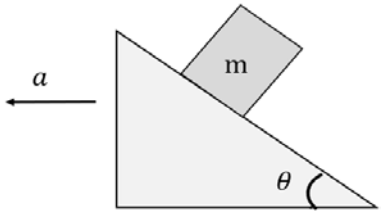
Chapter 6

Newton's Laws of Motion

Exercise

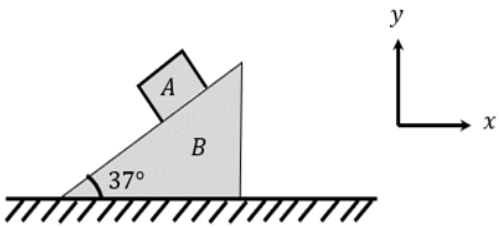
Constrained Motion

Q.1 A small block of mass, m rests on a smooth wedge of angle θ. With what horizontal acceleration a should the wedge be pulled (as shown in the figure) so that, the small block falls freely.



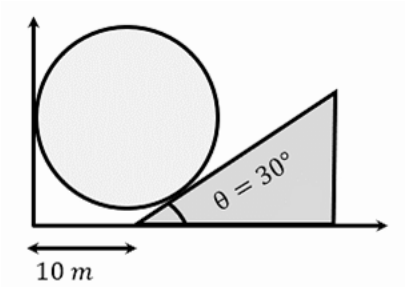
(**A**)g cosθ (**B**)g sinθ (**C**)g cotθ (**D**)g tanθ

Q.2 In the figure shown the acceleration of A is $\vec{a}_A = 15\hat{i} + 15\hat{j}$, then the acceleration of B is (A remains in contact with B)



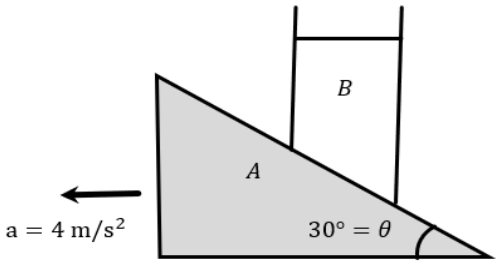
(**A**)$6\hat{i}$ (**B**)$-15\hat{i}$ (**C**)$-10\hat{i}$ (**D**)$-5\hat{i}$

Q.3 Find the height by which the sphere rises when the wedge touches the wall. The distance between the wedge and the wall us 10 m and the wedge is moved to the left until it touches the wall. (Assume all surfaces to be smooth).



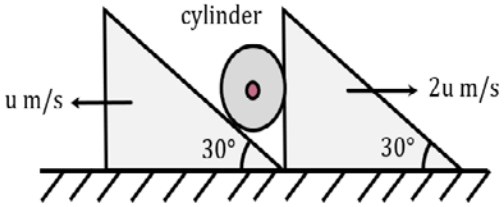
(**A**)10 m (**B**)$10\sqrt{3}$m (**C**)$\frac{10}{\sqrt{3}}$m (**D**)$5\sqrt{3}$ m

Q.4 Find the acceleration of B if the acceleration of A is 4m/s^2. (B is only allowed to move in vertical direction)



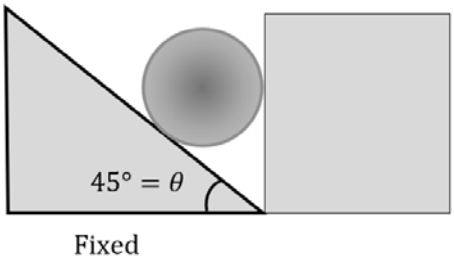
(**A**) $\frac{2}{\sqrt{3}}$ m/s^2 (**B**) $\frac{4}{\sqrt{3}}$ m/s^2 (**C**) $2\sqrt{3}$ m/s^2 (**D**) $4\sqrt{3}$ m/s^2

Q.5 For the system shown in figure, assume that cylinder remains in contact with the two wedges moving with constant velocity as indicated. What will be the velocity of cylinder?



(**A**) $\sqrt{19-4\sqrt{3}}\frac{u}{2}$ m/s (**B**) $\frac{\sqrt{13}u}{2}$ m/s (**C**) $\sqrt{3}$ m/s (**D**) $\sqrt{7}$ m/s^2

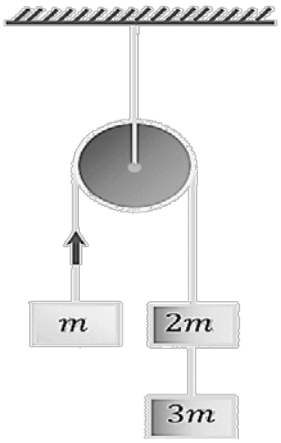
Q.6 Find the displacement travelled by the sphere in 1 second if the acceleration of the cube is 2 m/s^2. System starts from rest and the sphere remains in contact with cube.



(**A**) 1 m (**B**) 2 m (**C**) $\sqrt{2}$ m (**D**) $\sqrt{3}$ m

Pulley

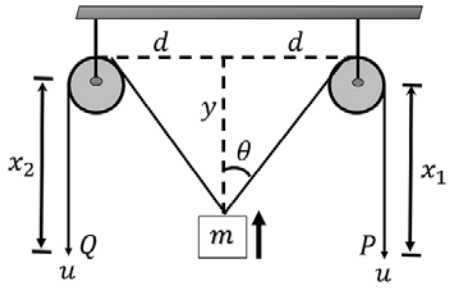
Q.7 In the figure given below, with what acceleration does the block of mass m will move? (Pulley and strings are massless and frictionless)



(**A**) $\frac{g}{3}$ (**B**) $\frac{2g}{5}$ (**C**) $\frac{2g}{3}$ (**D**) $\frac{g}{2}$

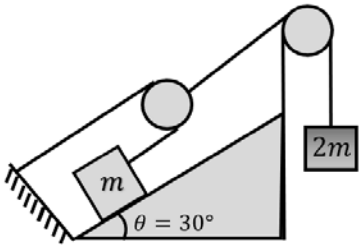
Constrained motion

Q.8 In the arrangement shown in figure, pulleys are fixed and the ends P and Q of an unstretchable string move downwards with a uniform speed u. Mass m moves upwards with a speed of



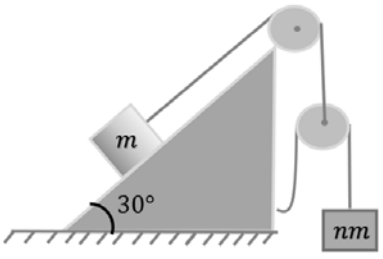
(**A**) u cos θ (**B**) $\frac{u}{\cos\theta}$ (**C**) $\frac{2u}{\cos\theta}$ (**D**) u sin θ

Q.9 Assuming that the surface is frictionless and strings are inextensible, find the acceleration of the block of mass 2m shown in the figure.



(**A**) $\frac{g}{6}$ (**B**) $\frac{g}{3}$ (**C**) $\frac{g}{4}$ (**D**) $\frac{g}{2}$

Q.10 If the acceleration of mass $'nm' = \frac{7g}{p}$, find the value of p if n = 2. Assume all surfaces to be smooth and strings inextensible. _____.



WORKSHEET

Vector

Q.1 Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} - \hat{k}$ be three vectors. A vector $\vec{v}$ in the plane of $\vec{a}$ and $\vec{b}$, Whose projection on $\vec{c}$ is $\frac{1}{\sqrt{3}}$, is given by

(**A**)$\hat{i} - 3\hat{j} + 3\hat{k}$ (**B**)$-3\hat{i} - 3\hat{j} - \hat{k}$ (**C**)$3\hat{i} - \hat{j} + 3\hat{k}$ (**D**)$\hat{i} + 3\hat{j} - 3\hat{k}$

Integration

Q.2 Find the integration of $\int \frac{e^{\tan^{-1} x}}{1+x^2}.dx$

(**A**)$e^{\tan^{-1} x} + C$ (**B**)$e^{-\tan^{-1} x} + C$ (**C**)$\frac{e^{-\tan^{-1} x}}{2} + C$ (**D**)$e^{\tan x} + C$

Motion Under Gravity

Q.3 A stone is dropped from a building of height h and it reaches after t second on the earth. From the same building if two stones are thrown (one upwards and other downwards) with the same velocity u and they reach the earth surface t_1 and t_2 seconds respectively, then.

(**A**)$t = t_1 - t_2$ (**B**)$t = \frac{t_1+t_2}{2}$ (**C**)$t = \sqrt{t_1 t_2}$ (**D**)$t = t_1^2 t_2^2$

Projectile Motion

Q.4 A boy is playing on the roof of a 10 m height building throws a ball with speed of 10 m/s at an angle of 30° with the horizontal. The time (t) taken by the ball to cross the point which at the height of 10 m from the ground is

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

Projectile Motion

Q.5 An aero plane is flying at a constant horizontal velocity of 600 km/hr at an elevation of 6 km towards a point directly above the target on the earth's surface. At an appropriate time, the pilot releases a ball so that it strikes the target on the earth. The ball will appear to be falling

(**A**)on a parabolic path as seen by pilot in the plane.

(**B**)vertically along a straight path as seen by anobserver on the ground near the target.

(**C**)on a parabolic path as seen by an observer on the ground near the target.

(**D**)on a zig-zag path as seen by pilot in the plane.

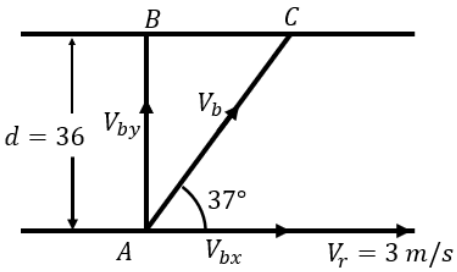
Velocity-Time Relation

Q.6 Three particles A, B and C are situated at the vertices of an equilateral triangle ABC of side d at $t = 0$. Each of the particles moves with constant speed v. A always has its velocity along AB, B along BC and C along the CA. At what time will the particles meet each other

(**A**)$t = \frac{d}{3v}$ (**B**)$t = \frac{2d}{3v}$ (**C**)$t = \frac{2d}{v}$ (**D**)$t = \frac{d}{v}$

Relative Velocity

Q.7 Velocity of the boat with respect to river (V_b) is 10 m/s. It passes the river of width 36 m and reaches opposite shore at a point C shown in the figure. If the velocity of the river is 3 m/s. Find the time of the trip and drift of the boat.



(**A**)$(6\text{ s}, 66\text{ m})$ (**B**)$(6\text{ s}, 60\text{ m})$ (**C**)$(4.5\text{ s}, 49.5\text{ m})$ (**D**)$(6\text{ s}, 49.5\text{ m})$

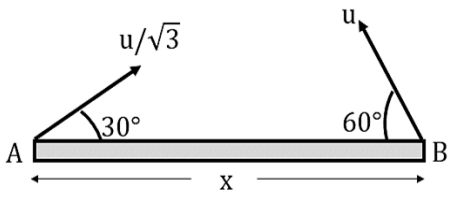
Relative Velocity

Q.8 A boat which has a speed of 5 km/hr in still water, crosses a river of width 1 km along the shortest possible path in 15minutes. The velocity of the river water is

(**A**)2 km/hr (**B**)4 km/hr (**C**)3 km/hr (**D**)5 km/hr

Projectile Motion

Q.9 The particles are separated at a horizontal distance x as shown in the figure. They are projected at the same time as shown in the figure with different initial speed. The time after which the horizontal distance between the particles become zero is



(**A**) $\frac{u}{2x}$ (**B**) $\frac{x}{u}$ (**C**) $\frac{2u}{x}$ (**D**) $\frac{u}{x}$

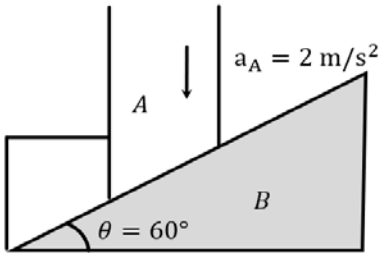
Relative Motion

Q.10 A motorbike is being chased by a car. The motorbike moves with speed of 10 m/s and has acceleration of 5 m/s^2. Whereas, the car speed of 20 m/s and accelerates with 3 m/s^2. If the initial separation between motorbike and car is 60 m , find the distance by which car will miss the motorbike.

(**A**)25 m (**B**)30 m (**C**)35 m (**D**)40 m

Constrained motion

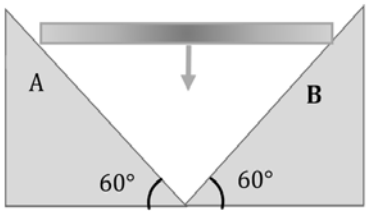
Q.11 In the given arrangement, find the distance travelled by wedge B in 1 sec. System starts from rest $(\theta = 60°)$



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

Constrained motion

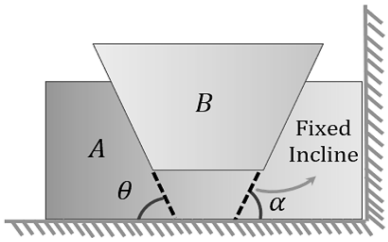
Q.12 By what distance do the wedges move if the horizontal plank moves by x cm downwards?



(**A**)x tan θ cm (**B**)x cot θ cm (**C**)x sin θ cm (**D**)x cos θ cm

Constrained motion

Q.13 In the figure shown below, if the downward acceleration a of B is along the fixed incline, then find the acceleration of A if A and B remains in contact.

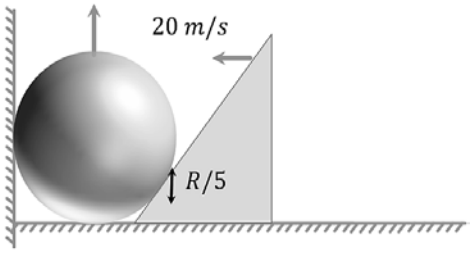


(**A**)a sin α (**B**)a cot α

(**C**)a tan θ (**D**)a[cos α + sin α cot θ]

Constrained motion

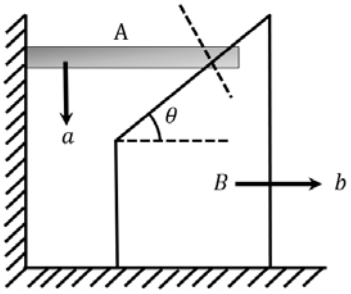
Q.14 A sphere of radius R is in contact with a wedge. The point of contact is $\frac{R}{5}$ from the ground as shownin the figure. Wedge is moving with velocity 20 ms^{-1} towards left. The velocity of the sphere at thisinstant will be



(**A**)20 ms^{-1} (**B**)15 ms^{-1} (**C**)16 ms^{-1} (**D**)12 ms^{-1}

Constrained motion

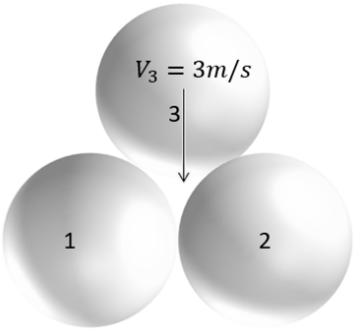
Q.15 Find the relation between acceleration of A(a) and acceleration of B(b) in the figure shown



(**A**)a = b sin θ (**B**)a = b cosθ (**C**)a = b tan θ (**D**)a = b cot θ

Constrained motion

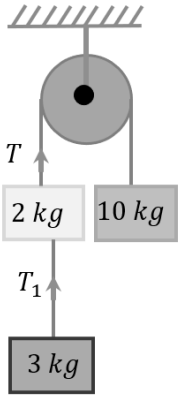
Q.16 Find the velocity of separation of the sphere 1 and 2 if the sphere 3 comes down with a velocity of 3 m/s. Assume all spheres to be identical and frictionless.



(**A**)$2\sqrt{3}$ m/s (**B**)$4\sqrt{3}$ m/s (**C**)$6\sqrt{3}$ m/s (**D**)$8\sqrt{3}$ m/s

Tension in a String

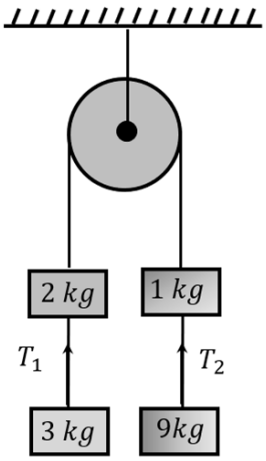
Q.17 In the figure shown, find the tension T_1 (in N) in the string Assume the strings to be inextensible and pulley frictionless.



(**A**)2g (**B**)3g (**C**)2.5g (**D**)4g

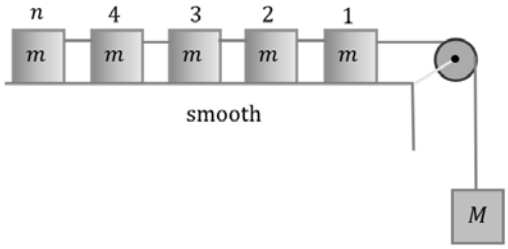
Tension in a String

Q.18 In the figure shown, find the ratio of tension T_1 and T_2 assuming that the string and pulley is massless (correct up to 2 decimal places) _____



Tension in a String

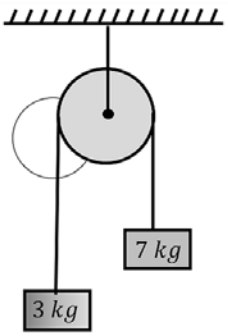
Q.19 In the given arrangement, n number of equal masses are connected by strings of negligible masses. The tension in the string connected to n^{th} mass is



(**A**) $\frac{mMg}{nm+M}$ (**B**) $\frac{mMg}{nmM}$ (**C**)mg (**D**)mng

Pulley

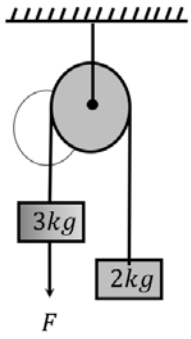
Q.20 In the figure shown, find the velocity of the 3 kg mass after 10 s if the system is released from rest at t = 0. (Take g = 10 m/s^2)_____



(**A**)30 m/s (**B**)40 m/s (**C**)50 m/s (**D**)70 m/s

Pulley

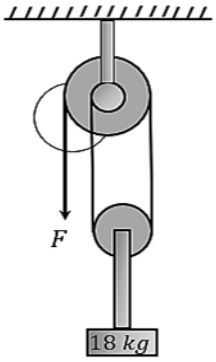
Q.21 Two unequal masses of 1 kg and 2 kg are connected by an inextensible light string passing over a smooth pulley as shown in the figure. A force F = 20 N is applied on 1 kg block. Find the acceleration of either block. (g = 10 m/s^2) in m/s^2.



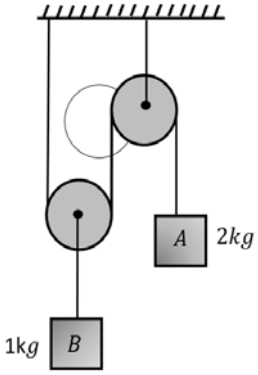
Constrained motion

Q.22 In the given figure, at the free end a force F is applied to keep the suspended mass of 18 kg at rest. The value of F (in N) is _____

(Take g = 10 m/s^2)



Q.23 Assuming that the string is inextensible and pulleys are smooth and light for the arrangement shown in the figure, choose the correct option (s)



Assuming that the string is inextensible and pulleys are smooth and light for the arrangement shown in the figure, choose the correct option (s)

(**A**)acceleartion of 1 kg block is $\frac{g}{3}$ upward

(**B**)acceleartion of 1 kg block is $\frac{g}{3}$ downward

(**C**)acceleartion of 2 kg block is $\frac{2g}{3}$ upward

(**D**)acceleartion of 2 kg block is $\frac{g}{3}$downward

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(C)	(D)	(C)	(B)	(D)	(C)	(C)	(B)	(A)	
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(B)	(C)	(C)	(A)	(C)	(B)	(A)	(C)	(B)	(C)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(B)	(B)	(D)	(B)	(C)	(C)	(D)		(A)	(B)
Q.	21	22	23	24	25	26	27	28	29	30
Sol.			(A),(D)							