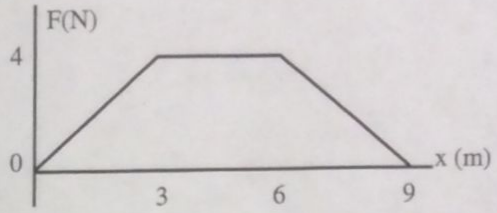
Physics Practice Problems: Work and Energy

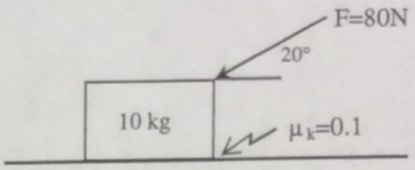
Please ignore air resistance, treat all surfaces as frictionless **unless otherwise specified or implied**.

Work and work-energy theorem:

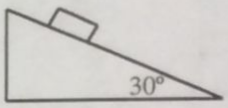
1. A 2kg crate rests on the floor. How much work is required to move it at constant speed
   a) 3m along the floor against a friction force of 4N, b) 3m along a frictionless air table, c) 3m vertically?
2. A 2-kg object is being pushed by a horizontal force F along a horizontal frictionless air-table. The object starts from rest at x = 0 and the force F acting on it changes according to the force F v.s. position x graph to the right.
   a) Find the work done by the force F on the object as the object moves from x=0 to x=9m.
   b) Find the speed of the object at x = 9 m.



3. The 10kg crate is being pushed 5m along a floor by an 80-N force. The μ_k between the floor and the crate is 0.1. Determine the work done on the crate by each of the following forces:
   a) the 80-N force, b) the gravity, c) the normal force, d) the friction, e) the net force.
   f) Find the change in the kinetic energy of the crate.



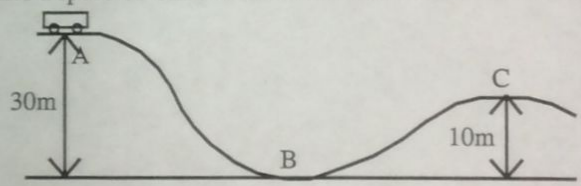
4. Starting from rest, a 4-kg block slides 10 m down a frictionless 30° incline. Determine the work done on the block by a) the force of gravity, b) the normal force, c) all of the forces (the net force) on the block.
   d) Find the kinetic energy of the block at the end of the 10m slide.
5. The 4-kg block is now pushed by a force parallel to the incline so that the block slides 10m up the 30° frictionless incline at constant speed. a) Find the magnitude of the pushing force. Determine the work done on the block by b) the pushing force, c) the force of gravity, d) the normal force, e) all of the forces (the net force) on the block. f) Find the change in the kinetic energy of the block.



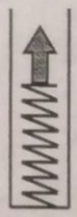
6. If the speed of a particle is tripled, by what factor does its kinetic energy change?
7. How much work does it take to accelerate a 1000kg car from rest to 50m/s?
8. How much work does it take to stop a 1000kg car traveling at 50m/s?
9. A baseball (m=0.14 kg) traveling at 40m/s moves a fielder's glove backward 0.2m when the ball is caught. What was the average amount of force exerted by the ball on the glove?

Energy conservation: with and without friction & with and without spring:

10. Tarzan is running at top speed 8m/s and grabs a vine hanging vertically from a tall tree in the jungle. How high can he swing upward?
11. 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?
12. A 0.01kg Styrofoam ball is released from rest 2 m above the floor. It reaches a speed of 3m/s the moment before it hits the floor. How much heat due to air resistance is generated during this process?
13. A roller coaster passes point A with a speed of 1.2 m/s.
    a) Assuming no friction, find the speed of the roller coaster at points B and C.
    b) If there is friction and the average friction equals to one-sixth of it's weight, with what speed will it reach point B? The distance traveled between A and B is 60 m.



14. The total length of a Hooke's law spring with a mass m = 0.2 kg hung under is 0.2 m. The total length of the same spring with a mass of 0.7kg hanging under is 0.25 m. a) Find the spring constant "k" of this spring.
    b) How much elastic potential energy is stored in the spring when the mass hung under is m = 0.7 kg?
15. What major energy change (e.g. U_g —> heat) is taking place when ...
    a) a rock is falling. b) a pendulum is swinging from its center position toward its endpoint.
    c) a parachutist is falling at a constant (terminal) speed. d) a pull-back car is accelerating across a level table.
16. If the potential energy stored in a spring is halved, by what factor has its stretched amount decreased?
17. A 1000kg car rolling on a horizontal surface has a speed of 30m/s when it strikes a horizontal coiled spring and is brought to rest in a distance of 2 m. What is the spring constant of the spring? Ignore friction.
18. A dart of 0.2-kg mass is loaded 0.05m into a vertically coiled spring (as shown on the right) and then is released. The spring has a stiffness constant k = 800 N/m and negligible mass.
    a) What is the block's speed the moment the spring restores to its relaxed length?
    b) What is the maximum height the block reaches (measured from its starting point)?



19. A 2-kg small block is dropped from rest at point A. The spring has a spring constant k = 500N/m.
    a) If the entire track is frictionless, find the maximum compression of the spring.
    If the entire track is frictionless except for the 1m between points B and C, where the coefficient of kinetic friction is 0.15, b) find the maximum compression of the spring, and
    c) find the final position of the block in terms of the distance from point B.