System of Particles and of Conservation of Momentum
Concept Questions

Question 1: Drop a stone from the top of a high cliff. Consider the earth and the stone as a system. As the stone falls, the momentum of the system

1. increases in the downward direction.

2. decreases in the downward direction.

3. stays the same.

4. not enough information to decide.

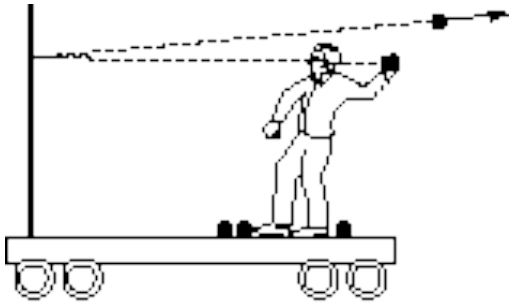
Answer 3: The system is approximately isolated with no external forces acting on the system so the momentum stays the same. (We are ignoring the effects of the sun and moon), The forces between the earth and the stone are internal forces and hence cancel in pairs.

Question 2: Consider yourself and the Earth as one system. Now jump up. Does the momentum of the system

1. increase in the downward direction as you rise?
2. increase in the downward direction as you fall?
3. stay the same?
4. dissipate because of friction?
5. Not enough information is given to decide.

Answer 3: (Same argument as in the previous question.) No external forces are acting on the system so the momentum is unchanged.

Question 3. Suppose you are on a cart, initially at rest on a track with very little friction. You throw balls at a partition that is rigidly mounted on the cart. If the balls bounce straight back as shown in the figure, is the cart put in motion?

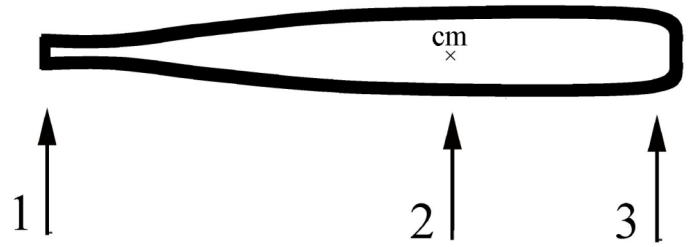


1. Yes, it moves to the right.
2. Yes, it moves to the left.
3. No, it remains in place.
4. Not enough information is given to decide.

Answer: 2. Because there are no horizontal external forces acting on the system, the momentum of the cart, person and balls must be constant. All the balls bounce back to the right, then in order to keep the momentum constant, the cart must move forward.

Question 5: Pushing a Baseball Bat

The greatest acceleration of the center of mass of a baseball bat will be produced by pushing with a force F at



1. Position 1
2. Position 2
3. Position 3
4. All the same
5. Not enough information is given to decide.

Answer 4. The external force is equal to the total mass times the acceleration of the center-of-mass. It doesn't matter where the external force acts with regards to the center-of-mass acceleration.

Question 6 A compact car and a large truck collide head on and stick together. Which undergoes the larger momentum change?

1. car
2. truck
3. The momentum change is the same for both vehicles.
4. Can't tell without knowing the final velocity of combined mass.

Answer: 3. Conservation of momentum tells us that the changes in momentum must add up to zero. So the change in the car's momentum must be equal to the change in the truck's momentum, and the two changes must be in the opposite directions.
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8.01SC Physics I: Classical Mechanics