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Section 14.1 Work and Power

(pages 412–416)

This section defines work and power, describes how they are related, and explains how to calculate their values.

Reading Strategy (page 412)

Relating Text and Visuals As you read, look carefully at Figures 1 and 2 and read their captions. Complete the table by describing the work shown in each figure. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

Figure	Direction of Force	Direction of Motion	Is Work Done?
1			
2A			
2B			
2C			

What Is Work? (pages 412–413)

1. In science, work is done when a(n) _____ acts on an object in the direction the object moves.

2. Why isn't work being done on a barbell when a weight lifter is holding the barbell over his head? _____

_____

3. Describe what conditions of force and motion result in maximum work done on an object. _____

_____

4. Is the following sentence true or false? A vertical force does work on an object that is moving in a horizontal direction. _____

Calculating Work (pages 413–414)

5. In science, work that is done on an object can be described as the force acting on the object multiplied by the _____ the object moves.

6. Circle the letter of the correct form of the work equation to use when determining the distance an object moves as a result of a force applied to it.

a. Distance = Force × Work

b. Distance = $\frac{\text{Force}}{\text{Work}}$

c. Distance = $(\text{Force})^2$

d. Distance = $\frac{\text{Work}}{\text{Force}}$

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7. The SI unit of work is the _____.

8. Circle the letter of the amount of work done when a 1 newton force moves an object 1 meter.

a. 1 newton per second b. 1 joule

c. 1 watt d. 1 newton per meter

What Is Power? (page 414)

9. Is the following sentence true or false? Power is the rate of doing work. _____

10. In order to do work faster, more _____ is required.

11. Circle the letter of each sentence that is true about power.

a. Power and work are always equal.

b. You can increase power by doing a given amount of work in a shorter period of time.

c. When you decrease the force acting on an object, the power increases.

d. When you do less work in a given time period, the power decreases.

Calculating Power (page 415)

12. Write a word equation describing how to calculate power. _____

_____

13. The SI unit of power is the _____.

14. Circle the letter of the expression that is equivalent to one watt.

a. one newton per meter

b. one joule per meter

c. one newton per second

d. one joule per second

15. How much work does a 100-watt light bulb do when it is lit for 30 seconds? _____

James Watt and Horsepower (page 416)

16. Circle the letter of the quantity that is approximately equal to one horsepower.

a. 746 J b. 746 W

c. 7460 N/m d. 7460 J

17. Why did James Watt use the power output of a horse to compare the power outputs of steam engines he designed? _____

_____

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Section 14.2 Work and Machines

(pages 417–420)

This section describes how machines change forces to make work easier to do. Input forces exerted on and output forces exerted by machines are identified and input work and output work are discussed.

Reading Strategy (page 417)

Summarizing As you read, complete the table for each machine. After you read, write a sentence summarizing the idea that your table illustrates. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

Machine	Increases or Decreases Input Force	Increases or Decreases Input Distance
Tire jack		
Lug wrench		
Rowing oar		
Summary: As input force decreases, the input distance increases.		

Machines Do Work (pages 417–418)

1. Describe what a machine is able to do. _____

_____

2. Is the following sentence true or false? A machine can make work easier to do by changing the size of the force needed, the direction of a force, or the distance over which a force acts.

_____

3. Consider the equation Work = Force × Distance. If a machine increases the distance over which a force is exerted, the force required to do a given amount of work _____.

4. Give an example of a machine that changes the direction of an applied force. _____

5. When you make several trips to unload a few heavy items from a car instead of moving them all at once, the total distance over which you exert yourself _____.

Work Input and Work Output (pages 419–420)

6. The work done by a machine is always less than the work done on a machine because of _____.

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7. Circle the letter of the definition for input force.

a. the amount of force exerted by a machine

b. the amount of friction slowing the speed of a machine

c. the amount of work done by a machine

d. the amount of force exerted on a machine

8. Write a word equation that describes work input.

_____

9. Is the following sentence true or false? Every machine uses some of its work input to overcome friction. _____

10. The force exerted by a machine is called the _____ force.

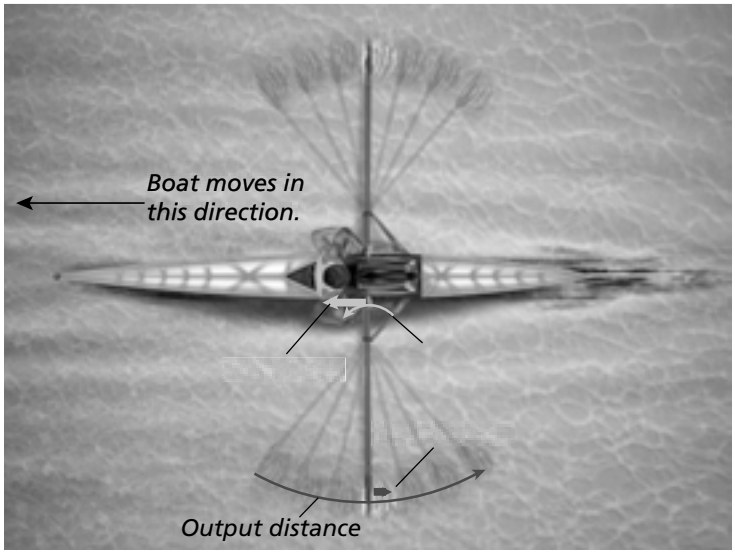
11. Circle the letter of the expression that equals the work output of a machine.

a. $\frac{\text{Input distance}}{\text{Output distance}}$ b. Output distance × Input distance

c. $\frac{\text{Output distance}}{\text{friction}}$ d. Output distance × Output force

12. Is the following sentence true or false? Output work always is less than input work. _____

For questions 13 through 15, refer to the figure below.



13. Which arrow represents the input force? Label it on the figure.

14. Which arrow represents the input distance? Label it on the figure.

15. Which arrow represents the output force? Label it on the figure.

16. How can you increase a machine's work output? _____

_____

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Section 14.3 Mechanical Advantage and Efficiency

(pages 421–426)

This section describes mechanical advantage and efficiency and how to calculate these values. Ways to maximize mechanical advantage and efficiency are discussed.

Reading Strategy (page 421)

Building Vocabulary As you read the section, write a definition in the table for each vocabulary term in your own words. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

Mechanical Advantage	
Vocabulary	**Definition**
Mechanical advantage	

Mechanical Advantage (pages 421–423)

1. The number of times that a machine increases an input force is the _____ of the machine.

2. For a given input force, what affects the output force that a nutcracker can exert on a nut? _____

_____

3. Mechanical advantage describes the relationship between input force and _____ force.

4. How is the actual mechanical advantage of a machine determined?

_____

5. Greater input force is required to move an object along a ramp with a rough surface, compared to a ramp with a smooth surface, because a greater force is needed to overcome _____.

6. Is the following sentence true or false? A loading ramp with a rough surface has a greater mechanical advantage than one with a smooth surface. _____

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7. Because friction is always present, the actual mechanical advantage of a machine is never _____ than its ideal mechanical advantage (IMA).

8. A machine's _____ is the mechanical advantage in the absence of friction.

9. What type of materials do engineers use to increase the mechanical advantage of a machine?

_____

Calculating Mechanical Advantage (pages 424–425)

10. Is the following sentence true or false? To calculate ideal mechanical advantage, divide input distance by output distance, and then divide the result by the force of friction.

_____

11. Is the following sentence true or false? An inclined plane is an example of a machine. _____

12. Calculate the IMA of a ramp for the distances given in the table.

Ideal Mechanical Advantages of Ramps		
Horizontal Distance	**Vertical Rise**	**IMA**
1.5 meters	0.5 meters	
12 meters	1.5 meters	
3.6 meters	0.3 meters	

13. Is the following sentence true or false? If the input distance of a machine is greater than the output distance, then the IMA for that machine is greater than one. _____

Efficiency (pages 425–426)

14. Why is the efficiency of a machine always less than 100 percent? _____

_____

15. Is the following sentence true or false? To calculate the efficiency of a machine, divide the work output by work input, and then multiply by 100. _____

16. What is a significant factor affecting a car's fuel efficiency?

_____

17. Calculate the efficiency of a machine with a work output of 120 J and a work input of 500 J. _____

18. Circle the letter of the work input for a machine with a work output of 240 J and an efficiency of 80 percent.

a. 300 J b. 200 J

c. 320 J d. 200 W

19. Reducing friction _____ the efficiency of a machine.

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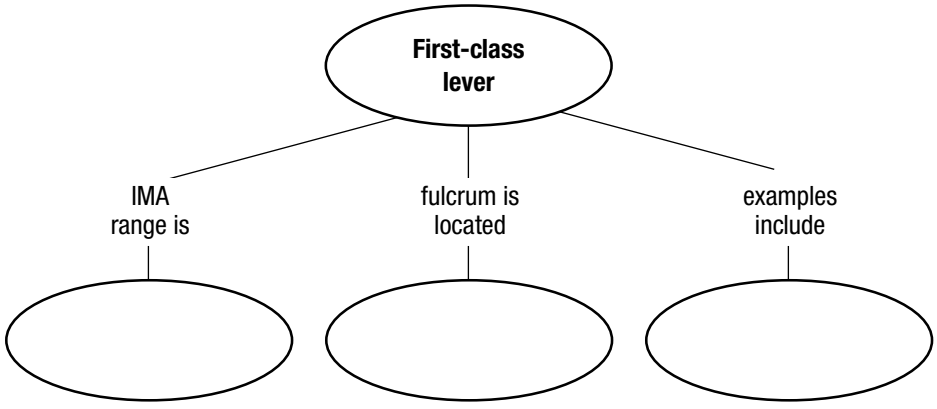
Section 14.4 Simple Machines

(pages 427–435)

This section presents the six types of simple machines. A discussion of how each type works and how to determine its mechanical advantage is given. Common uses of simple machines are also described.

Reading Strategy (page 427)

Summarizing After reading the section on levers, complete the concept map to organize what you know about first-class levers. On a separate sheet of paper, construct and complete similar concept maps for second- and third-class levers. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.



1. List the six types of simple machines.

a. _____ b. _____

c. _____ d. _____

e. _____ f. _____

Levers (pages 428–429)

2. A screwdriver used to pry the lid off a paint can is an example of a(n) _____.

3. The fixed point that a lever rotates around is called the _____.

4. To calculate the ideal mechanical advantage of any lever, divide the input arm by the _____.

5. What characteristics distinguish levers as first-class, second-class, or third-class?

_____

_____

6. Is the following sentence true or false? First-class levers always have a mechanical advantage that is greater than one.

_____

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7. Is the following sentence true or false? All second-class levers have a mechanical advantage greater than one because the input arm is longer than the output arm. _____

Wheel and Axle (page 430)

8. Describe a wheel and axle. _____

_____

9. Circle the letter of the sentence that describes how to calculate the IMA of a wheel and axle.

a. Multiply the area of the wheel by the area of the axle.

b. Divide input force by output force.

c. Divide the diameter where input force is exerted by the diameter where output force is exerted.

d. Divide the radius of the wheel by the force exerted on it.

Inclined Planes (pages 430–431)

10. A slanted surface along which a force moves an object to a different elevation is called a(n) _____.

11. Is the following sentence true or false? The ideal mechanical advantage of an inclined plane is the distance along the incline plane divided by its change in height. _____

Wedges and Screws (page 431)

12. A thin wedge of a given length has a(n) _____ mechanical advantage than a thick wedge of the same length.

13. Screws with threads that are close together have a greater _____.

Pulleys (pages 432–433)

14. A simple machine consisting of a rope fitted into a groove in a wheel is a(n) _____.

15. What determines the ideal mechanical advantage of a pulley or pulley system?

_____

Compound Machines (page 435)

16. Is the following sentence true or false? A compound machine is a combination of two or more simple machines that operate together. _____

17. Circle each letter that identifies a compound machine.

a. a car b. a handheld screwdriver

c. a washing machine d. a watch

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