Newton's Laws and Momentum Questions – OCR A Level Physics

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1. State Newton's First Law of Motion. (P)

Working and Answer:

An object remains at rest or moves with constant velocity unless acted on by a resultant external force.

Answer: Law of inertia – motion unchanged without resultant force.

Praineel Philipsics 2. Define momentum and state its unit. (P) Prance Prince Working and Answer:

Momentum is defined as mass multiplied by velocity: p = mvPrained Physics alleel. Physics Praineel Philipsics Praineel Philipsics Physical Working and Answer: $p = mv - 2 \times 3 = 6 \text{ kg} \cdot \text{m/s}$ Answer: $6 \text{ kg} \cdot \text{m/s}$

Working and Answer:
$$p=mv=2\times 3=6~\mathrm{kg\cdot m/s}$$
Answer: $6~\mathrm{kg\cdot m/s}$

4. State Newton's Second Law in terms of momentum. (P) Praineel Pinis

Working and Answer: The net force on an object is equal to the rate of change of momentum: $F = \frac{dp}{dt}$ $\ln swer: F = \frac{\Delta p}{\Delta t}$ Praineol Physics

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$$F = \frac{dp}{dt}$$

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5. A 4 kg object has its momentum changed by 12 kg m/s in 3 seconds. Calculate the force. (P) $F = \frac{\Delta p}{\Delta t} = \frac{12}{3} = 4 \text{ N}$ Answer: 4 N R. P. Allie C. L. P. M. J. C.

wer:
$$F = \frac{\Delta p}{\Delta t} = \frac{12}{3} = 4 \text{ N}$$

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6. A 5 kg object accelerates from rest to 10 m/s in 2 s. Calculate the resultant force acting on it. (PP)

Working and Answer:
$$a = \frac{\Delta v}{\Delta t} = \frac{10}{2} = 5 \text{ m/s}^2$$
 Force:
$$F = ma = 5 \times 5 = 25 \text{ N}$$
 Answer: 25 N

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7. Explain the difference between elastic and inelastic collisions. (PP)

Working and Answer:

Elastic: total kinetic energy conserved.

Inelastic: some kinetic energy is transformed to other forms (e.g., heat, sound).

Answer: Elastic = KE conserved; Inelastic = KE not conserved.

8. Calculate the impulse of a 20 N force acting for $0.4~\mathrm{s.}$ (PP)

Working and Answer:

Impulse = Force \times Time = $20 \times 0.4 = 8$ Ns

Answer: 8 Ns

9. A 1500 kg car slows from 25 m/s to 0 in 5 s. Calculate the average braking force. (PP) $\Delta p = 1500 \times (0-25) = -37500 \text{ kg} \cdot \text{m/s}$ $F = \frac{\Delta p}{\Delta t} = \frac{-37500}{5} = -7500 \text{ N}$ Answer: 7500 N

$$\Delta p = 1500 \times (0 - 25) = -37500 \text{ kg} \cdot \text{m/s}$$

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$$F = \frac{\Delta p}{\Delta t} = \frac{-37500}{5} = -7500 \text{ N}$$

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raineel Philipsics 10. State the law of conservation of momentum. (PP)

Working and Answer:

In a closed system with no external forces, total momentum before and after an interaction remains constant.

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Answer: Total momentum is conserved in isolated systems.

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Working and Answer:
$$p_{\text{total}} = (1.5 \times 4) + (2.5 \times -3) = 6 - 7.5 = -1.5 \text{ kg} \cdot \text{m/s}$$
Answer: $-1.5 \text{ kg} \cdot \text{m/s}$

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Answer:
$$v_2 = \frac{2m_1}{m_1 + m_2} u_1 = \frac{2 \times 3}{5} \times 6 = \frac{6}{5} \times 6 = 7.2 \text{ m/s}$$

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Praince. P. r. atheol. P. half 13. Define impulse and explain its relationship to force and time. (PPP)

Working and Answer:

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Impulse = Change in momentum = Force \times Time:

Impulse = $F\Delta t = \Delta p$

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Answer: Impulse is area under a force-time graph.

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Working and Answer:

Initial momentum: $p = 6 \times 3 = 18 \text{ kg} \cdot \text{m/s}$

Total mass = 6 + 4 = 10 kg

$$v = \frac{18}{10} = 1.8 \text{ m/s}$$

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Working and Answer:

Crumple zones increase impact time \rightarrow reduces rate of momentum change \rightarrow reduces force on passengers.

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Answer: $F = \Delta p/\Delta t$: increase Δt , reduce F.

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Working and Answer:
$$\Delta p = 1000 \times (0-15) = -15000 \text{ kg} \cdot \text{m/s}$$

$$F = \frac{-15000}{0.1} = -150000 \text{ N}$$
 Answer: 150000 N

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17. Two carts (2 kg and 3 kg) collide inelastically. The 2 kg cart moves at 3 m/s, the other is at rest. Find final velocity. (PPPP)raineel Ri caineel Ri

Working and Answer:

$$p_{\text{initial}} = 2 \times 3 = 6 \text{ kg} \cdot \text{m/s}$$

$$v = \frac{6}{5} = 1.2 \text{ m/s}$$

Total mass = 5 kg

$$v = \frac{6}{5} = 1.2 \text{ m/s}$$

Answer: 1.2 m/s

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18. A 0.5 kg ball hits a wall at 8 m/s and rebounds at -6 m/s. Collision lasts 0.05 s. Find average force. (PPPP)

$$\Delta v = -6 - 8 = -14 \text{ m/s}$$

$$\Delta p = 0.5 \times (-14) = -7 \text{ kg} \cdot \text{m/s}$$

Working and Answer:
$$\Delta v = -6 - 8 = -14 \text{ m/s}$$

$$\Delta p = 0.5 \times (-14) = -7 \text{ kg} \cdot \text{m/s}$$

$$F = \frac{-7}{0.05} = -140 \text{ N}$$

19. A 1000 kg van travelling at 12 m/s collides with a 600 kg car at 4 m/s in the same direction. After collision, they move together. Calculate final velocity. (PPPPP)

Working and Answer:

$$p_{\text{initial}} = (1000 \times 12) + (600 \times 4) = 12000 + 2400 = 14400 \text{ kg} \cdot \text{m/s}$$

Total mass = 1600 kg

$$v = \frac{14400}{1600} = 9 \text{ m/s}$$

Answer: 9 m/s

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raineelPinie aly wix 20. A 2 kg puck travelling at 5 m/s collides elastically with a 1 kg puck at rest. Calculate at i both final velocities. (PPPP)

Use elastic collision equations:

Answer: lision equations:
$$v_1 = \frac{m_1 - m_2}{m_1 + m_2} u_1 = \frac{2 - 1}{3} \times 5 = \frac{5}{3} \approx 1.67 \text{ m/s}$$

$$v_2 = \frac{2m_1}{m_1 + m_2} u_1 = \frac{4}{3} \times 5 = \frac{20}{3} \approx 6.67 \text{ m/s}$$

$$1.67 \text{ m/s}, v_2 = 6.67 \text{ m/s}$$

$$v_2 = \frac{2m_1}{m_1 + m_2} u_1 = \frac{4}{3} \times 5 = \frac{20}{3} \approx 6.67 \text{ m/s}$$

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Praince Prints Answer: $v_1 = 1.67 \text{ m/s}, v_2 = 6.67 \text{ m/s}$

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