Name: _____

I.  MULTIPLE CHOICE:  Choose the one best answer each.  Assume g = 10 m/s$^2$.  (2 points each).

1.  The momentum of an object is proportional to its
     A.  Velocity     B.  Mass          C.  Mass x Velocity       D.  All of the above      E.  None of the above

2.  Impulse is equal to the change of
     A.  Velocity     B.  Mass          C.  Force                 D.  Momentum              E.  Force x Velocity

3.  In order to double the momentum of an object, its velocity must change by a factor:
     A.  x 2                    B.  x 1/2                  C.  x 4                    D.  x 1/4

4.  When a force F is applied to an object on a frictionless surface over a time interval, a change in velocity
    is created.  If the time interval the force is applied increases by a factor of 2, what applied force below
    would yield the same change in velocity for the object?
     A.  2F                     B.  F/2                    C.  4F                     D.  F/4

5.  One egg is thrown against a solid wall, while a second egg is thrown against a hanging bed sheet.  Both
    eggs have the same initial velocity (35 miles per hour) and the same final velocity (zero miles per hour).
    Which egg experiences a greater <u>change in momentum</u>?
     A.  The egg stopped by the wall.
     B.  The egg stopped by the hanging sheet.
     C.  Both eggs experience the same change in momentum.

6.  One egg is thrown against a solid wall, while a second egg is thrown against a hanging bed sheet.  Both
    eggs have the same initial velocity (35 miles per hour) and the same final velocity (zero miles per hour).
    Which egg experiences a greater <u>force</u>?
     A.  The egg stopped by the wall.
     B.  The egg stopped by the hanging sheet.
     C.  Both eggs experience the same force.

7.  Which has the most momentum below?
     A.  a mass of 5.0 kg moving at 0.0 m/s
     B.  a mass of 2000 g moving at 500.0 cm/s
     C.  a weight of 30 N moving at 4.0 m/s
     D.  a mass of 1.5 kg moving at 6.0 m/s

8.  Mass $M_1$ moving with a speed $v_i$ collides with stationary mass $M_2$.  After the collision, the masses are
    interlocked and moving with a speed of $v_i/3$.  Which equation below correctly describes the relationship
    between $M_1$ and $M_2$?
     A.  $M_2 = 2M_1$    B.  $M_1 = 2M_2$           C.  $M_2 = 3M_1$           D.  $M_1 = 3M_2$

9.  A ball moving to the left strikes a wall at a speed of 4 m/s and rebounds to the right at a speed of 2 m/s.
    What is the change in velocity $\Delta v$ of the ball?
     A.  0 m/s          B.  2 m/s          C.  4 m/s          D.  6 m/s          E.  8 m/s

10. A 1,200-kilogram car traveling at 10.0 meters per second hits a tree and is brought to rest in 0.10
    second. What is the magnitude of the average force acting on the car to bring it to rest?
    A.  1.2 × 10$^2$ N          B.  1.2 × 10$^3$ N          C.  1.2 × 10$^4$ N          D.  1.2 × 10$^5$ N          E.  1.2 × 10$^6$ N

## II. PROBLEMS:

1. Calculate the momentum of a 2250-kg elephant charging a hunter at a speed of 7.00 m/s.

2. A hockey puck has a mass of 0.122 kg and is at rest. A hockey player makes a shot, exerting a constant force of 25.0 N on the puck for 0.180 s.  With what speed does the puck head toward the goal?

3. How long must a 12.0 N force be applied to a 4.00 kg block sitting at rest on a frictionless surface to increase its velocity to 4.40 m/s?

4. A 65.0-g arrow leaves a bowstring at a velocity of 54 m/s.
   A. What is the impulse on the arrow?

   B. What is the average force that the string exerts on the arrow if the string is in contact with the arrow for $9.0 \times 10^{-3}$ s?

5. A 1.90-kg falcon catches a 0.600-kg dove from behind in midair.  What is their velocity after impact if the falcon's velocity is initially 26.0 m/s and the dove's velocity is 6.00 m/s in the same direction?

**Bonus.** A ballistic pendulum was used to measure the speed of bullets before electronic timing devices were developed.
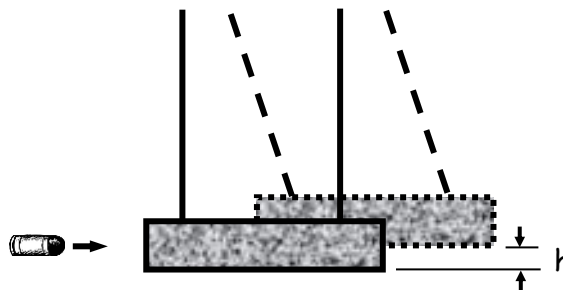


Suppose a 14.0-g bullet is fired and imbeds in a 2.50-kg wooden block.  The block and bullet then swing up to a maximum height of 18.0 cm above the starting position.  Find the initial velocity of the bullet.

**6.** Two dodgeballs of different mass collide head-on with a coefficient of restitution e = 0.4. Before the collision, ball A has a velocity of 1m/s, and ball B has a velocity of -3m/s.  After the collision, the velocity of ball B is -1m/s.  If the mass of ball A is 0.3kg, what is the mass of ball B? (answer: 0.54kg)