Chapter 5 XtraWrk – Work and Energy

5.1) A worker lifts a 350-N box from ground level vertically at constant speed to a shelf above his head, 2.0 m above the ground. How much work does the worker do, and why is it important that he lift the box at constant speed?

5.4) A mom pushes her baby's stroller with 35 N force slightly downward, at an angle of 25º below the horizontal. This is just enough force so the stroller rolls at constant speed, overcoming any frictional forces.

a) How much work is done by the mom as she covers 50.0 m of sidewalk?
b) What is the net work done on the stroller? Why?
c) The mom turns and goes down another segment of sidewalk of the same length, at the same constant speed as before. If now she pushes horizontally but nothing else changes (e.g. the work done by frictional forces stays the same), would the force she needs to apply be bigger, smaller, or the same? What about the work done on the stroller by the mom?

5.5) A 5.00 kg sled slides down a rough 30.0º ramp from rest. The ramp is 2.50 m long, and the coefficient of kinetic friction between the sled and the ramp is $\mu_k = 0.436$.

a) What is the work done by gravity?
b) What is the work done by friction?
c) What is the work done by the normal force?
d) Without doing any calculations, how would your answers change if the ramp were steeper but of shorter length? Explain.

5.6) Movers use 150 N of force to push a 40.0 kg bookcase across a rough surface. The bookcase moves at constant speed for 6.00 m of pushing.

a) What's the work done by the 150-N force?
b) What is the coefficient of kinetic friction between the bookcase and the surface?

5.9) A bobsled team does 5000 J of work pushing their 2500 kg bobsled from rest to a launch speed of v along a 25.0 m long segment of track. Ignoring friction,

a) What is v?
b) What is the horizontal force exerted by the team on the sled?

5.15) A ballistics expert shoots a 7.80-g bullet into a block of wood and observes the bullet penetrate to a depth of 5.50 cm. The muzzle velocity of the gun is 575 m/s.

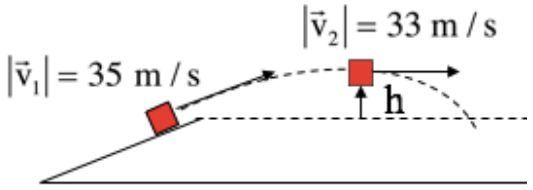
a) Using work and energy considerations, what is the average frictional force that brings the bullet to rest?
b) Assuming that frictional force is constant, how much time does it take for the bullet to come to rest after it first hits the block of wood?

5.18) A football player pushing a 92.0 kg sled at $v = 0.850$ m/s hits a rough patch of grass. He exerts 275 N of force to push the sled 0.65 m, and the coefficient of kinetic friction between the crate and rough grass is 0.358.

a) What is the magnitude and direction of the net force on the sled while it moves across the rough patch of grass?
b) What is the net work done of the sled on the rough patch?
c) What's the speed of the sled at the end of those 0.65 m?

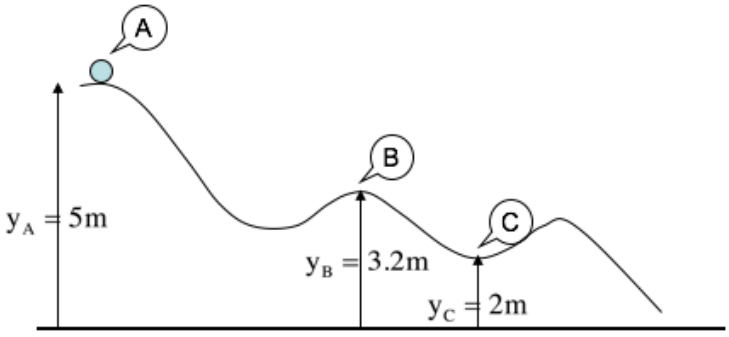
5.23) A pile driver is a standard construction tool to drive beams into hard ground. A 2100-kg pile driver starts at rest 5.00 m above the ground and falls onto a beam that is driven 12.0 cm into the ground by the impact before coming to rest. What is the average force the pile driver exerts on the beam while the beam is coming to rest?

5.25) A snowboarder leaves the end of a ramp at 35.0 m/s, and reaches a speed of 33.0 m/s at the top of his path, a distance *h* above the end of the ramp as shown. Ignoring friction and air resistance, what is *h*? Use only energy considerations.



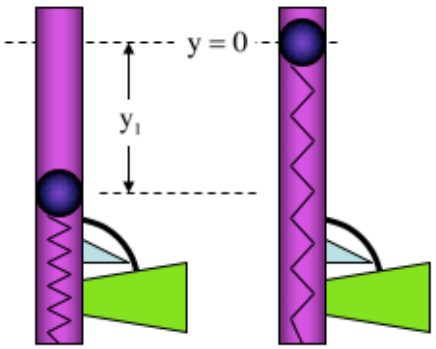
5.36) A 5.00 kg bead slides down a frictionless track as shown.

a) Find the bead's speed at points B and C
b) How much work did gravity do as the bead moved from A to C?



5.39) A spring-loaded gun has a 20-g projectile that initially compresses the spring 12 cm. When fired vertically, the gun launches the projectile to a maximum height of 20 m above the barrel of the gun. Ignoring air resistance,

a) Describe in words and with a graph the changes in mechanical energy that occur as the bullet rises to its maximum height.
b) Determine the spring constant *k*
c) Determine the bullet's muzzle velocity (that is, its speed as it moves through the position y = 0 shown on the sketch)

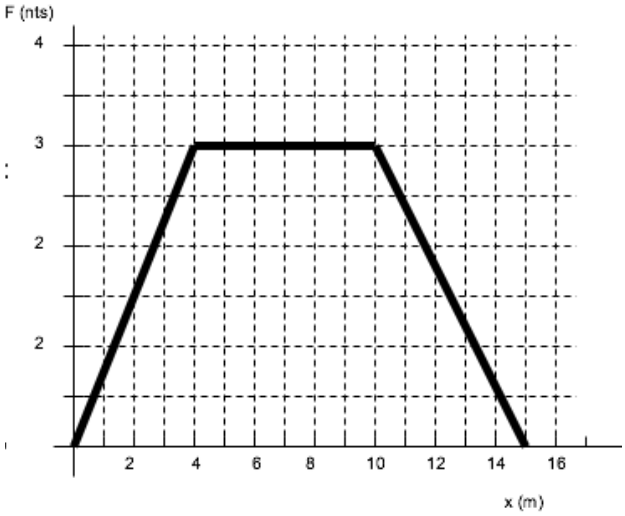


5.50) A motor-driven cable pulls a 70 kg crate up a frictionless slope at a constant speed of 20 m/s.

a) Determine the work required to pull the crate 60 m up the 30º slope.
b) What is the horsepower of the motor?

5.60) A variable force F_x is applied to a 3 kg mass as shown in the graph. Calculate the work done by the force over the following intervals:

a) From x = 0 to x = 5 m
b) From x = 5 m to x = 10 m
c) From x = 10 to x = 15 m
d) If the mass's initial speed is 0.500 m/s at the origin, what's its speed at x = 5 m and x = 15 m?

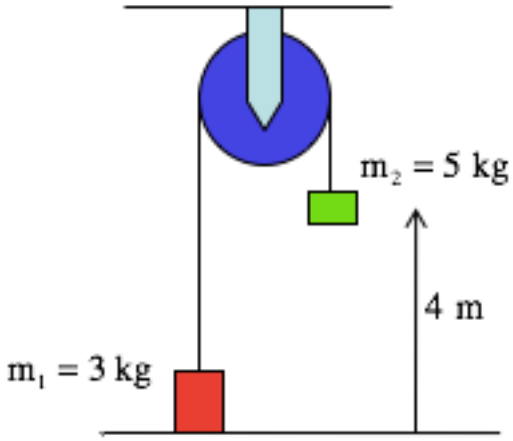


5.70) A 5.3-g pinball compresses the spring (k = 8.0 N/m) of the launching mechanism 5.0 cm. When released, the pinball is launched along a 15 cm tube, during which it experiences a constant frictional force of 0.032 N. What's the speed of the ball as it exits the tube?

Additional: if the tube was projected horizontally off a 0.50 m high table instead of inside the pinball machine, how far would the pinball travel horizontally before it hit the ground?

5.71) An Atwood machine consists of two objects (m_1 = 3.0 kg and m_2 =5.0 kg) connected by a light string over an ideal pulley. Both objects are initially at rest, and m_2 is initially 4 m above m_1, which is on the ground.

a) What will the objects' speeds be when they pass each other?
b) How fast will they be moving just before m_2 hits the ground?
c) How much higher will m_1 travel after m_2 hits the ground?



5.73) A 200 g block is released at point A on a smooth bowl. The radius of the frictionless bowl is 30 cm. Determine:

a) the gravitational potential energy at point A relative to point B.
b) the kinetic energy at point B.
c) the block's speed at point B.
d) the potential energy at point C relative to B.
e) the speed at C.
f) the normal force acting on the block when at point C.