Laws of Motion

Question1

A box of mass 5 kg is pulled by a cord, up along a frictionless plane inclined at 30° with the horizontal. The tension in the cord is 30N. The acceleration of the box is (Take g = 10m s^{-2})

[NEET 2024 Re]

Options:

A.

2m s^{-2}

B.

Zero

C.

0.1m s^{-2}

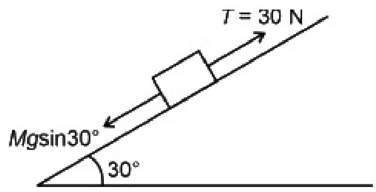
D.

1m s^{-2}

Answer: D

Solution:

$T - Mg\sin 30 = Ma$

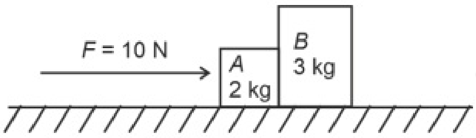


$30 - 5 \times 10 \times \frac{1}{2} = 5a$

$a = 1\text{m}/s^2$

Question2

A horizontal force 10N is applied to a block A as shown in figure. The mass of blocks A and B are 2kg and 3 kg respectively. The blocks slide over a frictionless surface. The force exerted by block A on block B is :



[NEET 2024]

Options:

A.

Zero

B.

4N

C.

6N

D.

10N

Answer: C

Solution:

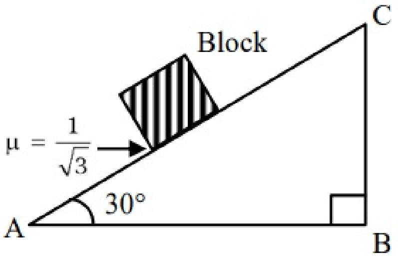
$$F = (M_1 + M_2)a$$

$$a = \frac{10}{2+3} = 2\text{ms}^{-2}$$

$$F' = M_2(2) = 3 \times 2\text{N} = 6\text{N}$$

Question3

A block of mass 2kg is placed on inclined rough surface AC (as shown in figure) of coefficient of friction μ. If g = 10m s^{-2}, the net force (in N) on the block will be :



[NEET 2023 mpr]

Options:

A.

$10\sqrt{3}$

B.

zero

C.

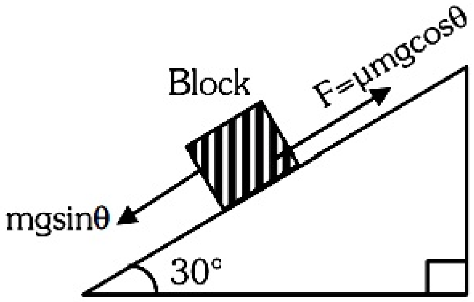
10

D.

20

Answer: B

Solution:



$\mu = \frac{1}{\sqrt{3}}$

$\tan 30^{\circ} = \frac{1}{\sqrt{3}}$

as $\mu = \tan\theta$

the block is at rest and net force on it must be zero

Question4

A 1kg object strikes a wall with velocity 1m s^{-1} at an angle of 60∘ with the wall and reflects at the same angle. If it remains in contact with wall for 0.1 s, then the force exerted on the wall is :-

[NEET 2023 mpr]

Options:

A.

$30\sqrt{3}$N

B.

Zero

C.

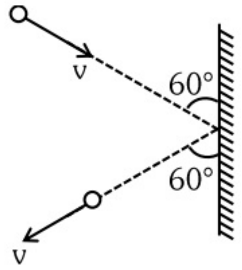
$10\sqrt{3}$N

D.

$20\sqrt{3}$N

Answer: C

Solution:



$$F = \left|\frac{\Delta \vec{p}}{\Delta t}\right| = \frac{2\,mv\sin\theta}{t} = \frac{2(1)(1)\sin 60^{\circ}}{0.1} = 10\sqrt{3}\text{N}$$

Question5

A football player is moving southward and suddenly turns eastward with the same speed to avoid an opponent. The force that acts on the player while turning is

[NEET 2023]

Options:

A.

Along northward

B.

Along north-east

C.

Along south-west

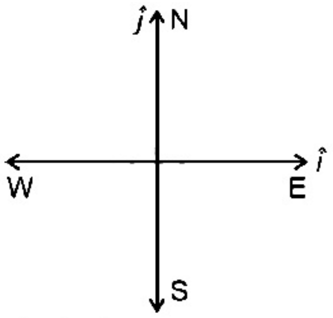
D.

Along eastward

Answer: B

Solution:

Solution:



$\Delta \vec{P} = \vec{P}_f - \vec{P}_i$

$\vec{P}_f = mu\hat{i}$

$\vec{P}_i = mu(-\hat{j})$

$\Delta \vec{P} = mu\hat{i} - mu(-\hat{j})$

$\Delta \vec{P} = mu(\hat{i} + \hat{j})$

$\vec{F} = \frac{\Delta \vec{P}}{\Delta t}$

Direction of change of momentum and direction of force acting on the player will be same, so correct answer is North east direction

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Question6

Calculate the maximum acceleration of a moving car so that a body lying on the floor of the car remains stationary. The coefficient of static friction between the body and the floor is 0.15 ($g = 10 m\ s^{-2}$).

[NEET 2023]

Options:

A.

$150 m\ s^{-2}$

B.

$1.5 m\ s^{-2}$

C.

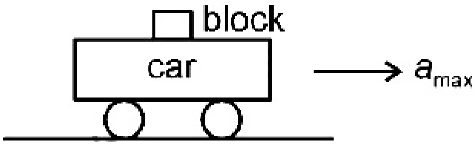
$50 m\ s^{-2}$

D.

$1.2 m\ s^{-2}$

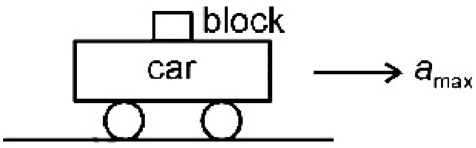
Answer: B

Solution:



w.r.t. car

$a_b = 0$

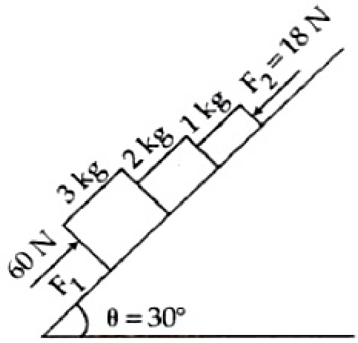


$ma_{max} = \mu_s mg$

$a_{max} = \mu_s g = 0.15 \times 10 = 1.5 m/s^2$

Question7

In the diagram shown, the normal reaction force between 2 kg and 1 kg is (Consider the surface, to be smooth) : Given g = $10 ms^{-2}$



[NEET Re-2022]

Options:

A. 10N

B. 25N

C. 39N

D. 6N

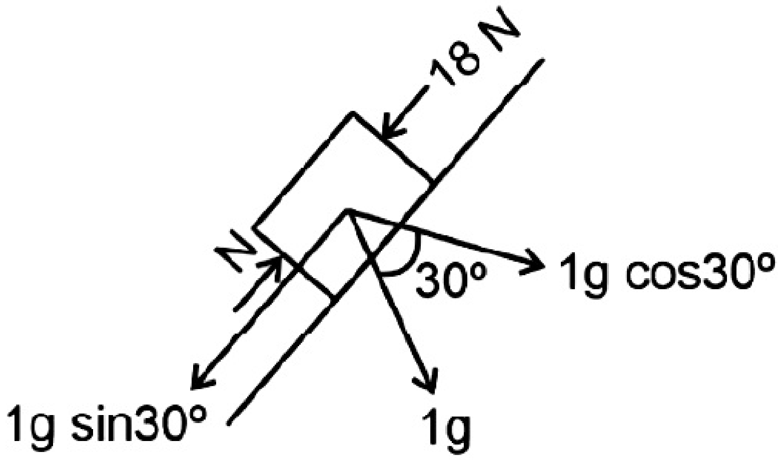
Answer: B

Solution:

Solution:

$$a = \frac{\text{Net pulling force}}{M_{\text{total}}} \text{ (up the inclined)}$$

$$a = \frac{60 - 18 - (3+2+1)g\sin 30^\circ}{3+2+1} = \frac{12}{6} = 2\text{m/s}^2$$



By taking F.B.D. of 1 kg

$$ma = N - 18 - 1 \times 10 \times \frac{1}{2}$$

$$\Rightarrow 2 = N - 23$$

$$\Rightarrow N = 25N$$

Question8

A ball of mass 0.15 kg is dropped from a height 10 m, strikes the ground and rebounds to the same height.
The magnitude of impulse imparted to the ball is ($g = 10\ m/s^2$) nearly [NEET 2021]

Options:

A. 0 kg m/s

B. 4.2 kg m/s

C. 2.1 kg m/s

D. 1.4 kg m/s

Answer: B

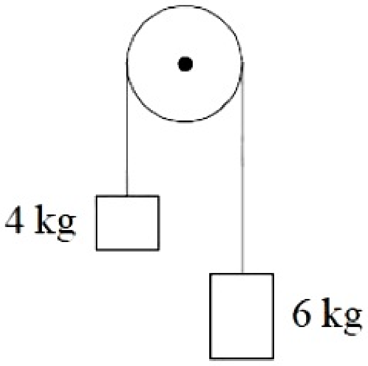
Solution:

Given that :
Mass of ball = 0.15 kg
Height from which ball is dropped = 10 m
Impulse, $\vec{I}$ = Change in linear momentum $= \Delta\vec{P} = \vec{P}_f - \vec{P}_i$
Velocity of ball at ground (v) = $\sqrt{2gh}$
$= \sqrt{2 \times 10 \times 10} = 10\sqrt{2}\text{m/s}$

$\vec{I} = 0.15 \times 10\sqrt{2}(-\hat{j}) - 0.15 \times 10\sqrt{2}(\hat{j})$
$\vec{I} = 2 \times 0.15 \times 10\sqrt{2}(-\hat{j}) = 4.2(-\hat{j})$
$\Rightarrow$ magnitude of impulse $= 4.2\text{kgm}/\text{s}$

Question9

Two bodies of mass 4kg and 6kg are tied to the ends of a massless string. The string passes over a pulley which is frictionless (see figure).



The acceleration of the system in terms of acceleration due to gravity (g) is:
[2020]

Options:

A. g / 2

B. g / 5

C. g / 10

D. g

Answer: B

Solution:

(b) Given : Mass $M_1 = 4\text{kg}$ and
$M_2 = 6\text{kg}$.
Acceleration of the system,
$a = \frac{(m_2 - m_1)g}{(m_1 + m_2)}$ where $m_1 > m_2$
$\therefore a = \frac{(6-4)g}{6+4} = \frac{g}{5}$

Question10

A block of mass 10kg is in contact against the inner wall of a hollow cylindrical drum of radius 1m. The coefficient of friction between the block and the inner wall of the cylinder is 0.1. The minimum angular velocity needed for the cylinder to keep the block stationary when the cylinder is vertical and rotating about its axis, will be ($g = 10\text{m}/\text{s}^2$)

(2019)

Options:

A. 10π rad / s

B. $\sqrt{10}$ rad / s

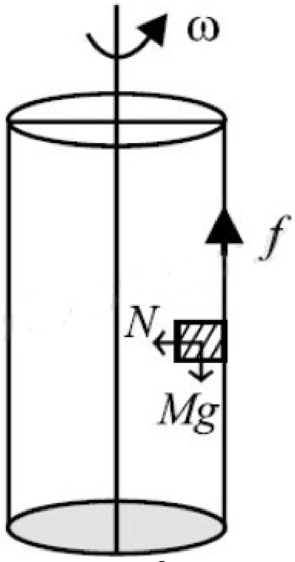
C. $\frac{10}{2\pi}$ rad / s

D. 10rad / s

Answer: D

Solution:

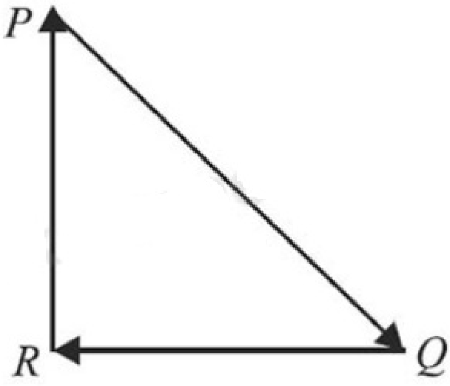
Solution:
(d): To keep the block stationary, Frictional force ≥ Weight $\mu N \geq Mg$



Here, $N = M\omega^2 r$
$r = 1m, \mu = 0.1$
For minimum ω, $\mu M\omega^2 r = Mg$
$$\omega = \sqrt{\frac{g}{\mu r}} = \sqrt{\frac{10}{0.1 \times 1}} = 10 \text{rad s}^{-1}$$

Question11

A particle moving with velocity $\vec{v}$ is acted by three forces shown by the vector triangle PQR. The velocity of the particle will



(NEET 2019)

Options:

A. change according to the smallest force $\overrightarrow{QR}$

B. increase

C. decrease

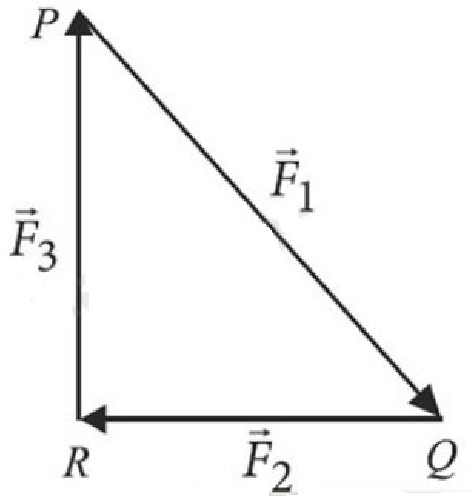
D. remain constant

Answer: D

Solution:

Solution:

(d) : As per triangle law, $\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$ i.e. net force on the particle is zero.



So, acceleration is also zero. Hence velocity of the particle will remain constant.

Question12

An object flying in air with velocity $(20\hat{i} + 25\hat{j} - 12\hat{k})$ suddenly breaks in two pieces whose masses are in the ratio 1: 5 . The smaller mass flies off with a velocity $(100\hat{i} + 35\hat{j} + 8\hat{k})$ The velocity of the larger piece will be (Odisha NEET 2019)

Options:

A. $4\hat{i} + 23\hat{j} - 16\hat{k}$

B. $-100\hat{i} - 35\hat{j} - 8\hat{k}$

C. $20\hat{i} + 15\hat{j} - 80\hat{k}$

D. $-20\hat{i} - 15\hat{j} - 80\hat{k}$.

Answer: A

Solution:

From the law of conservation of linear momentum

$m\vec{v} = m_1\vec{v}_1 + m_2\vec{v}_2$

$\Rightarrow 6k\left(20\hat{i} + 25\hat{j} - 12\hat{k}\right) = k\left(100\hat{i} + 35\hat{j} + 8\hat{k}\right) + 5k\vec{v}_2$

$\Rightarrow 5\vec{v}_2 = (120 - 100)\hat{i} + (150 - 35)\hat{j} + (-72 - 8)\hat{k}$

$\Rightarrow 5\vec{v}_2 = 20\hat{i} + 115\hat{j} - 80\hat{k}$

$\Rightarrow \vec{v}_2 = 4\hat{i} + 23\hat{j} - 16\hat{k}$

Question13

Which one of the following statements is incorrect? (NEET 2018)

Options:

A. Rolling friction is smaller than sliding friction.

B. Limiting value of static friction is directly proportional to normalreaction.

C. Frictional force opposes the relativemotion.

D. Coefficient of sliding friction has dimensions of length.

Answer: D

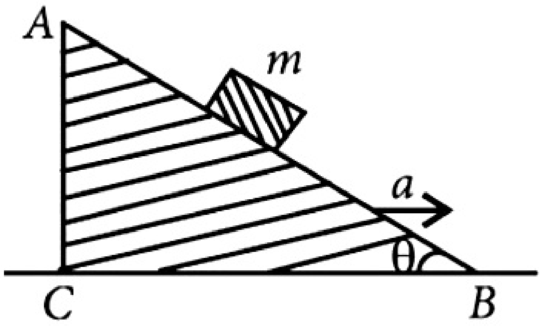
Solution:

Solution:

(d) : Coefficient of sliding friction has no dimension. $f = \mu_s N \Rightarrow \mu_s = \frac{f}{N}$

Question14

A block of mass m is placed on a smooth inclined wedge ABC of inclination θ as shown in the figure.



The wedge is given an acceleration a towards the right. The relation between a and θ for the block to remain stationary on the wedge is (NEET 2018)

Options:

A. $a = \frac{g}{\operatorname{cosec}\theta}$

B. $a = \frac{g}{\sin\theta}$

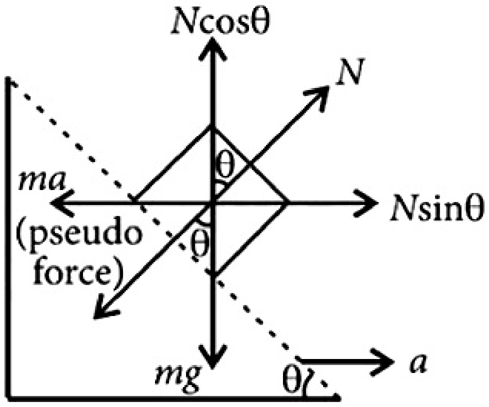
C. $a = g\cos\theta$

D. $a = g\tan\theta$

Answer: D

Solution:

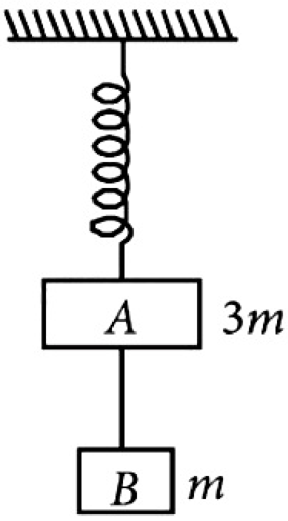
(d) : In non-inertial frame



$N \sin\theta = ma$ ... (i)
$N \cos\theta = mg$ ····· (ii)
From (i) and (ii),
$\tan\theta = \frac{a}{g}$
$\Rightarrow a = g\tan\theta$

Question15

Two blocks A and B of masses 3m and m respectively are connected by a mass-less and in extensible string. The whole system is suspended by a mass-less spring as shown in figure. The magnitudes of acceleration of A and B immediately after the string is cut are, respectively



(2017 NEET)

Options:

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

B. g, g

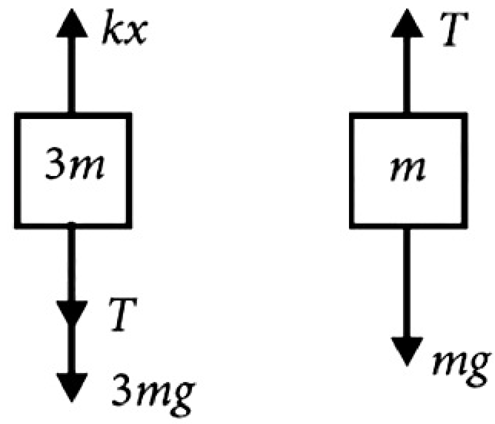
C. $\frac{g}{3}$, $\frac{g}{3}$

D. g, $\frac{g}{3}$

Answer: A

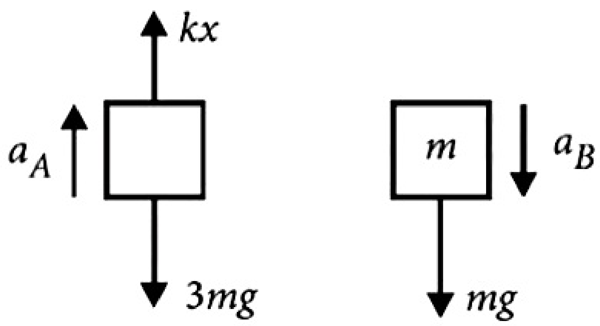
Solution:

Before the string is cut
$kx = T + 3mg$.........(i)
$T = mg$......(ii)



Before the string is cut

From eqns.(i) and (ii)
$kx = 4mg$
Just after the string is cut $T = 0$



After the string is cut

$$a_A = \frac{kx - 3mg}{3m}$$
$$a_A = \frac{4mg - 3mg}{3m}$$
$$= \frac{mg}{3m} = \frac{g}{3}$$
and also $a_B = g$

Question16

One end of string of length l is connected to a particle of mass 'm' and

the other end is connected to a small peg on a smooth horizontal table. If the particle moves in circle with speed 'V' , the net force on the particle (directed towards center) will be
(T represents the tension in the string)
(2017 NEET)

Options:

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

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

C. zero

D. T

Answer: D

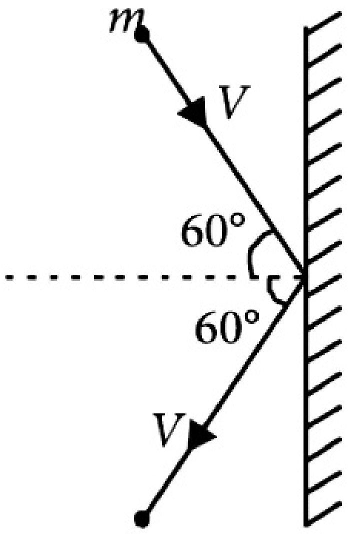
Solution:

Solution:

Centripetal force $\left(\frac{mv^2}{l}\right)$ is provided by tension so net force on the particle will be equal to tension T.

Question17

A rigid ball of mass m strikes a rigid w all at 60° and gets reflected without loss of speed as shown in the figure. The value of impulse imparted by the wall on the ball will be



(2016 NEET Phase-II)

Options:

A. mV

B. 2 mV

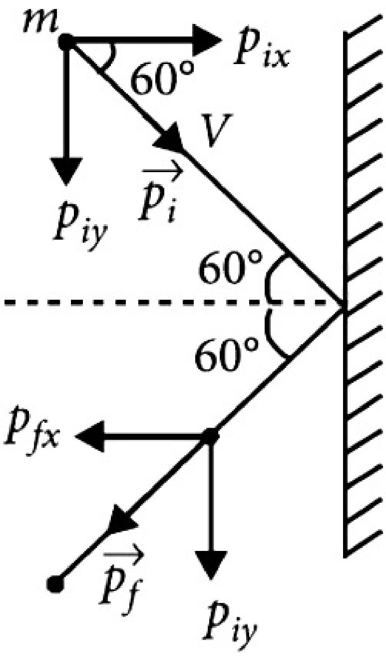
C. $\frac{mV}{2}$

D. $\frac{mV}{3}$

Answer: A

Solution:

Solution:



Given, $p_i = p_f = mV$

Change in momentum of the ball

$= \vec{p}_f - \vec{p}_i$

$= \left(p_{fx}\hat{i} - p_{fy}\hat{j}\right) - \left(p_{ix}\hat{i} - p_{iy}\hat{j}\right)$

$= -\hat{i}(p_{fx} + p_{ix}) - \hat{j}(p_{fy} - p_{iy})$

$= -2p_{ix}\hat{i} = -mV\,\hat{i}[\because p_{fy} - p_{iy} = 0]$

Here, $p_{ix} = p_{fx} = p_i\cos 60° = \frac{mV}{2}$

$\because$ Impulse imparted by the wall = change in the momentum of the ball = mV

Question18

A car is negotiating a curved road of radius R. The road is banked at an angle θ. The coefficient of friction between the tyres of the car and the road is μ_s. The maximum safe velocity on this road is

(2016 NEET Phase-I)

Options:

A. $\sqrt{\frac{g}{R}\frac{\mu_s + \tan\theta}{1 - \mu_s\tan\theta}}$

B. $\sqrt{\frac{g}{R^2}\frac{\mu_s + \tan\theta}{1 - \mu_s\tan\theta}}$

C. $\sqrt{gR^2\frac{\mu_s + \tan\theta}{1 - \mu_s\tan\theta}}$

D. $\sqrt{gR\frac{\mu_s + \tan\theta}{1 - \mu_s\tan\theta}}$

Answer: D

Question19

Two stones of masses m and 2m are whirled in horizontal circles, the heavier one in a radius $\frac{r}{2}$ and the lighter one in radius r. The tangential speed of lighter stone is n times that of the value of heavier stone when they experience same centripetal forces. The value of n is
(2015)

©

Options:

A. 4

B. 1

C. 2

D. 3

Answer: C

Solution:

Solution:
Let v be tangential speed of heavier stone. Then, centripetal force experienced by lighter stone is

$(F_c)_{lighter} = \frac{m(nv)^2}{r}$

and that of heavier stone is $(F_c)_{heavier} = \frac{2mv^2}{\left(\frac{r}{2}\right)}$

But $(F_c)_{lighter} = (F_c)_{heavier}$(given)

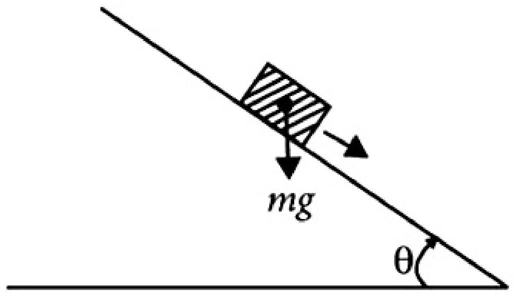
$\therefore \frac{m(nv)^2}{r} = \frac{2mv^2}{\left(\frac{r}{2}\right)}$

$\Rightarrow n^2\left(\frac{mv^2}{r}\right) = 4\left(\frac{mv^2}{r}\right)$

$n^2 = 4 \Rightarrow n = 2$

Question20

A plank with a box on it at one end is gradually raised about the other end. As the angle of inclination with the horizontal reaches 30°, the box starts to slip and slides 4.0 m down the plank in 4.0 s. The coefficients of static and kinetic friction between the box and the plank will be, respectively



(2015)

Options:

A. 0.5 and 0.6

B. 0.4 and 0.3

C. 0.6 and 0.6

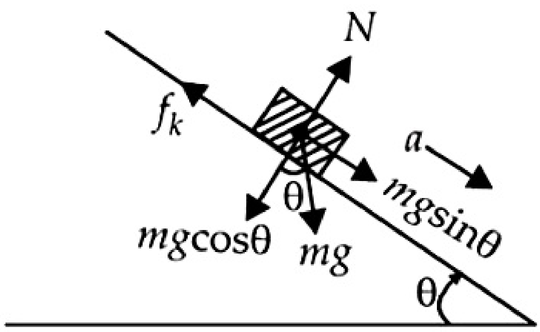
D. 0.6 and 0.5

Answer: D

Solution:

Solution:
Let μ_s and μ_k be the coefficients of static and kinetic friction between the box and the plank respectively. When the angle of inclination θ reaches 30°, the block just slides,

$\therefore \mu_s = \tan\theta = \tan 30° = \frac{1}{\sqrt{3}} = 0.6$



If a is the acceleration produced in the block, then

$ma = mg\sin\theta - f_k$ (where f_k is force of kinetic friction)

$= mg\sin\theta - \mu_k N$ (as $f_k = \mu_k N$)

$= mg\sin\theta - \mu_k mg\cos\theta$ (as N = mgcosθ)

$a = g(\sin\theta - \mu_k \cos\theta)$

As $g(\sin\theta - \mu_k\cos\theta)$

$\therefore a = (10 ms^{-2})(\sin 30° - \mu_k \cos 30°)$ ....(i)

If s is the distance travelled by the block in time t, then

$a = \frac{2s}{t^2}$ (as u = 0)
But s = 4.0m and t = 4.0s (given)
$\therefore a = \frac{2(4.0m)}{(4.0s)^2} = \frac{1}{2}ms^{-2}$
Substituting this value of a in eqn. (i), we get
$\frac{1}{2}ms^{-2} = (10ms^{-2})\left(\frac{1}{2} - \mu_k\frac{\sqrt{3}}{2}\right)$; $\mu_k = \frac{0.9}{\sqrt{3}} = 0.5$

Question21

A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pully at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k. When the block A is sliding on the table, the tension in the string is (2015 Cancelled)

Options:

A. $\frac{m_1 m_2(1 + \mu_k)g}{(m_1 + m_2)}$

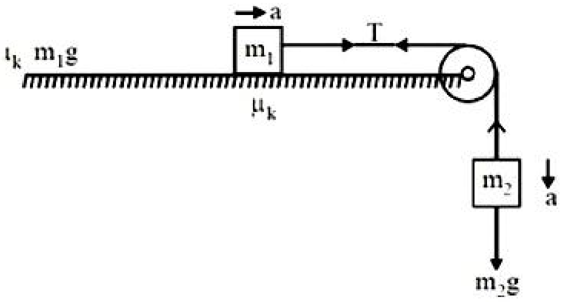
B. $\frac{m_1 m_2(1 - \mu_k)g}{(m_1 + m_2)}$

C. $\frac{(m_2 + \mu_k m_1)g}{(m_1 + m_2)}$

D. $\frac{(m_2 - \mu_k m_1)g}{(m_1 + m_2)}$

Answer: A

Solution:



The blocks m_1 and m_2 will move with combined acceleration a:
From F.B.D. of block m_1
$T - f_1 = m_1 a$... (i)
as the block m_1 is sliding, kinetic friction will be acting:
$T - \mu_k N = m_1 a$... (ii)
$N = mg$.....(iii)
From F.B.D. of block m_2
$m_2 g - T = m_2 a$... (iv)
adding (ii) and (iv) $a = \frac{m_2 g - \mu_k N}{m_1 + m_2}$... (v)

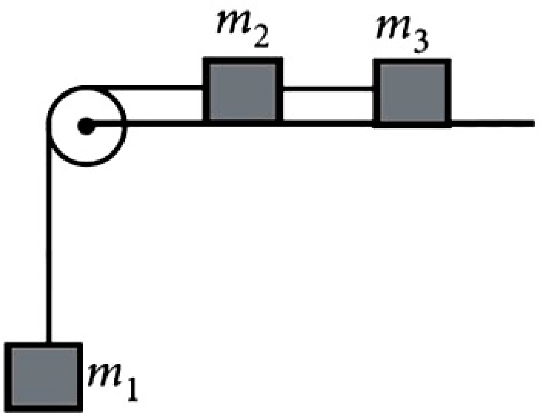
$$T = m_2 g - m_2 a = m_2 \left(g - \frac{m_2 g - \mu_k N}{m_1 + m_2} \right)$$

$$= m_2 \left(\frac{m_1 g + \mu_k m_{1g}}{m_1 + m_2} \right)$$

$$= m_1 m_2 \left(\frac{1 + \mu_k}{m_1 + m_2} g \right)$$

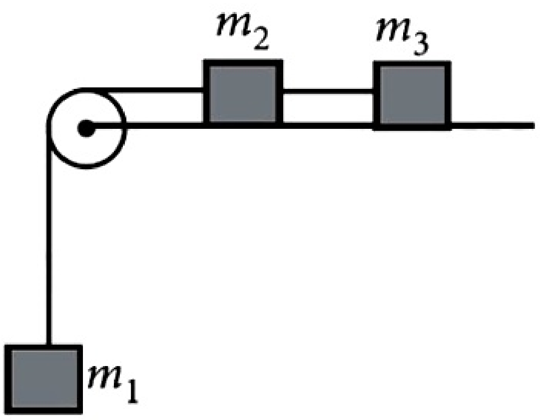
Question22

A system consists of three masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 andm_3 are on a rough horizontal table (the coefficient of friction = μ).The pulley is frictionless ad of negligible mass. The downward acceleration of mass m_1 is
(Assume $m_1 = m_2 = m_3 = m$)



(2014)

A system consists of three masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 andm_3 are on a rough horizontal table (the coefficient of friction = μ).The pulley is frictionless ad of negligible mass. The downward acceleration of mass m_1 is
(Assume $m_1 = m_2 = m_3 = m$)



(2014)

Options:

A. $\frac{g(1 - g\mu)}{9}$

B. $\frac{2g\mu}{3}$

C. $\frac{g(1-2\mu)}{3}$

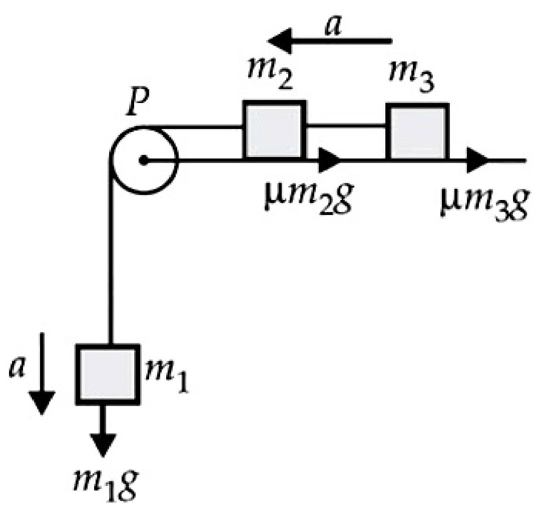
D. $\frac{g(1-2\mu)}{2}$

Answer: C

Solution:

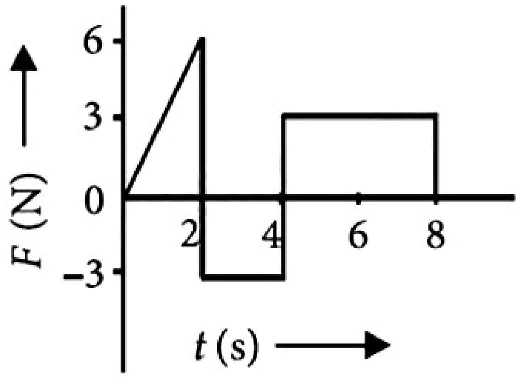
Solution:
Force of friction on mass
$m_2 = \mu m_2 g$
Force of friction on mass
$m_3 = \mu m_3 g$
Let a be common acceleration of the system.
$\therefore a = \frac{m_1 g - \mu m_2 g - \mu m_3 g}{m_1 + m_2 + m_3}$
Here, $m_1 = m_2 = m_3 = m$
$\therefore a = \frac{mg - \mu mg - \mu mg}{m + m + m} = \frac{mg - 2\mu mg}{3m} = \frac{g(1-2\mu)}{3}$

Hence, the downward acceleration of mass m_1 is $\frac{g(1-2\mu)}{3}$



Question23

The force F acting on a particle of mass m is indicated by the force-time graph shown below. The change in momentum of the particle over the time interval from zero to 8 s is



(2014)

Options:

A. 24 N s

B. 20 N s

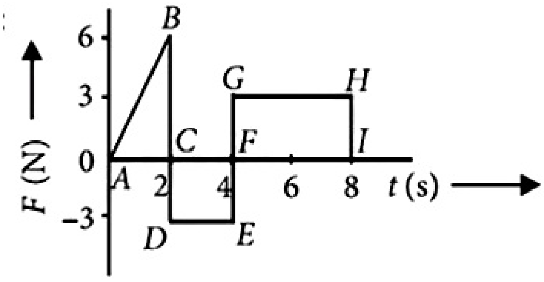
C. 12 N s

D. 6 N s

Answer: C

Solution:

Solution:
Change in momentum = Area under F-t graph in that interval
= Area of ΔABC - Area of rectangle CDEF + Area of rectangle FGHI
$\frac{1}{2} \times 2 \times 6 - 3 \times 2 + 4 \times 3 = 12\text{N s}$



Question24

A balloon with mass m is descending down with an acceleration a (where a < g). How much mass should be removed from it so that it starts moving up with an acceleration a?
(2014)

Options:

A. $\frac{2ma}{g + a}$

B. $\frac{2ma}{g - a}$

C. $\frac{ma}{g + a}$

D. $\frac{ma}{g} - a$

Answer: A

Solution:

Solution:
Let F be the upthrust of the air. As the balloon is descending down with an acceleration a,
$\therefore mg - F = ma$

Let mass m_0 be removed from the balloon so that it starts moving up with an acceleration a .Then,

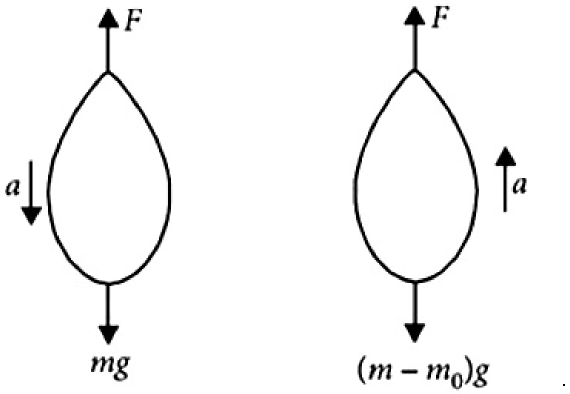
$F - (m - m_0)g = (m - m_0)a$

$F - mg + m_0g = ma - m_0a$....(ii)

Adding eqn. (i) and eqn. (ii), we get

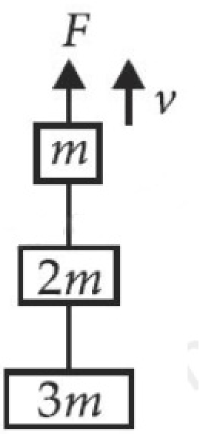
$m_0g = 2ma - m_0a$, $m_0g + m_0a = 2ma$, $m_0(g + a) = 2ma$

$$m_0 = \frac{2ma}{g + a}$$



Question25

Three blocks with masses m, 2m and 3m are connected by strings, as shown in the figure. After an upward force F is applied on block m, the masses move upward at constant speed v. What is the net force on the block of mass 2m?
(g is the acceleration due to gravity)



(2013 NEET)

Options:

A. 3 mg

B. 6 mg

C. zero

D. 2 mg

Answer: C

Solution:

As all blocks are moving with constant velocity, therefore, acceleration is zero. So net force on each block is zero.

Question26

An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1 kg moves with a speed of $12 ms^{-1}$ and the second part of mass 2 kg moves with $8 ms^{-1}$ speed. If the third part flies off with $4 ms^{-1}$ speed, then it mass is
(2013 NEET)

Options:

A. 7 kg

B. 17 kg

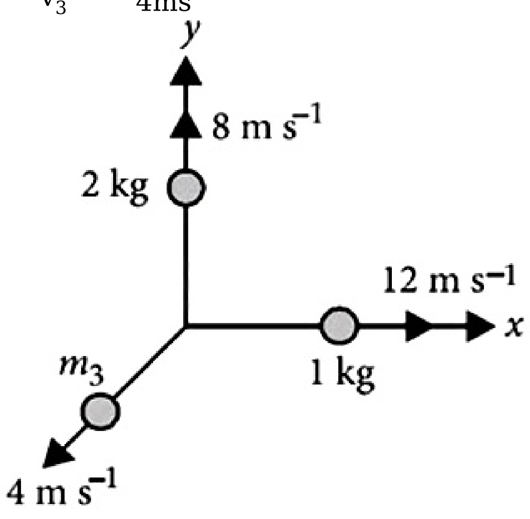
C. 3 kg

D. 5 kg

Answer: D

Solution:

The situation is as shown in the figure.
According to law of conservation of linear momentum
$\vec{p}_1 + \vec{p}_2 + \vec{p}_3 = 0$
$\therefore \vec{p}_3 = -(\vec{p}_1 + \vec{p}_2)$
Here,
$\vec{p}_1 = (1kg)(12ms^{-1})\hat{i} = 12\hat{i} kgms^{-1}$
$\vec{p}_2 = (2kg)(8ms^{-1})\hat{j} = 16\hat{j} kgms^{-1}$
$\therefore \vec{p}_3 = -(12\hat{i} + 16\hat{j}) kgms^{-1}$
The magnitude of p_3 is
$p_3 = \sqrt{(12)^2 + (16)^2} = 20 kgms^{-1}$
$\therefore m_3 = \frac{p_3}{v_3} = \frac{20 kgms^{-1}}{4 ms^{-1}} = 5 kg$



Question27

The upper half of an inclined plane of inclination θ is perfectly smooth while lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by
(2013 NEET)

Options:

A. $\mu = 2\tan\theta$

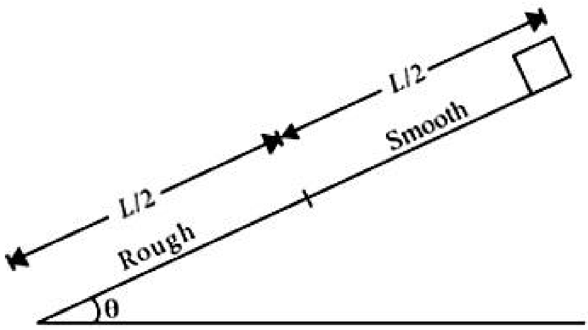
B. $\mu = \tan\theta$

C. $\mu = \frac{1}{\tan\theta}$

D. $\mu = \frac{2}{\tan\theta}$

Answer: A

Solution:



Let m be mass of the block and L be length of the inclined plane.
According to work-energy theorem $W = \Delta K = 0$ (Initial and final speeds are zero)
∴ Work done by friction + Work done by gravity $= 0$

$$-\mu mg\cos\theta\frac{L}{2} + mg\sin\theta L = 0$$

$$\frac{\mu}{2}\cos\theta = \sin\theta$$

$$\mu = \frac{2\sin\theta}{\cos\theta} = 2\tan\theta$$

Question28

A car is moving in a circular horizontal track of radius 10m with a constant speed of 10m / s. A bob is suspended from the roof of the car by a light wire of length 1.0m. The angle made by the wire with the vertical is
(KN NEET 2013)

Options:

A. $\pi / 3$

B. $\pi / 6$

C. $\pi / 4$

D. 0°

Answer: C

Solution:

Solution:
(c): Let θ is the angle made by the wire with the vertical.

$\therefore \tan\theta = \frac{v^2}{rg}$

Here, $v = 10 m / s$, $r = 10 m$, $g = 10 m / s^2$

$\therefore \tan\theta = \frac{(10 m / s)^2}{10 m (10 m / s^2)} = 1$

$\theta = \tan^{-1}(1) = \frac{\pi}{4}$

Question29

A person holding a rifle (mass of person and rifle together is 100kg) stands on a smooth surface and fires 10 shots horizontally, in 5 s. Each bullet has a mass of 10g with a muzzle velocity of $800 ms^{-1}$. The final velocity acquired by the person and the average force exerted on the person are
(Karnataka NEET 2013)

Options:

A. $-0.08 ms^{-1}$, 16N

B. $-0.8 ms^{-1}$, 16N

C. $-1.6 ms^{-1}$, 16N

D. $-1.6 ms^{-1}$, 8N

Answer: B

Solution:

Solution:
We have to use the Law of momentum conservation:
P (initial) = P (final)
$0 = n \cdot m \cdot u + (M - n \cdot m) \cdot v$
where: n=10, m=10, g = 0.01 kg, u = 800 m/s, M =100 kg

$0 = \frac{10 \times 10}{1000} \times 800 + \left(100 - 10 \times \frac{10}{1000}\right) v$

$-80 = \frac{999}{10} . v$

$v = -0.8 m / s$

Average force exerted = $\frac{\Delta p}{\Delta t}$ ($\because \Delta p = n . m . u$)

$10 \times \frac{10}{1000} \times \frac{800}{5} = 16N$

Question30

A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45°,the speed of the car is (2012)

©

Options:

A. $20ms^{-1}$

B. $30ms^{-1}$

C. $5ms^{-1}$

D. $10ms^{-1}$

Answer: B

Solution:

Here,$m = 1000kg$, $R = 90m$, $\theta = 45°$

For banking,$\tan\theta = \frac{v^2}{Rg}$

or $v = \sqrt{Rg\tan\theta} = \sqrt{90 \times 10 \times \tan 45°} = 30ms^{-1}$

Question31

A car of mass m is moving on a level circular Pack of radius R. If μ_s represents the static friction between the road any tyres of the car, the maximum speed of the car in circular motion is given by (2012 Mains)

©

Options:

A. $\sqrt{\mu_s mRg}$

B. $\sqrt{\frac{Rg}{\mu_s}}$

C. $\sqrt{\frac{mRg}{1/4_s}}$

D. $\sqrt{\mu_s Rg}$

Answer: D

Solution:

Solution:
Force of friction provides the necessary centripetal force.
$F \le \mu_s N = \frac{mv^2}{R}, v^2 \le \frac{\mu_s RN}{m}$
$v^2 \le \sqrt{\mu_s Rg}$ [∵N = mg]
or $v \le \sqrt{\mu_s Rg}$
∴ The maximum speed of the car in circular motion is
$v_{max} = \sqrt{\mu_s Rg}$

Question32

A stone is dropped from a height h. It hits the ground with a certain momentum P. If the same stone is dropped from a height 100% more than the previous height, the momentum when it hits the ground will change by (2011 Mains)

Options:

A. 68 %

B. 41 %

C. 200 %

D. 100 %

Answer: B

Solution:

Solution:
When a stone is dropped from a height h, it hits the ground with a momentum
$P = m\sqrt{2gh}$.........(i)
Where m is the mass of the stone
When the same stone is dropped from a height 2h (i.e. 100% of initial),then its momentum with which it hits the ground becomes
$P' = m\sqrt{2g(2h)} = \sqrt{2}P$ (Using(i)).......(ii)
% change in momentum $= \frac{P' - P}{P} \times 100\%$
$= \frac{\sqrt{2}P - P}{P} \times 100\% = 41\%$

Question33

A person of mass 60 kg is inside a lift of mass 940 kg and presses the button on control panel. The lift starts moving upwards with an acceleration $1.0 \frac{m}{s^{2.}}$ If $g = 10 ms^{-2}$, the tension in the supporting cable is (2011)

Options:

A. 8600 N

B. 9680 N

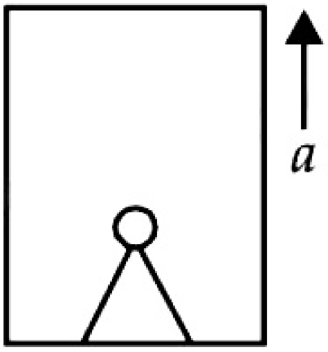
C. 11000 N

D. 1200 N

Answer: C

Solution:

Here, Mass of a person, m=60kg
Mass of lift, $M = 940 kg$, $a = 1 \frac{m}{s^2}$, $g = 10 \frac{m}{s^2}$
Let T be the tension in the supporting cable
$\therefore T - (M + m) g = (M + m) a$
$T = (M + m)(a + g)$
$= (940 + 60)(1 + 10) = 11000 N$



Question34

A body of mass M hits normally a rigid wall with velocity V and bounces back with the same velocity. The impulse experienced by the body is (2011)

Options:

A. MV

B. 1.5 MV

C. 2 MV

D. zero

Answer: C

Solution:

Impulse = Change in linear momentum
$= MV - (-MV) = 2MV$

Question35

A conveyor belt is moving at a constant speed of 2 m s'1.A box is gently dropped on it. The coefficient of friction between them is p = 0.5. The distance that the box willmove relative to belt before coming to rest on it, taking g = 10ms^{-2}, is
(2011 Mains)

Options:

A. 0.4 m

B. 1.2 m

C. 0.6 m

D. zero

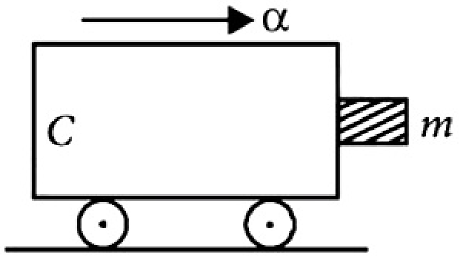
Answer: A

Solution:

Force of friction, $f = \mu mg$
$\therefore a = \frac{f}{m} = \frac{\mu mg}{m} = \mu g = 0.5 \times 10 = 5ms^{-2}$
Using $v^2 - u^2 = 2aS$
$0^2 - 2^2 = 2(-5) \times S \Rightarrow S = 0.4m$

Question36

A block of mass m is in contact with the cart C as shown in the figure. The coefficient of static friction between the block and the cart is μ. The acceleration α of the cart that will prevent the block from falling satisfies



(2010)

Options:

A. $\alpha > \frac{mg}{\mu}$

B. $\alpha > \frac{g}{\mu m}$

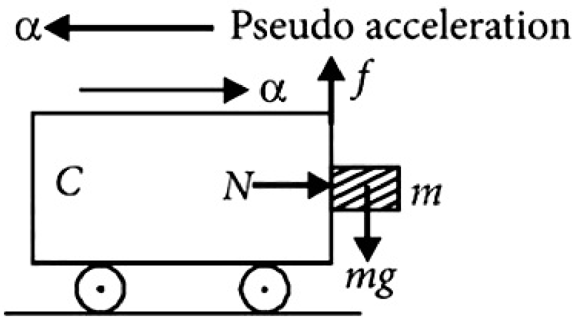
C. $\alpha \geq \frac{g}{\mu}$

D. $\alpha < \frac{g}{\mu}$

Answer: C

Solution:

Solution:
Pseudo force or fictitious force, $F_{fic} = m\alpha$
Force of friction, $f = \mu N = \mu m\alpha$
The block of mass m will not fall as long as $f \geq mg$
$\mu m\alpha \geq mg$ or $\alpha \geq \frac{g}{\mu}$



Question37

The mass of a lift is 2000 kg. When the tension in the supporting cable is 28000 N, then its acceleration is (2009)

Options:

A. $4ms^{-2}$ upwards

B. $4ms^{-2}$ downwards

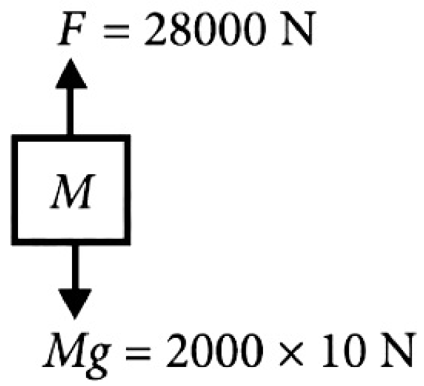
C. $14ms^{-2}$ upwards

D. $30ms^{-2}$ upwards

Answer: A

Solution:

$F - Mg = Ma$
$8000 - 2000a$
∴ Acceleration is $4ms^{-2}$ upwards



Question38

A body, under the action of a force $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$, acquires an acceleration of $1 m/s^2$.The mass of this body must be (2009)

Options:

A. 10 kg

B. 20 kg

C. $10\sqrt{2}$ kg

D. $2\sqrt{10}$ kg

Answer: C

Solution:

$\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$
$|\vec{F}| = \sqrt{36 + 64 + 100} = \sqrt{200} N = 10\sqrt{2} N$
Acceleration, $a = 1 ms^{-2}$
$\therefore$ Mass, $M = \frac{10\sqrt{2}}{1} = 10\sqrt{2} kg$

Question39

A roller coaster is designed such that riders experience "weightlessness" as they go round the top of a hill whose radius of curvature is 20m. The speed of the car at the top of the hill is between (2008)

Options:

A. 16m / s and 17m / s

B. 13m / s and 14m / s

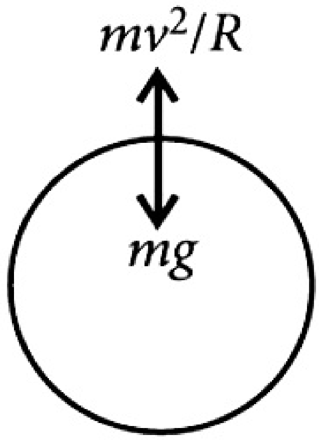
C. 14m / s and 15m / s

D. 15m / s and 16m / s

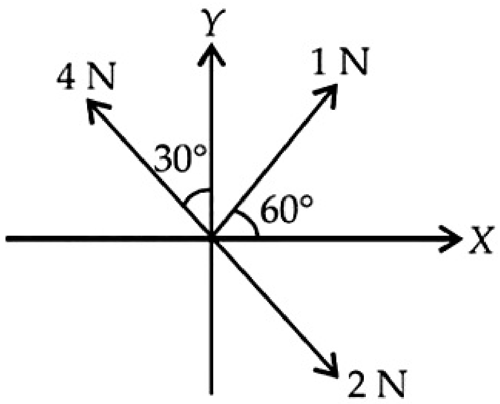
Answer: C

Solution:

(c) : $mg = \frac{mv^2}{R} \Rightarrow v = \sqrt{Rg}$
$v = \sqrt{20 \times 10} = \sqrt{200} = 14.1m / s$
i.e., Between 14 and 15m / s.



Question40



Three forces acting on a body are shown in the figure. To have the resultant force only along the y -direction, the magnitude of the minimum additional force needed is
(2008)

Options:

A. $\frac{\sqrt{3}}{4}N$

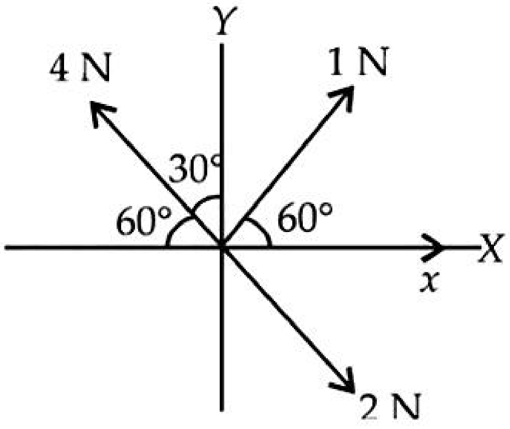
B. $\sqrt{3}N$

C. 0.5N

D. 1.5N

Answer: C

Solution:



Question41

Sand is being dropped on a conveyer belt at the rate of M kg/s. The force necessary to keep the belt moving with a constant velocity of v m/s will be
(2008)

Options:

A. $\frac{Mv}{2}$ newton

B. zero

C. Mv newton

D. $2MV$ newton

Answer: C

Solution:

$F = \frac{d}{dt}(Mv) = v\frac{dM}{dt} + M\frac{dv}{dt}$

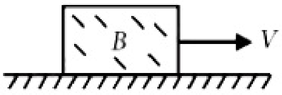
As v is a constant, $F = v\frac{dM}{dt}$

But $\frac{dM}{dt} = M\ kg/s$

$\therefore$ To keep the conveyer belt moving at vm/s
force needed $= vM$ newton.

Question42

A block B is pushed momentarily along a horizontal surface with an initial velocity V. If μ is the coefficient of sliding friction between B and the surface, block B will come to rest after a time



(2007)

Options:

A. gμ / V

B. g / V

C. V / g

D. V / (gμ)

Answer: D

Solution:

Given $u = V$, final velocity $= 0$.
Using $v = u + at$

$\therefore 0 = V - at$ or $, -a = \frac{0 - V}{t} = -\frac{V}{t}$

$f = \mu R = \mu mg$ (f is the force of friction)

$\therefore$ Retardation, $a = \mu g$

$\therefore t = \frac{V}{a} = \frac{V}{\mu g}$

Question43

A 0.5 kg ball moving with a speed of 12m / s strikes a hard wall at an angle of 30° with the wall. It is reflected with the same speed at the same angle. If the ball is in contact with the wall for 0.25 seconds, the average force acting on the wall is
(2006)

Options:

A. 96N

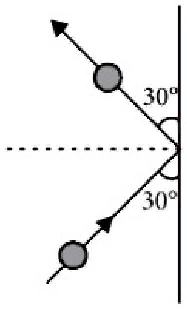
B. 48N

C. 24N

D. 12N

Answer: C

Solution:



Components of momentum parallel to the wall add each other and components of momentum in the perpendicular to the wall are opposite to each other. Therefore change of momentum is final momentum - initial momentum

i.e., ($mv \sin\theta$ after collision $-(-mv\sin\theta)$ before collision

$F \times t =$ change in momentum $= 2mv\sin\theta$

$\therefore F = \frac{2mv\sin\theta}{t} = \frac{2 \times 0.5 \times 12 \times \sin 30°}{0.25} = 48 \times \frac{1}{2} = 24N$

Question44

A block of mass m is placed on a smooth wedge of inclination θ. The whole system is accelerated horizontally so that the block does not slip on the wedge. The force exerted by the wedge on the block will be (g is acceleration due to gravity)
(2004)

Options:

A. $mg\cos\theta$

B. $mg\sin\theta$

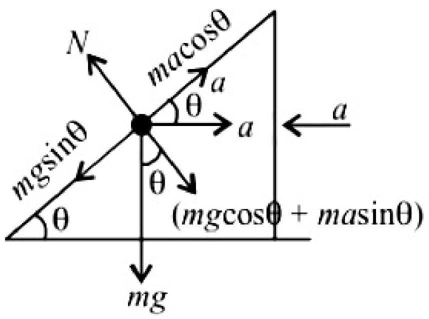
C. mg

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

Answer: D

Solution:

Solution:



The wedge is given an acceleration to the left.

∴ The block has a pseudo acceleration to the right, pressing against the wedge because of which the block is not moving.

$\therefore mg\sin\theta = ma\cos\theta$ or $a = \frac{g\sin\theta}{\cos\theta}$

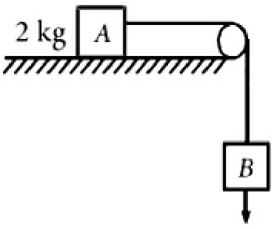
Total reaction of the wedge on the block is$N = mg\cos\theta + ma\sin\theta$

or $N = mg\cos\theta + \frac{mg\sin\theta \,.\, \sin\theta}{\cos\theta}$

or $N = \frac{mg(\cos^2\theta + \sin^2\theta)}{\cos\theta} = \frac{mg}{\cos\theta}$

Question45

The coefficient of static friction, μ_s between block A of mass 2 kg and the table as shown in the figure is 0.2.



What would be the maximum mass value of block B so that the two blocks do not move? The string and the pulley are assumed to be smooth and massless. ($g = 10 m / s^2$)
(2004)

Options:

A. 2.0 kg

B. 4.0 kg

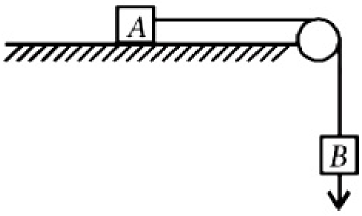
C. 0.2 kg

D. 0.4 kg

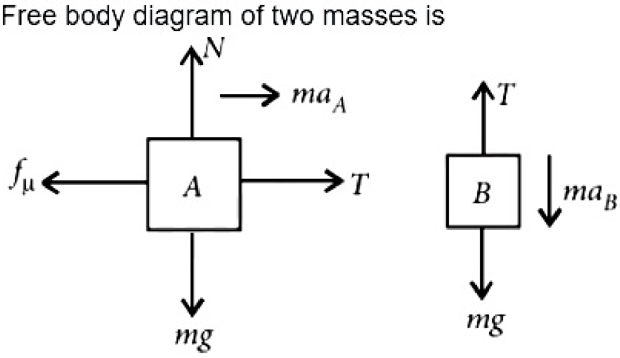
Answer: D

Solution:

Solution:



Free body diagram of two masses is



We get equations
$T + ma = f_\mu$ or $T = \mu N_A$(for a = 0)
and $T = ma + mg$ or $T = m_B g$ (for a = 0)
$\therefore \mu N_A = m_B g$
$\Rightarrow m_B = \mu m_A = 0.2 \times 2 = 0.4$ kg

Question46

A man weighs 80 kg. He stands on a weighing scale in a lift which is moving upwards with a uniform acceleration of $5m / s^2$. What would be the reading on the scale ?($g = 10m / s^2$)
(2003)

Options:

A. zero

B. 400N

C. 800N

D. 1200N

Answer: D

Solution:

Solution:
When the lift is accelerating upwards with acceleration a, then reading on the scale
$R = m(g + a) = 80(10 + 5)N = 1200N$

Question47

A monkey of mass 20 kg is holding a vertical rope. The rope will not break when a mass of 25 kg is suspended from it but will break if the mass exceeds 25 kg. What is the maximum acceleration with which the monkey can climb up along the rope? ($g = 10m / s^2$)
(2003)

Options:

A. $5m / s^2$

B. $10m / s^2$

C. $25m / s^2$

D. $2.5m / s^2$

Answer: D

Solution:

Solution:
Let T be the tension in the rope when monkey climbs up with an acceleration a. Then,
$T - mg = ma$

$25g - 20g = 20a$
$\Rightarrow a = \frac{5 \times 10}{20} = 2.5m / s^2$

Question48

A lift of mass 1000 kg which is moving with acceleration of $1m / s^2$ in upward direction, then the tension developed in string which is connected to lift is
(2002)

Options:

A. 9800N

B. 10, 800N

C. 11, 000N

D. 10, 000N

Answer: B

Solution:

Solution:
For a lift which is moving in upward direction with an acceleration a, the tension T developed in the string connected to the lift is given by $T = m(g + a)$
Here $m = 1000 kg$, $a = 1m / s^2$, $g = 9.8m / s^2$
$\therefore T = 1000(9.8 + 1) = 10,800N$

Question49

A block of mass 10 kg placed on rough horizontal surface having coefficient of friction $\mu = 0.5$, if a horizontal force of 100N acting on it then acceleration of the block will be
(2002)

Options:

A. $10m / s^2$

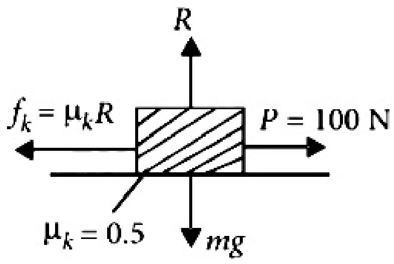
B. $5m / s^2$

C. $15m / s^2$

D. $0.5m / s^2$

Answer: B

Solution:



m = 10 kg, R = mg

∴ Frictional force $= f_k = \mu_k R = \mu_k mg = 0.5 \times 10 \times 10 = 50\text{N}[g = 10\text{m}/\text{s}^2]$

∴ Net force acting on the body $= F = P - f_k = 100 - 50 = 50\text{N}$

∴ Acceleration of the block $= a = \frac{F}{m} = \frac{50}{10} = 5\text{m}/\text{s}^2$

Question50

250N force is required to raise 75 kg mass from a pulley. If rope is pulled 12m then the load is lifted to 3m, the efficiency of pulley system will be
(2001)

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Options:

A. 25%

B. 33.3%

C. 75%

D. 90%.

Answer: C

Solution:

Solution:
Load $W = Mg = 75 \times 10 = 750\text{N}$
Effort $(P) = 250\text{N}$

∴ Mechanical advantage $= \frac{\text{load}}{\text{effort}} = \frac{W}{P} = \frac{750}{250} = 3$

Velocity ratio $= \frac{\text{distance travelled by effort}}{\text{distance travelled by load}} = \frac{12}{3} = 4$

Efficiency, $\eta = \frac{\text{Mechanical advantage}}{\text{Velocity ratio}} = \frac{3}{4} \times 100 = 75\%$

Question51

On the horizontal surface of a truck a block of mass 1 kg is placed ($\mu = 0.6$) and truck is moving with acceleration $5\text{m}/\text{sec}^2$ then the

frictional force on the block will be
(2001)

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Options:

A. 5N

B. 6N

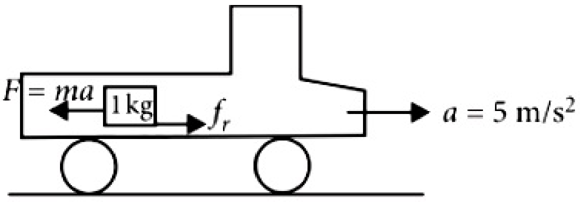
C. 5.88N

D. 8N

Answer: A

Solution:

Solution:



$f_{rL} = \mu_s N = \mu_s \times mg = 0.6 \times 1 \times 10 = 6N$
where f_{rL} is the force of limiting friction.
Pseudo force $= ma = 1 \times 5$; $F = 5N$
If $F < f_{rL}$ block does not move. So static friction is present.
Static friction = applied force.
$\therefore f_r = 5N$

Question52

A cricketer catches a ball of mass 150 gm in 0.1 sec moving with speed 20m / s, then he experiences force of
(2001)

©

Options:

A. 300N

B. 30N

C. 3N

D. 0.3N

Answer: B

Solution:

Impulse = Change in momentum
$F\ .\ \Delta t = m\ .\ v$

$\Rightarrow F = \frac{m\ .\ v}{\Delta t} = \frac{150 \times 10^{-3} \times 20}{0.1} = 30N$

Question53

A 1 kg stationary bomb is exploded in three parts having mass 1 : 1 : 3 respectively. Parts having same mass move in perpendicular direction with velocity 30m / s, then the velocity of bigger part will be (2001)

Options:

A. $10\sqrt{2}$ m/s

B. $\frac{10}{\sqrt{2}}$ m/s

C. $15\sqrt{2}$ m/s

D. $\frac{15}{\sqrt{2}}$ m/s

Answer: A

Solution:

Solution:
Apply conservation of linear momentum.
Total momentum before explosion = total momentum after explosion

$0 = \frac{m}{5}v_1\hat{i} + \frac{m}{5}v_2\hat{j} + \frac{3m}{5}\vec{v}_3$

$\frac{3m}{5}\vec{v}_3 = -\frac{m}{5}\left[v_1\hat{i} + v_2\hat{j}\right]$

$\vec{v}_3 = -\frac{v_1}{3}\hat{i} - \frac{v_2}{3}\hat{j}$

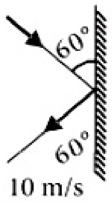
$\therefore v_1 = v_2 = 30m / s$

$\vec{v}_3 = -10\hat{i} - 10\hat{j}$

$v_3 = 10\sqrt{2}m / s$

Question54

A body of mass 3/kg hits a wall at an angle of 60° and returns at the same angle. The impact time was 0.2 sec. The force exerted on the wall



(2000)

Options:

A. $150\sqrt{3}$N

B. $50\sqrt{3}$N

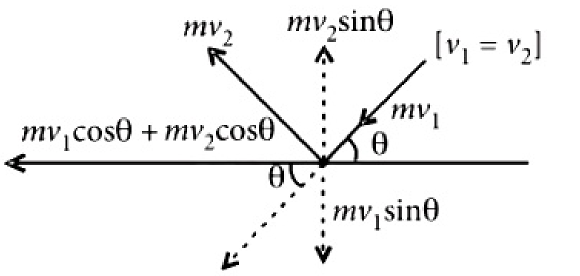
C. 100N

D. $75\sqrt{3}$N

Answer: A

Solution:

Solution:



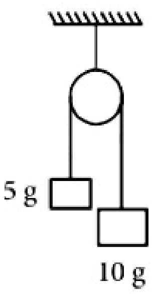
$$mv_2\sin\theta - (-mv_1\sin\theta) = 2\,mv\sin\theta$$

Change in momentum $= 2 \times 3 \times 10 \times \sin 60° = 60 \times \frac{\sqrt{3}}{2}$

Force $= \frac{\text{Change in momentum}}{\text{Impact time}} = \frac{30\sqrt{3}}{0.2} = 150\sqrt{3}\text{N}$

Question55

Two masses as shown in the figure are suspended from a massless pulley. The acceleration of the system when masses are left free is



(2000)

Options:

A. $\frac{2g}{3}$

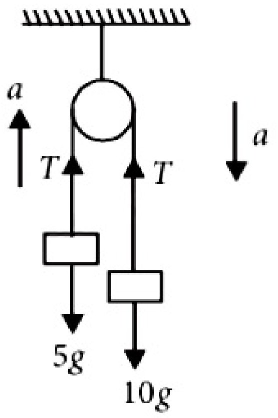
B. $\frac{g}{3}$

C. $\frac{g}{9}$

D. $\frac{g}{7}$

Answer: B

Solution:



The force equations are
$T - 5g = 5a$
$10g - T = 10a$
Adding, $10g - 5g = 15a$
or $a = \frac{5g}{15} = \frac{g}{3}$

Question56

If the force on a rocket, moving with a velocity of 300m / s is 210N, then the rate of combustion of the fuel is
(1999)

Options:

A. $0.07\,kg / s$

B. $1.4\,kg / s$

C. $0.7\,kg / s$

D. $10.7\,kg / s$

Answer: C

Solution:

Force $= \frac{d}{dt}$ (momentum)
$= \frac{d}{dt}(mv) = v\left(\frac{dm}{dt}\right) \Rightarrow 210 = 300\left(\frac{dm}{dt}\right)$
$\frac{dm}{dt} =$ rate of combustion $= \frac{210}{300} = 0.7\,kg / s$

Question57

A mass of 1 kg is suspended by a thread. It is
(i) lifted up with an acceleration $4.9 m / s^2$,
(ii) lowered with an acceleration $4.9 m / s^2$.
The ratio of the tensions is
(1998)

Options:

A. 1 : 3

B. 1 : 2

C. 3 : 1

D. 2 : 1

Answer: C

Solution:

Upward acceleration, $ma = T_1 - mg$
$T_1 = m(g + a)$
Downward acceleration, $ma = mg - T_2$ or, $T_2 = m(g - a)$
$$\frac{T_1}{T_2} = \frac{g + a}{g - a} = \frac{9.8 + 4.9}{9.8 - 4.9} = 3 : 1$$

Question58

A bullet is fired from a gun. The force on the bullet is given by $F = 600 - 2 \times 10^5 t$ where, F is in newton and t in seconds. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet?
(1998)

Options:

A. $9N - s$

B. zero

C. $1.8N - s$

D. $0.9N - s$

Answer: D

Solution:

When $F = 0$, $600 - 2 \times 10^5 t = 0$

$\therefore t = \dfrac{600}{2 \times 10^5} = 3 \times 10^{-3} s$

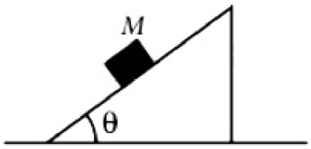
Now, impulse, $I = \int_0^t F\,dt = \int_0^t (600 - 2 \times 10^5 t)\,dt$

$600t - 2 \times 10^5 \dfrac{t^2}{2} = 600 \times 3 \times 10^{-3} - 10^5 \times (3 \times 10^{-3})^2$

or, $I = 1.8 - 0.9 = 0.9 N - s$

Question59

A mass M is placed on a very smooth wedge resting on a surface without friction. Once the mass is released, the acceleration to be given to the wedge so that M remains at rest is a where



(1998)

Options:

A. a is applied to the left and $a = g \tan \theta$

B. a is applied to the right and $a = g \tan \theta$

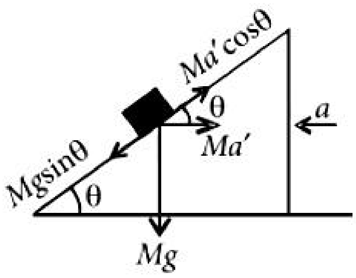
C. a is applied to the left and $a = g \sin \theta$

D. a is applied to the left and $a = g \cos \theta$

Answer: A

Solution:

Solution:



The pseudo acceleration for the body $a' = a$

If the pseudo force $M a \cos \theta = M g \sin \theta$, then the body will be at rest,

$a = g \tan \theta$

This horizontal acceleration should be applied to the wedge to the left.

Question60

A 5000 kg rocket is set for vertical firing. The exhaust speed is $800 ms^{-1}$. To give an initial upward acceleration of $20 ms^{-2}$, the amount of gas ejected per second to supply the needed thrust will be ($g = 10 ms^{-2}$) (1998)

Options:

A. $185.5 \mathrm{~kg} \mathrm{~s}^{-1}$

B. $187.5 \mathrm{~kg} \mathrm{~s}^{-1}$

C. $127.5 \mathrm{~kg} \mathrm{~s}^{-1}$

D. $137.5 \mathrm{~kg} \mathrm{~s}^{-1}$

Answer: B

Solution:

Thrust $= M(g+a) = u\frac{dm}{dt}$

$$\frac{dm}{dt} = \frac{M(g+a)}{u} = \frac{5000(10+20)}{800} = 187.5 \mathrm{~kg} / \mathrm{s}$$

Question61

A force of 6N acts on a body at rest and of mass 1 kg. During this time, the body attains a velocity of 30m / s. The time for which the force acts on the body is (1997)

Options:

A. 7 seconds

B. 5 seconds

C. 10 seconds

D. 8 seconds

Answer: B

Solution:

Solution:
Force $(F) = 6N$
Initial velocity $(u) = 0$
Mass $(m) = 1 \mathrm{~kg}$ and final velocity $(v) = 30 \mathrm{~m} / \mathrm{s}$
Therefore acceleration $(a) = \frac{F}{m} = \frac{6}{1} = 6 \mathrm{~m} / \mathrm{s}^2$ and
final velocity $(v) = 30 = u + at = 0 + 6 \times t$ or $t = 5$ seconds.

Question62

A 10N force is applied on a body produce in it an acceleration of $1m / s^2$. The mass of the body is
(1996)

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Options:

A. 15 kg

B. 20 kg

C. 10 kg

D. 5 kg

Answer: C

Solution:

Solution:
Force (F) = 10N and acceleration (a) = $1m / s^2$
$\text{Mass}(m) = \frac{F}{a} = \frac{10}{1} = 10\,kg$

Question63

A force vector applied on a mass is represented as $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$ and accelerates with $1m / s^2$. What will be the mass of the body?
(1996)

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Options:

A. 10 kg

B. 20 kg

C. $10\sqrt{2}$ kg

D. $2\sqrt{10}$ kg

Answer: C

Solution:

Force $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$ and acceleration (a) = $1m / s^2$
$\text{Mass}(m) = \frac{|\vec{F}|}{a} = \frac{|6\hat{i} - 8\hat{j} + 10\hat{k}|}{1}$
$= \sqrt{36 + 64 + 100} = \sqrt{200} = 10\sqrt{2}\,kg$

Question64

A man fires a bullet of mass 200g at a speed of 5m / s. The gun is of one kg mass. By what velocity the gun rebounds backward?
(1996)

Options:

A. 1m / s

B. 0.01m / s

C. 0.1m / s

D. 10m / s

Answer: A

Solution:

Solution:
Mass of bullet $(m_1) = 200\,gm = 0.2\,kg$
speed of bullet $(v_1) = 5m / sec.$
and mass of gun $(m_2) = 1\,kg.$
Before firing, total momentum is zero.
∴ After firing total momentum is $m_1v_1 + m_2v_2$
From the law of conservation of momentum
$m_1v_1 + m_2v_2 = 0$
or $v_2 = \dfrac{-m_1v_1}{m_2} = \dfrac{-0.2 \times 5}{1} = -1m / s$

Question65

In a rocket, fuel burns at the rate of 1 kg / s This fuel is ejected from the rocket with a velocity of 60 km / s. This exerts a force on the rocket equal to
(1994)

Options:

A. 6000N

B. 60000N

C. 60N

D. 600N.

Answer: B

Solution:

Solution:

Rate of burning of fuel $\left(\frac{dm}{dt}\right) = 1\,kg/s$ and velocity of ejected fuel $(v) = 60\,km/s = 60 \times 10^3 m/s$

Force = Rate of change of momentum $= \frac{dp}{dt} = \frac{d(mv)}{dt} = v\frac{dm}{dt} = (60 \times 10^3) \times 1 = 60000N$

Question66

A block has been placed on a inclined plane with the slope angle θ, block slides down the plane at constant speed. The coefficient of kinetic friction is equal to
(1993)

Options:

A. $\sin\theta$

B. $\cos\theta$

C. g

D. $\tan\theta$

Answer: D

Solution:

Solution:
The acceleration is nullified by force of kinetic friction/mass
$mg\sin\theta$ is force downwards.
μ_k is the coefficient of kinetic friction.
$\mu_k mg\cos\theta$ is force acting upwards.
$\therefore mg\sin\theta - \mu_k mg\cos\theta =$ mass × acceleration.
acceleration $= 0$ as v is constant
$\therefore \mu_k = \tan\theta$

Question67

A monkey is decending from the branch of a tree with constant acceleration. If the breaking strength is 75% of the weight of the monkey, the minimum acceleration with which monkey can slide down without branch is
(1993)

Options:

A. g

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

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

D. $\frac{g}{2}$

Answer: C

Solution:

Solution:
Let T be the tension in the branch of a tree when monkey is decending with acceleration a
Thus, $mg - T = ma$
also, $T = 75\%$ of weight of monkey
$T = \left(\frac{75}{100}\right)mg = \frac{3}{4}mg$
$\therefore ma = mg - \left(\frac{3}{4}\right)mg = \frac{1}{4}mg$ or $a = \frac{g}{4}$

Question68

Consider a car moving along a straight horizontal road with a speed of 72 km / h. If the coefficient of static friction between the tyres and the road is 0.5, the shortest distance in which the car can be stopped is (taking $g = 10 m/s^2$)
(1992)

Options:

A. 30m

B. 40m

C. 72m

D. 20m

Answer: B

Solution:

(b) Here $u = 72 km/h = 20 m/s$;
$v = 0$
$a = -\mu g = -0.5 \times 10 = -5 m/s^2$
As $v^2 = u^2 + 2as$,
$\therefore s = \frac{(v^2 - u^2)}{2a}$
$= \frac{(0 - (20)^2}{2 \times (-5)} = 40m$

Question69

Physical independence of force is a consequence of
(1991)

Options:

A. third law of motion

B. second law of motion

C. first law of motion

D. all of these laws

Answer: C

Solution:

Solution:
Newton's first law of motion is related to physical independence of force.

Question70

A heavy uniform chain lies on horizontal table top. If the coefficient of friction between the chain and the table surface is 0.25 , then the maximum fraction of the length of the chain that can hang over one edge of the table is
(1991)

Options:

A. 20%

B. 25%

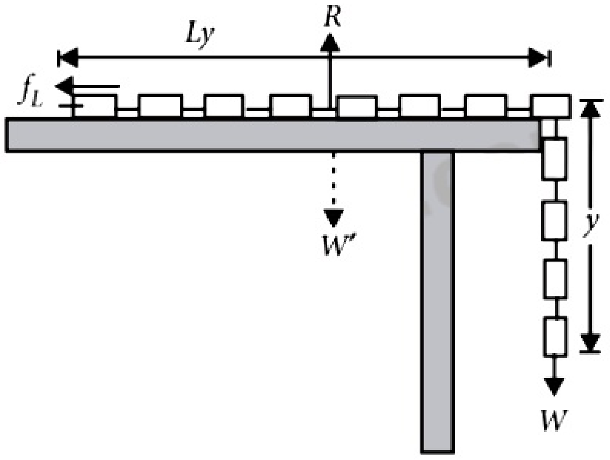
C. 35%

D. 15%

Answer: A

Solution:

Solution:
Let M is the mass of the chain of length L. If y is the maximum length of chain which can hang outside the table without sliding, then for equilibrium of the chain, the weight of hanging part must be balanced by the force of friction on the portion of the table.



W = f_L ....(i)
But from figure
W = $\frac{M}{L}yg$ and $R = W' = \frac{M}{L}(L-y)g$
So that $f_L = \mu R = \mu\frac{M}{L}(L-y)g$
Substituting these values of W and f_L in eqn.(i),we get
$\mu\frac{M}{L}(L-y)g = \frac{M}{L}yg$
or $m(L-y) = y$ or $y = \frac{\mu L}{\mu+1} = \frac{0.25L}{1.25} = \frac{L}{5}$
or $\frac{y}{L} = \frac{1}{5} = \frac{1}{5} \times 100\% = 20\%$

Question71

When milk is churned, cream gets separated due to (1991)

Options:

A. centripetal force

B. centrifugal force

C. fricitional force

D. gravitational force

Answer: B

Solution:

Solution:
When milk is churned, cream gets separated due to centrifugal force.

Question72

A particle of mass m is moving with a uniform velocity v_1. It is given an impulse such that its velocity becomes v_2. The impulse is equal to

(1990)

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Options:

A. $m[|v_2| - v_1|]$

B. $\frac{1}{2}m[v_2{}^2 - v_1{}^2]$

C. $m[v_1 + v_2]$

D. $m[v_2 - v_1]$

Answer: D

Solution:

Solution:
Impulse is a vector quantity and is equal to change in momentum of the body thus, (same as $F \times t$ where t is short)
Impulse $= mv_2 - mv_1 = m(v_2 - v_1)$

Question73

A 600 kg rocket is set for a vertical firing. If the exhaust speed is $1000ms^{-1}$, the mass of the gas ejected per second to supply the thrust needed to overcome the weight of rocket is (1990)

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Options:

A. $117.6\,kg\,s^{-1}$

B. $58.6\,kg\,s^{-1}$

C. $6\,kg\,s^{-1}$

D. $76.4\,kg\,s^{-1}$

Answer: C

Solution:

Solution:
Thrust is the force with which the rocket moves upward given by
$F = u\frac{dm}{dt}$
Thus mass of the gas ejected per second to supply the thrust needed to overcome the weight of the rocket is
$\frac{dm}{dt} = \frac{F}{u} = \frac{m \times a}{u}$ or $\frac{dm}{dt} = \frac{600 \times 10}{1000} = 6\,kg\,s^{-1}$

Question74

A body of mass 5 kg explodes at rest into three fragments with masses in the ratio 1 : 1 : 3. The fragments with equal masses fly in mutually perpendicular directions with speeds of 21m / s. The velocity of heaviest fragmentin m / s will be
(1989)

Options:

A. $7\sqrt{2}$

B. $5\sqrt{2}$

C. $3\sqrt{2}$

D. $\sqrt{2}$

Answer: A

Solution:

Solution:
since 5 kg body explodes into three fragments with masses in the ratio 1: 1: 3 thus, masses of fragments will be 1 kg, 1 kg and 3 kg respectively. The magnitude of resultant momentum of two fragments each of mass 1 kg, moving with velocity 21m / s, in perpendicular directions is
$\sqrt{(m_1v_1)^2 + (m_2v_2)^2}$
$m'v' = \sqrt{(21)^2 + (21)^2} = 21\sqrt{2}\text{kg m / s}$
According to law of conservation of linear momentum $m_3v_3 = m'v' = 21\sqrt{2}$ or $3v_3 = 21\sqrt{2}$
or $v_3 = 7\sqrt{2}\text{m / s}$

Question75

Starting from rest, a body slides down a 45° inclined plane in twice the time it takes to slide down the same distance in the absence of friction. The coefficient of friction between the body and the inclined plane is
(1988)

Options:

A. 0.80

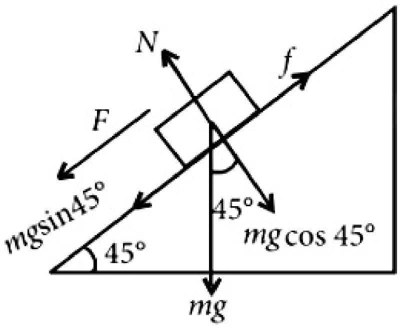
B. 0.75

C. 0.25

D. 0.33

Answer: B

Solution:



The various forces acting on the body have been shown in the figure. The force on the body down the inclined plane in presence of friction μ is

$F = mg\sin\theta - f = mg\sin\theta - \mu N = ma$

or $a = g\sin\theta - mu\,g\cos\theta$

since block is at rest thus initial velocity $u = 0$

∴ Time taken to slide down the plane

$$t_1 = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2s}{g\sin\theta - \mu g\cos\theta}}$$

In absence of friction time taken will be

$$t_2 = \sqrt{\frac{2s}{g\sin\theta}}$$

Given : $t_1 = 2t_2$

$\therefore t_1^2 = 4t_2^2$ or $\frac{2s}{g(\sin\theta - \mu\cos\theta)} = \frac{2s \times 4}{g(\sin\theta)}$

or $\sin\theta = 4\sin\theta - 4\mu\cos\theta$ or $\mu = \frac{3}{4}\tan\theta = 0.75$
