Chapter 04

Newton's Laws of Motion

Practice Section-01

Q.1 A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 m/s. What time does the body take to stop ?

(1) 2 s (2) 4 s (4) 6 s (4) 8 s

Q.2 A constant force acting on a body of mass 3 kg changes its speed from 2 m/s to 3.5 m/s in 25 s in the direction of the motion of the body. What is the magnitude and direction of the force ?

(1) 0.18 N In the direction of motion

(2) 0.20 N In the direction of motion

(3) 0.18 N In the direction of opposite to the motion

(4) 0.20 N In the direction of opposite to the motion

Q.3 A body of mass 5 kg is acted upon by two perpendicular forces of 8N and 6N, find the magnitude and direction of the acceleration.

(1) 2 m/s^2, 53° with 8 N force

(2) 2 m/s^2, 37° with 6 N force

(3) 4 m/s^2, 37° with 8 N force

(4) 2 m/s^2, 37° with 8 N force

Q.4 A ball of mass 1 kg dropped from 9.8 m height, strikes the ground and rebounds to a height of 4.9 m. If the time of contact between ball and ground is 0.1s, then find impulse and average force acting on ball.

(1) 23.52 N-s, 235.2 N (2) 235 N-s, 23.53 N

(3) 42.5 N-s, 525 N (4) 52.5 N-s, 525 N

Q.5 A machine gun fires a bullet of mass 50 gm with velocity 1000 m/s. If average force acting on gun is 200 N then find out the maximum number of bullets fired per minute.

(1) 60 (2) 30 (3) 240 (4) 180

Q.6 A machine gun has a mass of 20 kg. It fires 35 g bullets at the rate of 400 bullets per minute with a speed of 400 m/s. What average force must be applied to the gun to keep it in position?

(1) 5800 N (2) 56 N

(3) 560 N (4) 5600 N

Q.7 A force of 10 N acts on a body for 3 μs. If mass of the body is 5 g, calculate the impulse and the change in velocity.

(1) 6×10^{-3} ms^{-1} (2) 3×10^{-3} ms^{-1}

(1) 8×10^{-3} ms^{-1} (1) 16×10^{-3} ms^{-1}

Q.8 A body of mass 0.025 kg moving with velocity 12 m/s is stopped by applying a force of 6.0 N. Calculate the time taken to stop the body. Also calculate the impulse of this force.

(1) 0.01 s, 0.30 Ns (2) 0.05 s, 0.30 Ns

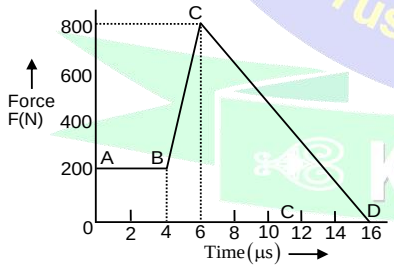
(3) 0.06 s, 0.60 Ns (4) 0.5 s, 0.30 Ns

Q.9 A batsman deflects a ball by an angle of 90° without changing its initial speed, which is equal to 54 km/hr. What is the impulse imparted to the ball ? (Mass of the ball is 0.15 kg)

(1) 4.19 kgm/s (2) 2.19 kgm/s

(3) 3.19 kgm/s (4) 3.60 kgm/s

Q.10 The magnitude of the force (in newton) acting on a body varies with time in (in microsecond) as shown in figure. AB, BC and CD are straight line segments. Find the magnitude of the total impulse of the force (in N-s) on the body from t = 4 μs to t = 16 μs.



(1) 5×10^{-3} Ns (2) 5.8×10^{-3} Ns

(3) 5.8×10^{3} Ns (4) 5×10^{3} Ns

Practice Section-02

Q.1 A cylinder of weight W is resting on a V-groove as shown in figure. Draw its free body diagram.

Q.2 A person of mass M kg is standing on a lift. If the lift moves vertically upwards according to given v-t graph then find out the weight of man at the following instants : ($g = 10\ m/s^2$)

(i) t = 1 second

(1) 10 M newton (2) 20 M newton

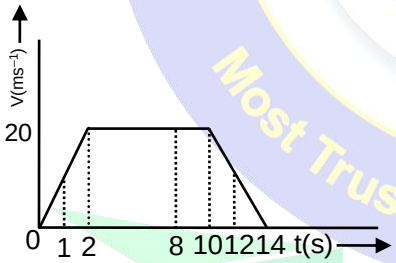
(3) 30 M newton (4) 40 M newton

(ii) t = 8 seconds

(1) 5 M newton (2) 10 M newton

(3) 15 M newton (4) 20 M newton

(iii) t = 10, 12 and 14 seconds



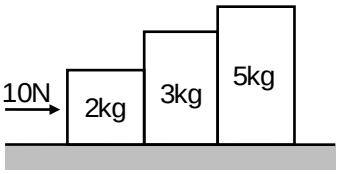
(1) 5 M newtons at t = 10, 12, 14 second

(2) 8 M newtons at t = 10, 12, 14 second

(3) 10 M newtons at t = 10, 12, 14 second

(4) 12 M newtons at t = 10, 12, 14 second

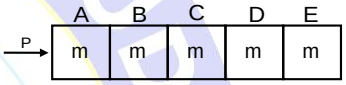
Q.3 Find the acceleration of the system and the contact force between 2kg and 3kg blocks



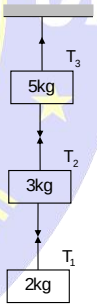
(1) $2m/s^2$, 8 N (2) $1m/s^2$, 10 N

(3) $2m/s^2$, 6 N (4) $1m/s^2$, 8 N

Q.4 Calculate : (i) a_{system} (ii) F_{DE} (iii) F_{CD} (iv) F_{BC} (v) F_{AB} corresponding to the following diagram.



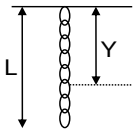
Q.5 In the given figre determine $T_1 : T_2 : T_3$



(1) 2 : 5 : 10 (2) 1 : 3 : 2

(1) 4 : 5 : 1 (1) 2 : 5 : 15

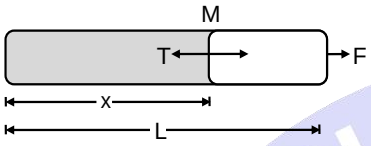
Q.6 Find the tension in the chain at a distance Y from the support. Mass of chains is M.



(1) $\left(\frac{M}{L}(L+Y)\right)g$ (2) $\left(\frac{M}{L}(L-Y)\right)g$

(3) $\left(\frac{M}{L}(L\times Y)\right)g$ (4) None of these

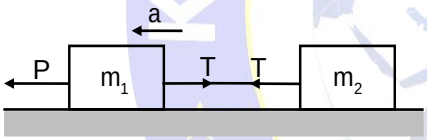
Q.7 A uniform rope of mass M and length L is placed on a smooth horizontal surface. A horizontal force F is acting at one end of rope. Calculate the tension in the rope at a distance x as shown.



(1) $F\left(\frac{X}{L}\right)$ (2) $F\left(\frac{L}{X}\right)$

(3) F(XL) (4) None of these

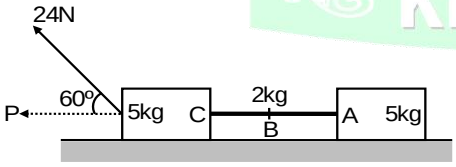
Q.8 Calculate T for the following diagram :



(1) $\frac{pm_1}{m_1+m_2}$ (2) $\frac{pm_2}{m_1-m_2}$

(3) $\frac{m_2}{p(m_1+m_2)}$ (4) $\frac{pm_2}{m_1+m_2}$

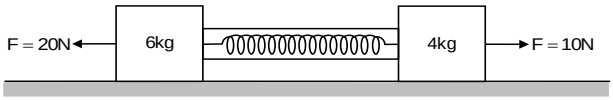
Q.9 Calculate T_A, T_B, T_C for the following diagram: (B is the mid-point of rope)



(1) 5N,6N,7N (2) 7N,6N,5N

(3) 7N,5N,6N (4) 3N,6N,9N

Q.10 A dynamometer is attached to two blocks of masses 6 kg and 4 kg. Forces of 20 N and 10 N are applied on the blocks as shown in figure. Find the dynamometer reading in the steady state.



(1) 10 N (2) 12 N

(3) 14 N (4) 16 N

Practice Section-04

Q.1 A body of mass 5 kg is placed on a rough horizontal surface. It coefficients of static and kinetic friction are 0.5 and 0.4 respectively, then find value of force of friction when external applied horizontal force is

(i) 15 N

(1) 10 N (2) 15 N

(3) 25 N (4) 20 N

(ii) 25 N

(1) 10 N (2) 15 N

(3) 25 N (4) 20 N

(iii) 35 N.

(1) 10 N (2) 15 N

(3) 25 N (4) 20 N

Q.2 A body of mass 5 kg is placed on a rough horizontal surface. It coefficient of friction is $\frac{1}{\sqrt{3}}$, find what pulling force should act on the body at an angle 30° to the horizontal so that the body just begins to move.

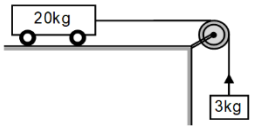
(1) 20 N (2) 25 N (3) 30 N (4) 35 N

Q.3 A body sliding on ice with a velocity of 8 m/s comes to rest after travelling 40 m. Find the coefficient of friction ($g = 9.8\ m/s^2$).

(1) 0.816 (2) 0.716

(3) 0.625 (4) 0.135

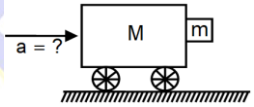
Q.4 What is the acceleration of the block and trolley system shown in figure, if the coefficient of kinetic friction between the trolley and the surface is 0.4 ? What is the tension in the string ? (Take $g = 10\ m/s^2$). Neglect the mass of the string.



(1) $\frac{22}{23}\ m/s^2$, 28.1 N (2) $\frac{23}{22}\ m/s^2$, 27.1 N

(3) $\frac{22}{23}\ m/s^2$, 27.1 N (4) $\frac{25}{24}\ m/s^2$, 25.1 N

Q.5 A cart of mass M has a block of mass m in contact with it as shown in figure. The coefficient of friction between the block and the cart is μ. What should be the minimum acceleration of the cart so that the block of mass m does not fall?



(1) $\frac{g}{\mu}$ (2) $\frac{2g}{\mu}$ (3) $\frac{3g}{\mu}$ (4) $\frac{4g}{\mu}$

Q.6 A cubical block rests on a plane of $\mu = \frac{1}{\sqrt{3}}$ determine the angle through which the plane be inclined to the horizontal, so that the block just slides down.

(1) 40° (2) 50° (3) 30° (4) 20°

Q.7 A body in limiting equilibrium on a rough inclined plane at angle 30° with horizontal. Calculate the acceleration with which the body will slide down, when inclination of the plane is changed to 60°. (Take $g = 10\ m/s^2$)

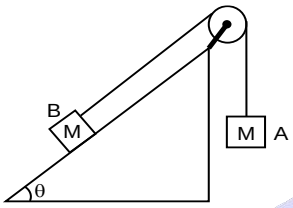
(1) $\frac{20}{\sqrt{3}}$ (2) $\frac{10}{\sqrt{3}}$ (3) $10\sqrt{3}$ (4) $20\sqrt{3}$

Q.8 A weight W rests on rough horizontal palne. If the angle of friction be θ, then caluculate the least horizontal force that will move the body along the plane.

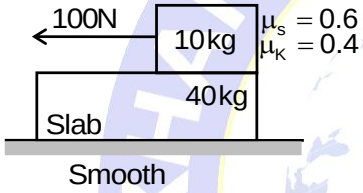
(1) W tan θ (2) W sin θ

(3) W cos θ (4) W cot θ

Q.9 Two blocks A and B of masses m and M are connected to the two ends of a string passing over a pulley. B lies on plane inclined at an angle θ with the horizontal and A is hanging freely as shown. The coefficient of static friction between B and the plane is μ_s. Find the minimum and maximum values of m so that the system is at rest.



Q.10 If 100 N force is applied to the 10 kg blocks as shown in diagram. What is the acceleration produced for slab and block ?



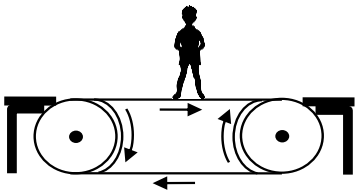
(1) 1.65 m/s^2 (2) 0.98 m/s^2

(3) 0.25 m/s^2 (4) 1.2 m/s^2

Q.11 A 3 kg block (A) is placed on a 6 kg block (B) which rests on a table. Coefficient of friction between (A) and (B) is 0.3 and between (B) and table is 0.6 A 30 N horizontal force is applied on the block (B), then calculate the frictional force between the blocks (A) and (B).

(1) 1 N (2) 2 N (3) 3 N (4) Zero

Q.12 Figure shows a man standing stationary with respect to a horizontal conveyor belt which is accelerating with 1 m/s^2. What is the net force on the man ? If the coefficient of static friction between the man's shoes and the belt is 0.2, upto what acceleration of the belt can the man continue to remain stationary relative to the belt ? (Mass of the man = 65 kg).



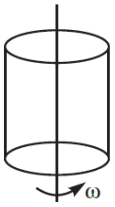
(1) 60 N, 1 m/s^2 (1) 65 N, 2 m/s^2

(1) 70 N, 3 m/s^2 (1) 75 N, 2 m/s^2

Practice Section-05

Q.1 A particle moves in a circle of radius 0.5 m at a speed thatuniformly increases. Find the angular acceleration of particle if its speedchanges from 2.0 m/s to 4.0 m/s in 4.0 s.
(1) 1rad s^2 (2) 2rad s^2
(3) 4rad s^2 (4) 3rad s^2

Q.2 An insect of mass m = 3kg is inside a vertical drum of radius 2 m that is rotating with an angular velocity of 5 rad s^{-1}. The insect doesn't fall off. Then, the minimum coefficient of friction required is



(1) 0.5 (2) 0.4
(3) 0.2 (4) None of the above

Q.3 A motorcycle is going on an over bridge of radius R. The driver maintains a constant speed. As the motorcycle is ascending on the over bridge, the normal force on it-
(1) Increases (2) Decreases
(3) Remains the same (4) Fluctuates

Q.4 A turn has a radius of 10 m. If a vehicle goes round it at an average speed of 18 km/h, what should be the proper angle of banking?
(1) $\sin^{-1}\left(\frac{1}{4}\right)$ (2) $\cos^{-1}\left(\frac{1}{4}\right)$
(3) $\tan^{-1}\left(\frac{1}{4}\right)$ (4) None of these

Q.5 A circular road of radius 50 m has the angle of banking equal to 30°. At what speed should a vehicle go on this road so that the friction is not used?
(1) 34 m/s (2) 17 m/s
(3) 20 m/s (4) 84 m/s

Q.6 The speed of a particle moving in a circle of radius r = 2m varies with time t as $v = t^2$, where t is in second and v in m/s. Find the radial, tangential and net acceleration at t = 2 s.
(1) $\sqrt{80}$ m/s^{-2}, 4 m/s^2, 8 m/s^{-2}
(2) 4m/s^{-2}, 8 m/s^2, $\sqrt{80}$ m/s^{-2}
(3) $\sqrt{80}$ m/s^{-2}, 8 m/s^2, 4 m/s^{-2}
(4) 8m/s^{-2}, 4 m/s^2, $\sqrt{80}$ m/s^{-2}

Q.7 The coordinates of a moving particle at any time 't' are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of the particle at time 't' is given by
(1) $\sqrt{\alpha^2+\beta^2}$ (2) $3t\sqrt{\alpha^2+\beta^2}$
(3) $3t^2\sqrt{\alpha^2+\beta^2}$ (4) $t^2\sqrt{\alpha^2+\beta^2}$

Q.8 A car is moving with speed 30 m / sec on a circular path of radius 500 m. Its speed is increasing at the rate of 2m / sec^2. What is the acceleration of the car
(1) 2m / sec^2 (2) 2.7m / sec^2
(3) 1.8m / sec^2 (4) 9.8m / sec^2

Q.9 Angular displacement of any particle is given $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ where ω_0 and α are constant if w_0 = 1 rad/sec, α = 1.5 rad/sec^2 then in t = 2 second angular velocity will be (in rad/sec)
(1) 1 (2) 5
(3) 3 (4) 4

Q.10 A grind-stone starts revolving from rest, if angular acceleration is 4.0 rad/sec^2 (uniform) then after 4 sec. what is its angular displacement and angular velocity respectively –
(1) 32 rad. 16 rad/sec
(2) 16 rad, 32 rad/sec
(3) 64 rad, 32 rad/sec
(4) 32 rad, 64 rad/sec

ANSWER KEY

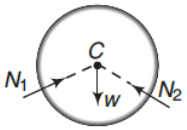
PRACTICE SECTION-01

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	1	4	1	3	4	1	2	3	1

PRACTICE SECTION-02

Que.	2(i)	2(ii)	2(iii)	3	5	6	7	8	9	10
Ans.	2	2	1	4	1	2	1	4	1	3

Q.1



Q.4 (i) (P/5m) (ii) P/5 (iii) 2P/5 (iv) 3P/5 (v) 4P/5

PRACTICE SECTION-03

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	4	2	1	4	1	2	1	2	2

PRACTICE SECTION-04

Que.	1(i)	1(ii)	1(iii)	2	3	4	5	6	7	8	10	11	12
Ans.	2	3	4	2	1	3	1	3	2	1	2	4	2

Q.9 $m_{min} = M(\sin\theta - \mu\cos\theta)$ & $m_{max} = M(\sin\theta + \mu\cos\theta)$

PRACTICE SECTION-05

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	3	1	3	2	4	3	2	4	1