1) Which is a vector quantity?

A) energy B) speed C) momentum D) power

2) The product of an object's mass and velocity is equal to

A) force B) weight C) kinetic energy D) momentum

3) The momentum of an object is the product of its

A) mass and acceleration B) force and distance C) force and displacement D) mass and velocity

4) A 2.0-kilogram toy cannon is at rest on a frictionless surface. A remote triggering device causes a 0.005-kilogram projectile to be fired from the cannon. Which equation describes this system after the cannon is fired?

A) momentum of cannon + momentum of projectile = 0

B) speed of cannon + speed of projectile = 0

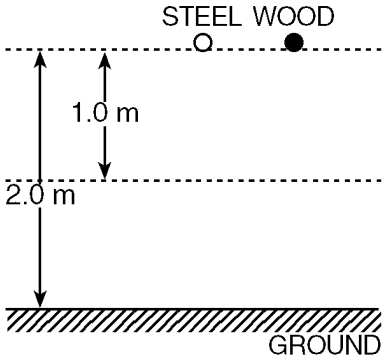
C) velocity of cannon + velocity of projectile = 0

D) mass of cannon + mass of projectile = 0

5) Two rocks weighing 5 newtons and 10 newtons, respectively, fall freely from rest near the Earth's surface. After 3 seconds of free-fall, compared to the 5-newton rock, the 10-newton rock has *greater*

A) height B) speed C) momentum D) acceleration

6) In the diagram below, a 0.4-kilogram steel sphere and a 0.1-kilogram wooden sphere are located 2.0 meters above the ground. Both spheres are allowed to fall from rest.




Which one of the following statements *best* describes the spheres after they have fallen 1.0 meter? [*Neglect air resistance*.]

A) The steel sphere has greater speed than the wooden sphere and both spheres have the same momentum.

B) Both spheres have the same speed and the steel sphere has more momentum than the wooden sphere.

C) Both spheres have the same speed and momentum.

D) The steel sphere has greater speed and has less momentum than the wooden sphere.

7) A 5-newton ball and a 10-newton ball are released simultaneously from a point 50 meters above the surface of the Earth. Neglecting air resistance, which statement is true?

A) At the end of 3 seconds of free-fall, the 10-N ball will have a greater momentum than the 5-N ball.

B) The 5-N ball will have a greater acceleration than the 10-N ball.

C) The 10-N ball will have a greater acceleration than the 5-N ball.

D) At the end of 3 seconds of free-fall, the 5-N ball will have a greater momentum than the 10-N ball.

8) A 2.0-kilogram ball traveling north at 4.0 meters per second collides head on with a 1.0-kilogram ball traveling south at 8.0 meters per second. What is the magnitude of the total momentum of the two balls after collision?

A) 8.0 kg•m/s B) 0 kg•m/s C) 32 kg•m/s D) 16 kg•m/s

9) A 2.0-kilogram rifle initially at rest fires a 0.002-kilogram bullet. As the bullet leaves the rifle with a velocity of 500 meters per second, what is the momentum of the rifle-bullet system?

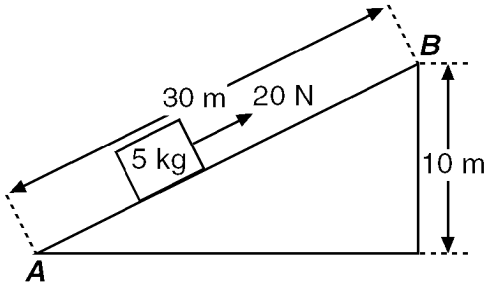
A) 2.5 kg•m/s B) 2.0 kg•m/s C) 0.5 kg•m/s D) 0 kg•m/s

10) A rocket with a mass of 1,000 kilograms is moving at a speed of 20 meters per second. The magnitude of the momentum is

A) 400,000 kg•m/s B) 50 kg•m/s C) 200 kg•m/s D) 20,000 kg•m/s

**Question 11 refers to the following:**

The diagram below represents a 20-newton force pulling an object up a hill at a constant rate of 2 meters per second.




11) The magnitude of the momentum of the moving object is

A) 10 kg•m/s B) 100 kg•m/s C) 0 kg•m/s D) 600 kg•m/s

12) A 1.0-kilogram mass changes speed from 2.0 meters per second to 5.0 meters per second. The change in the object's momentum is

A) 3.0 kg-m/sec B) 9.0 kg-m/sec C) 21 kg-m/sec D) 29 kg-m/sec

13) If a net force of 10. newtons acts on a 6.0-kilogram mass for 8.0 seconds, the total change of momentum of the mass is

A) 60. kg•m/s B) 48 kg•m/s C) 80. kg•m/s D) 480 kg•m/s

14) A 25-kilogram mass travels east with a constant velocity of 40. meters per second. The momentum of this mass is

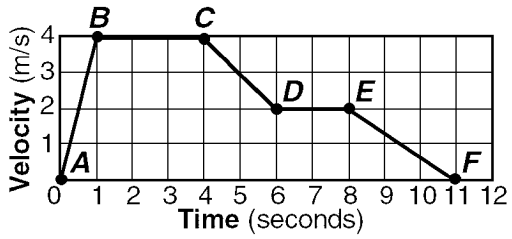
A) $9.8 \times 10^3$ kg•m/s west B) $1.0 \times 10^3$ kg•m/s east C) $9.8 \times 10^3$ kg•m/s east D) $1.0 \times 10^3$ kg•m/s west

15) A 2-kilogram object traveling 10 meters per second north has a perfect elastic collision with a 5-kilogram object traveling 4 meters per second south. What is the total momentum after collision?

A) 20 kg•m/s south B) 20 kg•m/s north C) 0 kg•m/s D) 40 kg•m/s east

**Questions 16 and 17 refer to the following:**

The graph below represents the velocity-time relationship for a 2.0-kilogram mass moving along a horizontal frictionless surface.



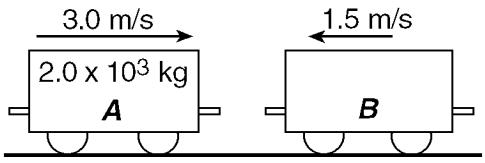

16) The net force on the mass during interval *DE* is

A) 4.0 N B) 0 N C) 2.0 N D) 1.0 N

17) The momentum of the mass during interval *BC* is

A) 0 kg•m/s B) 12 kg•m/s C) 4.0 kg•m/s D) 8.0 kg•m/s

18) Two railroad carts, *A* and *B*, are on a frictionless, level track. Cart *A* has a mass of $2.0 \times 10^3$ kilograms and a velocity of 3.0 meters per second toward the right. Cart *B* has a velocity of 1.5 meters per second toward the left. The magnitude of the momentum of cart *B* is $6.0 \times 10^3$ kilogram-meters per second. When the two carts collide, they lock together.




(a) What is the magnitude of the momentum of cart *A* before the collision? [*Show all work.*]

(b) On the diagram, construct and label a scaled vector that represents the momentum of cart *A* before the collision. [*The momentum vector must be drawn to a scale of 1.0 centimeter = 1,000 kilogram-meters per second.*]

(c) In one or more complete sentences, describe the momentum of the two carts after the collision and justify your answer based on the initial momenta of both carts.