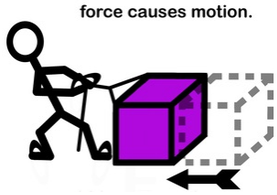
# Physics 2204
## Unit 3: Work, Power and Energy
## Worksheet 1: Work

**Student Name:**_____

Work:




- is considered to be done when an object changes:

  - position
  - shape
  - speed

- is the amount if energy that placed in or taken out of a system
- is defined as a force acting upon an object to cause a displacement in the direction of the force.
- Formula is

WORK = FORCE PARALLEL X DISPLACEMENT

$$W = \vec{F}_{//} \bullet \vec{d}$$

$$W = \vec{F} \bullet \vec{d} \, Cos\theta$$

W = Joule (J)
F = Newton (N)
d = displacement (m)

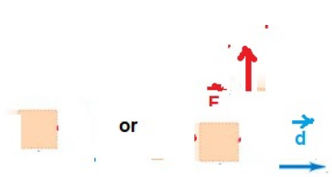
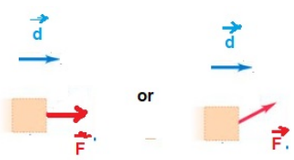
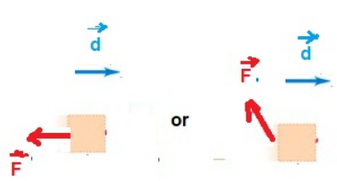
- Conditions for work:

  1) Force MUST cause the displacement

  2) Displacement MUST happen parallel to the force

  3) The greater the angle between the direction of the force and the direction that the object moves, the smaller will be the work done on the object.

- Three ways of describing work:

| Zero | Positive | Negative |
|---|---|---|
|   -Object does not move -Force is at 90 º with motion |   -Force is in direction of motion |   -Force opposes motion |

**Example 1:**

Is work being done?

A) A person applies a force to a wall and becomes exhausted.

_____

_____

B) A book falls off a table and free falls to the ground

_____

_____

C) A person carries a box on his shoulders across the room.

_____

_____

D) D. A rocket accelerates through space.

_____

_____

**Example 2:**

A car accelerates to "highway speed" by using a net force of 2400. N, which is applied over a distance of 150.0 m. How much work is done?

**Example 3:**

Calculate the work done by a weightlifter in lifting a 150 kg barbell 1.6 m vertically at a constant velocity

**Example 4:**

A 75 kg boulder rolls off a cliff and falls to the ground below. If the force of gravity did $6.0 \times 10^4$ J of work on the boulder, how far did it fall?

**Example 5:**

A 1.1 kg physics book slides to the right on a table at a constant speed. The book encounters a rough patch where the coefficient of kinetic friction is 0.15 and slows down over a distance of 1.5 m. Calculate the work done by friction.

**Example 6:**

A boy pulls a wagon a distance of 1.2 km. An applies force of 28N is directed at an angle of $40^{O}$ above the horizontal. How much work is done?

**Example 7:**

A locomotive exerts a constant forward force of 5.4 x $10^4$ N while pulling a train at a constant velocity of 25 m/s for 1.0 hours. How much work does the locomotive do?

**PART A: MULTIPLE CHOICE**

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

1. Which factor affects the amount of work done on an object which is being pulled across a horizontal, frictionless surface?

   (A) Displacement
   (B) Mass
   (C) Speed
   (D) Time

2. Which of the following units is used to measure energy?

   (A) Joule (J)
   (B) Newton (N)
   (C) Kg•m/s
   (D) Watts (W)

3. Which of the following is equivalent to a Joule?

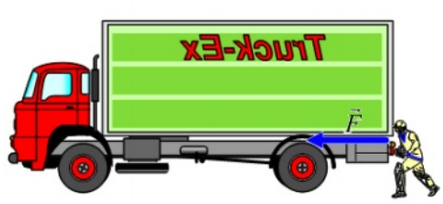
   (A) N
   (B) N/kg
   (C) N•m
   (D) N•s

4. When is work done on an object?

   (A) An object is at rest
   (B) A force causes the object to move perpendicular to its direction
   (C) A force is applied
   (D) A force causes the object to move parallel to its direction

5. A truck driver is trying to push a loaded truck with an applied force. Unfortunately, his attempt was unsuccessful the truck stays stationary no matter how hard the driver pushes. How much work is done by the driver?

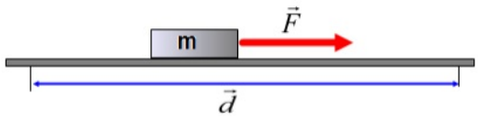
   (A) $-\vec{F} \bullet \vec{d}$
   (B) $\vec{F} \bullet \vec{d}$
   (C) $\frac{\vec{F}}{\vec{d}}$
   (D) Zero



6. Which of the following situations involves no work being done on the crate.

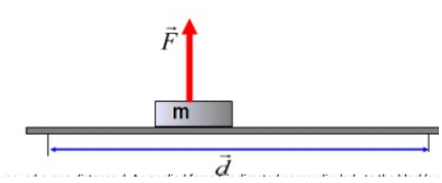
(A) A force is applies to slow a crate down as it slides along the floor
(B) A force is used to push a crate across the floor
(C) A person walks while holding the crate stationary in is arms
(D) A person lifts the crate off the floor

7. A block of mass m is pulled over a distance d by an applied force F which is directed in parallel to the displacement. How much work is done on the block by the force F?



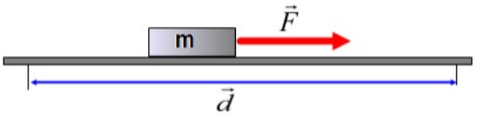

(A) $-\vec{F} \bullet \vec{d}$
(B) $\vec{F} \bullet \vec{d}$
(C) $\frac{\vec{F}}{\vec{d}}$
(D) Zero

8. A block of mass m is moved over a distance d. An applied force F is directed perpendicularly to the block's displacement. How much work is done on the block by the force F?




(A) $-\vec{F} \bullet \vec{d}$
(B) $\vec{F} \bullet \vec{d}$
(C) $\frac{\vec{F}}{\vec{d}}$
(D) Zero

9. A block of mass m is moved over a distance d. An applied force F is opposite to the block's displacement. How much work is done on the block by the force




(A) $-\vec{F} \bullet \vec{d}$
(B) $\vec{F} \bullet \vec{d}$
(C) $\frac{\vec{F}}{\vec{d}}$
(D) Zero

10. A student exerts a horizontal force of 500.0 N on his friend's chair to move her a distance of 2.0 m across the floor. How much work is done by the student?

(A) 0 J
(B) $4.0 \times 10^{-1}$ J
(C) $2.5 \times 10^{2}$ J
(D) $1.0 \times 10^{3}$ J

11. A horizontal force of 3.0 N is applied to an object on a frictionless surface and 33 J of work is done. What distance does the object move?

(A) 0.091 m
(B) 11 m
(C) 36 m
(D) 99 m

12. A wagon is pulled 5.00 m along a sidewalk by a force of 55.0 N exerted at an angle of 35.0° to the horizontal. How much work is done on the wagon?

(A) 45.1 J
(B) 90.1 J
(C) 158 J
(D) 225 J

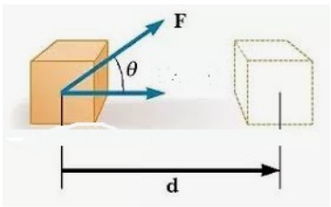
13. A truck pulls a trailer with a forward force of 3500 N while moving at a constant velocity of 22 m/s. How much work does the truck do in 36 s?

(A) $7.7\times10^{2}$ J
(B) $7.7\times10^{5}$ J
(C) $2.8\times10^{6}$ J
(D) $2.8\times10^{7}$ J

14. A force of 6.5 N is exerted upon an object causing it to move at 0.80 m/s for 9.0 s. How much work is done on the object?

(A) 0.58 J
(B) 1.1 J
(C) 47 J
(D) 73 J

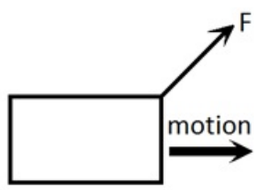
15 A force F is exerted at an angle θ on a box of mass m as it is dragged across the floor at constant velocity. If the box travels a distance x, Which of the following would be used to calculate the amount of work done?



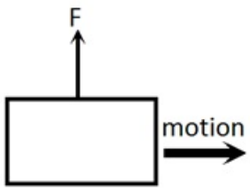

(A) $\vec{F}\bullet\vec{d}$
(B) $\vec{F}\bullet\vec{d}\,Cos\,\theta$
(C) $\vec{F}\bullet\vec{d}\sin\theta$
(D) $\vec{F}\bullet\vec{d}\,Tan\,\theta$

16. In which situation is the most work being done by the force, F?

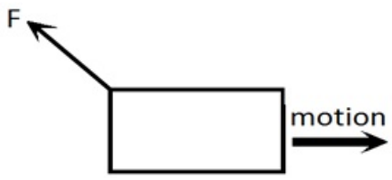
(A)




(B)

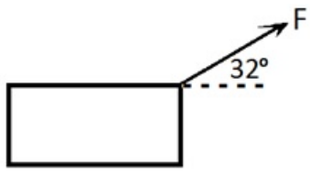



(C)



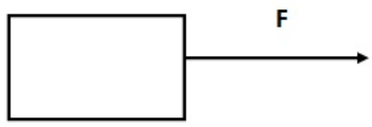

(D)

17. How much work is done by a $4.50 \times 10^2$ N force applied at an angle of 32°, while moving the block a distance of 2.0 m?




(A) $3.8 \times 10^2$ J
(B) $4.8 \times 10^2$ J
(C) $7.6 \times 10^2$ J
(D) $9.0 \times 10^2$ J

18. A force applied to a box does 22.0 J of work while moving the box 4.50 m. What is the magnitude of the applied force?

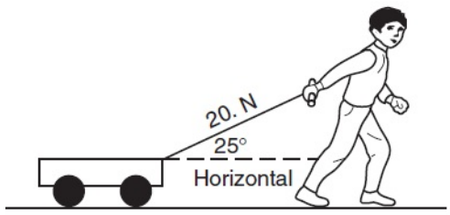



(A) 4.89 N
(B) 10.1 N
(C) 17.5 N
(D) 26.5 N

19. How much work is done to lift a 5.0 kg object to a height of 5.0 m ?

(A) 25 J
(B) 49 J
(C) 98 J
(D) 245 J

20. As shown in the diagram below, a child applies a constant 20. N force along the handle of a wagon which makes a 25° angle with the horizontal.




How much work does the child do in moving the wagon a horizontal distance of 4.0 m?

(A) 5.0 J
(B) 34 J
(C) 73 J
(D) 80. J

**PART B: WRITTEN RESPONSE**

1. Complete the following:

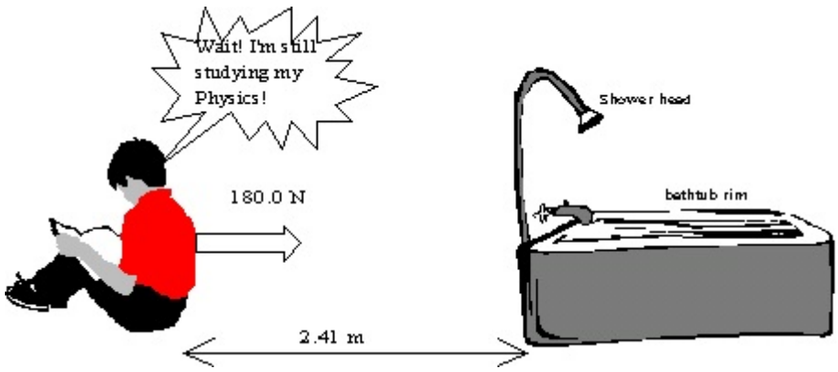
a. Suppose that you spent a whole day holding boards in place while your friend nailed them in place. Why could it be said, at the end of the day, that you did no work?

b. If you were in deep outer space and fired a cannonball it could possibly keep moving forever. Even though it might move for millions of light years, why would it still be true that the only work done was when it was first fired?

2. Explain why no work is done in each instance:

a. A curling stone moves at a speed of 0.8 m/s for 10.0 m
b. A crane holds a 5.0 tonne girder stationary while it is welded in place.

3. How much WORK will be done in dragging the boy over to the tub?




4. Calculate the amount of work done in each instance.

a. The coefficient of friction between a sled and the snow is 0.100. The sled has a mass of 50.0 kg and is towed at constant speed by a horizontal force. How much work is done if the sled is towed for a total of 100.0 m? Note: recall that $F_{fr} = mg$.

b. The engines of a jet apply an average force of $2.0 \times 10^4$ N while the jet taxis a distance of 455 m along the runway.

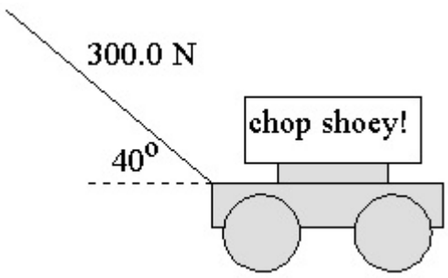
c. A car's engine applies the force needed to overcome friction while the car moves a distance of 75 km at constant speed. The mass of the car is 1400 kg and the coefficient of friction is 0.300.

5. A 300.0 kg load is dragged horizontally through a distance of 8.20 m. If the total energy expended is $4.32 \times 10^3$ J what force was applied?

6. A tractor does 8.3 kJ of work towing a crate across a warehouse floor. If the force that did the work was 450 N, then through what distance did the crate move?

7. Calculate the amount of work done in each instance.

a. A mower handle makes an angle of $40^o$ with the horizontal. A force of 300.0 N, applied along the handle, causes it to move a total distance of 340 m.




b. The handle of a "snow pusher" makes an angle of $35^o$ with the horizontal. Every sweep of the blade moves the snow 1.2 m. A force of 220 N is used. How much work is done with each sweep?

8. You are towing your little sister on a slide. The rope makes an angle of $42^o$ with the ground. You apply a force of 234 N along the rope. How much work will be done if you tow the sled a distance of 300.0 m?

9. Under what condition can the amount of work done be negative?

10. A hockey puck is passed to a player. The player's stick moves back a distance of 0.18 m while "catching" the puck. The average stopping force needed was 1.50 N. Calculate the amount of work done in stopping the puck.

11. A force of 85 N is applied to a lawn mower at an angle of 60.0º above the horizontal. Calculate the distance the mower must be pushed to do 2000.0 J of work.

12. Using principles of Physics, explain which one of these Olympic weight lifters is doing the most work.

    Lifter A raises a 50 kg mass 2m vertically from the floor.

    Lifter B holds a 50 kg mass at shoulder height and walks 2m forward at a constant velocity.