Glencoe Science

## Chapter Resources

# Work and Simple Machines

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### Reproducible Student Pages

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# Reproducible Student Pages

## Reproducible Student Pages

### ■ Hands-On Activities



### ■ Meeting Individual Needs

#### Extension and Intervention



### ■ Assessment



### ■ Transparency Activities

# Hands-On Activities

TRY AT HOME Mini LAB

# Work and Power

## Procedure

1. Weigh yourself on a **scale.**
2. Multiply your weight in pounds by 4.45 to convert your weight to newtons. Record your data in the Data and Observations section.
3. Measure the vertical height of a **stairway.**
   **WARNING:** *Make sure the stairway is clear of all objects.*
4. Time yourself walking slowly and quickly up the stairway.

## Data and Observations

| | |
|---|---|
| Your weight × 4.45 | |
| Vertical height of stairway | |
| Walking slowly up stairway | |
| Walking quickly up stairway | |

## Analysis

Calculate and compare the work and power in each case.

Mini LAB

# Observing Pulleys

## Procedure

1. Obtain two **broomsticks.** Tie a 3-m-long **rope** to the middle of one stick. Wrap the rope around both sticks four times.
2. Have two students pull the broomsticks apart while a third pulls on the rope.
3. Repeat with two wraps of rope.

## Analysis

1. Compare the results.

___

___

2. Predict whether it will be easier to pull the broomsticks together with ten wraps of rope.

___

___

# LAB Building the Pyramids

## Lab Preview

**Directions:** *Answer these questions before you begin the Lab.*

1. What safety materials does this lab call for? Why might they be needed?

___

2. Why is it important to measure the height of the books?

___

***Imagine moving 2.3 million blocks of limestone, each weighing more than 1,000 kg. That is exactly what the builders of the Great Pyramid at Giza did. Although no one knows for sure exactly how they did it, they probably pulled the blocks most of the way.***

## Real-World Question

How is the force needed to lift a block related to the distance it travels?

### Materials

wood block
tape
spring scale
ruler
thin notebooks
meterstick
several books

### Goals

- **Compare** the force needed to lift a block with the force needed to pull it up a ramp.

### Safety Precautions

### Procedure

1. Stack several books together on a table-top to model a half-completed pyramid. Measure the height of the books in centimeters. Record the height on the first row of the data table under *Distance.*
2. Use the wood block as a model for a block of stone. Use tape to attach the block to the spring scale.
3. Place the block on the table and lift it straight up the side of the stack of books until the top of the block is even with the top of the books. Record the force shown on the scale in the data table under *Force.*
4. **Arrange** a notebook so that one end is on the stack of books and the other end is on the table. Measure the length of the notebook and record this length as distance in the second row of the data table under *Distance.*
5. **Measure** the force needed to pull the block up the ramp. Record the force in the data table.

LAB (continued)

6. Repeat steps 4 and 5 using a longer notebook to make the ramp longer.
7. **Calculate** the work done in each row of the data table.

## Data and Observations

| Distance (cm) | Force (N) | Work (J) |
|---|---|---|
| | | |
| | | |
| | | |

## Conclude and Apply

1. **Evaluate** how much work you did in each instance.

2. **Determine** what happened to the force needed as the length of the ramp increased.

3. **Infer** How could the builders of the pyramids have designed their task to use less force than they would lifting the blocks straight up? Draw a diagram below to support your answer.

## Communicating Your Data

Add your data to that found by other groups. **For more help refer to the Science Skill Handbook.**

Name ____________________ Date __________ Class __________

*Design Your Own*

# Pulley Power



## Lab Preview

**Directions:** *Answer these questions before you begin the Lab.*

**1.** What is a pulley?

______________________________________________

______________________________________________

**2.** Why is it important to use safety goggles and to be careful when using a pulley?

______________________________________________

______________________________________________

***Imagine how long it might have taken to build the Sears Tower in Chicago without the aid of a pulley system attached to a crane. Hoisting the 1-ton I beams to a maximum height of 110 stories required large lifting forces and precise control of the beam's movement.***

***Construction workers also use smaller pulleys that are not attached to cranes to lift supplies to where they are needed. Pulleys are not limited to construction sites. They also are used to lift automobile engines out of cars, to help load and unload heavy objects on ships, and to lift heavy appliances and furniture.***

## Real-World Question

How can you use a pulley system to reduce the force needed to lift a load?

## Form a Hypothesis

Write a hypothesis about how pulleys can be combined to make a system of pulleys to lift a heavy load, such as a brick. Consider the efficiency of your system.

### Goals

- **Design** a pulley system.
- **Measure** the mechanical advantage and efficiency of the pulley system.

### Safety Precautions

**WARNING:** *The brick could be dangerous if it falls. Keep your hands and feet clear of it.*

### Possible Materials

single- and multiple-pulley systems
nylon rope
steel bar to support the pulley system
meterstick
**metric tape measure*
variety of weights to test pulleys
force spring scale
brick
**heavy book*
balance
**scale*
**Alternate materials*

## Test Your Hypothesis

### Make a Plan

1. Decide how you are going to support your pulley system. What materials will you use?
2. How will you measure the effort force and the resistance force? How will you determine the mechanical advantage? How will you measure efficiency?
3. **Experiment** by lifting small weights with a single pulley, double pulley, and so on. How efficient are the pulleys? In what ways can you increase the efficiency of your setup?
4. Use the results of step 3 to design a pulley system to lift the brick. On a separate sheet of paper, draw a diagram of your design. Label the different parts of the pulley system and use arrows to indicate the direction of movement for each section of rope.

### Follow Your Plan

1. Make sure your teacher approves your plan before you start.
2. Assemble the pulley system you designed. You might want to test it with a smaller weight before attaching the brick.
3. **Measure** the force needed to lift the brick. How much rope must you pull to raise the brick 10 cm?

## Analyze Your Data

1. **Calculate** the ideal mechanical advantage of your design.

______________________________

2. **Calculate** the actual mechanical advantage of the pulley system you built.

______________________________

3. **Calculate** the efficiency of your pulley system.

______________________________

4. How did the mechanical advantage of your pulley system compare with those of your classmates?

______________________________

## Conclude and Apply

1. **Explain** how increasing the number of pulleys increases the mechanical advantage.

______________________________

2. **Infer** How could you modify the pulley system to lift a weight twice as heavy with the same effort force used here?

______________________________

3. **Compare** this real machine with an ideal machine.

______________________________

## Communicating Your Data

Show your design diagram to the class. Review the design and point out good and bad characteristics of your pulley system. **For more help, refer to the Science Skill Handbook.**

LAB 1 Laboratory Activity

# Calculating Work and Power

When work is done on an object, energy is transferred to the object. When a force acts on an object and moves that object a certain distance, work is done on the object. Work ($W$) is defined by the following equation.

$$W = F \times d$$

In this equation, $F$ represents a force acting on the object and $d$ represents the distance through which the object moves as that force acts on it. In the metric system, force is measured in newtons (N), and distance is measured in meters (m). If a force of 1 newton acts on an object and the object moves 1 meter while the force is acting on it, the value of $F \times d$ equals 1 newton-meter (N-m), which is the same as to 1 joule (J) of energy being transferred.

Power ($P$) is the rate at which work is done. It can be calculated by the following equation.

$$P = W/t$$

In this equation, $W$ represents the work done and $t$ represents the amount of time required to do the work. In the metric system, the unit of power is the watt (W). If 1 joule of work is done in 1 second, $W/t$ has a value of 1 J/s, which is equal to 1 watt.

## Strategy

You will determine the amount of work required to lift an object.
You will determine the power used while lifting the object.

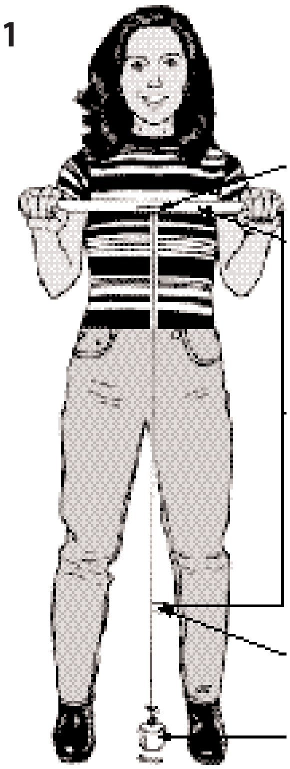
## Materials

spring scale
mass (1-kg)
scissors
string
dowel (wood, about 50 cm long)
masking tape
wire tie (plastic-coated)
meterstick
stopwatch

## Procedure

1. Weigh the 1-kg mass using the metric spring scale. Record this value in the Data and Observations section.
2. Cut a 1.3-m length of string. Tightly tie one end of the string to the center of the wood dowel. Secure the knot with a piece of masking tape to prevent the string from slipping.
3. Make a small loop at the other end of the string and knot it. Attach the 1-kg mass to the loop with a plastic-coated wire tie.
4. Measure a 1-m distance along the string from the dowel using the meterstick. Mark this distance on the string with a small strip of masking tape.
5. Hold the dowel at both ends as shown in Figure 1.

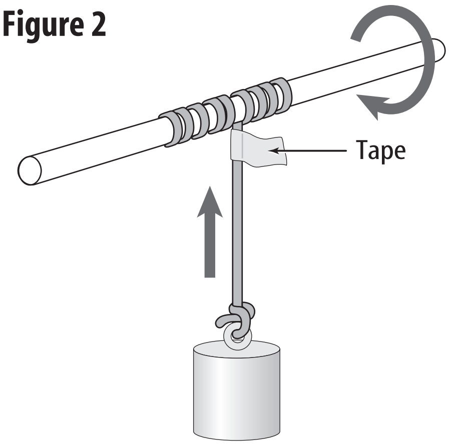
**Figure 1**



## Laboratory Activity 1 (continued)

6. Raise the 1-kg mass by winding up the string on the dowel as shown in Figure 2. Keep the winding motion steady so that the string winds up and the mass rises at a constant speed. Practice raising the mass in this manner several times.
7. You are now ready to have your lab partner measure the time it takes for you to raise the mass a distance of 1 m.
8. Suspend the 1-kg mass from the dowel as before. At a signal from your lab partner, begin to raise the mass at a constant speed by winding the string on the dowel.

**Figure 2**




Have your lab partner use a stopwatch to measure the time required for the piece of masking tape on the string to reach the dowel. Record this value under Student 1 in Table 1.

9. Reverse roles with your lab partner and allow him or her to repeat steps 6–8. Record the time value under Student 2 in Table 1.
10. The size of the force that was needed to raise the 1-kg mass is equal to the weight of 1 kg. The distance that the 1-kg mass was raised is the distance between the dowel and the piece of masking tape, which is 1 m. Record the values for the force and distance under Student 1 and Student 2 in Table 1.
11. Calculate the work you did to raise the 1-kg mass and record this value under Student 1 in Table 2.
12. Calculate the power you developed lifting the 1-kg mass. Record the value under Student 1 in Table 2.
13. Complete Table 2 using your lab partner's data from Table 1.

## Data and Observations

Weight of 1-kg mass: ____________

**Table 1**

| Measurement | Student 1 | Student 2 |
|---|---|---|
| time | | |
| force (N) | | |
| distance | | |

## Laboratory Activity 1 (continued)

**Table 2**

| Calculation | Student 1 | Student 2 |
|---|---|---|
| work (J) | | |
| power (W) | | |

## Questions and Conclusions

**1.** Compare the amounts of work that you and your lab partner did.

**2.** Why would you expect both amounts of work to be the same?

**3.** Compare the amounts of power developed by you and your lab partner.

**4.** Why would you expect the amounts of power to differ?

**5.** How do the amounts of work and power depend on the speed at which the 1-kg mass is lifted?

## Strategy Check

_______ Can you determine the amount of work required to lift an object?

_______ Can you determine the power used while lifting an object?

LAB 2 Laboratory Activity

# The Bicycle



You have learned about many simple machines that are used in compound machines. The bicycle is a familiar compound machine that uses a wheel and axle.

James Starley designed and manufactured one of the first successful bicycles in 1868. He developed his design so that once it was moving, only a small amount of force would be required to keep the vehicle and driver in motion on level ground.

A multigear bicycle can either multiply its speed or increase the force on the wheels. However, it can never do both at the same time. If the bicycle's gears increase the force on the wheels, then the pedals turn at a faster rate than the wheels do. If the gears decrease the force on the wheels, the wheels turn faster than the pedals. The mechanical advantage of a bicycle is the number of times the force applied by the rider's legs is multiplied. The speed advantage is the number of times the wheel turns for each rotation of the pedals. As the mechanical advantage increases, the speed advantage decreases.

## Strategy

You will determine the mechanical advantage and the speed advantage of a multigear bicycle.
You will explain the relationship between mechanical advantage and speed advantage.
You will describe the distance traveled by a bicycle depending on the gear combination used.

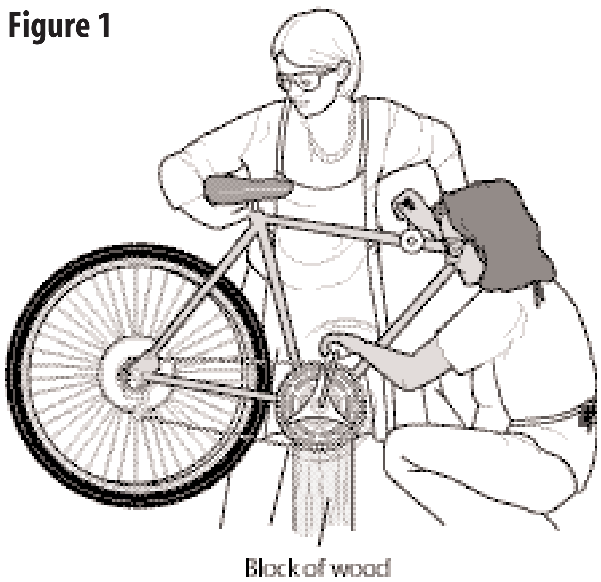
## Materials

30-cm-long block of wood
multigear bicycle
meterstick

## Procedure

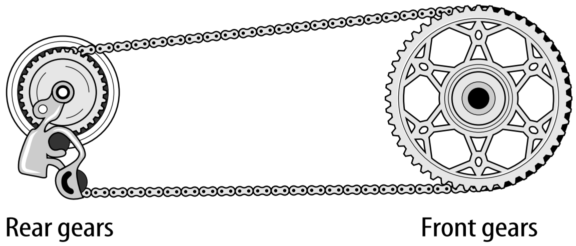
1. Place a block of wood under the bottom bracket of the bicycle's frame so the rear wheel is lifted off the ground. Have your lab partner steady the bicycle by holding the handle bars and the seat as shown in Figure 1.
2. **WARNING:** *Avoid placing your hand or any object near the rear wheel, chain, or gears.* Rotate the pedals with one of your hands to make the rear wheel turn. Shift the gears and observe the speed of the rear wheel as you shift through each gear. Be sure to continue rotating the pedal as you switch gears. Switching gears without moving the pedal may result in the chain jumping off the gears. Record your observations in the Data and Observations section.
3. Remove the bicycle from the block of wood and lay it on its side. Count the number of teeth in each gear of both the front section and rear section. Record the data in Table 1.

**Figure 1**



## Laboratory Activity 2 (continued)

**Figure 2**




4. Measure the diameter of the bicycle's rear wheel to the nearest centimeter. Record this in the Data and Observations section.
5. Set the bicycle upright. Place the gears in the lowest gear combination, with the chain on the smallest sprocket of the front gears and the largest sprocket of the back gears.
6. Measure how many centimeters the bicycle travels as the pedal makes one complete revolution. Mark the starting and ending points using the front edge of the front tire and measure the distance between these two points. Record this distance in the Experimental column in the data table.
7. Repeat steps 5 and 6 for each of the other gear combinations. Record your observations.
8. Calculate the mechanical advantage (M.A.) for each gear combination using the equation below. Record your answers.

$$\text{M.A.} = \frac{\text{number of teeth on rear gear}}{\text{number of teeth on front gear}}$$

9. Calculate the speed advantage (S.A.) for each gear combination using the equation below. Record your answers.

$$\text{S.A.} = \frac{\text{number of teeth on front gear}}{\text{number of teeth on rear gear}}$$

10. Find the theoretical distance the bicycle should travel as the pedal makes one revolution for each gear combination using the equation below. Record your answers. ($\pi = 3.14$)

$$\text{Distance} = \text{S.A.} \times \text{rear wheel diameter} \times \pi$$

11. Calculate the experimental error between the theoretical and the experimental distance traveled using the equation below. Record your answers.

$$\text{Percent error} = \frac{\text{theoretical} - \text{experimental}}{\text{theoretical}} \times 100\%$$

12. Graph the mechanical advantage versus the speed advantage on graph 1.

## Data and Observations

1. Effect shifting gears has on the rear wheel speed:

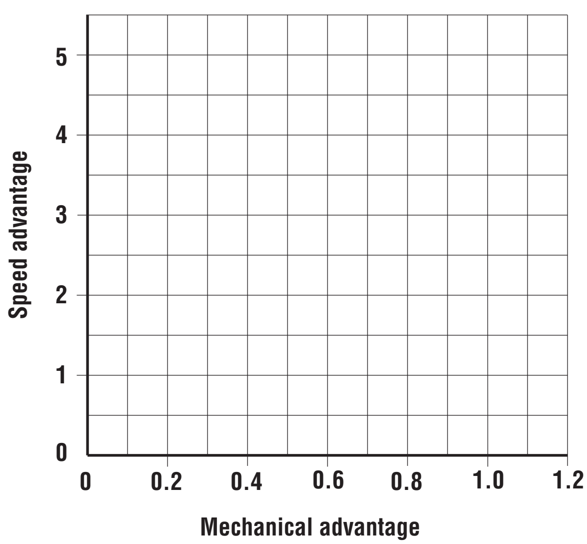
______________________________________

______________________________________

2. Bicycle's rear wheel diameter:

______________________________________

**Graph 1**



## Laboratory Activity 2 (continued)

**Table 1**

| Front teeth | Rear teeth | M.A. | S.A. | Experimental distance (cm) | Theoretical distance (cm) | Percent error |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## Questions and Conclusions

1. Why is a high mechanical advantage important to bicycle riders?

2. Why is a high speed advantage important to bicycle riders?

3. What simple machines are involved in a bicycle?

4. What is the mathematical relationship between mechanical advantage and speed advantage?

## Laboratory Activity 2 (continued)

**5.** Which gear combination produced the greatest mechanical advantage in the bicycle you tested?

______________________________

**6.** Which gear combination produced the greatest speed advantage in the bicycle you tested?

______________________________

______________________________

______________________________

**7.** Under what conditions is friction useful in riding a bicycle?

______________________________

______________________________

______________________________

**8.** How does friction make riding a bicycle more difficult?

______________________________

______________________________

______________________________

## Strategy Check

_______ Can you determine the mechanical advantage and the speed advantage of a multigear bicycle?

_______ Can you explain the relationship between mechanical advantage and speed advantage?

_______ Can you describe the distance traveled by a bicycle depending on the gear combination used?

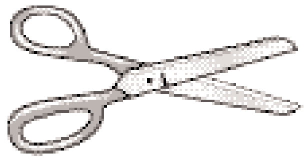
FOLDABLES Reading & Study Skills

# Work and Simple Machines



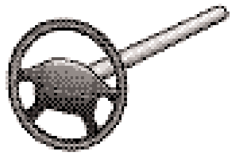
**Directions:** *Use this page to label your Foldable at the beginning of the chapter.*

# Work



## Inclined Plane

## Lever

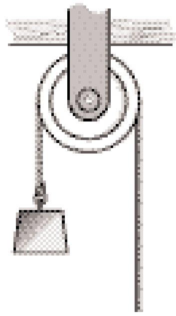


## Wheel and Axle

## Pulley

**Work is done when a force causes an object to move.**

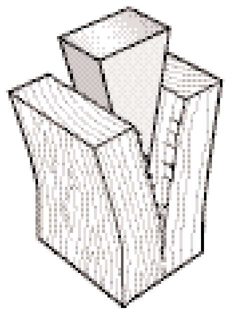
**2 circular objects of different sizes attached to rotate together**



**2 types include screws and wedges**

**a grooved wheel with a rope or chain wrapped around it**

**any rod that rotates or pivots about a fulcrum**



# Meeting Individual Needs

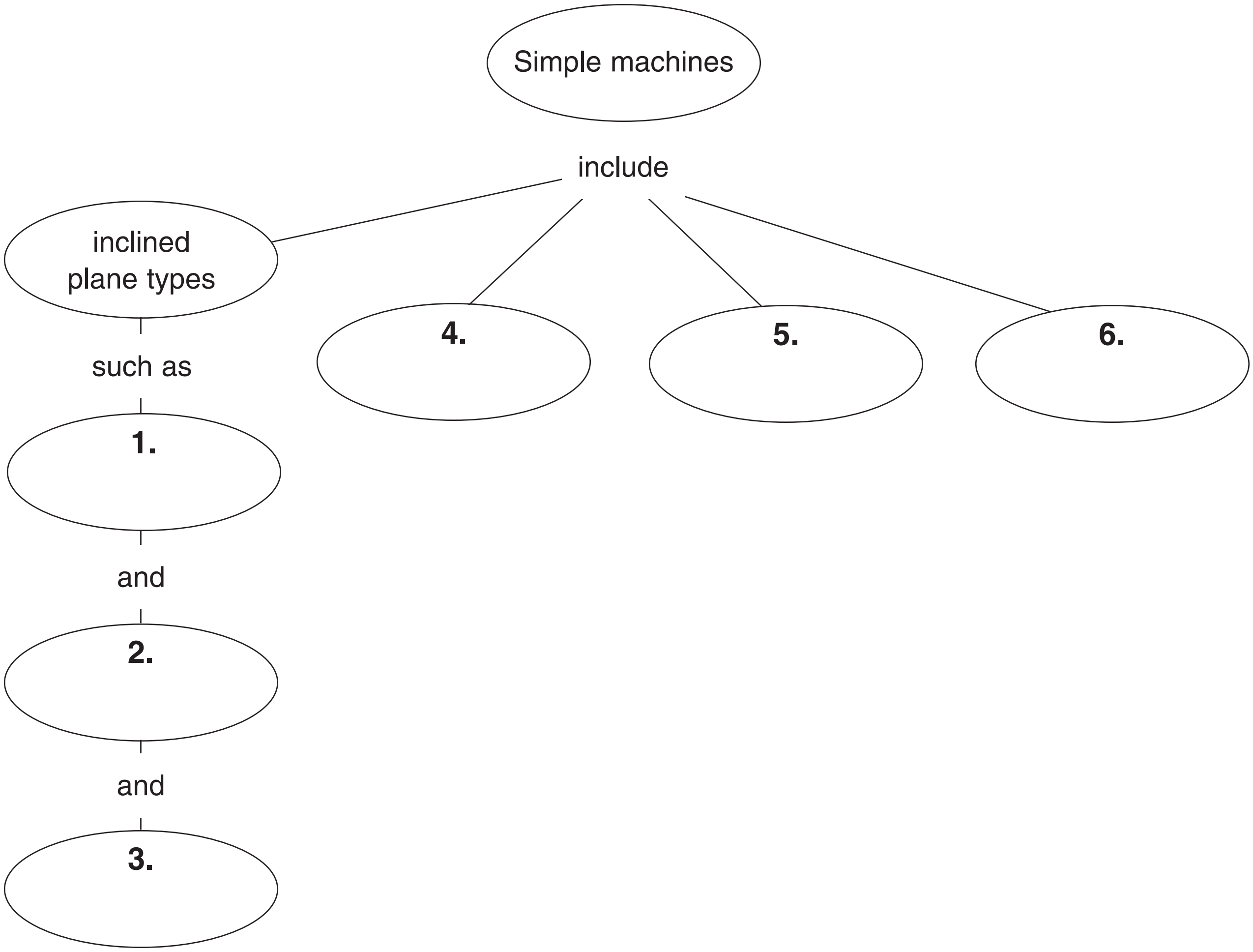
Name Date Class

Directed Reading for Content Mastery

## *Overview*
## Work and Simple Machines

**Directions:** *Use the following terms to complete the concept map below.*

| | | |
|---|---|---|
| **pulleys** | **inclined planes** | **levers** |
| **wheels and axles** | **screws** | **wedges** |




**Directions:** *In the spaces provided, write the letters of the words or phrases that best answer the questions.*

_______ **7.** Why are machines useful?
**a.** They can increase force.
**b.** They can increase distance over which force acts.
**c.** They can change direction of force.
**d.** all of these

_______ **8.** If you are standing still and holding a heavy iron doorstop in front of the class to demonstrate a wedge, are you doing work?
**a.** yes **b.** no **c.** maybe **d.** all of these

Meeting Individual Needs

Directed Reading for Content Mastery

# Section 1 ▪ Work and Power

**Directions:** *Write* **work** *on the line provided if work is done, and* **none** *if no work is done.*

______ **1.** Someone is sitting on a cushion on the floor.

______ **2.** The cushion is picked up and put on the couch.

______ **3.** The cushion is put back on the floor.

______ **4.** A baseball is hit into the bleachers.

______ **5.** You lift your arms over your head.

______ **6.** You study two hours for a science test.

______ **7.** A little girl on a swing is pushed by her father.



**Directions:** *Draw lines matching the units of measure in Column I with the words in Column II as used in the formula below.*

| Column I | Column II |
|---|---|
| **8.** watt (W) | **a.** time |
| **9.** newton (N) | **b.** distance |
| **10.** joule (J) | **c.** work |
| **11.** meter (m) | **d.** force |
| **12.** second (s) | **e.** power |

**Directions:** *Use the formulas to solve the following problems.*

$$\text{work} = \text{force} \times \text{distance} \qquad \text{power} = \frac{\text{work done}}{\text{time needed}}$$

**13. a.** How much work was done to move a 10 N book 5 meters?

______

**b.** What power was used if it took 2 s?

______

**14. a.** Two people each applied 100 N of force to move a crate 3 m. How much work was done?

______

**b.** How much power was used if it took them 60 s?

______

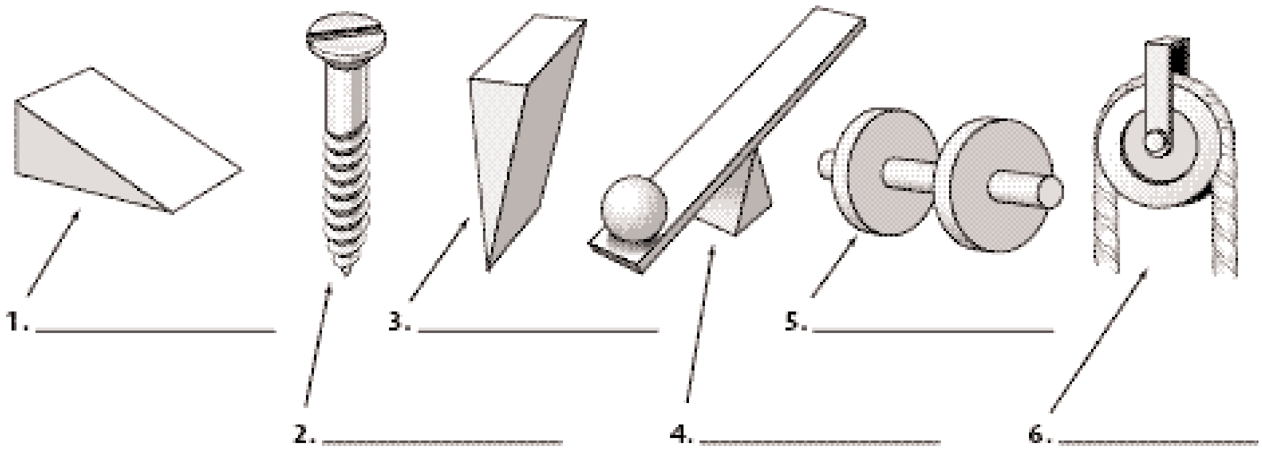
Name Date Class

Directed Reading for Content Mastery

# Section 2 ▪ Using Machines
# Section 3 ▪ Simple Machines

**Directions:** *Use the following terms to label each simple machine.*

| | | |
|---|---|---|
| **lever** | **pulley** | **wedge** |
| **inclined plane** | **screw** | **wheels and axle** |




**Directions:** *Circle the term that correctly completes each sentence.*

7. Mechanical advantage is the number of times the input force is (divided/multiplied) by a machine.
8. The point about which a lever pivots is called a (fulcrum/rotator).
9. Wedges and screws are both (levers/inclined planes).
10. An inclined plane allows you to lift a heavy load by using (less/more) force over a greater distance.
11. One way to reduce friction and increase efficiency is to add (input/lubricant).
12. A wheel and axle consists of two circular objects of (different/identical) sizes that are attached in such a way that they rotate together.
13. When you use a machine, the output work can never be (greater/less) than the input work.
14. A fixed pulley changes the (distance/direction) of the force you exert.

Meeting Individual Needs

Directed Reading for Content Mastery

# *Key Terms*
# Work and Simple Machines

**Directions:** *Write the correct terms next to their definitions below.*

| | | | |
|---|---|---|---|
| **inclined plane** | **compound machine** | **efficiency** | **input force** |
| **power** | **wedge** | **lever** | **simple machine** |
| **output force** | **mechanical advantage** | **work** | |
| **screw** | **wheel and axle** | **pulley** | |



______ **1.** when a force produces motion in the direction of the force

______ **2.** the force you exert when using a machine

______ **3.** the force you must overcome when using a machine

______ **4.** a comparison of the input force applied to a machine to the output force it must overcome

______ **5.** the ability of a machine to convert input work into output work

______ **6.** the rate at which work is done

______ **7.** machine made of two or more simple machines

______ **8.** a flat, sloped surface

______ **9.** an inclined plane that moves

______ **10.** a machine with one movement

______ **11.** an inclined plane wrapped around a cylinder

______ **12.** two circular objects of different sizes that are attached in such a way that they rotate together

______ **13.** any rigid rod or plank that pivots about a point

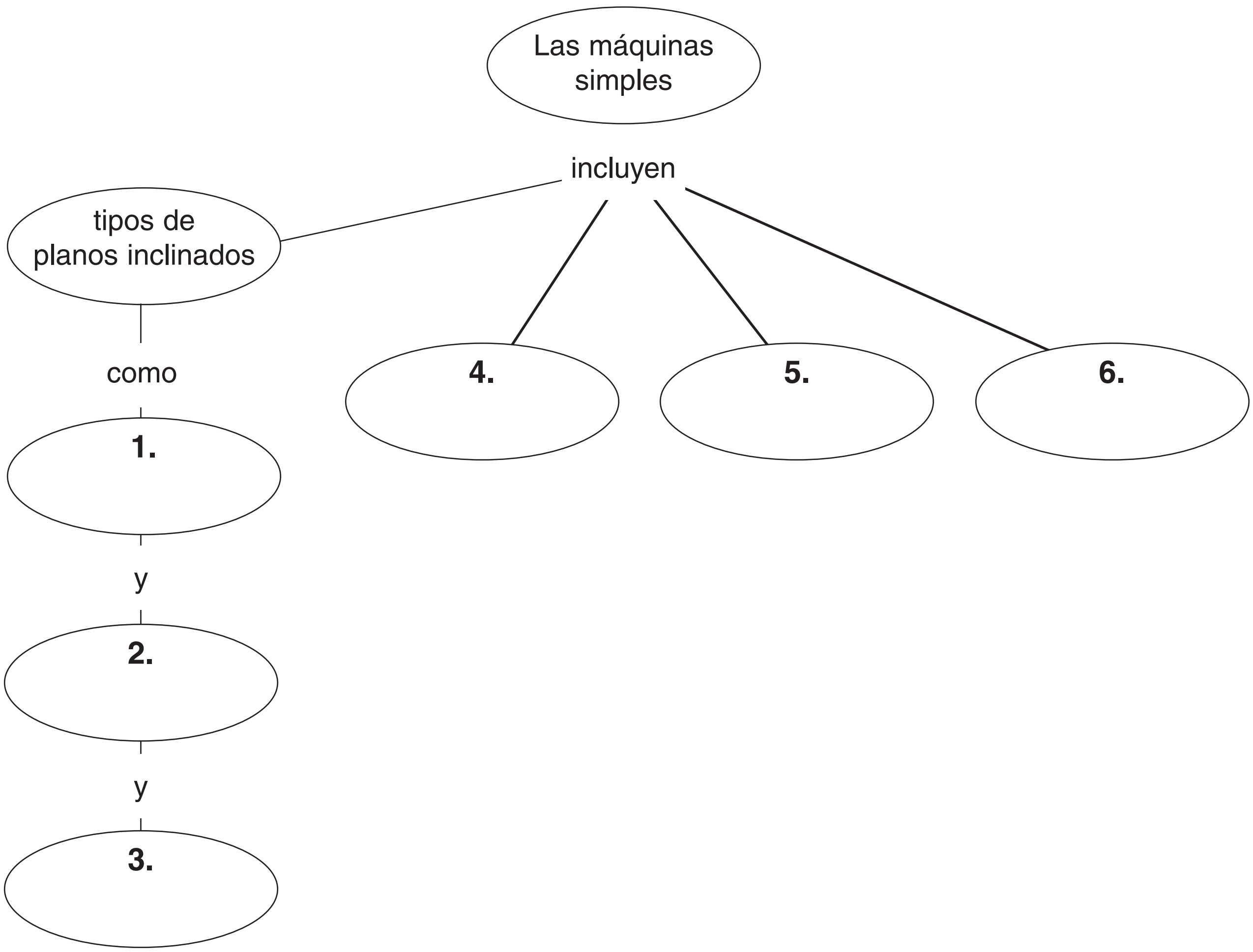
______ **14.** a grooved wheel with a rope or chain wrapped around it

Lectura dirigida para Dominio del contenido

# *Sinopsis*
# Trabajo y máquinas simples

**Instrucciones:** *Usa los siguientes términos para completar el mapa conceptual.*

| | | |
|---|---|---|
| **poleas** | **planos inclinados** | **palancas** |
| **ruedas y ejes** | **tornillos** | **cuñas** |




**Instrucciones:** *En los espacios dados, escribe la letra de las palabras o frases que mejor responden cada pregunta.*

_______ **7.** ¿Por qué son útiles las máquinas?
**a.** porque pueden aumentar la fuerza
**b.** porque pueden aumentar la distancia
**c.** porque pueden cambiar la dirección de una fuerza
**d.** todas las anteriores

_______ **8.** ¿Realizas trabajo si te paras en un sitio y sostienes una tranca de puerta pesada en frente de la clase para demostrar una cuña?
**a.** sí **b.** no **c.** tal vez **d.** todas las anteriores

Lectura dirigida para Dominio del contenido

# *Sección 1* ▪ Trabajo y potencia

**Instrucciones:** *En los espacios asignados, escribe* **trabajo** *si se hace trabajo y* **ninguno** *si no se hace trabajo.*

_______________ **1.** Alguien está sentado en el suelo sobre un cojín.

_______________ **2.** El cojín es levantado y puesto sobre el sillón.

_______________ **3.** El cojín es puesto de nuevo en el suelo.

_______________ **4.** Una pelota de béisbol es lanzada a la gradería.

_______________ **5.** Levantas tus brazos por encima de tu cabeza.

_______________ **6.** Estudias dos horas para tu examen de ciencias.

_______________ **7.** Una niña en el columpio es empujada por su padre.

**Instrucciones:** *Une con una línea cada unidad de medición de la Columna I con las palabras de la Columna II que se usan en la fórmula que aparece más abajo.*

| Columna I | Columna II |
|---|---|
| **8.** vatio | **a.** tiempo |
| **9.** newton (N) | **b.** distancia |
| **10.** julio (J) | **c.** trabajo |
| **11.** metro (m) | **d.** fuerza |
| **12.** segundo (s) | **e.** potencia |

**Instrucciones:** *Usa las fórmulas para resolver los problemas siguientes.*

trabajo = fuerza x distancia  $\text{potencia} = \dfrac{\text{trabajo realizado}}{\text{tiempo requerido}}$

**11. a.** ¿Cuánto trabajo se hizo para mover un libro de 10 N 5 metros?

_______________________________________________

**b.** ¿Qué potencia se usó si tomó 2 s?

_______________________________________________

**12. a.** Dos personas aplicaron 100 N de fuerza cada una para mover una caja 3 m. ¿Cuánto trabajo se hizo?

_______________________________________________

**b.** ¿Cuánta potencia se usó si les tomó 6 s?

_______________________________________________

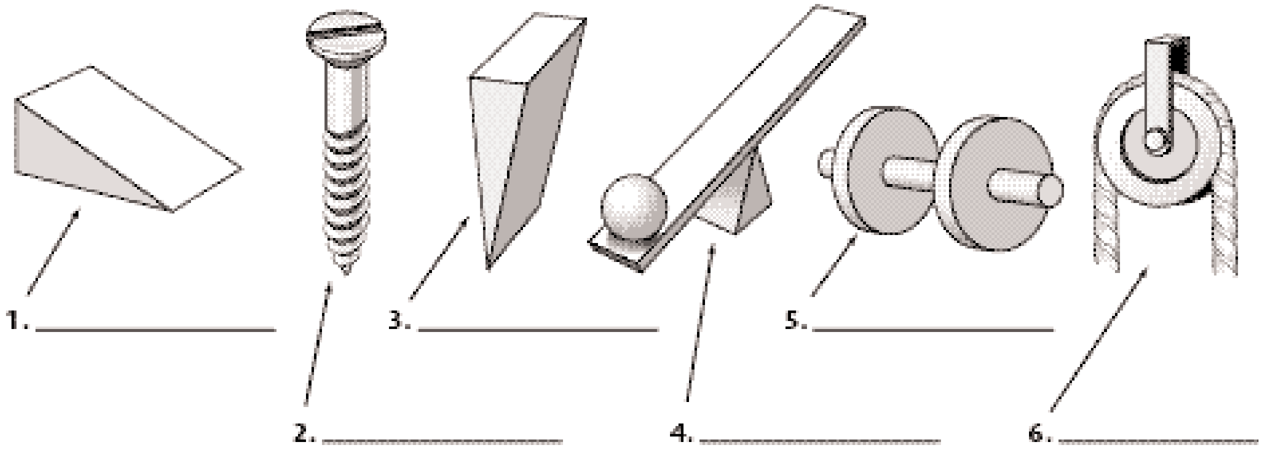
Satisface las necesidades individuales

Lectura dirigida para Dominio del contenido

# *Sección 2* ▪ Usa máquinas
# *Sección 3* ▪ Máquinas simples

**Instrucciones:** *Usa los términos para rotular cada máquina simple.*

| | | |
|---|---|---|
| **palanca** | **polea** | **cuña** |
| **plano inclinado** | **tornillo** | **rueda y eje** |




**Instrucciones:** *Encierra en un círculo el término que completa correctamente cada oración.*

**7.** La ventaja mecánica es el número de veces que la fuerza de entrada es (dividida/multiplicada) por la máquina.

**8.** El punto en el cual una palanca rota se llama (fulcro/rotador).

**9.** Las cuñas y tornillos son (palancas/planos inclinados).

**10.** Un plano inclinado permite que levantes una carga pesada usando (menos/más) fuerza a lo largo de una distancia mayor.

**11.** Una manera de reducir la fricción y aumentar la eficiencia es agregando (entrada/lubricantes).

**12.** Una rueda y eje consiste de dos objetos circulares de (idéntico/diferente) tamaño que están unidos de tal forma que rotan juntos.

**13.** Cuando usas una máquina, el trabajo de salida nunca puede ser (más grande/menor) que el trabajo de entrada.

**14.** Una polea fija cambia la (distancia/dirección) de la fuerza que haces.

Lectura dirigida para Dominio del contenido

# *Términos claves*
# Trabajo y máquinas simples

**Instrucciones:** *Escribe los términos correctos al lado de sus definiciones.*

**plano inclinado** **máquina compuesta** **eficiencia** **fuerza de entrada**
**potencia** **cuña** **palanca** **máquina simple**
**fuerza de entrada** **ventaja mecánica** **trabajo**
**tornillo** **rueda y eje** **polea**

Satisface las necesidades individuales

______________________ **1.** cuando una fuerza produce movimiento paralelo a la dirección de la fuerza

______________________ **2.** la fuerza que haces cuando usas una máquina

______________________ **3.** la fuerza que debes superar cuando usas una máquina

______________________ **4.** comparación entre la fuerza de entrada que se aplica a una máquina y la fuerza de salida que debe superar

______________________ **5.** habilidad de una máquina de convertir el trabajo de entrada en trabajo de salida

______________________ **6.** tasa a la cual se hace el trabajo

______________________ **7.** máquina hecha de dos o más máquinas simples

______________________ **8.** superficie plana en declive

______________________ **9.** plano inclinado que se mueve

______________________ **10.** máquina con sólo un movimiento

______________________ **11.** Plano inclinado enrollado alrededor de un cilindro

______________________ **12.** dos objetos circulares de tamaño diferentes que están unidos de tal forma que rotan juntos

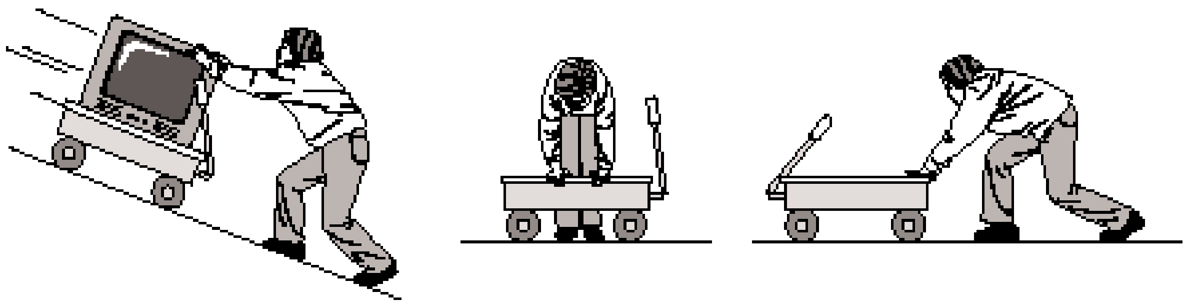
______________________ **13.** barra o tabla rígida que rota alrededor de un punto

______________________ **14.** rueda acanalada que tiene una cuerda o cadena a su alrededor

SECTION 1 Reinforcement

# Work and Power

**Directions:** *Describe the work in each situation as* **work** *or* **no work**.



1. ____________ 2. ____________ 3. ____________

**Directions:** *Name two situations in which no work is done to an object.*

4. ____________

5. ____________

**Directions:** *Answer the following questions on the lines provided.*

6. If you push an object at an angle so that the object moves along the ground, how much of your push counts as work?

7. How is work measured?

8. What is power?

9. How is power measured?

10. Can only engines have power? Explain.

**Directions:** *Use the formula,* power = work/time, *to calculate the power required in the following problem.*

11. A weightlifter lifts a 1,250-N barbell 2 m in 3 s. How much power was used to lift the barbell?

SECTION 2 Reinforcement

# Using Machines

**Directions:** *Use the formula,* efficiency $= (W_{out}/W_{in}) \times 100\%$, *to calculate the efficiency of each of the following machines.*

**1.** A 600-N box is pushed up a ramp that is 2 m high and 5 m long. The person pushing the box exerts a force of 300 N. What is the efficiency of the ramp?

______________________________

______________________________

______________________________

______________________________

**2.** A person uses a fixed pulley to raise a 75-N object 40 m. The force exerted on the object is 120 N. What is the efficiency of the pulley?

______________________________

______________________________

______________________________

______________________________

**Directions:** *Complete the following sentences using the correct terms.*

**3.** The work input is equal to the work ______________ in an ideal machine.

**4.** Machines are useful because they can change the ______________, ______________, or ______________ of the force you need to exert.

**5.** The force you exert on an object is the effort, or ______________ force.

**6.** The ______________ of a machine compares the input force to the output force.

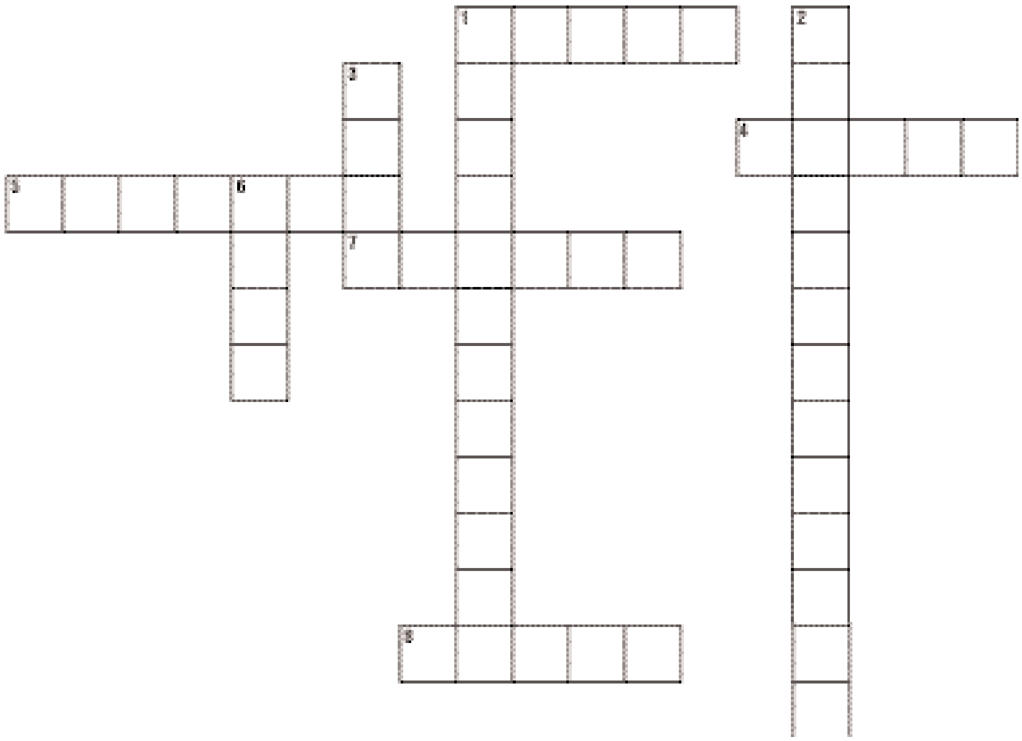
**7.** ______________ can reduce a machine's efficiency.

**8.** The ability of a machine to convert input work to output work is called the machine's ______________.

SECTION 3 Reinforcement

# Simple Machines

**Directions:** *Use the clues to complete the puzzle.*




## Across

**1.** A moving inclined plane

**4.** An inclined plane wrapped around a post

**5.** The pivot point of a lever

**7.** A surface that re-directs force using a rope

**8.** A rod that pivots about a point

## Down

**1.** Two rigidly attached wheels that rotate together

**2.** A sloped surface

**3.** An inclined plane

**6.** Used with a pulley to change the direction of a force

SECTION 1 Enrichment

# Work, Work, and More Work

**Directions:** *Classify the following as* **work** *or* **no work.**

______________ **1.** carrying a suitcase

______________ **2.** typing

______________ **3.** holding a bag of groceries

______________ **4.** lifting a book bag

______________ **5.** upward part of a jump on a trampoline

______________ **6.** downward part of a jump on a trampoline

## Designing Your Own

**Directions:** *Use the materials listed below to create an experiment or experiments that will demonstrate work or no work. Then answer the following questions about your experiment.*

| | | |
|---|---|---|
| ball(s) | string | book(s) |
| tape | board | object of your choice |

**7.** Describe your experiment(s). Include exactly what was done to demonstrate work and no work.

______________________________________________

______________________________________________

**8.** In the space below, sketch a picture of your experiment(s). Use arrows to indicate the direction of work.

**9.** Calculate the amount of work done in your experiment(s).

______________________________________________

______________________________________________

SECTION 2 Enrichment

# Fighting Friction in Train Travel

For many years, researchers have looked for ways to make trains more energy efficient. One way to do this is to reduce the amount of friction caused by the steel wheels on tracks.

The first serious attempt to develop new energy-efficient trains for commercial use are magnetically levitated trains, or maglev trains. Maglev trains float on magnetic fields created by tracks lined with electromagnets. The trains float 10 mm above the track, or guideway, and are pulled along the track by the magnets.

In theory, these trains require less maintenance because there is no damage caused by the interaction of moving parts. Furthermore, because there is no friction, the trains are somewhat more energy efficient than are conventional trains. The lack of friction also allows the trains to get to very high speeds—around 500 km/h or 300 mph. However, the trains still lose energy due to air resistance.

## Flying Trains

A more recent development in train technology involves a new approach. Researchers in Japan have built a model of a train that flies. The researchers think these trains might use only one fourth of the energy required by maglev trains. Flying trains are designed to use the "wing-in-ground," or WIG, effect. This effect forms a cushion of air as a flying object nears the ground. The WIG effect is what causes a piece of paper to float along the floor when it is dropped.

## Using Wings and Walls

The flying train model has two wings in the front and back, and vertical fins at the end of each wing. The train is designed to move 5 to 10 cm above a track with walls on either side. The walls also create the WIG effect, which propels the vertical fins forward, further increasing the efficiency of the trains. So far, the model takes off after reaching a speed of 50 km/h, but researchers are working to decrease the distance necessary to reach that speed. A shorter distance means less time on a track and, therefore, less energy lost to friction.

The research team has several goals for future developments of the trains. They plan to build a model that has propellers so that it can reach speeds of 150 km/h. By 2020, the team would like to develop a train that could seat 335 passengers and reach a speed of 500 km/h. In order to make the trains less polluting, the team plans to design the trains to be powered by either solar panels on top of the trains or wind turbines along the tracks.

1. How do maglev trains work?

_______________________________________________

_______________________________________________

2. What makes flying trains and maglev trains energy efficient?

_______________________________________________

_______________________________________________

3. What might be some potential problems with using maglev trains or flying trains on a large scale?

_______________________________________________

_______________________________________________

SECTION 3 Enrichment

# Bicycle Gears

The first bicycles did not have multiple gears for ease of riding. Cyclists worked hard to cover ground. They sat over the front wheel because the pedals were attached directly to the wheel's axle. Rotating the pedals once around moved the front wheel only one complete revolution. The invention of the chain drive allowed the rider to sit in a safer, more balanced position between the front and back wheels.

## Chain Drives

Chain drives transfer the power from the rider's legs, which push down on the pedals attached to levers (the cranks), which turn the axle of the toothed wheel (front sprocket, or chain ring). The chain is a continuous loop attached to the chain ring and a rear sprocket. As the chain ring rotates, it moves the chain, which moves the rear sprocket, which turns the rear wheel's axle. Thus, the invention of the chain drive meant that a rider propelled the bike forward by moving the rear wheel, not the front one. If you think chain drives resemble pulley systems, you are right!

## Gears

Later, the addition of gears with varying ratios made it easier to ride up steep inclines and pedal more efficiently. Gear ratios are figured by dividing the number of teeth in the front sprocket by the number of teeth in the rear sprocket. If there are 54 teeth in front and 27 in back, the ratio is 2 to 1 because $54 \div 27 = 2$. This means that the rear sprocket goes around twice each time the rider moves the chain ring one complete revolution. If the rear sprocket has 13 teeth, the ratio is about 4 to 1. One turn of the pedals will rotate the back sprocket four times. Bicycle riders use high gear ratios on downhill slopes or level ground to help increase their speed. However, it takes more effort to turn the pedals in a higher gear.

To pedal up a hill, a bicycle rider has to exert more force than the force needed to pedal along level ground. Less effort is needed to turn the pedals in a lower gear where the gear ratio is lower. So bike riders shift into lower gears as they climb hills. However, in a lower gear the rear wheel turns fewer times for each turn of the pedals.

**Directions:** *Complete the table below by computing the gear ratios. Round to the nearest whole number.*

| Gear | Number of teeth in rear sprocket | Number of teeth in front sprocket | Gear ratio |
|---|---|---|---|
| **1.** a | 11 | 60 | |
| **2.** b | 22 | 54 | |
| **3.** c | 41 | 84 | |
| **4.** d | 60 | 54 | |

**5.** Which gear would be best for riding up a steep hill? Why?

______________________________

______________________________

Name ____________________ Date ____________ Class ____________

Note-taking Worksheet

# Work and Simple Machines

## Section 1 Work and Power

**A.** ______________—occurs when a force causes an object to move in the same direction that the force is applied

1. Work involves ________________, not just effort.
2. Work is done only when the ______________ you exert on an object is in the same direction as the object's motion; lifting a clothes basket is work, but carrying it while walking is not work.
3. When a force is exerted at an angle, only the part of the force that is in the ______________ direction as the motion does work.

**B.** Work can be calculated using the formula *work* = ______________ × *distance.*

1. Force is measured in newtons, distance is measured in meters, and the unit for work is the _______________.
2. Distance in the work equation is the distance an object moves only _______________ the force is being applied.

**C.** _______________—how quickly work is done

1. Power can be calculated using the formula *power* = ______________ / *time needed.*
2. The unit of power is the ______________.
3. Doing work on an object increases the object's kinetic ________________.
4. The amount of work done is the amount of energy _____________________ and can be expressed in the power formula in place of work done: *power = energy transferred / time needed.*
5. Power is always the ______________ at which energy is transferred.

## Section 2 Using Machines

**A.** _________________—device that makes doing work easier

**B.** Machines change the _____________ a person does work, not the amount of work that needs to be done.

1. _____________________—the effort, or work, force you exert on a machine

Meeting Individual Needs

## Note-taking Worksheet (continued)

2. ______—the resistance force, or the work a machine does to move an object over some distance
3. When using a machine, the output work can never be ______ then the input work.
4. ______—number of times the input force is multiplied by a machine; calculated as *mechanical advantage = output force / input force*
   a. Some machines make work easier by allowing you to exert a smaller force over a ______ distance, resulting in a mechanical advantage of more than one.
   b. Other machines allow you to exert your force over a ______ distance resulting in a mechanical advantage of less than one.
   c. Still other machines allow you to change the ______ of input force resulting in a mechanical advantage equal to one.

C. ______—ability of a machine to convert input work to output work; calculated as *efficiency = output work / input work* × *100%*
1. ______ reduces efficiency by converting some work into heat.
2. The efficiency of a real machine is always ______ 100 percent because of friction.
3. Oil, or another lubricant, can increase efficiency by reducing the number of ______ between surfaces.

## Section 3 Simple Machines

A. ______—does work with only one movement; a machine made of a combination of simple machines is a ______.

B. ______—a flat, sloped surface
1. Less ______ is needed to move an object from one height to another using an inclined plane than is needed to lift the object.
2. As the inclined plane gets longer, the force needed to move the object gets ______.
3. The ______ of an inclined plane is the length of the inclined plane divided by its height.
4. Inclined plane that moves—______; changes the direction of the applied force; example: your front teeth

## Note-taking Worksheet (continued)

5. _______________—inclined plane wrapped around a cylinder or post; the screw threads form the inclined plane on a screw; the mechanical advantage of the screw is the length of the inclined plane wrapped around the screw divided by the length of the screw.

**C.** _______________—any rigid rod or plank that pivots about a point.

1. point about which the lever pivots— _________________________
2. Mechanical advantage—divide the distance from the fulcrum to the _________________________ force by the distance from the fulcrum to the _________________________ force.
3. Levers can be divided into classes depending on the position of the _________________________.

**D.** _________________________—two circular objects of different sizes that rotate together

1. The mechanical advantage of a wheel and axle is found by _________________________ the radius of the wheel by the radius of the axle.
2. In some cases, the input force turns the wheel, and the axle exerts the output force, resulting in a mechanical advantage _________________________ than one; examples are a doorknob a steering wheel, and a screwdriver.
3. In other cases, the input force turns the axle, and the wheel exerts the output force, resulting in a mechanical advantage of _________________________ than one; examples are a fan and a ferris wheel.

**E.** ________________—grooved wheel with a rope or chain wrapped around it

1. _______________ pulleys, such as on window blinds or flagpoles, are attached to an overhead structure and change the direction of the force you exert; they have a mechanical advantage of one.
2. __________________ pulleys are attached to the object being lifted and allow you to exert a smaller force; they have a mechanical advantage of two.
3. Pulley _________________________ —combination of fixed and moveable pulleys

Meeting Individual Needs

# Assessment

Name _______________ Date _______________ Class _______________

# Chapter Review

# Work and Simple Machines

## Part A. Vocabulary Review

**Directions:** *Match the terms in Column II with the definitions in Column I. Write the letter of the correct term in the blank at the left.*

**Column I**

_______ **1.** a device that makes work easier by changing the size or direction of the applied force

_______ **2.** SI unit for work

_______ **3.** causes the output work of a machine to be less than the input work

_______ **4.** the rate at which work is being done

_______ **5.** the ratio of the output force to the input force

_______ **6.** a moving inclined plane

_______ **7.** has only one movement

_______ **8.** the unit of measurement of power

_______ **9.** two rigidly attached wheels that rotate together

_______ **10.** a sloped surface

_______ **11.** exertion of a force on an object that produces motion in the direction of the force

_______ **12.** the force a machine exerts

_______ **13.** a machine's ability to convert work input into work output

_______ **14.** machine with 100% efficiency

_______ **15.** the pivot point of a lever

_______ **16.** an inclined plane wrapped around a shaft

_______ **17.** a grooved wheel that redirects force using a rope

_______ **18.** the effort force you exert

**Column II**

**a.** simple machine
**b.** work
**c.** input force
**d.** inclined plane
**e.** joule
**f.** output force
**g.** power
**h.** machine
**i.** friction
**j.** watt
**k.** ideal machine
**l.** screw
**m.** pulley
**n.** mechanical advantage
**o.** efficiency
**p.** fulcrum
**q.** wheel and axle
**r.** wedge

Assessment

## Chapter Review (continued)

### Part B. Concept Review

**Directions:** *Circle the term in parentheses that correctly completes the sentence.*

1. A blender is a (simple, compound, pulley) machine.
2. The mechanical advantage that makes work easiest is one that is (large, small, zero).
3. Holding a watermelon in your hands is an example of (work, no work) being done.
4. A goalie stopping a hockey puck is an example of (work, no work) being done.
5. Power does **NOT** depend on (work done, muscles, time).
6. As you increase the effort distance, you (decrease, increase, stabilize) the effort force needed.
7. The mechanical advantage tells you the number of times a machine (increases, decreases, eliminates) the effort force.
8. A (shovel, crowbar, potter's wheel) is **NOT** an example of a lever.
9. An ideal machine has an efficiency (less than one, equal to one, greater than one).
10. (Heat, Friction, Work) is **NOT** a source of energy loss in a machine.

**Directions:** *Name the six types of simple machines and give an example of each, or what each might be used to do.*

11. ______________________________
12. ______________________________
13. ______________________________
14. ______________________________
15. ______________________________
16. ______________________________

# Transparency Activities

SECTION 1 Section Focus Transparency Activity

# Weighted Down

**A heavy backpack can be a load to carry. Just lifting it can take a lot of effort, but it's easier to take it off your back.**

1. **What forces are acting on the backpack?**
2. **Compare the direction the backpack moves when it is lifted by the girl with the direction it moves when the girl is walking.**
3. **Why is it easier to lower something down than it is to lift it up?**

SECTION 2 Section Focus Transparency Activity

# The Puck Stops Here

**If you've ever tried to walk or run on ice, you know how difficult it can be. Because ice can be so slippery, hockey players on skates can move quickly, making hockey a fast and exciting sport.**


**1. Why do you sometimes slip when you step onto a patch of ice on the sidewalk?**

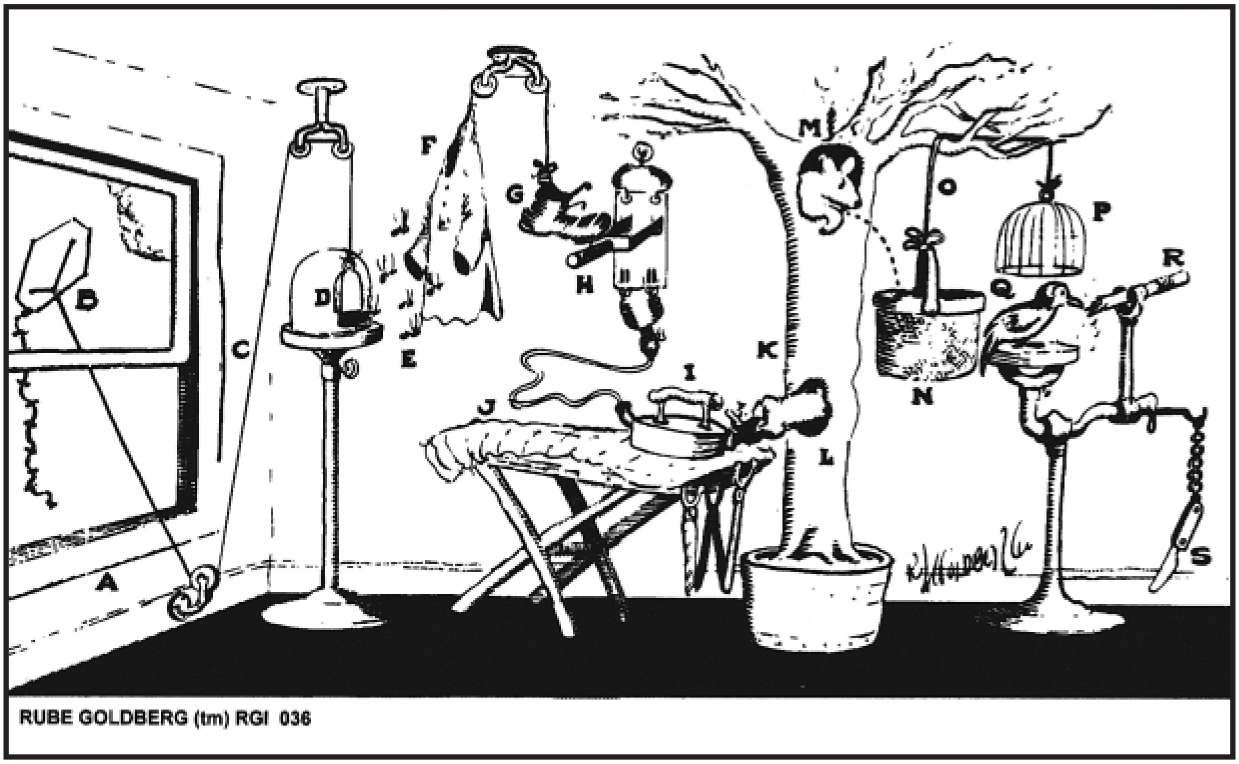
**2. Why can a hockey player move faster than a runner?**

**3. When a player takes a shot, is work being done on the puck? Explain.**

SECTION 3 Section Focus Transparency Activity

# Useful?

**A Rube Goldberg contraption uses comically complex methods to perform a fairly simple task. In this case, more effort is expended on the machine than it would take to simply do the job.**

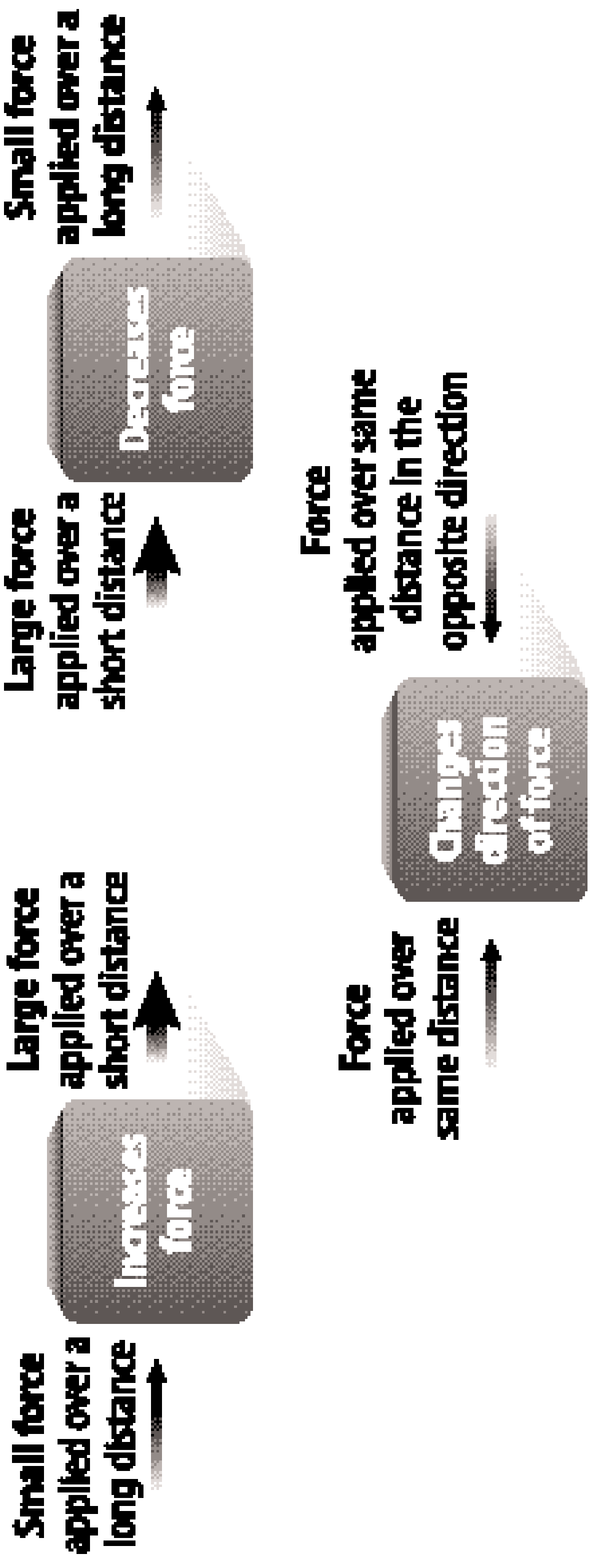



1. What do you think this contraption is supposed to do?
2. Do machines usually increase or decrease the amount of effort involved in accomplishing a task? Explain.
3. What parts of this machine could really work? Which parts wouldn't work so well?

Name Date Class

SECTION 2 Teaching Transparency Activity

# Schematic Depiction of a Machine



## Teaching Transparency Activity (continued)

**1.** What is the advantage of using a machine?

**2.** What does force times distance equal?

**3.** Name three ways that machines make work easier.

**4.** What is a machine's ability to convert input work to output work called?

**5.** If a person applies a force to an object but the object doesn't move, has any work been done?

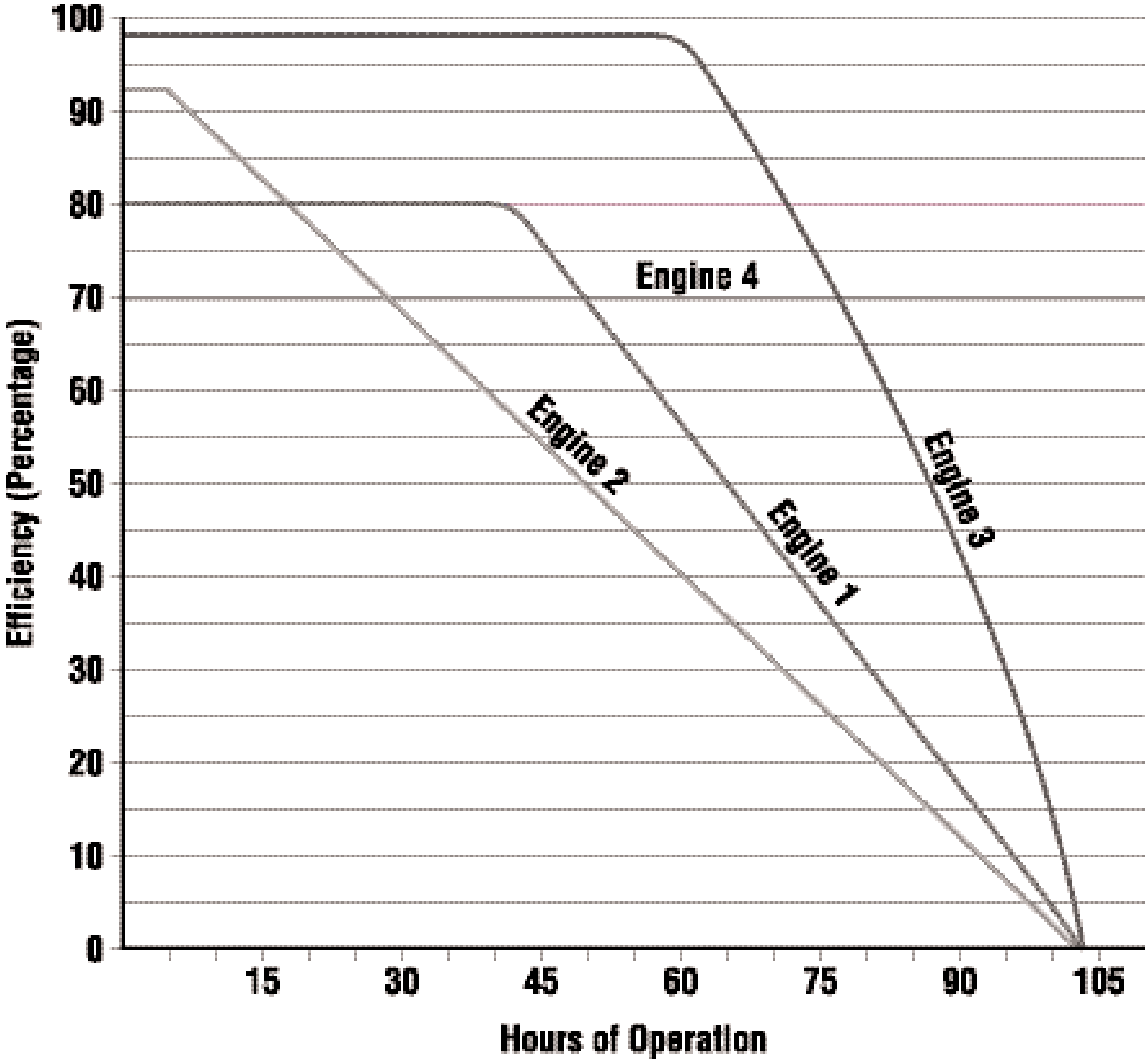
**6.** In which direction must an object move in order for work to be done?

Name Date Class

Assessment Transparency Activity

# Work and Simple Machines

**Directions:** *Carefully review the graph and answer the following questions.*




1. According to the graph, which engine is initially the most efficient?
   **A** Engine 1 **B** Engine 2 **C** Engine 3 **D** Engine 4

2. According to the graph, the engine that most likely will require the least maintenance is ___.
   **A** Engine 1 **B** Engine 2 **C** Engine 3 **D** Engine 4



Transparency Activities