINCIPLES OF ENERGY IN MECHANICAL AND</u>
<u>FLUID SYSTEMS</u>

LEVEL

E PERFORMANCE OBJECTIVE: Provided with the appropriate materials, demonstrate through application the energy principles as they relate to mechanical and fluid systems.

ENABLING OBJECTIVES:

1. Distinguish between linear kinetic energy and rotational kinetic energy.

2. Calculate fluid potential energy. Use SI units and English units.

3. Calculate linear kinetic energy, using the formula $E_\kappa = \frac{1}{2} m v^2$.

4. Describe what's meant by the moment of inertia (I) of rotating bodies.

5. Calculate rotational kinetic energy using the formula, $E_\kappa = \frac{1}{2} I \omega^2$.

6. Describe the relationship between work and mechanical energy.

7. Use the law of conservation of energy to describe how one form of energy is changed into another form.

8. Measure kinetic energy.

9. Identify workplace applications where technicians measure and control kinetic energy.

10. Rearrange the equation to solve for mass (m), or linear speed (v), when given the equation for linear kinetic energy, $E_\kappa = \frac{1}{2} m v^2$.

11. Rearrange the equation to solve for moment of inertia (I), or rotational speed (ω), when given the equation for rotational kinetic energy, $E_\kappa = \frac{1}{2} I \omega^2$.

12. Substitute correct numerical values and units in energy equations. Solve the equations for a numerical value with the proper units.

13. Use the energy stored in compressed air to operate an air motor.

14. Measure the rotational speed of an air motor.

15. Find the pressure drop across an operating air motor.

16. Relate change in pressure drop across an air motor--and change in rotation speed--to change in output load on the air motor.

17.   Descibe how a hydraulic accumulator absorbs and releases energy within a hydraulic system.

18.   Describe the effect of accumulators in systems where sudden change in pressure occur.

19.   Set up a hydraulic system with an accumulator. Measure the effect of pressure pulses in the system with and without the accumulator.

05.03   TASK: APPLY ENERGY CONCEPTS IN BASIC ELECTRICAL SYSTEMS
LEVEL
   E   PERFORMANCE OBJECTIVE: Given the proper equipment and materials, describe
       and apply energy concepts in basic electrical systems.

ENABLING OBJECTIVES:

1.   Describe the nature of potential energy in an electrical system.

2.   Describe a capacitor. Explain how a capacitor works.

3.   Define capacitance.

4.   Use the equation, $E_P = \frac{1}{2} CV^2$, to find the electrical energy stored in a
       capacitor.

5.   Describe an inductor and how an inductor works.

6.   Define inductance.

7.   Use the equation, $E_P = \frac{1}{2} LI^2$, to calculate energy stored in an inductor.

8.   Describe the relationship between work and electrical energy.

9.   Measure electrical energy stored in a capacitor.

10.   Measure electrical energy stored in an inductor.

11.   Identify workplace applications where technicians measure and control energy in
       an electrical system.

12.   Given the equation for potential energy stored in a capacitor, $E_P = \frac{1}{2} CV^2$,
       rearrange the equation to solve for capacitance (C), or voltage (V).

13.   Given the equation for potential energy stored in an inductor, $E_P = \frac{1}{2} LI^2$,
       rearrange the equation to solve for inductance (L), or current (I).

14.   Substitute correct numerical values and units in energy quotations. Solve the
       equations for a numerical value with the proper units.

15.   Find the amount of energy stored in a capacitor, given the voltage across the
       capacitor and its capacitance.

16.   Interpret a graph provided by a strip-chart recorder.

17.   Use a rotameter to measure the airflow rate through an air motor.

18.   Determine the amount of energy input to an air motor from a measure of the
       pressure drop across it, and the flow rate through it.

19.   Find the amount of energy dissipated in a resistor of known resistance from
       measured values of voltage, current and time.

20.   Identify energy losses in the conversion of fluid energy to electrical energy.

05.04 TASK: <u>DEMONSTRATE THE PRINCIPLES OF ENERGY IN THERMAL SYSTEMS</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Given the appropriate information and pieces of
       equipment, apply the principles of energy in thermal systems.

       ENABLING OBJECTIVES:

       1.   Describe the relationship between thermal energy and work.

       2.   Define the mechanical equivalent of heat.

       3.   Use the equation, $H = mc\Delta T$, to find how much heat energy is transferred
               between two objects at different temperatures.

       4.   Describe three ways to transfer heat energy.

       5.   Describe how heat energy changes states--from solids to liquids to gases and back
               again.

       6.   Describe the role of heat energy in the law of conservation of energy.

       7.   Measure the transfer of heat energy.

       8.   Identify workplace applications where technicians measure or control energy in
               thermal systems.

       9.   Substitute appropriate numerical values and units in the heat-transfer equation,
               $H = mc\Delta T$, to determine a specified unknown quantity.

       10.   Solve practical problems involving heat transfer between hot and cold objects.

       11.   Describe the changes that occur when thermal energy is added to a substance.

       12.   Define the specific heat of a material.

       13.   Find the final temperature of a mixture of hot and cold water.

       14.   Set up an experiment to measure the final temperature of a mixture.

       15.   Set up an apparatus to find the specific heat of a solid material.

       16.   Measure the specific heat of a material. Give its value in appropriate units.

06.01   TASK: APPLY PRINCIPLES OF POWER IN MECHANICAL SYSTEM

LEVEL

E   PERFORMANCE OBJECTIVE: Given the appropriate information, materials and equipment, demonstrate the application of power in mechanical systems.

ENABLING OBJECTIVES:

1.   Describe what's meant by power in general.

2.   Explain how power in each energy system relates to the unifying principle of work divided by time.

3.   Explain why power also can be described in terms of a "force" times a rate for mechanical, fluid and electrical systems.

4.   Identify technical workplace applications where technicians measure or control power.

5.   Define power in a linear mechanical system as work divide by time
$$P = \frac{W}{t} \text{ , or } P = \frac{F \times D}{t}$$

6.   Explain why power in a linear mechanical system also can be described as times a rate: $P = F \times \frac{D}{t}$ or $P = F \times v$

7.   Define power in a rotational mechanical system as work divided by time:
$$P = \frac{W}{t} \text{ or } P = \frac{T \times \theta}{t}$$

8.   Explain why power in a rotational mechanical system also can be described as a "force" times a rate: $P = T \times \frac{\theta}{t}$, or $P = T \times \omega$.

9.   Identify units of power in mechanical systems.

10.   Define efficiency as output power/input power.

11.   Measure power in mechanical systems.

12.   Work problems that involve units of power in both English and SI units.

13.   Solve problems that involve the power formulas:
$$P = \frac{W}{t} \text{, or } P = \frac{F \times D}{t}, P = F \times v \text{, and } P = T \times \omega .$$

06.02   TASK: <u>MEASURE POWER IN LINEAR AND ROTATIONAL MECHANICAL</u>
                <u>SYSTEMS</u>

LEVEL
  E   PERFORMANCE OBJECTIVE: Given the appropriate informat: n, materials and
        equipment, properly measure power in linear and rotational mechanical systems.

        ENABLING OBJECTIVES:

        1.   Measure the electrical input power to a motor that does mechanical work.

        2.   Find the mechanical output power of a motor that raises a load at a constant
                speed.

        3.   Find the efficiency of a motor that converts electrical power to mechanical power
                while doing mechanical work.

        4.   Measure the angular speed of a rotating disc with a stroboscope.

        5.   Find the rotational kinetic energy of a spinning flywheel (disc), given its mass,
                radius and angular speed.

        6.   Find the average power it takes to stop a rotating mechanical object.

06.03 TASK: <u>DEMONSTRATE THE PRINCIPLES OF POWER IN FLUID/AIR SYSTEMS</u>
LEVEL
E   PERFORMANCE OBJECTIVE: Provided the materials and equipment, demonstrate the applications of power in various fluid/air systems.

ENABLING OBJECTIVES:

1.   Define power in a fluid system as work divided by time:
$$P = \frac{(\Delta P) \times V}{t}, \text{ or } P = \frac{P \times (\Delta V)}{t}.$$

2.   Show that power in a fluid system obeys the unifying principle of work divided by time, or "*force*" times a rate.

3.   Use the equation for power in a fluid system to solve for an unknown.

4.   Measure power in fluid systems.

5.   Identify workplace applications where technicians measure or control power in fluid systems.

6.   Recognize units used to make power measurements in fluid systems. Use the units correctly.

7.   Solve problems that involve power in fluid energy systems.

8.   Show that the higher the amount of fluid moved per unit of time, the higher the fluid power developed.

9.   Explain why it takes more power to move a fluid through a vertical distance than through an equal horizontal distance if the fluid rate is the same.

10.   Set up a hydraulic system to measure and calculate fluid power.

11.   Describe an air motor. Explain how it works.

12.   Use an air motor to lift a load.

13.   Measure pressure drop across, and flow rate through, an air motor.

14.   Measure the efficiency of an air motor.

06.04   TASK: <u>APPLY THE PRINCIPLE OF POWER IN ELECTRICAL SYSTEMS</u>
LEVEL
   E   PERFORMANCE OBJECTIVE: Given the appropriate instruction materials and
        equipment, demonstrate through discussion and application the principle of power in
        electrical systems.

        ENABLING OBJECTIVES:

        1.   Define power in an electrical system as electrical work divided by time, or
                $P = \dfrac{(\Delta V) \times q}{t}$.

        2.   Explain why power in an electrical system also can be described as a voltage
                times a current. Since voltage is a "forcelike" quantity, this means that power in
                an electrical system also is a "force" times a rate.

        3.   Show that power in an electrical system obeys the unifying principle of work
                divided by time, or "force" times a rate.

        4.   Define the units for electrical power.

        5.   Use the equation for power in an electrical system to solve for an unknown.

        6.   Measure power in an electrical system.

        7.   List workplace applications where technicians measure or control power in fluid
                systems.

        8.   Compute an electric bill when given KWh of energy used.

        9.   Solve problems that involve power in an electrical energy system.

        10.   Given problems where mixed units are involved, convert all units to one system.
                Then solve the problems for answers that are expressed in the desired units.

        11.   Describe a meter than can be used to measure the electrical energy used by
                various electrical devices and appliances.

        12.   Read the dials on a typical electric meter.

        13.   Do measurements and calculations to find the electrical energy used by various
                electrical devices.

        14.   Measure the electrical power used to operate DC motors.

        15.   Measure the output electrical power of a generator that's being driven by a DC
                motor.

        16.   Find the efficiency of a motor/generator assembly.

06.05 TASK: RELATE POWER FORMULAS IN THERMAL SYSTEMS
LEVEL
E **PERFORMANCE OBJECTIVE:** Given the necessary materials, calculate power using two unifying formulas.

ENABLING OBJECTIVES:

1. Define power in a thermal system as work (energy) divided by time.

2. Relate power in a thermal system to thermal rate.

3. Define power in a thermal system as times rate.

4. Explain how thermal power and thermal rate are the same.

5. Calculate various problems using the two unifying formulas.

MODULE 7 - TRANSFORMERS

07.01   TASK: <u>SOLVE LINEAR TRANSFORMER PROBLEMS IN MECHANICAL
                SYSTEMS</u>

LEVEL

E   PERFORMANCE OBJECTIVE: Given the necessary instruction and materials, solve
    various problem relating to linear transformers in mechanical systems.

ENABLING OBJECTIVES:

1.   Describe transformers in general.

2.   Explain why transformers form a unifying principle in mechanical systems.

3.   List examples of transformers in mechanical systems.

4.   Explain the relationship between Input Work and Output Work for linear
        transformers.

5.   Use the equation, Work In = Work Out, to find an unknown force or displace-
        ment when using a particular force transformer.

6.   Explain the difference between ideal mechanical advantage (IMA) and actual
        mechanical advantage (AMA).

7.   Find the ideal mechanical advantage and actual mechanical advantage of a force
        transformer.

8.   Determine the efficiency of a force transformer.

9.   Explain the difference between three classes of levers.

10.   List or identify different kinds of force transformers for linear mechanical
        systems.

11.   Identify workplace applications where technicians use force transformers.

12.   Measure the mechanical advantage of a linear force transformer.

13.   Define ratio. Give an example.

14.   Define proportion. Give an example.

15.   Show that the work equation, $F_i \times D_i = F_o \times D_o$, leads to a useful proportion,

        $$\frac{F_o}{F_i} = \frac{D_i}{D_o}$$

16. Solve linear mechanical force transformer problems for mechanical advantage. Make use of ratios and proportions.

17. Describe how a come-along winch works. Tell how it's made up of three simple machines. Explain which kind of transformer each machine is.

18. Measure input force, input displacement, output force and output displacement of a come-along winch in operation.

19. Use a come-along winch. Determine its ideal mechanical advantage, actual mechanical advantage and efficiency.

20. Identify the main parts of the simple machine known as the screw.

21. Find the ideal mechanical advantage of a given pipe vise.

22. Measure input and output forces in a pipe clamp. Find the actual mechanical advantage.

07.02 TASK: <u>DEMONSTRATE THE PRINCIPLE OF TRANSFORMERS IN</u>
             <u>ROTATIONAL MECHANICAL SYSTEMS</u>

LEVEL
  E   PERFORMANCE OBJECTIVE: Provided with the proper equipment, demonstrate the
         principle of transformers in rotational mechanical systems.

         ENABLING OBJECTIVES:

         1.   Explain the relationship between the input work and output work for rotational
                 force transformers.

         2.   Find the mechanical advantage and efficiency of a wheel and axle.

         3.   Find the mechanical advantage and efficiency of a belt-drive system.

         4.   Find the mechanical advantage and efficiency of a gear-drive system.

         5.   ꞁ ꞏst of identify various rotational force transformers.

         6.   Measure the mechanical advantage of a rotational force transformer.

         7.   Identify workplace applications where technicians use rotational force
                 transformers.

         8.   Solve and interpret rotational force transformer problems for mechanical
                 advantage and efficiency.

         9.   Distinguish between force, torque and speed mechanical advantages.

         10.   Find the ideal mechanical advantage of a spur-gear drive train. Count the
                 number of teeth and measure the diameters of the various gears.

         11.   Find the ideal mechanical advantage of a warm-and-wheel gear train. Measure
                 the gear-wheel diameter and worm gear pitch.

         12.   Measure input and output forces in gear trains. Find the actual mechanical
                 advantages of the two drives.

         13.   Find the efficiencies of the two lab gear trains from the measurements of the two
                 lab gear trains from the measurements of input/output forces and input/output
                 displacements.

         14.   Find the mechanical advantage and efficiency of a belt-drive system.

         15.   Identify the pros and cons of V-belt and cogged-belt drive systems.

07.03 TASK: <u>APPLY THE PRINCIPLE OF TRANSFORMERS IN FLUID SYSTEMS</u>
LEVEL

E PERFORMANCE OBJECTIVE: Given the necessary materials and pieces of equipment, demonstrate through ampliation the principles of transformers in fluid systems.

ENABLING OBJECTIVES:

1. Describe force transformers in fluid systems.

2. Explain why force transformers form a unifying principle in fluid systems.

3. List examples of force transformers in fluid systems.

4. Relate input work to output work for a hydraulic jack.

5. Find the mechanical advantage of a hydraulic jack.

6. Explain how pressure is amplified in a pressure intensifier.

7. Find the efficiency of a pressure intensifier.

8. List of identify various fluid transformers.

9. Measure the mechanical advantage of a fluid transformer.

10. Identify workplace applications where technicians use fluid transformers.

11. Solve and interpret "*force*" transformer problems for fluid systems.

12. Relate ideal mechanical advantage to ratio of piston face areas (or diameters) on input and output sides of the transformer.

13. Relate actual mechanical advantage to ratio of forces (or pressures) on input and output sides of the transformer.

14. Recognize that a hydraulic jack combines a simple lever and a hydraulic transformer.

15. Assemble an apparatus that tests the principles of a hydraulic jack.

16. Find the mechanical advantage of a hydraulic jack.

17. Measure the input work and output work of a hydraulic jack. Find the jack's efficiency.

18. Connect two air cylinders of different diameters in such a way as to build a pressure intensifier.

19. Given the diameters of the two air cylinder pistons, find the ideal mechanical advantage of the lab pressure intensifier.

20. From the measurements of input/output pressure and distance traveled, find both the efficiency and the actual mechanical advantage of the lab apparatus.

07.04 TASK: <u>DETERMINE THE RESULTS OF TRANSFORMERS IN ELECTRICAL SYSTEMS</u>
LEVEL

E **PERFORMANCE OBJECTIVE:** Provided the necessary tools and materials, determine the results of transformations in electrical systems.

ENABLING OBJECTIVES:

1. Describe force Transformers in electrical systems.

2. Explain why force transformers form a unifying principle in electrical systems.

3. List examples of force transformers in electrical systems.

4. Describe how a voltage transformer is used to "step up" or "step own" AC voltage.

5. Explain the relationship between input power and output power for a voltage transformer.

6. Explain the relationship between voltage in, voltage out, and number of wire windings in a voltage transformer.

7. Find the "electrical" advantage of a voltage transformer.

8. Find the efficiency of a voltage transformer.

9. Measure the "electrical" advantage of a voltage transformer.

10. Identify workplace applications where technicians use electrical transformers.

11. Solve and interpret "*force*" transformer problems in electrical systems.

12. Distinguish between step-up and step-down transformer actions for both voltage and current.

13. Use a voltage transformer to step down input voltage.

14. Use a voltage transformer to step up input voltage.

15. Find the ideal and actual electrical advantage of a transformer.

16. Find power in, power out--and the operating efficiency of a simple transformer.