JEE Main Most Important Questions from Laws of Motion

Question 1:
A block of mass M placed inside a box descends vertically with acceleration a. The block exerts a force equal to one-fourth of its weight on the floor of the box. What will be the value of a? **[29-Jun-2022 Shift-2]**
(a) g/4
(b) g/2
(c) 3g/4
(d) g
Click for Answer

Question 2:
A monkey of mass 50 kg climbs on a rope which can withstand a tension (T) of 350N. If the monkey initially climbs down with an acceleration of 4 m/s² and then climbs up with an acceleration of 5 m/s², choose the correct option (g = 10 m/s²). **[26-Jul-2022 Shift-1]**
(a) T = 700N while climbing upward
(b) T = 350N while going downward
(c) Rope will break while climbing upward
(d) Rope will break while going downward
Click for Answer

Question 3:
A bag is gently dropped on a conveyor belt moving at a speed of 2 m/s. The coefficient of friction between the conveyor belt and bag is 0.4. Initially, the bag slips on the belt before it stops due to friction. The distance travelled by the bag on the belt during slipping motion is: **[27-Jul-2022 Shift-1]**
(a) 2m
(b) 0.5m
(c) 3.2m
(d) 0.8m
Click for Answer

Question 4:
A block 'A' takes 2 seconds to slide down a frictionless incline of 30° and length 'L', kept inside a lift going up with uniform velocity 'v'. If the incline is changed to 45°, the time taken by the block to slide down the incline will be approximately: **[27-Jul-2022 Shift-2]**
(a) 2.66s
(b) 0.83s
(c) 1.68s
(d) 0.70s
Click for Answer

Question 5:
A balloon has a mass of 10g in air. The air escapes from the balloon at a uniform rate with a velocity of 4.5 cm/s. If the balloon shrinks completely in 5 seconds, what is the average force acting on the balloon (in dyne)? **[28-Jul-2022 Shift-1]**
(a) 3
(b) 9
(c) 12
(d) 18
Click for Answer

Question 6:
A particle is moving with uniform speed along the circumference of a circle of radius R under the action of a central fictitious force F, which is inversely proportional to R^3. The time period of revolution will be given by: **[26-Feb-2021 Shift-1]**
(a) $T \propto R^2$
(b) $T \propto R^{3/2}$
(c) $T \propto R^{5/2}$
(d) $T \propto R^{4/3}$
Click for Answer

Question 7:

Statement I: A cyclist is moving on an unbanked road with a speed of 7 km/h and takes a sharp circular turn along a path of radius 2 m without reducing the speed. The static friction coefficient is 0.2. The cyclist will not slip and pass the curve ($g = 9.8\ m/s^2$).

Statement II: If the road is banked at an angle of 45°, the cyclist can cross the curve of 2 m radius with a speed of 18.5 km/h without slipping.In the light of the above statements, choose the correct answer from the options below. **[16 Mar 2021 Shift 2]**

(a) Statement I is false and statement II is true
(b) Statement I is true and statement II is false
(c) Both statement I and statement II are false
(d) Both statement I and statement II are true

Click for Answer

Question 8:

A block of 200g mass moves with a uniform speed in a horizontal circular groove, with vertical side walls of radius 20 cm. If the block takes 40 seconds to complete one round, what is the normal force exerted by the side walls of the groove? **[16 Mar 2021 Shift 1]**

(a) 0.0314 N
(b) 9.859×10^−2N
(c) 6.28×10^−3N
(d) 9.859×10^−4N

Click for Answer

Question 9:

A steel block of 10 kg rests on a horizontal floor as shown. When three iron cylinders are placed on it, the block and cylinders descend with an acceleration of $0.2\ m/s^2$. The normal reaction R′ by the floor, if the mass of the iron cylinders is equal and each cylinder has a mass of 20 kg, is ____ N.

[20 Jul 2021 Shift 1]

(a) 716
(b) 686
(c) 714
(d) 684

Click for Answer

Question 10:

The normal reaction 'N' for a vehicle of 800 kg mass, negotiating a turn on a 30° banked road at maximum possible speed without skidding is _____ x 10^3 kgm/s^2.

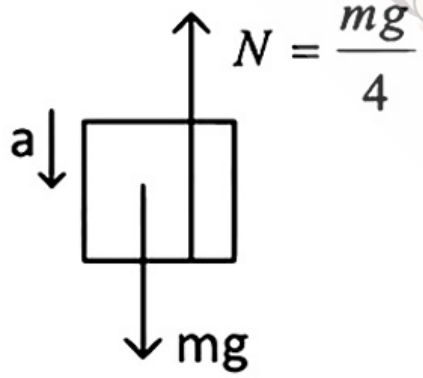
[20 Jul 2021 Shift 1]

(a) 10.2
(b) 7.2
(c) 12.4
(d) 6.96

Click for Answer

Solution 1:

The correct answer is Option (c)



Using Newton's second law

$$mg - \frac{mg}{4} = ma$$

$$\Rightarrow a = \frac{3g}{4}$$

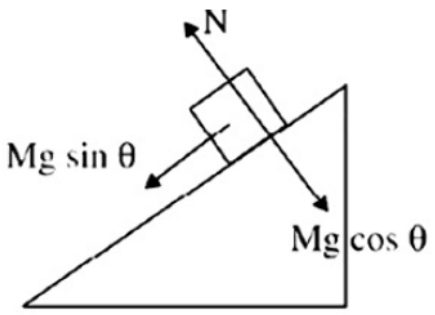
Solution 2:
The correct answer is Option (c)

$T_{down} = 50 \times (10 - 4)$
$= 50 \times 6$
$= 300N$
$T_{up} = 50 \times (10 + 5)$
$= 50 \times 15$
$= 750N$
⇒ Rope will break while climbing up.

Solution 3:
The correct answer is Option (b)

$v = 2m / s$
$\mu = 0.4$
$a = +(0.4)(g)$
$= +4m / s^2$
$v^2 - u^2 = 2as$
$\Rightarrow (4) = 2 \times (4)(s)$
$s = 0.5m$

Solution 4:
The correct answer is Option ©



$$a = g\sin\theta$$
$$\ell = \frac{1}{2}g\sin 30^\circ (2)^2$$
$$\ell = \frac{1}{2}g\sin 45^\circ t^2$$
$$\left(\frac{1}{2}\right)(4) = \frac{1}{\sqrt{2}}t^2 \Rightarrow t = \sqrt{2\sqrt{2}} \simeq 1.68$$

Solution 5:

The correct answer is Option (b)

$$F = \frac{dm}{dt}v$$
$$= \frac{10g}{5\ s}\left(4.5\ \frac{cm}{s}\right) = 9\ \frac{gcm}{s^2} = 9\ \text{dyne}$$

Solution 6:

The correct answer is Option (a)

Given, radius of circle $= R$

Central fictitious force is, $F \propto \frac{1}{R^3}$.

Let T be the time period of revolution, m, ω be the mass and angular velocity of Earth

$\because\ F = m\omega^2 R \propto \frac{1}{R^3}$

$\Rightarrow\ \omega^2 \propto \frac{1}{R^4} \Rightarrow \omega = \frac{2\pi}{T} \propto \frac{1}{R^2}$

$\Rightarrow\ T \propto R^2$

Solution 7:

The correct answer is Option (d)

The maximum speed of cyclist on turn of unbanked road without slipping is given as

$v_{max} = \sqrt{\mu gR} = \sqrt{0.2 \times 10 \times 2} = 2ms^{-1}$ [$\because \mu = 0.2$ (given)]

Given, speed $= 7km/h$

$= \frac{7000}{3600}ms^{-1} = \frac{70}{36} = 1.94ms^{-1}$

As given speed is lesser than v_{max}, so the cyclist will not slip. Therefore, Statement I is true.

As per Statement II, angle of banking, $\theta = 45^{\circ}$

We know that, for banked road,

$$V_{max} = \sqrt{\frac{gR(\mu + \tan\theta)}{(1 - \mu\tan\theta)}}$$

and $$v_{min} = \sqrt{\frac{gR(\tan\theta - \mu)}{1 + \mu\tan\theta}}$$

$$\Rightarrow v_{max} = \sqrt{\frac{10 \times 2(0.2 + \tan 45^{\circ})}{1 - 0.2\tan 45^{\circ}}}$$

and $$v_{min} = \sqrt{\frac{10 \times 2(1 - 0.2)}{1 + 0.2}}$$

and $$v_{min} = \sqrt{\frac{10 \times 2(1 - 0.2)}{1 + 0.2}}$$

$$\Rightarrow v_{max} = 5.47 ms^{-1} \text{ and } v_{min} = 3.65 ms^{-1}$$

$$\because v = 18.5 km/h = \frac{18.5 \times 1000}{5600} = 5.13 ms^{-1}$$

[$\because$ given speed $= 18.5 kmh^{-1}$]

As, $v_{min} < v < v_{max}$, so the cyclist will not slip.

$\therefore$ Statement II is also true.

Hence, option (d) is the correct.

Solution 8:

The correct answer is Option (d)

The normal force by the side walls of the groove will be equal to the centripetal force acting on it.

i.e. $$N = \frac{mv^2}{r} .....(i)$$

where,

$r = 20cm = 0.2m$

$m = 200g = 200 \times 10^{-3} kg$ and $v = r\omega = \frac{2\pi r}{T} = \frac{2\pi \times 0.2}{40} m/s$

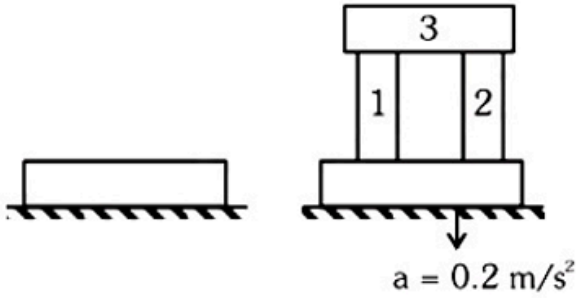
Substituting the given values in Eq. (i), we get

$$N = \frac{(200 \times 10^{-3}) \times \left(\frac{2\pi \times 0.2}{40}\right)^2}{0.2}$$

$$\approx 9.859 \times 10^{-4} N$$

Solution 9:

The correct answer is Option (b)



Writing force equation in vertical direction

$Mg - N = Ma$

$\Rightarrow 70g - N = 70 \times 0.2$

$\Rightarrow N = 70[g - 0.2] = 70 \times 9.8$

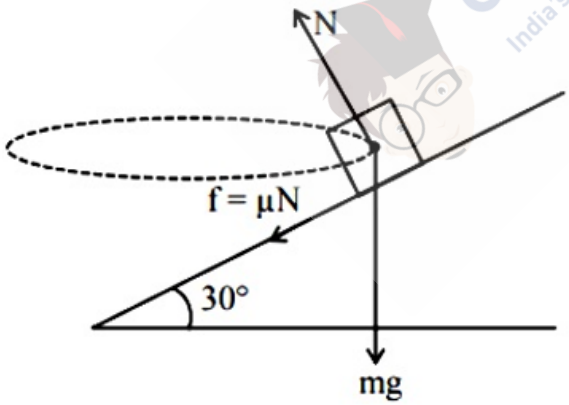
$\therefore N = 686$ Newton

Note : Since there is no compressive normal from the sides, hence friction will not act.

Hence option 2.

Solution 10:

The correct answer is Option (a)



At v_{max}, f will be limiting in nature.

$\therefore$ Balancing force in vertical direction,

$N\cos 30° - mg - \mu N\cos 60° = 0$

$\Rightarrow N[\cos 30° - \mu\cos 60°] = mg$

$\therefore N = \frac{800 \times 10}{(0.87 - 0.1)} \approx 10.2 \times 10^3 \text{kgm/s}^2$

Hence option 1 .