AP Physics 1
Unit 3 Practice Exercises

Directions: Show the steps required to arrive at the answer. Work out the problems on separate page.

3.1 – Work & Power

1. Identify is work is done in the following cases:
   a) A physics student works tirelessly on this homework assignment.
   b) An elevator takes you from the 1st to the 3rd floor of Suncoast, and returns to the 1st floor.
   c) Link pulls a block 10 m across the floor of a temple at constant speed.
   d) A guy pushes the wall with all his strength.
   e) A student picks up a textbook from the ground.

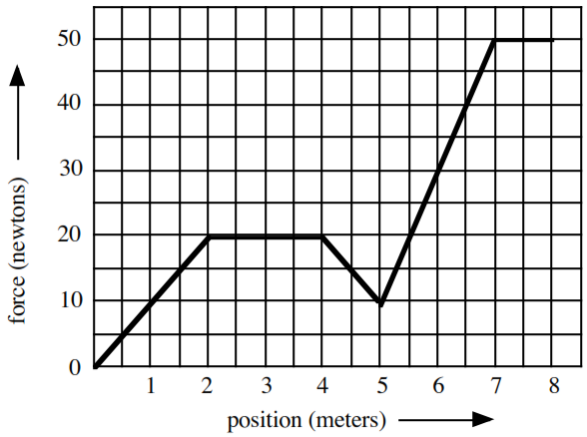
2. a) Why can the force of static friction only do zero work?
   b) Why can the force of kinetic friction only do negative work?

3. What are the units of work and what is that equal to in terms of newtons and meters?

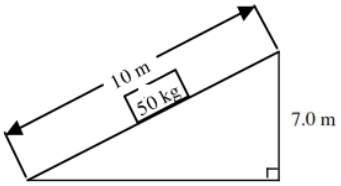
4. Some guy pushes on horizontally on a box of mass $\boldsymbol{m}$ which moves with constant speed $\boldsymbol{v}$ across a horizontal floor. The coefficient of friction between the box and floor is $\boldsymbol{\mu}$. At what rate does the guy do work on the box?

5. A book is pushed across a horizontal table at constant speed. The mass of the book is 2 kg. How much work is done to push the block 3 m if the coefficient of friction between the book and the table is .30?

6. The force vs. position graph for a 50 kg object is shown for a 18 s time interval in which is moves from x = 0 m to x = 8.0 m . How much work is done on the object in that time?



7. A mass of 50 kg is lifted from the bottom to the top of 7 m tall incline with a length of 10 m as shown. The coefficient of sliding friction between the block and the plane is .18. The block moves up the incline at constant speed for 20 s until it reaches the top.
   a) How much work is done to lift the mass up the incline?
   b) What is the work done by friction as the block moves up the incline?
   c) What is the power required to move the mass up the incline?



8. A 10.0 kg object is accelerated from rest by a 15 N force on a level surface without friction. How much power is done in the following cases?
   a) The object attains a speed of 20m/s.
   b) The mass traveled for 20 s.

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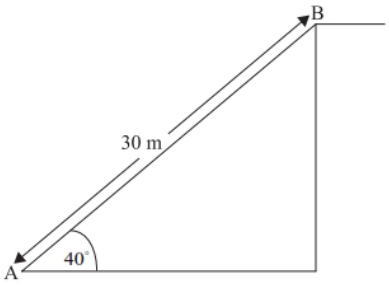
9. A 300 kg golf cart travels at constant speed on a level path. The coefficient of friction is .16 (treat the golf cart as a sliding object). If the motor uses 2.5 kW of power to move the cart and is 85% efficient, at what speed does the cart travel?

10. The diagram represents an escalator. People step on to it at point A and step off at point B. The escalator is 30 m long and makes an angle of 40° with the horizontal. At full capacity of 48 people step on at point A and step off at point B every minute.

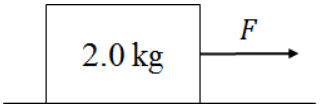


a) Calculate the potential energy gained by a person of weight 700 N
b) Estimate the energy supplied by the escalator motor to the people every minute when the escalator is working at full capacity.
c) State one assumption that you have made to obtain your answer to b).

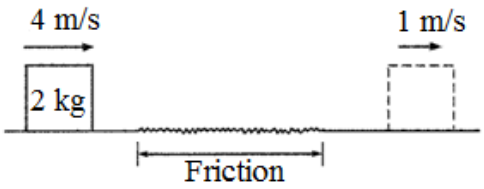
3.2 – Work & Energy

1. A satellite of mass $\boldsymbol{m}$ orbits the Earth, of mass $\boldsymbol{M}$, in a circular orbit of radius $\boldsymbol{R}$.
a) What is the kinetic energy of the satellite?
b) Does the Earth's gravity do work on the satellite? Why or why not?

2. A force F is exerted on a 2.0 kg block to move it across a rough surface. The magnitude of the force is initially 5 N, and the block moves at constant velocity. While the block is moving, the force is instantaneous increases to 12 N. How much kinetic energy does the block now gain at it moves a distance of 2 m?



3. A block of mass 2 kg slides along a horizontal surface that has negligible friction except for one section, as shown. The block arrives at the rough section with a speed of 4 m/s and leaves it 0.5 s later with a speed of 1 m/s. What is the work done by frictional force exerted on the block?

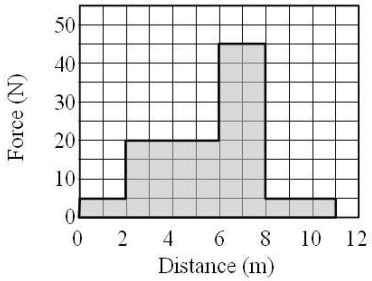


4. A softball player catches a ball of mass m, which is moving towards her with horizontal speed V. While bring the ball to rest, her hand moves back a distance d. Assuming constant deceleration, what is the horizontal force exerted on the ball by the hand?

5. A 70-kg base runner begins his slide into second base when he is moving at a speed of 4.0 m/s. The coefficient of friction between his clothes and Earth is 0.70. He slides so that his speed is zero just as he reaches the base.
a) How much mechanical energy is lost due to friction acting on the runner?
b) How far does he slide?

6. A block is traveling at a speed v when it comes to a rough surface. The block moves a distance D before it comes to a complete stop. If the block had been moving at $2v$, how far would it slide before stopping?

7. A 3.0 kg object is traveling at a velocity of 2.0 m/s when it is subjected to a force. The value of the force as function of distance traveled is given in the graph to the right. Find the speed of the object at t = 11.0 s.



8. A 60 N force stretches a spring 5.0 m. What is the spring constant of the spring? What is the work done to stretch the spring? What is the elastic potential energy of the spring at this point?

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9. A 1.0 kg block is attached to an unstretched spring of spring constnat 50 N/m and releasted from rest from the position shown. The block oscillates and eventually stops 0.20 m below its start point, as shown. What is the change in potential energy of the block-spring-Earth system between the two figures?

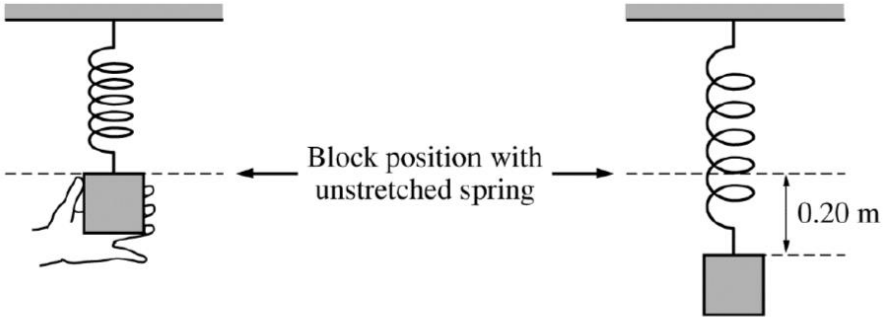


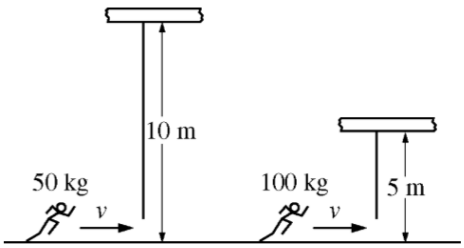
Figure 1 Figure 2

3.3 – Conservation of Energy

1. A ball is thrown vertically upwards with a velocity $\boldsymbol{v}$ and kinetic energy, KE. When it is halfway to its max height, what are its potential and kinetic energies in terms of the given variables?

2. a) Is it possible to give a block a push and then have it slide up an incline at a constant speed (without you continuing to push on it)? Explain your reasoning.
b) Is it possible to give a block a push and then have it slide down an incline at a constant speed (without continuing to push on it)?

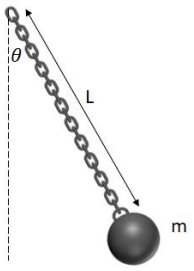
3. A 50 kg athlete running at speed v grabs a light rope that hangs from a 10 m high platform and swings to some maximum height. Later, a 100 kg athlete, running at the same speed, grabs and similar rope hanging from a 5 m high platform. Which athlete swings higher, and why?



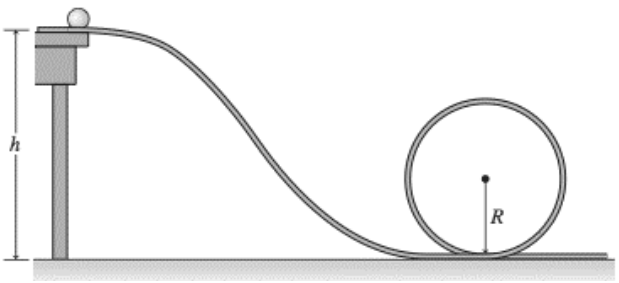
4. An archer pulls with a force of 420 N on a .20 kg arrow. The bowstring is drawn back .60 m. Assume the bowstring obeys Hooke's Law.
a) What is the force constant k for the bowstring?
b) How much work is done drawing the bowstring back?
c) With what speed will the arrow be released from the bowstring?

5. The school district of Calm Peach County votes to demolish a magnet school of the arts. The wrecking ball has mass m and is attached to a massless chain of length L. The ball is displaced an angle of θ as shown.

a) Determine the amount of destructive energy the wrecking ball has.
b) Determine an expression for the speed of the wrecking ball at the bottom of its path.
c) Determine an expression for the tension in the chain when the wrecking ball has max speed.



6. An object of mass M is released from rest on a frictionless track. The object slides along the frictionless track and goes through a vertical loop of radius R, as shown. What is the minimum starting height of the object required so that the object makes it through the circle without falling off the track?



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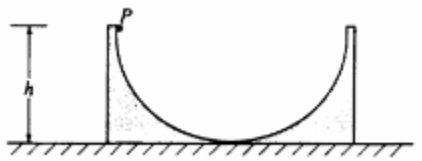
7. A projectile is fired at an upward angle of 60° with a speed of 100 m/s. It lands on a plateau 150 m higher. What is the projectile's speed the moment before it strikes the plateau? Solve using conservation of energy; not kinematics.

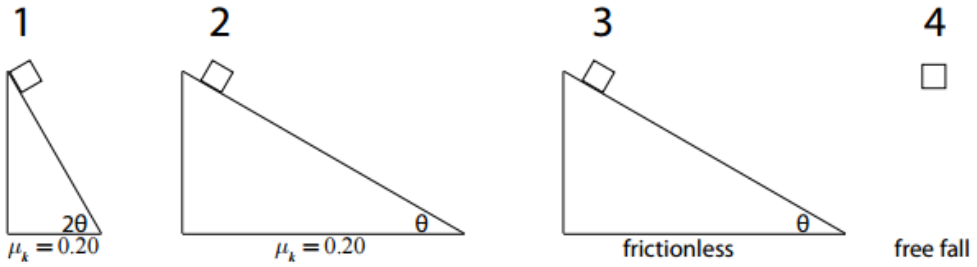
3.4 – Nonconservative Forces

1. A textbook is pushed 2 meters across a teacher's desk at constant speed in the presence of friction. Describe the forces that do work while the book is in motion and how those forces affect the energy of the system.

2. An object of mass ***m*** is dropped at point P at time = 0. Sketch a graphs of the kinetic and potential energy with respect to time for 2 complete cycles of the system assuming some amount of energy is lost to friction.



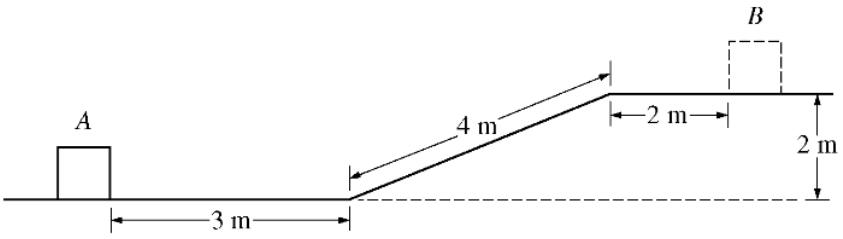
3. Identical metal blocks initially at rest are released in various environments as shown in scenarios A through D below. In all cases, the blocks are released from a height of 2m. Neglect air resistance.



Rank the scenarios from least kinetic energy to greatest kinetic energy at the instant before the block reaches the ground.

4. A bouncy ball with a mass of 0.50 kg is dropped vertically from a height of 1.0 m above the floor. The ball bounces off the floor. During the bounce, the ball loses 2.0 J of energy from interacting with the ground. What is the maximum height the ball will reach after bouncing back up?

5. A block mass 5.0 kg moves from position A to position B in the figure below. The speed of the block is 8.0 m/s at A and 3.0 m/s at B. What is the work done by friction?



6. A 0.01 kg ping pong ball is released from rest 2 m above the floor. It reaches a speed of 3 m/s the moment before it hits the floor. How much heat due to air resistance is generated during this process?

7. A force of 120 N is used to push a 12 kg package up an inclined plane that makes an angle of 40° with the horizontal. The coefficient of sliding friction is .25.

a) Describes what happens to the kinetic energy as it slides up the ramp.
b) High far up the incline does the package go before sliding back down?
c) Sketch graphs of the kinetic and potential energy of the box vs. time.

8. A skier starts from rest at the top of a 30° incline and skis down 300 m. If the coefficient of kinetic friction between the skis and the snow is 0.15, calculate the skiers speed at the bottom.

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