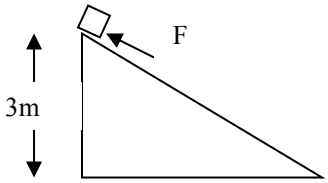
**Unit 4: Work. Energy, Momentum, and Collisions Practice**

_____1. Which of the following is NOT true of work?

a) It is the scalar product of force and displacement. b) It is measured in joules. c) It has the same units as energy.
d) It is a vector which is always in the same direction as the displacement. e) It takes energy to perform work

_____2. A 4-kg box is pushed across a level floor with a force of 60 N for a displacement of 20 m, and then lifted to a height of 2 m. What is the total work done on the box?

_____3. A 20-kg cart is pushed up the inclined plane shown by a force **F** to a height of 3 m. What is the potential energy of the cart when it reaches the top of the inclined plane?




_____4. A ball falls from a height *h* from a tower. Which of the following statements is true?

a) The potential energy of the ball is conserved as it falls. b) The kinetic energy of the ball is conserved as it falls.
c) The sum of the kinetic and potential energies of the ball is a constant.
d) The velocity of the ball is constant as the ball falls.

_____5. A 0.5-kg ball is dropped from a third story window which is 20 m above the sidewalk. What is the speed of the ball just before it strikes the sidewalk?

_____6. Drew lifts a 60-kg crate onto a truck bed 1 meter high in 3 seconds. Connor lifts sixty 1-kg boxes onto the same truck in a time of 2 minutes. Which of the following statements is true?

a) Drew does more work than Connor does.
b) Connor does more work than Drew does. c) They do the same amount of work, but Drew operates at a higher power level.
d) They do the same amount of work, but Connor operates at a higher power level.
e) Drew and Connor do the same amount of work and operate at the same power level.

_____7. A crane can lift a 500 kg mass to a height of 30 m in 2 minutes. The power at which the crane is operating is

_____8. A truck and a skateboard can have the same kinetic energy if

a. they have the same mass b. the truck goes faster than the skateboard
c. they have the same speed d. the skateboard goes faster than the truck

_____9. During a tug-of-war, team A does $3.44 \times 10^4$ J of work in pulling team B a distance of 6.00 m. What force was team A exerting?

_____10. In which of the following situations is no work done on a fish?

a. when it is dropped to the floor b. when it is picked up off the floor and put into the sink
c. when it is carried horizontally at a constant speed

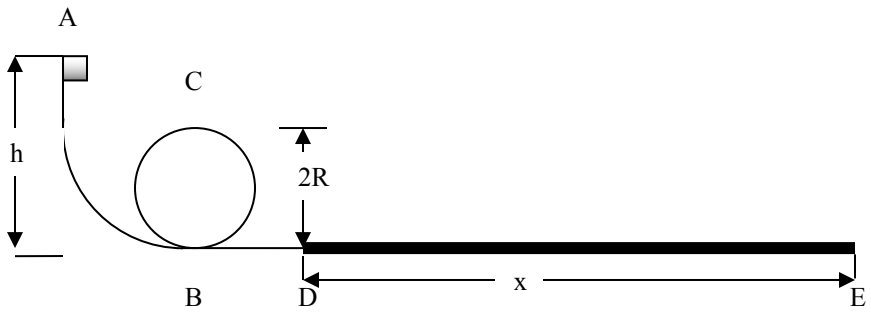
_____11. Which book has the greater gravitational potential energy, a 0.715 kg book on a 1.4 m high shelf or a 0.601 kg book on a 2.3 m high shelf? Show work

_____12. A biker and a bike (with combined mass 71.0 kg) travels at 4.00 m/s, and then speeds up to 8.00 m/s. The new kinetic energy of the bike and biker is _____ the original kinetic energy. a. half b. equal to c. twice d. four times

_____13. When you catch a baseball, it can hurt. It hurts less if one 'goes with the ball'. This is because:

(a) This makes the KE less b) This makes the momentum change less
(b) c)This makes the time interval for stopping greater This makes the impulse less

**Problem Solving: Show all work, equations used, draw diagrams, and give correct units and sig figs**.
The sum of the kinetic and potential energies of a system is called the *total mechanical energy* of the system. These same principles can be applied to a block sliding down a frictionless ramp, a pendulum swinging from a height, and many other situations. We could use Newton's laws and kinematics to solve these types of problems, but usually conservation of energy is easier to apply.




**1)** A small block of mass *m* begins from rest at the top of a curved track at a height *h* and travels around a circular loop of radius *R*. There is negligible friction between the block and the track between points A and D, but the coefficient of kinetic friction on the horizontal surface between points D and E is μ. The distance between points D and E is *x*.

Answer all of the following questions in terms of the given quantities and fundamental constants.

(a) Determine the speed of the block at point B, at the bottom of the loop.

(b) Determine the kinetic energy of the block at point C, at the top of the loop.

After the block slides down the loop from point C to point D, it enters the rough portion of the track. The speed of the block at point E is half the speed of the block at point D.
(c) Determine the speed of the block at point D, just before it enters the rough portion of the track.

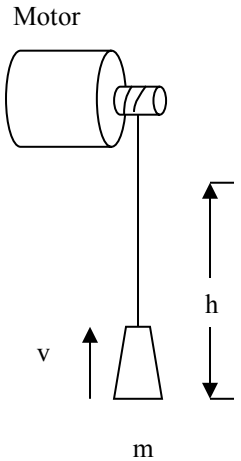
(d) Determine the amount of work done by friction between points D and E.

(e) Find an expression for the coefficient of kinetic friction μ.

**2)** A motor raises a mass of 3.00 kg to a height *h* at a constant speed of 0.0500 m/s. The battery (not shown) which provides energy to the motor originally stores 4.00 J of energy, all of which can be used to lift the mass.

(a) What is the power developed in the motor?

(b) To what maximum height can the motor lift the mass using its stored energy?



**3)** A 40.0 kg box initially at rest is pushed 5.00 m along a rough, horizontal floor with a constant applied horizontal force of 130. N. The acceleration of gravity is 9.8 m/s$^2$ if the coefficient of friction between box and floor is 0.300

a) Find the work done by the applied force.

b) Find the work done by the friction.

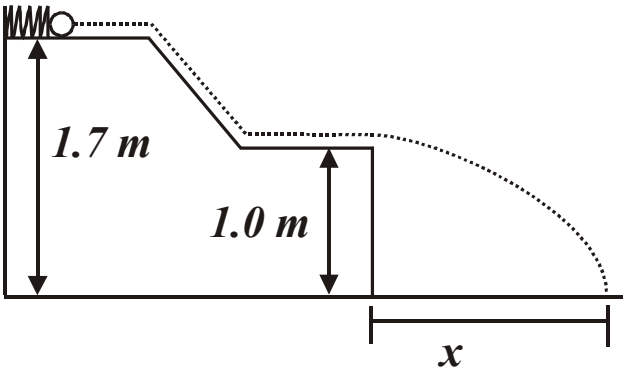
c. Find the change in kinetic energy of the box.

d. Find the final speed of the box.

**4)** A spring has a constant of 125 N/m. If the spring is compressed a distance of 13 cm, what is (a) the force required to do this and (b) the potential energy stored in the spring?

**5)** A 255 g block is traveling along a smooth surface with a velocity of 12.5 m/s. It runs head on into a spring ($\boldsymbol{k}$ = 125 N/m). How far is the spring compressed?

**6)** A spring is compressed a distance of 12 cm by a 675 g ball. The spring constant is 225 N/m. The ball is on a smooth surface as shown. The spring is released and sets the ball into motion. Find: (a) the speed of the ball when it leaves the spring, (b) the speed of the ball just before it leaves the edge of the table, (c) the kinetic energy of the ball just before it hits the deck, (d) the horizontal distance, $\boldsymbol{x}$, it travels when it leaves the table until it hits the deck. Assume that the ball rolls down the ramp.

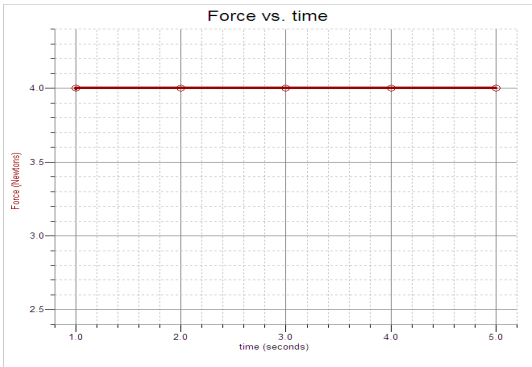



7) A 0.2-kg hockey puck is sliding along the ice with an initial speed of 12 m/s when a player strikes it with his stick, causing it to reverse its direction and giving it a speed of 23 m/s. The impulse the stick applies to the puck is most nearly:

8) An astronaut floating at rest in space throws a wrench in one direction and subsequently recoils back with a velocity in the opposite direction. Which of the following statements is/are true?
I. The velocity of the wrench is equal and opposite to the velocity of the astronaut.
II. The momentum of the wrench is equal and opposite to the momentum of the astronaut.
III. The impulse applied to the wrench is equal and opposite to the impulse applied to the astronaut.

(A) I only (B) II only (C) I and II only (D) II and III only (E) I, II, and III

*Questions 9-10*: A net force is applied to a block of mass 4 kg according to the *Force vs. time* graph below.




9. The impulse given to the mass between 1 and 5 seconds is most nearly

10. If the mass starts from rest at t = 1 s, the speed of the mass at t = 5 s is most nearly

11. A block of mass *m* slides with a speed $v_o$ on a frictionless surface and collides with another mass *M* which is initially at rest. The two blocks stick together and move with a speed of $\frac{v_o}{3}$. In terms of *m*, mass *M* is most nearly:

12. If two objects have an inelastic collision and one is initially at rest, is it possible for both of them to be at rest after the smash up? Is it possible for only one of them to be at rest? How come?

13. In a bizarre carnival activity you are required to catch a tennis ball. This you easily do. Next, a solid metal (iron) ball of the same diameter is to be thrown to you. You are given the following choices: same kinetic energy, same velocity, same momentum. Which of them would be the best choice to give you an easy catch?

Let: Tennis ball mass = 0.250 kg, v = 10.0 m/s. Mass of iron ball = 10 kg

14. It takes you all of 0.018 s to initially touch and then catch a 0.600 kg football traveling at 16.0 m/s. (a) What is the change in momentum for the football? (b) What is the impulse? (c) What is the force that must be exerted to stop the ball?

15. You throw a 0.345 kg ball straight up with an initial velocity of 13.5 m/s. (a) What is the momentum of the ball at the highest point of its path? (b) What is its momentum halfway up? (c) What is its kinetic energy halfway up?