Solutions

socrative
by MasteryConnect

AP Physics 1 - Test 08 - Linear Momentum Score: 100 ?

1. Momentum may be expressed in:

(A) kg/m
(B) gram·s
(C) N·s
(D) kg/(m·s)
(E) N/s

or $kg \cdot \frac{m}{s}$

2. Two bodies, A and B, have equal kinetic energies. The mass of A is nine times that of B. The ratio of the momentum of A to that of B is:

(A) 1:9
(B) 1:3
(C) 1:1
(D) 3:1
(E) 9:1

$K = \frac{1}{2}mv^2$ $\quad v = \sqrt{\frac{2K}{m}}$ $\quad v \propto \sqrt{\frac{1}{m}}$ (×1/3, ×9)

$V_A = \frac{1}{3}V_B$ $\quad m_A = 9m_B$

$P_A = m_A V_A = 9m_B\left(\frac{1}{3}V_B\right) = 3m_B V_B$ $\quad P_B = m_B V_B$

$P_A = 3P_B$

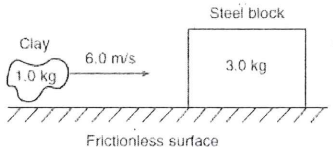
3. A 3.0 kg steel block is at rest on a frictionless horizontal surface. A 1.0 kg lump of clay propelled horizontally at 6.0 m/s toward the block as shown in the diagram. Upon collision, the clay and steel block stick together and move to the right with a speed of:

(A) 1.5 m/s
(B) 2.0 m/s
(C) 3.0 m/s
(D) 6.0 m/s

$m_1v_1 + m_2v_2 = (m_1+m_2)v'$

$(1)(6) = (4)v'$

$v' = 1.5\ m/s$



4. Two objects, P and Q, have the same momentum. Q has more kinetic energy than P if it:

(A) weighs more than P
(B) is moving faster than P
(C) weighs the same as P
(D) is moving slower than P
(E) is moving at the same speed as P

momentum scales linearly with velocity

but kinetic energy scales squarely with velocity.

$P = mv$ $\quad K = \frac{1}{2}mv^2$

However both scale linearly with mass.

So the only way the momentums can equal but Q have more kinetic energy is if Q is lighter, but faster than P.

$V_f = -1.5$ m/s

m $\qquad$ $V_i = 2$ m/s

5. A 1.0-kg ball moving at 2.0m/s perpendicular to a wall rebounds from the wall at 1.5m/s. The change in the momentum of the ball is:

(A) zero
(B) 0.5N·s away from wall
(C) 0.5N·s toward wall
(D) 3.5N·s away from wall
(E) 3.5N·s toward wall

$\Delta P = m\Delta V = m(V_f - V_i)$

$= (1)(-1.5 - 2)$

$\Delta P = -3.5 \text{ kg } \frac{m}{s}$ or -3.5 N·s

6. A 2.5-kg stone is released from rest and falls toward Earth. After 4.0 s, the magnitude of its momentum is:

(A) 98 kg·m/s
(B) 78 kg·m/s
(C) 39 kg·m/s
(D) 24 kg·m/s
(E) zero

$\Delta P = F\Delta t = mg\Delta t = (2.5)(9.8)(4)$

$\Delta P = 98 \text{ kg } \frac{m}{s}$

m_1 $\quad V_1 = 0$ $\qquad$ m_2 $\qquad V_2 = 0$

7. A 64-kg woman stands on frictionless level ice with a 0.10-kg stone at her feet. She kicks the stone with her foot so that she acquires a velocity of 0.0017m/s in the forward direction. The velocity acquired by the stone is:

$V_1' = +0.0017$

(A) 1.1m/s forward
(B) 1.1m/s backward
(C) 0.0017m/s forward
(D) 0.0017m/s backward
(E) none of these

Total initial momentum = total final momentum

$m_1 V_1 + m_2 V_2 = m_1 V_1' + m_2 V_2'$ ($V_1 = 0$, $V_2 = 0$)

$0 = (64)(0.0017) + (0.1) V_2'$

$V_2' = -1.088$ m/s

8. Two spacemen are floating together with zero speed in a gravity-free region of space. The mass of spaceman A is 120 kg and that of spaceman B is 90 kg. Spaceman A pushes B away from him with B attaining a final speed of 0.5m/s. The final recoil speed of A is:

$m_1 V_1 + m_2 V_2 = m_1 V_1' + m_2 V_2'$ ($V_1 = 0$, $V_2 = 0$)

(A) zero
(B) 0.38 m/s
(C) 0.5 m/s
(D) 0.67 m/s
(E) 1.0 m/s

$0 = (120) V_1' + (90)(0.5)$

$V_1' = -0.375$ m/s

9. A projectile in flight explodes into several fragments. The total momentum of the fragments immediately after this explosion:

(A) is the same as the momentum of the projectile immediately before the explosion
(B) has been changed into kinetic energy of the fragments
(C) is less than the momentum of the projectile immediately before the explosion
(D) is more than the momentum of the projectile immediately before the explosion
(E) has been changed into radiant energy

10. A man is marooned at rest on level frictionless ice. In desperation, he hurls his shoe to the right at 15m/s. If the man weighs 720N and the shoe weighs 4.0N, the man moves to the left with a speed of:

↳ $m = 73.5$ kg ↳ 0.408 kg

$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

$0 = (73.5) v_1' + (0.408)(15)$

$v_1' = -0.083$ m/s

(A) 0
(B) 0.021 m/s
(C) 0.083 m/s
(D) 15 m/s
(E) 2700

11. A 10-kg block of ice is at rest on a frictionless horizontal surface. A 1.0-N force is applied in an easterly direction for 1.0 s. During this time interval, the block:

$\Delta p = F \Delta t = (1)(1) = 1$

(A) acquires a speed of 1 m/s
(B) moves 10 cm
(C) acquires a momentum of 1.0 kg·m/s
(D) acquires a momentum of 1.0 J
(E) none of the above

12. The physical quantity "impulse" has the same dimensions as that of:

$J = \Delta p$

impulse is change in an objects momentum

(A) force
(B) power
(C) energy
(D) momentum
(E) work

13. A 0.2-kg rubber ball is dropped from the window of a building. It strikes the sidewalk below at 30m/s and rebounds up at 20m/s. The impulse on the ball during the collision is:

$v_i = -30$ $v_f = +20$

$J = \Delta p = m \Delta v = m(v_f - v_i) = (0.2)(20 - (-30))$

$J = +10$ N·s

(A) 10N · s upward
(B) 10N · s downward
(C) 2.0N · s upward
(D) 2.0N · s downward
(E) 9.8N · s upward

14. A student's life was saved in an automobile accident because an airbag expanded in front of his head. If the car had not been equipped with an airbag, the windshield would have stopped the motion of his head in a much shorter time. Compared to the windshield, the airbag:

(A) causes a much smaller change in momentum
(B) exerts a much smaller impulse
(C) causes a much smaller change in kinetic energy
(D) exerts a much smaller force
(E) does much more work

15. A 640-N acrobat falls 5.0m from rest into a net. The net tosses him back up with the same speed he had just before he hit the net. The magnitude of the average upward force exerted on him by the net during this collision is:

(A) 32 N
(B) 64 N
(C) 320 N
(D) 640 N
(E) impossible to determine from given data

$F = \frac{\Delta p}{\Delta t}$ ← don't know time

16. An inelastic collision is one in which:

(A) momentum is not conserved but kinetic energy is conserved
(B) total mass is not conserved but momentum is conserved
(C) neither kinetic energy nor momentum is conserved
(D) momentum is conserved but kinetic energy is not conserved — lost
(E) the total impulse is equal to the change in kinetic energy

0.4 kg 0.8 kg

17. A 4.0-N puck is traveling at 3.0m/s. It strikes a 8.0-N puck, which is stationary. The two pucks stick together. Their common final speed is:

(A) 1.0 m/s
(B) 1.5 m/s
(C) 2.0 m/s
(D) 2.3 m/s
(E) 3.0 m/s

$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$ ($v_2 = 0$)

$(0.4)(3) = (1.2) v'$

$v' = 1$ m/s

18. A 3.00-g bullet traveling horizontally at 400m/s hits a 3.00-kg wooden block, which is initially at rest on a smooth horizontal table. The bullet buries itself in the block without passing through. The speed of the block after the collision is:

(A) 1.33 m/s
(B) 0.40 m/s
(C) 12.0 m/s
(D) 40.0 m/s
(E) 160 m/s

$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$ ($v_2 = 0$)

$(0.003)(400) = (3.003) v'$

$v' = 0.4$ m/s

19. Blocks A and B are moving toward each other. A has a mass of 2.0 kg and a velocity of 50m/s, while B has a mass of 4.0 kg and a velocity of −25m/s. They suffer a perfectly inelastic collision. The kinetic energy lost during the collision is:

(A) 0
(B) 1250 J
(C) 3750 J
(D) 5000 J
(E) 5600 J

$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$

$(2)(50) + (4)(-25) = (6) v'$

$v' = 0$

Final kinetic energy = 0 J

Initial kinetic energy

$K_i = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$

$K_i = \frac{1}{2}(2)(50)^2 + \frac{1}{2}(4)(-25)^2$

$K_i = 3750$ J

lost all of it.

Starts as 1 object, ends with 2 objects

20. A 75-kg man is riding in a 30-kg cart at 2.0m/s. He jumps off in such a way as to land on the ground with no horizontal velocity. The final speed of the cart is:

(A) 0
(B) 2.0 m/s
(C) 3.0 m/s
(D) 5.0 m/s
(E) 7.0 m/s

$(m_1+m_2)v = 0 + m_2 v_2'$

m_1 = man v_1 = man
m_2 = cart v_2 = cart

$(105)(2) = (30) v_2'$

$v_2' = 7$ m/s

21. An elastic collision is one in which:

(A) momentum is not conserved but kinetic energy is conserved
(B) total mass is not conserved but momentum is conserved
(C) kinetic energy and momentum are both conserved
(D) momentum is conserved but kinetic energy is not conserved
(E) the total impulse is equal to the change in kinetic energy

22. Ball A of mass 5.0 kg moving at 20 m/s collides with ball B of unknown mass moving at 10 m/s in the same direction. After the collision, ball A moves at 10 m/s and ball B at 15 m/s, both still in the same direction. What is the mass of ball B?

(A) 6.0 kg
(B) 2.0 kg
(C) 10 kg
(D) 12 kg

Starts with 2 objects, ends with 2 objects

$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

$(5)(20) + m_2(10) = (5)(10) + m_2(15)$

$100 + 10m_2 = 50 + 15m_2$

$50 = 5m_2$

$m_2 = 10$ kg

23. At the circus, a 100 kg clown is fired 15 m/s from a 500 kg cannon. What is the recoil speed of the cannon?

(A) 75 m/s
(B) 15 m/s
(C) 3.0 m/s
(D) 5.0 m/s

Starts with 1 object, ends with 2 objects

$(m_1+m_2)V = m_1 v_1' + m_2 v_2'$

$0 = 100(15) + 500 v_2'$

$v_2' = -3$ m/s

24. Which two quantities can be expressed using the same units?

(A) energy and force
(B) impulse and force
(C) momentum and force
(D) impulse and momentum

impulse is change in momentum

25. A 3.1 kg gun initially at rest is free to move. When a 0.015 kg bullet leaves the gun with a speed of 500 m/s, what is the speed of the gun?

(A) 0 m/s
(B) 2.4 m/s
(C) 7.5 m/s
(D) 500 m/s

$(m_1+m_2)V = m_1v_1' + m_2v_2'$

$0 = (0.015)(500) + (3.1)v_2'$

$v_2' = -2.4$ m/s

26. The cart's change of momentum Δp_x is

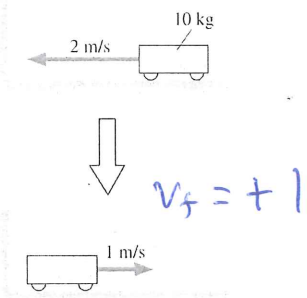
(A) –20 kg m/s
(B) –10 kg m/s
(C) 0 kg m/s
(D) 10 kg m/s
(E) 30 kg m/s

$\Delta P = m\Delta v$

$= (10)(1-(-2))$

$= 30$ kg $\frac{m}{s}$

$v_i = -2$



$v_f = +1$

27. A 2.0 kg object moving to the right with speed 0.50 m/s experiences the force shown. What are the object's speed and direction after the force ends?

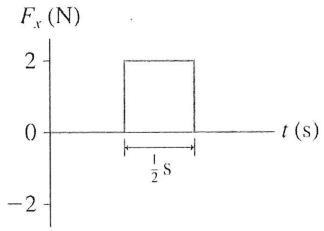
(A) 0.50 m/s left
(B) At rest
(C) 0.50 m/s right
(D) 1.0 m/s right
(E) 2.0 m/s right

$\Delta P = \text{area}$

$= 1$

add +

$\Delta v = \frac{\Delta P}{\Delta t} = \frac{1}{2} = 0.5$



$0.5 + 0.5 = 1.0$

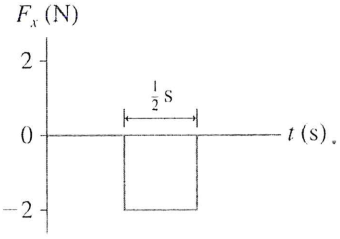
28. A 2.0 kg object moving to the right with speed 0.50 m/s experiences the force shown. What are the object's speed and direction after the force ends?

(A) 0.50 m/s left
(B) At rest
(C) 0.50 m/s right
(D) 1.0 m/s right
(E) 2.0 m/s right

$\Delta P = -0.5 + 0.5$

$0.5 + (-0.5)$

$= 0$

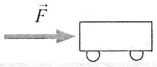


29. A force pushes the cart for 1 s, starting from rest. To achieve the same speed with a force half as big, the force would need to push for

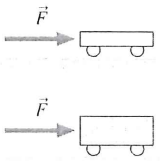
(A) 1/4 s
(B) 1/2 s
(C) 1 s
(D) 2 s
(E) 4 s

$\Delta P = m\Delta v = F\Delta t$

$\times\frac{1}{2}$ $\times 2$



30. A light plastic cart and a heavy steel cart are both pushed with the same force for 1.0 s, starting from rest. After the force is removed, the momentum of the light plastic cart is _____ that of the heavy steel cart.



(A) Greater than

(B) Equal to

(C) Less than

(D) Can't say. It depends on how big the force is.

31. You awake in the night to find that your living room is on fire. Your one chance to save yourself is to throw something that will hit the back of your bedroom door and close it, giving you a few seconds to escape out the window. You happen to have both a sticky ball of clay and a super-bouncy Superball next to your bed, both the same size and same mass. You've only time to throw one. Which will it be? Your life depends on making the right choice!

(A) Throw the Superball.

(B) Throw the ball of clay.

(C) It doesn't matter. Throw either.

Elastic collisions have larger momentum changes than inelastic collisions.

32. A mosquito and a truck have a head-on collision. Splat! Which has a larger change of momentum?

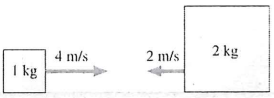
(A) The mosquito

(B) The truck

(C) They have the same change of momentum.

(D) Can't say without knowing their initial velocities.

33. The two boxes are sliding along a frictionless surface. They collide and stick together. Afterward, the velocity of the two boxes is



(A) 2 m/s to the left

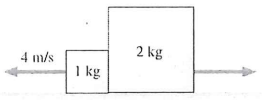
(B) 1 m/s to the left

(C) 0 m/s, at rest

(D) 1 m/s to the right

(E) 2 m/s to the right

34. The two boxes are on a frictionless surface. They had been sitting together at rest, but an explosion between them has just pushed them apart. How fast is the 2-kg box going?



(A) 1 m/s

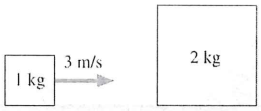
(B) 2 m/s

(C) 4 m/s

(D) 8 m/s

(E) There's not enough information to tell.

35. The 1-kg box is sliding along a frictionless surface. It collides with and sticks to the 2-kg box. Afterward, the speed of the two boxes is



(A) 0 m/s
(B) 1 m/s
(C) 2 m/s
(D) 3 m/s
(E) There's not enough information to tell.

36. Curling is a sport played with 20 kg stones that slide across an ice surface. Suppose a curling stone sliding at 2.5m/s strikes another stone and comes to rest in 0.002 seconds. What is the average force acting on the curling stoneduring this time.

$F = \frac{\Delta P}{\Delta t} = \frac{20(2.5)}{0.002} = 25000$

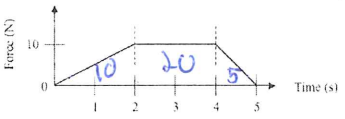
(A) 125000 N
(B) 250000 N
(C) 12500 N
(D) 25000 N

37. A tiger is running in a straight line. If we double both the mass and speed of the tiger, the magnitude of its momentum will increase by what factor?

$P = mv$ (m: ×2, v: ×2, P: ×4)

(A) 8
(B) 16
(C) 2
(D) 4

38. An object of mass m = 2.0 kg experiences a changing force depicted by the graph. For the time interval shown, what is the total change in momentum of the object?



area = 35

(A) 35 kg·m/s
(B) 70 kg·m/s
(C) -35 kg·m/s
(D) -70 kg·m/s