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 ______________ acting over some amount of ___________________ to cause a change in __________________.

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: ____ ____	Yes or No?
b. A weightlifter lifts a barbell above her head. Explanation: ____ ____	Yes or No?
c. A waiter carries a tray full of meals across a dining room at a constant speed. Explanation: ____ ____	Yes or No?
d. A rolling marble hits a note card and moves it across a table. Explanation: ____ ____	Yes or No?
e. A shot-putter launches the shot. Explanation: ____ ____	Yes 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

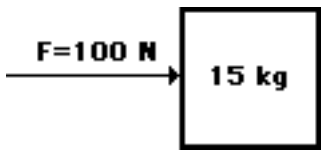
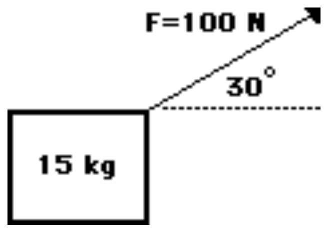
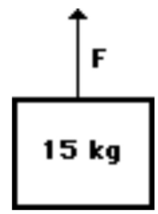
BEWARE

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.

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.

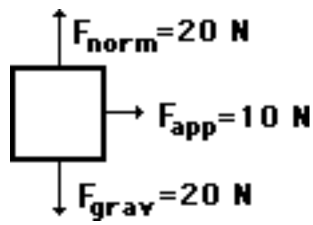
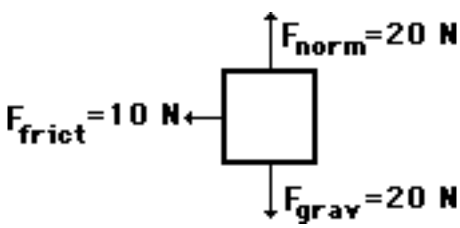
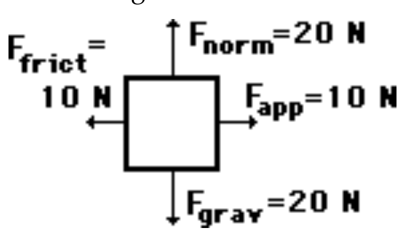
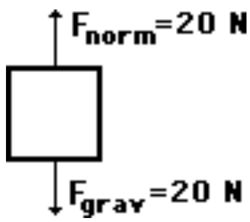
______ d. A catcher puts out his mitt and catches the **baseball**.

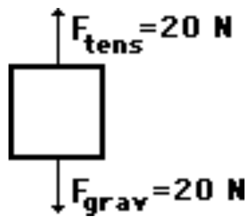
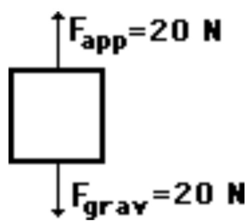
______ e. A falling **parachutist** opens the chute and slows down.

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.

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

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} = _______ • _______ • cos(_______) = _______ J W_{app} = _______ • _______ • cos(_______) = _______ J W_{grav} = _______ • _______ • cos(_______) = _______ J W_{total} = ____________ 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} = _______ • _______ • cos(_______) = _______ J W_{grav} = _______ • _______ • cos(_______) = _______ J W_{frict} = _______ • _______ • cos(_______) = _______ J W_{total} = ____________ 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} = _______ • _______ • cos(_______) = _______ J W_{app} = _______ • _______ • cos(_______) = _______ J W_{grav} = _______ • _______ • cos(_______) = _______ J W_{frict} = _______ • _______ • cos(_______) = _______ J W_{total} = ____________ 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} = _______ • _______ • cos(_______) = _______ J W_{grav} = _______ • _______ • cos(_______) = _______ J W_{total} = ____________ 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} = ________ • ________ • cos(_______) = ________ J W_{grav} = ________ • ________ • cos(_______) = ________ J W_{total} = ______________ 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} = ________ • ________ • cos(_______) = ________ J W_{grav} = ________ • ________ • cos(_______) = ________ J W_{total} = ______________ J

9. When a force is applied to do work on an object, does the object always accelerate? __________
Explain why or why not.

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.

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

    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.

