Short Answer Questions

Chapter 3: Dynamics

9th Class Physics — New Syllabus (PCTB)

3.1 What kind of changes in motion may be produced by a force?

A force may produce the following kinds of changes in motion: (i) it can move a body at rest, (ii) it can stop a moving body, (iii) it can increase the speed of a body (acceleration), (iv) it can decrease the speed of a body (deceleration), and (v) it can change the direction of motion of a body. Since velocity is a vector quantity, a force may change its magnitude, its direction, or both. For example, a footballer kicks a ball at rest into motion, a goalkeeper stops it, and a batsman changes the direction of a moving ball.

3.2 Give 5 examples of contact forces.

Five examples of contact forces are: (i) Friction — resists motion when one surface moves over another; (ii) Normal force — the reaction force exerted by a surface, perpendicular to it, on an object lying on it; (iii) Tension force — experienced by a rope or string when a load pulls it; (iv) Air resistance — opposition offered by air to an object falling or moving through it; (v) Elastic force — brings materials like springs and rubber bands back to their original shape after deformation. All these acts at the point of contact between two objects.

3.3 An object moves with constant velocity in free space. How long will the object continue to move with this velocity?

The object will continue to move with the same constant velocity forever. In free space, no external force such as friction, air resistance or gravity acts on it, so the net force $F = 0$. By Newton's second law: $a = F/m = 0/m = 0$. Since acceleration is zero, the change in velocity $\Delta v = a \times t = 0$ for any time t, however long. Hence, by Newton's first law, the object maintains its uniform motion in a straight line indefinitely until some external force acts on it.

3.4 Define impulse of force.

When a large force F acts on a body for a very short interval of time Δt, the product of force and time is called the impulse of the force. It is equal to the total change in momentum of the body: **Impulse = $F \times \Delta t = m\Delta v$ = change in momentum.** Its SI unit is N s (equivalent to kg m s^{-1}) and it is a vector quantity. **Example:** when a bat strikes a cricket ball, a large force acts for a few milliseconds; if the bat exerts 500 N for 0.01 s, the impulse $= 500 \times 0.01 = 5$ N s, which equals the change in the ball's momentum.

3.5 Why has not Newton's first law been proved on the Earth?

Newton's first law states that a body will continue its state of rest or of uniform motion unless acted upon by an external force. This law has not been proved on Earth because a completely force-free body is impossible here: friction between surfaces, air resistance and gravity always act on every body. A ball rolled on the ground always stops after covering some distance because friction opposes its motion. Since the condition "no external force" can never be achieved on Earth, the law cannot be practically demonstrated, although it holds perfectly in principle (and nearly so in outer space).

3.6 When sitting in a car which suddenly accelerates from rest, you are pushed back into the seat, why?

This happens due to inertia — the property of a body to maintain its state of rest or of uniform motion. When the car suddenly accelerates from rest, the car and the seat attached to it move forward at once. Our body, however, tends to remain in its state of rest because of inertia. As a result, the seat moves forward while our body lags behind, so the back of the seat presses against us and we feel ourselves pushed back into the seat. The greater the acceleration of the car, the stronger this backward push is felt.

3.7 The force expressed in Newton's second law is a net force. Why is it so?

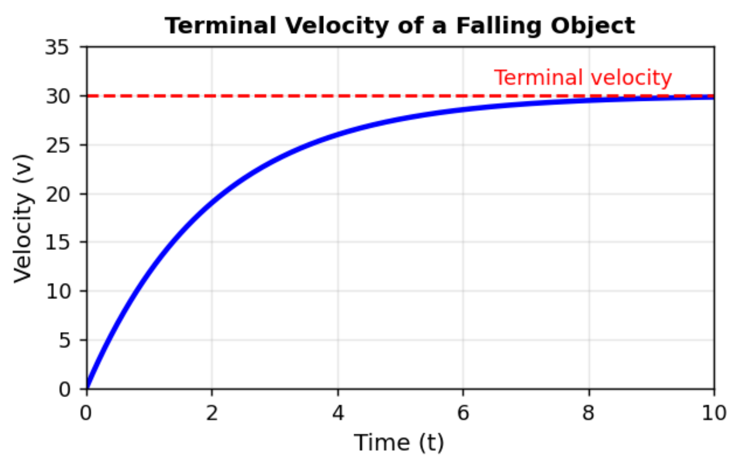
In Newton's second law (F = ma), F is the net (resultant) force because acceleration is produced only by the unbalanced force acting on the body. In practice, several forces act on a body at the same time — applied force, friction, air resistance, weight, normal force — and each does not produce its own separate acceleration. The body accelerates only according to the vector sum of all these forces. **Example:** if a 2 kg block is pushed with 10 N while friction opposes with 4 N, the net force = 10 − 4 = 6 N, so a = 6/2 = 3 m s^{-2} — the acceleration corresponds to 6 N, not 10 N. Balanced forces (net force zero) produce no acceleration at all.

3.8 How can you show that rolling friction is lesser than the sliding friction?

It can be shown by a simple experiment. Drag a heavy block across the floor with a spring balance and note the reading — a large force is required to keep it sliding. Now place the same block on rollers or a wheeled trolley and pull it again: the spring balance reading becomes many times smaller. The reason is that a rolling wheel touches the surface only at a single point and does not slide over it, so there is no relative sliding motion between the surfaces. This proves rolling friction is much less than sliding friction — about 100 times smaller — which is why ball bearings are used in machines.

3.9 Define terminal velocity of an object.

When an object falls through air, its speed increases, and the upward air resistance on it also increases. A stage comes when the upward force of air resistance becomes equal to the downward force of gravity (weight). The net force then becomes zero, acceleration stops, and the object falls with a constant maximum velocity called terminal velocity. So, terminal velocity is the constant (safe) velocity of a falling object attained when air resistance balances its weight. **Example:** a paratrooper descends safely at terminal velocity because the large surface area of the parachute increases air resistance.



3.10 An astronaut walking in space wants to return to his spaceship by firing a hand rocket. In what direction does he fire the rocket?

The astronaut fires the hand rocket in the direction opposite to the spaceship, i.e., away from it. The rocket expels hot gases away from the spaceship, and by Newton's third law the gases exert an equal and opposite reaction force on the astronaut, pushing him towards the spaceship. This also follows from conservation of momentum: initially the total momentum is zero, so when the gases gain momentum in one direction, the astronaut gains equal momentum in the opposite direction — towards his spaceship. Space has no air to push against, so this is the only way he can move.