CHAPTER 4

Laws of Motion

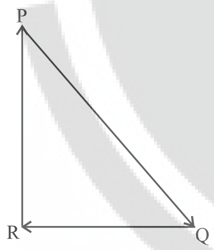
Equation of Motion and Newton's Laws of Motion

1. A small block slides down on a smooth inclined plane, starting from rest at time t = 0. Let S_n be the distance travelled by the block in the interval t = n – 1 to t = n. The, the ratio $\frac{S_n}{S_{n+1}}$ is: *(2021)*

a. $\frac{2n-1}{2n+1}$ b. $\frac{2n+1}{2n-1}$

c. $\frac{2n}{2n-1}$ d. $\frac{2n-1}{2n}$

2. A particle moving with velocity $\overline{V}$ is acted by three forces shown by the vector triangle PQR. The velocity of the particle will: *(2019)*



a. Increase
b. Decrease
c. Remain constant
d. Change according to the smallest force

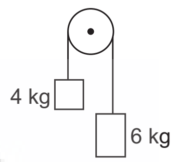
3. A balloon with mass m is descending down with an acceleration a (where a < g). How much mass should be removed from it so that it starts moving up with an acceleration a? *(2014)*

a. $\frac{2ma}{g+a}$ b. $\frac{2ma}{g-a}$

c. $\frac{ma}{g+a}$ d. $\frac{ma}{g-a}$

Motion of Connected Bodies

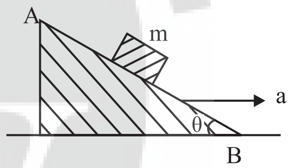
4. Two bodies of mass 4 kg and 6 kg are tied to the ends of a massless string. The string passes over a pulley which is frictionless (see figure). The acceleration of the system in terms of acceleration due to gravity (g) is: *(2020)*



a. g/2   b. g/5

c. g/10   d. g

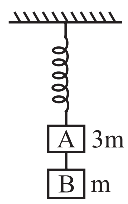
5. A block of mass m is placed on a smooth inclined wedge ABC of inclination θ as shown in the figure. The wedge is given an acceleration 'a' towards the right. The relation between a and θ for the block to remain stationary on the wedge is: *(2018)*



a. $a = g \cos\theta$ b. $a = \frac{g}{\sin\theta}$

c. $a \ \frac{g}{\text{cosec}}$ d. $a = g \tan\theta$

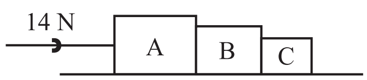
6. Two blocks A and B of masses 3 m and m respectively are connected by a massless and inextensible string. The whole system is suspended by a massless spring as shown in figure. The magnitudes of acceleration of A and B immediately after the string is cut, are respectively: *(2017-Delhi)*



a. $g, \frac{g}{3}$ b. g, g

c. $\frac{g}{3}, \frac{g}{3}$ d. $\frac{g}{3}, g$

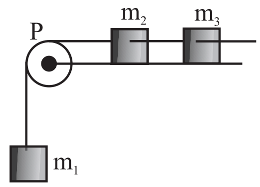
7. Three blocks A, B and C of masses 4 kg, 2 kg and 1 kg respectively, are in contact on a friction less surface, as shown. If a force of 14 N is applied on the 4 kg block, then the contact force between A and B is: *(2015)*



a. 6 N   b. 8 N

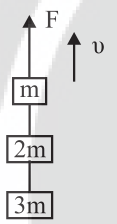
c. 18 N   d. 2 N

8. A system consists of three masses m_1, m_2 and m_3 is connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction = μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is: (Assume $m_1 = m_2 = m_3 = m$) *(2014)*



a. $\frac{g(1-g\mu)}{9}$
b. $\frac{2g\mu}{g}$
c. $\frac{g(1-2\mu)}{3}$
d. $\frac{g(1-2\mu)}{2}$

9. 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)*



a. 6 mg
b. Zero
c. 2 mg
d. 3 mg

Conservation of Momentum and Impulse Momentum Theory

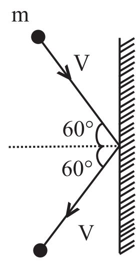
10. A shell of mass m is at rest initially. It explodes into three fragments having mass in the ratio 2 : 2 : 1. If the fragments having equal mass fly off along mutually perpendicular directions with speed v, the speed of the third (lighter) fragment is: **[RC]** *(2022)*

a. $3\sqrt{2}$ v
b. v
c. $\sqrt{2}$ v
d. $2\sqrt{2}$ v

11. 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: *(2021)*

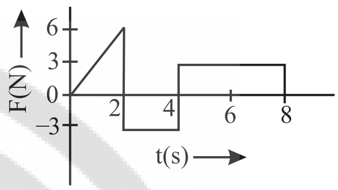
a. 4.2 kg m/s
b. 2.1 kg m/s
c. 1.4 kg m/s
d. 0 kg m/s

12. A rigid ball of mass m strikes a rigid wall at 60° and gets reflected without loss of speed as shown in the figure below. The value of impulse imparted by the wall on the ball will be: *(2016 - II)*



a. $\frac{mV}{2}$
b. $\frac{mV}{3}$
c. mv
d. 2mv

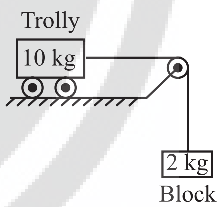
13. The force F acting on a particle of mass m is indicated by the force-time graph shown. The change in momentum of the particle over the time interval from zero to 8 s is: *(2014)*



a. 24 Ns
b. 20 Ns
c. 12 Ns
d. 6 Ns

Friction

14. Calculate the acceleration of the block and trolly system shown in the figure. The coefficient of kinetic friction between the trolly and the surface is 0.05. (g = 10 m/s^2, mass of the string is negligible and no other friction exists). *(2020-Covid)*



a. 1.50 m/s^2
b. 1.66 m/s^2
c. 1.00 m/s^2
d. 1.25 m/s^2

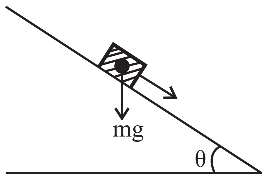
15. Which one of the following statements is incorrect? *(2018)*

a. Frictionless force opposes the relative motion.
b. Limiting value of static friction is directly proportional to normal reaction.
c. Rolling friction is smaller than sliding friction.
d. Coefficient of sliding friction has dimensions of length.

16. A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley 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 table is μ_k. When the block A is sliding on the table, the tension in the string is: *(2015)*

a. $\frac{(m_2-\mu_k m_1)g}{(m_1+m_2)}$
b. $\frac{m_1 m_2(1+\mu_k)g}{(m_1+m_2)}$
c. $\frac{m_1 m_2(1-\mu_k)g}{(m_1+m_2)}$
d. $\frac{(m_2+\mu_k m_1)g}{(m_1+m_2)}$

17. 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 - Re)*



a. 0.4 and 0.3
b. 0.6 and 0.6
c. 0.6 and 0.5
d. 0.5 and 0.6

18. 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)*

a. $\mu = 2\tan\theta$
b. $\mu = \tan\theta$
c. $\mu = \dfrac{1}{\tan\theta}$
d. $\mu = \dfrac{2}{\tan\theta}$

Circular Motion, Banking of Road

19. A block of mass 10 kg is in contact against the inner wall of a hollow cylindrical drum of radius 1 m. 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: ($g = 10\ m/s^2$) *(2019)*

a. $\sqrt{10}$ rad / s
b. $\dfrac{10}{2\pi}$ rad / s
c. 10 rad/s
d. 10 π rad/s

20. 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-Delhi)

a. $T + \dfrac{mv^2}{l}$
b. $T - \dfrac{mv^2}{l}$
c. Zero
d. T

21. 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 - I)*

a. $\sqrt{gR^2 \dfrac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$

b. $\sqrt{gR \dfrac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$

c. $\sqrt{\dfrac{g\mu_s + \tan\theta}{R\,1 - \mu_s \tan\theta}}$

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

22. Two stones of masses m and 2 m are whirled in horizontal circles, the heavier one in a radius 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 Re)*

a. 1
b. 2
c. 3
d. 4

Answer Key

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
a	c	a	b	d	d	a	c	b	d	a	c	c	d	d	b	c
18	19	20	21	22												
a	c	d	b	b												