**Work and Power**

Work is done when a force causes an object to move in the direction of the force

**What is Work?**

Work is only done while the force is acting on the object. Once you let go of the ball no more work is done.

**Transfer of Energy**

The ball is put into motion - it gains kinetic energy (energy of motion).

**Differences between Force and Work**

You can push (force) but if the object does not move no work is done.

**Force and motion in the same direction**

When you hold something up and carry it forward you are not doing work because the force is up and the movement is forward.

Force and movement must have same direction.

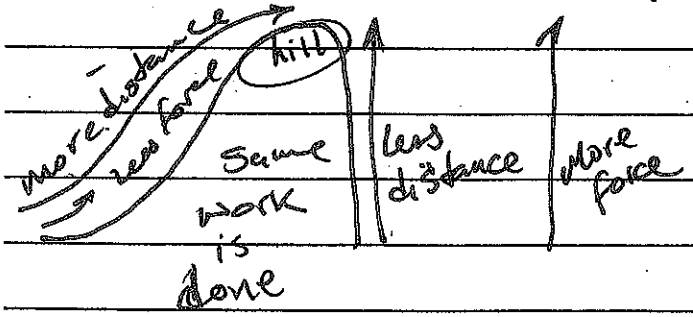
**Figure 2: Draw and Label**

| Example | direction of force | direction of motion | Doing work? |
|---|---|---|---|
| Push a box | → | → | yes |
| Carry a backpack | ↑ | → | No |
| lift groceries | ↑ | ↑ | yes |
| Carry groceries | ↑ | → | No |

**How much work?**

**Same Work, Different Forces**

For the same work to be done using less force it must be done over a longer distance.




**Calculating Work**

$W = F \times d$ work = force x distance

the unit of measure is Joule (J)

joule is also used for energy.

**Figure 5: Draw and Label**

| lifting 80N 1 meter | lifting 160N 1 meter | lifting 8N 2 meters |
|---|---|---|
| $W = f \times d$ | more force is more work | More distance is more work |
| $= 80N \times 1m$ | $W = f \times d$ | $W = f \times d$ |
| $= 80J$ | $= 160N \times 1m$ | $= 80N \times 2m$ |
| | $= 160J$ | $= 160\ J$ |

**Power: How Fast Work is done.**

Power is the rate at which energy is transfered.

**Calculating Power** $P = W/t$ Power = work/time

1 J/s is one watt (W)

Power measures how fast work is done.

**Increasing Power**

Using more power you do the same amount of work in less time.

# Stairs Lab Today you will be exploring work and power.

**Procedure**

1. Calculate your weight in newtons by multiplying your weight in pounds x 4.5.

   _____ N

2. Time it takes to walk up the stairs.

   Your time: _____ S

3. Time it takes to run up stairs.

   Your time: _____ S

4. Measure the vertical height of the stairs to the nearest 0.01 meter. ____ M

5. Using the formula (work = weight x height) to calculate how much work you have done for walking up the stairs, and running up the stairs:

   Walking : J

   Running : J

6. Using the formula (power = work divided by time) to calculate the power.

   Walking: W

   Running: W

**Questions:**

1. Compare the amount of work done when you walk vs.run. Explain

   Same amount of work is done because you lift yourself up the same amount each time

2. Why is there a difference in the amount of power? you do the same amount of work in less time.

**Work and Power Lab Activity**

1. Pick up box #1 and carry it from point A to point B. What is the work done?

Picking box up:
$W = F \times d$
$= 4N \times 1m$
$= 4J$

Putting box down:
$W = F \times d$
$= 4N \times 1m$
$= 4J$

$8J$

2. Push box #2 from point C to point D. What is the work done?

$W = F \times d$
$= 1.5N \times 0.54m$
$= 0.81J$

3. Move box #3 sideways from point E to directly over point F. Then put the box down on Point F. What is the work done?

$W = F \times d$
$= 4N \times 1m$
$= 4J$

4. Lift box #4 one meter off the ground in two seconds. What was the amount of power used?

$W = F \times d$
$= 4N \times 1m$
$= 4J$

$P = W/t$
$= 4J/2s$
$= 2W$

5. Lift box#5 one meter off the ground in 4 seconds. What was the amount of power used?

$W = F \times d$
$= 2N \times 1m$
$= 2J$

$P = W/t$
$= 2J/4s$
$= 0.5W$

6. Lift box #6 one meter off the ground in 10 seconds. What was the amount of power used?

$W = F \times d$
$= 4N \times 1m$
$= 4J$ 6

$P = W/t$
$= 4J/10s$
$= 0.4W$

Name _____

# ELEMENTS OF PHYSICS
# ENERGY: WORK and POWER

## Video Quiz

**Directions: Answer the following true or false, or fill in the blank with the correct word to make it true.**

1. Energy can be created and sometimes destroyed. T_____ F X.

2. The formula physicists use to express the expenditure of work or energy is W = F x d

3. Kinetic energy is described as energy of matter in motion. T X F_____.

4. Potential energy is not important in the total amount of energy available in the universe. T_____ F X.

5. Electromagnetic energy only exists as radiant energy from the sun and stars. T_____ F X.

6. Under intense heat two hydrogen atoms will fuse to form a helium atom and release energy. This process is called fusion.

7. Photosynthesis is a process that converts energy from the sun into chemical energy in the leaves of plants. T X F_____.

8. Energy can be changed and recycled from one form to another. T X F_____.

9. The second law of thermodynamics concludes that all things are moving towards equilibrium.

10. Einstein's formula of $E = mc^2$ states that energy equals mass times the speed of light squared. T X F_____.

mechanical
heat
chemical
radiant
electrical
sound
nuclear

**HOMEWORK: Chapter 4, Section 1 Review Questions.**

1. Work and Joule:

Joule is the unit of measure for work.

2. Power and Watt:

Watt is the unit of measure for power

3. A

4. Power is the rate at which work is done

5. $W = f \times d = 10N \times 10m = 100\ J$

6. $P = W/t = 100J/5s = 20W$

7. No, work is only done while the ball is in his hand and he is applying the force.

8. $W = f \times d = 50N \times 0.5m = 25\ J$

Work is only done to lift the chair.

9. Same amount of work is done. More distance with less force up the ramp. More force over less distance up the cliff side.

## HOMEWORK: Sample Problems for Work and Power:

- **Write out the formula. Work = Force x distance or Power = work/time**
- **Put the numbers into the formula.**
- **Solve.**

1. You pick up the trash can (45 N) from the ground to waist high ( 1 m).

Calculate the work.

$$W = F \times d$$
$$= 45\,N \times 1\,m$$
$$= 45\,J$$

2. You are pushing a rolly chair 10 meters down the hall. The weight of the chair is 40 N. The person sitting in the chair weighs 450 N. 250 N are required to accelerate the person in the chair. Calculate the work.

$$W = F \times d$$
$$= 250\,N \times 10\,m$$
$$= 2500\,J$$

3. It took you 5 seconds to pick up the trash can in problem #1. Calculate the power.

$$P = \frac{W}{t}$$
$$= \frac{45\,J}{5\,s} = 9\,W.$$

4. It took you 25 seconds to push the rolly chair in problem #2. Calculate the power.

$$P = \frac{2500\,J}{25\,s} = 100\,W$$

Name _____ Class _____ Date _____

Skills Worksheet

# Directed Reading A

## Section: Work and Power

C 1. What is the transfer of energy to an object using a force that causes the object to move in the direction of the force?
   a. movement
   b. power
   c. work
   d. force

### WHAT IS WORK?

A 2. Which of the following is considered work?
   a. throwing a bowling ball
   b. doing homework
   c. watching television
   d. trying to push a box, but not moving it

3. One way you can tell that the bowler has done work is that when the ball is moving, it has Kinetic energy.

4. When a bowling ball has kinetic energy, the bowler has transferred energy to the ball

5. What two things need to happen for work to be done on an object?
   1) Force makes the object move
   2) Object moves the same direction as the applied force.

### HOW MUCH WORK?

6. Why is it the same amount of work for a hiker to climb straight up a cliff and to walk up a slope?
   Same job is done, they go from the bottom to the top!
   less force over more distance equals more force over less distance.

7. The formula used to calculate work is:

*work* = force × distance

8. The unit used to express energy is the Joule

9. Work is the transfer of energy to an object.

10. Increasing the amount of work done can be accomplished by increasing what two things?

force or distance

## POWER: HOW FAST WORK IS DONE

B 11. What is the rate at which work is done or energy is transformed called?

a. force
b. power
c. work
d. energy

B 12. What is the equation used to calculate power?

a. $t = \frac{P}{W}$
c. $t = \frac{W}{P}$
b. $P = \frac{W}{t}$
d. $W = \frac{t}{P}$

C 13. What is the unit used to express power called?

a. joule
b. inch
c. watt
d. meter

D 14. One watt is equal to

a. one joule per hour
b. one joule per minute
c. one joule per day
d. one joule per second.

15. Name the two things that power measures.

how fast work is done.
how quickly energy is transferred.

16. In what two instances does power output become greater?

More work or less time.

17. If you sand a shelf by hand, the energy needed is the same as if you sanded it with an electric sander, but the power output is greater

18. How does a powerful engine affect the performance of a car?

The car will have greater acceleration and go faster.