Reading Comprehension: Momentum & Conservation of Momentum

Momentum is a physical quantity that describes how difficult it is to stop a moving object. It depends on both the mass of the object and its velocity. The greater the mass or the faster the object moves, the larger its momentum. Momentum is calculated using the equation:

momentum = mass × velocity

and is measured in kg m/s.

One of the most important principles in physics is the conservation of momentum. This principle states that in a closed system, where no external forces act, the total momentum before an event is equal to the total momentum after the event. This applies to collisions and explosions. For example, when two trolleys collide on a frictionless track, the total momentum of both trolleys before the collision must be the same as the total momentum after the collision, even though their individual velocities may change.

There are two main types of collisions: elastic and inelastic. In an elastic collision, both momentum and kinetic energy are conserved. In an inelastic collision, momentum is still conserved, but kinetic energy is not. Many everyday collisions, such as cars bumping into each other or a ball hitting a wall, are inelastic.

Understanding momentum and its conservation allows scientists and engineers to analyse motion, design safer vehicles, and predict the outcomes of interactions between objects.

Section A: Multiple-Choice Questions

1. Which quantity determines the momentum of an object? [1 mark]
A. Mass only
B. Velocity only
C. Mass and velocity
D. Acceleration and mass

2. The unit of momentum is: [1 mark]
A. N
B. J
C. kg m/s
D. m/s^2

3. In a closed system, the total momentum after a collision is: [1 mark]
A. Greater than before
B. Less than before

C. Equal to before
D. Zero

Section B: Short-Answer Questions

4. A 2.0 kg trolley moves at 1.5 m/s. Calculate its momentum. [2 marks]

5. Explain what is meant by a “closed system” in the context of momentum. [2 marks]

6. A 3.0 kg trolley moving at 2.0 m/s collides with a stationary 1.0 kg trolley. After the collision, the two trolleys stick together. Calculate their combined velocity. [3 marks]

Section C: Longer-Answer Question

7. Describe the difference between elastic and inelastic collisions. Explain why momentum is conserved in both types of collisions. [4 marks]

Section D: Challenging Questions

8. A 0.20 kg ball is thrown horizontally at 8.0 m/s towards a 0.30 kg ball at rest. After the collision, the 0.20 kg ball rebounds at –2.0 m/s. Calculate the velocity of the 0.30 kg ball after the collision. [4 marks]

9. A 5.0 kg object explodes into two pieces. One piece has a mass of 3.0 kg and moves at 4.0 m/s to the right. Calculate the velocity of the second piece if momentum is conserved. [3 marks]

Answer Key

Section A

1. C
2. C
3. C

Section B

4. $p = mv = 2.0 \times 1.5 = 3.0$ kg m/s

5. A closed system is one where no external forces act on the objects involved. Momentum can only be conserved if no outside forces change the total momentum.

6. Total momentum before: $(3.0 \times 2.0) + (1.0 \times 0) = 6.0$ kg m/s. Combined mass = 4.0 kg. $v = 6.0 / 4.0 = 1.5$ m/s.

Section C

7. In an elastic collision, both momentum and kinetic energy are conserved. In an inelastic collision, momentum is conserved but kinetic energy is not. Momentum is conserved in both cases because no external forces act on the system.

Section D

8. Total momentum before: (0.20 × 8.0) + (0.30 × 0) = 1.6 kg m/s. After: (0.20 × –2.0) + (0.30 × v). Solve: 1.6 = –0.4 + 0.30v → v = 6.7 m/s.

9. Total momentum before explosion = 0. Momentum of 3.0 kg piece: 3.0 × 4.0 = 12 kg m/s. Second piece must have –12 kg m/s. Mass = 2.0 kg → v = –6.0 m/s.