RADIANT 2026

Physics

Laws of Motion

Lecture - 05

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Topics *to be covered*

1. Newton's Third Law of Motion
2. Questions
3) Numerical Practice

Recap *of previous lecture*

1. Linear Momentum ($p = mv$)
2. Newton's Second Law of Motion
3. Newton's Third Law of Motion

F = ?

A → ma

B → m/a

C → a/m

D → m/ma

Question

Force is a ____________ quantity.

(A) scalar

(B) vector

(C) directionless

(D) none of these

Question

Force is a ____________ quantity.

(A) scalar

(B) vector

(C) directionless

(D) none of these

Ans. (B) vector

Reason- Force is a vector quantity as it has magnitude as well as direction.

Question

The property of an object by virtue of which it tends to retain its state of rest or of motion is called

(A) friction

(B) inertia

(C) force

(D) mass

Rest ⟶ Rest

motion ⟶ motion

Question

The property of an object by virtue of which it tends to retain its state of rest or of motion is called

(A) friction

(B) inertia

(C) force

(D) mass

Ans. (N) inertia

Reason- If the object is in the state of rest, it will remain in the state of rest and if it is moving in some direction, it will continue to move with the same speed in the same direction unless an external force is applied on it. This property is called inertia.

Question

In inertia of motion, the body continues to be in a state of motion with ________ speed in ________ direction unless an external force is applied.

(A) variable, zigzag

(B) same, same

(C) same, variable

(D) variable, same

Question

In inertia of motion, the body continues to be in a state of motion with ________ speed in ________ direction unless an external force is applied.

(A) variable, zigzag

(B) same, same

(C) same, variable

(D) variable, same

Ans. (B) same, same

Reason- According to inertia of motion, a body in a state of motion, continues to be in the state of motion with the same speed in the same direction in a straight line unless an external force is applied on it to change its state.

Question

State Newton's first law of motion.

law of Inertia

Rest → Rest

Motion → Motion

Question

State Newton's first law of motion.

Solution:

According to Newton's first law of motion, if a body is in a state of rest, it will remain in the state of rest and if it is in the state of motion, it will remain moving in the same direction with the same speed unless an external force is applied on it.

Question

Give qualitative definition of force on the basis of Newton's first law of motion.

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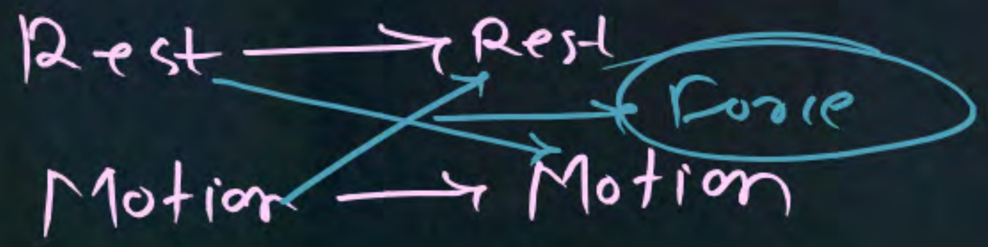

Solution:

The qualitative definition of force on the basis of Newton's first law of motion is-

Force is that external cause which tends to change the state of rest or the state of motion of an object.

Example- A book lying on a table gets displaced from it's place when it is pushed.

Question

Give one example of each of the following-
(a) Inertia of rest, and (b) inertia of motion.

Question

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(a) Inertia of rest, and (b) inertia of motion.

Solution:

(a) **Example of inertia of rest-** When a train suddenly starts moving forward, the passenger standing in the compartment tends to fall backwards. The reason is that the lower part of the passenger's body is in close contact with the train. As the train starts moving, the person's lower part shares the motion at once. However, the upper part, due to the inertia of rest cannot share the motion simultaneously and so it tends to remain at the same place. Hence, the lower part of the body moves ahead and the upper part is left behind, so the passenger tends to fall backwards.

(b) **Example of inertia of motion-** A cyclist riding along a level road does not come to rest immediately after he stops pedalling. The reason is that the bicycle continues to move due to inertia of motion even after the cyclist stops applying the force on the pedal.

Question

Linear momentum is a:

(A) scalar quantity

(B) vector quantity

(C) directionless quantity

(D) none of these

P = m × v

Question

Linear momentum is a:

(A) scalar quantity

(B) vector quantity

(C) directionless quantity

(D) none of these

Ans. **(B)** vector quantity

Reason- Linear momentum is a vector quantity in the direction of the motion of the body (i.e., along the velocity of the body).

Question

Newton's first law of motion defines force:

(A) quantitatively

(B) qualitatively

(C) both (A) and (B)

(D) none of these

Question

Newton's first law of motion defines force:

(A) quantitatively

(B) qualitatively

(C) both (A) and (B)

(D) none of these

Ans. **(B)** qualitatively

Newton's first law of motion defines force only qualitatively.

Question

The correct form of Newton's second law is:

(A) $F = \frac{\Delta p}{\Delta t}$

(B) $F = m\frac{\Delta v}{\Delta t}$

(C) $F = v\frac{\Delta m}{\Delta t}$

(D) $F = mv$

Question

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(A) $F = \frac{\Delta p}{\Delta t}$

(B) $F = m\frac{\Delta v}{\Delta t}$

(C) $F = v\frac{\Delta m}{\Delta t}$

(D) $F = mv$

Ans. (A) $F = \frac{\Delta p}{\Delta t}$

Question

The force required to produce an acceleration of $5\ ms^{-2}$ in a body of mass 2 kg is:

(A) 2.5 N

(B) 20 N

(C) 10 N

(D) 25 N

Given

$a = 5\ m/s^2$

$m = 2\ kg$

$F = m \times a$

$= 5 \times 2$

$F = 10\ N$

Question

The force required to produce an acceleration of $5\ ms^{-2}$ in a body of mass 2 kg is:

(A) 2.5 N

(B) 20 N

(C) 10 N

(D) 25 N

Ans. (C) 10 N

Reason- Given, $a = 5\ ms^{-2}$ and $m = 2$ kg, Using, $F = ma$

we get, $F = 5 \times 2 = 10$ N, Hence, force required = 10 N

Question

According to Newton's second law of motion, the change in momentum takes place in a direction:

(A) opposite to the direction of force applied

(B) perpendicular to the direction of the force applied

(C) similar to the direction of the force applied

(D) none of these

Question

A body of 10 kg is moving at a velocity of 100m/s. A force starts acting on it and the velocity becomes 20m/s in a time of 10 seconds. Find the force applied to the body.

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given
$m = 10\ kg$
$u = 100\ m/s$ $v = 20\ m/s$
$t = 10\ sec$

$F = ma$

Solution:

Given,

$m = 10\text{Kg}$

$v_i = 100\ \text{m/s}$

$v_f = 20\ \text{m/s}$

$t = 10\text{s}$

Force is defined as the rate of change of momentum

$F = m(v_f - v_i)/t$

$F = (10)(80 - 20) / (10)$

$F = 80\text{N}$

$a = \frac{v-u}{t}$

$a = \frac{20-100}{10}$

$= \frac{-80}{10}$

$a = -8\ m/s^2$

$F = ma$

$= 10 \times -8$

$F = -80N$

Question

A force produces an acceleration of 16 m/s^2 in a body of mass 0.5 kg and an acceleration of 4.0 m/s^2 in another body. If both the bodies are fastened together then how much acceleration will be produced by this force?

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Solution:

$a_1 = 16\ m/s^2$

$m_1 = 0.5$ kg

force = $F = m_1 a_1 = 16 \times 0.5 = 8N$

same force is applied to the second mass; m_2

$F = m_2 a_2 = 8$ N or $m_2 = 8/a^2$

total mass = $m_1 + m_2 = 0.5 + 2 = 2.5$ kg

force is same as before

So, $a = F/M \Rightarrow 8/2.5 \Rightarrow 3.2\ m/s^2$

$\Rightarrow$ So an acceleration of 3.2 m/s^2 will be produced b this force.

Question

On a smooth table are placed two blocks in contact (i) A horizontal force of 5.0 N is applied on the 20 kg block as shown. State by what force this block presses the 10 kg block. (ii) If the above force is applied on the other side of the 10 kg block then by 5.0 N what force the 20 kg block will press the 10 kg block?

Question

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Solution:

Total mass 20 + 10 = 30 kg

Total force 5 = N

$F = ma$

$a = 5/30 = 1/6\ m/s^2$

(i) $F = ma \Rightarrow (10 \times 1/6) = 10/6N.$

(ii) $F = ma \Rightarrow (20 \times 1/6) = 20/6N.$

Question

Draw graphs to show the dependence of (i) acceleration on force for a constant mass, and (ii) force on mass for a constant acceleration.

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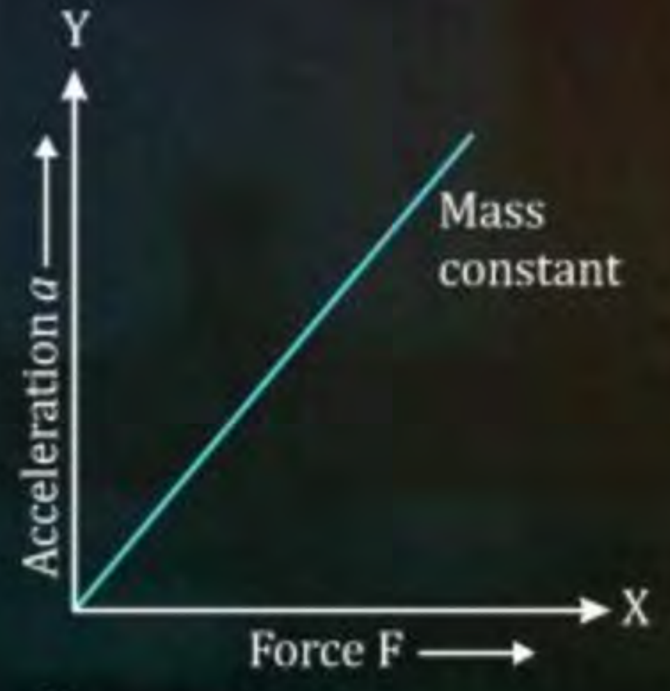
Solution:

(i) The acceleration produced in a body of given mass is directly proportional to the force applied on it.

i.e., $a \propto F$ (if mass remains constant)

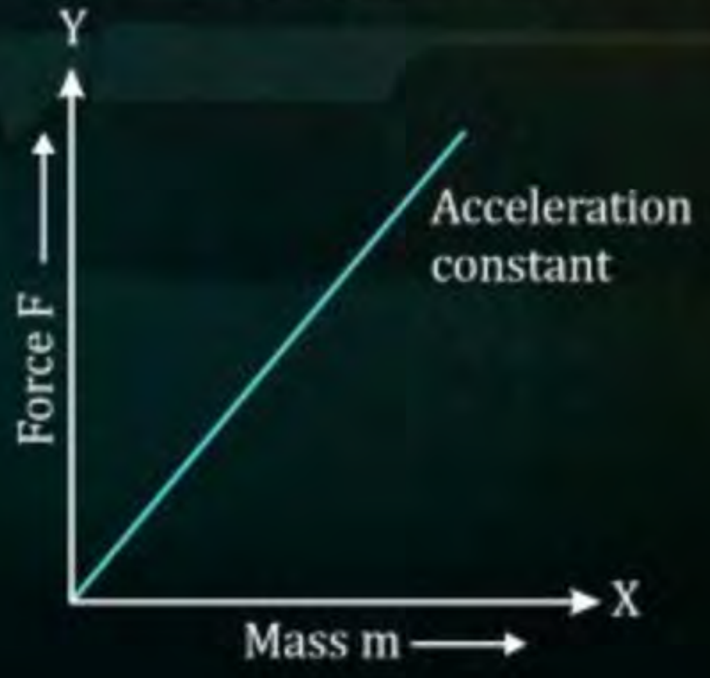
The graph plotted for acceleration on force for a constant mass is as shown below-



(ii) The force needed to produce a given acceleration in a body is proportional to the mass of the body.

i.e., $F \propto m$ (if acceleration remains the same)

The graph plotted for force on mass for a constant acceleration is shown below



Question

The linear momentum of a ball of mass 50 g is 0.5 kg ms^{-1}. Find it's velocity.

$m = 50\,gm$

$p = 0.5\,kg\,\frac{m}{s}$

$v = ?$

$m = \frac{50}{1000} = 5 \times 10^{-2}$

$P = m \times v$

$0.5 = 5 \times 10^{-2} \times v$

$\frac{0.5}{5 \times 10^{-2} \times 10} = v$

$v = 10\,m/s$

Question

The linear momentum of a ball of mass 50 g is 0.5 kg ms^{-1}. Find it's velocity.

Solution:

As we know,

linear momentum (p) = mass (m) × velocity (v)

Given,

$p = 0.5$ kg ms^{-1}

$m = 50\ g$

Converting g to kg,

1000 g = 1 kg

$50\ g = \left(\frac{1}{1000}\right) \times 50$

$\Rightarrow 50\ g = 0.05\ kg$

Hence, $m = 0.05kg$

Substituting the values in the formula above we get,

$0.5 = 0.05 \times v$

$\Rightarrow v = \frac{0.5}{0.05}$

$\Rightarrow v = \frac{0.1}{0.01}$

$\Rightarrow v = 10\ ms^{-1}$

Hence, velocity = 10 ms^{-1}

Question

A car of mass 1000 kg is moving with a velocity and is acted upon by a forward force of 1000 N due to engine and retarding force of 500 N due to friction. What will be its velocity after 10 seconds?

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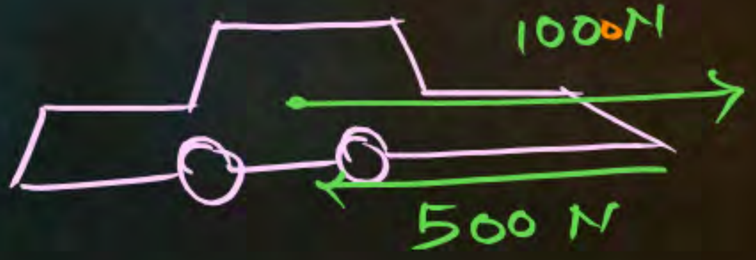

Solution:

Here $m = 1000$ kg $u = 10$ ms^{-1}, $u = ?$

Net forward force,

F = Forward force – Retarding force

$= 1000 - 500 = 500$ N

Acceleration,

$$a = \frac{F}{m} = \frac{500}{1000} = \frac{1}{2}\text{ms}^{-2}$$

$$\therefore v = u + at = 10 + \frac{1}{2} \times 10 = 15 \text{ ms}^{-1}$$

Question

A bullet of mass 0.04 kg moving with a speed of 90 ms^{-1} enters a heavy wooden block and is stopped after a distance of 60 cm. What is the average resistive force exerted by the block on the bullet ? [NCERT; Central Schools 14]

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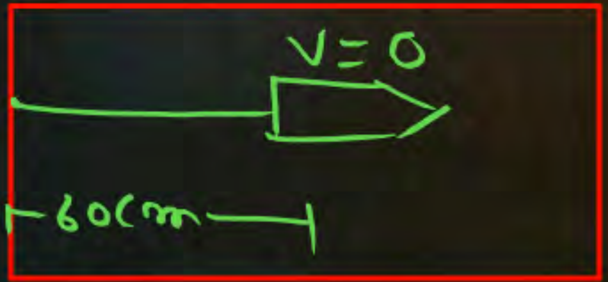

Solution:

Here $m = 0.04$ kg, $u = 90$ ms^{-1},

$v = 0$, $s = 60$ cm $= 0.60$ m

As $v^2 - u^2 = 2as$

$\therefore 0 - (90)^2 = 2a \times 0.60$ or $a = -6750$ ms^{-2}

i.e. Retardation = 6750 ms^{-2}

$\therefore$ Retarding force = Mass × retardation

$= 0.04 \times 6750 = 270$ N.

Question

A force acts for 10 s on a body of mass 10 kg after which the force ceases and the body describes 50 m in the next 5 s. Find the magnitude of the force.

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$t = 10\,sec$ $\quad m = 10\,kg$ $\quad s = 50\,m$

$F = ma$

$F = 10 \times 1$

$F = 10\,N$

$V = \frac{s}{t}$

$V = \frac{50}{5}$

$V = 10\,m/s$

$v = u + at$

$10 = 0 + a \times 10$

$10 = a \times 10$

$\frac{10}{10} = a$

$a = 1\,m/s^2$

Solution:

After the force ceases, the body covers 50 m in 5 s, so final velocity of the body is

$$v = \frac{\text{Distance}}{\text{Time}} = \frac{50\text{ m}}{5\text{ s}} = 10\text{ ms}^{-1}$$

But $\quad v = u + at$

$\therefore \quad 10 = 0 + a \times 10$ or $a = 1\text{ ms}^{-2}$

$\therefore \quad F = ma = 10\text{ kg} \times 1\text{ ms}^{-2} = 10\text{ N}$

Question

A truck starts from rest and rolls down a hill with constant acceleration. It travels a distance of 400 m in 20 s. Calculate the acceleration and the force acting on it if its mass is 7 metric tonnes.

$u = 0 \quad s = 400\,m \quad t = 20\,s \qquad m = 7000\,kg$

$S = ut + \frac{1}{2}at^2$

$400 = 0 \times 20 + \frac{1}{2} \times a \times 20 \times 20$

$400 = 10 \times 20 \times a$

$a = 2\,m/s^2$

$F = ma$

$= 7000 \times 2$

$F = 14000\,N$

Question

A truck starts from rest and rolls down a hill with constant acceleration. It travels a distance of 400 m in 20 s. Calculate the acceleration and the force acting on it if its mass is 7 metric tonnes.

Solution:

As $s = ut + \frac{1}{2}at^2$

$\therefore$ $400 = 0 + \frac{1}{2}a(20)^2$

or $a = 2\ ms^{-2}$

and $F = ma = 7000 \times 2 = 14{,}000$ N.

Question

The non-contact force is

(A) force of reaction

(B) force due to gravity

(C) tension in string

(D) force of the friction

Question

The non-contact force is

(A) force of reaction

(B) force due to gravity

(C) tension in string

(D) force of the friction

Ans. **(B)** force due to gravity

Reason-The forces experienced by bodies even without being physically in touch, are called non-contact forces. Hence, out of the given options, force due to gravity is a non-contact force.

Question

A ball placed on a table starts rolling down when the table is tilted. This is an example of:

(A) contact force

(B) non-contact force

(C) both (A) and (B)

(D) none of these

Question

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(D) none of these

Ans. **(B)** non-contact force

Reason- The force on a body due to earth's attraction is called the force of gravity or the weight of the body and it is a non-contact force.

Question

When a comb is rubbed on dry hair, it gets charged. This is an example of:

(A) Gravitational force

(B) normal reaction force

(C) magnetic force

(D) electrostatic force

Question

When a comb is rubbed on dry hair, it gets charged. This is an example of:

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(D) electrostatic force

Ans. **(D)** electrostatic force

Question

Give one example in each of the following cases where a force

(a) stops a moving body.

(b) moves a stationary body.

(c) changes the size of a body.

(d) changes the shape of a body.

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Solution:

(a) **Stops a moving body-** A fielder on the ground stops a moving ball by applying force with his hands.

(b) **Moves a stationary body-** A ball lying on the ground moves when it is kicked.

(c) **Changes the size of a body-** By loading a spring hanging from a rigid support, the length of the spring increases.

(d) **Changes the shape of a body-** On pressing a piece of rubber, it's shape changes.

Question

The force needed to stop a moving body in a definite time depends on:

(A) mass of the body

(B) velocity of the body

(C) both (A) and (B)

(D) none of these

Question

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(A) mass of the body

(B) velocity of the body

(C) both (A) and (B)

(D) none of these

Ans. **(C)** both (A) and (B)

Reason- The force needed to stop a moving body in a definite time depends on the product of mass and velocity, which is called linear momentum of the moving body. Thus, $p = mv$.

Question

Linear momentum is a:

(A) scalar quantity

(B) vector quantity

(C) directionless quantity

(D) none of these

Question

Linear momentum is a:

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(D) none of these

Ans. **(B)** vector quantity

Reason- Linear momentum is a vector quantity in the direction of the motion of the body (i.e., along the velocity of the body).

Question

1 Newton is equal to:

(A) 10^3 dyne

(B) 10^8 dyne

(C) 10^{10} dyne

(D) 10^5 dyne

Thank you