Name _____ Date _____ Class _____

Lesson Outline

LESSON 1

Work and Power

A. What is work?

1. _____ is the transfer of energy that to an object by a force that makes an object move in the direction of the force.

2. A weightlifter does work when exerting a force that makes weights _____, but does no work to hold weights in place because the weights are not _____.

B. Calculating Work

1. You must know two things to calculate work—_____ and _____.

a. The force must be in _____.

b. The distance must be in _____.

2. A newton-meter is also called a(n) _____, which is the unit of work.

3. The work equation uses the distance that the _____ acts on the object, not necessarily the total _____ that the object moves.

4. The work done on an object depends on the _____ of the force applied and the direction of the motion.

a. When the force on an object and the motion of the object are in the same direction, you multiply the total _____ times the total distance to determine the amount of work done.

b. When the force on an object is at a(n) _____ to the direction of motion of the object, you multiply only the part of the force that is in the _____ of motion times the total distance to determine the amount of work done.

5. The weight of any object is due to the downward force of _____ on the object.

a. To lift an object, you must pull upward on the object with a force _____ to the object's weight.

b. The work done to lift any object is equal to the _____ of the object multiplied by the distance the object is lifted.

Name _____ Date _____ Class _____

Lesson Outline continued

C. Work and Energy

1. Doing work on an object increases transfers _____ to the object.

2. Because doing work on an object requires that the object move, doing work on the object increases its _____ energy.

3. Lifting an object increases the object's gravitational _____ energy.

D. What is power?

1. _____ is the rate at which work is done.

2. Power is determined by dividing the work done by the amount of _____ needed to do the work.

a. In the power equation, _____ done is in joules.

b. In the power equation, _____ is in seconds.

c. In the power equation, power is in _____.

Name _____ Date _____ Class _____

Math Skills **LESSON 1**

Solve for Work

Work is the transfer of energy that occurs when a force makes an object move. So, work is the product of the force that is applied to the object and the distance that the object moves. This can be shown by the equation below, where w = work (in joules), F = force (in newtons), and d = distance (in meters).

$$W = Fd$$

You can rearrange the equation to solve for either of the other variables.

$$F = \frac{W}{d} \qquad d = \frac{W}{F}$$

A student pushes a box **2.0** m across the floor using a constant force of **15.0** N. How much work does the student do on the box?

Step 1 Identify the variable you will solve for and choose the appropriate equation.
You are solving for w, work.

$W = Fd$

Step 2 Substitute the known values to solve the equation.

$W = \mathbf{15.0}\ \text{N} \times \mathbf{2.0}\ \text{m}$

$W = \mathbf{30}\ \text{J}$

Practice

1. A student pushes a box 5.0 m across the floor using a constant force of 20.0 N. How much work does the student do on the box?

2. Eli lifts his little brother 1.0 m off the ground using a constant force of 15.5 N. How much work does Eli do?

3. Mary applies a constant force of 25 N as she pushes a desk. In total, she does 75 J of work. How far does she push the desk?

4. A student does 120 J of work pushing a box 6 m across the floor. What force did the student apply?

Name _____ Date _____ Class _____

Math Skills **LESSON 1**

Solve for Power

Power is the rate at which work is done. Power is calculated by dividing the work done by the time needed to do the work. This can be shown by the equation below, where P = power (in watts), W = work (in joules), and t = time (in seconds). The symbol for work, W, is usually italicized. However the abbreviation for watt, W, is not italicized.

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

You can rearrange the equation to solve for either of the other variables.

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

A student does **24** J of work in **3** seconds as she pushes a box across the floor. How much power does the student use on the box?

Step 1 Identify the variable you will solve for and choose the appropriate equation. You are solving for P, power.

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

Step 2 Substitute the known values to solve the equation.

$$P = \frac{\mathbf{24}\,\text{J}}{\mathbf{3}\,\text{s}}$$

$$P = \mathbf{8}\ \text{W}$$

The student used **8** W of power.

Practice

1. Joel does 12 J of work in 2 seconds as he lifts a box off of the floor. How much power does Joel use on the box?

2. Sasha does 15 J of work in 4 seconds as she lifts a chair off the floor. How much power does Sasha use on the chair?

3. A student pushes a box across the floor, using 9 W of power in 6 seconds. How much work does the student do?

4. Yusef pushes a chair across the room, using 9 W of power to do 45 J of work. How much time does it take him to push the chair?

Name _____ Date _____ Class _____

Content Practice on Work and Power

Directions: *On each line, write the term from the word bank that correctly completes each sentence. Each term is used only once.*

distance	**energy**	**Joule**	**motion**
power	**Watt**	**weight**	**work**

1. In science,_____ is done when a force produces _____ in an object.

2. A newton-meter is the same thing as a(n) _____.

3. The work done in lifting an object is equal to the _____ of the object times the _____ it is lifted.

4. Doing work on an object transfers _____ to the object.

5. The rate at which work is done is called _____.

6. We know that 1 J/s is equal to 1 _____.

For this activity, you will need a calculator.

7. A crane lifts a load 210 m to the top of a construction site. The crane used 800 N of force. How many joules of work were done?

_____

8. An ice-skater pushes off from a wall and skates 20 m across the ice. The skater did 2 J of work. If the skater used twice as much force, what would happen to the work done?

_____

9. If the distance an object moves is reduced by one-fourth, what would happen to the amount of work done?

_____

10. Calculate the power, in watts, that will be needed to vacuum the floors in a house in 30 minutes if the work involved is 27,000 J.

_____

11. What would happen to the power of the vacuum if the work doubled in the same amount of time?

_____

Key Concept What must happen for work to be done?

Directions: *Put a check mark on the line before the each example that represents work being done on an object.*

_____ **12.** lifting a box off the ground

_____ **13.** carrying a box across a room

_____ **14.** carrying a box up a flight of stairs

_____ **15.** pushing a stalled car

_____ **16.** pushing against a sturdy stone wall

_____ **17.** holding a suitcase

_____ **18.** putting a suitcase on an overhead rack

_____ **19.** picking up a penny from a sidewalk

Directions: *On each blank line, write the word that correctly completes the sentence.*

20. When a force is applied to an object, no work is being performed on the object unless the object _____.

21. The unit of work, the newton-meter, is also known as the _____.

22. Power is the rate at which _____ is done.

23. Power is also considered to be the rate at which _____ is transferred to an object.

Directions: *Use the equation to calculate how much work is being done in each example.*

24. Sam lifts a brick weighing 10 N from the ground and places it on a ledge 1.5 m high. How much work has Sam done on the brick? _____

25. Tara pushes a 140-N chair 12 m across the basement floor. How much work has been performed on the chair? _____

26. Erik pulls a sled 25 m through the snow. The sled weighs 200 N. How much work has Erik done on the sled? _____

Directions: *Answer each question on the lines provided.*

27. If a leaf falls from a tree, has work been done on the leaf? Explain.

_____

28. What is the amount of force required to lift an object against the force of gravity equal to?

_____

29. What is the only part of an applied force that performs work on object?

_____

Calculating Power Practice Problems NAME: _____ Hr:_____
(Show and label ALL work)

(Example) You do 2 Joules of work lifting a book to a shelf in 1 second. What was your power?

Power = Work/time = 2 J/ 1 s = 2

1) You are working in a factory where you push boxes along a conveyor belt. You can do 350 Joules of work each 5 seconds. What is your power?

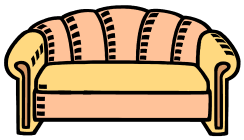
2) It takes you 10 seconds and 2,000 Joules of work to slide a chair across a floor. What power was demonstrated?

3) Using 60 Watts of power it takes you 15 seconds to lift a rock. How much work was done?

4) A book cart is pushed using 2,000 Joules of work in 4 seconds. How much power did the person pushing the cart demonstrate?

5) Zach's car used 12,000 Joules of work with a power of 200 Watts to get out of the mud. How many seconds did it take to get his car unstuck?

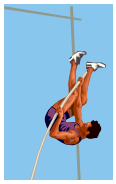
6) A couch is pushed across the floor and 550 Joules of work is done in 8 seconds. How much power was demonstrated while working on the couch?



7) A Hummer in a rock climbing competition climbs to the top of a mound using 34,000 Joules of work with a power of 2,000 Watts. How long did it take the driver to reach the top of the mound?

8) 70 Watts of power were used to slide a T.V. set into the corner of a room. If it took 6 seconds to do this, how much work was done?

9) How powerful is Sam if he does 500 Joules of work on his body during a pole vault competition in 2.5 seconds?

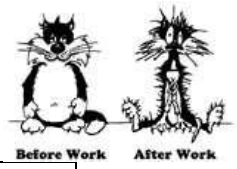


10) Using 500 Watts of power you move a blocking sled for your coach in 30 seconds. How much work did you do?

(Bonus) A semi-truck stalls in the road and a bus of 15 elderly people help push your rig to the nearest gas station 30 meters away. Each person pushing exerts a force of 12,000 Newtons to the semi. It takes these kind folks 1 minute to move you to the service area. What was the power exerted into this effort?

Name: _____ Hour: _____

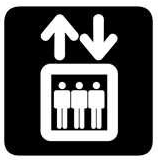
Work & Power Worksheet



1. An impulse is a force acting over some amount of time to cause a change in momentum. On the other hand, work is a _____ acting over some amount of distance to cause a change in _____.
2. Indicate whether or not the following represent examples of work.

SITUATION	WORK DONE?
a. A teacher applies a force to a wall and becomes exhausted.	Yes or No
b. A weightlifter lifts a barbell above her head.	Yes or No
c. A rolling marble hits a note card and moves it across a table.	Yes or No
d. A shot-putter launches the shot.	Yes or No
e. A waiter carries a tray full of meals across a room.	Yes or No

3. Power is defined as the _____ is done.
   a. Amount of work which
   b. Direction at which work
   c. Angle at which work
   d. The rate at which work
4. Two machines (for example, elevators) might do identical jobs (for example lift 10 passengers three floors) and yet the machines might have different power outputs. Explain how this can be so.



5. There are a variety of units for power. Which of the following would be fitting units of power (though perhaps not the standard)? Include all that apply!
   a. Watt
   b. Joule
   c. Joule/second
   d. Horsepower
6. Two physics students, Will N. Andable and Ben Pumpiniron are in the weightlifting room. Will lifts the 100-pound barbell over his head 10 times in 1 minute. Ben lif the 100-pound barbell over his head 10 times in 10 seconds.

   a. Which student does the most work? _____
   b. Which student delivers the most power? _____
   c. Explain you answer to question “b.”
      _____
7. During the Powerhouse lab, Jack and Jill ran up the hill. Jack is twice as massive as Jill, yet Jill ascended the same distance in half the time.
   a. Who did the most work? _____
   b. Who delivered the most power? _____
8. An often-used equation for power is : **Power = Force x velocity.** Express an understanding of the meaning of this equation by using it to explain what type of individual would be the best choice for a lineman on the football team._____

Name _____ Date _____ Class _____

Chapter 3, Lesson 1 Review

Work and Power

True or False

Directions: *On the line before each statement, write* T *if the statement is true or* F *if the statement is false.*

_____ **1.** According to a scientist, reading and studying is not an example of work.

_____ **2.** Only the part of a force that acts in the direction of motion does work.

_____ **3.** No work is done to lift an object off the ground.

_____ **4.** Moving something faster changes the amount of work done on the object in comparison to moving it the same distance at a slower speed.

Multiple Choice

Directions: *On the line before each question or statement, write the letter of the correct answer.*

_____ **5.** You push on an object for 3 seconds. During those 3 seconds, the object moves 0.65 m. After you stop pushing, the object moves another 0.20 m. Which distance should you use to calculate work?

A. 0.20 m
B. 0.65 m
C. 0.85 m

_____ **6.** Lifting an object in the air increases the _____ energy of the object.

A. kinetic
B. potential
C. kinetic and potential

_____ **7.** Which equation is used to calculate power?

A. work/time
B. force × distance
C. weight × height

_____ **8.** What must occur for work to be done?

A. heat
B. motion
C. pushing

Work & Power Calculations Name: _____

Work = Force x distance W = F x d	Power = Work/time P = W/t	Work = Joules Force = Newtons Distance = meters	Power = Watts Time = seconds

1. A book weighing 1.0 Newton is lifted 2 meters. How much work was done?

2. A force of 15 Newtons is used to push a box along the floor a distance of 3 meters. How much work was done?

3. It took 50 Joules to push a chair 5 meters across the floor. With what force was the chair pushed?

4. A force of 100 Newtons was necessary to lift a rock. A total of 150 Joules of work was done. How far was the rock lifted?

5. It took 500 Newtons of force to push a car 4 meters. How much work was done?

6. A young man exerted a force of 9,000 Newtons on a stalled car but was unable to move it. How much work was done?

7. A set of pulleys is used to lift a piano weighing 1,000 Newtons. The piano is lifted 3 meters in 60 seconds. (Hint: You'll need to calculate work first! Then, you can calculate the power.)

8. How much power is used if a force of 35 Newtons is used to push a box a distance of 10 meters in 5 seconds? (Hint: You'll need to calculate work first!)

9. What is the power of a kitchen blender if it can perform 3,750 Joules of work in 15 seconds?

10. How much work is done using a 60 Watt light bulb for 1 hour (3,600 seconds)?

11. How much work is done using a 500 Watt microwave oven for 5 minutes? (Hint: You'll need to calculate how many seconds are in 5 minutes.)