JEE Main Must-do Questions from Laws of Motion

Question 1: Given are two statements regarding an elevator:

Statement-I: An elevator can go up or down with uniform speed when its weight is balanced with the tension of its cable.
Statement-II: The force exerted by the floor of an elevator on the foot of a person standing on it is more than his/her weight when the elevator goes down with increasing speed.

Select the correct option based on the above statements. **[24-Jan-2023 Shift 1]**
(a) Both statement I and statement II are false
(b) Statement I is true but Statement II is false
(c) Both Statement I and Statement II are true
(d) Statement I is false but Statement II is true
Click for Answer

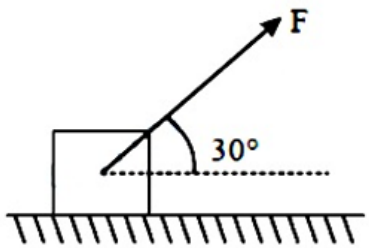
Question 2:
A force acts for 20 seconds on a body of mass 20 kg, starting from rest. After the force ceases, the body covers 50 meters in the next 10 seconds. What is the value of the force? **[29-Jan-2023 Shift 2]**

(a) 40 N
(b) 5 N
(c) 20 N
(d) 10 N
Click for Answer

Question 3:
A body of mass 10 kg is moving with an initial speed of 20 m/s. The body stops after 5 seconds due to friction between the body and the floor. Determine the value of the coefficient of friction. (Acceleration due to gravity is 10 m/s^2) **[31-Jan-2023 Shift 2]**

(a) 0.2
(b) 0.3
(c) 0.5
(d) 0.4
Click for Answer

Question 4:
A block of mass 10 kg lying on a horizontal surface is pulled by a force F acting at an angle of 30° with the horizontal. For a coefficient of friction μs=0.25\mu_s = 0.25μs=0.25, determine the force F required to just start moving the block. (Take acceleration due to gravity as 10 m/s²) **[1-Feb-2023 Shift 2]**



(a) 33.3 N
(b) 25.2 N
(c) 20 N
(d) 35.7 N
Click for Answer

Question 5:
A small block of mass 100g is tied to a spring with a spring constant of 7.5 N/m and length 20 cm. The other end of the spring is fixed at a particular point A. If the block moves in a circular path on a smooth horizontal surface with constant angular velocity 5 rad/s around point A, what is the tension in the spring? **[6-Apr-2023 Shift 1]**

(a) 0.75 N
(b) 1.5 N
(c) 0.25 N
(d) 0.50 N
Click for Answer

Question 6:
Given below are two statements: one is labelled as Assertion A and the other as Reason R.
Assertion A: An electric fan continues to rotate for some time after the current is switched off.
Reason R: The fan continues to rotate due to inertia of motion.

In the light of the above statements, choose the most appropriate answer from the options given below. **[10-Apr-2023 Shift 2]**

(a) A is not correct but R is correct
(b) Both A and R are correct and R is the correct explanation of A
(c) Both A and R are correct but R is NOT the correct explanation of A
(d) A is correct but R is not correct
Click for Answer

Question 7:
A body of mass 500g moves along the x-axis such that its velocity varies with displacement x according to the relation v=10xv = 10\sqrt{x}v=10x m/s. What is the force acting on the body? **[11-Apr-2023 Shift 2]**

(a) 25 N
(b) 5 N
(c) 166 N
(d) 125 N
Click for Answer

Question 8:
A system of two blocks of masses m=2 kg and M=8 kg is placed on a smooth table as shown in the figure. The coefficient of static friction between the two blocks is 0.5. What is the maximum horizontal force F that can be applied to the block of mass M so that the blocks move together? **[27-Jun-2022 Shift 1]**

(a) 9.8 N
(b) 39.2 N
(c) 49 N
(d) 78.4 N
Click for Answer

Question 9:

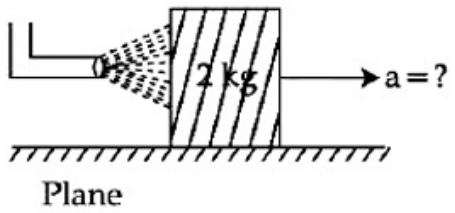
A block of mass 2 kg moving at a speed of 4 m/s on a horizontal surface enters a rough surface spanning from x=0.5 to x=1.5. The retarding force in this range of the rough surface is related to distance by F=−kx where k=12 N/m. What will be the speed of the block as it just crosses the rough surface? **[28-Jun-2022 Shift 2]**

(a) zero
(b) 1.5 m/s
(c) 2.0 m/s
(d) 2.5 m/s

Click for Answer

Question 10:

A block of metal weighing 2 kg is resting on a frictionless plane. It is struck by a jet releasing water at a rate of 1 kg/s and at a speed of 10 m/s. What is the initial acceleration of the block, in m/s²? **[29-Jun-2022 Shift 1]**



(a) 3
(b) 6
(c) 5
(d) 4

Click for Answer

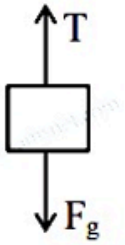
Solution 1:

The correct answer is Option (b)

Statement-1

When elevator is moving with uniform speed $T = F_g$

Statement-2



When elevator is going down with increasing speed, its acceleration is downward.

Hence

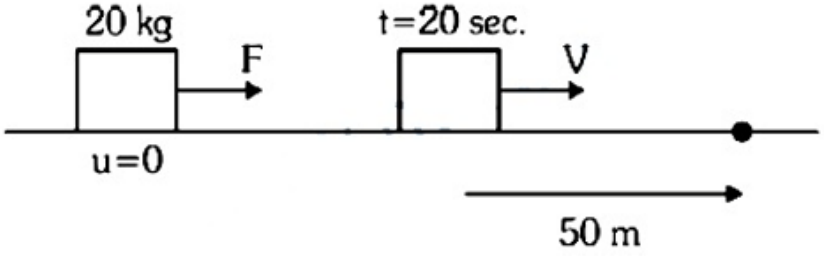
$$W - N = \frac{W}{g} \times a$$

$N = W\left(1 - \frac{a}{g}\right)$ i.e. less than weight.

Solution 2:

The correct answer is Option (b)

Solution:



$50 = V \times 10$

$V = 5m/s$

$V = 0 + a \times 20$

$5 = a \times 20$

$a = \frac{1}{4} m/s^2$

$F = ma = 20 \times \frac{1}{4} = 5N$

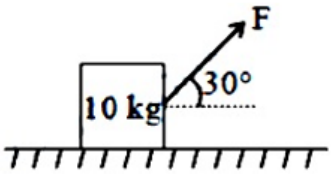
Solution 3:

The correct answer is Option (d)

$$a = -\mu g$$
$$\because v = u + at$$
$$0 = 20 + (-\mu \times 10) \times 5$$
$$50\mu = 20$$
$$\mu = \frac{2}{5} = 0.4$$

Solution 4:

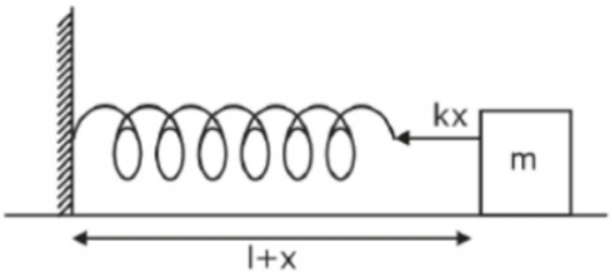
The correct answer is Option (b)



$$N = Mg - F\,Sin\,30^{\circ}$$
$$= mg - \frac{F}{2} = 100 - \frac{F}{2} = \frac{200 - F}{2}$$
$$F\,Cos\,30^{\circ} = \mu N$$
$$\sqrt{3}\,\frac{F}{2} = 0.25 \times \left(\frac{200 - F}{2}\right)$$
$$4\sqrt{3}F = 200 - F$$
$$F = \frac{200}{4\sqrt{3} + 1} = 25.22$$

Solution 5:

The correct answer is Option (a)



$kx = m\omega^2 r$

$\Rightarrow kx = 0.1 \times 25 \times (0.2 + x)$

$\Rightarrow 7.5x = 2.5(0.2 + x)$

$\Rightarrow 3x = 0.2 + x$

$\Rightarrow 2x = 0.2$

$\Rightarrow x = 0.1m$

Now, tension in the spring $= kx = 7.5 \times 0.1N = 0.75N$

Solution 6:

The correct answer is Option (b)

Inertia is the property of mass that causes an object to maintain its state of motion unless acted upon by an external force. In the case of a rotating fan, even after the power is switched off, it continues to move for some time. This continued motion occurs because the air resistance gradually slows down the fan's rotation, and due to the fan's inertia, it keeps moving until the resistive forces sufficiently counteract its momentum.

Solution 7

The correct answer is Option (a)

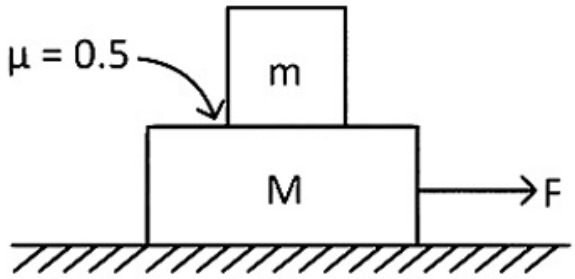
$$v = 10\sqrt{x} \Rightarrow \frac{dv}{dx} = \frac{10}{2\sqrt{x}} = \frac{5}{\sqrt{x}}$$

$$a = v\frac{dv}{dx}$$

$$a = v \times \frac{5}{\sqrt{x}} = 10\sqrt{x} \times \frac{5}{\sqrt{x}} = 50ms^{-2}$$

$$F = ma = \frac{500}{1000} \times 50 = 25N$$

Solution 8:
The correct answer is Option (c)



$\therefore a_{max} = \mu g$
$= 0.5 \times 9.8 = 4.9 m / s^2$
$\therefore F_{max} = (8 + 2) \times 4.9 = 49 N$

Solution 9:
The correct answer is Option (c)

$$F = -12x$$
$$mv\frac{dv}{dx} = -12x$$
$$\int_4^v v\,dv = -6\int_{0.5}^{1.5} x\,dx (m = 2\,kg)$$
$$\frac{v^2 - 16}{2} = -6\left[\frac{1.5^2 - 0.5^2}{2}\right]$$
$$\frac{v^2 - 16}{2} = -6$$
$$v = 2 m / sec$$

Solution 10:
The correct answer is Option (c)

$$F = \rho v^2 a$$
$$\Rightarrow 10 \times 1 = 2 \times \text{acceleration}$$
$$\Rightarrow \text{Acc.} = 5 m / s^2$$