PHYSICS

The following question given below consist of an "Assertion" (A) and "Reason" (R) Type questions. Use the following Key to choose the appropriate answer.

(A) If both (A) and (R) are true, and (R) is the correct explanation of (A).

(B) If both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) If (A) is true but (R) is false.

(D) If (A) is false but (R) is true.

Q. 1 **Assertion :** A car is moving with acceleration on a straight road. Net force on a milestone with respect to car is zero.

Reason : Pseudo force acts on each body if aberration is made with respect to a non-inertial reference frame. **[D]**

Sol. Net force on milestone with respect to car is

$$\vec{F} = -m\vec{a}$$

[where m = mass of milestone

$\vec{a}$ =acceleration of car]

Q.2 **Assertion :** The apparent weight of a body in an elevator moving with some downward acceleration is less than the actual weight of body.

Reason : The part of the weight is spent in producing downward acceleration, when body is in elevator. **[A]**

Sol. If lift accelerates downward,

$W_{app} = m(g - a)$

Q. 3 **Assertion :** In a free fall, weight of a body becomes effectively zero.

Reason : Acceleration due to gravity acting on a body having free fall is zero. **[C]**

Sol. In free fall,

$W_{app} = m(g - g) = 0$

Q. 4 **Statement-I :** Newton's second law of motion gives the measurement of force.

Statement-II : According to Newton's second law of motion, force is directly proportional to the rate of change of momentum. **[A]**

Sol. Think yourself. (Both Statement-I and Statement-II are true and Statement-II is the correct explanation of A)

Q. 5 **Assertion:** If pseudo force on a body is assumed as action then frictional force may be reaction for this action.

Reason : Action-reaction must acts on different bodies.

Sol. **[D]**

Action-Reaction must be of same nature.

Q. 6 **Statement-I :** A table cloth can be pulled from a table without dislodging the dishes.

Statement-II : To every action there is an equal and opposite reaction. **[B]**

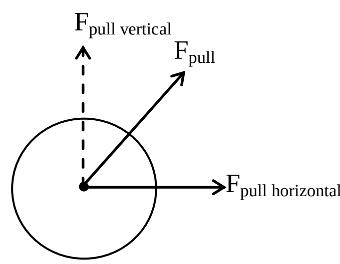
Sol. Statement-I is Newton's first law where as Statement-II is Newton's third law

Q. 7 **Assertion:** Pulling a lawn roller is easier than pushing it.

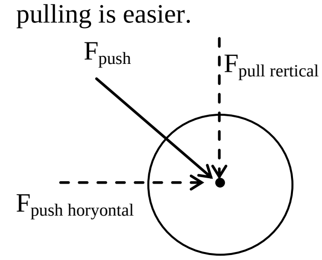
Reason : Pushing increase the apparent weight and hence the force of friction.

Sol. **[A]**

As (A) / R True & correct explanation



F_{pull} horizontal help to move forward & vertical component of F_{pull} is opposite to its weight, thus Normal Reaction is & weight is reduce, so pulling is easier.



F_{push} vertical increase the weight &will increase the friction.

Q.8 **Assertion :** When a block is placed in a lift which is accelerating upwards then the body experiences the following three forces.

(a) weight

(b) normal reaction

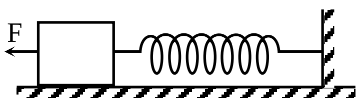
(c) pseudo force

Reason : Pseudo force is applied on the body only when body is seen by an accelerated observer.

Sol. **[D]**

Pseudo force is an imaginary force and it can be experienced by body.

Q.9 **Assertion :** A block is pulled by external force 'F' as shown in figure. In equilibrium external force and spring force on block are action and reaction pair.



Reason : Action and reaction pair are always equal and opposite.

Sol. **[D]**

(A) is false but (R) is true

Q.10 **Assertion :** A force F_1 is applied on lower block in fig. 1 due to which only lower block is moving with constant velocity. A force F_2 is applied on lower block in figure 2 due to which both blocks are moving with constant velocity. Then F_1 and F_2 will be equal.

Reason : Friction force between ground and m_2 as well as between m_1 and m_2 will be same for both cases.

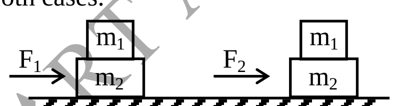


fig. 1 fig. 2

Sol. **[A]**

Both (A) and (R) are true and (R) is the correct explanation of (A).

Q.11 **Assertion :** Nuclear force doesn't obey Newton's third law.

Reason : Nuclear force is not a central force.

Sol. **[A]**

Both A & R are true & R is correct explanation.

Q.12 **Statement I :** If a man with wrist watch on his hand falls from the top of a tower, its watch gives correct time during the free fall.

Statement II : The working of the wrist watch depends on spring action and it has motion to do with gravity

Sol. **[A]**

Both assertion and reason are true and reason is a correct explanation of the assertion.

Q.13 **Assertion :** The apparent weight of a body in an elevator moving with some downward acceleration is less than the actual weight of body.

Reason : The part of the weight is spent in producing downward acceleration, when body is in elevator.

Sol [A] If lift accelerates downward,

$W_{app} = m(g - a)$

Q.14 **Assertion/Statement -1**

A cloth covers a table. Some dishes are kept on it. The cloth can be pulled out without dislodging the dishes from the table.

Reason/Statement -2

For every action there is an equal and opposite reaction. **[IIT-2007]**

[B]

Q.15 **Assertion :** A body whatever its motion is always at rest in reference frame which is fixed to the body itself.

Reason : The relative velocity of a body with respect to itself is always zero. **[A]**

Q.16 **Assertion :** Newton's third law is not applicable for nuclear forces.

Reason : Nuclear force are short ranged force.

[B]

Sol. Nuclear force are not a central force.

Q.17 **Statement- I :** A lighter and a heavier bodies moving with same momenta and experiencing same retarding force have equal stopping times.

Statement-II : For a given force and momentum, stopping time is independent of mass. **[A]**

Q.18 **Assertion :** The third law of motion concludes that the forces occur in pairs of action and reacion.

Reason : The action force is more than the reaction force.

(A) a (B) b

(C) c (D) d **[C]**

Q.19 **Assertion :** In a free fall, weight of a body becomes effectively zero.

Reason : Acceleration due to gravity acting on a body having free fall is zero.

(A) a (B) b

(C) c (D) d **[C]**

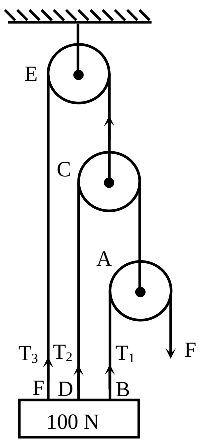
Q.20 **Assertion:** Centripetal force and centrifugal force act opposite to each other on a body moving in a circular path.

Reason : Centripetal force & centrifugal force depend on frame of reference. **[D]**

Sol. Inertial observer recognizes centripetal force.
Non-inertial (accelerated) observer recognizes centrifugal force.

PHYSICS

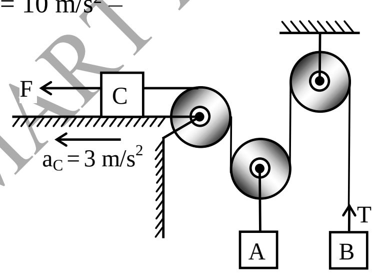
Q.1 In the arrangement shown below, force F is just sufficient to keep equilibrium of 100 N block T_1, T_2 and T_3 are tension in string AB, CD, and EF and T_4 is total force of all tensions on block 100 N.



Column I	**Column II**
(A) T_1	(P) $\frac{400}{7}$ N
(B) T_2	(Q) $\frac{100}{7}$ N
(C) T_3	(R) $\frac{200}{7}$ N
(D) T_4	(S) 100 N

(A) → Q (B) → R (C) → P (D) → S

Q.2 As shown block C of mass 5 kg is pulled by a force F and its acceleration is found to be 3 m/s^2. The masses of blocks A and B are 10 kg and 5 kg respectively while the string passing over ideal pullies is ideal and is under tension T. If acceleration of blocks A and B are a_1 and a_2 respectively then if all surfaces are smooth and g = 10 m/s^2 –



Column-I	**Column-II**
(A) F	(P) 2
(B) T	(Q) 1
(C) a_1	(R) 55
(D) 2 a_2	(S) 70

(A) → S (B) → R (C) → Q (D) → PS

Q.3 If the net force acting on a system is represented by $\vec{F}$ and its momentum is $\vec{p}$, then match the entries of column I with the entries of column II.

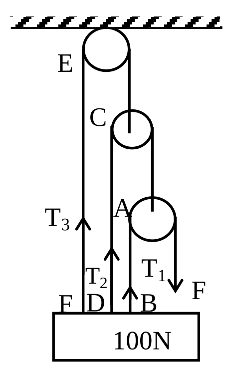
Column I	**Column II**
(A) If $\vec{F}$ is constant	(P) $\vec{p}$ may change its direction
(B) If $\vec{F}$ is changing in magnitude	(Q) $\vec{p}$ must change its magnitude
(C) if $\vec{F}$ is changing in direction	(R) $\vec{p}$ may not change its direction
(D) If $\vec{F}$ is zero	(S) $\vec{p}$ must not change its direction

Sol. **A → P,Q,R ; B → P,Q,R ; C → P,Q ; D → S**

The directions of $\vec{F}$ and $\vec{p}$ may be different, so $\vec{p}$ may change its direction. If direction of $\vec{F}$ and $\vec{p}$ are the same, then direction of $\vec{p}$ would not change.

If $\vec{F}$ is non-zero in magnitude then magnitude of $\vec{p}$ will change.

Q.4 In the arrangement shown below force F is just sufficient to keep equilibrium of 100 N block, T_1, T_2 and T_3 are tension, in strings AB, CD and EF and T_4 is total force of all tensions on block 100 N

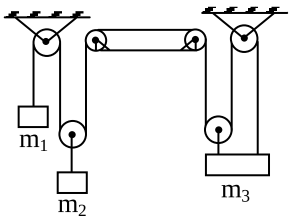


Match the following :

Column I	**Column II**
(A) T_1	(P) $\frac{400}{7}$ N
(B) T_2	(Q) $\frac{100}{7}$ N
(C) T_3	(R) $\frac{200}{7}$ N
(D) T_4	(S) 100 N

A → Q, B → R, C → P, D → S

Q.5 Consider the situation shown in figure. All pulley and strings are light. Acceleration of block m_1, m_2 and m_3 are a_1, a_2 and a_3 respectively. Assuming that all the blocks are undergoing pure translatory motion, match the following –



Column I	Column II
(A) $m_1 = 2$ kg, $m_2 = 4$ kg, $m_3 = 6$ kg	(P) $a_1 = 0$
(B) $m_1 = 4$ kg, $m_2 = 3.2$ kg, $m_3 = 6$ kg	(Q) a_2 is in upward direction
(C) $m_1 = m_2 = 2$ kg, $m_3 = 9$ kg	(R) $a_3 = 0$
(D) $m_1 = 1$ kg, $m_2 = 8$ kg, $m_3 = 6$ kg	(S) a_3 is in downward direction

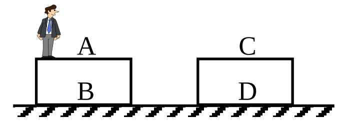
Ans. A $\rightarrow$ **P, R ; B $\rightarrow$ Q, R ; C $\rightarrow$ P,Q,S ; D $\rightarrow$ R**

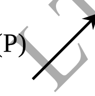
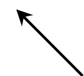
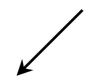
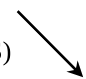
Q.6 Column I contains laws/principles and column II contain phenomena/things explained by them.

Column-I	Column-II
(A) Newton's 1st law	(P) Explanation of no effect of internal forces on the acceleration of system
(B) Weak form of Newton's 2nd law	(Q) Definition of inertial reference frame
(C) Strong form of Newton's 2nd law	(R) Definition of force
(D) Newton's third law	(S) Study of variable mass system

Ans. **A $\rightarrow$ Q ; B $\rightarrow$ R ; C $\rightarrow$ S ; D $\rightarrow$ P**

Q.7 Figure shows two blocks. A rough surface are identified as shown in figure. Blocks and man are initially at rest. The man started running with non zero acceleration on surface 'A' and jumps on surface 'C' and stays there stationary w.r.t. other block. Then -



Column-I	Column-II
(A) Direction of contact force on 'A' when man is on 'A'	(P) 
(B) Direction of contact force on surface B when man is on A	(Q) 
(C) Direction of contact force on surface 'C' when man reaches at 'C'	(R) 
(D) Direction of contact force on surface 'D' when man reaches at 'C'	(S) 

Sol. **A $\rightarrow$ R ; B $\rightarrow$ P ; C $\rightarrow$ S ; D $\rightarrow$ Q**

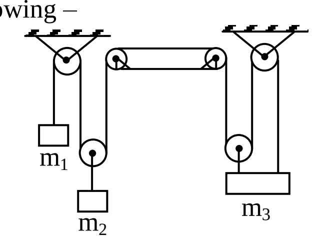
Contact force on a surface is given by

$\vec{R} = \vec{N} + \vec{f}$

Where $\vec{N}$ = normal force on the surface.

$\vec{f}$ = friction force on the surface.

Q.8 Consider the situation shown in figure. All pulley and strings are light. Acceleration of block m_1, m_2 and m_3 are a_1, a_2 and a_3 respectively. Assuming that all the blocks are undergoing pure translatory motion, match the following –

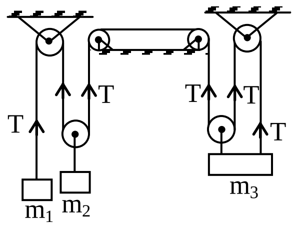


Column I	Column II
(B) $m_1 = 2$ kg, $m_2 = 4$ kg, $m_3 = 6$ kg	(P) $a_1 = 0$
(B) $m_1 = 4$ kg, $m_2 = 3.2$ kg, $m_3 = 6$ kg	(Q) a_2 is in upward direction
(C) $m_1 = m_2 = 2$ kg, $m_3 = 9$ kg	(R) $a_3 = 0$
(D) $m_1 = 1$ kg, $m_2 = 8$ kg, $m_3 = 6$ kg	(S) a_3 is in downward direction

Ans. **A → P,R; B → Q,R ; C → P,Q,S ; D → R**

Consider case A :

m_1 = 2 kg, m_2 = 4 kg, m_3 = 6 kg



Let us assume $a_3 = 0$

$\Rightarrow T = 20$ N

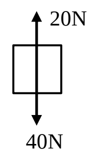
$\Rightarrow a_1 = a_2 = 0$

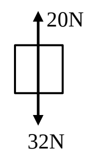
Consider case B :

m_1 = 4 kg, m_2 = 3.2 kg, m_3 = 6 kg

T = 20 N

m_1 **m_2**

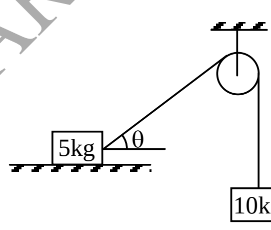




Net force on m_1 is in downward direction while on 'm_2' is in upward direction.

Similar logic for 'C' and 'D'.

Q.9 In the arrangement shown pulley is ideal and string is massless. 5 kg block is moving on the horizontal which is smooth. When θ is 37° acceleration of 5 kg and 10 kg blocks are a_1 and a_2. Tension in string connecting blocks is T and the total force applied by this string on pulley is F. Then : ($g = 10\ m/s^2$)
(Values of quantities in column II are in SI units)



Column I	**Column II**
(A) a_1	(P) 5.6
(B) a_2	(Q) 43.75
(C) T	(R) 7
(D) F	(S) 78.26

Sol. **A → R ; B → P ; C → Q ; D → S**

$a_1 \cos 37° = a_2$

$\therefore \quad 4a_1 = 5a_2 \quad ... (1)$

$100 - T = 10a_2 \quad ... (2)$

$T \cos 37° = 5a_1$

$T = \frac{25}{4} a_1 \quad ... (3)$

and $F = \sqrt{T^2 + T^2 + 2.T.T.\cos 53°}$

Q.10 Velocity of three particles A, B and C varies with time t as, $\vec{v}_A = (2t\hat{i} + 6\hat{j})$ m/s, $\vec{v}_B = (3\hat{i} + 4\hat{j})$ m/s and $\vec{v}_C = (6\hat{i} + 4t\hat{j})$. Regarding the pseudo force match the following table -

Column -I	**Column-II**
(A) On A as observed by B	(P) Along positive x-direction
(B) On B as observed by C	(Q) Along negative x-direction
(C) On A as observed by C	(R) Along positive y-direction
(D) On C as observed by A	(S) Along negative y-direction
	(T) zero

Sol. **A → T ; B → R ; C → R ; D → Q**

$\vec{v}_A = (2t\hat{i} + 6\hat{j})$m/s, $\vec{a}_A = \frac{d\vec{v}_A}{dt} = 2\hat{i}\ m/s^2$

$\vec{v}_B = 3\hat{i} + 4\hat{j}$, $\vec{a}_B = \frac{dv_B}{dt} = 0$

$\vec{v}_C = (6\hat{i} + 4t\hat{j})$, $\vec{a}_C = \frac{d\vec{v}_C}{dt} = 4\hat{j}\ m/s^2$

(A) $\vec{F}_1 = -m_A \vec{a}_B = 0$

(B) $\vec{F}_2 = -m_B \vec{a}_C \;\; -4m\hat{j}$

(C) $\vec{F}_3 = -m_A \vec{a}_C = -4m\hat{j}$

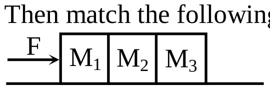
(D) $\vec{F}_4 = -m_C \vec{a}_A = -2m\hat{i}$

Q.11 Considering real forces only match the following

Column-I	Column-II
(A) Velocity	(P) Frame expendent
(B) Acceleration	(Q) Force must be involved
(C) Momentum	(R) Must be in the direction of net force (including pseudo force)
(D) Work	(S) Must remain constant if net force is zero.

Sol. **A → P ; B → P, R ; C → P ; D → P,Q,S**

Q.12 A system of masses M_1, M_2 and M_3 is shown in the diagram. Then match the following columns

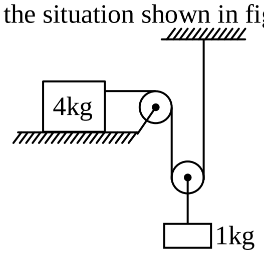


Column I	Column II
(a) acceleration of system	(p) $\frac{F(M_2+M_3)}{M_1+M_2+M_3}$
(b) Reaction force of M_2 on M_1 is	(q) $\frac{F}{M_1+M_2+M_3}$
(c) Reaction force of M_2 on M_3 is	(r) $\frac{F(M_3)}{M_1+M_2+M_3}$

(A) a → p, b → r, c → q
(B) a → q, b → p, c → r
(C) a → q, b → r, c → p
(D) a → r, b → p, c → q

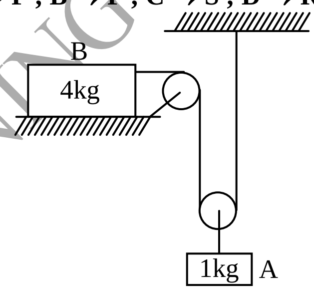
Sol. [B] a → q , b → p , c → r

Q.13 Consider the situation shown in fig.



Column –I	***Column-II***
(A) The ratio of acceleration of block of 1 kg to that of 4 kg is	*(P) 0.5*
(B) The ratio of velocity of 1 kg to that of 4 kg is	*(Q) 1*
(C) The coefficient of kinetic friction between the block and table is. For 1 kg block having a speed of 0.3 ms^{-1} after descending 1m	*(R) 0.6*
(D) The velocity of 4 kg block at this instant mentioned in (C) is ms^{-1}	*(S) 0.12*

Sol. **A → P ; B → P ; C → S ; D → R**



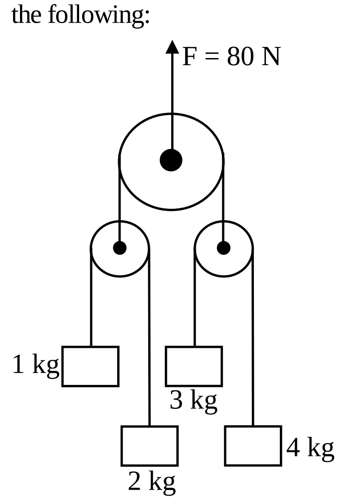
$2a_A = a_B \quad \Rightarrow \quad \frac{a_A}{a_B} = \frac{1}{2} = 0.5$

$2V_A = V_B \quad \Rightarrow \quad \frac{V_A}{V_B} = \frac{1}{2} = 0.5$

$m_A g\, x_A = \frac{1}{2} \times 1 \times (0.3)^2 + \frac{1}{2} \times 4 \times (0.6)^2 + \mu_B m_B g\, x_B$

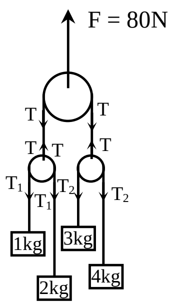
$\mu = 0.12$

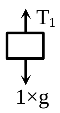
Q.14 In the diagram shown in figure, all pulleys are smooth and massless and strings are light. Match the following:



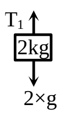
Column -I	Column-II
(A) 1 kg block	**(P) will remain stationary**
(B) 2 kg block	**(Q) will move down**
(C) 3 kg block	**(R) will move up**
(D) 4 kg block	**(S) 5 m/s^2**
	(T) 10 m/s^2

Sol. A → R, T, B → P, C → Q, D → Q, S

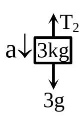




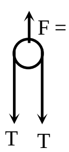
$T_1 - 1 \times g = 1 \times a$
$a = 10\ m/s^2$



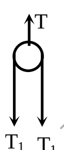
$T_1 - 20N = 2 \times a$
$a = 0$



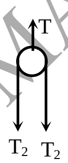
$30N - 20N = 3 \times a$
$a = 10/3$



$80N = 2T$
$T = 40N$

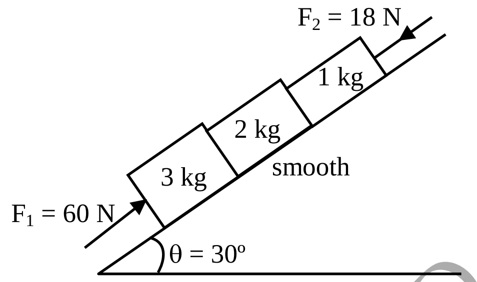


$40N = 2T_1$
$T_1 = 20N$



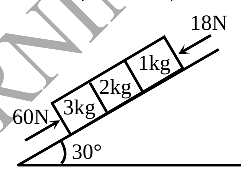
$40N = 2T_2$
$T_2 = 20N$

Q.15 In the diagram shown in figure, match the following: ($g = 10\ m/s^2$)



Column -I	Column-II
(A) Acceleration of 2 kg block	(P) 8 SI unit
(B) Net force on 3kg block	(Q) 25 SI unit
(C) Normal reaction between 2 kg and 1 kg	(R) 2 SI unit
(D) Normal reaction between 3 kg and 2kg	(S) 45 N
	(T) None

Sol. **A → R, B → T, C → Q, D → T**



(A) $a = \dfrac{42N - 6 \times g \times \sin 30°}{6} = 2 m/s^2$

(B) F_{net} on 3kg = 3 × a = 6N

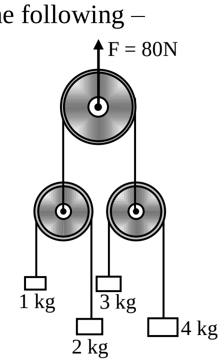
(C) $R_1 - 1 \times g \sin 30° - 18 = 1 \times a$

$R_1 = 18 + 5 + 2 = 25N$

(D) $60N - R_2 - 3 \times g \sin 30° = 3 \times 2$

$R_2 = 60 - 15 - 6 = 39N$

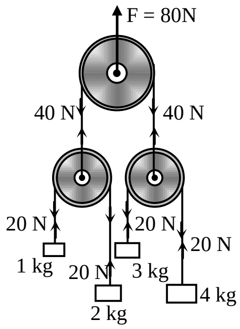
Q.16 In the diagram shown in figure, all pulleys are smooth and massless and strings are light. Match the following –



Column -I	Column-II
(A) 1 kg block	(P) will remain stationary
(B) 2 kg block	(Q) will move down
(C) 3 kg block	(R) will move up
(D) 4 kg block	(S) 5 m/s^2

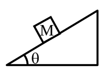
(T) 10 m/s^2

Sol. [A → R, T ; B → P; C → Q; D → Q,S]



Now acceleration of all the blocks can be calculated.

Q.17 Match the column-I with Column-II :

Column -I	Column-II
(A) Tension at each point of string is same if the string is	(P) Upward
(B)  A block of mass M is kept stationary on an inclined plane. Number of force acting on the block is	(Q) Mg sin θ
(C) The magnitude of normal reaction in B	(R) Mg cos θ
(D) Force of friction in B is	(S) Massless
	(T) 3

Sol. A → S; B → T; C → R; D → P,Q

Q.18 Match the force or set of forces in the left hand column to a characteristic of force or set of forces in the right-hand column.

Column I (Force) (Characteristic)	**Column II**
(A) Electric (Electrostatic) to	(P) Proportional $\frac{1}{(\text{distance})^2}$
(B) Gravity attracts	(Q) Always
(C) Both Electric and Gravity	(R) Always repels
(D) Neither electric nor gravity	(S) Attracts or repels
	(T) Central force

Sol. **A→ P,S,T ; B→ P,Q,T ; C→ P,T; D→ R**

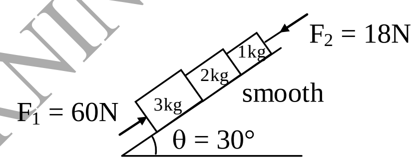
Q.19 Column I contains laws/principles and column II contain phenomena/things explained by them.

Column-I	**Column-II**
(A) Newton's 1st law	(P) Explanation of no effect of internal forces on the acceleration of system
(B) Weak form of Newton's 2nd law	(Q) Definition of inertial reference frame
(C) Strong form of Newton's 2nd law	(R) Definition of force
(D) Newton's third law	(S) Study of variable mass system
	(T) None

Sol. [A → Q ; B → R ; C → S ; D → P]

Conceptual

Q.20 In the diagram shown in figure, match the following: ($g = 10\ m/s^2$)



Column I	**Column II**
(A) Acceleration of 2 kg block	(P) 8 SI unit
(B) Net force on 3 kg block	(Q) 25 SI unit
(C) Normal reaction between 2 kg and 1 kg	(R) 2 SI unit
(D) Normal reaction between 3 kg and 2 kg	(S) 24 S.I. unit
	(T) None

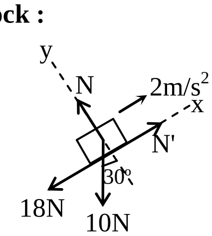
Sol. **[A → R ; B → T ; C → Q ; D → T]**

system (1 + 2 +3)

$$a = \frac{60 - 18 - 60 \sin 30^\circ}{6} = \frac{12}{6} = 2\ m/s^2$$

3kg block : $F_{net} = m \times a = 6N$

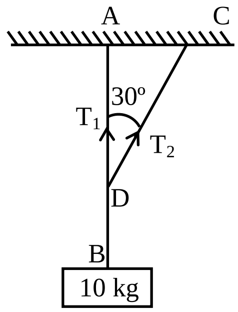
1 kg block :



$F_x = N' - 18 - 10 \sin 30^\circ = 1 \times 2$

N' = 25 newton

Q. 1 The values of tensions T_1 and T_2 in the strings shown are (assume string AB to be vertical) –



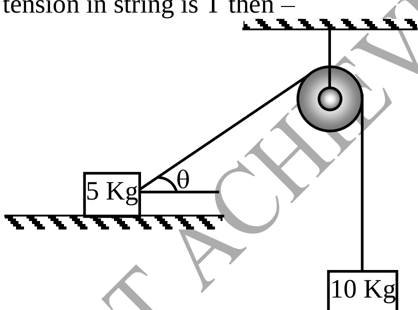
(A) $T_1 = 50$ N (B) $T_1 = 100$ N
(C) $T_2 = 50$ N (D) $T_2 = 0$ N

[B,D]

Q. 2 The force exerted by the lift on the foot of a person standing in it, is more than his weight than the lift is -
(A) going up and slowing down
(B) going up and speeding up
(C) going down and slowing down
(D) going down and speeding up

[B,C]

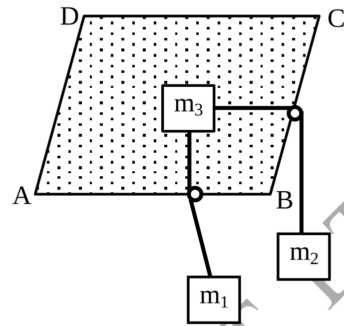
Q. 3 In the arrangement shown pulley is ideal and string is massless. 5 kg block is moving on the smooth surface. When θ is 37º acceleration of 5 kg and 10 kg blocks are a_1 and a_2 while tension in string is T then –



(A) $4a_1 = 5a_2$ (B) $5a_1 = 4a_2$
(C) T = 43.86 N (D) T = 58.14 N

[A,C]

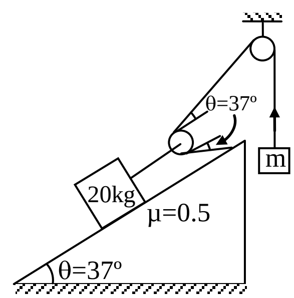
Q. 4 Three blocks are arranged as shown. ABCD is the horizontal plane. Strings are massless and both pulley stands vertical while the strings connecting blocks m_1 and m_2 are also vertical and perpendicular to each other. The masses m_1 and m_2 are 3 kg and 4 kg respectively. Coefficient of friction between the block m_3 = 10 kg and surface is μ = 0.6 then –



(A) The system of blocks can be in equilibrium
(B) At equilibrium frictional force on block m_3 is 60 N
(C) At equilibrium frictional force on block m_3 is 50 N
(D) Total force applied by surface on block m_3 is $50\sqrt{5}$ N

[A,C,D]

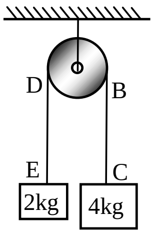
Q. 5 As shown in figure pulley is ideal and strings are massless. If mass m of hanging block is the minimum mass to set the equilibrium of system then,



(A) m = 2.5 kg
(B) m = 5 kg
(C) force applied by 20 kg block on inclined plane is 179 N
(D) force applied by 20 kg block on inclined plane is 223 N

[A,BC,]

Q. 6 As shown is figure the string BC is 10 cm long and has a linear mass density of 10 kg/m while the string ED is massless. If both strings are inextensible and pulley is ideal then when the system is released from rest the ratio of tension in the string.



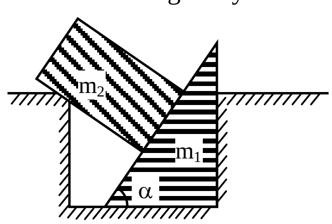
(A) at points E and C is $\frac{5}{4}$

(B) at points E and C is $\frac{4}{5}$

(C) at points D and E is 1

(D) at points D and E is $\frac{1}{2}$ **[A,C,]**

Q. 7 A wedge of mass m_1 and a block of mass m_2 is in equilibrium as shown. Inclined surface of the wedge has an inclination α with the horizontal and all contacts are smooth. The normal reaction on the wedge may be –

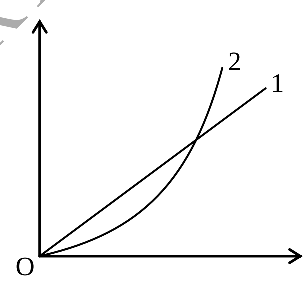


(A) $m_2g\cos\alpha$ (B) $m_2g\sin\alpha\cos\alpha$

(C) $m_1g + m_2g\cos^2\alpha$ (D) $m_1g+m_2g\sin\alpha\cos\alpha$

[BC,]

Q.8 A particle is resting over a smooth horizontal floor. At t = 0, a horizontal force starts acting on it. Magnitude of the force increases with time as F = kt, where k is a constant. The two curves are drawn for this particle as shown.



(A) Curve-1 shows acceleration versus time
(B) Curve-2 shows velocity versus time
(C) Curve-2 shows velocity versus acceleration
(D) None of these

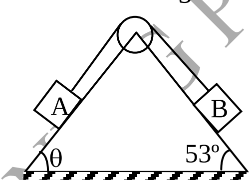
Sol. **[A,B,C]**

$F = kt \Rightarrow \frac{mdv}{dt} = kt \Rightarrow mv = \frac{kt^2}{2}$ .....(i)

Now $a = \frac{F}{m} \Rightarrow a = \frac{k}{m}t$ ....(ii)

from (i) and (ii) $mv = \frac{k}{2} \times \left(\frac{ma}{k}\right)^2$

Q.9 As shown in figure two blocks A and B of mass 1kg each are connected by an ideal string that passes over a smooth pulley that is fixed on a smooth fixed wedge as shown. If the ratio of normal reaction on block A and on block B is $\frac{4}{3}$ then –



(A) $\cos\theta = \frac{4}{5}$

(B) $\sin\theta = \frac{4}{5}$

(C) acceleration of blocks is $\frac{g}{10}$ m/s^2

(D) acceleration of blocks is $\frac{g}{5}$ m/s^2

Sol. **[A,C]**

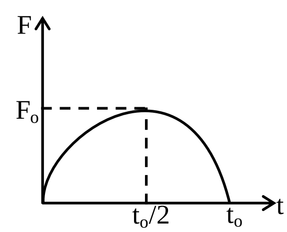
$N_A = mg\cos$ and $N_B = mg\cos 53^\circ$

as given $\frac{N_A}{N_B} = \frac{4}{3} \Rightarrow \frac{\cos\theta}{\cos 53^\circ} = \frac{4}{3}$

$\therefore \cos\theta = \frac{4}{3} \times \frac{3}{5} \Rightarrow \cos\theta = \frac{4}{5}$

Now, $a = \frac{mg[\sin 53^\circ - \sin\theta]}{2m} = \frac{g}{10}$

Q.10 A variable force acts on a body of mass m (initially at rest) from t = 0 to t = t_0. The curve of F plotted versus t is semicircle as shown, then-



(A) Impulse imparted to particle is infinite

(B) Impulse imparted to particle is $\frac{1}{4}\pi F_o t_o$

(C) The velocity acquired by the particle is $\frac{\pi F_o t_o}{4m}$

(D) The gain in momentum is $\frac{\pi F_o t_o}{4}$

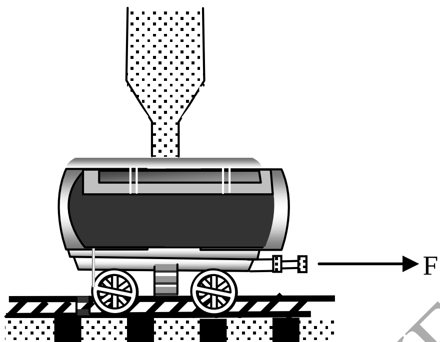
Sol. **[B,C,D]**

Impulse = change in momentum

= Area under F – t curve

$= \frac{1}{2}\pi \times F_o \times \frac{t_o}{2}$

Q.11 A flat cart of mass m_0 starts moving to the right due to a constant horizontal force F at t = 0. Sand spills on the flat cart from a stationary hopper. The velocity of loading is constant and is equal to μ kg/sec.



(A) Initial acceleration is equal to F/m_0

(B) Acceleration at time t is $F/(m_0 + \mu t)$

(C) Kinetic energy of loaded cart at an instant is equal to work done by force F upto that instant

(D) Momentum of loaded cart at an instant is equal to impulse of force F upto that instant.

Sol. **[A,D]**

Suppose at an instant 't' velocity of cart be v. Due to the sand falling on the cart, it experiences a retarding force, which is equal to μv. It means net accelerating force on the cart is equal to (F – μv). But at this instant, mass of the loaded cart is equal to $(m_0 + \mu t)$.

Therefore, acceleration at time t will be equal to $\frac{(F-\mu v)}{(m_0+\mu t)}$. It means, option (B) is wrong.

If in above equation t is substituted as zero, then initial acceleration of the cart is, $a_0 = \frac{(F-\mu v)}{m_0}$

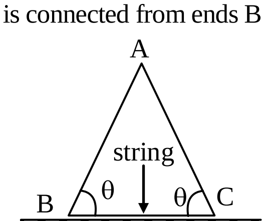
But at initial moment, speed of flat cart is equal to zero. Hence, the initial acceleration becomes (F/m_0). It means, option (A) is correct.

If we consider a system of flat cart and falling sand particles, then sand particles exert a retarding force on the cart which is equal to μv and the cart exerts an accelerating force on sand particles which is also equal to μv. It means the only external force or the only resultant force acting on the system is equal to F.

It means the momentum of the system at any instant t will be equal to impulse of the force F. Hence, option (D) is correct.

The collision of the sand particles with the cart is perfectly inelastic because just after falling on the cart, sand particles start to move horizontally rightward with the cart while just before coming onto the cart, these sand particles have zero horizontal velocity. It means there is a loss of energy during the collision. Hence, kinetic energy of loaded cart at an instant will be less than the work done by the force F upto that instant. Hence, option (C) is wrong.

Q.12 Two uniform identical ladders AB and AC each of mass m leans against each other and a string is tied between them which is horizontal. The system stands on a smooth horizontal surface as shown, then, string is connected from ends B and C.



(A) the force exerted by one rod on other at A is equal to the tension T in the string

(B) tension in string T = $\left(\frac{mg}{2}\right)\cot\theta$

(C) tension in string T = $\left(\frac{mg}{2}\right)\tan\theta$

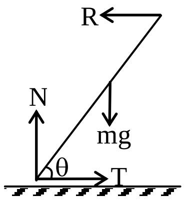
(D) None of these

Sol. **[A,B]**

R= T …..(1)

N = mg…..(2)

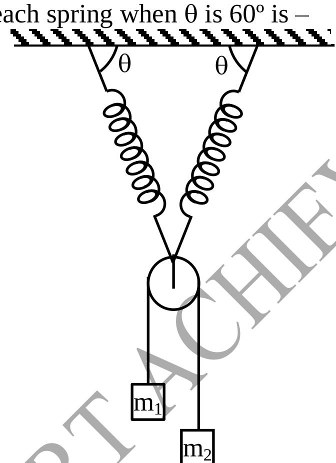
taking torque about centre of mass



$$N \times \frac{L}{2}\cos\theta = R \times \frac{L}{2}\sin\theta + T \times \frac{L}{2}\sin\theta$$

$$\therefore \frac{mg}{2}\cos\theta = T\sin\theta \Rightarrow T = \frac{mg}{2}\cot\theta$$

Q.13 Two identical ideal springs of spring constant 1000 N/m as connected by an ideal pulley as shown and system is arranged in vertical plane. At equilibrium θ is 60º and masses m_1 and m_2 are 2kg and 3kg respectively. Then elongation in each spring when θ is 60º is –



(A) $1.6\sqrt{3}$ cm (B) 1.6 cm

(C) 4.8 cm (D) none of these

Sol. **[A]**

$$T = \frac{2m_1m_2}{m_1+m_2}g = \frac{2\times2\times3}{5} \times 10 = 24 \text{ N on pulley}$$

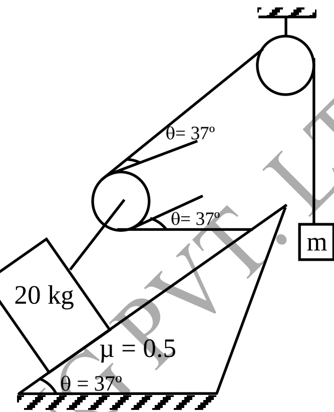
2k x cos30º = 2T

$$kx \times \frac{\sqrt{3}}{2} = 24$$

$$1000 \times x \times \frac{\sqrt{3}}{2} = 24$$

$x = 1.6\sqrt{3}$ cm

Q.14 As shown in figure pulley is ideal and strings are massless. If mass m of hanging block is the minimum mass to set the equilibrium of system then – (g = 10 m/s^2)



(A) m = 2.5 kg

(B) m = 5 kg

(C) force applied by 20 kg block on inclined plane is 179 N

(D) force applied by 20 kg block on inclined plane is 223 N

Sol. **[A,C]**

for 20 kg block

$$20 \times 10 \times \frac{3}{5} = 0.5 \times 20 \times 10 \times \frac{4}{5} + T$$

120 = 80 + T

T = 40 N

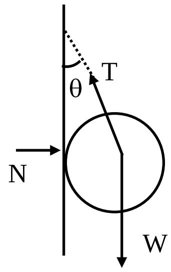
∴ 2 mg cos 37º = T

$$2m \times 10 \times \frac{4}{5} = 40$$

m = 2.5 kg

force applied by 20 kg block on inclined = $\sqrt{N^2+f^2}$

Q.15 A metal sphere is hung by a string fixed to a wall. The forces acting on the sphere are shown in figure. Which of the following statement is/are correct ?

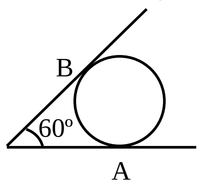


(A) $\vec{N}+\vec{T}+\vec{W}=0$ (B) $T^2 = N^2 + W^2$

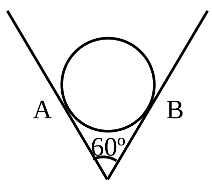
(C) T = N + W (D) N = W tan θ

[A,B,D]

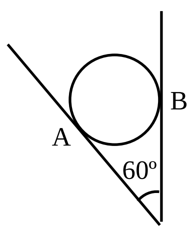
Q.16 An iron sphere weighing 10 N and rests in a V shpaed trough whose sides form an angle of 60º as shown in figure–



(i)



(ii)



(ii)

(A) R_A = 10 N and R_B = 0 in case (i)

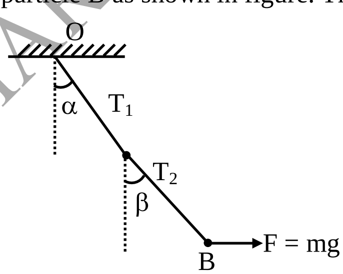
(B) R_A = 10 N and R_B = 0 in case (ii)

(C) $R_A = 20/\sqrt{3}$ N and $R_B = (10/\sqrt{3})$ in case (iii)

(D) R_A = 10 N and R_B = 10 N in all three cases

[A,C]

Q.17 Two particles A and B, each of mass m, are kept stationary by applying a horizontal force F = mg on particle B as shown in figure. Then–

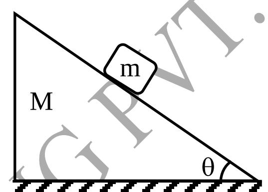


(A) tan β = 2 tan α (B) $2T_1 = 5T_2$

(C) $T_1\sqrt{2} = T_2\sqrt{5}$ (D) None of these

[A,C]

Q.18 A block of mass m slides down on a wedge of mass M as shown in figure. Let $\vec{a}_1$ be the acceleration of the wedge and $\vec{a}_2$ the acceleration of block. N_1 is the normal reaction between block and wedge and N_2 the normal reaction between wedge and ground. Friction is absent everywhere. Select the correct alternative(s)



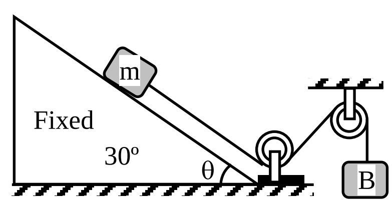
(A) $N_2 < (M + m)g$

(B) $N_1 = m(g\cos\theta - |\vec{a}_1|\sin\theta)$

(C) $N_1\sin\theta = M|\vec{a}_1|$

(D) $m\vec{a}_2 = -M\vec{a}_1$ **[A,B,C]**

Q.19 Two blocks A and B of equal mass m are connected through a massless string and arranged as shown in figure. Friction is absent everywhere. When the system is released from rest.



(A) tension in string is $\frac{mg}{2}$

(B) tension in string is $\frac{mg}{4}$

(C) acceleration of A is $\frac{g}{2}$

(D) acceleration of A is $\frac{3g}{4}$ **[B,D]**

Q.20 A body is kept on a smooth inclined plane having an inclination of 1 in x. Then–

(A) slope of inclined plane is $\frac{1}{x}$

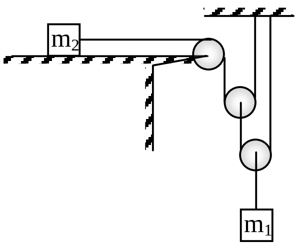
(B) slope of inclined plane is $\frac{1}{\sqrt{x^2-1}}$

(C) for the body of mass m to remain stationary relative to the incline, the incline must offer a normal reaction of mg $\frac{x}{\sqrt{x^2-1}}$

(D) for the body to remain stationary relative to the incline, the incline must be given a horizontal acceleration $\frac{g}{\sqrt{x^2-1}}$

[B,C,D]

Q.1 Pulleys are ideal and string are massless. The masses of blocks are m_1 = 4 kg and m_2 = 1 kg as shown. If all surfaces are smooth then the acceleration of m_2 in m/s^2 is (g = 10 m/s^2)



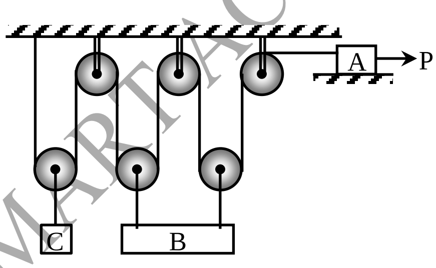
[0008]

Q.2 A block of mass 5 kg is placed on bus moving with acceleration $2m/s^2$. Pseudo force acting on block as seen by a man on ground is -

Sol. **[0]**

Pseudo force doesn't exist in Inertial ref. frame.

Q.3 Three blocks A, B and C of mass m each are arranged in pulley mass system as shown. Coefficient of friction between block A and horizontal surface is equal to 0.5 and a force P acts on 'A' in the direction shown. The value of P/mg so that block 'C' doesn't move is –



Sol. **[5]**

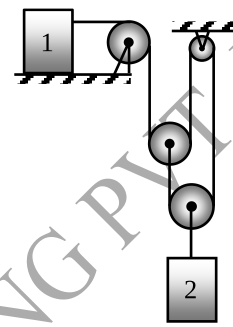
If C doesn't move then $a_A = 4a_B$ … (i)

$P - T - \mu mg = m\,4a_B$ …(ii)

$4T - mg = ma_B$ …(iii)

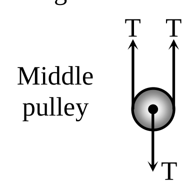
$\therefore \dfrac{p}{mg} = 5$

Q.4 Two blocks 1 and 2 of mass 2kg and 4 kg are kept connected as shown in figure. All pulley and string are massless and surfaces are frictionless. Acceleration of block 1 at the instant shown is -



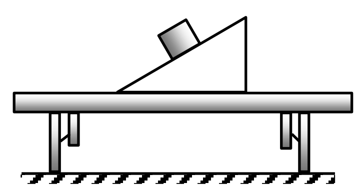
Sol. **[0]**

Tension in string is zero.



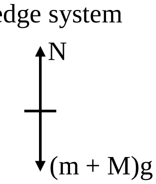
$2T = T \Rightarrow T = 0$

Q.5 A block of mass 0.2kg is kept on wedge of mass 0.6 kg which is kept on rough table. Block is slipping down with constant speed 2m/s. Normal force on wedge due to table is (Assume wedge is stationary) -



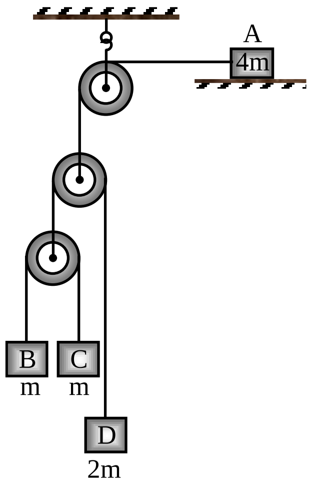
Sol. **[8]**

Block + wedge system

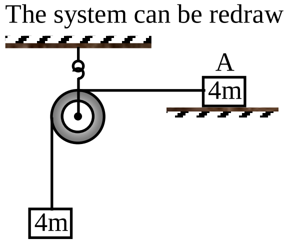


$\because$ acceleration is zero $\Rightarrow N = (m + M)g = 8N$

Q.6 In the given arrangement, strings and pulleys are light and all surface are frictionless. Assuming at t = 0, system is released from rest, find the speed of block A (in decameter/sec) at t = 2 sec.



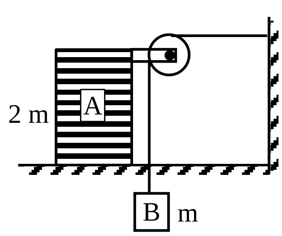
Sol. **[1]**
The system can be redraw as



$\therefore\ a = \dfrac{4mg}{8m} = \dfrac{g}{2} = 5 m/s^2$

$\therefore\ v = u + at = 2 \times 5 = 10$ m/s

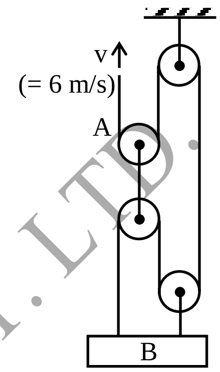
Q.7 In the system shown in figure all surfaces are frictionless while pulley and strings are light. Mass of block A is 2m while that of B is 'm'. Acceleration of block 'B' (in cm/s^2) immediately after system is released from rest minus 320 cm/s^2 is (Take g = 981 cm/s^2).



Sol. **[7]**

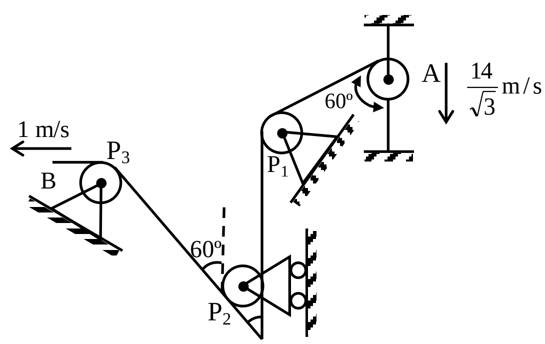
T = 2 ma
mg – T = ma
$\Rightarrow$ a = g/3.

Q.8 In the arrangement shown in figure end 'A' of light inextensible string is pulled with constant velocity v = 6 m/s. The velocity of block 'B' is (in m/s) -



Sol. **[2]**
According to principle of virtual work
$T.\ v = 3T\ .\ v_B \Rightarrow v_B = v/3$

Q.9 Figure shows a string passing through two fixed pulley P_1 and P_3 and a pulley P_2 free to move vertically. One end of string is attached with ring A. Velocity of pulley P_2 at the instant shown is (in m/s) -



Sol. **[4]**
By constraint relation
$V_A \sin 60° = V_{P_2} (1 + \cos 60°) + V_B$
$\therefore\ V_{P_2} = 4$ m/s.

Q.10 A block of mass 1 kg is just fit in a groove in a platform kept horizontally. Groove is along + ve x-axis. The platform is given acceleration

$\vec{a} = 2\hat{i} + 3\hat{j}$ m/s^2. If block is not slipping on platform the friction force acting on block (in Newton)

Sol. **[2]**

$\vec{f} = -\,m\,a\,\hat{i}$

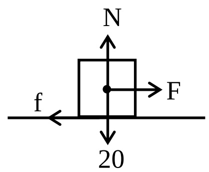
$= -\,1 \times 2\,\hat{i}$

$= 2\,\hat{i}$ Newton.

Q.11 A block of mass 2 kg is placed on rough horizontal surface (coefficient of friction = 0.2) and is pulled by horizontal force F = 2t N where t : time in sec. Velocity of block at t = 4 sec is –

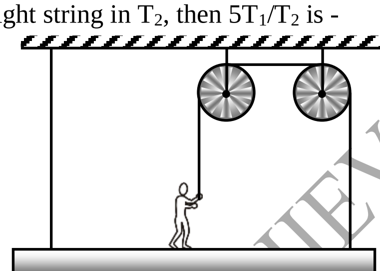
Sol. **[4]**

$v = \int_0^4 a\,dt = \int_0^2 a\,dt + \int_2^4 a\,dt$



$= \int_2^4 (2t - 4)\,dt = 4$ m/s.

Q.12 A system consisting of man on platform is in equilibrium. Mass of man and platform are equal. If tension in left string is T_1 and that in right string in T_2, then $5T_1/T_2$ is -



Sol. **[6]**

$\frac{3}{2} T_1 = \frac{3}{2} T_2 + \frac{N}{2}$

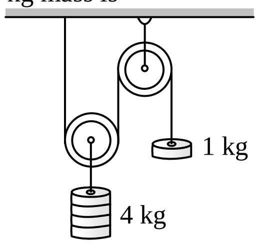
$N + T_2 = Mg$

$T_1 + T_2 = Mg$

$\therefore \frac{T_1}{T_2} = \frac{6}{5}$

PHYSICS

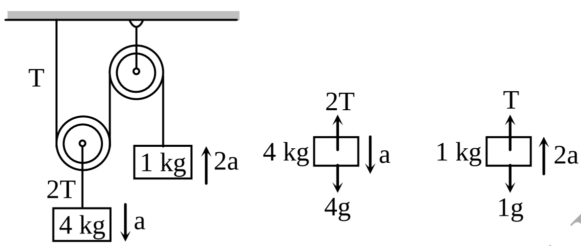
Q.1 In the system shown in figure, the acceleration of the 1 kg mass is -



(A) $\frac{g}{4}$ downward (B) $\frac{g}{4}$ upward

(C) $\frac{g}{2}$ downward (D) $\frac{g}{2}$ upward

Sol. **[D]**



$4g - 2T = 4(a)$ ... (1)

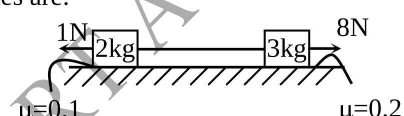
$T - 1(g) = 1\,(2a)$ ... (2)

Solving equation no. (1) and (2)

we get $a = \frac{g}{4}$

$\therefore$ Acceleration of 1 kg mass = $\frac{g}{2}$ upward

Q.2 In the shown arrangement if f_1, f_2 and T be the frictional forces on 2 kg block, 3kg block and tension in the string respectively, then their values are:



(A) 2N, 6N, 3.2 N

(B) 2N, 6N, 0N

(C) 1N, 6N, 2N

(D) Data insufficient to calculate the required values

[C]

Sol. FBD

1N ← [2kg] → T   ← [3kg] →

f_{max}=2N f_{max}=6N

Net force without friction on system is '7N' in right side so first maximum friction will come on 3 kg block

1N, 1N ← [2kg] → 2N   2N, 6N ← [3kg] → 8N

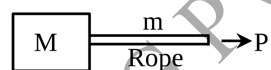
So f_1 = 1N, f_2 = 6N, T = 2N

Q.3 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) $\frac{PM}{M+m}$ **[D]**

Sol.

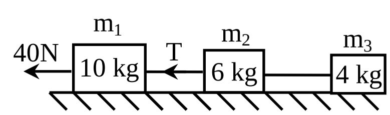


$P = (M + m)\,a$

$a = \frac{P}{(M+m)}$

$F = Ma = \frac{PM}{(M+m)}$

Q.4 Three blocks of masses m_1, m_2 and m_3 are placed on a horizontal frictionless surface. A force of 40 N pulls the system then calculate the value of T, if m_1 = 10kg, m_2 = 6 kg, m_3 = 4 kg –



(A) 40 N (B) 20 N

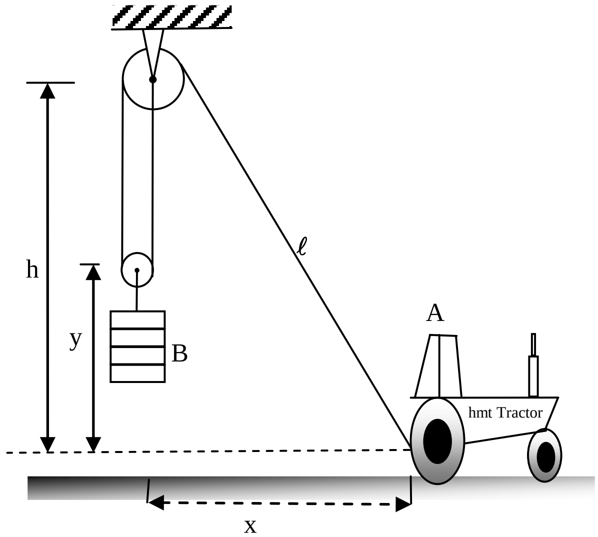
(C) 10 N (D) 5 N **[B]**

Sol. $a = \frac{F}{m_1+m_2+m_3} = \frac{40}{10+6+4} = 2\text{m/s}^2$

$40 - T = 10 \times 2$

$T = 20$ N

Q. 5 The tractor A is used to hoist the bale B with the pulley arrangement shown. If A has a forward velocity v_A, determine an expression for the upward velocity v_B of the bale in terms of x.



(A) $\frac{v_A x}{h}$ (B) $\frac{1}{2}\frac{v_A x}{\sqrt{h^2+x^2}}$

(C) $\frac{1}{2}\frac{v_A h}{\sqrt{h^2+x^2}}$ (D) $\frac{v_A h}{x}$ **[B]**

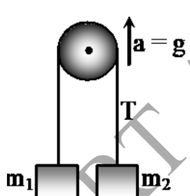
Q.6 Two weights w_1 and w_2 are suspended from the ends of a light string passing over a smooth fixed pulley. If the pulley is pulled up at an acceleration g , the tension in the string will be-

(A) $\frac{4w_1w_2}{w_1+w_2}$ (B) $\frac{2w_1w_2}{w_1+w_2}$

(C) $\frac{w_1-w_2}{w_1+w_2}$ (D) $\frac{w_1w_2}{2(w_1-w_2)}$

[A]

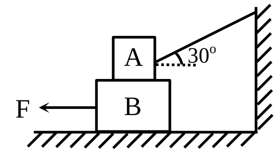
Sol.



$T = \frac{2m_1m_2(g+a)}{m_1+m_2}$,

$T = \frac{2\frac{w_1}{g}.\frac{w_2}{g}(g+g)}{\frac{w_1}{g}+\frac{w_2}{g}}$ $\Rightarrow T = \frac{4w_1w_2}{(w_1+w_2)}$

Q.7 In the figure given below, if all surface are assumed to be smooth and the force F = 100N. If acceleration of block B of mass 20kg is 'a' and tension in string connecting block A of mass 20 kg is T then just after when the force F is applied-



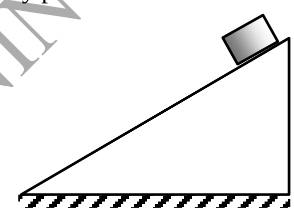
(A) T =0 and a = 5m/s^2 (B) T = 100 N and a = 0
(C) T = 200 N and a =5m/s^2 (D) None

Sol. **[A]**

As no force on A

$\therefore$ T = 0 & $a_B = \frac{F}{m_B}$

Q.8 A block of mass 'm' is slipping down a rough inclined plane with constant speed. The force on block by plane is -



(A) mg

(B) $\frac{mg}{2}$

(C) Depends upon coefficient of friction

(D) Depends upon angle of inclination **[D]**

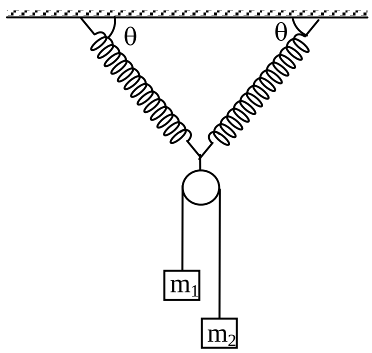
Sol. Net force on block $\vec{F}_{net} = m\vec{g} + \vec{F}_{BW}$

As block is slipping with constant speed $\vec{F}_{net} = 0$

$\Rightarrow \vec{F}_{BW} = -m\vec{g}$

$\Rightarrow F_{BW} = mg$

Q. 9 Two identical ideal springs of spring constant 1000 N/m are connected by a pulley as shown in figure and this arrangement is established in the vertical plane. The pulley is ideal and string passing over pulley is massless. At equilibrium of pulley θ is 60º and the masses m_1 and m_2 are 2 kg and 3 kg respectively. Then the elongation in each spring when θ is 60º is –



(A) $1.6\sqrt{3}$ cm (B) 1.6 cm

(C) 4.8 cm (D) None of these

[A]

Sol. $2kx\cos 30^o = \left(\frac{4m_1m_2}{m_1+m_2}\right)g$

Q. 10 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 -

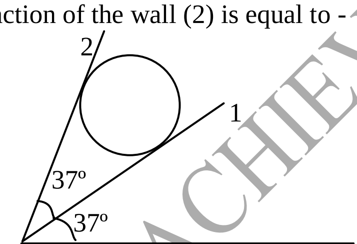
(A) 8 : 1 (B) 9 : 7

(C) 4 : 3 (D) 5 : 3

Sol. **[B]**

$a = \frac{m_2 - m_1}{m_1 + m_2}g = \frac{g}{8}$

Q.11 A sphere of mass m is held between two smooth inclined walls. For sin 37º = 3/5, the normal reaction of the wall (2) is equal to -

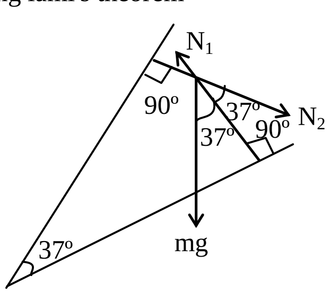


(A) mg (B) mg sin 74º

(C) mg cos 74º (D) None of these

[A]

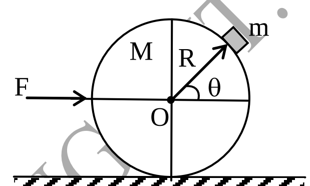
Sol.4[A] Using lami's theorem



$$\frac{mg}{\sin(180^o - 37^o)} = \frac{N_2}{\sin(180^o - 37^o)}$$

$\therefore N_2 = mg$

Q.12 A smooth sphere of radius R and mass M is placed on the smooth horizontal floor. Another smooth particle of mass m is placed on the sphere and a horizontal force F is applied on the sphere as shown. If the particle does not slip on the sphere then the value of force F is –



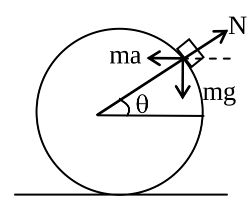
(A) F = mg cotθ

(B) F = Mg cotθ

(C) F=(m + M)g cotθ

(D) F =(m + M)g tanθ

Sol. **[C]**



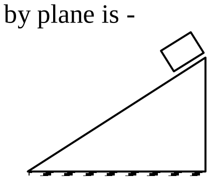
By F.B.D of m

N sinθ = mg and N cosθ = ma

$\therefore \tan\theta = \frac{g}{a} \Rightarrow a = g\cot\theta$

$\therefore F = (m + M)g\cot\theta$

Q.13 A block of mass 'm' is slipping down a rough inclined plane with constant speed. The force on block by plane is -



(A) mg

(B) $\frac{mg}{2}$

(C) Depends upon coefficient of friction

(D) Depends upon angle of inclination **[D]**

Sol. Net force on block $\vec{F}_{net} = \overrightarrow{mg} + \vec{F}_{BW}$

As block is slipping with constant speed

$\vec{F}_{net} = 0$

$\Rightarrow \vec{F}_{BW} = -\overrightarrow{mg}$

$\Rightarrow \quad F_{BW} = mg$

Q.14 If $\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$ is a conservative force then.

(A) $\frac{\partial F_x}{\partial y} = \frac{\partial F_y}{\partial x}, \frac{\partial F_y}{\partial z} = \frac{\partial F_z}{\partial y}, \frac{\partial F_z}{\partial x} = \frac{\partial F_x}{\partial z}$

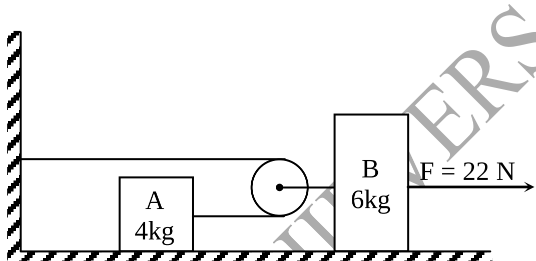
(B) $\frac{\partial F_x}{\partial y} - \frac{\partial F_y}{\partial x} = \frac{\partial F_z}{\partial z}$

(C) $\frac{\partial F_x}{\partial y} + \frac{\partial F_y}{\partial x} = \frac{\partial F_z}{\partial z}$

(D) All of these

Sol. **[A]** Conceptual

Q.15 Two blocks are connected by a massless string through an ideal pulley as shown. A force of 22N is applied on block B when initially the blocks are at rest. Then speed of centre of mass of block A and block B, 2 sec, after the application of force is (masses of A and B are 4 kg and 6 kg respectively and surfaces are smooth) –



(A) 1.4 m/s^2 (B) 1 m/s^2
(C) 2 m/s^2 (D) None of these

Sol. **[A]**

F – 2T = 6a and T = 4 × 2a

$\therefore \quad F - 16a = 6a$

$\Rightarrow a = \frac{F}{22} \Rightarrow a = 1 m/s^2$

$\therefore \quad a_{CM} = \frac{6\times1+4\times2}{10} = 1.4 m/s^2$

Q.16 A block of mass m is kept on a moving block of mass M in such a way that M moves but m remains at rest with respect to M. Then –

(A) momentum of m must not be zero in any frame

(B) kinetic energy of m must not be zero in any frame

(C) kinetic energy and momentum may be zero in a frame

(D) none of the above

Sol. **[C]**

Conceptual.

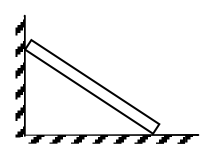
Q.17 A body in equilibrium will not have -

(A) velocity (B) momentum
(C) acceleration (D) All of the above

Sol. **[C]**

conceptual.

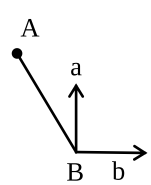
Q.18 A rod of length L is sliding such that one of its ends is always in contact with a vertical wall and its other end is always in contact with horizontal surface. Just after the rod is released from rest, the magnitude of acceleration of rod at this instant will be -



(A) $\frac{a+b}{\ell}$ (B) $\frac{\sqrt{|a^2-b^2|}}{\ell}$

(C) $\frac{\sqrt{a^2+b^2}}{\ell}$ (D) None of these

Sol. **[C]**



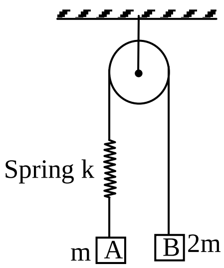
At the initial moment, angular velocity of rod is zero. Acceleration of end B of rod with respect to end A is shown in figure. Centripetal acceleration of point B with respect to A is zero ($\because \omega^2\ell = 0$)

So at the initial moment, acceleration of end B with respect to end A is perpendicular to the rod which is equal to $\sqrt{a^2+b^2}$

$a_{rel} = \ell\,\alpha$

$\dfrac{\sqrt{a^2+b^2}}{\ell} = \alpha$ where α is angular acceleration

Q.19 Two blocks A and B of masses m and 2m respectively are held at rest such that the string is in natural length. Find out the accelerations of both the blocks just after release.

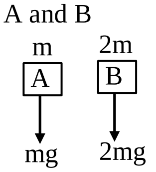


(A) $g\downarrow, g\downarrow$ (B) $\dfrac{g}{3}\downarrow, \dfrac{g}{3}\uparrow$

(C) 0, 0 (D) $g\downarrow$, 0

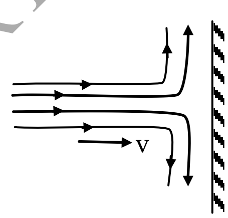
Sol. **[A]**

In this case spring force is zero initially F.B.D of A and B



$a_A = g$ $a_B = g$

Q.20 A stream of water of density d, cross-section A and speed v strikes a wall that is perpendicular to the stream as shown. The water then flows sideways along the wall. The force exerted by the stream on the wall is -



(A) dv^2A (B) dvA/2

(C) dghA (D) v^2A/d

Sol. **[A]**

The mass of water reaching the wall per second = v Ad.

the momentum transferred per second = (vAd)v

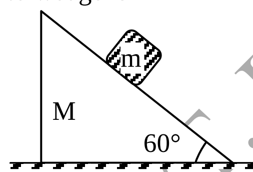
$\Rightarrow \vec{p}$ per unit time = v^2 Ad.

The flow of water , tangential to the wall does not contribute to the force.

Therefore, force = rate of change of momentum

= v^2 Ad.

Q.21 In the arrangement shown in figure wedge of mass M moves towards left with an acceleration a. All surfaces are smooth. The acceleration of mass m relative to wedge is –



(A) a/2 (B) $\dfrac{2Ma}{m}$

(C) $\dfrac{2(M+m)a}{m}$ (D) $\dfrac{(M+m)a}{m}$

Sol. **[C]**

Let acceleration of mass m relative to wedge down the plane is a_r. Its absolute acceleration in horizontal direction is $a_r \cos 60° - a$(towards right). Hence, let N be the normal reaction between the mass and the wedge. Then

$N \sin\theta = Ma = m(a_r \cos 60° - a)$

or $a_r = \dfrac{(M+m)a}{m\cos 60°} = \dfrac{2(M+m)a}{m}$

Q. 22 A block of mass m = 1kg moving on horizontal surface with speed u = 2m/s enters a rough horizontal patch ranging from x = 0.10 m to x = 2.00m. If the retarding force f_r on the block in this range is inversely proportional to x over this range i.e.

$f_r = \dfrac{-k}{x}$ $0.10 < x < 2.00$

$= 0$ for $x < 0.10$ and $x > 2.00$

If k = 0.5 J then the speed of this block as it crosses the patch is (use $\ell n\, 20 = 3$)

(A) 2.65 m/s (B) 1 m/s

(C) 1.5 m./s (D) 2 m/s

Sol. **[B]**

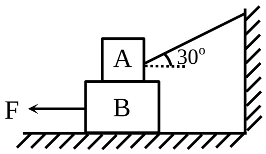
$W = \int f_r\, dx = -k \log_e \dfrac{2}{0.1} = -1.5$ J

$\therefore$ $W = \Delta K$

$\dfrac{1}{2} \times 1 \times v^2 - \dfrac{1}{2} \times 1 \times 4 = -1.5$

$\Rightarrow$ v = 1 m/s

Q.23 In the figure given below, all surfaces are assumed to be smooth and the force F = 100N. If acceleration of block B of mass 20kg is 'a' and tension in string connecting block A of mass 20 kg is T then just after when the force F is applied .



(A) T =0 and a = 5m/s^2 (B) T = 100 N and a = 0

(C) T = 200 N and a =5m/s^2 (D) None

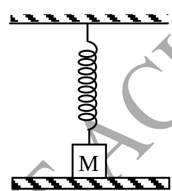
Sol. **[A]**

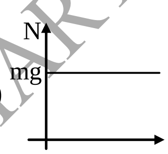
As there is no friction, horizontal force on B is therefore F = 100 N

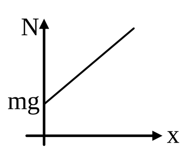
$\therefore$ a = $\frac{100}{20}$ = 5m/s^2

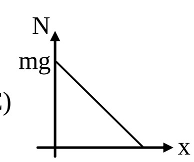
but no horizontal force on A acts therefore T = 0

Q. 24 A block of mass m is attached to an ideal spring and system lies in vertical plane as shown. Initially the supporting plane is placed so that spring remains in its natural length then the plane is moved very slowly downwards. The graph showing variation of normal reaction applied by mass on supporting plane with distance travelled by block is –



(A) 

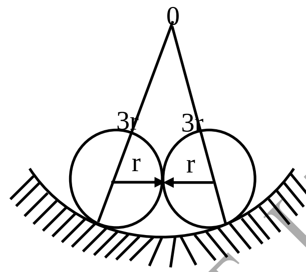
(B) 

(C) 

(D) None of these

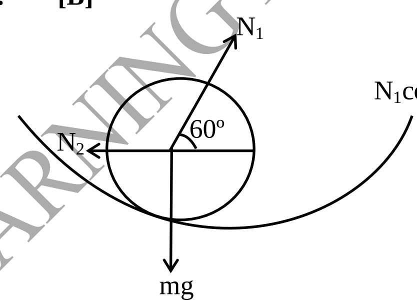
Sol. **[C]**
as supporting plane is lowered slowly
$\therefore$ N = mg – kx

Q.25 Two identical heavy spheres of equal mass are placed on smooth cup of radius 3r where r is radius of each sphere as shown. Then the ratio of reaction force between cup and any sphere to reaction force between two sphere is –



(A) 1
(B) 2
(C) 3
(D) none of these

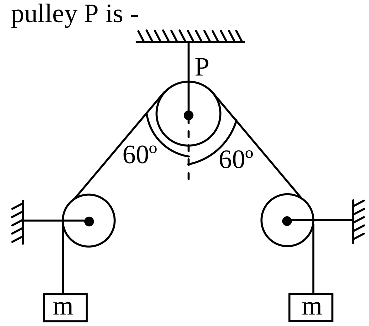
Sol. **[B]**



$N_1 \cos 60^\circ = N_2$

$\frac{N_1}{N_2} = 2$

Q.26 The force exerted by the ideal string on the ideal pulley P is -



(A) mg (B) 2 mg

(C) $\sqrt{2}$ mg (D) 4 mg

Sol. **[A]**

As T = mg and for pulley P

$T_{Net} = \sqrt{T^2 + T^2 + 2.T.T.\cos 120^\circ}$ = T = mg.

Q.27 In a cricket match the fielder draws his hands backward after receiving the ball in order to take a catch because -

(A) His hands will be saved from getting hurt

(B) He deceives the player

(C) It is a fashion

(D) He catches the ball firmly **[A]**

Q.28 A jet engine works on the principle of -

(A) conservation of mass

(B) conservation of energy

(C) conservation of linear momentum

(D) conservation of angular momentum **[C]**

Q.29 A boy sitting on the top most berth in the compartment of a train which is just going to stop on a railway station, drops an apple aiming at the open hand of his brother situated vertically below his hands at a distance of about 2m. The apple will fall -

(A) in the hand of his brother

(B) Slightly away from the hands of his brother in the direction of motion of the train

(C) Slightly away from the hands of his brother in the direction opposite to the direction of motion of the train

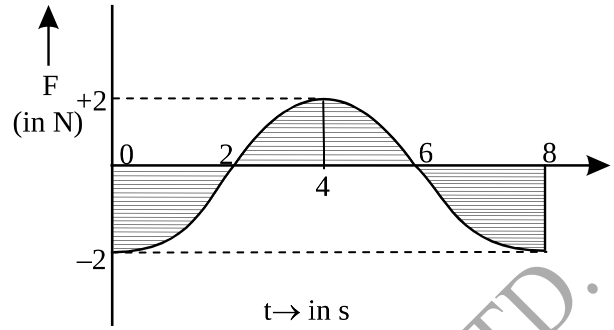
(D) none of the above **[B]**

Q.30 In a legend the hero kicked a body pig so that he is projected with a speed greater than that of his cry. If the weight of the body pig is assumed to be 5kg and the time of contact 0.01 sec., the force with which the hero kicked him was - (Speed of cry = 330 m/s)

(A) 5×10^{-2} N (B) 2×10^5 N

(C) 1.65×10^5 N (D) 1.65×10^3 N **[C]**

Q.31 A force - time graph for the motion of a body is shown in figure. Change in linear momentum between 0 and 8 s is –



(A) zero (B) 4 N-s

(C) 8 N-s (D) None **[A]**

Q.32 A force of 5 N acts on a body of weight of 10 N. What is the acceleration in m/s^2 ?

(A) 50 (B) 5

(C) 0.5 (D) 2 **[B]**

Q.33 A particle is acted upon by two mutually perpendicular forces of 3N and 4N. In order that the particle remains stationary, the magnitude of the third force that should be applied is -

(A) 12 N (B) 5 N

(C) 8 N (D) 7 N **[C]**

Q.34 Two objects A and B are thrown upward simultaneously with the same speed. The mass of A is greater than the mass of B. Suppose the air exerts a constant and equal force of resistance on the two bodies-

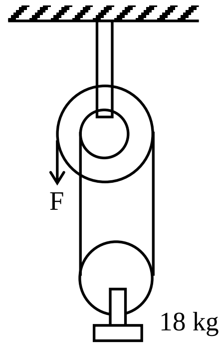
(A) The two bodies will reach the same height

(B) A will go higher than B

(C) B will go higher than A

(D) Any of the above three may happen depending on the speed with which the objects are thrown **[B]**

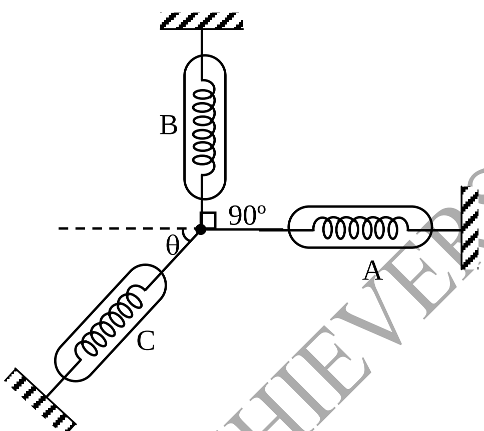
Q.35 In the figure at the free end a force F is applied to keep the suspended mass of 18 kg at rest . The value of F is-



(A) 180 N (B) 90 N

(C) 60 N (D) 30 N **[B]**

Q.36 Three spring balances are attached to the ring as shown in the figure. There is an angle of 90° between the balance A and balance B. There is a reading of 5 N on balance A and 12 N on the balance B –



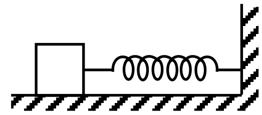
(A) Reading in the balance C is 13 N and angle θ is 67.4°

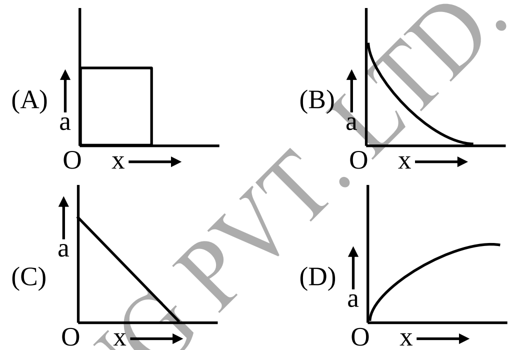
(B) Reading in the balance C is 13 N and angle θ is 22.6°

(C) Reading in the balance C is 5 N and angle θ is 67.4°

(D) Reading in the balance C is 5 N and angle θ is 22.6° **[A]**

Q.37 A light spring is compressed and placed horizontally between a vertical fixed wall and a block, free to slide over a smooth horizontal table top as shown in figure. If the system is released from rest, which of the graphs below represents the relation between the acceleration 'a' of the block and the distance 'x' travelled by it ?





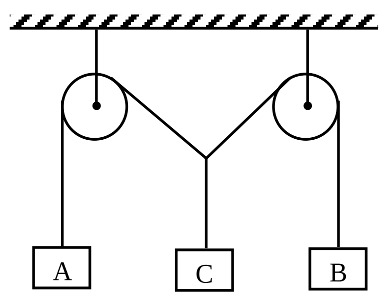
[C]

Q.38 A particle of small mass m is joined to a very heavy body by a light string passing over a light pulley. Both bodies are free to move. The total downward force on the pulley is –

(A) mg (B) 2 mg

(C) 4 mg (D) >> mg **[C]**

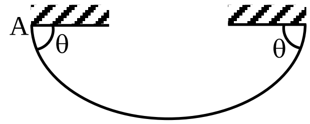
Q.39 Three blocks A, B and C are suspended as shown in figure. Mass of each of blocks A and B is m. If system is in equilibrium, and mass of C is M then –



(A) M = 2m (B) M < 2m

(C) M > 2m (D) $M \ngtr 2m$ **[B]**

Q.40 A flexible chain of weight w hangs between two fixed points A and B as shown in fig. at the same level. Then the vector force exerted by the chain on each end point, and the tension in the chain at the lowest point.



(A) 2w sin θ, 2w cot θ

(B) 2w cot θ, 2w sin θ

(C) w/2 sin θ, w/2 cot θ

(D) w/2 cos θ, w/2 tan θ **[C]**

Q.41 A man slides down a light rope whose breaking strength is η times his weight (η < 1). What should be his maximum acceleration so that the rope just breaks ?

(A) ηg (B) g(1 – η)

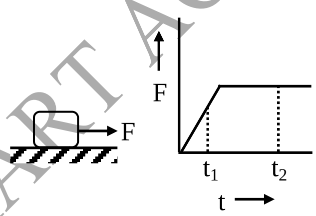
(C) $\frac{g}{1+\eta}$ (D) $\frac{g}{2-\eta}$ **[B]**

Q.42 An empty plastic box of mass m is found to accelerate up at the rate of g/6 when placed deep inside water. How much sand should be put inside the box so that it may accelerate down at the rate of g/6?

(A) 2 m/3 (B) 2 m/5

(C) m/5 (D) 6 m/7 **[B]**

Q.43 A particle is on a smooth horizontal plane. A force F is applied whose F-t graph is given. Then–



(A) at t_1 acceleration is constant

(B) initially body must be in rest

(C) at t_2, acceleration is constant

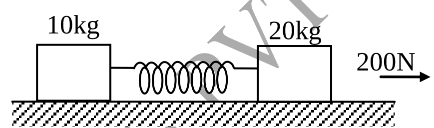
(D) Finally acceleration is zero **[C]**

Q.44 A stretching force of 1000 newton is applied at one end of a spring balance and an equal stretching force is applied at the other end at the same time. The reading of the balance will be -

(A) 2000 N (B) 0 N

(C) 1000 N (D) 500 N **[C]**

Q.45 The masses of 10 kg and 20 kg respectively are connected by massless spring as shown in the figure. A force of 200 N acts on the 20kg mass. At the instant shown, the 10 kg mass has acceleration of 12 m/s^2. What is the acceleration of 20 kg mass ?



(A) 12 m/s^2 (B) 4 m/s^2

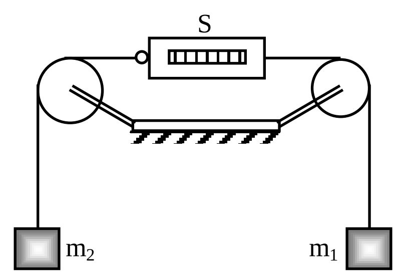
(C) 10 m/s^2 (D) zero **[B]**

Q.46 A spring toy of weight 1 kg rests on a weighing machine. The toy suddenly jumps and the balance reads 11 N. The acceleration of the toy just on jumping up is -

(A) 0.5 m/s^2 (B) 1 m/s^2

(C) 1.5 m/s^2 (D) 2 m/s^2 **[B]**

Q.47 In the arrangement shown, the pulleys are fixed and ideal, the strings are light, $m_1 > m_2$ and S is a spring balance which is itself massless. The reading of S (in units of mass) is –

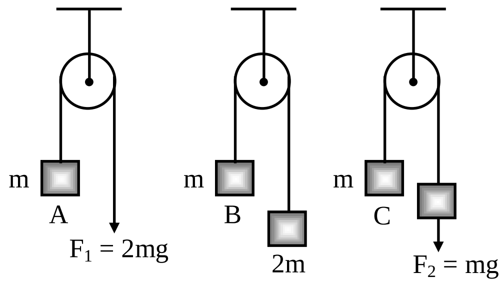


(A) $m_1 - m_2$ (B) $\frac{1}{2}(m_1 + m_2)$

(C) $\frac{m_1 m_2}{m_1 + m_2}$ (D) $\frac{2m_1 m_2}{m_1 + m_2}$ **[D]**

Q.48 In the figure, the blocks A, B and C of mass m each have accelerations a_1, a_2 and a_3

respectively. F_1 and F_2 are external forces of magnitude 2mg and mg respectively.

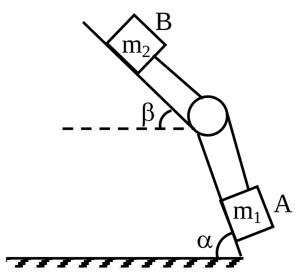


(A) $a_1 = a_2 = a_3$ (B) $a_1 > a_3 > a_2$

(C) $a_1 = a_2$, $a_2 > a_3$ (D) $a_1 > a_2$, $a_2 = a_3$

[B]

Q.49 Two blocks A and B of masses m_1 and m_2 are connected by an inextensible string rest on two smooth planes inclined at angle α and β as shown. The tension in string is-



(A) $(m_1 \sin\alpha - m_2 \sin\beta)\, g$

(B) $(m_1 + m_2)(\sin\alpha - \sin\beta)g$

(C) $\dfrac{m_1 m_2 g}{m_1 + m_2}(\sin\alpha + \sin\beta)$

(D) $\dfrac{m_1 m_2 g}{m_1 + m_2}(\sin\alpha - \sin\beta)$ **[D]**

Q.50 A chain of mass M and length L held vertical by fixing its upper end to a rigid support. The tension in the chain at a distance y from the rigid support is –

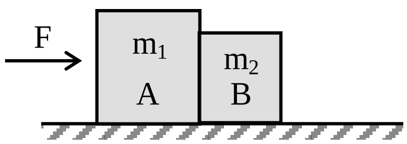
(A) mg (B) Mg(L – y)/L

(C) MgL / (L – y) (D) Mgy / L **[B]**

Q.1 A body of mass 45 kg. is moving with a constant velocity of 10 m/s. A constant force acts on the body for four second, and the speed of the body becomes 2 m/s in opposite direction, calculate the acceleration produced.

Ans. – 3 m/s^2

Q.2 Two blocks A and B of masses m_1 and m_2 respectively are in contact on frictionless horizontal table. A horizontal force is applied to the block A as shown in the figure. Take m_1 = 3 kg , m_2 = 2 kg and F = 5 N.

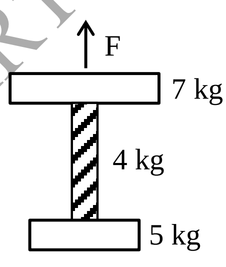


(A) Find the force of contact between the two blocks.

(B) Show that it the same force F = 5 N is applied to m_2 rather than m_1 then the force of contact between the two blocks will have a different value.

Ans. 2 N

Q.3 The two blocks shown in figure are connected by a heavy uniform rope of mass 4 kg. An upward force of 200 N is applied as shown in figure.



(a) What is the acceleration of the system ?

(b) What is the tension at the top of the heavy rope?

Ans. (a) 2.69 m/s^2 upward (b) 112.5 N (c) 87.5 N

Q.4 At the moment t = 0, a stationary particle of mass m experiences a time-dependent force F = k t (t' - t), where k is a constant vector, t' is the time during which the given force acts. Find-

(a) the momentum of the particle when the action of the force discontinued;

(b) the distance covered by the particle while the force acted.

Ans. (a) $k(t')^3/6$ (b) $k(t')^4/12$ m

Q.5 A uniform flexible chain of length *l*, with weight per unit length λ, passes over a small frictionless mass less pulley. It is released from a rest position with a length of chain x hanging from one side and a length (*l* – *x*) from the other side.

(a) Under what circumstances will it accelerate?

(b) Assuming these circumstances are met, find the acceleration a as a function of x.

Ans. (a) $x = \ell / 2$; (b) $a = g\left(1 - \frac{2x}{\ell}\right)$

Q.6 A 10 kg monkey is climbing a mass less rope attached to a 15 kg mass over a (frictionless!) tree limb. (a) Explain quantitatively how the monkey can climb up the rope so that he can raise the 15 kg mass off the ground. (b) If, after the mass has been raised off the ground, the monkey stops climbing and holds on to the rope, what will his acceleration and the tension in the rope now be ?

Ans. (a) a ≥ g/2 ; (b) a = g/5, T = 118 N

Q.7 A block is kept on the floor of an elevator at rest. The elevator starts descending with an acceleration of 12 m/s^2. Find the displacement of the block during the first 0.2 s after the start. Take g = 10 m/s^2.

Ans. 20 cm

Q.8 A lamp hangs from a light cord, from the roof of an elevator. When the elevator is descending, it decelerates at 2.5 m/s^2 before it comes to rest.

(a) If the tension in the string is 25 N, calculate the mass of the lamp.

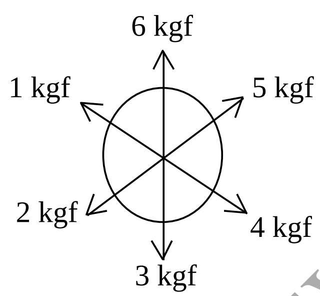
(b) What will be the tension in the string, when

(i) The elevator is descending with an acceleration 2.5 m/s^2 ? and

(ii) The cord, supporting the elevator snaps ? Take g = 10 m/s^2.

Ans. (a) 2 kg (b) (i) 15N (ii) 0

Q.9 Six forces lying in a plane and forming angles of 60º relative to one another are applied to the centre of a homogeneous sphere with a mass m = 4 kg. In what direction and with what acceleration will the sphere move ?

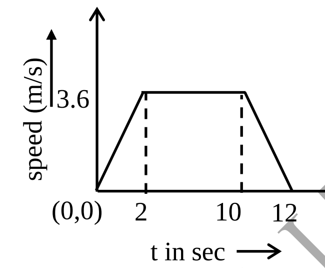


Ans. Resultant force is 6 kgf along the direction of 5 kgf. Acceleration is 14.7 m/s^2 in the direction of resultant force

Q.10 A force $\vec{F} = \vec{V} \times \vec{A}$ is exerted on a particle in addition to the force of gravity, where $\vec{V}$ is velocity of the particle and $\vec{A}$ is a constant vector in the horizontal direction. With what minimum speed a particle of mass m be projected so that it continues to move undeflected with a constant velocity ?

Ans. $\frac{mg}{A}$

Q.11 A lift is going up. The total mass of the lift and the passengers is 1500 kg. The variation of the speed of the lift is as given in the graph.



(a) What will be the tension in the rope pulling the lift at 't' equal to

(i) 1 s (ii) 6 s (iii) 11 s ?

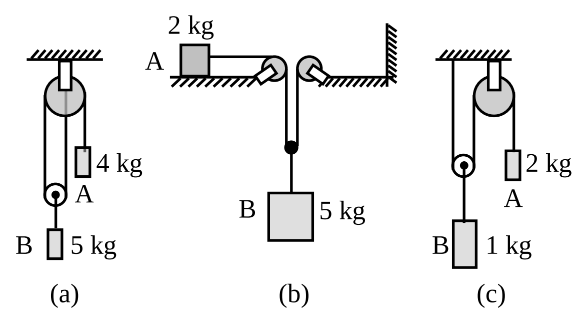
(b) What is the height to which the lift takes the passengers?

(c) What is the average speed and average acceleration during the entire motion ?

Ans. **(a)** (i) 17400 N (ii) 17400 N (iii) 12000N

(b) 36 m **(c)** 3m/s, Zero

Q.12 Find the acceleration of the block A and B in the three situations shown in figures.

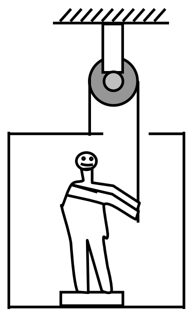


Ans. (a) $\frac{2}{7}$ g, downward, $\frac{1}{7}$ g upward

(b) $\frac{10}{13}$ g forward, $\frac{5}{13}$ g downward

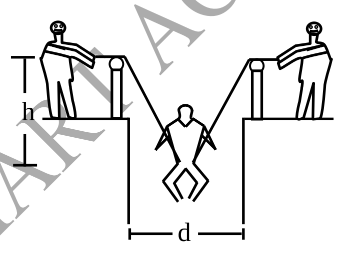
(c) $\frac{2}{3}$ g downward, $\frac{1}{3}$ g upward

Q.13 Figure shows a man of mass 60 kg standing on a light weighing machine kept in a box of mass 30 kg. The box is hanging from a pulley fixed to the ceiling through a light rope, the other end of which is held by the man himself. If the man manages to keep the box at rest, what is the weight shown by the machine ? What force should he exert on the rope to get his correct weight on the machine ?



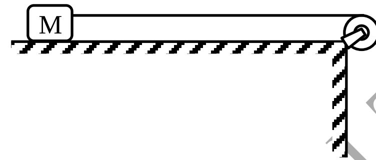
Ans. 15 kg, 1800 N

Q.14 A man has fallen into a ditch of width d and two of his friend are slowly pulling him out using a light rope and two fixed pulleys as shown in the figure. Show that the force (assumed equal for both the friends) exerted by each friend on the rope increases as the man moves up. Find the force when the man is at a depth h.



Ans. $\frac{mg}{4h}\sqrt{d^2+4h^2}$

Q.15 A monkey of mass m clings to a rope slung over a light frictionless pulley. The opposite end of the rope is tied to a weight of mass M lying on a smooth horizontal plane (see Figure). Find the acceleration of both bodies (relative to the plane) and the tension of the rope for the three cases (neglect mass of pulley and rope):



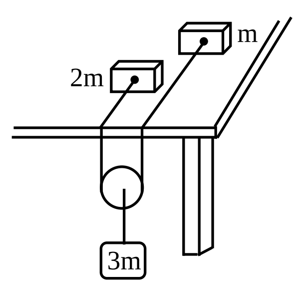
(a) the monkey does not move relative to the rope;

(b) the monkey moves upwards with an acceleration b relative to the rope;

(c) the monkey moves downwards with an acceleration b relative to the rope.

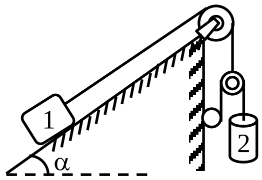
Ans. (a) $\frac{mM}{m+M}g$ (b) $\frac{mM}{m+M}(g+b)$ (c) $\frac{mM}{m+M}(g-b)$

Q.16 Two blocks of masses m and 2 m are placed on a smooth horizontal table. A string joining these block hangs over the edge supporting a light and frictionless pulley which carries a block of mass 3 m. The two portions of the string on the table are parallel and perpendicular to the edge of the table. The parts of the string outside the table are vertical. Calculate the acceleration of the block of mass 3 m



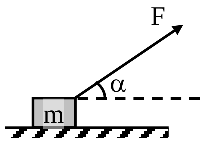
Ans. $\frac{9}{17}g$

Q.17 Find the acceleration of body 2 in the arrangement shown in the Fig., if its mass is η times as great as the mass of bar 1 and the angle that the inclined plane forms with the horizontal is equal to α. The masses of the pulley and the threads, as well as the friction, are assumed to be negligible. Look into possible cases.



Ans. $a = \frac{2g(2\eta - \sin\alpha)}{(4\eta + 1)}$

Q.18 At the moment t = 0 the force F = at is applied to a small body of mass m resting on a smooth horizontal plane (a is a constant).



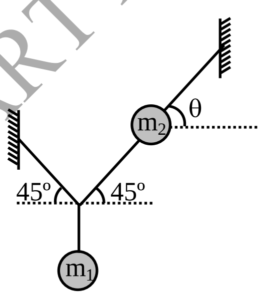
The permanent direction of this force forms an angle α with the horizontal Find :

(a) the velocity of the body at the moment of its breaking off the plane.

(b) the distance traversed by the body up to this moment.

Ans. (a) $v = \frac{mg^2\cos\alpha}{2a\sin^2\alpha}$ (b) $s = \frac{m^2g^3\cos\alpha}{6a^2\sin^3\alpha}$

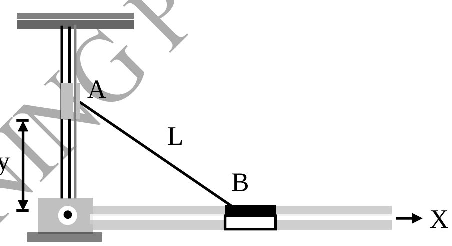
Q.19 Two masses m_1 and m_2 are attached with strings as shown in the figure. If the system is in equilibrium show that $\tan\theta = 1 + \frac{2m_2}{m_1}$.



Q.20 Two blocks of mass m_1 = 1 kg and m_2 = 2 kg are suspended from a spring balance attached to ceiling of a lift moving upwards with an acceleration of g/10. Determine the reading on the spring balance. Take g = 10 m/s^2.

Ans. F = 29.33 N

Q.21 Collars A and B slide along the fixed right angled rods and are connected by a cord of length L. Determine the acceleration a_x of collar B as a function of y if collar A is given a constant upward velocity v_A.



Ans. $a_x = \frac{-L^2v_A^2}{(L^2 - y^2)^{3/2}}$