Chapter 5: Exploring Forces

Exercises — Keep the Curiosity Alive

Q1 Match items in Column A with the items in Column B.

Column A (Type of force) | Column B (Example)

(i) Muscular force | (a) A cricket ball stopping on its own just before touching the boundary line

(ii) Magnetic force | (b) A child lifting a school bag

(iii) Frictional force | (c) A fruit falling from a tree

(iv) Gravitational force | (d) Balloon rubbed on woollen cloth attracting hair strands

(v) Electrostatic force | (e) A compass needle pointing North

SOLUTION

(i) Muscular force → (b) A child lifting a school bag.
Lifting requires muscles in the arms to exert an upward pull — a direct example of muscular force.

(ii) Magnetic force → (e) A compass needle pointing North.
The Earth's magnetic field exerts a magnetic force on the needle, aligning it towards geographic North.

(iii) Frictional force → (a) A cricket ball stopping on its own just before touching the boundary line.
As the ball rolls along the ground, friction between the ball's surface and the ground opposes its motion and eventually brings it to rest.

(iv) Gravitational force → (c) A fruit falling from a tree.
The Earth's gravitational pull acts on the fruit, pulling it downward towards the ground.

(v) Electrostatic force → (d) Balloon rubbed on woollen cloth attracting hair strands.
Rubbing transfers static charges to the balloon; the charged balloon then exerts an electrostatic force on the uncharged hair strands, attracting them.

Answer: (i)–(b), (ii)–(e), (iii)–(a), (iv)–(c), (v)–(d).

Q2 State whether the following statements are True or False.
(i) A force is always required to change the speed of motion of an object.
(ii) Due to friction, the speed of the ball rolling on a flat ground increases.
(iii) There is no force between two charged objects placed at a small distance apart.

SOLUTION

(i) TRUE.
A change in speed means a change in velocity, which is acceleration. By Newton's second law, a net force is required to produce acceleration. Therefore, a force is always needed to change an object's speed.

(ii) FALSE.
Friction always acts opposite to the direction of motion. For a ball rolling on flat ground, friction opposes rolling; it therefore decreases the speed, not increases it. The ball slows down and eventually stops.

(iii) FALSE.
Two charged objects exert electrostatic force on each other even without physical contact. Like charges repel; unlike charges attract. This force acts across the small distance between them.

Answer: (i) True; (ii) False; (iii) False.

Q3 Two balloons rubbed with a woollen cloth are brought near each other. What would happen and why?

SOLUTION

When a balloon is rubbed with a woollen cloth, static electric charges build up on its surface. Both balloons are rubbed in the same way with the same material, so both acquire the same kind of charge.

When two similarly charged objects are brought near each other, like charges repel.

Therefore, the two balloons will repel each other and move away from each other.

The force responsible is the electrostatic force, which is a non-contact force that acts even without physical contact between the charged objects.

Answer: The two balloons will repel each other and move apart, because both acquire the same kind of static charge after rubbing with wool, and like charges repel.

Q4 When you drop a coin in a glass of water, it sinks, but when you place a bigger wooden block in water, it floats. Explain.

SOLUTION

Two forces act on any object placed in a liquid: the gravitational force (weight) acting downward, and the buoyant force (upthrust) applied by the liquid acting upward.

For the coin:
A coin is made of metal (dense material). Its weight is much greater than the buoyant force exerted by the water on it. Since the downward gravitational force exceeds the upward buoyant force, the coin sinks.

For the wooden block:
Wood is less dense than water. Even though the wooden block is bigger and may weigh more in absolute terms, when placed in water it displaces a volume of water whose weight equals (or exceeds) the block's own weight before the block is fully submerged. At that point, the upward buoyant force balances the downward gravitational force, so the block floats.

In summary: an object floats when the buoyant force equals its weight; it sinks when its weight exceeds the buoyant force.

Answer: The coin sinks because its weight (gravitational force) is greater than the buoyant force water exerts on it. The wooden block floats because the buoyant force from the water equals its weight before the block is fully submerged, so the two forces balance.

Q5 If a ball is thrown upwards, it slows down, stops momentarily, and then falls back to the ground. Name the forces acting on the ball and specify their directions.
(i) During its upward motion
(ii) During its downward motion
(iii) At its topmost position

SOLUTION

(i) During upward motion:
Gravitational force acts on the ball in the downward direction (towards the Earth). Air resistance (friction of air) also acts in the downward direction, opposing the upward motion. The combined effect of these forces opposes the ball's upward movement, causing it to slow down.

(ii) During downward motion:
Gravitational force acts on the ball in the downward direction (towards the Earth), which is now in the direction of motion — this accelerates the ball. Air resistance acts in the upward direction, opposing the downward motion.

(iii) At the topmost position:
The ball is momentarily at rest. Gravitational force still acts on the ball in the downward direction. This unbalanced downward force causes the ball to begin moving downward. There is no air resistance at this instant since the ball has zero velocity.

Answer: (i) Upward motion — gravitational force (downward) and air resistance (downward). (ii) Downward motion — gravitational force (downward) and air resistance (upward). (iii) Topmost point — gravitational force (downward) only.

Q6 A ball is released from the point P and moves along an inclined plane and then along a horizontal surface as shown in Fig. 5.16. It comes to stop at the point A on the horizontal surface. Think of a way so that when the ball is released from the same point P, it stops (i) before the point A (ii) after crossing the point A.

SOLUTION

The ball is always released from the same point P, so it always has the same speed when it reaches the bottom of the incline (same kinetic energy). On the horizontal surface, friction between the ball and the surface opposes the ball's motion and brings it to rest.

The distance the ball travels on the horizontal surface depends on how much friction acts on it: more friction dissipates the kinetic energy faster (shorter distance), less friction allows the ball to travel farther.

(i) To stop before point A:
Increase friction on the horizontal surface. This can be done by using a rougher horizontal surface (for example, covering it with sand, cloth, or rough material). The greater friction force will dissipate the ball's kinetic energy more quickly, making it stop before reaching A.

(ii) To stop after crossing point A:
Reduce friction on the horizontal surface. This can be done by using a smoother horizontal surface (for example, polishing it, or placing the ball on ice or a lubricated surface). With less friction, the ball's kinetic energy is dissipated more

slowly, allowing it to travel beyond A before stopping.

Answer: (i) Use a rougher horizontal surface to increase friction — ball stops before A. (ii) Use a smoother horizontal surface to reduce friction — ball crosses A and stops further away.

Q7 Why do we sometimes slip on smooth surfaces like ice or polished floors? Explain.

SOLUTION

When we walk, we push backward on the ground with our feet. Friction between our feet and the ground provides the forward reaction force that allows us to move forward. Friction also prevents our feet from sliding backward.

Smooth surfaces like ice or polished floors have very few surface irregularities. Recall that friction arises because the tiny irregularities of two surfaces interlock with each other. On very smooth surfaces, these irregularities are minimal, so the interlocking is negligible.

As a result, the force of friction between our feet and the smooth surface is very small. Without adequate friction, our feet cannot grip the surface. When we put our weight on one foot and push, that foot tends to slide instead of staying put — and we slip.

Answer: Smooth surfaces have very few irregularities, so friction between our feet and the surface is very low. Without enough friction to grip the surface, our feet slide and we slip.

Q8 Is any force being applied to an object in a non-uniform motion?

SOLUTION

Non-uniform motion means the speed or direction of the object changes over time, that is, the object has non-zero acceleration.

A force is required to change the speed or direction of motion of an object. If an object is in non-uniform motion, its speed or direction (or both) is changing.

Therefore, yes, a net force must be acting on an object undergoing non-uniform motion.

Example: A ball slowing down due to friction is in non-uniform motion; the

frictional force is the net force causing the change in its speed.

Answer: Yes. Non-uniform motion means changing speed or direction, which requires a net force to act on the object.

Q9 The weight of an object on the Moon becomes one-sixth of its weight on the Earth. What causes this change? Does the mass of the object also become one-sixth of its mass on the Earth?

SOLUTION

Weight is the gravitational force with which a planet (or the Moon) pulls an object towards itself. Weight = gravitational force, and it depends on the strength of gravity at that location.

The Moon is much smaller and less massive than the Earth. As a result, the Moon's gravitational pull is weaker — approximately one-sixth of the Earth's gravitational pull. This is why the weight of any object on the Moon is one-sixth of its weight on the Earth.

Mass, on the other hand, is the amount of matter contained in an object. It is an intrinsic property of the object and does not depend on the gravitational force at a location.

Therefore, the mass of the object remains the same on the Moon as on the Earth — it does NOT become one-sixth.

Summary: Weight changes because gravity is weaker on the Moon; mass does not change because it is independent of gravity.

Answer: The change in weight is caused by the Moon's weaker gravitational pull (about one-sixth of Earth's). The mass of the object does not change — mass is the same everywhere.

Q10 Three objects 1, 2, and 3 of the same size and shape but made of different materials are placed in the water. They dip to different depths as shown in Fig. 5.17. If the weights of the three objects 1, 2, and 3 are w_1, w_2, and w_3, respectively, then
(i) w1 = w2 = w3
(ii) w1 > w2 > w3
(iii) w2 > w3 > w1
(iv) w3 > w1 > w2

SOLUTION

From Fig. 5.17: Object 1 is submerged the deepest (almost fully dipped, only its top just above the water), object 2 is at an intermediate depth (partially submerged), and object 3 floats highest (least submerged, roughly half above the water).

For a floating object, the buoyant force equals the object's weight. The buoyant force equals the weight of the liquid displaced, which depends on the volume of the object submerged.

Since all three objects have the same size and shape, a greater depth of submersion means a greater volume of water displaced, which means a greater buoyant force is needed, which means the object is heavier.

Object 1 is submerged the deepest → displaces the most water → needs the greatest buoyant force → w_1 is the greatest.
Object 2 is at intermediate depth → intermediate weight → w_2 is in the middle.
Object 3 is submerged the least → displaces the least water → w_3 is the smallest.

Therefore: $w_1 > w_2 > w_3$, which corresponds to option (ii).

Answer: Option (ii): w1 > w2 > w3. Object 1 dips deepest, displacing the most water, so it is the heaviest; object 3 dips shallowest, so it is the lightest.