 Name: ______________________

Work

Read from **Lesson 1** of the **Work, Energy and Power** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/energy/u5l1a.html
http://www.physicsclassroom.com/Class/energy/u5l1aa.html

MOP Connection: Work and Energy: sublevel 1

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 __force__ acting over some amount of __displacement__ to cause a change in __energy__.

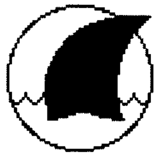
2. Indicate whether or not the following represent examples of work.

	Work Done?
a. A teacher applies a force to a wall and becomes exhausted. Explanation: nothing moves	Yes or (No?) circled
b. A weightlifter lifts a barbell above her head. Explanation: force is applied equal to gravitational force to move the barbell a distance.	(Yes) circled or No?
c. A waiter carries a tray full of meals across a dining room at a constant speed. Explanation: constant velocity means no net force.	Yes or (No?) circled
d. A rolling marble hits a note card and moves it across a table. Explanation: The marble did not apply a force over a distance	Yes or (No?) circled
e. A shot-putter launches the shot. Explanation: a force is applied over the distance that the shot-putter's arm moves	(Yes) circled or No?

3. Work is a ____________; a + or - sign on a work value indicates information about _______.
   a. vector; the direction of the work vector
   b. scalar; the direction of the work vector
   c. vector; whether the work adds or removes energy from the object
   (d.) scalar; whether the work adds or removes energy from the object

4. Which sets of units represent legitimate units for the quantity *work*? Circle all correct answers.
   (a.) Joule (b.) N x m
   c. Foot x pound d. kg x m/sec
   e. kg x m/sec^2 (f.) kg x m^2/sec^2

$W = Fd$
$[=](N)(m)$
$= \frac{kg\,m}{s^2}(m)$



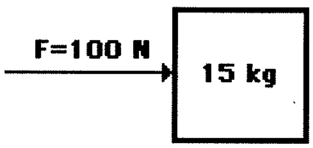
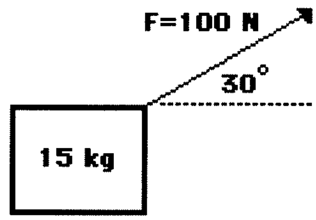
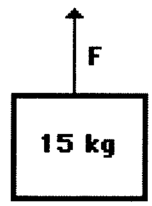
BEWARE

The amount of work (W) done on an object by a given force can be calculated using the formula

$$W = F\,d\cos\Theta$$

where **F** is the force and **d** is the distance over which the force acts and **Θ** is the angle between **F** and **d**. It is important to recognize that the angle included in the equation is not *just any old angle;* it has a distinct definition that must be remembered when solving such work problems.

5. For each situation below, calculate the amount of work done by the applied force. **PSYW**

		
A 100 N force is applied to move a 15 kg object a horizontal distance of 5 meters at constant speed.	A 100 N force is applied at an angle of 30° to the horizontal to move a 15 kg object at a constant speed for a horizontal distance of 5 m.	An upward force is applied to lift a 15 kg object to a height of 5 meters at constant speed.
W = Fd = 500 J	W = Fd sin 30 = 250 J	Fa = Fg = 15(9.8) = 147N W = Fd = ~735 J

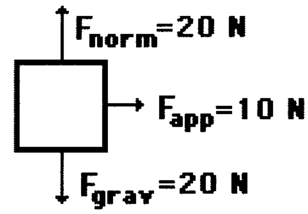
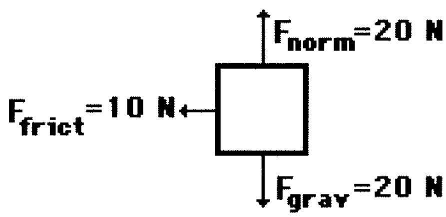
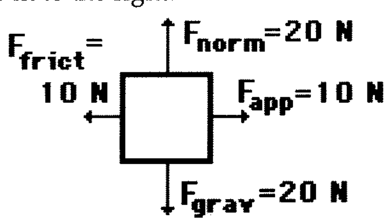
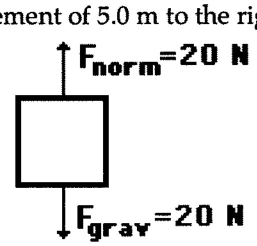
6. Indicate whether there is positive (+) or negative (-) work being done on the object.

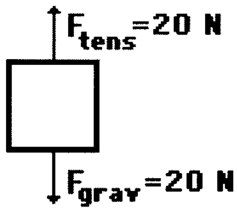
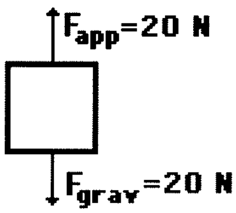
__–__ a. An eastward-moving **car** skids to a stop across dry pavement.
__+__ b. A freshman stands on his toes and lifts a **World Civilization book** to the top shelf of his locker.
__+__ c. At Great America, **a roller coaster car** is lifted to the peak of the first hill on the Shock Wave.
__–__ d. A catcher puts out his mitt and catches the **baseball**.
__–__ e. A falling **parachutist** opens the chute and slows down.

7. Before beginning its initial descent, a roller coaster car is always pulled up the first hill to a high initial height. Work is done on the car (usually by a chain) to achieve this initial height. A coaster designer is considering three different angles at which to drag the 2000-kg car train to the top of the 60-meter high hill. Her big question is: which angle would require the most work?
______________ Show your answers and explain. W = Fdcos Θ

Angle	Force	Distance	Work
35°	$1.15 * 10^4$ N	105 m	989 000 J
45°	$1.41 * 10^4$ N	84.9 m	846 000 J
55°	$1.64 * 10^4$ N	73.2 m	689 000 J

8. The following descriptions and their accompanying free-body diagrams show the forces acting upon an object. For each case, calculate the work done by these forces; use the format of force • displacement • cosine(Θ). Finally, calculate the total work done by all forces.

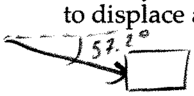
Free-Body Diagram	Forces Doing Work on the Object Amount of Work Done by Each Force
a. A 10-N force is applied to push a block across a frictionless surface for a displacement of 5.0 m to the right.  	W_{norm} = 20 • 0 • cos(—) = 0 J W_{app} = 10 • 5 • cos(0) = 50 J W_{grav} = -20 • 0 • cos(—) = 0 J W_{total} = 50 J
b. A 10-N frictional force slows a moving block to a stop along a horizontal surface after a displacement of 5.0 m to the right.  	W_{norm} = 20 • 0 • cos(—) = 0 J W_{grav} = -20 • 0 • cos(—) = 0 J W_{frict} = -10 • 5 • cos(0) = -50 J W_{total} = -50 J
c. A 10-N forces is applied to push a block across a frictional surface at constant speed for a displacement of 5.0 m to the right.  	W_{norm} = 20 • 0 • cos(____) = 0 J W_{app} = 10 • 5 • cos(0) = 50 J W_{grav} = 20 • 0 • cos(____) = 0 J W_{frict} = -10 • 5 • cos(0) = -50 J W_{total} = 0 J
d. A 2-kg object is sliding at constant speed across a frictionless surface for a displacement of 5.0 m to the right.  	W_{norm} = 20 • 0 • cos(—) = 0 J W_{grav} = -20 • 0 • cos(—) = 0 J W_{total} = 0 J

Free-Body Diagram	Forces Doing Work on the Object Amount of Work Done by Each Force
e. A 2-kg object is pulled upward at constant speed by a 20-N force for a vertical displacement of 5.0 m. 	W_{tens} = 20 • .5 • cos(0) = 10 J W_{grav} = -20 • .5 • cos(0) = -10 J W_{total} = 0 J
f. A 2-kg tray of dinner plates is held in the air and carried a distance of 5.0 m to the right. 	W_{app} = 20 • 0 • cos(-) = 0 J W_{grav} = -20 • 0 • cos(-) = 0 J W_{total} = 0 J

9. When a force is applied to do work on an object, does the object always accelerate? no
Explain why or why not.
- a frictional force may be acting against the motion
- the net work will be zero, but the applied force is doing work.

10. Determine the work done in the following situations.

a. Jim Neysweeper is applying a 21.6-N force downward at an angle of 57.2° with the horizontal to displace a broom a distance of 6.28 m.



$W = Fd\cos\theta$
$= (21.6)(6.28)\cos(57.2) = 73.5$ J

b. Ben Pumpiniron applies an upward force to lift a 129-kg barbell to a height of 1.98 m at a constant speed.

$W = Fd\cos\theta$
$= mgd\cos\theta$
$= 129(9.8)\,1.98\text{m}\cos(0)$
$= 2500$ J

c. An elevator lifts 12 occupants up 21 floors (76.8 meters) at a constant speed. The average mass of the occupants is 62.8 kg.

Total mass = 12(62.8) = 753.6 kg
$W = Fd\cos\theta$
$= mgd$
$= (753.6)(9.8)(76.8) = 568\,000$ J