Important Questions for Class 11 Physics Chapter 4: Chapter 4, "Laws of Motion," in Class 11 Physics, focusses on the basic ideas that explain object motion. It presents Newton's three laws of motion: the first, known as inertia, which states that unless an outside force acts upon an object, it will remain at rest or move uniformly; the second, which establishes a relationship between force, mass, and acceleration (F = ma); and the third, which asserts that every action has an equal and opposite reaction.

To provide the groundwork for future mechanical research, the chapter also discusses ideas like friction, circular motion, and the practical applications of these laws.

Important Questions for Class 11 Physics Chapter 4 Overview

Class 11 Physics Chapter 4, "Law of Motion," is crucial as it forms the foundation for understanding mechanics. The key questions in this chapter typically focus on Newton's three laws of motion, their applications in real-life scenarios, concepts like inertia, momentum, and force, as well as the relationship between mass, acceleration, and force. Understanding these principles is vital for solving problems related to motion, such as free-body diagrams and collision analysis.

This chapter's concepts are also essential for higher-level physics and engineering courses, making it a cornerstone in the study of classical mechanics and a key to competitive exams.

Important Questions for Class 11 Physics Chapter 4 Law of Motion

1. What is the unit of coefficient of friction?

Ans: Since, $Coefficientpffriction = FrictionalForce \times [NormalForce]^{-1}$ ......(1)

Also, we know that

$$\mathrm{Force\ (F)} = \mathrm{Mass} \times \mathrm{acceleration} = \mathrm{Mass} \times \mathrm{Velocity} \times [\mathrm{Time}]^{-1}$$

And

$$\mathrm{Velocity} = \mathrm{Displacement} \times [\mathrm{Time}]^{-1}$$

$\therefore$ The dimensions of Force $= [\mathrm{M}] \times [\mathrm{LT}^{-1}] \times [\mathrm{T}]^{-1} = [\mathrm{M}^1\ \mathrm{L}^1\ \mathrm{T}^{-2}]$ ......(2)

On putting the equation (2) in equation (1) we get,

$$\mu = [\mathrm{M}^1\ \mathrm{L}^1\ \mathrm{T}^{-2}] \times [\mathrm{M}^1\ \mathrm{L}^1\ \mathrm{T}^{-2}]^{-1} = [\mathrm{M}^0\ \mathrm{L}^0\ \mathrm{T}^0].$$

Since mass, velocity and time all having zero dimensions. Hence, the coefficient of friction has no units.

2. Name the factor on which coefficient of friction depends?

Ans: The coefficient of friction will mainly depends upon two factor, they are as following:

1. The materials of the surfaces in contact.
2. The characteristics of the surfaces.

3. What provides the centripetal force to a car taking a turn on a level road?

Ans: The frictional contact between the tyres and the road provides centripetal force.

4. Why is it desired to hold a gun tight to one's shoulder when it is being fired?

Ans. The gun must be held gently on the shoulder as it recoils after firing. The back kick will be lessened because the pistol and shoulder are one mass system in this instance. When shooting, a shooter must hold his weapon firmly against his shoulder.

5. Why does a swimmer push the water backwards?

Ans: We know that "when one body exerts a force on the other body, the first body experiences a force equivalent in magnitude in the opposite direction of the force exerted" because of Newton's third law of motion. Consequently, the swimmer uses his hands to push water backward in order to swim ahead.

6. Friction is a self-adjusting force. Justify.

Ans: Friction is a self-adjusting force that changes in magnitude from zero to maximum to limit friction.

7. A thief jumps from the roof of a house with a box of weight WW on his head. What will be the weight of the box as experienced by the thief during jump?

Ans: The thief is in free fall during the jump. Both he/she and the box will be weightless during that time. So, the weight of the box experience by the thief during the jump will be zero.

So, mathematically it can be written as:

Weight of the box, W = m(g - a) = m(g - g) = 0.

8. Which of the following is scalar quantity? Inertia, force and linear momentum.

Ans: Inertia is a measure of a body's resistance to its own acceleration. Mass thus turns into a qualitative measure of inertia. linear inertia is a scalar quantity since mass is a scalar number. The scalar quantity among them will therefore be inertia.

9. Action and reaction forces do not balance each other. Why?

Ans: Action and reaction do not balance one another since a force of action and response always acts on two different bodies.

10. If force is acting on a moving body perpendicular to the direction of motion, then what will be its effect on the speed and direction of the body?

Ans: When a force acts in a perpendicular direction on a moving body, the work done by the force is zero.

Since

$W = F \cdot S \cos\theta$, where $S = 90^\circ$ and $\cos 90^\circ = 0$, therefore $W = 0$.

As a result, the magnitude of the body's velocity (or speed) will remain unchanged. The direction of motion of the body, however, will be altered.

11. The two ends of spring - balance are pulled each by a force of 10kg.wt. What will be the reading of the balance?

Ans:

The spring balancing measures weight because it is dependent on the spring's tension. Now, if a 10 kg weight is pulled on both ends, the tension and reading will both be 10 kg.

12. A lift is accelerated upward. Will the apparent weight of a person inside the lift increase, decrease or remain the same relative to its real weight? If the lift is going with uniform speed, then?

Ans: The perceived weight is going to rise. If the lift travels at a steady pace, the apparent weight will remain the same as the true weight.

13. One end of a string of length l is connected to a particle of mass m and the other to a small peg on a smooth horizontal table. If the particle moves in a circle with speed v the net force on the particle (directed towards the centre) is:

i.

ii. $T - \frac{mv^2}{l}$

iii. $T + \frac{mv^2}{l}$

iv. 0

T **is the tension in the string. (Choose the correct alternative).**

Ans: (i) The tension created in the string provides the centripetal force when a particle attached to a string spins in a circular motion around a centre. As a result, in the given situation, the particle's net force is tension. T, i.e.

$$F = T = \frac{mv^2}{l}$$

Where, F is the net force acting on the particle.

2 Mark Questions

1. Give the magnitude and direction of the net force acting on

(a) A drop of rain falling down with constant speed.

(b) A kite skillfully held stationary in the sky.

Ans:

(a) The raindrop's acceleration will be zero because it is falling at a constant pace. Since a particle's force is determined by, the raindrop's net force will be zero.

(b) Newton's first law of motion states that the algebraic sum of the forces operating on the kite is zero since it is held motionless.

2. Two blocks of masses m1, m2are connected by light spring on a smooth horizontal surface. The two masses are pulled apart and then released. Prove that the ratio of their acceleration is inversely proportional to their masses.

Ans: Due to inertia, the mass of the two bodies tries to expand, and the acceleration will act in the opposite direction as it shrinks.

So let us assume that the F_1 and F_2 be the forces acting in opposite directions due to masses m_1 and m_2.

Thus $F_1 + F_2 = 0$

$m_1 a_1 + m_2 a_2 = 0$

$m_1 a_1 = -m_2 a_2$

$\frac{a_1}{a_2} = -\frac{m_1}{m_2}$

Hence the above is proved.

3. A shell of mass 0.020 kg is fired by a gun of mass 100 kg. If the muzzle speed of the shell is 80ms, what is the recoil speed of the gun?

Ans: From the question, we have the shell having mass 0.020 kg and is fired by a gun having the mass 100 kg. We need to find the recoil speed of the gun, when the muzzle speed is given as 80 ms^{-1}.

Since, the momentum before firing $= 0$

As the momentum after firing = momentum of (bullet + gun).

Therefore, momentum after firing will be $= m_b v_b - m_g v_g$

As per the law of conservation of linear momentum:

$\Rightarrow 0 = m_b v_b - m_g v_g \Rightarrow m_b v_b = m_g v_g \Rightarrow v_g = \frac{m_b v_b}{m_g}$
$\Rightarrow v_g = \frac{m_b v_b}{m_g} \Rightarrow v_g = \frac{0.02 \times 80}{100} \Rightarrow v_g = 0.016 \text{ ms}^{-1}$

4. A force is being applied on a body but it causes no acceleration. What possibilities may be considered to explain the observation?

Ans: (1) If the force is a deforming force, no acceleration is produced.

(2) Internal force is incapable of causing acceleration.

5. Forces of 16N and 12N are acting on a mass of 200kg in mutually perpendicular directions. Find the magnitude of the acceleration produced?

Ans: In the given question, we have the force of $16N$ and $12N$ given and they are acting on a mass of $200kg$ in mutually perpendicular directions. We need to find the magnitude of the acceleration produced.

$$F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2 \cos\theta}$$

Since, the forces are in mutually perpendicular directions. Therefore, $\theta = 90^\circ$. Hence, the force will become:

$$F = \sqrt{F_1^2 + F_2^2}$$

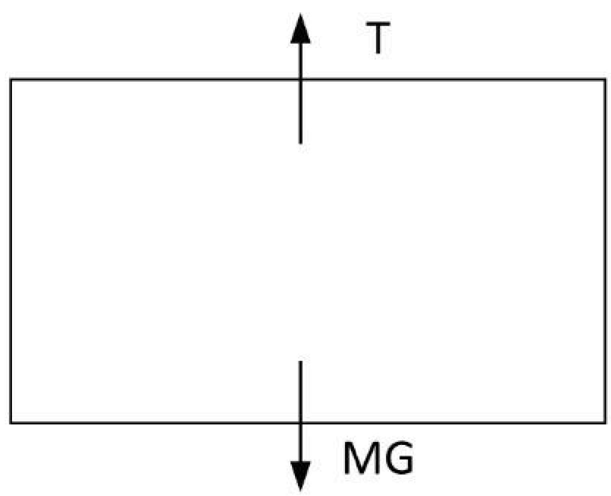
Now substituting the values, we get

$$\mathrm{F} = \left(\sqrt{16)^2 + (12)^2}\right) = 20\mathrm{N}$$

Hence, the magnitude of the acceleration will be:

$$a = \frac{F}{m} a = \frac{20}{200} a = 0.1\mathrm{ms}^{-2}$$

6. An elevator weighs 3000 kg. What is its acceleration when the tension supporting cable is 33000 N. Given that $g = 9.8m^{-2}$.



Ans: From the question, we have an elevator having the weighs given as 3000 kg. We need to find the acceleration, if the tension in the supporting cable is given as 33000 N.

Net upward force on the Elevator F is equal to $= T\ mg\ because\ F = ma$

$\Rightarrow ma = T - mg$

$\Rightarrow T = m(a + g)$

$\Rightarrow T = 33000\ \mathrm{N} = 3000(a + 9.8)$

$$a = \frac{33000 - 3000 \times 9.8}{3000} = 1.2\ \mathrm{ms}^{-2}$$

3 Mark Questions

1. A train runs along an unbanked circular bend of radius $30\ \mathrm{m}$ at a speed of $54\ \mathrm{kmhr}^{-1}$. The mass of the train is $106\ \mathrm{kg}$. What provides the necessary centripetal force required for this purpose? The engine or the rails? What is the angle of banking required to prevent wearing out of the rail?

Ans: From the question, we have the radius of circular bend given as, $r = 30\ \mathrm{m}$

$$\text{Speed of train } = v = 54\mathrm{kmh}^{-1} = 54 \times \frac{5}{18} = 15\ \mathrm{ms}^{-1}$$

Mass of train given as, $m = 10^6\ \mathrm{kg}$

Then we need to find the angle of banking θ.

(1) The centripetal force is generated by the lateral force exerted by rails on the train's wheels.

(2) The centripetal force is provided by the lateral thrust by the outer rail.

(3) According to Newton's third law of motion, the train exerts (i.e., causes) an equal and opposite thrust on the outer rail causing its wear and tear.

Therefore, the angle of baking:

$$\tan\theta = \frac{v^2}{rg} = \frac{(15)^2}{30 \times 9.8}$$

$\theta = 37.4$

2. A block of mass $15\ \mathrm{kg}$ is placed on a long trolley. The coefficient of static friction between the block and the trolley is 0.18. The trolley accelerates from rest with $0.5\ \mathrm{ms}^{-2}$ for $20\ \mathrm{s}$ and then moves with uniform velocity. Discuss the motion of the block as viewed by (a) a stationary observer on the ground, (b) an observer moving with the trolley.

Ans:

(a) Mass of the block is given as, $m = 15\ \mathrm{kg}$

Coefficient of static friction is given as, $\mu = 0.18$

Acceleration of the trolley is given as, $a = 0.5\ \mathrm{ms}^{-2}$

According to Newton's second law of motion, the force F exerted on the block by the trolley's motion is given by the relationship:

$\Rightarrow F = ma = 15 \times 0.5 = 7.5\ \mathrm{N}$

This force is applied in the trolley's forward motion.

The block and the trolley have a static friction force of:

$\Rightarrow f = \mu m g$

$\Rightarrow f = 0.18 \times 15 \times 10 = 27\ \mathrm{N}$

The static friction force between the block and the tram is less than the applied external force. A ground observer will therefore perceive the block as being at rest.

The tram will travel at a steady speed without any external force being exerted. Friction is the only force affecting the block in this instance.

(b) A spectator feels some acceleration as they go with the tram. This circumstance has a non-inertial frame of reference. The frictional force pulling the tram backward is opposed by a fake force of equal magnitude. In contrast, this force acts in the opposing direction. The tram will appear to be at rest to the observer moving with it.

3. What is the acceleration of the blocks? What is the net force on the block P? What force does P apply on Q. What force does Q apply on R ? (Given: $\tan\theta = 0.7653$)

Ans: If a is the acceleration

Then $\mathrm{F} = (3\ \mathrm{m})\mathrm{a}$

$a = F/3m$

(1) Net force on P

$$F_1 = ma = m \times \frac{F}{3m}$$

$$F_1 = F/3$$

(2) Force applied on Q

$$\mathrm{F}_2 = (\mathrm{m} + \mathrm{m})\mathrm{a}$$

$$F_2 = 2m \times a$$
$$= 2m \times \frac{F}{3m}$$

$$F_2 = \frac{2F}{3}$$

4. How is centripetal force provided in case of the following?

(i) Motion of planet around the sun,

(ii) Motion of moon around the earth.

(iii) Motion of an electron around the nucleus in an atom.

Ans:

(i) The centripetal force is provided by the gravitational force acting on the earth and the sun.

(ii) Centripetal force is provided by the earth's gravitational attraction on the moon.

(iii) The centripetal force is provided by the electrostatic attraction between the electron and the proton.

Benefits of Using Important Questions for Class 11 Physics Chapter 4

Using important questions for Class 11 Physics Chapter 4, "Laws of Motion," offers several benefits, especially for students preparing for exams and enhancing their understanding of the concepts. Here are the key advantages:

Concept Clarity:
Important questions are often curated to focus on the core concepts and principles of the chapter, helping students gain a deeper understanding of topics like Newton's Laws, free-body diagrams, and friction.

Exam-Focused Preparation:
These questions are typically aligned with exam patterns, including frequently asked and high-weightage questions. This ensures students are well-prepared for tests and competitive exams.

Application-Oriented Learning:
The questions emphasize applying theoretical knowledge to solve practical problems, which enhances problem-solving skills and analytical thinking.

Time Management:
Practicing important questions helps students gauge the time required to solve problems during exams, allowing them to improve their speed and efficiency.

Better Retention:
Revisiting these questions frequently reinforces key concepts, making it easier for students to recall and apply them in exams.

Variety of Problems:
Important questions often include a mix of conceptual, numerical, and application-based problems, ensuring comprehensive coverage of the chapter.