Name: _____

Class: _____

Due Date: _____

Physics Topic 15A – Work and Energy

Part 1: Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. C: State the meaning and equation for *work*. Units? Is it a scalar or vector?

2. C: State the meaning of *energy*. Units? Is it a scalar or vector?

3. C: State the meaning and equation for *kinetic energy*. Define each variable.

4. C: What will happen to the kinetic energy of a moving object if its

   a. Mass halves and speed halves?

   b. Mass doubles and speed doubles?

   c. Mass decreases by three (one third) and speed increases by four (quadruples)?

5. C: State the meaning of *potential energy*.

6. C: State the meaning of *gravitational potential energy*. State the equation for *gravitational potential energy* of an object near the surface of a planet. Define each variable.

7. C: State the equation for the *total mechanical energy* of an object.

8. C: What is the work done on a 3.00 kg rock if it travels 60.0 m with a constant speed of 4.00 m/s in outer space?

9. C: True or false: Work is done on an object if the object moves.

10.C: What does the slope of a *force vs. displacement* graph tell us?

11.C: What does the area under a *force vs. displacement* graph tell us?

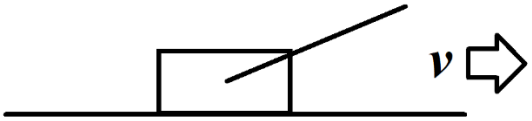
12.C: State the meaning of and the equation for the *law of conservation of energy*.

13.C: List some characteristics of a *Sankey diagram*. Sketch a simple *Sankey diagram*.
http://sankeymatic.com/

14.C: State the equation for *efficiency*. Units? Is it a scalar or vector?

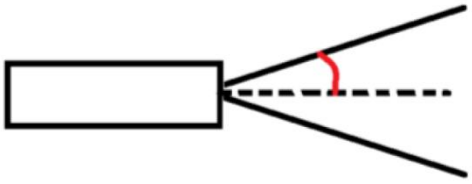
Part 2: Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. E: A force of 120. N is applied to the front of a sled at an angle of 28.0° above the horizontal so as to pull the sled a distance of 165 m. How much work was done by the applied force?



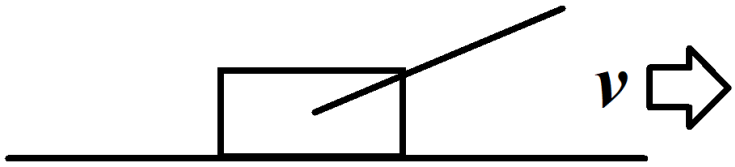
2. E: How much work would be required to lift a 12.0 kg mass up onto a table 1.15 m high with a constant speed?

3. E: A barge is being pulled along a canal by two cables being pulled as shown below. The tension in each cable is 1.40×10^4 N and each cable is being pulled at an angle of 18.0° relative to the direction of motion. How much work will be done in pulling this barge a distance of 3.00 km?



4. E: Job pulls a massless rope at an angle of 40.0° from the horizontal which is attached to a block of mass $m = 60.0$ kg on a rough horizontal surface with a coefficient of friction of $\mu = 0.200$ with a constant speed of 2.00 m/s for 300. m.

   a. Draw a free body diagram.

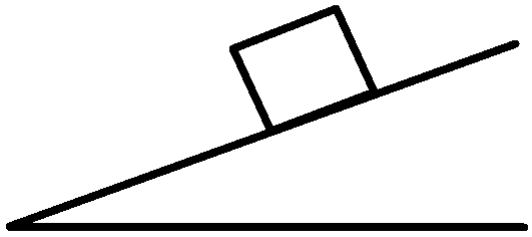


   b. Use Newton's second law of motion to find F_{pull}.

c. How much work was done by Job?

d. What is the average power performed by Job?

5. E: A man pushes a 25.0 kg box uphill 22.0° above the incline which is 125 m long. The man pushes the box parallel to the slope with a force of 65.0 N.



a. Calculate the work the man does on the box.

b. Calculate the work done by the force of gravity on the box.

6. E: A man pushes a 4.00 kg box 8.00 m across a floor with a force of 13.0 N. He then lifts the box above a closet which is 2.25 m high. Calculate the amount of work the man does on the box.

7. E: A 10.0 kg object initially at rest is 12.0 m above the surface of the Earth. It is released. There is no air friction.

   a. Draw a figure.

   b. What is the initial kinetic energy of the object?

   c. What is the initial gravitational potential energy of the object?

   d. What is the initial total energy of the object?

   e. What is the kinetic energy of the object when it is halfway to the surface?

f. What is the gravitational potential energy of the object when it is halfway to the surface?

g. What is the total energy of the object when it is halfway to the surface?

h. What is the final gravitational potential energy of the object just before it reaches the surface?

i. What is the final kinetic energy of the object just before it reaches the surface?

j. What is the total energy of the object just before it reaches the surface?

k. What is the final speed of the object just before it reaches the ground? From part d the total energy of the object is 1,177.2 J.

l. Draw a *gravitational potential energy vs. height* graph, a *kinetic energy vs. height* graph, and a *total energy vs. height* graph.

8. E: Jethro throws a 5.00 kg object from the surface of the Earth vertically upwards with an initial speed of 8.00 m/s. There is no air friction.

a. Draw a figure.

b. What is the initial gravitational potential energy of the object?

c. What is the initial kinetic energy of the object?

d. What is the initial total energy of the object?

e. What is the maximum height the object will travel?

f. How long will it take for the object to reach its maximum height?

g. What is the gravitational potential energy of the object when it is halfway to its maximum height?

h. What is the kinetic energy of the object when it is halfway to its maximum height?

i. What is the total energy of the object when it is halfway to its maximum height?

j. What is the gravitational potential energy of the object when it reaches its maximum height?

k. What is the kinetic energy of the object when it reaches its maximum height?

l. What is the total energy of the object when it reaches its maximum height?

m. What is the speed of the object when it reaches its maximum height?

n. Draw a *gravitational potential energy vs. height* graph, a *kinetic energy vs. height* graph, and a *total energy vs. height* graph.

9. E: A 8.00 kg object is falling vertically freely with a speed of 40.0 m/s at an elevation of h_1. What will be the speed of the object after it has fallen a distance of 70.0 m?

10.E: A 8.00 kg object is falling down with a speed of 40.0 m/s at an elevation of 300. m. After the object has fallen a distance of 90.0 m its speed is now 45.0 m/s.

a. What is the magnitude of energy lost from air friction?

b. What is the magnitude of the force of air friction during this 90.0 m?

11.E: A 7.00 kg object is placed on top of a 12.0 m long smooth incline which is 30.0° above the horizontal. It is released and slides down.

a. Draw a figure.

b. What is the initial height of the object?

c. What is the initial gravitational potential energy of the object?

d. What is the initial kinetic energy of the object?

e. What is the initial total energy of the object?

f. What is the final speed of the object when it reaches the bottom of the incline?

g. What is the final kinetic energy of the object?

h. What is the final gravitational potential energy of the object?

i. What is the acceleration of the object?

j. How long does it take for the object to reach the bottom of the incline?

12. E: A 4.00 kg block is placed on top of a 20.0 m long rough incline which is 30.0° above the horizontal. The coefficient of friction between the block and the incline is $\mu = 0.300$. The block is released and slides down.

a. Draw a figure.

b. What is the initial height of the object?

c. What is the initial gravitational potential energy of the object?

d. What is the initial kinetic energy of the object?

e. What is the initial total energy of the object?

f. What is the normal force acting on the block?

g. What is the force of friction acting on the block?

h. What is the final speed of the object when it reaches the bottom of the incline? Use the law of conservation of energy:

i. What is the acceleration of the object?

j. What is the final kinetic energy of the object?

k. What is the final gravitational potential energy of the object?

l. What is the final total energy of the object?

m. How long will it take for the object to reach the bottom of the incline?

n. How much energy was lost by the block?

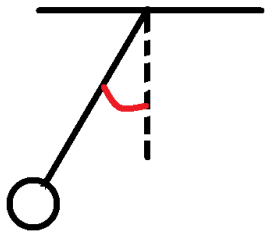
13. E: A block with a mass 3.50 kg begins from rest and slides down a ramp which has a vertical length of 12.0 m. 35.0% of the initial gravitational potential energy is lost from air and surface friction. Calculate the speed of the block when it reaches the bottom.

14.E: A 6.00 kg block is moving to the right with a constant speed of 22.0 m/s on a horizontal frictionless surface. The block then goes up a 30.0° incline which has a coefficient of friction of 0.800.

a. Draw a figure.

b. How many meters up the incline and how high does the block move?

15.E: A child, which has a mass of 23.0 kg, is sitting on a swing. The ropes of the swing are 5.20 m long and the child is pulled back until the angle between the ropes of the swing and the vertical is 35.0° as shown below. The child is released and is allowed to swing back and forth.



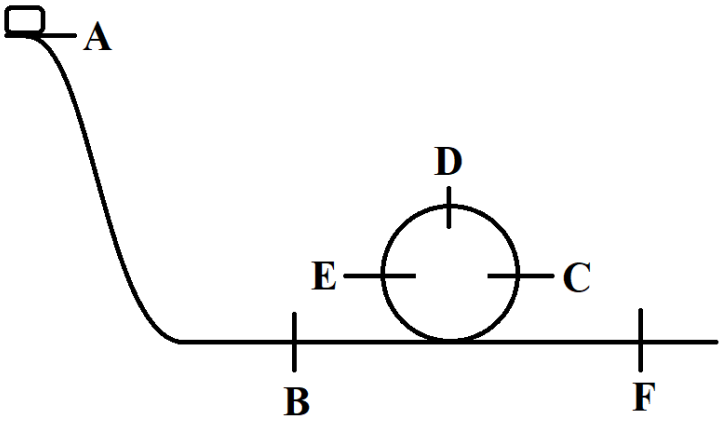
a. What is the gravitational potential energy, relative to the lowest point reached by the swing as it swings back and forth, of the child at the moment the child is released?

b. What will be the total kinetic energy of the child at the lowest point of the swing?

c. What will be the child's velocity at the bottom of the swing?

d. What will be the tension in the ropes of the swing when the child swings through the lowest point?

16.E: A 425. kg roller coaster begins from rest at a height $h_1 = 140.\,\text{m}$ above the surface of the Earth. The roller coaster makes a circular loop with a radius of $r = 24.0\ \text{m}$.



a. Determine the total energy of the roller coaster at points A, B, C, D, E, and F. Write neatly, show all your work, and place a box around all six of your answers.

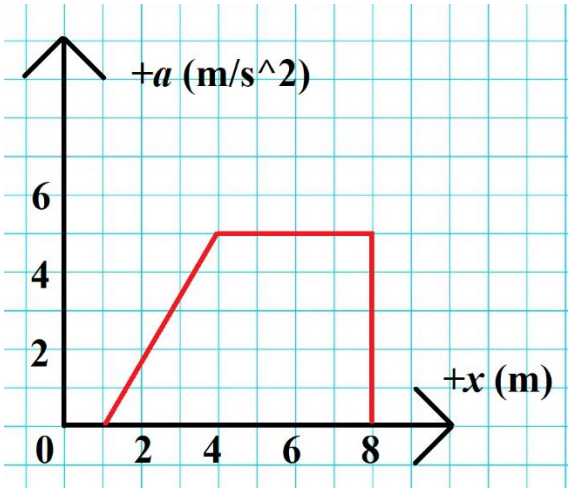
b. Determine the gravitational potential energy of the roller coaster at points A, B, C, D, E, and F. Write neatly, show all your work, and place a box around all six of your answers.

c. Determine the kinetic energy of the roller coaster at points A, B, C, D, E, and F. Write neatly, show all your work, and place a box around all six of your answers.

d. Determine the speed of the roller coaster at points A, B, C, D, E, and F. Write neatly, show all your work, and place a box around all six of your answers.

17.E: A mass is displaced by a force F. The displacement always acts in the same direction as the force. Determine an equation in terms of F_0 and x_0 for the work done on the mass when the displacement increases from 0 to x_0 and returns to 0.

18.E: An object with a mass of 2.00 kg is accelerated in a straight line. The graph below shows how the acceleration of the object varies with displacement. Calculate the work done on the object.



19. An object begins at rest and is then accelerated by a constant force. Draw a graph of the speed v vs. time t of the object and the kinetic energy E_{k} vs. time t of the object. There is no friction.

20. Allison throws a 0.600 kg basketball at 50.0 m/s from atop the gym, whose elevation is 210. m. The balls parabolic trajectory has a total curved length of 300. m to the ground, which strikes the ground with a speed of 70.0 m/s. Find the force of friction acting on the ball during its flight.