Laws of Motion

Question1

A ball is dropped on the floor from a height of 20 m . It rebounds to a height of 5 m . Ball remains in contact with floor for 1 s . The average acceleration during contact is (acceleration due to gravity $= 10 \mathrm{~m/s^2}$)

MHT CET 2025 5th May Evening Shift

Options:

A.

$30 \mathrm{~m/s^2}$

B.

$20 \mathrm{~m/s^2}$

C.

$40 \mathrm{~m/s^2}$

D.

$35 \mathrm{~m/s^2}$

Answer: A

Solution:

Velocity just before hitting the ground is

$v_1 = \sqrt{2gh_1} = \sqrt{2 \times 10 \times 20} = 20 \mathrm{~m/s}$

Velocity just after hitting the ground is

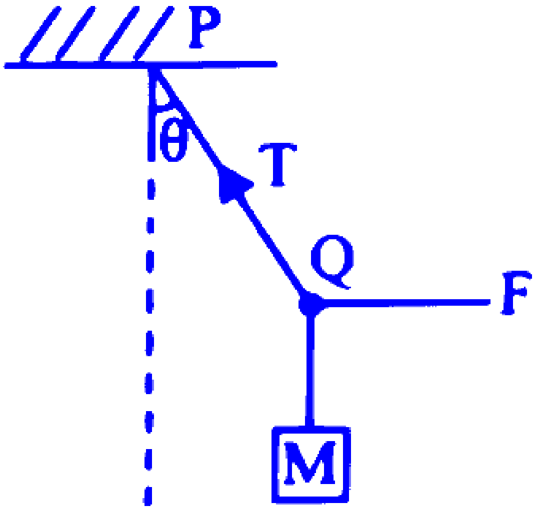
$v_2 = \sqrt{2gh_2} = \sqrt{2 \times 10 \times 5} = 10 \mathrm{~m/s}$

After hitting the ground ball goes in opposite direction, $\therefore$ v_2 will be $-10\ \mathrm{m/s}$

$a_{av}=\frac{\Delta v}{\Delta t}=\frac{20-(-10)}{1}=30\ \mathrm{m/s^2}$

Question2

A mass ' M ' is suspended by a rope from a rigid support at point ' P ' as shown in figure. Another rope is tied at end ' Q ' and pulled horizontally with a force ' F '. If the rope makes an angle ' θ ' with vertical then the tension in the string ' PQ ' is



MHT CET 2025 26th April Evening Shift

Options:

A. $F \sin \theta$

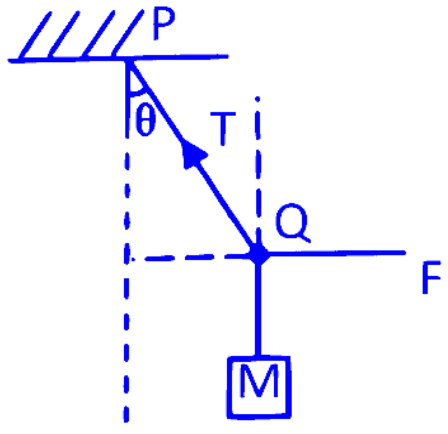
B. $\frac{F}{\sin \theta}$

C. $F \cos \theta$

D. $\frac{F}{\cos \theta}$

Answer: B

Solution:



Since the system is in equilibrium, the forces balance each other in both the horizontal and vertical direction.

Taking the horizontal component, we have:

$T \sin \theta = F \Rightarrow T = \frac{F}{\sin \theta}$

Question3

A machine gun fires a bullet of mass 35 gram with a speed of $600 \mathrm{~m/s}$. The person holding the gun can extract a maximum force of 147 N on it. The number of bullets that can be fired from the gun per second is

MHT CET 2025 25th April Morning Shift

Options:

A. 3

B. 5

C. 7

D. 9

Answer: C

Solution:

1. Given data:

- Mass of bullet, $m = 35\,\text{g} = 0.035\,\text{kg}$
- Speed of bullet, $v = 600\,\text{m/s}$
- Maximum force person can apply (i.e. average resisting force), $F = 147\,\text{N}$

We want: number of bullets per second, i.e. rate of fire n.

2. Momentum per bullet:

Impulse per bullet = change in momentum of one bullet =

$\Delta p = mv = 0.035 \times 600 = 21\,\text{kg·m/s}$.

3. Time rate of momentum (Force):

When n bullets are fired per second, the rate of momentum imparted per second is $n \times 21$.

This equals the average force:

$F = n\Delta p$

So,

$147 = n \times 21$

$n = \frac{147}{21} = 7$.

Answer:

$\boxed{7}$

So the correct option is **C (7)**.

Question4

The weight of man in a stationary lift is w_1 and when it is moving downwards with uniform acceleration ' a ' is w_2. If the ratio $\mathrm{w}_1 : \mathrm{w}_2 = 4 : 3$, then the value of ' a ' is ($\mathrm{g} =$ acceleration due to gravity)

MHT CET 2025 23rd April Morning Shift

Options:

A. $\frac{g}{3}$

B. $\frac{g}{4}$

C. $\frac{3}{4}$ g

D. $\frac{4}{g}$

Answer: B

Solution:

Weight of a man when the lift is stationary, $W_1 = mg$.

Weight when the lift is going down,

$$W_2 = m(g - a)$$

$$\therefore \quad \frac{W_1}{W_2} = \frac{mg}{m(g-a)} = \frac{4}{3} \quad \text{....(Given)}$$

$$\therefore \quad \frac{g}{g-a} = \frac{4}{3}$$

$$\therefore \quad 3g = 4g - 4a$$

$$\therefore \quad g = 4a \Rightarrow a = \frac{g}{4}$$

Question5

A constant force acts on two different masses independently and produces accelerations A_1 and A_2. When the same force acts on their combined mass, the acceleration produced is

MHT CET 2025 22nd April Evening Shift

Options:

A. $A_1 - A_2$

B. $A_1 + A_2$

C. $\frac{A_1 A_2}{A_1+A_2}$

D. $\sqrt{A_1^2+A_2^2}$

Answer: C

Solution:

From Newton's second Law

$\mathrm{F}=\mathrm{ma} \Rightarrow \mathrm{a}=\frac{\mathrm{F}}{\mathrm{m}}$

Acceleration A_1 in mass m_1,

$A_1=\frac{F}{m_1} \Rightarrow m_1=\frac{F}{A_1}$

Acceleration A_2 in mass m_2,

$A_2=\frac{F}{m_2} \Rightarrow m_2=\frac{F}{A_2}$

Acceleration ' a ' of combined Mass.

$\therefore \quad a=\frac{F}{m_1+m_2}=\frac{F}{\frac{F}{A_1}+\frac{F}{A_2}}=\frac{1}{\frac{1}{A_1}+\frac{1}{A_2}}=\frac{A_1 A_2}{A_1+A_2}$

Question6

A conveyor belt is moving with constant velocity (V). Sand is being dropped on the belt at the rate of $\mathrm{M} \mathrm{kg} / \mathrm{s}$. The force necessary to keep the belt moving with a constant velocity $\mathrm{V} \mathrm{m} / \mathrm{s}$ will be

MHT CET 2025 21st April Evening Shift

Options:

A. $\frac{M V}{2}$ N

B. 2 MV N

C. Zero N

D. MV N

Answer: D

Solution:

We need to find the force needed to keep the conveyor belt moving at the same speed when sand is dropped on it.

Newton's second law says that force is the change in momentum per second:

$F=\frac{d\vec{p}}{dt}$

Here, momentum ($\vec{p}$) is mass (m) times velocity ($\vec{v}$):

$F=\frac{d(m\vec{v})}{dt}$

The velocity of the belt is constant (V), and sand is added at a rate of M kg/s, so:

$F=\frac{dm}{dt}\times V$

Since $\frac{dm}{dt}=M$, we get:

$F=MV$

Question7

A child stands on a weighing machine inside a lift. When the lift is going down with acceleration $\mathrm{g}/3$, the machine shows a reading 20 N . When the lift goes upwards with acceleration $\mathrm{g}/3$, the reading would be ($\mathrm{g}=$ gravitational acceleration)

MHT CET 2025 21st April Morning Shift

Options:

A. 40 N

B. 30 N

C. 20 N

D. 50 N

Answer: A

Solution:

Given:

- The reading of the weighing machine (apparent weight) inside the lift going down with acceleration $\frac{g}{3}$ is **20 N**.
- We need to find the reading when the lift is going **up** with acceleration $\frac{g}{3}$.

Let actual weight of the child$= mg$.

Step 1: Find the true weight using the "down" scenario

When the lift is **going down** with acceleration $a = \frac{g}{3}$:

The apparent weight is given by:

$N_1 = m(g - a) = m\left(g - \frac{g}{3}\right) = m\left(\frac{2g}{3}\right)$

Given $N_1 = 20$ N,

$m\left(\frac{2g}{3}\right) = 20$

Step 2: Express mg in terms of N_1

$mg = x$ (let)

So,

$\frac{2}{3}x = 20 \implies x = \frac{20\times3}{2} = 30$

Thus, the real weight $mg = 30$ N.

Step 3: Find the reading when the lift is going UP

When the lift is **going up** with acceleration $a = \frac{g}{3}$:

The apparent weight is

$N_2 = m(g + a) = m\left(g + \frac{g}{3}\right) = m\left(\frac{4g}{3}\right)$

We already found $mg = 30$ N:

$N_2 = 30 \times \frac{4}{3} = 40$ N

Final Answer:

Option A

40 N

Question8

Which one of the following person is in an inertial frame of reference?

MHT CET 2025 20th April Morning Shift

Options:

A. A person (man) in a train which is slowing down to stop.

B. A person (child) revolving in a merry-goround.

C. A person (driver) in a bus which is moving with constant velocity.

D. A person (pilot) in an aeroplane which is taking off.

Answer: C

Solution:

An **inertial frame of reference** is one that moves with **constant velocity** (no acceleration).

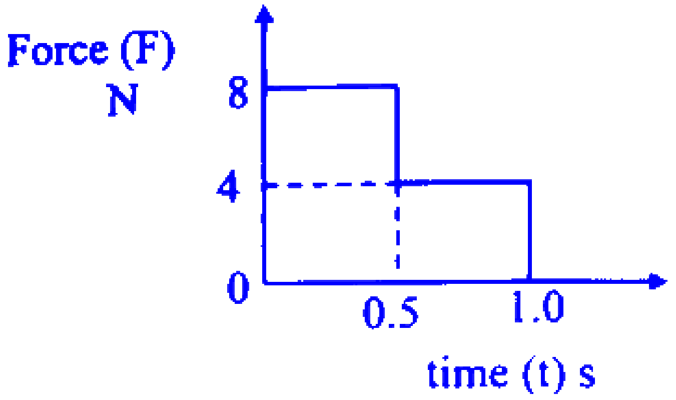
Check each option:

- **A**: Train slowing down → **accelerating** → non-inertial
- **B**: Merry-go-round → **rotating**, centripetal acceleration → non-inertial
- **C**: Bus moving with **constant velocity** → **no acceleration** → **inertial frame** ✅
- **D**: Aeroplane taking off → **accelerating** → non-inertial

👉 **Correct answer: C**

Question9

Force is applied to a body of mass 3 kg at rest on a frictionless horizontal surface as shown in the force against time (F-t) graph. The speed of the body after 1 s is



MHT CET 2025 19th April Evening Shift

Options:

A. $8 \mathrm{~m/s}$

B. $6 \mathrm{~m/s}$

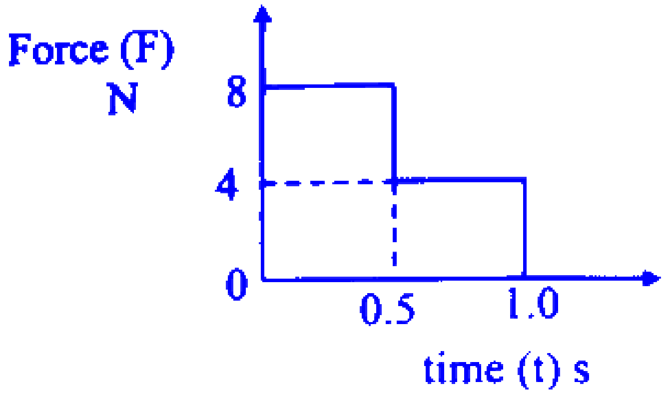
C. $4 \mathrm{~m/s}$

D. $2 \mathrm{~m/s}$

Answer: D

Solution:

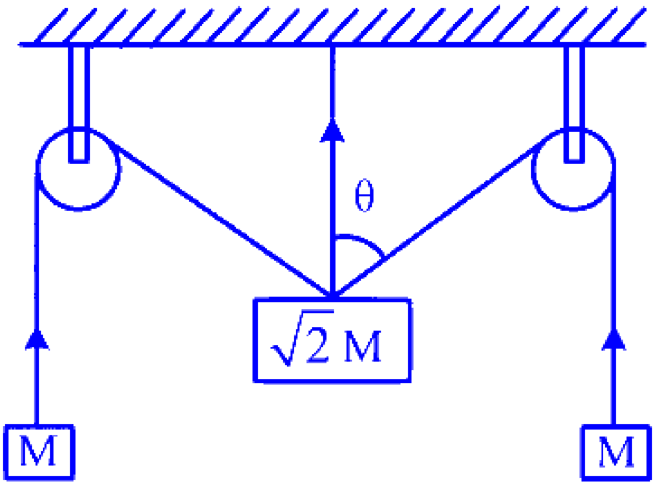
Change in momentum is given by the area under the F - t graph.



$$\begin{aligned} \text{Area } & = 8 \times 0.5 + 4 \times 0.5 \\ & = 4 + 2 = 6 \mathrm{~N} - \mathrm{s} \end{aligned}$$
$$\therefore \mathrm{mv} = 6 \mathrm{~N} - \mathrm{s}$$
$$\therefore \mathrm{v} = \frac{6}{3} = 2 \mathrm{~m/s}$$

Question10

The pulleys and strings shown in figure are smooth and of negligible mass. For the system to remain in equilibrium, angle θ should be



MHT CET 2024 15th May Morning Shift

Options:

A. $\cos^{-1}(1)$

B. $\cos^{-1}\left(\frac{\sqrt{3}}{2}\right)$

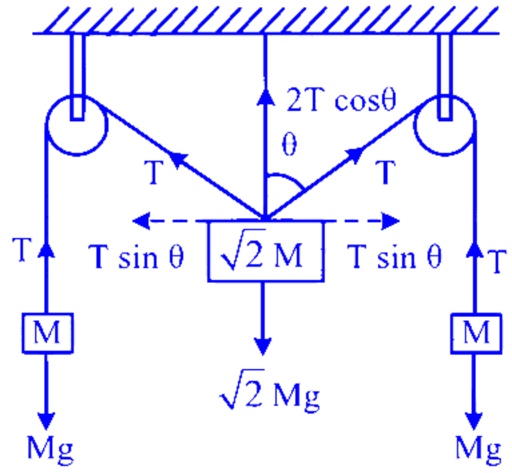
C. $\cos^{-1}\left(\frac{1}{2}\right)$

D. $\cos^{-1}\left(\frac{1}{\sqrt{2}}\right)$

Answer: D

Solution:

From the diagram,



$\mathrm{T}=\mathrm{Mg}$ and,For the system to remain in equilibrium,

$$
\begin{aligned}
& 2 \mathrm{~T} \cos \theta=\sqrt{2} \mathrm{Mg} \\
\therefore \quad & 2 \mathrm{~T} \cos \theta=\mathrm{T} \sqrt{2} \\
\therefore \quad & \cos \theta=\frac{\sqrt{2}}{2}=\frac{1}{\sqrt{2}} \\
\therefore \quad & \quad \theta=\cos ^{-1}\left(\frac{1}{\sqrt{2}}\right)
\end{aligned}
$$

Question11

Which one of the following is 'NOT' a contact force?

MHT CET 2024 10th May Evening Shift

Options:

A. Force of friction.

B. Normal reaction.

C. Gravitational force.

D. Viscous force.

Answer: C

Solution:

Option C, Gravitational force, is 'NOT' a contact force.

Contact forces require physical contact between objects, including:

Force of friction: This is a contact force that opposes the relative motion or tendency of such motion of two surfaces in contact.

Normal reaction: A contact force exerted perpendicular to the surfaces in contact, often experienced as the support force from a surface.

Viscous force: Another contact force, occurring between layers of fluid in motion relative to each other.

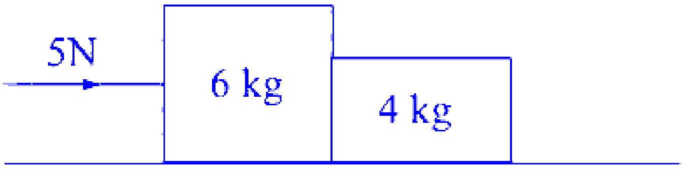
In contrast, a gravitational force is a non-contact force that acts at a distance, pulling two masses toward each other without needing any direct physical interaction. The mathematical expression for gravitational force between two masses m_1 and m_2 separated by a distance r is given by:

$F = \frac{Gm_1m_2}{r^2}$

where G is the gravitational constant. This formula shows how gravitational force operates over a distance, not requiring objects to touch or interact directly.

Question12

Two blocks of masses 6 kg and 4 kg are placed in contact with each other on a smooth surface as shown. If a force of 5 N is applied on a heavier block, the force on the lighter block is



MHT CET 2024 3rd May Morning Shift

Options:

A. 5N

B. 4N

C. 2N

D. 1N

Answer: C

Solution:

Given: $\mathrm{m}_1=6\ \mathrm{kg},\ \mathrm{m}_2=4\ \mathrm{kg}$ and $\mathrm{F}=5\ \mathrm{N}\ \mathrm{F}=(\mathrm{m}_1+\mathrm{m}_2)\mathrm{a} \therefore \quad a=\frac{F}{(m_1+m_2)}=\frac{5}{(6+4)}=0.5\ \mathrm{m}/\mathrm{s}^2$

$$\begin{aligned} \therefore \quad \text{Force on second mass } & =\mathrm{m}_2\times\mathrm{a} \\ & =4\times0.5 \\ & =2\ \mathrm{N} \end{aligned}$$

Question13

The mass of the lift is 200 kg , when it ascends with an acceleration of $4\ \mathrm{m}/\mathrm{s}^2$ then the tension in the cable supporting the lift will be [Given: Acceleration due to gravity $g=10\ \mathrm{m}/\mathrm{s}^2$]

MHT CET 2024 2nd May Evening Shift

Options:

A. 800 N

B. 2800 N

C. 4200 N

D. 2000 N

Answer: B

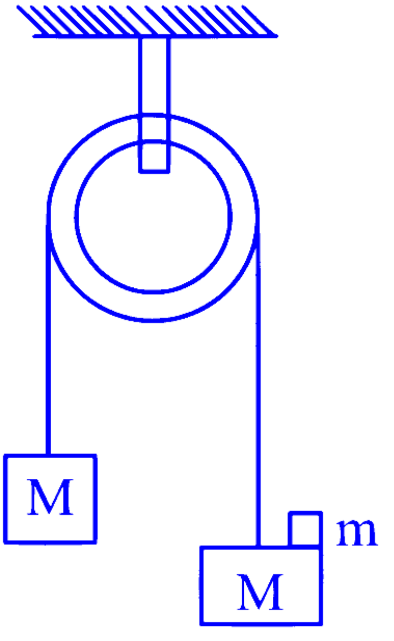
Solution:

The equation of motion for the lift is:

$$\begin{aligned} & T-ma=mg \\ & T=m(g+a) \\ & \quad=200(10+4) \\ & T=2800\ \mathrm{N} \end{aligned}$$

Question14

Two identical blocks each of mass ' M ' attached to the ends of a massless inextensible string which passes over a pulley with a fixed axis as shown below. A small mass ' m ' is now placed on the block B. The acceleration with which the two blocks move together is[g = gravitational acceleration]



MHT CET 2024 2nd May Morning Shift

Options:

A. $\frac{mg}{2M+m}$

B. $\frac{Mg}{M+2m}$

C. $\frac{\mathrm{Mg}}{2\mathrm{M}+\mathrm{m}}$

D. $\frac{mg}{M+2m}$

Answer: A

Solution:

$(\mathrm{M}+\mathrm{m})\mathrm{g}-\mathrm{T}=(\mathrm{M}+\mathrm{m})\mathrm{a}$
$\mathrm{T}-\mathrm{Mg}=\mathrm{Ma}$

Adding the above equations,

$$(M+m)g - Mg = (2M+m)a$$

$$\therefore \quad a = \frac{mg}{(2M+m)}$$

Question15

A machine gun fires bullets of mass 30 g with velocity of 1000 m/s. The man holding the gun can exert a maximum force of 300 N on it. How many bullets can he fire per second at most?

MHT CET 2023 14th May Evening Shift

Options:

A. 3

B. 6

C. 10

D. 9

Answer: C

Solution:

To determine how many bullets the man can fire per second without exceeding the maximum force he can exert, we need to compute the force applied due to the momentum change of the bullets being fired.

The momentum p of a single bullet is given by:

$p = m \cdot v$

where m is the mass of the bullet and v is the velocity of the bullet. Here, $m = 30 \text{ g} = 0.03 \text{ kg}$ (since $1 \text{ g} = 0.001 \text{ kg}$) and $v = 1000 \text{ m/s}$.

Now we calculate the momentum of a single bullet: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$p = 0.03 \text{ kg} \cdot 1000 \text{ m/s} = 30 \text{ kg} \cdot \text{m/s}$

The rate of change of momentum gives us the force exerted by the bullets being fired. If F is the force and n is the number of bullets fired per second, the force is equal to the rate of change of momentum:

$F = n \cdot \frac{\Delta p}{\Delta t}$

Since Δp is the change in momentum per bullet and $\Delta t = 1$ second (because n is measured in bullets per second), the force exerted by n bullets is:

$F = n \cdot \frac{30 \text{ kg } \cdot \text{m/s}}{1 \text{ s}} = n \cdot 30 \text{ N}$

We know the man can exert a maximum force of $F_{\text{max}} = 300$ N. Therefore, the maximum number of bullets (n_{max}) that can be fired per second without exceeding the maximum force is obtained by equating the two:

$300 \text{ N} = n_{\text{max}} \cdot 30 \text{ N}$

Solving for n_{max}:

$n_{\text{max}} = \frac{300 \text{ N}}{30 \text{ N/bullet}} = 10 \text{ bullets/s}$

Thus, the man can fire at most 10 bullets per second. Hence, the correct answer is:

Option C: 10

Question16

A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring balance reads $49 \mathrm{~N}$, when the lift is stationary. If the lift moves downward with an acceleration of $5 \mathrm{~m} / \mathrm{s}^2$, the reading of the spring balance will be $\left(g=9.8 \mathrm{~m} / \mathrm{s}^2\right)$

MHT CET 2023 13th May Evening Shift

Options:

A. 15 N

B. 24 N

C. 49 N

D. 74 N

Answer: B

Solution:

When lift is stationary, reading of spring balance

$= 49 \text{ N}$

i.e., weight of bag, $= 49 \text{ N}$

$\Rightarrow \quad m = \frac{49}{g}$

When lift moves downward, $a = 5 \text{ m/s}^2$

Weight (reading on spring balance) $= (g - a)\text{m}$

$= (9.8 - 5) \times \frac{49}{9.8} = 24 \text{ N}$

Question17

A door 1.2 m wide requires a force of 1 N to be applied perpendicular at the free end to open or close it. The perpendicular force required at a point 0.2 m distant from the hinges for opening or closing the door is

MHT CET 2022 11th August Evening Shift

Options:

A. 3.6 N

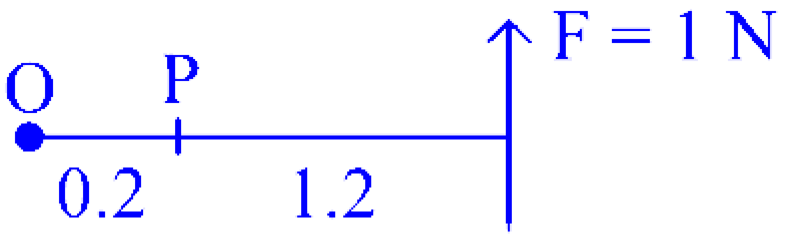
B. 2.4 N

C. 1.2 N

D. 6.0 N

Answer: D

Solution:



To open or close the door, a force of 1 N is applied at a distance of 1.2 m from the hinges.

Moment of the force $= \mathrm{F} \times \mathrm{d} = 1 \times 1.2 = 1.2 \mathrm{~N} - \mathrm{m}$

When the force is applied at P at a distance of 0.2 m from O, then the force required to have the same moment is given by

$1.2 = \mathrm{F} \times 0.2 \quad \therefore \mathrm{F} = \frac{1.2}{0.2} = 6 \mathrm{~N}$

Question18

A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring balance reads $49 \mathrm{~N}$, when the lift is stationary. If the lift moves downward with an acceleration of $5 \mathrm{~m} / \mathrm{s}^2$, the reading of the spring balance will be $\left(\mathrm{g} = 9.8 \mathrm{~m} / \mathrm{s}^2\right)$

MHT CET 2021 24th September Morning Shift

Options:

A. 74 N

B. 15 N

C. 24 N

D. 49 N

Answer: C

Solution:

Here's how to solve this problem:

When the lift is stationary, the spring balance reads the actual weight of the bag, which is 49 N. This means the mass of the bag is:

$$m = \frac{W}{g} = \frac{49 \text{ N}}{9.8 \text{ m/s}^2} = 5 \text{ kg}$$

Now, when the lift accelerates downwards, the apparent weight of the bag will change. Here's why:

The net force acting on the bag is the difference between its weight (mg) and the upward force exerted by the spring balance (let's call it T). This net force is what causes the bag to accelerate downwards with the lift.

Applying Newton's second law (F = ma):

$$mg - T = ma$$

We can rearrange this to solve for the reading of the spring balance (T):

$$T = mg - ma = m(g - a)$$

Plugging in the values:

$$T = 5 \text{ kg}(9.8 \text{ m/s}^2 - 5 \text{ m/s}^2) = 24 \text{ N}$$

Therefore, the reading of the spring balance will be **24 N** when the lift accelerates downwards.

So the correct answer is Option C.

Question19

The weight of a man in a lift moving upwards with an acceleration 'a' is 620 N. When the lift moves downwards with the same acceleration, his weight is found to be 340 N. The real weight of the man is

MHT CET 2021 20th September Morning Shift

Options:

A. 620 N

B. 680 N

C. 380 N

D. 480 N

Answer: D

Solution:

$W_1 = 620$ N, $W_2 = 340$ N

$W_1 = m(g + a)$ ..... (i)

$W_2 = m(g - a)$ ..... (ii)

$\therefore \frac{W_1}{W_2} = \frac{620}{340} = \frac{g+a}{g-a}$

$\therefore \frac{31}{17} = \frac{g+a}{g-a}$

Solving : $a = \frac{7}{24}g$

Putting this value in Eq. (i) and solving we get mg = 480 N

Question20

A block of mass m is moving on rough horizontal surface with momentum p. The coefficient of friction between the block and surface is μ. The distance covered by block before it stops is [$g =$ acceleration due to gravity]

MHT CET 2020 16th October Evening Shift

Options:

A. $\frac{2\mu M^2 g}{p^2}$

B. $\frac{p}{2\mu M g}$

C. $\frac{2\mu M g}{p}$

D. $\frac{p^2}{2\mu M^2 g}$

Answer: D

Solution:

Using kinematic relation,

$v^2 = u^2 - 2as$ .... (i)

The momentum p is given by

$p = Mu$
$u = \frac{p}{M}$

and acceleration is given as $a = \mu g$

Substituting values in Eq. (i), we get

$0 = u^2 - 2$ as $\quad (\because$ final velocity $, v = 0)$

$0 = \left(\frac{p}{M}\right)^2 - 2\mu g s$

$\left(\frac{p}{M}\right)^2 = 2\mu g s$

$\Rightarrow \quad s = \frac{p^2}{2M^2\mu g}$

Question21

A body of mass 2 kg is acted upon by two forces each of magnitude 1 N and inclined at 60° with each other. The acceleration of the body in $\mathrm{m/s}$ is $[\cos 60^\circ = 0.5]$

MHT CET 2020 16th October Morning Shift

Options:

A. $\sqrt{0.75}$

B. $\sqrt{0.65}$

C. $\sqrt{0.20}$

D. $\sqrt{0.35}$

Answer: A

Solution:

Given, $F_1 = F_2 = 1\ \mathrm{N}, m = 2$ kg and $\theta = 60^\circ$

Resultant force,

$$
\begin{aligned}
F &= \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta} \\
&= \sqrt{1^2 + 1^2 + 2\cos 60^\circ} \\
&= \sqrt{2 + 2(0.5)} = \sqrt{3}\,\mathrm{N}
\end{aligned}
$$

$$\Rightarrow \quad ma = \sqrt{3}$$

$$\text{or} \quad a = \frac{\sqrt{3}}{m} = \frac{\sqrt{3}}{2} = \sqrt{\frac{3}{4}} = \sqrt{0.75}\,\mathrm{ms}^{-2}$$

Question22

A block of mass M is pulled along a smooth horizontal surface with a rope of mass m by force F. The acceleration of the block will be

MHT CET 2019 3rd May Morning Shift

Options:

A. $\frac{F}{(M-m)}$

B. $\frac{F}{(M+m)}$

C. $\frac{F}{m}$

D. $\frac{F}{M}$

Answer: B

Solution:

When a block of mass m is pulled along smooth horizontal surface with rope of mass m by force F, then $(M+m)$ will be the total mass of the system.

$$\therefore \quad F = (M+m)a$$

$$\Rightarrow \quad a = \frac{F}{M+m}$$

Question23

An aircraft is moving with uniform velocity $150 \mathrm{~m/s}$ in the space. If all the forces acting on it are balanced, then it will

MHT CET 2019 2nd May Evening Shift

Options:

A. keep moving with same velocity

B. remain floating at its place

C. escape in space

D. fall down on earth

Answer: A

Solution:

As all the forces acting on the aircraft are balanced, so the net force on it will be zero, i.e., no external force act on it. Thus, the aircraft will keep moving with the same velocity of $150 \mathrm{~m/s}$ in the space.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