SCIENCE CLASS IX
CHAPTER-9 FORCE AND LAWS OF MOTION

Q.1. Why do we tend to fall outwards when a car takes a steep turn?

Ans. We tend to fall outwards when a car takes a steep turn due to interia of direction.

Q.2. An athlete always runs some distance before taking a jump. Why?

Ans. When athlete runs some distance he increases his interia of motion. At the jumping time, when he takes jump, this increased interia of motion carries him over a long distance of height.

Q.3. Two similar vehicles are moving with the same velocity on the roads such that one of them is loaded and the other is empty. Which of the vehicles will require larger force to stop it? Give reasons.

Ans. Both has some velocity, but one of them is loaded, so its momentum is greater then other. Thus, for greater change of momentum, larger force will require to stop it.

Q.4. Is it possible that the train in whgich you are sitting appears to move while it is at rest?

Ans. Yes, it is possible, when two trains are at rest on the two parallel tracks. If one train is started suddenly then passengers sitting in the stationary train appear to move.

Q.5. Which has more inertia, a table tennis ball or a rubber ball of the same size?

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Ans. Having the same size, a rubber ball has more then a table tennis ball, so a rubber ball has more inertia.

Q.6. Apart from changing the magnitude of velocity of an object (or) changing the direction of motion of an object, what other changes can force bring on an object?

Ans. Force can change the state of rest to state of motion and vice-versa. It can change the shape and position of the body.

Q.7. You are applying force on the pan of single pan weighing balance and the pointer points to 100g. what is the force in Newton's applied by you?

Ans. Weight W = mg

$= 0.1 \times 10 = 1$ N

[therefore m = 100 g = 0.1 kg, g = 10 m/s^2]

Q.8. While riding on the bicycle, if we stop peddling, why does the bicycle begin to slow down?

Ans. The bicycle begin to slow down because force of friction which is acting in opposite direction to that of motion.

Q.9. How is force related to acceleration produced in a body by its application?

Ans. Force is directly propotional to acceleration produced in a body by its application.

Q.10. Atheletes in pole jump events fall on cushioned surface and not on floor. Why?

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Ans. The change in momentum occurs in a long duration of time which reduces the force acting on athlete and he does not hurt.

Q.11. A balloon is inflated and released. Why does it fly forward as air escapes out of it?

Ans. The reaction force of air pushed out of balloon pushes the balloon in forward direction.

Q.12. If the action and reaction are equal and opposite forces, then why do not they cancel each other?

Ans. Action and reaction forces act upon different bodies. Hence, they cannot cancel each other.

Q.13. An automobile vehicle has a mass of 1500 kg. what muct be the force between the vehicle and road if the vehicle is to be stopped with a negative acceleration of 1.7 ms^{-2}?

Ans. Mass, m = 1500 kg

Acceleration, a = - 1.7 m/s^2

Therefore Force, F = ma

= 1500 × (- 1.7)

= - 2550 N

(against the direction of motion)

Q.14. Using a horizontal force of 200 N, we intend to move a wooden cabinet across a floor at constant velocity. What is the fractional force that will be exerted on the cabinet?

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Ans. The frictional force is 200 N but in opposite direction.

Q.15. If action is always equal to the reaction, explain how a horse can pull a cart?

Ans. We know that action and reaction occur on different bodies and not on the same body. Thus, horse exerts a force on ground and reaction of ground pushes him forward.

Q.16. Place a water filled tumbler on a tray. Hold the tray and turn around as fast as you can. Why does water not pull?

Ans. The downward weight of water provides it the force required to keep moving in circle.

Q.17. Does Newton's third law apply to a system where bodies do not actually touch each other?

Ans. Yes, whenever the bodies are in actual contact or even if there is an interaction between the bodies (e.g., attraction or repulsion between two magnets charges, etc.) Newton's third law is applicable.

Q.18. What did Galileo conclude on the basis of his experiments on the motion of objects?

Ans. A body continues to move with the same velocity if no unbalanced force acts on it.

Q.19. Why mass is sometimes called coefficient of linear inertia?

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Ans. It is easier to pull a lighter body than a heavier body. Therefore, more the mass more will be the inertia. That is why mass is sometimes termed a coefficient of linear inertia.

Q.20. What is the net momentum of gun and bullet system before firing?

Ans. The net momentum of gun and bullet system before firing is zero, as velocities of both (gun and bullet) are zero.

Q.21. What is the net momentum of gun and bullet system after firing?

Ans. The momentum of gun and bullet system after firing is equal to initial momentum, i.e., zero because no external force is acting.

Q.22. Why should we wear safety seat belts in a car?

Ans. Due to our inertia we may be hurt when the car suddenly starts or stops. Safety belts protect us by showing down the motion in such situations.

Q.23. Dry leaves fallen on ground from trees blow off with wind, while fruits do not. Why?

Ans. Fruit has more mass, hence greater inertia of rest than leaves.

Q.24. A body accelerates when balanced force acts on it. Is it true or false? Why?

Ans. It is False because momentum of a body changes only when an unbalanced force acts on it.

Q.25. How is force related to momentum of a body?

Ans. Force is directly propotional to the rate of change of momentum.

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Q.26. If F_1 is force exerted on a body and F_2 is the reaction force exerted by the body, relate F_1 and F_2 ?

Ans. According to Newton's third law, action and reaction force are equal and opposite to each other $F_1 = - F_2$ (i.e., equal in magnitude but opposite in direction).

Q.27. Relate SI unit of momentum with its CGS unit.

Ans. 1 kg-m/s = 10^5 g-cm/s

Q.28. Why is the person hurt less when he falls on a spongy surface?

Ans. In case of spongy surface, the change in momentum takes longer duration of time. So force exerted on his body is less.

Q.29. State a relation for velocity of rocket at any instant of time.

Ans. If m is the mass of burnt fuel,

M is the mass of rocket at given time,

v is the velocity of burnt fuel,

then velocity of rocket, $V = -\frac{mv}{M}$

Q.30. Which law can explain the process of recoil of gun?

Ans. Newton's third law of motion explain the process of recoil of gun.

Q.31. According to the third law of motion action and reaction force act on same body or different bodies.

Ans. According to third law of motion, action and reaction force always act on different bodies in opposite directions.

Q.32. A goalkeeper in a game of football pulls his hands backwards after holding the ball shot at the goal. Explain.

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Ans. The goalkeeper pulls his hands backwards after holding the ball to decrease the rate of change of momentum by increasing the time.

By doing this, less force is exerted on his hands (therefore Force is directly propotional to the rate of change of momentum).

Q.33. A passenger in a moving train tosses a coin which falls behind him. From this incident, what you can predict about the motion of train.

Ans. If the coin falls behind the passenger that means the train is accelerated. When the coin is tossed it has same velocity as that of train but during the time it is in air its velocity becomes less than that of train (because the train is accelerated), so it falls behind the passenger.

Q.34. A water tanker filled upto $\frac{2}{3}$ of its height is moving with a uniform speed. On sudden application of the brake, in which direction the water in the tank would flow?

Ans. On the sudden application of brake, the tanker will come in the state of rest but the water remains in the state of motion, so the water will move forward.

Q.35. What do you mean by a resultant force?

Ans. When two or more forces act on a body simultaneously, then the single force which products the same effect as produced by all the forces acting together is known as the resultant force.

Q.36. Give two examples of effects of force.

Ans. (i) A toy car starts moving when pushed.

(ii) Shape of dough ball changes when rolled.

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Q.37. Name the agency which when applied to a body is directly propotional to the rate of change of momentum which it produces in the body.

Ans. Force which when applied to a body is directly propotional to the rate of change of momentum.

Q.38. A Cricket ball of mass 70 g moving with a velocity of 0.5 m/s is stopped by a player in 0.5 s. What is the force exerted by the player to stop it?

Ans. Mass of cricket ball, m = 70 g = 0.07 kg

Initial velocity, u = 0.5 m/s, final velocity v = 0, t = 0.5 s

From Newton's second law, of motion, we have

$$F = ma = m\left(\frac{v-u}{t}\right)$$

$$= 0.07 \times \left(\frac{0-0.5}{0.5}\right) = -0.07 \text{ N}$$

(Negative sign shows that force is in opposite direction to motion of ball)

Magnitude of force = 0.07 N

Q.39. A force of 30 N produces an acceleration of 2 m/s^2 in a body of mass m. Find the mass of the body. Also find the acceleration if force is doubled in magnitude along the same direction.

Ans. Force, F = 30 N, Acceleration a = 2 m/s^2

Mass of a body m = $\frac{F}{a} = \frac{30}{2}$ = 15 kg (therefore F = ma)

If f is doubled, a is doubled as F $\propto$ a (m is constant)

So a = 4 m/s^2

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Q.40. Two children stand on wheel-carts facing each other. One student throws a heavy mass towards the other who catches it. What will be the direction? Give reason for your answer.

Ans. The child who throws the mass towards the other, and the one who catches it, both move backwards.

Reason

Thrower moves due to forward reaction of mass pushed and pushed forward.

Catcher moves due to forward reaction of mass pushed and held backward.

Q.41. A car is moving horizontally on a surface along a straight line at constant speed. Is any force acting on it? If not, why is the fuel required to run it?

Ans. The car moves with constant velocity. So on unbalanced force acts on it.

The fuel is used to move the car with a force which balances with the force of friction exerted by the surface.

Q.42. A bullet of mass 20 g is fired from a pistol of mass 2 kg with a horizontal velocity of 150 m/s. Calculate the recoil velocity of the pistol.

Ans. Mass of bullet, m = 0.02 kg

Mass of pistal, M = 2 kg

Velocity of bullet v = 150 m/s

therefore Velocity of pistol, V = - $\frac{mv}{M}$

(- ve sign shows that direction of motion of bullet and pistol are opposite to each other)

From law of conservation of momentum,

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Momentum of pistol = Momentum of bullet

$$MV = - mv$$

Therefore, Velocity of pistol, $V = -\frac{mv}{M}$

$$= \frac{-0.02 \times 150}{2}$$

$$V = - 1.5 \text{ m/s}$$

(in opposite direction to bullet)

Q.43. Name the forces acting on a book placed on a table. Why does the book not move on its own if forces are acting on it?

Ans. The forces acting on the book are

(i) Weight of the book downwards.

(ii) Reaction of the table upwards. $\left(\frac{1}{2} \times 2 = 1\right)$

The book does not move on its own because the forces are balanced forces.

Q.44. For how much time should a force of 200 N acts on an object having mass 5 kg so as to increase its velocity from 50 m/s to 100 m/s?

Ans. Given, Force, F = 200 N, Mass of an object , m = 5 kg, Initial velocity, u = 50 m/s, final velocity, v = 100 m/s

By second law of motion,

$$F = ma = m\left(\frac{v-u}{t}\right)$$

$$200 = 5\left(\frac{100-50}{t}\right)$$

Or $t = 5\left(\frac{100-50}{200}\right)$, t = 1.25 s

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The time taken is 1.25 s.

Q.45. Give two applications of inertia in daily life.

Ans. Applications of inertia in daily life are given below

(i) A carpet is beaten with stick so that dust particles fall down.

(ii) Branches of trees are shaken so that fruits fall down.

Q.46. Why can a small mass such as a bullet kill a person when fired from a gun?

Ans. It is so because even if the mass of the bullet is small, it moves out of the gun with a very high velocity, due to which the momentum produced is high (p = mv). This high momentum of the bullet kills a person.

Q.47. Why does the pillion rider fall forward when brakes are applied?

Ans. During the ride, pillion rider and driver are in a state of motion. But when the driver applies brakes, the body of pillion rider continues moving forward on account on inertia of motion. Therefore, the pillion rider falls forward.

Q.48. A bullet fired against a glass window pane makes a hole in it and the glass pane is not cracked. But on the other hand, when a stone strikes the same glass pane, it gets smashed. Why is it so?

Ans. When the bullet stikes the glass pane, the part of the glass pane which comes in contact with the bullet immediately shares the large velocity of bullet and makes a hole, while the remaining part of the glass remains at restand is therefore not smashed due to inertia of rest.

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But when a slow moving stone strikes the same glass pane, the various parts of the glass pane gets enough time to share the velocity of the stone, and the glass is smashed.

Q.49. When small boy is trying to push a heavy stone, mention various forces acting on the stone.

Ans. The various forces acting on the stone are

(i) The force of reaction exerted by the ground on the stone vertically upwards.

(ii) The gravitational force exerted by the earth which pulls the stone downwards.

(iii) The force of pushing exerted by the boy.

Q.50. Why does a boat tend to leave the shore, when passengers are alighting from it?

Ans. When the passengers alight from the boat, they push the boat in backward direction. As a result, the boat has a tendency to slip back into water. This difficulty is usually overcome by the boatman by trying the boat to some rigid support.

Q.51. There are three solids made up of aluminium, steel and wood, of the same shape and same volume. Which of them would have highest inertia?

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Ans. Steel. As the mass is a measure of inertia, the ball of same shape and size, having more mass than other balls will have highest inertia. Since steel has greater density and greatest mass, therefore, it has highest inertia.

Q.52. Describe our walking in terms of Newton's third law of motion.

Ans. When we walk on the ground or road, our foot pushes the ground backward(action) and the ground pushes our foot forward (reaction). Thus, the forward reaction exerted by the ground on our foot makes us walk forward.

Q.53. Give few examples of Newton's third law of motion.

Ans. (i) Jet aeroplanes and rockets work on the principle of third law of motion. In this case, the hot gases come out of a nozzle with great forces, i.e., action and the rocket moves with high speed upwards as a reaction as shown in figure A.

(ii If we fill a balloon with air and hold it with its mouth downwards, then when release the balloon, the air rushes out vertically downwards(action).

Q.54. Two friends on roller-skates are standing 5 m apart facing each other. One of them throws a ball of 2 kg towards the other, who catches it? How will this activity affect the position of the two? Explain your answer.

Ans. Separation between them will increase. Initially the momentum of both of them are zero as they are at rest. In order to conserve the momentum the one who throws the ball would move backward.

The second will experience a net force after catching the ball and therefore will move backwards that is in the direction of the force.

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Q.55.Two balls of the same size but of different materials, rubber and iron, are kept on the smooth floor of a moving train. The brakes are applied suddenly to stop the train. Will the balls start rolling? If so, in which direction? Will they move with the same speed? Give reasons for your answer.

Ans. When the train is stopped suddenly, then it comes in the state of rest but the balls remain in the state of motion. So, due to inertia of motion, the balls move in the forwarded direction.

As the balls are of the same size but of different materials that means their mass will be different. So, both the balls will move with different speeds.

Q.56. Two identical bullets are fired one by one by one by a light rifle and another by a heavy rifle with the same force, which rifle will hurt the shoulder more and why?

Ans. As both the bullets are identical and are fired with the same force. So, according to Newtons's third law of motion, same force will be applied on both the rifles. With the application of same force, the light rifle will move more quickly in the forward direction, so it will hurt more to the shoulder.

Q.57. A horse continues to apply a force in order to move the cart with a constant speed. Explain why?

Ans. The cart will move with a constant speed if there is no external force applied on it. When a horse applies a force on the cart, frictional force acting between the wheels of the cart and the road apposes the motion of the cart. The cart will

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move with the constant speed only when the force applied by horse is equal to the force of friction.

Q.58. Suppose a ball of mass m is thrown vertically upward with an initial speed v, its speed decreases continuously till it becomes zero. Thereafter, the ball begins to fall downward and attain the speed v again before striking the ground. It implies that the magnitude of initial and final momentums of the ball are same. Yet, it is not an example of conservation of momentum. Explain why?

Ans. Momentum of a system remains conserved if no external forces acts on the system. In the given example, there is gravitational force acting on the ball, so it is not an example of conservation of momentum.

Q.59. Two hockey players of opposite teams while trying to hit a hockey ball on the ground, collide and immediately get entangled. One has a mass of 60 kg and was moving with a velocity of 5 m/s.

The other has a mass of 55 kg and was moving with a velocity of 6 m/s, towards the first player. In which direction and with what velocity will they move after they become entangled?

Assume that the frictional force acting between the feet of two players and ground is negligible.

Ans. Mass of I player, m_1 = 60 kg

Velocity of I player, u_1 = 5 m/s

Mass of II player, m_2 = 55 kg

Velocity of II player, u_2 = -6 m/s

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(as direction of motion is opposite)

On getting entangled, final mass

$$M = 60 + 55 = 115 \text{ kg}$$

Final velocity, v = ?

As no external force is acting on the system, so form conservation of momentum

$m_1u_1 + m_2u_2 = Mv$

$$(60)(5) + (55)(-6) = 115\ v$$

$$300 - 300 = 115\ v$$

or $$v = \frac{-30}{115} = \frac{6}{23} \text{ m/s}$$

the engangled mass moves at $\frac{6}{23}$ m/s towards the first player.

Q.60. Give reasons for the following.

(i) Horse continues to apply force in order to move cart with constant speed.

(ii) Water sprinkler used for grass lawns begins to rotate as soon as water is supplied.

(iii) Water drops are removed from wet clothes by giving tight jerk to the Cloth.

Ans. (i) The frictional force acts on carts wheel in opposite direction to motion of the cart.

(ii) When water is pushed out of sprinkler with a force, it exerts reaction

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force on the sprinkler, causing it to rotate.

(iii) Water drops have inertia of rest. They do not move with the cloth as it is jerked and come out.

Q.61. Two friends on roller skates are standing 5 m apart facing each other. One of them throws a ball of 2 kg towards the other, who catches it. How will this effect the position of the two? Explain.

Ans. Total initial momentum of the two friends is zero as both are at rest. When one person throws the ball towards the other and the other catches it, then the total linear momentum of both will have to be zero as no external force acts on them.

Thus, both friends must move in opposite direction. Hence, the distance between both friends will increase.

Q.62. A boy pulls a table along the floor of a room.

(i) Name the forces acting on the table.

(ii) Which of these forces perform positive work?

(iii Which of these forces perform negative work?

Ans. (i) Forces exerted by boy, weight of table, reaction due to ground, friction against the pull.

(ii Force exerted by the boy performs positive work.

(iii Frictional force perform negative work.

Q.63. Two friends were playing 'catch the ball' in a park. A was able to catch the ball comfortably without hurting himself, while 'B' was hurt everytime he

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caught a ball. Finally B asked A how he could catch the ball with ease. A explained the phenomena to B. B thanked him.

(i) Why was A not hurt while catching the ball?

(ii) Compare and contrast the values of A and B.

Ans. (i) A would lower his hands while catching the ball. This increased time of momentum change and ball exerted less force on hands of A.

(ii) B is inquisitive, accommodating and a keen observer. A is scientifically tempered, logical and has applicative mind.

Q.65. William was having a gun-shoot session in a training camp. As soon as he shot a bullet, he fell backwards. Sanat started making fun of him. William stood up and explained the cause of this effect and told him not to laugh without understanding the scientific cause behing it.

(i) What explanation did William give to Sanat?

(ii) Compare and contrast the values of William and Sanat?

(iii) If you were in place of Sanat, how would you reach to such a situation?

Ans. (i) He fell down due to recoil force of gun.

(ii) William is logical and scientific, while Sanat needs to work on his basic ethics and listen to the facts behind this phenomena.

(iii) I would help William to stand up and check whether he needed medical help.

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