CLASS 9 SCIENCE

CHAPTER 6

HOW FORCES AFFECT MOTION

NCERT QUESTIONS & ANSWERS

Chapter coverage: Force • balanced and unbalanced forces • friction • Newton's first, second and third laws • momentum • F = ma • gravitational force • force-time effects • systems of objects.

Source basis: Prepared from the supplied NCERT Grade 9 *Exploration* Chapter 6 and its chapter-end "Revise, Reflect, Refine" questions. The textbook identifies the end-of-chapter exercise beginning with Question 1. ■filecite■turn164file0■L169-L208■

CHAPTER-END QUESTIONS & ANSWERS

Revise • Reflect • Refine — Chapter 6

1. A horizontal force F moves a table across the floor at constant velocity. How much is the frictional force exerted by the floor on the table?

Answer: F, in the direction opposite to the applied force.
The table moves with constant velocity, so its acceleration is zero. Therefore the net force is zero. Hence friction must have the same magnitude as the applied force and act in the opposite direction.

2. For a ball moving on a smooth frictionless surface, choose the correct option: (i) no net force; (ii) force in direction of motion; (iii) force opposite to motion.

Answer:
(i) Velocity will remain **the same**.
(ii) Magnitude of velocity will **increase**.
(iii) Magnitude of velocity will **decrease**.
This follows from Newton's first and second laws: zero net force produces no acceleration, while a net force changes velocity in its direction.

3. Two blocks P and Q are shown. P has forces of 4 N and 5 N in opposite directions, while Q moves with constant velocity. Which statement is correct?

Answer: (i) P experiences a net force and Q does not experience a net force.
For P, the forces are unequal, so the net force is 5 – 4 = **1 N**. For Q, constant velocity means acceleration is zero and therefore the net force is zero.

4. In a snake boat race, 95 of 100 oarsmen row backwards to propel the boat forward, while 5 row in the opposite direction. Each applies 200 N. Find the net force.

Forward force: 95 × 200 = 19,000 N.
Opposing force: 5 × 200 = 1,000 N.
Net force: 19,000 – 1,000 = **18,000 N**.
Answer: 18,000 N in the forward direction.

Exam Tip: Always identify the direction of the net force. In numerical problems, convert units first, write the relevant equation, substitute values, and include the final direction where applicable.

5. When a net force acts on an object, which statement correctly describes its acceleration?

Answer: (iv). The object accelerates **in the direction of the force**, with acceleration proportional to the force acting on it (for a fixed mass). This follows from F = ma.

6. The position-time graphs for four objects A, B, C and D are given. On which object does a net force act?

Answer: (iii) Object C.
A net force produces acceleration. On a position-time graph, acceleration is indicated by a **curved** graph because the slope (velocity) changes with time. The source answer key identifies option (iii).

7. A sailor jumps out from a small boat to the shore. Will the boat move? If yes, in which direction and why?

Answer: Yes. The sailor pushes the boat backward while jumping forward. By Newton's third law, the boat exerts an equal and opposite force on the sailor, while the sailor exerts a force on the boat in the opposite direction. Therefore, the **boat moves backward**, opposite to the sailor's jump.

8. Why is a landing mat or sand bed placed for an athlete during a high jump?

Answer: The mat or sand bed increases the time over which the athlete comes to rest after landing. For the same change in momentum, increasing the stopping time reduces the magnitude of acceleration and therefore reduces the force acting on the athlete. This helps prevent injury.

9. A loaded hand cart collides with an identical empty cart. During the collision, which statement is correct?

Answer: (iv). The loaded cart and the empty cart **both exert an equal magnitude of force on each other**. Newton's third law states that interaction forces are equal in magnitude and opposite in direction, even though the resulting accelerations can differ because the masses differ.

Exam Tip: Always identify the direction of the net force. In numerical problems, convert units first, write the relevant equation, substitute values, and include the final direction where applicable.

10. The acceleration-mass graph for a force acting on objects of different masses is plotted. Plot the force-mass graph for this case.

Answer: The force is constant because the acceleration varies inversely with mass according to **F = ma**. Therefore, a force-mass graph has **mass on the x-axis and a horizontal line parallel to the mass axis at the constant force value on the y-axis**. In other words, force does not change as mass changes in the given situation.

11. A 10 kg object has the velocity-time graph shown in Fig. 6.41. Calculate the force acting on it.

Answer: 25 N.
From the graph, velocity changes from 0 to 10 m s■¹ in 4 s, so
a = (10 − 0)/4 = 2.5 m s■².
Using F = ma:
F = 10 × 2.5 = 25 N.

12. A bullet of mass 50 g moving at 100 m s■¹ enters a wooden block and stops after penetrating 50 cm. Estimate the stopping force.

Given: m = 50 g = 0.05 kg, u = 100 m s■¹, v = 0, s = 50 cm = 0.5 m.
Using v² = u² + 2as:
0 = 100² + 2a(0.5), so **a = –10,000 m s■²**.
F = ma = 0.05 × (–10,000) = **–500 N**.
Answer: 500 N opposite to the direction of motion.

13. A football is kicked at 108 km h■¹. The force imparted is 800 N and the football mass is 0.4 kg. Calculate the time of contact.

Convert speed: 108 km h■¹ = 30 m s■¹.
Taking the ball initially at rest, change in momentum = mv = 0.4 × 30 = 12 kg m s■¹.
Using F = change in momentum / time:
800 = 12/t
t = 12/800 = 0.015 s.
Answer: 0.015 s.

14. A 2 kg object moves at 10 m s■¹. On a rough patch, friction is 7 N and an additional 3 N force opposes the motion. How far does it travel before stopping?

Total opposing force = 7 + 3 = 10 N.
Acceleration: a = F/m = –10/2 = **–5 m s■²**.
Using v² = u² + 2as with v = 0 and u = 10 m s■¹:
0 = 100 + 2(–5)s
so **s = 10 m**.
Answer: 10 m.

Exam Tip: Always identify the direction of the net force. In numerical problems, convert units first, write the relevant equation, substitute values, and include the final direction where applicable.

15. A tractor pulls a harrow of mass m■ with force F and acceleration a■, and a trolley of mass m■ with the same force F and acceleration a■. Find the acceleration when both are pulled together.

For the harrow: F = m■a■, so m■ = F/a■.
For the trolley: F = m■a■, so m■ = F/a■.
Together, mass = m■ + m■ and acceleration A = F/(m■ + m■). Therefore,
A = 1 / (1/a■ + 1/a■) = (a■a■)/(a■ + a■).
Answer: A = a■a■/(a■ + a■).

16. A bar magnet is brought close to a magnetic compass. Both exert equal and opposite forces, but the compass needle moves while the bar magnet appears stationary. Explain.

Answer: The magnetic forces on the two objects are equal and opposite, but their masses are very different. For the same force, acceleration is a = F/m. The compass needle has a much smaller mass, so it gets a noticeable acceleration, whereas the much heavier bar magnet gets an extremely small acceleration that is difficult to observe.

QUICK REVISION — CHAPTER 6

High-priority concepts, laws and formulas

Force: A physical quantity having magnitude and direction. SI unit = newton (N). The motion of an object depends on the net force acting on it.

Newton's First Law: An object at rest remains at rest, and an object in motion continues with constant velocity unless a net force acts on it. Zero net force means zero acceleration.

Newton's Second Law: F = ma. Acceleration is in the direction of the net force. For fixed mass, acceleration is directly proportional to force; for fixed force, acceleration is inversely proportional to mass.

Newton's Third Law: Whenever one object exerts a force on another, the second simultaneously exerts an equal and opposite force on the first. The two forces act on different objects, so they do not cancel each other.

Useful formulas: F = ma • F = mg • v = u + at • $v^2 = u^2 + 2as$ • Momentum p = mv. For a system of connected objects on a frictionless surface: a = F/(m■ + m■).

Key answers: Q1 F opposite to applied force • Q2 same, increase, decrease • Q3 (i) • Q4 18,000 N forward • Q5 (iv) • Q6 (iii) • Q9 (iv) • Q11 25 N • Q12 500 N opposite to motion • Q13 0.015 s • Q14 10 m • Q15 a■a■/(a■+a■).

Important application: Airbags and landing mats increase the stopping time, reducing acceleration and therefore reducing the force experienced during impact. The textbook also explains how friction helps walking, running, rowing and vehicle motion.