CPS lesson
Linear Momentum and Collisions
ANSWER KEY

1. Two equal-mass carts are put back-to-back on a level frictionless track. Cart 1 has a spring-loaded piston which pushes on cart 2 to separate them. Which is true?

A. 1 moves but 2 remains at rest.

B. Both move but 1 has larger speed than 2.

* C. They gain equal and opposite velocities.

D. Both move but 1 has less speed than 2.

E. 2 moves but 1 remains at rest.

2. Two carts are put back-to-back on a level frictionless track. Cart 1 has a spring-loaded piston which pushes on cart 2 to separate them. Cart 2 has twice the mass of cart 1. Which is true afterward?

A. p1>p2 and K1>K2

B. p1>p2 and K1=K2

C. p1>p2 and K1<K2

D. p1=p2 and K1<K2

* E. p1=p2 and K1>K2

3.
Two carts are put back-to-back on a level frictionless track. Cart 1 has a spring-loaded piston which pushes on cart 2 to separate them. Cart 2 has twice the mass of cart 1. Which is true afterward about the magnitudes of the acceleration?

A. both carts have the same acceleration

* B. cart 1 has larger acceleration

C. cart 2 has larger acceleration

4. Two people on frictionless roller blades throw a ball back and forth. They are initially at rest. After two throws they are:

A. in the same spots they were initially

B. at rest further apart from each other

C. at rest closer together

* D. moving away from each other

E. moving toward each other

5. Two people on frictionless roller blades throw a ball back and forth. Which is true?

* A. The interaction between them is repulsive.

B. If we film them and play the movie backward, the interaction between them is attractive.

C. The sum of the momenta of the two people is conserved.

D. The sum of the mechanical energies of the two people is conserved.

E. More than one is true.

6.
Two cars of different mass are at rest on a horizontal, frictionless track. A person pushes on the light car for 1 minute. He then exerts the same force on the heavy car for 1 minute. Which car acquires more momentum?

A. The light car.

B. The heavy car.

* C. Both end up with the same momentum.

7.
Two cars of different mass are at rest on a horizontal, frictionless track. A person pushes on the light car for 1 minute. He then exerts the same force on the heavy car for 1 minute. Which car acquires more kinetic energy?

* A. The light car.

B. The heavy car.

C. Both end up with the same kinetic energy.

8. Cart A is initially at rest on a level, frictionless track. Cart B collides elastically with it.

Afterward, both carts move in the same direction, but B has less speed than A. Which cart has more mass?

A. A

* B. B

C. Both have the same mass.

9.

Which of the following systems is isolated?

* A. A car slipping on ice collides inelastically with another car. System = both cars.

B. The cue ball collides elastically with the 8 ball.
System = cue ball.

C. A box is falling to the ground.

System = box.

10.

A car accelerates from rest when the light turns green. In so doing, the car gains some momentum while the earth gains (in magnitude):

A. more momentum

* B. an equal amount of momentum

C. less momentum than the car

11.

A car accelerates from rest when the light turns green. In so doing, the car gains some kinetic energy while the earth gains:

A. more kinetic energy

B. the same amount of kinetic energy

* C. less kinetic energy than the car

12.

The entire population of the world gathers in one spot and at a signal everyone jumps up. While the people are in the air, does the earth gain momentum in the opposite direction?

A. No, none at all.

B. Yes, but much less than that of the people.

* C. Yes, its change in momentum is equal and opposite to that of the people.

13.

The entire population of the world gathers in one spot and at a signal everyone jumps up. After the people land, the earth's momentum:

* A. is back to what it was before they ever jumped up.

B. has increased only due to the recoil when the people jumped up.

C. has increased both due to the recoil when they jumped up and the impact when they landed.

14.

Rain falls vertically downward into an open cart rolling along a level, frictionless track. Consequently the cart's speed:

A. increases

B. remains unchanged

* C. decreases

15.

Rain falls vertically downward into an open cart rolling along a level, frictionless track. Consequently the cart's kinetic energy:

A. increases

B. remains unchanged

* C. decreases

16. In which case is the magnitude of the change in momentum of the ball largest?

A. A ball moving at speed v is brought to rest.

B. A ball at rest is struck so that it ends up with speed v.

* C. A ball comes in at speed v and is struck so that it returns backward at speed v.

D. More than one of the above is correct.

17. Two carts of mass m and 2m are at rest on a level, frictionless track. You exert the same force on both for the same amount of time. The momentum of the lighter cart ends up being:

A. four times that of the heavier cart

B. double

* C. equal to

D. half

E. a quarter that of the heavier cart

18. Two carts of mass m and 2m are at rest on a level, frictionless track. You exert the same force on both for the same amount of time. The kinetic energy of the lighter cart ends up being:

A. four times that of the heavier cart

* B. double

C. equal to

D. half

E. a quarter that of the heavier cart

19.

A ping-pong and a bowling ball are rolling toward you with equal momenta. You exert the same force to stop each.

Which statement is true?

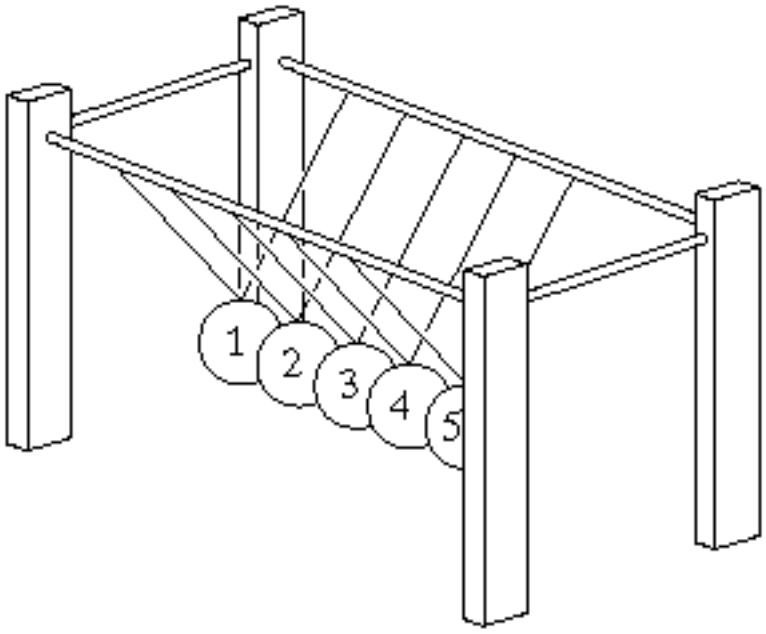
A. It takes less time to stop the ping-pong ball.

* B. It takes the same amount of time to stop them.

C. It takes less time to stop the bowling ball.

20.

If ball 1 is pulled back and released, ball 5 bounces forward. To explain this, you need to invoke:



A. conservation of linear momentum

B. conservation of mechanical energy

* C. both A and B

21.
A cart moving with speed v collides with and sticks to an identical cart at rest on a level, frictionless track. What is their speed afterward?

A. v

* B. v/2

C. zero

22. A person attempts to knock down a pin by throwing balls at it. All balls have the same size and mass, but one kind is made of rubber and bounces off the pin while the other is made of putty and sticks to the pin.

Which kind of ball is most likely to topple the pin?

* A. The rubber balls.

B. The putty balls.

C. They are equally likely to do so.

23. THINK FAST! You've just entered a narrow alley at 25 mph when you notice an identical car headed toward you at 25 mph. You have two options: hit the other car head on or swerve into a concrete wall head on.

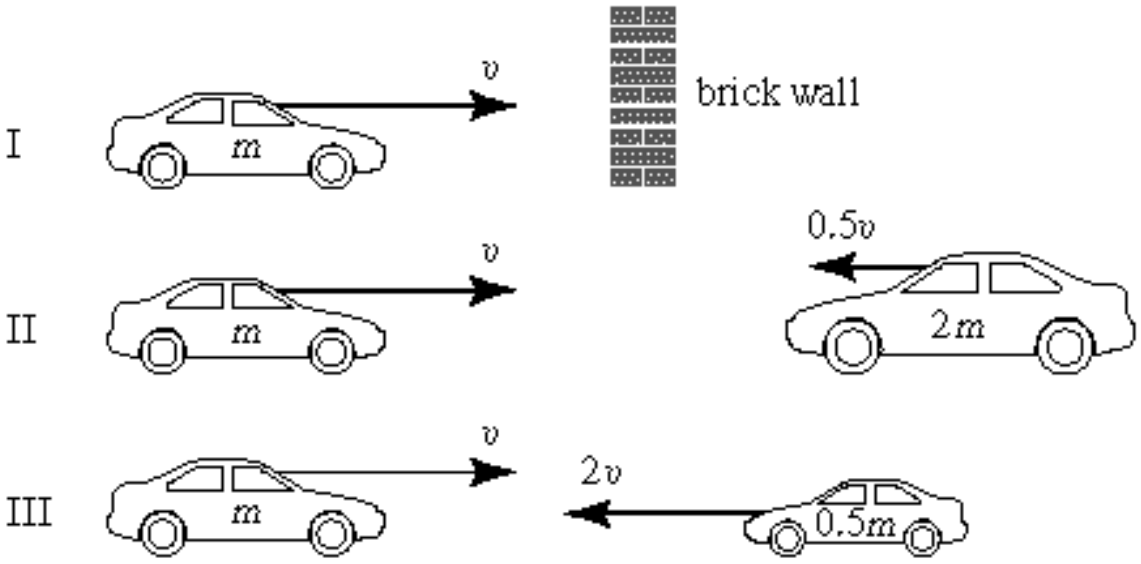
What should you do?

A. Hit the car.

B. Hit the wall.

* C. Hit either one: it makes no difference.

24. If every collision is perfectly inelastic, which will stop the car?



A. I only

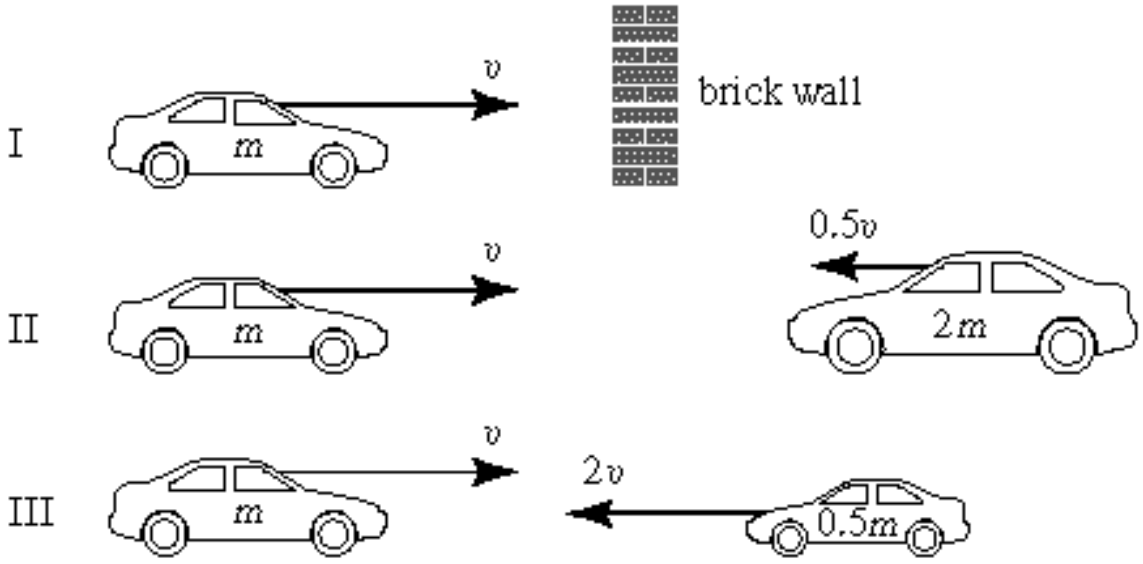
B. II only

C. III only

D. exactly two of them

* E. all three of them

25. If every collision is perfectly inelastic, which causes most damage?



A. I

B. II

* C. III

D. two of them

E. all three of them

26. A golf ball is fired at a bowling ball initially at rest and bounces back elastically. Compared to the bowling ball, the golf ball ends up with:

A. more momentum but less kinetic energy

B. more momentum and more kinetic energy

C. less momentum and less kinetic energy

* D. less momentum but more kinetic energy

27. A golf ball is fired at a bowling ball initially at rest and sticks to it. Compared to the bowling ball, the golf ball ends up with:

A. more momentum but less kinetic energy

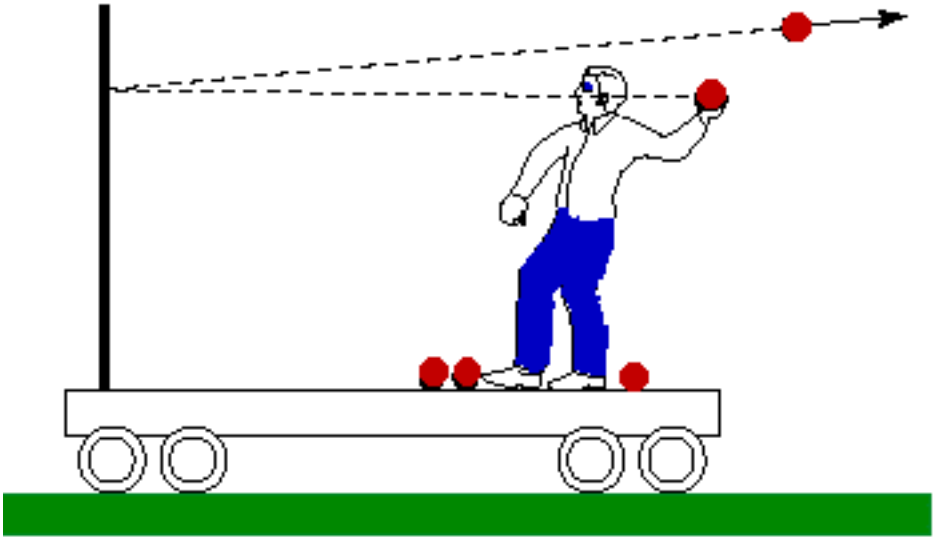
B. more momentum and more kinetic energy

* C. less momentum and less kinetic energy

D. less momentum but more kinetic energy

28.

You are on a cart at rest on a level, frictionless track. Will throwing balls as shown put you into motion?



A. Yes, to the right.

* B. Yes, to the left.

C. No.

29.

A compact car and a cement truck collide. Which undergoes the larger momentum change during the collision?

A. the car

B. the truck

* C. the same for both

D. Need information about their speeds and angles before and after.

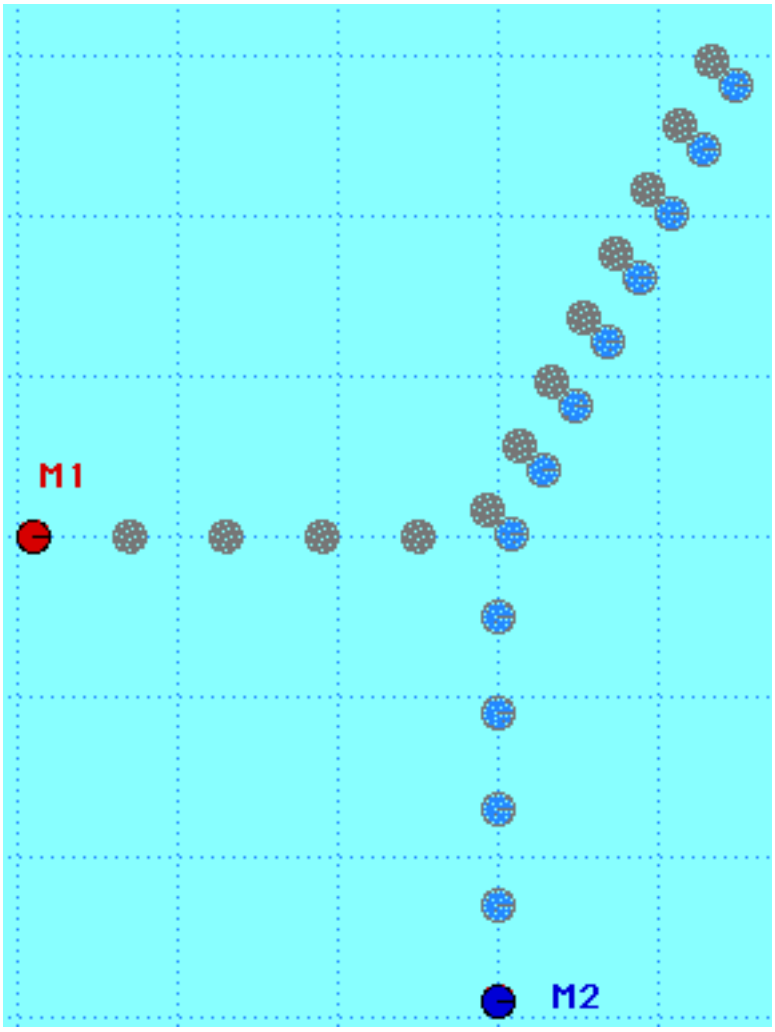
30. A stationary object is struck by a moving object. Is it possible for the stationary object to end up with a larger final momentum than the initial momentum of the incoming object?

* A. Yes.

B. No.

31. Consider the collision at right, where the dots are at equal time intervals.

Which object has larger mass?



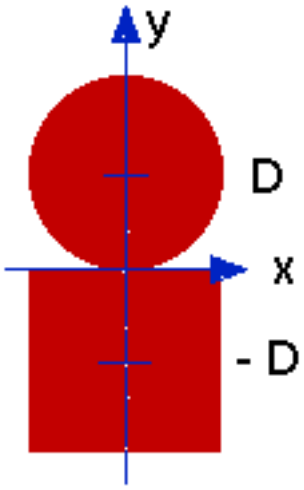
A. 1

* B. 2

C. both the same

32.

A sphere of diameter 2D touches a cube of side 2D. Both have the same density. The center of mass is at y =



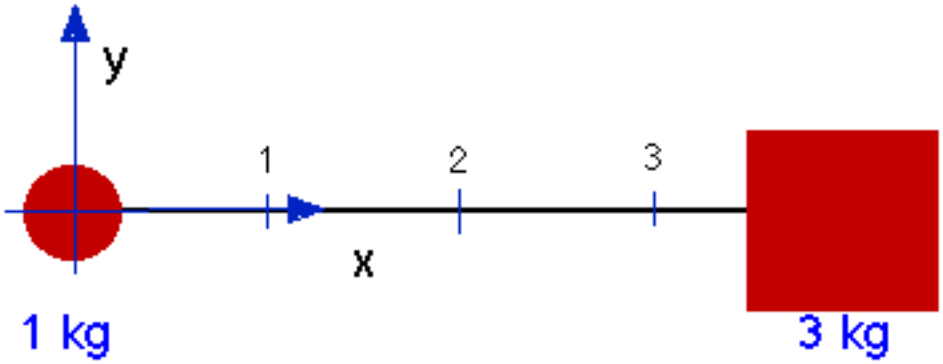
A. 0

* B. D(p-6)/(p+6)

C. -D/2

D. -D

33. The position of the center of mass is x = ?



A. 0

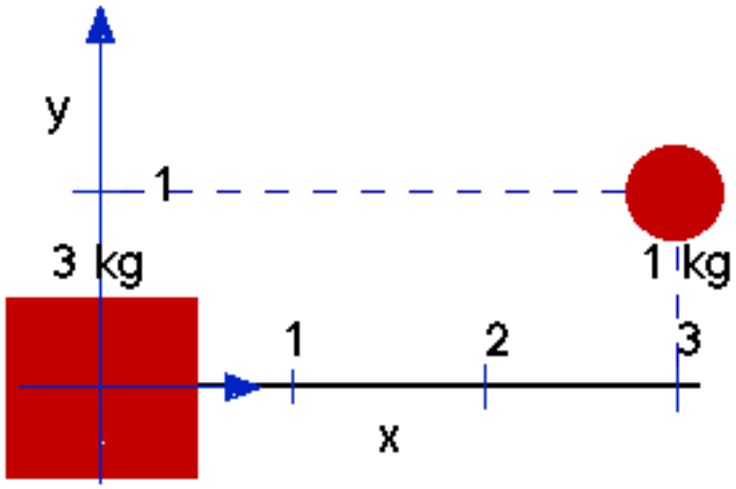
B. 1 m

C. 2 m

* D. 3 m

E. 4 m

34. The position of the center of mass is (x,y) = ?



A. (0,0)

* B. (0.75,0.25) m

C. (3,0) m

D. (1,1/3) m

E. (1.5,0.5) m

35. Which of the following quantities is conserved when a ball of putty falls and sticks to a table top?
(System = putty + table + earth.)

A. linear momentum

B. mechanical energy

C. total energy

* D. exactly two of these quantities

E. all three of them

36. A ball of putty collides perfectly inelastically with a table top. Initially, the system of ball+earth had only gravitational PE. After the collision, this was converted into:

A. kinetic energy

* B. internal energy

C. linear momentum

D. none of the above

37.
Which of the following statements is false?

A. Linear momentum is always conserved.

B. Linear momentum is a scalar.

C. Linear momentum can never be negative.

* D. Exactly two of these statements is false.

E. All three of them are false.

38.

Which of the following statements is false?

* A. In an elastic collision, mechanical energy is not conserved.

B. In an elastic collision, linear momentum may not be conserved.

C. In the absence of external forces, both linear momentum and mechanical energy are conserved in an elastic collision.

39.
In a perfectly inelastic head-on collision, linear momentum cannot be conserved.

A.
True

* B.
False

40. Which of the following statements is true?

A. Impulse has the same units as linear momentum.

B. Impulse is not a force.

C. If the contact force is constant, impulse is greater the longer two objects remain in contact.

* D. All of these statements are true.

41. A car collides with and rebounds off a parked truck. This real-life collision is:

A. elastic

* B. partially inelastic

C. perfectly inelastic

D. none of the above

42. A car collides with and locks bumpers with a parked truck. This real-life collision is:

A. elastic

B. partially inelastic

* C. perfectly inelastic

D. none of the above

43. Two objects A and B collide.

Which of the following statements is true?

A. The change in momentum of A is equal and opposite to the change in momentum of B.

B. The force A exerts on B is equal and opposite to the force B exerts on A.

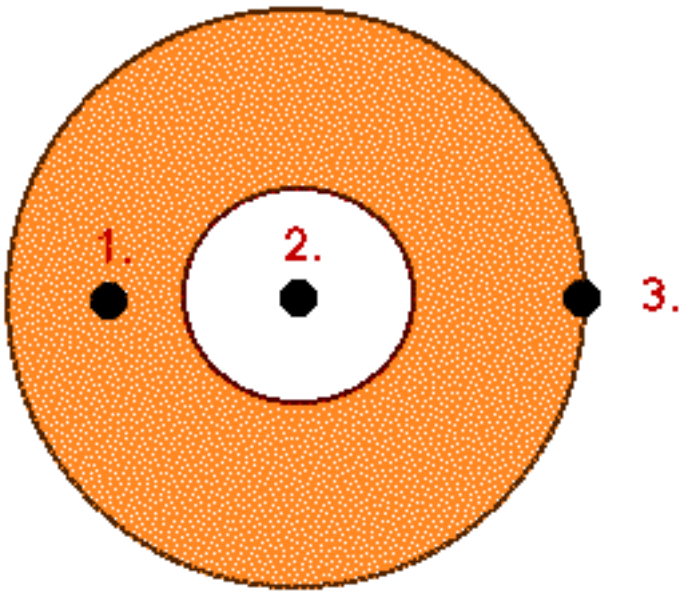
C. The momentum of the system of two objects is constant.

* D. All of the above statements are true.

44.

A uniform-density donut is shown.

Which point is at its center of mass?



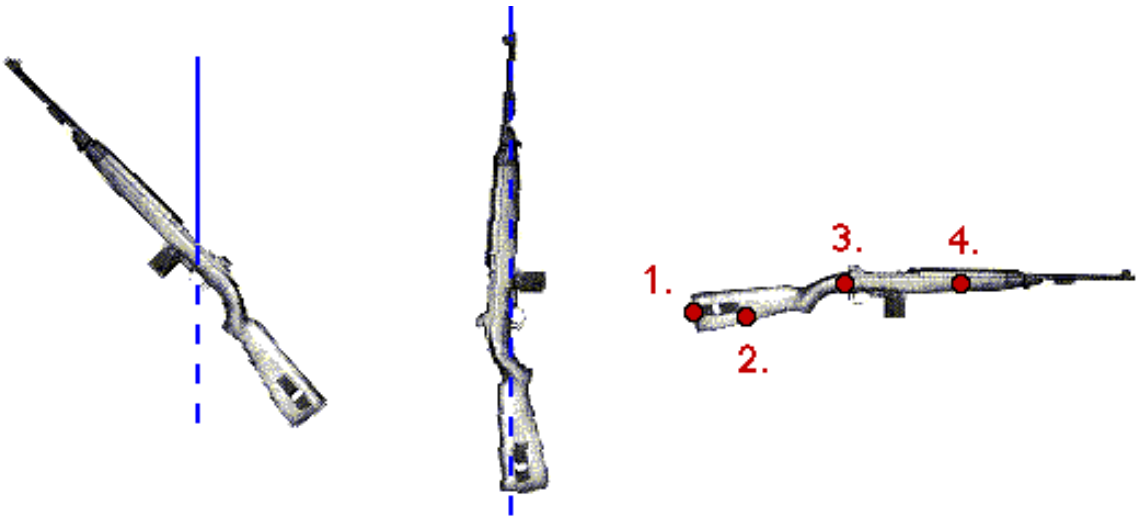
A. 1

* B. 2

C. 3

D. need more information

45.
Your rifle is suspended from a blue rope in two different ways and hangs as shown. Which red point is at its center of mass?



A. 1

* B. 3

C. 2

D. 4

46.
Which of the following statements is false?

A. Center of mass has units of kilograms.

B. Center of mass cannot lie outside the surface of an object.

C. Center of mass is only defined in a gravitational field.

* D. All of these statements are false.

47. A ball with a large mass M moving at speed V collides with a small ball of mass m at rest. The change in the small ball's momentum is approximately:

A. MV

B. 2MV

C. mV

* D. 2mV

48. A small rubber ball is put on top of a volleyball and the pair is dropped. Compared to the speed it has just before hitting the ground, the speed with which the rubber ball rebounds is:

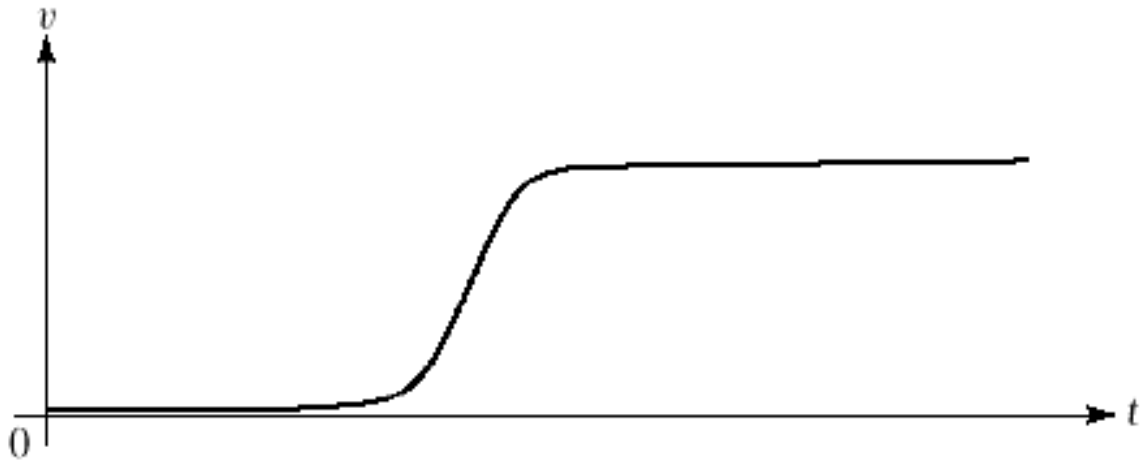
A. the same

B. twice as big

* C. three times as big

D. four times as big

49. A compressed spring pushes on an aircart initially at rest, so that its velocity-vs-time graph in the lab is as shown. You observe this from a train passing by with unknown constant speed. You cannot predict the cart's change in:



A. velocity

B. linear momentum

* C. kinetic energy

D. none of the above

50. Two objects collide inelastically. Can all of the initial kinetic energy of the system be converted into non-mechanical energy by the collision?

A. Yes, whenever the two objects have equal and opposite initial momenta.

B. Yes, whenever the two objects stick together.

* C. Yes, but only if A and B are simultaneously true.

D. No, this violates conservation of mechanical energy.

E. No, this violates conservation of linear momentum.

51. Which statement is true?

Conservation of linear momentum:

A. only holds if mechanical energy is conserved.

B. is valid for any system.

C. can be derived from Newton's second law.

* D. follows from Newton's third law.

52.
The forward motion of a rocket is a consequence of:

A. conservation of mechanical energy

* B. conservation of linear momentum

C. both of the above

D. neither of the above

53.

The impulse delivered to an object by a force is:

A. defined only for short-lived interactions

* B. equal to the change in momentum of the object

C. equal to the area under a graph of F vs. x

D. meaningful only for elastic collisions

54.

In a 2D elastic collision, the conservation laws enable us to:

A. determine the final velocities

* B. place restrictions on the possible final velocities

C. not say anything about the final velocities

55. A thousand people are randomly milling around Times Square. Suppose a typical person has mass m and speed v.The magnitude of the momentum of this entire system of people is closest to:

A. 1000mv

B. 500mv

C. 100mv

D. 50mv

* E. zero