Module-Test-8
(Physics-JEE)

December 31, 2022

Section-A
(One Options Correct Type)

This section contains 20 multiple choice questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE option is correct.

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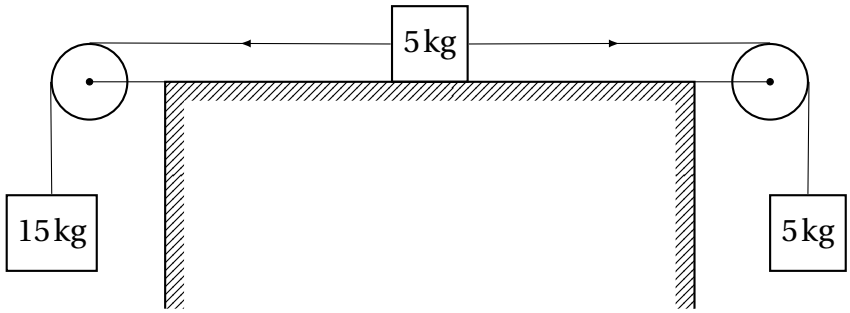
1. In the figure shown, the frictional coefficient between table and block is 0.2. Find the ratio of tensions in the right and left strings.



a) 17 : 24 *Ans.*
b) 34 : 12
c) 2 : 3
d) 3 : 2

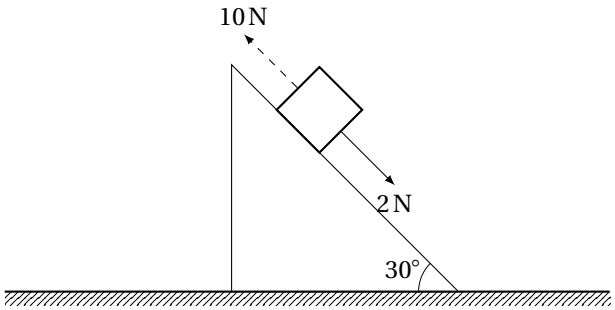
2. To mop-clean a floor, a cleaning machine presses a circular mop of radius R vertically down with a total force F and rotates it with a constant angular speed about its axis. If the force F is distributed uniformly over the mop and if coefficient of friction between the mop and the floor is μ, the torque applied by the machine on the mop in (N m) is

a) $\frac{2}{3}\mu FR$ *Ans.*
b) $\frac{1}{6}\mu FR$
c) $\frac{1}{3}\mu FR$
d) $\frac{1}{2}\mu FR$

3. A particle of mass m is moving in a straight line with momentum p. Starting at time $t = 0$, a force $F = kt$ acts in the same direction on the moving particle during time interval T , so that its momentum changes from p to $3p$. Here, k is a constant. The value of T is

a) $\sqrt{\frac{2p}{k}}$
b) $2\sqrt{\frac{p}{k}}$ *Ans.*
c) $\sqrt{\frac{2k}{p}}$
d) $2\sqrt{\frac{k}{p}}$

4. A block kept on a rough inclined plane, as shown in the figure, remains at rest upto a maximum force 2 N down the inclined plane. The maximum external force up the inclined plane that does not move the block is 10 N. The coefficient of static friction between the block and the plane is (Take, $g = 10\,\mathrm{m\,s^{-2}}$)



a) $\frac{2}{3}$

b) $\frac{\sqrt{3}}{2}$ *Ans.*

c) $\frac{\sqrt{3}}{4}$

d) $\frac{1}{2}$

5. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the mass, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is

   a) 70 N

   b) 200 N

   c) 100 N *Ans.*

   d) 140 N

6. A block of mass m is placed on a surface with a vertical cross-section given by $y = x^3/6$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is

   a) $\frac{1}{6}$ m *Ans.*

   b) $\frac{2}{3}$ m

   c) $\frac{1}{3}$ m

   d) $\frac{1}{2}$ m

7. The minimum force required to start pushing a body up a rough (frictional coefficient μ) inclined plane is F_1 while the minimum force needed to prevent it from sliding down is F_2. If the inclined plane makes an angle θ from the horizontal such that $\tan\theta = 2\mu$, then the ratio $\frac{F_1}{F_2}$ is

   a) 4

   b) 1

   c) 2

   d) 3 *Ans.*

8. A block of mass m is connected to another block of mass M by a spring (massless) of spring constant k . The blocks are kept on a smooth horizontal plane. Initially the blocks are at rest and the spring is unstretched. Then, a constant force F starts acting on the block of mass M to pull it. Find the force on the block of mass m.

   a) $\frac{mF}{M}$

   b) $\frac{(M+m)F}{m}$

   c) $\frac{mF}{m+M}$ *Ans.*

   d) $\frac{MF}{m+M}$

9. A mass of M kg is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45° with the initial vertical direction is

   a) $Mg(\sqrt{2}+1)$

   b) $Mg\sqrt{2}$

   c) $\frac{Mg}{\sqrt{2}}$

   d) $Mg(\sqrt{2}-1)$ *Ans.*

10. Consider a car moving on a straight road with a speed of 100 m s^{-1}. The distance at which car can be stopped, is [$\mu_k = 0.5$]

    a) 800 m

    b) 1000 m *Ans.*

    c) 100 m

    d) 400 m

11. A smooth block is released at rest on a 45° incline and then slides a distance d.The time taken to slide is n times as much to slide on rough incline than on a smooth incline. The coefficient of friction is

a) $\mu_k = 1 - \frac{1}{n^2}$ *Ans.*

b) $\mu_k = \sqrt{1 - \frac{1}{n^2}}$

c) $\mu_s = 1 - \frac{1}{n^2}$

d) $\mu_s = \sqrt{1 - \frac{1}{n^2}}$

12. The upper half of an inclined plane with inclination θ is perfectly smooth, while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom, if the coefficient of friction for the lower half is given by

a) $2\sin\theta$

b) $2\cos\theta$

c) $2\tan\theta$ *Ans.*

d) $\tan\theta$

13. A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is 10 N, the mass of the block (in kg) is ($g = 10\,\mathrm{m\,s^{-2}}$)

a) 2.0 *Ans.*

b) 4.0

c) 1.6

d) 2.5

14. A marble block of mass 2 kg lying on ice when given a velocity of $6\,\mathrm{m\,s^{-1}}$ is stopped by friction in 10 s. Then, the coefficient of friction is

a) 0.02

b) 0.03

c) 0.06 *Ans.*

d) 0.01

15. A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m. If a force P is applied at the free end of the rope, the force exerted by the rope on the block is

a) $\frac{Pm}{M+m}$

b) $\frac{Pm}{M-m}$

c) P

d) $\frac{PM}{M+m}$ *Ans.*

16. A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 (vertically). If the acceleration of the system is $g/8$,then the ratio of the masses is

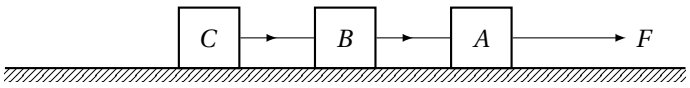
a) 8 : 1

b) 9 : 7 *Ans.*

c) 4 : 3

d) 5 : 3

17. Three identical blocks of masses $m = 2\,\mathrm{kg}$ are drawn by a force $F = 10.2\,\mathrm{N}$ with an acceleration of $0.6\,\mathrm{m\,s^{-2}}$ on a frictionless surface, then what is the tension (in N) in the string between the blocks B and C ?



a) 9.2

b) 7.8 *Ans.*

c) 4

d) 9.8

18. When forces F_1 , F_2 , F_3 are acting on a particle of mass m such that F_2 and F_3 are mutually perpendicular, then the particle remains stationary. If the force F_1 is now removed, then the acceleration of the particle is

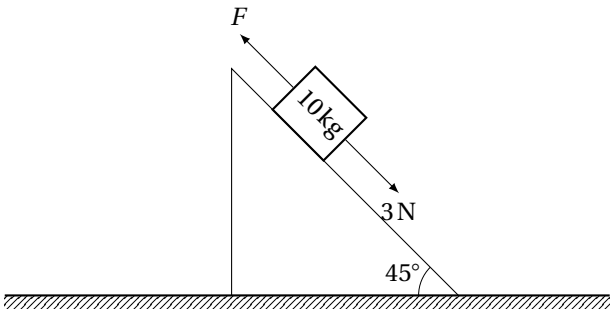
a) $\frac{F_1}{m}$ *Ans.*

b) $\frac{F_2 F_3}{m F_1}$

c) $\frac{F_2 - F_3}{m}$

d) $\frac{F_2}{m}$

19. A block of mass 10 kg is kept on a rough inclined plane as shown in the figure. A force of 3 N is applied on the block. The coefficient of static friction between the plane and the block is 0.6. What should be the minimum value of force F , such that the block does not move downward ?



a) 32 N *Ans.*
b) 25 N
c) 23 N
d) 18 N

20. A block of mass m is placed at rest on a horizontal rough surface with angle of friction ϕ. The block is pulled with a force F at an angle θ with the horizontal. The minimum value of F required to move the block is

a) $\dfrac{mg\sin\phi}{\cos(\theta-\phi)}$ *Ans.*
b) $\dfrac{mg\cos\phi}{\cos(\theta-\phi)}$
c) $mg\tan\phi$
d) $mg\sin\phi$

Section-B
(Numerical Answer Type)

This section contains 10 questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place).
Do any 5 questions out of 10 Questions.

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1. A thin rod of length 1 m is fixed in a vertical position inside a train, which is moving horizontally with constant acceleration $4\,\mathrm{m\,s^{-2}}$. A bead can slide on the rod and friction coefficient between them is 0.5. If the bead is released from rest at the top of the rod, it will reach the bottom in time t then the value of $2t$ is [1]

2. A uniform cube of mass m and side a is resting in equilibrium on a rough 45° inclined surface. The distance of the point of application of normal reaction measured from the lower edge of the cube is [0]

3. A block A of mass 2 kg rests on another block B of mass 8 kg which rests on a horizontal floor. The coefficient of friction between A and B is 0.2 while that between B and floor is 0.5. When a horizontal force F of 25 N is applied on the block B, the force of friction between A and B is [0]

4. A block A of mass 4 kg is kept on ground. The coefficient of friction between the block and the ground is 0.8. The external force of magnitude 30 N is applied parallel to the ground. The resultant force exerted by the ground on the block in newton is ($g = 10\,\mathrm{m\,s^{-2}}$) [50]

5. A horizontal force of 10 N is necessary to just hold a block stationary against a wall. The coefficient of friction between the block and the wall is 0.2. The weight of the block is [2]

6. A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is 10 N, the mass of the block (in kg) is ($g = 10\,\mathrm{m\,s^{-2}}$) [2]

7. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of $5\,\mathrm{m\,s^{-2}}$, the reading of the spring balance will be [24]

8. Two blocks of equal mass are stacked on top of each other on a horizontal plane, then the frictional force between them is [0]

9. A block of mass m is placed on a frictionless inclined plane, then the angle of repose is [0]

10. A block of mass m is placed on a frictionless horizontal plane, then the angle of friction is [0]