3 Laws of Motion

- Force is required to starts the motion of static body, to change in motion and to stop the body. Acoording to external factor force is divided into two parts :

If external factor applies force remaining in contact with a body such force is called contact force. e.g. Frictional force	If external factor applies force without contact of a body then it is called field force. e.g. Gravitational force electrical force magnetic force.

- According to Galileo
  (i) Static position and position with uniform motion both are equal, because no force is required for that.
  (ii) Body it self can not change the position of motion. This is called "Property of Inertia".
  (iii) Mass of a body is measurement of Inertia.

Three types of Inertia

Inertia of Staticness	**Inertia due to motion**	**Inertia due to direction**
Due to this body maintain its steady position e.g. (1) A person pushed in back ward direction when stationary bus suddenly starts. (2) If bullet fires on the glass of window it makes a hole but when stone throws on the glass it breaks whole glass. (3) When pillow hit by stick dust particle goes down ward	Due to this body maintain its state of motion. e.g. (1) A person pushed in forward direction when break is applied in moving bus. (2) A player of long jump runs before taking jump.	Due to this body maintain its direction of motion. e.g. (1) When a car suddenly takes a turn passenger pushed outword. (2) When a stone tied with a string and rotates circularly, if string breaks stone moves towards the direction of tangent.

Newton's First law of motion

''Unless external force acting on a body steady body remains steady and body in motion moving with constant velocity.''

So,

(i) First law is actual law of inertia given by Galileo.

(ii) First law gives the definition of force but does not explain about its value.

(iii) Acceleration in a body produced by force. So, $\Sigma \vec{F} = 0$ then $\vec{a} = 0$ and $\vec{v}$ = constant

- First law depends on frame of reference

Two types of frame of references

Inertial frame of reference	**Non-inertial frame of reference**
• It follows Newton's First law. So, $\vec{F} = 0$ then $\vec{a} = 0$	• It does not follow Newton's first law so it is not essential that $\vec{F} = 0$ then $\vec{a} = 0$ • In such a frame of reference, for a solution of problem regarding to motion, Acceleration of body is taken in opposition direction of motion, which is equal to acceleration of frame of reference, called pseudo acceleration and corresponding force is called pseudo force.

(1) In a bus, going from Ahmedabad to Baroda when suddenly break applies, passenger pushed in forward direction because...

(A) Some one pushed passenger from backside.

(B) Passenger affraid and starts to run forward.

(C) Due to Inertial upper part of his body is moving with speed of bus and his legs sticks to the bus.

(D) Due to inertia upper part of his body remains stationary and his legs pushed in backward.

(2) A passenger seating in upper seat of a train moving with velocity of 54 kmh^{-1} throws a pen in vertical direction on a passenger seating exactly in lower seat, them this pen...

(A) Falls on head of passenger seating lower.

(B) Falls on front side of passenger seating lower.

(C) Falls on back side of passenger seating lower.

(D) Where pen fall, can not be said.

(3) As Shown in figure a bucket filled 10 litre water hanged with the help of string from point P

(i) If a string suddenly pulled from point R

(ii) If a string pulled slowly from point R...

(A) In first case PQ part of string and in second case SR part of String breaks.

(B) In frist case SR part of String and in second case PQ part of string breaks.

(C) In both the cases PQ part breaks.

(D) In both the cases SR part breaks.

(4) According to Aristotal concept, to stop the cycle slowly which is moving with constant velocity on the road...

(A) Force should be applied slowly in the opposite direction of cycle's motion.

(B) It is essential to decrease the force with slow rate in the opposite direction of cycle's motion.

(C) There is no need to apply the force.

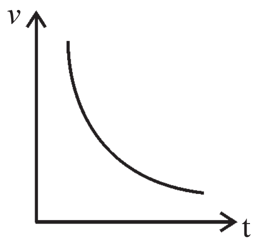
(D) The force should be applied perpendicular to the direction of cycle's motion.

(5) Inertia of body is measured with the help of which physical quantity ?

(A) Mass (B) Force (C) Momentum (D) Acceleration

(6) For the graph of speed time, for a substance having mass 22 kg moving in the absence of external force which one is suitable ?

(A)



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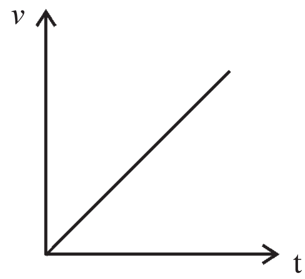

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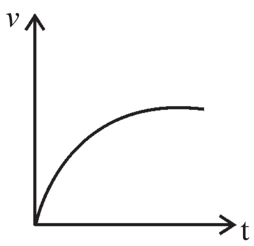

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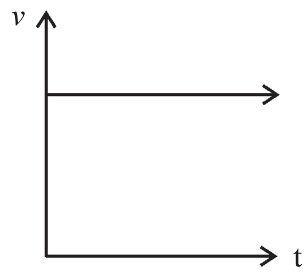


(7) A person sitting on a running horse falls in fornt direction when horse suddenly stops, because.

(A) It is intertia of motion of a person. (B) It is inertia of direction of a person.

(C) It is inertia of motion of a horse. (D) It is inertia of direction of a horse.

Ans. : 1 (C), 2 (A), 3 (B), 4 (C), 5 (A), 6(D), 7 (A)

Newton's second law of motion

"The time rate of momentum of a body is directly proportional to resultant external force and it is in the direction of external force."

Resultant external force $\propto$ Time rate of change of momentum.

So, $\vec{F} \propto \frac{d\vec{p}}{dt}$

$\therefore \vec{F} = k\frac{d\vec{p}}{dt}$

Unit of $\vec{F}$ is defined in such a way, so that value of proportionality constant k = 1.

$$\therefore \vec{F} = \frac{d\vec{p}}{dt} \qquad .... \quad (1)$$

but, $\vec{p} = m\vec{v}$

$$\therefore \vec{F} = \frac{d}{dt}(m\vec{v})$$

$$\therefore \vec{F} = m\frac{d\vec{v}}{dt} + \vec{v}\frac{dm}{dt} \qquad .... \ (2)$$

eqution (2) is more general form. In practise it is taken as special cases

If m is constant

$\vec{F} = m\vec{a}$ ... (3)

If ($\vec{v}$) is constant,

$\vec{F} = \vec{v}\frac{dm}{dt}$ ... (4)

e.g. In case of Rocket, For conveyor belt...

Newton's second law

(i) gives measurement of force and defined force only quantitively.

(ii) In eq^n - (3) $\vec{F} = 0$ then $\vec{a} = 0$. (i.e. $\vec{v}$ = constant) which matches with Newton's first law.

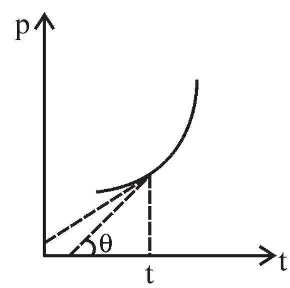
(iii) Acceleration of a particle at any moment $\vec{a}$ at any point is decided by force $\vec{F}$ acting on that point, at that moment.

(iv) Force depends on time - rate of change of momentum not on momentum.

(v) When more than one force are acting on a body, 'F' Shows resultant external force and '*a*' shows acceleration of centre of mass.

(vi) For a graph of p → t, slope at any point gives value of force at that time.

Slope = tan θ = Force acting on a particle at time t



- SI unit of force = newton (N)

  CGS unit is dyne

- gravitational unit of force : kg *w*t (Kilogram weight) or *kgf* (Kilogram force)

  1 k*gf* = 9.8 N

Cases of variable mass :

- **Rocket's motion :**
- In case of Rocket, mass of the system does not remain constant, it varies.
- In a rocket, during the combustion of fuel, gas is ejects from nozzel, which applies force on a rocket according to Newton's third law.

- Thrust acting on a rocket at any moment,

  $F = -v\dfrac{dm}{dt} - mg$ where v = velocity of a gas with respect to rocket.

  $\dfrac{dm}{dt}$ = Rate of change of mass of rocket due to combustion of fuel.

  by neglecting the effect of acceleration due to gravity, $F = -v\dfrac{dm}{dt}$

  Speed of rocket at time t is Where m_0 is a mass of rocket at $t = 0$

  $v_R = v\ ln\left(\dfrac{m_0}{m}\right) - gt$ m is a mass of rocket at time t

  by neglecting the effect of acceleration due to gravity,

  $v_R = v\ ln\left(\dfrac{m_0}{m}\right)$

- **Burnt out Speed (v_b) :** When all the fuel of rocket combusted (burnt), the final speed attains by rocket, is called burnt out Speed (v_b).

  $v_b = v\ ln\dfrac{m_0}{m_a}$ Where m_a = mass of frame of rocket without Fuel.

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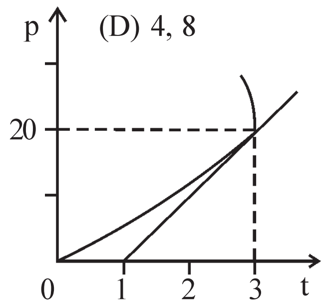
(8) A block of mass 1500 g is moving with speed of 30 ms^{-1}. 12 N Force is acting in the direction of motion and 5 N force is acting in the perpendicular direction for 3 s. The speed of a block after 3 s is ...... ms^{-1}.

(A) 56 (B) 0.56 (C) 0.056 (D) 560

(9) A substance of mass 5 kg is moving in Y direction, Force $F = kt^2$ is acting in the direction of motion. Where $k = 15\ s^{-2}$. The distance travelled by substance in first two sec is ...... m and speed after two sec is ...... ms^{-1}.

(A) 3, 6 (B) 6, 3 (C) 8, 4 (D) 4, 8

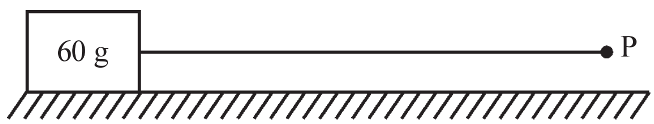
(10) The graph of momentum → time is as shown in figure, for a substance. The ratio of force acting on it at t = 3 s and during the first three sec is ......



(A) 1 : 1 (B) 3 : 2

(C) 2 : 3 (D) 1 : 2

(11) A block of mass 60 g tied with the help of string of mass 30 g and length 30 cm as shown in Figure. If force acting at point 'P' is 1800 dyne, then tension produced at a distance of 10 cm form point P is ...... N.



(A) 1600 (B) 16 (C) 0.16 (D) 0.016

(12) A body of mass 30 kg is moving with velocity 20 ms^{-1} in north direction, making an angle of 30° with east, the force of 150 N is acting on it in south direction. Find the magnitude and direction of velocily after 5 s.

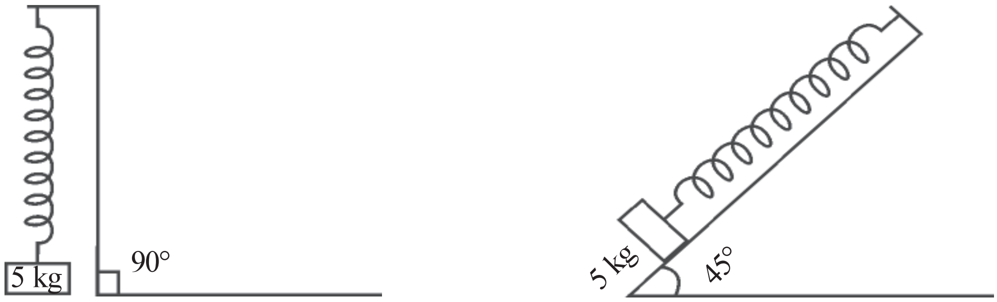
(A) 45 ms^{-1}, at an angle of $\tan^{-1} \frac{5}{\sqrt{3}}$ with east

(B) 45 ms^{-1}, at an angle of 60° with west toward north

(C) 22.9 ms^{-1}, angle of 41° with South

(D) 22.9 ms^{-1}, at an angle of 41° with east towords north.

(13)



(a) (b)

As shown in Figure (a) block of mass 5 kg is hanged to spring balance on a stand attached to a two perpendicular wooden slabs. When an angle decreases to half of initial as shown in figure (b) change in the observation of spring balance is ......

(A) 50 N (B) Zero (C) 25 N (D) 14.65 N

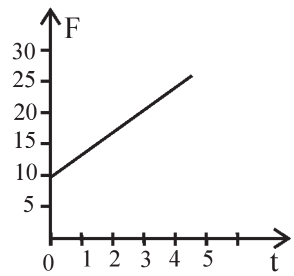
(14) A body of mass 10 g is moving in one dimension, its momentum changes according to time as relation $p = \alpha + \beta t^2$ where $\alpha = 3\ Ns^{-1}$ and $\beta = 2\ Ns^{-2}$. Find the instanteneous force at t = 3 s and average force in t = 3 s ?

(A) 0, 12 N (B) 6 N, 12 N (C) 12 N, 6 N (D) 0, 6 N

(15) A child releases freely a ball of 150 g from the 20 m high tower, other child standing on the earth hits it with a bat. Hence this ball, reach again to first child, If the contact between bat and ball is 0.1 s, then the force acting on a bat by ball is ......

(A) Zero (B) 20 N (C) 30 N (D) 60 N

(16) The graph of force acting on a body versus time is given as shown in Figure. If mass and initial velocity of a body is 1 kg and 30 ms^{-1} respectively. What is the velocity of a body at t = 4 s.



(A) 70 (B) 30

(C) 40 (D) 100

Ans. : 8 (A), 9 (D), 10 (B), 11 (D), 12 (C), 13 (D), 14 (C), 15 (D), 16 (D)

Impulsive force :

When a force acting on a substance for very small duration then it is called impulsive force.

- This force changes with time.
- It changes in a small duration, so difficult to measure. In such a case we measure total effect during the whole period, so it is called **impulse or impulse of force.**

$$\vec{F} = \frac{\Delta \vec{P}}{\Delta t}$$

$$\therefore \ \vec{F} \cdot \Delta t = \Delta \vec{p}$$

Where $\vec{F} \cdot \Delta t$ = impulse of force which is equal to change of momentum.

Area enclosed by graph of F $\rightarrow$ t Shows impulse of force.

Newton's third law :

"Action and Reaction are always equal and mutually in opposite direction."

- According to Newton's third law,
  (i) Forces always produced in pair.
  (ii) In a pair any one is considered as action and other as reaction.
  (iii) Action and reaction are equal and in opposite direction but they are acting on a different body so their resultant force is not zero.
  (iv) Action and reaction produced at the same instant.
  (v) When we are discussing motion of some substance, we have to consider the force acting on it by others, not acting on others by it.

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(17) A ball of mass 100 g collides with a vertical wall at an angle of 45° reflects perpendicularly with its original direction of motion. In this collision ball losses 50 % of its velocity, the change in momentum of ball is ...... Ns. Initial velocity of ball is 20 ms^{-1}.

(A) $\sqrt{5}$ (B) Zero (C) 5 (D) 3

(18) A substance is moving with a velocity of 16 ms^{-1} under the influence of resistive force. After 4 s its velocity becomes 4 ms^{-1}. If the mass of substance is 2 kg the average resistive force acting on it is ......N.

(A) 12 (B) 8 (C) 6 (D) 4

(19) A Swimmer of mass 60 kg jumps from height of 5 m in swimming pool. When it comes in contact with the surface of water, its velocity becomes zero in 0.4 s. The average resistive force is ...... N.

(A) 1000 (B) 1500 (C) 2000 (D) 2500

(20) A passenger in a airport applies force of 50 N at an angle of 60° with the horizontal on a trollybag of mass 40 kg. If the surface of airport is frictionless find the acceleration of trollybag.

(A) 1.25 ms^{-2} (B) $25\sqrt{3}$ ms^{-2} (C) 0.625 ms^{-2} (D) 25 ms^{-2}

(21) Force acting on a body is given by F = $(1200 - 4 \times 10^5 t)$ N. After starting the motion to it moves with constant velocity, how much impulse of force is acting on it ?

(A) Zero (B) 0.9 Ns (C) 1.8 Ns (D) 3.6 Ns

(22) A servant of fire-brigade spraying water at the rate of 30 cm^3s^{-1} from the pipe of 1 cm diameter to control the fire. what is the force of reaction acting on him ?

(A) 30 N (B) 3 N (C) 0.3 N (D) 0.03 N

(23) Sand is thrown at the rate of 4 kgs^{-1} on a belt moving horizontal in a automatic machine. How much force is required so that belt is moving with constant velocity of 5 ms^{-1} ?

(A) 0 (B) 5 N (C) 20 N (D) 100 N

(24) A Rocket arranged vertically having total mass with fuel is 10,000 kg and gas ejected with velocity of 108×10^2 kmh^{-1} from it. If the rate of combustion is 50 kgs^{-1} what is its initial acceleration ?

(A) 0 (B) 10 ms^{-2} (C) 15 ms^{-2} (D) 20 ms^{-2}

(25) An object is falling with constant rate on a upper part of conveyor belt. The force required to move it with constant speed of 3 ms^{-1} is equal to the force needed to move a car of mass 50 kg with an acceleration of 0.3 ms^{-2}. Find the rate of falling an object on conveyor belt ?

(A) 5 kg s^{-1} (B) 4 kg s^{-1} (C) 3 kg s^{-1} (D) 2 kg s^{-1}

(26) A goods train full of coals moving on a railway track, due to opening of a door of one wagon coals falling outside with the rate of Δm in time Δt. To maintain the constant velocity of train as 'v', how much motion resistive force should be applied ?

(A) $\Delta m \left(\frac{\Delta v}{\Delta t}\right)$ (B) $\Delta v \left(\frac{\Delta m}{\Delta t}\right)$ (C) $v\left(\frac{\Delta m}{\Delta t}\right)$ (D) $v\,\Delta m$

(27) Mass of Rocket and its fuel 2000 kg and 18,000 kg respectively. Speed of gas ejected with respect to surface is 7×10^3 ms^{-1} and speed of rocket with respect to surface is 6×10^3 ms^{-1}. Find the maximum speed of rocket ?

(A) 10 kms^{-1} (B) 9.8 kms^{-1} (C) 2.3 kms^{-1} (D) Zero

(28) Fuel of mass 14,000 kg is filled in a rocket of mass 21,000 kg. Combustion rate of 300 kg/s and velocity of gas with respect to rocket is 1200 ms^{-1}, then find the resultant force acting on a rocket.

(A) 24×10^4 N (B) 12×10^4 N (C) 6×10^4 N (D) 1×10^4 N

(29) Water fills at the rate of 0.3 kgs^{-1} in wagons of goods train moving while raining. The force acting on goods train by its engine is 30 N, then find the constant speed of goods train ?

(A) 120 ms^{-1} (B) 100 ms^{-1} (C) 60 ms^{-1} (D) 30 ms^{-1}

(30) By pulling hairs one can not lift a whole body. why ?

(A) Due to fatigue.

(B) Feeling pain when one pulled hairs.

(C) due to oil hand slips.

(D) Actually while pulling the hair, applied force is internal force, whose resultant is zero.

(31) Newton's third law shows conservation of ......

(A) Force (B) Energy (C) mass (D) momentum

(32) A person of mass 50 kg is standing on a spring balance, now he suddenly jumps from the spring balance, then observation of spring balance ......

(A) Increases (B) Decreases

(C) First increases then decreases to zero (D) becomes zero

(33) A bird of mass 400 g is kept on a spring-balance in a cage. Observation of spring balance is 25 N when bird is stationary, if it is flying in upwards with an acceleration of 2.5 ms^{-2}, the instanteneous observation of spring balance is ....

(A) 24 N (B) 25 N (C) 26 N (D) 27 N

(34) What is the angle between the force of action on a bench by physics textbook kept on it and force of reaction on a textbook by bench ?

(A) 0° (B) 90° (C) 180° (D) 360°

(35) Equal force of 8 N is acting on both the ends of a massless spring as shown in the figure, the force of tension acting at any point on the spring is ......

(A) 4 N (B) 8 N (C) 12 N (D) 16 N

(36) When bullet fires from a gun, gun moves in backward direction. It supports Newlon's which law of motion ?

(A) First (B) Second

(C) Third (D) It is not related to Newton's laws.

(37) A carpenter is fitting a nail of mass 20 mg and length 6 cm on a wall with the help of 2 kg hammer. While collides with nail speed of hammer is 8 ms^{-1}, nail enters half a way in the wall in three equal strokes of hammer. Find the impulse of force on a nail in each stroke ?

(A) 16 Ns (B) 16×10^{-6} Ns (C) 16×10^{-3} Ns (D) 160 Ns

Ans. : 17 (A), 18 (C), 19 (B), 20 (C), 21 (C), 22 (D), 23 (C), 24 (C), 25 (A), 26 (C), 27 (C), 28 (D), 29 (B), 30 (D), 31 (D), 32 (C), 33 (C), 34 (C), 35 (B), 36 (C), 37 (A)

Momentum :

Product of mass (m) and velocity ($\vec{v}$) is called momentum ($\vec{p}$). $\vec{p} = m\vec{v}$

- Momentum gives more information than velocity.
- SI unit : $kgms^{-1}$ or Ns
- Dimensional formula : $M^1L^1T^{-1}$
- Relation of momentum with other physical quantity : kinetic energy $K = \frac{p^2}{2m} = \frac{1}{2}\vec{p}\cdot\vec{v}$
- De-broglie wave length $\lambda = \frac{h}{p}$, Where h = plank's constant = 6.625×10^{-34} Js

Law of Conservation of momentum :

"Total momentum of isolated system remains constant."

If the resultant external force acting on a system $\vec{F} = 0$ then,

(i) Total momentum of system $\vec{p}$ = Constant

(ii) Momentum of the system can individually change, but their vector addition (total momentum) remains constant.

(iii) Resultant acceleration of the system $\vec{a} = 0$

(iv) velocity of the system $\vec{v}$ = constant

(v) path of motion of a body does not change.

- Law of conservation of momentum is fundamental and universal.

(38) A player of circus keeping a disc of mass 6 kg in horizontally static condition in air by firing bullets of mass 30 g from gun. If he is firing 40 bullets per sec, the velocity of bullet when it reach to the disc is ...... ms^{-1}.

(A) 0.18 (B) 50 (C) 1.8 (D) 5

(39) If the velocity of a body increases by 100 %, what is the percentage change in momentum ?

(A) 100 % (B) 200 % (C) 300 % (D) 400 %

(40) A steady substance of mass 9 kg divides into three fragments of equal masses. When it explodes, velocities of two fragments are $-3\hat{i}$ cms^{-1} and $4\hat{j}$ cms^{-1} respectively. If time interval of explosion is 3×10^{-2} s, the velocity of the third fragment is ......

(A) $400\hat{i} + 300\hat{j}$ (B) $300\hat{i} + 400\hat{j}$ (C) $0.04\hat{i} + 0.03\hat{j}$ (D) $0.03\hat{i} + 0.04\hat{j}$

(41) For a substance having constant momentum, probably which physical quantity remains constant ?

(A) Force (B) Velocity (C) Acceleration (D) All the above

(42) A person having rifle is standing on a stationary raft in a lake. Mass of the system (person + rifle + raft) is 100 kg. A person is 3 m away from the bank, can fire a bullet of mass 100 g with velocity 10 ms^{-1} from his rifle. If he having 100 bullet, what should he do to reach on a bank ? (There is no friction acting between raft and water and person should not allow to steer or to take help of any external force).

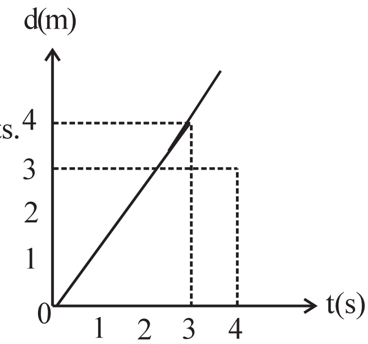
(A) bullets should be fired in the opposite direction of a bank.

(B) bullets should be fired in the direction of a bank.

(C) bullets should be fired in the upward direction.

(D) A person can not reach to a bank, though he fired all the bullets.

(43) A substance of mass 12 kg is moving with constant acceleration.The graph of distance versus time for it is as shown in figure, then its momentum is ...... Ns.



(A) 48 (B) 24

(C) 16 (D) 6

(44) A person is standing on a stationary raft of mass 60 kg in a lake, the mass of a person is 80 kg. If person is moving in opposite direction of a bank with a velocity of 7 ms^{-1} with respect to raft, After 2 sec, find the distance of a person from a bank ? Initially a person is 20 m away from bank,.

(A) 14 m (B) 17 m (C) 23 m (D) 26 m

(45) A bomb suddenly explodes into three fragments from static condition. The ratio of masses are 1:2:3 and velocities of first two fragments are $9\hat{i}$ ms^{-1} and $6\hat{j}$ ms^{-1} respectively, the velocity of third fragment is ...... ms^{-1} ?

(A) 4 (B) 5 (C) 8 (D) 12

Ans : 38 (B), 39 (A), 40 (D), 41 (B), 42 (A), 43 (C), 44 (D), 45 (B)

Equillibrium of concurrent forces

- The line of action of concurrent forces passes through a single point.
- When they are in equillibrium,

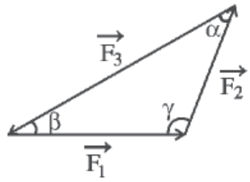
$\Sigma \vec{F} = 0$

$\therefore \Sigma F_x = 0 ; \Sigma F_y = 0 ; \Sigma F_z = 0$

- When two Forces are in equillibrium, $\vec{F_1} + \vec{F_2} = 0 \Rightarrow \vec{F_1} = -\vec{F_2}$
- When three forces are in equillibrium, $\vec{F_1} + \vec{F_2} + \vec{F_3} = 0$

$$\therefore \vec{F_1} + \vec{F_2} = -\vec{F_3}$$

When three vectors of forces are arranged head to tail as shown in figure and formed regular triangle, then the relation is obtained as below :



$$\frac{F_1}{\sin\alpha} = \frac{F_2}{\sin\beta} = \frac{F_3}{\sin\gamma}$$

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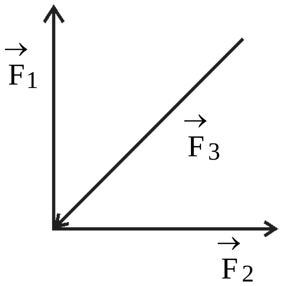
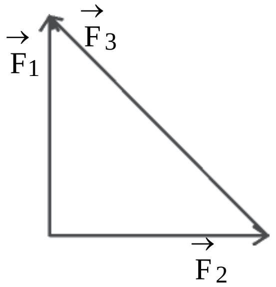
(46) Three forces $\vec{F_1}$, $\vec{F_2}$ and $\vec{F_3}$ are in equillibrium. Which figure represent this situation ?

(A)



(B)



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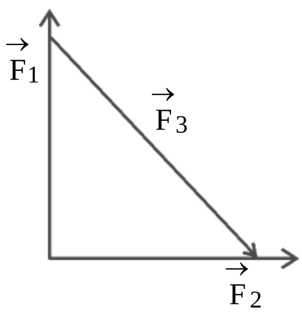
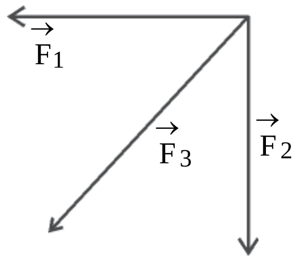


(D)



(47) Resultant of two forces 3F and 2F is R. If first force doubles, resultant force doubles, then find the angle between these two forces.

(A) 180° (B) 120° (C) 90° (D) 60°

(48) A substance of mass $5\sqrt{3}$ kg is hanged with the help of 3m long string. If horizontal force of 50 N is applied to the mid point of string, then what is angle made by upper part of the string with vertical direction in equillibrium position ?

(A) 30° (B) 45° (C) 60° (D) 90°

(49) Wooden block is kept on the slope of an angle θ and given acceleration '*a*'. If block does not slide on the slope then what is the value of '*a*' ? (The length and height of slope are 4m and 1m respectively.) ($g = 10\ ms^{-2}$)

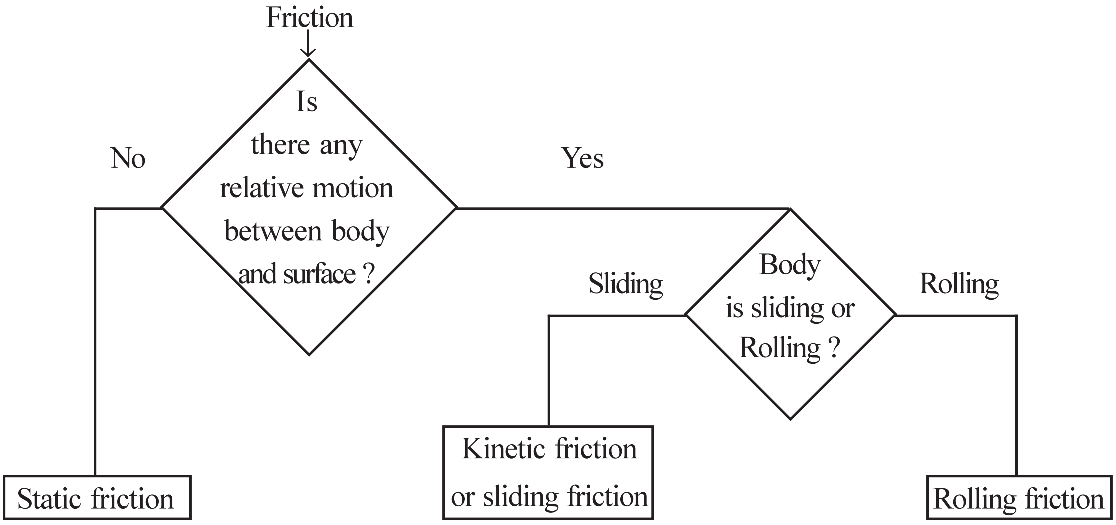
(A) Zero (B) $4\ ms^{-2}$ (C) $\sqrt{\frac{20}{3}}\ ms^{-2}$ (D) $\sqrt{\frac{5}{4}}\ ms^{-2}$

Ans. : 46 (A), 47 (B), 48 (A), 49 (C)

- **Friction**

When two bodies are in contact with each other, horizontal component to the surface of contact force (R) is called frictional force or friction (f).

$\therefore$ R = $\sqrt{f^2+N^2}$ Where N = Normal force



Static friction characteristics :

(1) It is self-ad-justing force. As external force increases, it increases.

(2) It opposes the impending motion

Value : $0 \le f \le \mu_s N$

$F_{ext} > (f_s)_{max}$, $(f_s)_{max} = \mu_s N$

$F_{ext} \le (f_s)_{max}$, $\therefore f = -F_{ext}$

Kinetic friction characteristics :

(1) It opposes the relative motion of contact surface.

(2) It does not depend on the speed of a body.

(3) $f_k < f_{s\,(max)}$

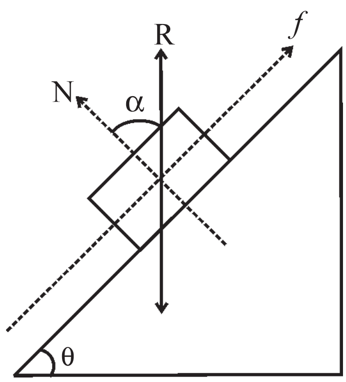
Value : $f_k = \mu_k N$, $\mu_k < \mu_s$, μ_k = co-efficient of kinetic friction

Rolling friction characteristics :

(1) It is less than static and kinetic friction.

Value : $f_r = \mu_r N$, μ_r = co-efficient of Rolling friction

μ_s = co-efficient of static friction



- **Angle of friction (θ) :**

The angle between contact force and Normal force is called Angle of friction (α).

- **Work done against ffrictional force :**

(1) Work done for a motion on horizontal plane :

$W = \mu\, mg \cdot d$

(2) Work done to apply motion to a body in upward direction on a slope of an angle θ is : $W = mg(\sin\theta + \mu\cos\theta).d$

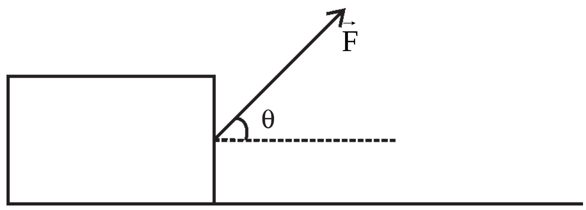
(3) A substance sliding downward from the slope of an angle θ, work done in this case :

$W = mg(\sin\theta - \mu\cos\theta).d$

(50) An explosive substance is kept between two blocks of 8 kg and 12 kg. When it suddenly explodes, substance of mass 8 kg travels a distance of 9 m and become stationary.What is the distance travellad by substance of mass 12 kg. Frictional force acting on both bodies are equal.

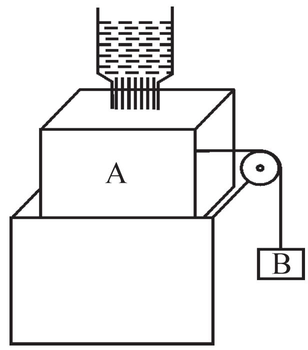
(A) 9 m (B) 6 m (C) 5 m (D) 4 m

(51) As shown in figure, force F is acting on a block of weight 'W'. If the co-efficient of friction between block and surface is μ_s, find the minimum value of F, so that block comes in to motion.



(A) $\frac{\mu_s W}{\sin\theta + \mu_s \cos\theta}$ (B) $\frac{\mu_s W \cos\theta}{\sin\theta + \cos\theta}$ (C) $\frac{\mu_s W \cos\theta}{\cos\theta + \mu_s \sin\theta}$ (D) $\frac{\mu_s W}{\cos\theta + \mu_s \sin\theta}$

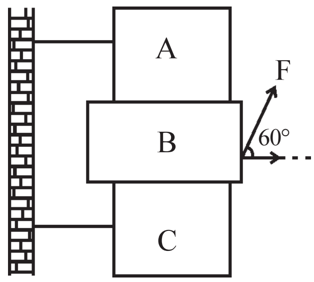
(52) As shown in figure a box is kept on a table, connecting with block B. Send is falling in the box at the rate of 200 gs^{-1} and box is moving with constant velocity of 2 ms^{-1}. Co-efficient of friction between box and surface of table is 0.2 and mass of block B is 10 kg. After how much time box become stationary ? Mass of box is 5 kg.



(A) 100 s (B) 200 s

(C) 225 s (D) 450 s

(53) Three blocks are arranged as shown in figure, block A and C are tied with wall. Static friction between A and B is 0.25 and between B and C is 0.4. Find the minimum value of required force so that block B performs horizontal motion.



(A) 37 N (B) 18.5 N [m_A = 2 kg, m_B = 1 kg

(C) 34 N (D) 10 N g = 10 ms^{-2}]

(54) A block of mass 8 kg is kept on a horizontal surface. Static friction between block and surface is 0.25. When external force acting on a block are 5 N and 25 N, static friction are f_1 and f_2 respectively then $f_1 \times f_2$ = ... N^2

(A) 4 (B) 0.25 (C) 100 (D) 20

(55) A player to play gymnast's pole moving with constant speed on a pole. The mass of player is 60 kg and co-efficient of friction is 0.2 between his palm and pole.What would be the horizontal force acting on pole by him ? (g = 10 ms^{-2})

(A) 600 N (B) 1800 N (C) 2400 N (D) 3000 N

(56) Force of 13.2 N is acting on a stationary block of mass 6 kg kept on a horizontal surface, block travels a distance of 2 km and attains velocity of 64 ms^{-1}. Co-efficient of kinetic friction between block and surface is ......

(A) 0.4 (B) 0.5 (C) 0.1176 (D) 0.7

(57) A car of mass 2000 kg is moving with constant speed 20 ms^{-1}. When break applies it becomes stationary. If the frictional force between tyre of car and surface of the road is 8000 N, how much distance is travelled by a car ?

(A) 50 m (B) 100 m (C) 150 m (D) 200 m

(58) Escalator-belt is moving with constant speed of 2 ms^{-1}. A passenger keeps his bag on it, co-efficient of friction between bag and belt of escalator is 0.5. Find the distance travelled by bag with respect to belt before it becomes steady on the belt. (g = 10 ms^{-2})

(A) Zero (B) 1.2 m (C) 0.6 m (D) 0.4 m

(59) The time taken by block to sliding downward from the smooth surface of an angle 45° is 'n' times the time taken by block kept on same type of rough surface. Then what is the co-efficient of frication between block and surface ?

(A) $1 - \frac{1}{n^2}$ (B) $\frac{1}{1-n^2}$ (C) $\left(1-\frac{1}{n^2}\right)^{\frac{1}{2}}$ (D) $\left(\frac{1}{1-n^2}\right)^{\frac{1}{2}}$

(60) The ratio of required force for a block kept on a inclined track of inclination θ, for the upward motion and for the downward motion is 2. If the co-efficient of friction is 0.3, find the value of an angle θ ?

(A) $\tan^{-1}(2)$ (B) $\tan^{-1}(0.9)$ (C) $\tan^{-1}(0.3)$ (D) $\tan^{-1}(6)$

(61) The force required to placed a substance of mass 102 kg in steady position on a plane making an angle of 30° with the horizontal is 750 N. If the co-efficient of static friction and kinetic friction of the surface are 0.4 and 0.3 respectively. Find the magnitude of frictional force ?

(A) 750 N (B) 500 N (C) 250 N (D) 0

(62) The length of friction less surface is 3 m and it is making an angle of 30° with the horizontal. A body is moving on this inclined track from stationary position and reached at the bottom, after that it is moving on a frictionless surface in horizontal direction. Co-efficient of friction of surface is 0.25, then how much distance is travelled by body before it come to rest ?

(A) 8 m (B) 6 m (C) 4 m (D) 2 m

Ans. : 50 (D), 51 (D), 52 (C), 53 (C), 54 (C), 55 (D), 56 (C), 57 (A), 58 (D), 59 (A), 60 (B), 61 (C), 62 (B)

Dynamics of Uniform Circular motion :

Maximum safe speed on a path having inclination 'θ', radius 'r', and co-efficient of friction μ_s is :

$$v_{max} = \sqrt{rg\left(\frac{\mu_s + \tan\theta}{1-\mu_s \tan\theta}\right)}$$

Case - I : If path is horizontal, θ = 0 $v_{max} = \sqrt{rg\,\mu_s}$

Case - II : In the absence of friction (when plane is taking turn in the air, by neglecting air resistance)

∴ Optimum speed $v_0 = \sqrt{rg\tan\theta}$ (∴ $\mu_s = 0$)

Case - III : When it is required to stop the vehicle on inclined track then, $\tan\theta \le \mu_s$

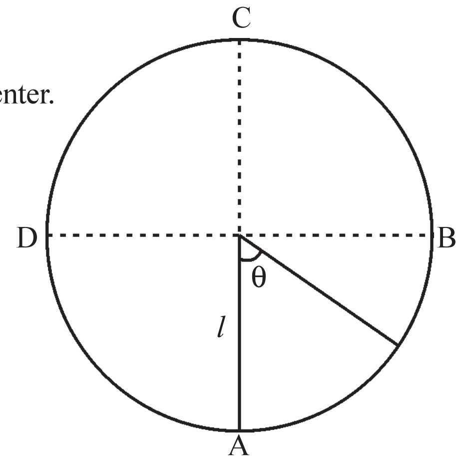
- To obtain the maximum safe speed on horizontal road, vehicle should be inclined at an angle 'θ' with vertical.

  $\theta = \tan^{-1}\left(\frac{v^2}{rg}\right)$

- For the coin kept on a horizontal disc and should not be thrown outside to it : (remains on the verge of the disc)

  $r \le \frac{\mu_s g}{\omega^2}$ Where, r = Distance of the coin from the center.

  ω = angular speed of the disc.



For circular motion in vertical Direction :

Velocity of body at any point on the path of motion is,

$v = \sqrt{v_0^2 - 2gh} = \sqrt{v_0^2 - 2gl(1-\cos\theta)}$

Where, h = height of the object from horizontal

l = length of the string

θ = angle made by string with the downward.

Velocity of body and Tension produced in the string T at different points on the path of motion.

Point	Velocity	Tension (T)	minimum velocity required to start the motion	T_{max}	Kinetic energy
A	v_0	$\frac{mv_0^2}{l}$ + mg	$\sqrt{5gl}$	6 mg	$\frac{5}{2}$ mgl
B	$\left(v_0^2 - 2gl\right)^{\frac{1}{2}}$	$\frac{mv_0^2}{l}$ – 2 mg	$\sqrt{3gl}$	3 mg	$\frac{3}{2}$ mgl
C	$\left(v_0^2 - 4gl\right)^{\frac{1}{2}}$	$\frac{mv_0^2}{l}$ – 5mg	$\sqrt{gl}$	0	$\frac{1}{2}$ mgl
D	$\left(v_0^2 - 2gl\right)^{\frac{1}{2}}$	$\frac{mv_0^2}{l}$ – 2mg	$\sqrt{3gl}$	3 mg	$\frac{3}{2}$ mgl

- **Relation between angular velocity and linear velocity :** $v = r\omega$

  1 rotation = 2π radian

  1 rotation/minute = $\frac{2\pi}{60} = \frac{\pi}{30}\ \frac{\text{rad}}{\text{s}}$

(63) A cyclist is moving with speed of 10 ms^{-1} on a circular path, centripetal force is acting on it is 20 N. If he doubles the speed, the required centripetal force is ...... N.

(A) 20 N (B) 40 N (C) 60 N (D) 80 N

(64) Two substances of mass m_1 and m_2 are moving on a circular path of equal radii. If these substances complete 5 rotation and 10 rotation in 2 s respectively, the ratio of centripetal force $\frac{F_1}{F_2}$ = ...

(A) $\frac{m_1}{m_2}$ (B) $\frac{m_1}{2m_2}$ (C) $\frac{m_1}{4m_2}$ (D) $\frac{m_1}{8m_2}$

(65) Radius of horizontal circular path is 3 m. A cyclist completes 30 rounds in 6 minutes on this path, What would be the centripetal acceleration ? ($\pi^2 = 10.$)

(A) $\frac{5}{6}$ ms^{-2} (B) 6 ms^{-2} (C) 5 ms^{-2} (D) 9 ms^{-2}

(66) Centre of horizonted circular track is origin. At a point on a circumference whose co-ordinate is $x = -4$ m and velocity of a particle at that point is $10\hat{j}$ ms^{-1}. Find the acceleration of a particle at a point, whose y - cordinate is – 4 m.

(A) $25\hat{i}$ ms^{-2} (B) $10\hat{i}$ ms^{-2} (C) $25\hat{j}$ ms^{-2} (D) $10\hat{j}$ ms^{-2}

(67) A particle is rotating on a circular path with velocity 0.2 ms^{-1} in a cone shaped cap kept on the surface. Height of cap is 10 cm and its edged portion is in upper side. What is the height of particle from the surface ?

(A) 0 cm (B) 9.6 cm (C) 4 cm (D) 10 cm

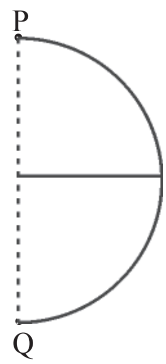
(68) A body of mass 'm' is moving with speed 'v' on a circular tath of 'r' radius then ......

(A) Magnitude of force changes, but acceleration remains constant.

(B) Magnitude of force is constant, but acceleration changes.

(C) Magnitude of force and acceleration both changes.

(D) Magnitude of force and acceleration both remains constant.



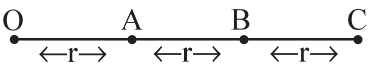
(69) A particle of mass 10g is moving from point P to point Q on a semi - circle path as shown in Figure .

Find the centripetal force on it at point 'Q'

(A) 10 N (B) 0.4 N (C) 6 N (D) 0.2 N

(70) A substance of mass 'm' is moving on a circular path of radius 'r' with momentum 'p', then centripetal force acting on it is ....

(A) pv (B) $\frac{pr}{m}$ (C) $\frac{p^2}{mr}$ (D) $\frac{p^2 m}{r}$

(71) 

As shown in Figure, mass of 5 kg, 10 kg and 15 kg are tied to the points A, B and C respectively. If it is moved circularly from point '0', what is the ratio of centripetal force acting on a body at A, B and C ?

(A) 1 : 1 : 1 (B) 1 : 2 : 3 (C) 1 : 4 : 9 (D) 1 : 5 : 8

(72) A substance 'A' freely falls from 20 m high tower, at the same instant another substance 'B' is moving on a circular path of radius 7 m. When B completes 10 rotations, 'A' falls on the surface, what is centripatal acceleration of a substance 'B' ?

(A) 5×10^3 ms^{-2} (B) 7×10^3 ms^{-2} (C) 9×10^3 ms^{-2} (D) 11×10^3 ms^{-2}

(73) A motor cyclist is moving with a speed of 36 kmh^{-1} on a horizontal road, takes a turn on curved path of 20 m radius, the speed decreased by him, so that he does not thrown out from the road is ...... ? ($\mu = 0.18$)

(A) 6 ms^{-1} (B) 4 ms^{-1} (C) 10 ms^{-1} (D) 8 ms^{-1}

(74) A cyclist takes a turn with speed 6 ms^{-1} on a horizontal, frictionless circular path of radius '9 m'. For safety of himself he should alligned the cycle at angle of ...... with vertical ?

(A) $\tan^{-1}(2)$ (B) $\tan^{-1}\left(\frac{5}{2}\right)$ (C) $\tan^{-1}\left(\frac{2}{5}\right)$ (D) $\tan^{-1}(6)$

(75) A body of mass 100 g is tied at the end of 4 m long string and revolves with 5 revolution / minute. What is the Tension produced in the string ? ($\pi^2 = 10$)

(A) 9 N (B) $\frac{1}{9}$ N (C) $\frac{25\pi}{4}$ N (D) Zero

(76) A car of mass 1200 kg is moving on a circular path of radius 30 m. A car attains maximum safe speed v_1 when co-efficient of friction is 0.5. If this car moves on a inclined track with an angle of inclination 45° having same radius and same co-efficient of friction, its maximum safe speed is v_2, then $\frac{v_1}{v_2}$ = ...

(A) $1 : \sqrt{6}$ (B) $\sqrt{6} : 1$ (C) $\sqrt{5} : 1$ (D) $1 : \sqrt{5}$

(77) A car of mass 500 kg is moving on a inclined curved surface of an angle 30° and co-efficient of friction 0.4 with maximum safe speed $\sqrt{6.93}$ ms^{-1}. What would be the optimum speed v_0 of this car ?

(A) 2.66 ms^{-1} (B) 6.93 ms^{-1} (C) 1.77 ms^{-1} (D) 8.3 ms^{-1}

(78) A car of 2000 kg mass is moving on a circular path of radius 270 m and inclination 16.7° is taking turn. What is maximum safe speed of car, if the co - efficient of friction between tyre of car and surface of the road is 0.5. ($\tan 16.7° = 0.3$).

(A) 30 ms^{-1} (B) 40 ms^{-1} (C) 50 ms^{-1} (D) 60 ms^{-1}

(79) A cyclist completes one revolution in 3.14 sec, on a circular path of circumference 62.8 m. The cycle should be alligned at an angle of ...... with upward direction, by cyclist.

(A) $\tan^{-1}(1)$ (B) $\tan^{-1}(2)$ (C) $\tan^{-1}(3)$ (D) $\tan^{-1}(4)$

(80) A particle performing uniform circular motion in a circular path of radius 'r' in XY plane, whose centre is at origin. Co-ordinates of particle at time 't' is $p(r, \theta)$, where θ = Angle with X-axis then acceleration $\left(\vec{a}\right)$ of a particle is given by ......

(A) $\frac{v^2}{r}\hat{i} + \frac{v^2}{r}\hat{j}$ (B) $\frac{-v^2}{r}\sin\theta\hat{i} + \frac{v^2}{r}\cos\theta\hat{j}$

(C) $\frac{-v^2}{r}\cos\theta\hat{i} + \frac{v^2}{r}\sin\theta\hat{j}$ (D) $\frac{-v^2}{r}\cos\theta\hat{i} - \frac{v^2}{r}\sin\theta\hat{j}$

(81) A student tied a stone of mass 200 g at the end of thread and rotates it circularly in vertical plane. The ratio of minimum velocity of this stone at uppermost point and lowermost point of this circular path is ....

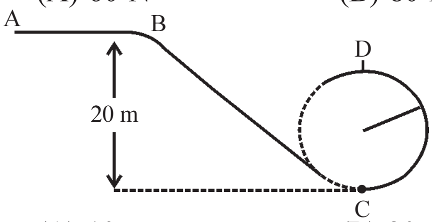
(A) $1 : \sqrt{5}$ (B) $\sqrt{5} : 1$ (C) $1 : \sqrt{3}$ (D) $\sqrt{3} : 1$

(82) A bucket filled with water and tied with thread revolves on a part of redius '4 m'. If water doesn't fall down from the uppermost point of the path. What would be periodic time of revolution of a bucket ?

(A) 2 s (B) 4 s (C) 6 s (D) 8 s

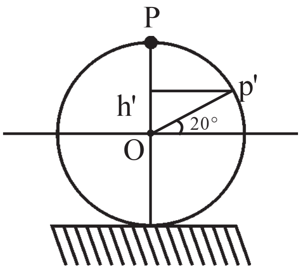
(83) An object of mass 3 kg is tied with 2 m long thread and hanged in a plane. An object is given a velocity in horizontal direction such that thread makes an angle of 60° with the upward direction. How much tension is produced in the thread at this position ?

(A) 60 N (B) 80 N (C) 100 N (D) 120 N

(84) 

10 N force is acting on a sphere starting from point A to point B as shown in figure. It moves from B to C and then after moving on a circular path of radius 'r'. Finally it stops at point D, the radius 'r' of circular loop is ...... m. (mass of sphere is 2 kg).

(A) 10 (B) 20 (C) 5 (D) 18

(85) 

As shown in Figure, a particle (P) sticks on a sphere of radius 24 m. Now, this sphere rolls in horizontal direction, at how much height a particle 'P' becomes free from the surface of a sphere ?

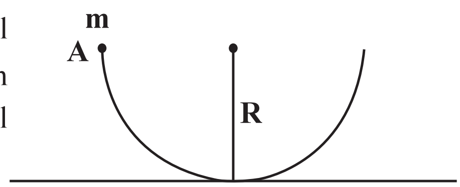
(A) 30 m (B) 40 m

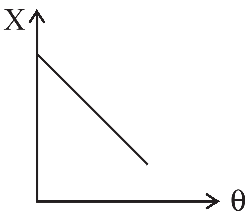
(C) 20 m (D) 10 m

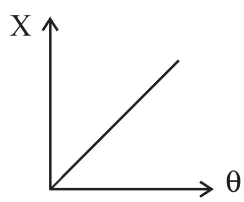
(86) A stone is tied at the end of 2 m long thread and given a motion with uniform velocity in vertical upward plane, the ratio of minimum and maximum tension produced at that time is 25:3. What is the velocity of the stone ?

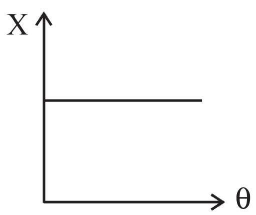
(A) $2\sqrt{3}$ ms^{-1} (B) $2\sqrt{5}$ ms^{-1} (C) $4\sqrt{3}$ ms^{-1} (D) $4\sqrt{5}$ ms^{-1}

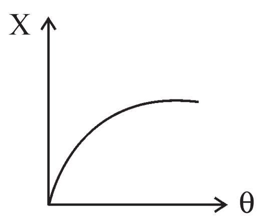
(87) A particle of mass 'm' falls from point 'A' in a spherical surface of radius 'R' as shown in figure. Which graph represents the relation of ratio of centripetal force to normal force acting on a particle with θ at any point. (θ ≠ 0 or π)



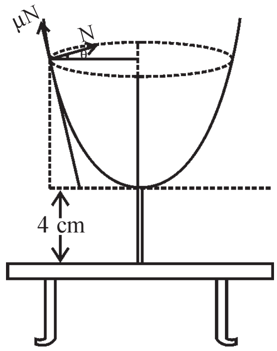
(A)


(B)


(C)


(D)


(88) A parabolic glass is arranged as shown in Figure. Here $x^2 = 20y$ and co-efficient of static friction of a glass is 0.5. An insect of mass 'm' can sticks steady in a glass upto how much height from the surface of a table ?



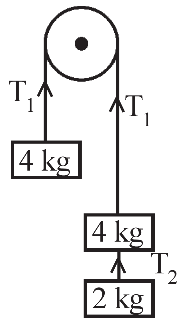
(A) 5.25 cm (B) 2.5 cm

(C) 1.25 cm (D) 0.625 cm

(89) A rope of mass 4 kg and length 10 m is pulled by a force of 50 N. Find the tension produced in the rope at a distance 3 m from the point where force is acting ?

(A) 50 N (B) 35 N (C) 15 N (D) 0

(90) Three blocks are hanged with the help of string having negligible mass from a pulley which is massless and frictionless, as shown in the figure

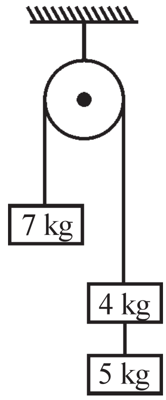


Find the tension T_1 and T_2 produced in the string and $\frac{T_1}{T_2}$ = ...

(A) 4 (B) 8

(C) 3 (D) 32

(91) Three blocks are hanged on a pulley (friction less) with the help of massless string as shown in the figure. Pulley it self is hanged from rigid support with the help of string with negligible weight. Find the tension produced in the string and acceleration of the blocks ? ($g = 10\ ms^{-2}$)



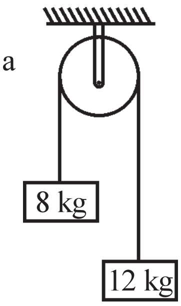
(A) $1.25\ ms^{-2}$, 12.5 N

(B) $3.75\ ms^{-2}$, 14.6 N

(C) $4.25\ ms^{-2}$, 125 N

(D) $1.25\ ms^{-2}$, 78.75 N

(92) What is the acceleration of blocks and tension produced in the string in a system as shown in the figure.



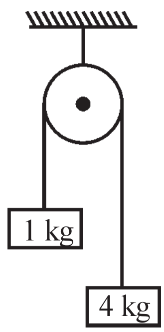
(A) $2\ ms^{-2}$, 64 N

(B) $2\ ms^{-2}$, 96 N

(C) $0.5\ ms^{-2}$, 64 N

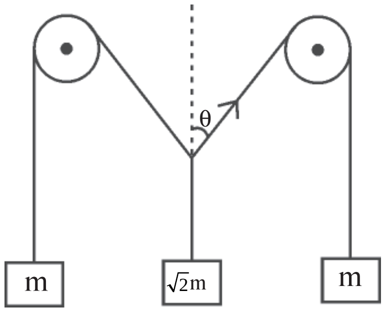
(D) $0.5\ ms^{-2}$, 96 N

(93) Two wooden blocks are hanged from pulley with the help of massless string as shown in the figure. If they releases the block of mass 4 kg travels a distance of 3 m, in the same time how much distance is travelled by block of mass 1 kg.



(A) 3 m (B) 6 m

(C) 9 m (D) 12 m

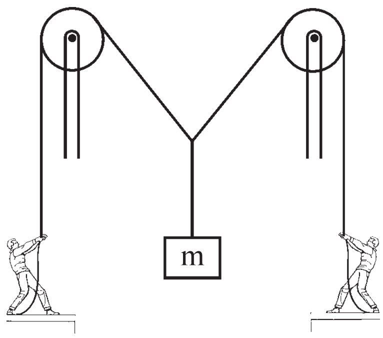
(94) 

What should be the value of 'θ' so that system remains in equillibrium, given in the figure.

(A) 60° (B) 45°

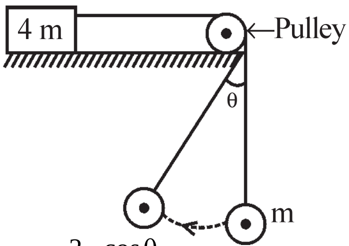
(C) 30° (D) 0°

(95) As shown in the figure two labours are pulling a block of mass 'm' in upward direction by applying same force. If the velocities of the string in downward direction, which is in the hand of labours are equal v, what is the velocity of block ?



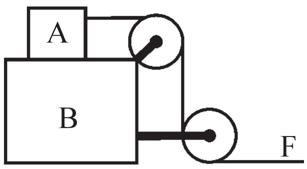
(A) $v \cos \theta$ (B) $2\, v \cos \theta$

(C) $v \sec \theta$ (D) $2\, v \sec \theta$

(96) 

Two block of mass m and 4m are attached with the string and passes through a pulley as shown in the figure. A block of mass 'm' hanging from length 'l' performs oscillations at angle θ. What should the minimum co-efficient of friction between block and surface so that block of mass 4m does not slide ?

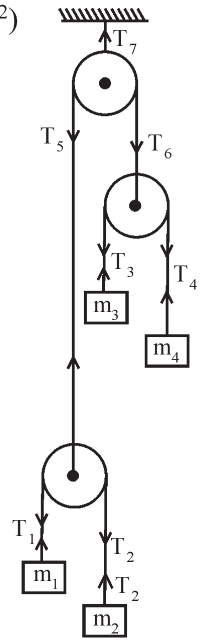
(A) $\frac{2-\cos\theta}{3}$ (B) $\frac{1-\cos\theta}{2}$ (C) $\frac{2\cos^2\theta}{2}$ (D) $\frac{3-2\cos\theta}{4}$

(97) 

$m_A = m_B = 6$ kg in the arrangement given in the figure and string is massless, co-efficient of friction between B and surface is 0.5. What shold be the maximum force applied on a block A, So that it does not slide on a block 'B' ? ($g = 10\ ms^{-2}$)

(A) 36.72 N (B) 60 N

(C) 96 N (D) 103.78 N



(98) If $T_7 = 60$ N and $T_3 = 2T_1$, in the given figure. Find the value of T_1.

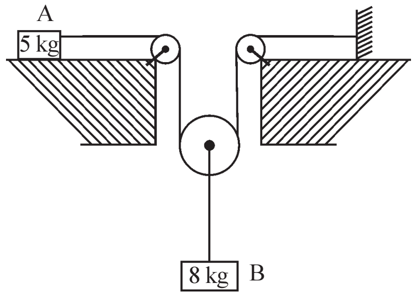
(A) 10 N

(B) 120 N

(C) 40 N

(D) 160 N

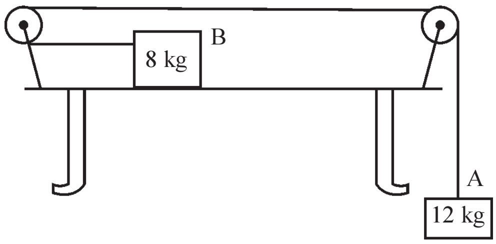
(99) What is the ratio of acceleration in block A and B, in a system as shown in the figure ?



(A) 1 : 1 (B) 5 : 2

(C) 2 : 5 (D) 5 : 8

(100)

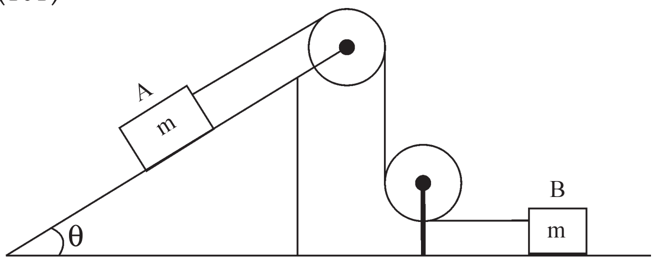


All the pulley and string are massless, surface is frictionless arranged in the figure. What is the tension produced in the string ?

(A) Zero (B) 12 N

(C) 24 N (D) 48 N

(101)

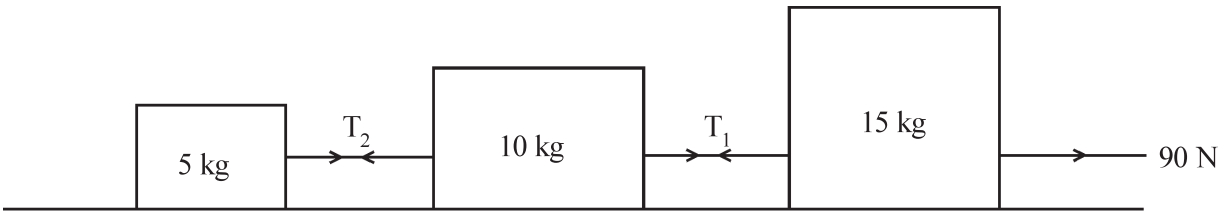


All the pulley and string are massless, surface is friction less and block A sliding downward from the slope during equillibrium, what is the tension produced in the string ?

(A) $\frac{2}{3}$ mg sin θ (B) $\frac{3}{2}$ mg sin θ

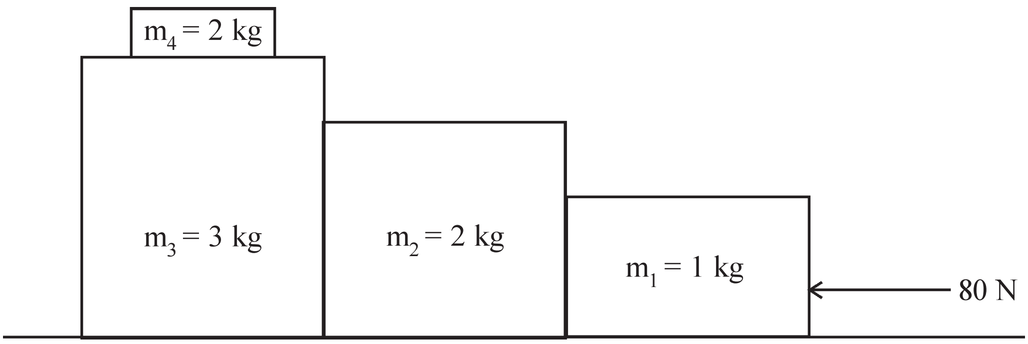
(C) $\frac{1}{2}$ mg sin θ (D) 2 mg sin θ

(102) Three blocks of mass 5 kg, 10 kg and 15 kg are tied with weightless string and kept on a frictionless plane. If a body of mass 15 kg is pulled by force of 90 N then $\frac{T_2}{T_1}$ = ...



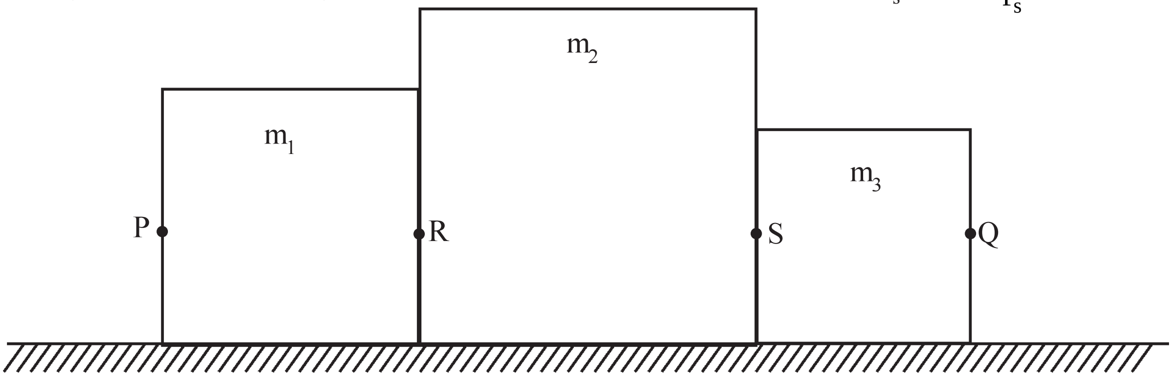
(A) 3 (B) $\frac{1}{3}$ (C) 2 (D) $\frac{1}{2}$

(103) Four blocks are in contact with each other as shown in the figure. Relative velocity between m_3 and m_4 is zero. If the contact force between m_1 and m_2 is F_1 and between m_2 and m_3 is F_2 then F_1 = ... N, and F_2 = ... N.



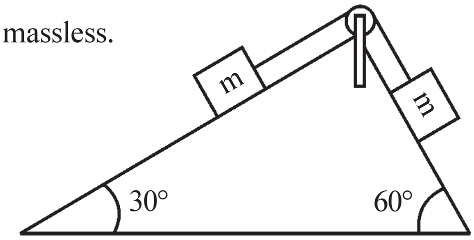
(A) 50, 30 (B) 30, 50 (C) 70, 50 (D) 50, 70

(104) As shown in the figure, three blocks of mass $m_1 = 12$ kg, $m_2 = 24$ kg and $m_3 = 8$ kg are in contact with each other. Some force is applied to a point P, hence system moves with acceleration 2 ms^{-2} at that time the contact force at R is F_R. When some force is applied to Q system attains velocity of 12 ms^{-1} in 3 s, and contact force at S is F_s. Then $\frac{F_R}{F_S}$ = ...



(A) 2 : 3 (B) 4 : 9 (C) 3 : 2 (D) 9 : 4

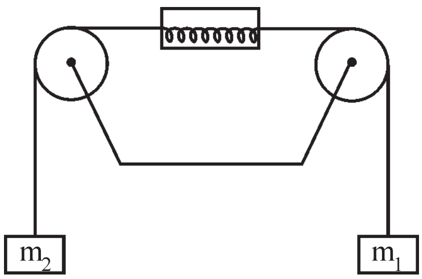
(105) As shown in the figure pulley is frictionless and string is massless. What is the acceleration of the system ?



(A) Zero (B) 8.66 ms^{-2}

(C) 5 ms^{-2} (D) 3.66 ms^{-2}

(106)

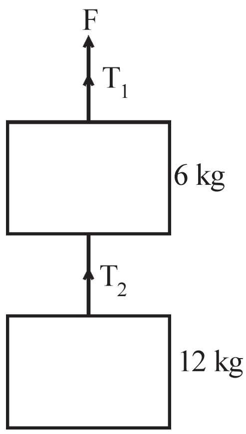


Two bodies of masses m_1 and m_2 are attached with an identical pulley to a spring balance as shown in the figure. What is the reading of spring balance ?

(A) $\frac{2m_1m_2}{m_1+m_2}g$ (B) $\frac{m_1m_2}{m_1+m_2}g$

(C) $\frac{1}{2}(m_1+m_2)$ g (D) (m_1+m_2) g

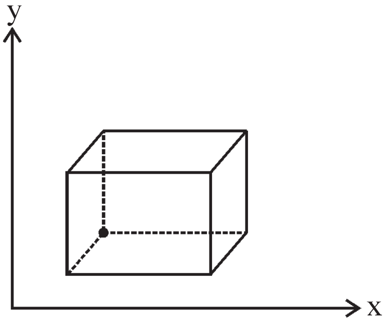
(107) Two blocks are tied with the help of string and given a acceleration of 3 ms^{-2} in upward direction as shown in figure. If the tension produced in the strings are T_1 and T_2 then $\frac{T_1}{T_2}$ = ...



(A) 3 : 2 (B) 2 : 3

(C) 2 : 1 (D) 1 : 2

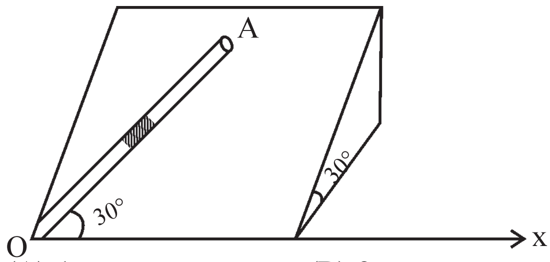
(108) A sphere of mass 2 kg is kept in a cube as shown in the figure. A cube is given a motion with velocity $\vec{v} = (5t\hat{i} + 2t\hat{j})$ ms^{-1}. So that sphere remains stationary with respect to cube. Find the magnitude of resultant force acting on a cube by a Sphere ?



(A) $\sqrt{29}$ (B) $\sqrt{89}$ N

(C) 29 N (D) 26 N

(109)



An inclination making an angle of 30° with the horizontal as shown in the figure. A slot of length 5 m is made in a plane as shown in the figure. A frictionless cylinder is released in a slot to perform motion. How much time is taken by it to travel a distance AO ?

(A) 1 s (B) 2 s (C) 3 s (D) 4 s

Ans. :	**63 (D), 64 (C), 65 (A), 66 (C), 67 (B), 68 (B), 69 (B), 70 (C), 71 (C), 72 (B), 73 (B), 74 (C), 75 (B), 76 (A), 77 (C), 78 (B), 79 (D), 80 (D), 81 (A), 82 (B), 83 (A), 84 (D), 85 (B), 86 (D), 87 (C), 88 (A), 89 (B), 90 (C), 91 (D), 92 (B), 93 (A), 94 (B), 95 (C), 96 (D), 97 (B), 98 (A), 99 (C), 100 (D), 101 (C), 102 (B), 103 (C), 104 (B), 105 (D), 106 (D), 107 (A), 108 (D), 109 (B)**

Experimental work :

Object : To study the relation between maximum static friction f_s(max) and Normal reaction force (N), and find out the Co-efficient of maximum static friction (μ_s) between block and horizontal Surface.

Explaination : Suppose one wants to obtain co-efficient of maximum static friction for surface 'A' kept on a table in a arrangement as shown in the figure.

- Suppose weight of pan = P_0
- As a weight in a pan increases slowly, block starts motion on a surface. At that time,

Force of the effort = weight of pan (P_0) + weight in a pan (P')

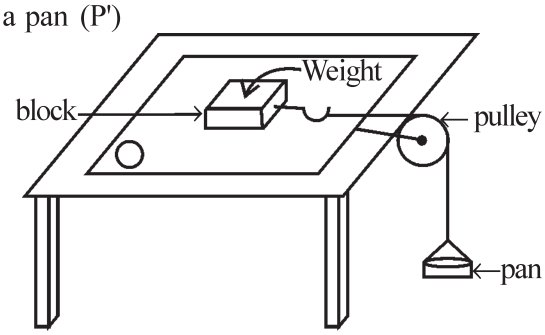
$\therefore$ P = P_0 + P' .... (1)

and Normal reactional force,

N = weight of block (W_0) + weight in a block (W)

$\therefore$ N = W_0 + W

and co-efficient of friction of the surface

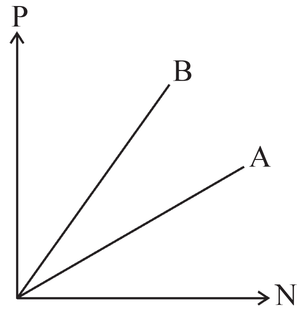


$$\mu = \frac{\text{Force of the effort (P)}}{\text{Normal reactional force (N)}} = \text{slope of the graph of } P \rightarrow N$$

(110) In a experiment of static friction, the graph of force of the effort (P) versus Normal reactional force (N) making an angle of 30° with the axis of normal reactionaly force. What would be the co-efficient of friction of the surface ?

(A) 0.26 (B) 0.58 (C) 0.42 (D) 0.37

(111) The graph of force of the effort (P) versus normal reactionary force (N) for a experiment of static friction done by a student for two surfaces A and B is as shown in the figure, then we can say that,



(A) The work done against frictional force on a body of equal mass moves to a equal distance is more for surface 'A' than surface 'B'.

(B) The work done against frictional force on a body of equal mass moves to a equal distance is less for surface 'A' than surface 'B'.

(C) The work done against frictional force on a body of equal mass moves to a equal distance is equal for both the surfaces.

(D) We can not predict about work from the graph.

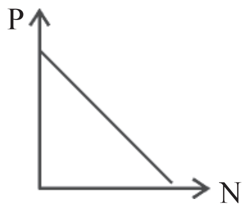
(112) The readings (observations) taken by a student for two different surface in a Experiment of static friction is given as below. Weight of pan and block are equal.

Obs. No.	**Weight kept in a wooden block (W') gm. wt**	**for a displacent of body**	
		weight in pan for surface 'A'	**minimum weight (gm. wt) for surface 'B'**
1.	150	10	12
2.	200	20	22
3.	250	30	32
4.	300	40	42
5.	350	50	52

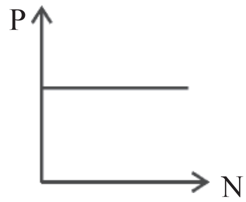
(A) $\mu_A > \mu_B$ (B) $\mu_A < \mu_B$ (C) $\mu_A = \mu_B$ (D) $\mu_A \geq \mu_B$

(113) The experiment done in a laboratatory for the study of co-efficient of static friction. Which graph of force of the effort (P) versus normal reactionary force (N) is suitable ?

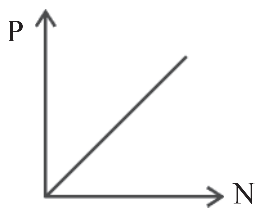
(A)



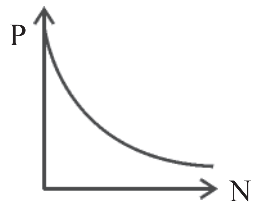
(B)



(C)



(D)



Ans. : 110 (B), 111 (B), 112 (B), 113 (C)

Assertion - Reason type Question :

Instruction : Read assertion and reason carefully, select proper option from given below.

(a) Both assertion and reason are true and reason explains the assertion.

(b) Both assertion and reason are true but reason does not explain the assertion.

(c) Assertion is true but reason is false.

(d) Assertion is false and reason is true.

(114) **Assertion :** For a particle performing uniform circular motion, linear momentum constantly changes.

Reason : For a particle performing uniform circular motion, magnitude of velocity remains constant but direction of velocity constantly changes.

(A) a (B) b (C) c (D) d

(115) **Assertion :** The slope of graph of momentum versus velocity shows the mass of a body.

Reason : Kinetic energy of a body, K = $\frac{P^2}{2m}$

(A) a (B) b (C) c (D) d

(116) **Assertion :** The frame attached with the earth is non-inertial frame of reference.

Reason : The frame of reference moving with acceleration is an example of non - inertial frame of reference.

(A) a (B) b (C) c (D) d

(117) **Assertion :** A body kept in a lift, which is moving with constant speed in downward direction. It's weight observes less than the original weight.

Reason : According to Galilyo, static position and position of constant speed for a body are equal.

(A) a (B) b (C) c (D) d

(118) **Assertion :** A player in cricket pulls his hand in backside while catching, because reaction decreases on his hand.

Reason : While taking catch, as player pulls his hand in backside, the time of contact increases.

(A) a (B) b (C) c (D) d

(119) **Assertion :** Frictional force is acting in the direction of motion by surface on both the wheels of a cycle, when it is moving.

Reason : When two surfaces are in contact with each other, frictional force produced.

(A) a (B) b (C) c (D) d

(120) **Assertion :** "Ball - bearing" is used between two moving parts of machine.

Reason : Frictional force is decreased by "ball - bearing."

(A) a (B) b (C) c (D) d

(121) **Assertion :** A cyclist bent his cycle in inner side while moving along the curved path.

Reason : By bending cycle mass of cyclist decreases.

(A) a (B) b (C) c (D) d

(122) **Assertion :** Action and reaction are equal and in opposite direction according to Newton's third law.

Reason : Action $\geq$ Reaction

(A) a (B) b (C) c (D) d

(123) **Assertion :** Effective mass of a freely falling body is zero.

Reason : Acceleration produced on a freely falling body by the earth is equal to 'g'.

(A) a (B) b (C) c (D) d

(124) **Assertion :** To attract iron nails by magnet, it should be in contact with magnet.

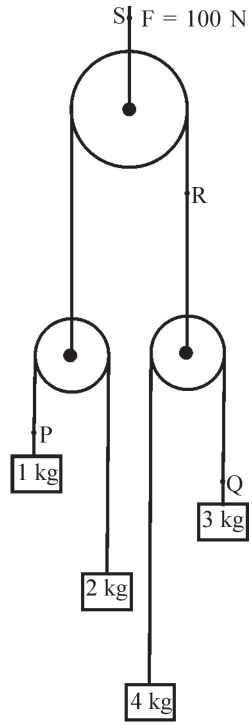
Reason : A substance is moving under the effect of field force. When force is applied, it is not essential that this force is in contact with external factor.

(A) a (B) b (C) c (D) d

Ans. : 114 (A), 115 (B), 116 (A), 117 (D), 118 (A), 119 (D), 120 (A), 121 (C), 122 (C), 123 (C), 124 (D)

Match the columns :

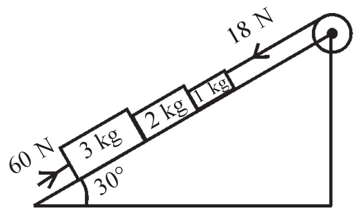
(125) The arrangement of block and pulley is as shown in the figure. Consider pulley and block massless and ignore frictional forces.



	Column - 1		Column - 2
(i)	Tension near P	(P)	2.5 ms^{-2}
(ii)	Tension near R	(Q)	50 N
(iii)	Acceleration of a block of mass 2 kg	(R)	25 N
(iv)	Acceleration of a block of mass 4 kg	(S)	3.75 ms^{-2}

(A) i → P ii → Q iii → S iv → P
(B) i → S ii → R iii → Q iv → R
(C) i → R ii → Q iii → P iv → S
(D) i → Q ii → P iii → R iv → Q

(126) Match the columns, in the reference of arrangement as shown in the figure. Surface is friction less, and string is tension less.



	Column - 1		Column - 2
(i)	Acceleration of block having mass 1 kg	(P)	4 SI
(ii)	Resultant force on a block having mass 2 kg	(Q)	25 SI
(iii)	Normal force on a block having mass 3 kg	(R)	2 SI
(iv)	Normal reaction force between the block having mass 2 kg and 1 kg	(S)	$15\sqrt{3}$ SI

(A) i → R ii → P iii → S iv → Q
(B) i → P ii → R iii → Q iv → S
(C) i → R ii → Q iii → S iv → P
(D) i → Q ii → P iii → Q iv → R

Ans. : 125 (C), 126 (A)

Comprehension Type Questions :

A person of mass 60 kg is standing on a spring balance in a lift. Lift is connected with cable rotar, to control the speed of lift there's an arrangement of break and accelerator in it. In this conditions, select the proper answer in a questions given below. ($g = 10\ ms^{-2}$)

(127) What is the observation of spring balance, when lift is moving with acceleration of 5 ms^{-2} in upward direction ?

(A) 300 N (B) 200 N (C) 100 N (D) Zero

(128) What is the acceleration experienced by a person when lift is moving in downward direction with an acceleration 5 ms^{-2}.

(A) 5 ms^{-2} (B) 10 ms^{-2} (C) 15 ms^{-2} (D) 20 ms^{-2}

(129) What is the observation of spring balance when cable of lift breaks ?

(A) Zero (B) 5 ms^{-2} (C) 10 ms^{-2} (D) 15 ms^{-2}

Ans. : 127 (A), 128 (C), 129 (A)