CBSE Pattern Test 1 — Laws of Motion

Maximum Marks: 40 · Time Allowed: 90 minutes

General Instructions: All questions are compulsory. The paper has four sections. Section A : Q1–Q10 carry 1 mark each (Q1–Q8 are MCQs chosen from the options; Q9–Q10 are assertion–reason). Section B : Q11–Q15 carry 2 marks each. Section C : Q16–Q20 carry 3 marks each (Q20 is a case study). Section D : Q21 carries 5 marks. In Section A, for each assertion–reason question select the correct alternative: (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false but R is also false. Take $10\,\text{m/s}^2 = 10\,\text{m/s}^2$ wherever required.

Section	Questions	Marks each	Total marks
A	Q1–Q10	1	10
B	Q11–Q15	2	10
C	Q16–Q20	3	15
D	Q21	5	5

Section A · Q1 – Q10 (1 mark each)

1. The SI unit of linear momentum is

(A) kg m s^{-1}
(B) N
(C) N s^{-1}
(D) kg m s^{-2}

2. A pebble of mass 0.05 kg is thrown vertically upwards. Neglecting air resistance, the net force on it at the highest point is

(A) zero
(B) 0.5 N upward
(C) 0.5 N downward
(D) dependent on the initial speed

3. The impulse of a force is equal to the

(A) change in momentum of the body
(B) product of mass and velocity
(C) product of force and displacement
(D) change in velocity alone

4. A rocket can accelerate in empty space because

(A) it pushes against the surrounding air
(B) the ejected gases carry backward momentum, so the rocket gains forward momentum
(C) of a pseudo force from the escaping gases
(D) friction with space dust propels it

5. Action and reaction forces

(A) always cancel each other immediately
(B) act on two different bodies
(C) act on the same body
(D) always produce motion

6. On a level circular road, the centripetal force on a turning car is supplied by

(A) friction between the tyres and the road
(B) the normal reaction
(C) the weight of the car
(D) the engine force

7. A block just begins to slide down an incline when the plane is tilted through 30°. The coefficient of friction between the block and the plane is

(A) $1/\sqrt{3}$
(B) $1/2$
(C) $\sqrt{3}$
(D) 1

8. A body suspended from a spring balance in a freely falling lift shows a reading of

(A) zero
(B) its true mass
(C) $2mg$
(D) half its mass

9. Assertion (A): A fielder pulls his hands backwards while catching a fast-moving cricket ball. *[1]*
Reason (R): Increasing the time of contact reduces the force on the hands, since the impulse required is fixed.

10. Assertion (A): The apparent weight of a man in a lift moving up with acceleration a is greater than his true weight. *[1]*
Reason (R): The normal reaction must provide the additional upward acceleration, $N = m(g + a)$.

Section B · Q11 – Q15 (2 marks each)

11. Define inertia. Give one example each of inertia of rest and inertia of motion. *[2]*

12. A $150\ \text{g}$ ball moving at $20\ \text{m/s}$ is caught and brought to rest. If the catch takes $0.1\ \text{s}$, find the average force on the hands. *[2]*

13. A bullet of mass $20\ \text{g}$ is fired from a gun of mass $2\ \text{kg}$ at $80\ \text{m/s}$. Find the recoil speed of the gun. *[2]*

14. State whether the apparent weight of a person in a lift increases, decreases or stays the same when the lift (i) accelerates upwards and (ii) accelerates downwards. Explain briefly. *[2]*

15. Two forces of $8\ \text{N}$ and $6\ \text{N}$ act at right angles on a body of mass $5\ \text{kg}$. Find the magnitude and direction of its acceleration. *[2]*

Section C · Q16 – Q20 (3 marks each)

16. State and prove the impulse–momentum theorem. *[3]*

17. A block of mass $2\ \text{kg}$ slides down a rough inclined plane of inclination 30° with $\mu = 0.2$. Find its acceleration. (Use $10\ \text{m/s}^2$.) *[3]*

18. Explain the working of a rocket on the basis of conservation of momentum. Why can a rocket work in empty space? *[3]*

19. Derive $v = \sqrt{rg\tan\theta}$ for the optimum safe speed of a vehicle on a banked road (no friction). Evaluate for $r = 100\ \text{m}$ and $\tan\theta = 0.9$ using $10\ \text{m/s}^2$. *[3]*

20. Case study: An elevator of total mass $800\ \text{kg}$ (cabin plus occupants) starts from rest and accelerates uniformly upwards at $4\ \text{m/s}^2$. *[3]*

(i) Draw a free body diagram of the elevator, naming all the forces acting on it.

(ii) Write the relation between the tension in the cable, the weight of the elevator and its acceleration.

(iii) Calculate the tension in the cable. (Take $10\ \text{m/s}^2$.)

Section D · Q21 (5 marks)

21. A mass m_1 hangs vertically from a light inextensible string that passes over a frictionless pulley and connects to a mass m_2 resting on a smooth horizontal table. Derive expressions for the acceleration of the system and the tension in the string. Hence evaluate for $m_1 = 3\,\text{kg}$, $m_2 = 5\,\text{kg}$ and $10\,\text{m/s}^2 = 10\,\text{m/s}^2$. *[5]*

Answer Key — ${id}

Section A: 1–kg m s^{-1}, 2–0.5 N downward, 3–change in momentum, 4–gases carry backward momentum, 5–two different bodies, 6–friction, 7–$1/\sqrt{3}$, 8–zero. 9–(a), 10–(a)

12. $J = 0.15 \times 20 = 3\,\text{N s}$; $F = 3/0.1 = 30\,\text{N}$.

13. $V = 0.02 \times 80/2 = 0.8\,\text{m/s}$.

15. $a = 2\,\text{m/s}^2$ at 36.9° to the 8 N force.

17. $a = 10(0.5 - 0.2 \times 0.866) = 3.27\,\text{m/s}^2$.

19. $v = \sqrt{100 \times 10 \times 0.9} = \sqrt{900} = 30\,\text{m/s}$.

20. (ii) $T - mg = ma$. (iii) $T = m(g + a) = 800 \times 14 = 11200\,\text{N}$.

21. $a = \frac{m_1 g}{m_1 + m_2} = \frac{3 \times 10}{8} = 3.75\,\text{m/s}^2$; $T = \frac{m_1 m_2 g}{m_1 + m_2} = \frac{3 \times 5 \times 10}{8} = 18.75\,\text{N}$.