PHYSICS
DPP
DAILY PRACTICE PROBLEMS
NO. 02

TARGET : JEE (Advanced) 2015

Course: VIJETA & VIJAY (ADP & ADR) **Date : 11-04-2015**

TEST INFORMATION

TEST : PART TEST (PT)-1 (3 HOURS) (**Test Date : 15-04-2015**)

Syllabus : Geometrical Optics, Electrostatics, Gravitation, Kinematics, Newton's laws of motion, Friction.

This DPP is to be discussed (14-04-2015)

PT-1 to be discussed (17-04-2015)

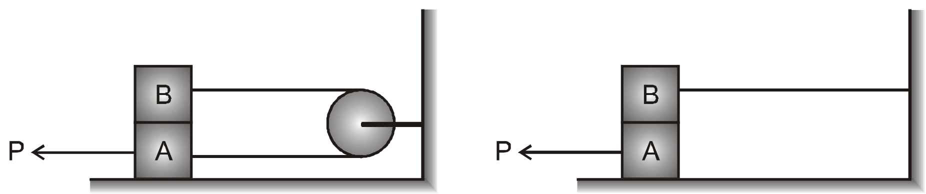
DPP No. # 02

Total Marks : 155		**Max. Time : 168 min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.17	(3 marks 3 min.)	[51, 51]
Multiple choice objective ('–1' negative marking) Q.18 to Q.24	(4 marks 4 min.)	[28, 28]
Subjective Questions ('–1' negative marking) Q.25 to 31	(4 marks 5 min.)	[28, 35]
Comprehension ('–1' negative marking) Q.32 to Q.39	(3 marks 3 min.)	[24, 24]
Match the Following (no negative marking) (2 × 4) Q. 40 to Q.42	(8 marks 10 min.)	[24, 30]

1. A cannon fires successively two shells from the same point with velocity v_0 = 250m/s ; the first at the angle θ_1 =60° and the second at the angle θ_2 =45° to the horizontal, the azimuth being the same. Neglecting the air drag, find the approximate time interval between firings leading to the collision of the shells (g = 9.8 m/s^2.)

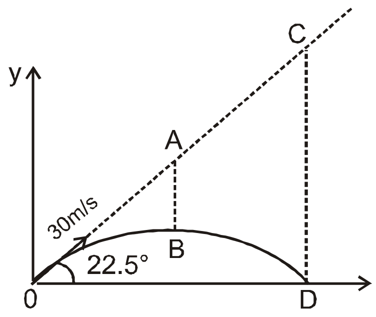
(A) 11 sec (B) 6 sec (C) 15 sec (D) 5 sec

2. Each of the two block shown in the figure has mass m. The pulley is smooth and the coefficient of friction for all surfaces in contact is μ. A constant horizontal force P applied in two cases shown in such a way that block A start just sliding then the value of minimum force P in case-I and case-II is :



(A) 2μ mg, 3μ mg (B) 3μ mg, 2μ mg
(C) 4μ mg, 3μ mg (D) 3μ mg, 3μ mg

3. A particle is projected with speed 30m/s at angle 22.5° with horizontal from ground as shown. AB and CD are parallel to y-axis and B is highest point of trajectory of particle. CD/AB is

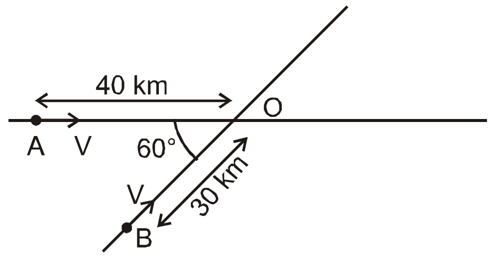


(A) 3 (B) 3/2 (C) 2 (D) 4

4. A block of mass m is pulled on an incline surface having coefficient of friction $\mu = 1$ & angle of inclination $\theta = 30°$, with the horizontal, such that required external force is minimum. The angle made by this force with the incline is :

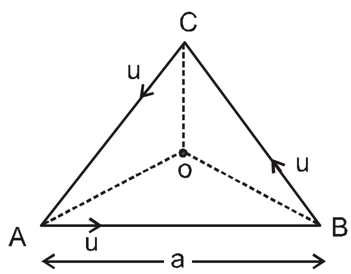
(A) 45° (B) 30° (C) 75° (D) 53°

5. Two cars A and B moving on two straight tracks inclined at an angle 60° heading towards the crossing initially their positions are as shown in the figure. Both cars have same speed. Minimum seperation between them during their motion will be.



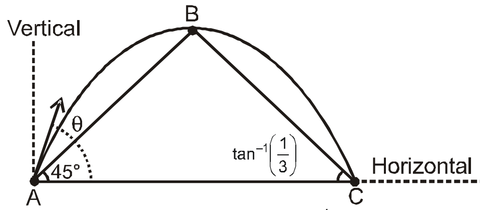
(A) 10 km (B) $5\sqrt{3}$ km (C) 5 km. (D) $\frac{20}{\sqrt{3}}$ km

6. Three particles A, B and C situated at vertices of an equilateral triangle, all moving with same constant speed such that A always move towards B, B always towards C and C always towards A. Initial seperation between each of the particle is a. O is the centroid of the triangle. Distance covered by particle A when it completes one revolution around O is



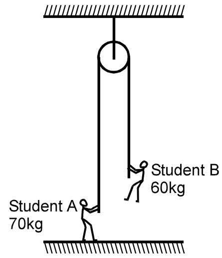
(A) $2a\left(1-e^{-2\sqrt{3}\pi}\right)$ (B) $\frac{2a}{3}\left(1-e^{-2\sqrt{3}\pi}\right)$ (C) $a\left(1+e^{-2\sqrt{3}\pi}\right)$ (D) $\frac{2a}{3}\left(1-e^{-\sqrt{3}\pi}\right)$

7. ABC is a triangle in vertical plane. Its two base angles $\angle BAC$ and $\angle BCA$ are 45º and $\tan^{-1}(1/3)$ respectively. A particle is projected from point A such that it passes through vertices B and C. Find angle of projection in degrees:



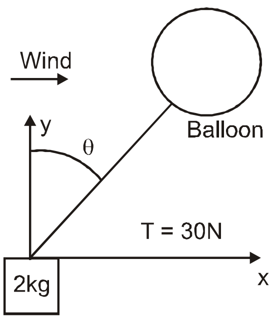
(A) 60º (B) 53º (C) $\tan^{-1}(5/4)$ (D) $\tan^{-1}(5/3)$

8. A rope of negligible mass passes over a pulley of negligible mass attached to the ceiling, as shown in figure. One end of the rope is held by Student A of mass 70 kg, who is at rest on the floor. The opposite end of the rope is held by Student B of mass 60 kg, who is suspended at rest above the floor. The minimum acceleration a_0 with which the Student B should climb up the rope to lift the Student A upward off the floor. (g = 10 m/s^2)



(A) $\frac{1}{3}$ m/s^2 (B) $\frac{2}{3}$ m/s^2 (C) $\frac{4}{3}$ m/s^2 (D) $\frac{5}{3}$ m/s^2

9. A balloon is tied to a block. The mass of the block is 2kg. The tension of the string between the balloon and the block is 30N. Due to the wind, the string has an angle θ relative to the vertical direction. $\cos\theta = 4/5$ and $\sin\theta = 3/5$. Assume the acceleration due to gravity is g = 10 m/s^2. Also assume the block is small so the force on the block from the wind can be ignored. Then the x-component and the y-component of the acceleration a of the block.



(A) 9 m/s^2, 2 m/s^2 (B) 9 m/s^2, 12 m/s^2 (C) 18 m/s^2, 2 m/s^2 (D) 18 m/s^2, 12 m/s^2

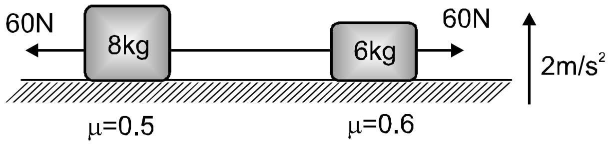
10. The maximum angle to the horizontal at which a stone can be thrown so that it always moves away from the thrower will be :

(A) $\sin^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (B) $\sin^{-1}\left(\frac{2\sqrt{2}}{3}\right)$ (C) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (D) $\sin^{-1}\left(\sqrt{\frac{2}{3}}\right)$

11. A man starts walking on a circular track of radius R. First half of the distance he walks with speed V_1, half of the remaining distance with speed V_2, then half of the remaining time with V_1 and rest with V_2 and completes the circle. Average speed of the man during entire motion in which he completes the circle is.

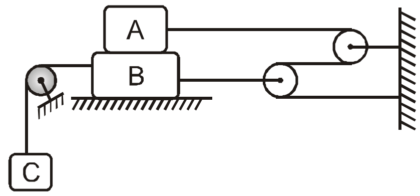
(A) $\frac{2V_1V_2(V_1+V_2)}{V_2^2+2V_1^2+2V_1V_2}$ (B) $\frac{4V_1V_2(V_1+V_2)}{V_1^2+2V_2^2+5V_1V_2}$ (C) $\frac{V_1V_2(V_1+2V_2)}{V_1^2+V_2^2+4V_1V_2}$ (D) $\frac{(V_1+2V_2)^2}{V_1+V_2+2V_1^2V_2^2}$

12. Two blocks of masses 8kg and 6kg are connected with a string & placed on a rough horizontal surface. Surface itself is accelerating up with constant acceleration 2 m/s^2. Two forces 60 N each are acting on the two blocks as shown. Friction coefficient for 8kg is 0.5 & that for 6 kg is 0.6. Tension in the string is : (g = 10 m/s^2)



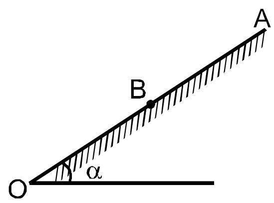
(A) 60 N (B) 12 N (C) 43.2 N (D) 16.8 N

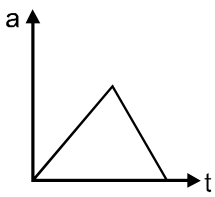
13. Block A of weight 500 N and block B of weight 700 N are connected by rope pulley system as shown. The largest weight C that can be suspended without moving block A and B is W. The coefficient of friction for all plane surfaces of contact is 0.3. The pulleys are ideal. Find $\frac{W}{90}$.

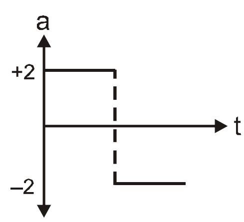


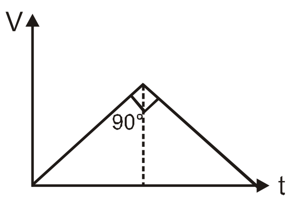
(A)12 (B) 22 (C) 9 (D) 18

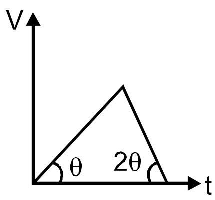
14. O is a point at the bottom of a rough plane inclined at an angle α to the horizontal. Coefficient of friction between AB is $\frac{\tan\alpha}{2}$ and between BO is $\frac{3\tan\alpha}{2}$. B is the mid–point of AO. A block is released from rest at A. Then identify which graphs are correct during motion of block from point A to O taking direction down the incline plane as positive (sinα = 1/5) :



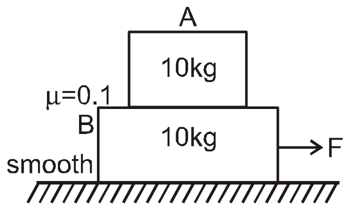
(A)


(B)


(C)


(D)


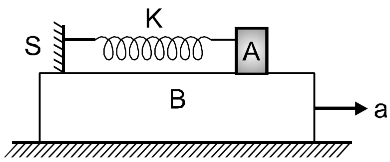
15. A block B of mass 10 kg is placed on smooth horizontal surface over it another block A of same mass is placed. A horizontal force F is applied on block B.



S_1 : No block will move unless F > 10 N.
S_2 : Block A will move towards left.
S_3 : Acceleration of block B will never be less than that of A.
S_4 : The relative motion between A and B will start when F exceeds 10 N.

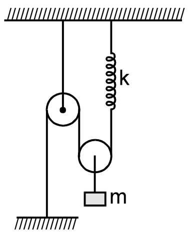
(A) F F F F
(B) T T T T
(C) F F T F
(D) T T F F

16. Block A of mass m is placed on a plank B. A light support S is fixed on plank B and is attached with the block A with a spring of spring constant K. Consider that initially spring is in its natural length. If the plank B is given an acceleration a, then maximum compression in the spring is $\frac{xma}{k}$. Find the value of x. (All the surfaces are smooth)



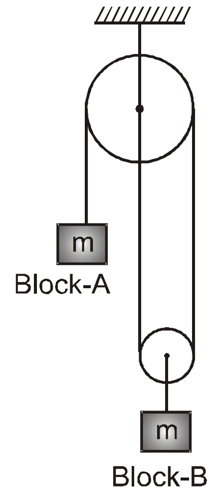
(A) $\frac{ma}{2k}$
(B) $\frac{2ma}{k}$
(C) $\frac{ma}{k}$
(D) $\frac{4ma}{k}$

17. Mass m shown in figure is in equilibrium. If it is displaced further by x and released find its acceleration just after it is released. Take pulleys to be light & smooth and strings light.



(A) $\frac{4kx}{5m}$
(B) $\frac{2kx}{5m}$
(C) $\frac{4kx}{m}$
(D) none of these

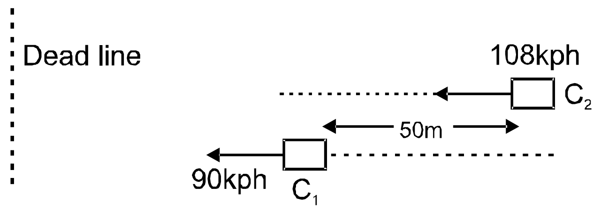
18. Both the blocks shown in figure have same mass 'm'. All the pulley and strings are massless.



(A) Acceleration of block A is $\frac{2g}{5}$ (B) Acceleration of block A is $\frac{g}{5}$

(C) Acceleration of block B is $\frac{g}{5}$ (D) Tension in the string attached with A is $\frac{3mg}{5}$

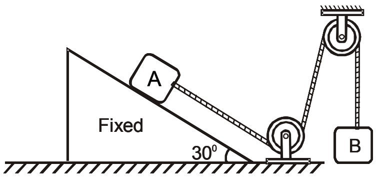
19. Two cars C_1 & C_2 are moving in parallel lanes in the same direction at speeds 90 kph & 108 kph respectively. (see figure). As the traffic signal turns red , both applies brake (assume constant retardation) simultaneously. If they both stop together at the dead line :



(A) distance of dead line from C_2 is 300 m
(B) distance of dead line from C_1 is 250 m
(C) time taken by the cars to ends up after the signal turn red is 15 sec
(D) time taken by the cars to ends up after the signal turn red is 20 sec

20. A man is standing on a road and observes that rain is falling at angle 45º with the vertical. The man starts running on the road with constant acceleration 0.5 m/s². After a certain time from the start of the motion, it appears to him that rain is still falling at angle 45º with the vertical, with speed $2\sqrt{2}$ m/s . Motion of the man is in the same vertical plane in which the rain is falling. Then which of the following statement(s) are true.
(A) It is not possible
(B) Speed of the rain relative to the ground is 2 m/s.
(C) Speed of the man when he finds rain to be falling at angle 45º with the vertical, is 4m/s.
(D) The man has travelled a distance 16m on the road by the time he again finds rain to be falling at angle 45°.

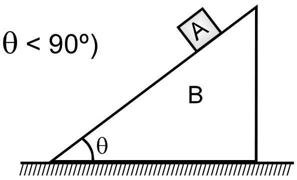
21. Two blocks A and B of equal mass m are connected through a massless string and arranged as shown in figure. The wedge is fixed on horizontal surface. Friction is absent everywhere. When the system is released from rest.



(A) tension in string is $\frac{mg}{2}$ (B) tension in string is $\frac{mg}{4}$

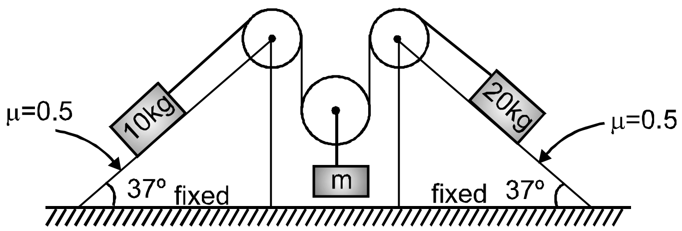
(C) acceleration of A is $\frac{g}{2}$ (D) acceleration of A is $\frac{3}{4}g$

22. In the figure shown, A & B are free to move. All the surfaces are smooth. ($0 < \theta < 90^\circ$)



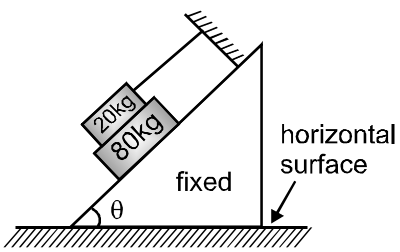
(A) the acceleration of A will be more than g sin θ
(B) the acceleration of A will be less than g sin θ
(C) normal force on A due to B will be more than mg cos θ
(D) normal force on A due to B will be less than mg cos θ

23. In given arrangement, 10 kg and 20 kg blocks are kept at rest on two fixed inclined planes. All strings and pulleys are ideal. value(s) of m for which system remain in equilibrium are: (g = 10 m/s^2)



(A) m = 6 kg (B) m = 13 kg (C) m = 9 kg (D) m = 12 kg

24. The system shown is in limiting equilibrium. The coefficient of friction for all contact surfaces is $\frac{1}{4}$.

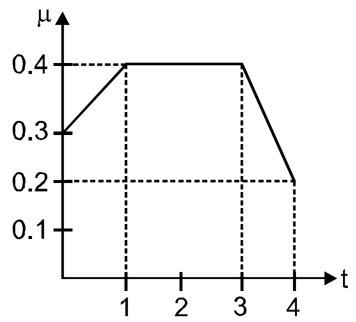


(A) $\tan\theta = \frac{3}{8}$

(B) Tension in the string = $\left(\frac{100}{3} g \sin\theta\right)$N

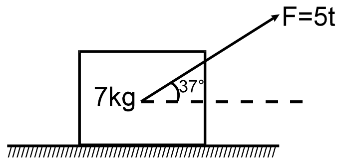
(C) Net frictional force on 80 kg block is (80 g sinθ)N
(D) Force exerted by 20 kg block on 80 kg block is (20 g cosθ)

25. A small body is projected with a velocity of 20.5 ms^{-1} along rough horizontal surface. The coefficient of friction (μ) between the body and surface changes with time t (in s) as the body moves along the surface. Find the velocity at the end of 4s in m/s

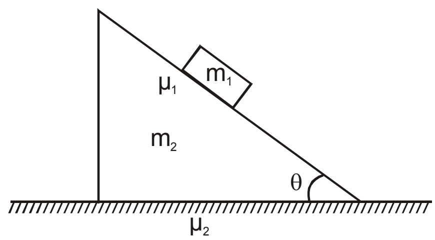


26. Position (in m) of a particle moving on a straight line varies with time (in sec) as $x = t^3/3 - 3t^2 + 8t + 4$ (m). Consider the motion of the particle from t = 0 to t = 5 sec. S_1 is the total distance travelled and s_2 is the distance travelled during retardation. If $s_1/s_2 = \frac{(3\alpha + 2)}{11}$ the find α.

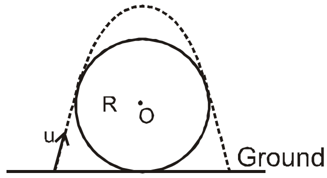
27. A block of 7 kg is placed on a rough horizontal surface and is pulled through a variable force F(in N) = 5t, where 't' is time in second, at an angle of 37° with the horizontal as shown in figure. The coefficient of static friction of the block with the surface is one. If the force starts acting at t = 0 s, Find the time at which the block starts to slide. (Take g = 10 m/s²) :



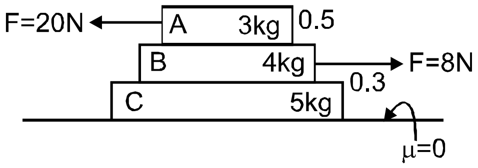
28. A block of mass m_1 is placed on a wedge of an angle θ, as shown. The block is moving over the inclined surface of the wedge. Friction coefficient between the block and the wedge is μ_1, whereas it is μ_2 between the wedge and the horizontal surface. If $\mu_1 = \frac{1}{2}$, $\theta = 45°$, $m_1 = 4$ kg, $m_2 = 5$kg and g = 10 m/s², find minimum value of μ_2 so that the wedge remains stationary on the surface. Express your answer in multiple of 10^{-3}.



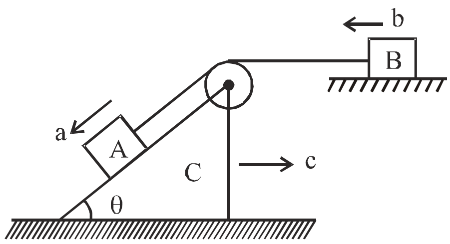
29. One has to throw a particle from one side of a fixed sphere, in diametrical plane to another side such that it just grazes the sphere. Minimum possible speed for this is $\sqrt{2gR(\sqrt{\alpha} + \sqrt{\beta})}$. Find $\alpha + \beta$.



30. In the situation shown coefficient of friction between A and B is 0.5 and between B and C is 0.3. Friction acting between B and C is xN then $\frac{9x}{7}$ is :

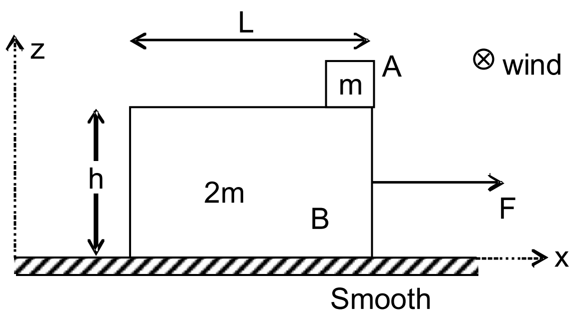


31. In the figure acceleration of bodies A, B and C are shown with directions. Values b and c are w.r.t. ground. Whereas a is acceleration of block A w.r.t. wedge C. Acceleration of block A w.r.t. ground is $\sqrt{\beta}$ m/s^2. Find β . (Use b = c = 1 m/s^2,θ = 60°)



Comprehension-1

Two blocks A and B of masses m and 2m are initially at rest. Length of block B is L and the block A is placed at the right end corner of block B and the friction coefficient between them is μ = 1/2. At t = 0 a constant force F = $\frac{5mg}{2}$ begins to act on block B towards right. Just when the block A leaves B, wind begins to blow along y - direction which exerts a constant force $\frac{mg}{2}$ on A. Assume the size of block A is small compared to B and neglect any rotational effects and toppling of block B. (Given h = 1/2 m, L = 1m and g = 10 m/s^2)



32. Find ratio of the displacements of block A along x and y directions S_x/S_y after the time block A leaves the surface of B till the time it reaches ground

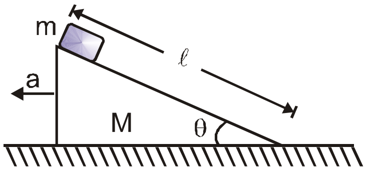
(A) $\frac{1}{2}$ (B) $\frac{1}{4}$ (C) 4 (D) $\sqrt{\frac{8}{5}}$

33. The magnitude of relative acceleration of A with respect to B (in m/s²) just after the block A leaves B is (assume wind does not effects motion of B)

(A) $\sqrt{10}g$ (B) $\frac{\sqrt{29}g}{4}$ (C) $\frac{g\sqrt{5}}{4}$ (D) $\frac{3\sqrt{5}}{4}g$

Comprehension : 2

A smooth wedge of mass M is pulled towards left with an acceleration $a = g\cot\theta$ on a horizontal surface and a block of mass m is released w.r.t wedge. Then answer the following :



34. Time taken by the block to reach the ground is :

(A) $\sqrt{\frac{2\ell\sin\theta}{g}}$ (B) $\sqrt{\frac{2\ell}{g\sin\theta}}$ (C) $\sqrt{\frac{2\ell}{g\cos\theta}}$ (D) $\frac{v}{g\sin\theta}$

35. Normal reaction between the wedge and block is :

(A) mg $\cos\theta$ (B) mg $\sec\theta$ (C) mg $\cot\theta$ (D) zero

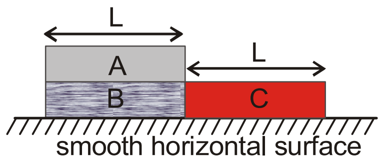
36. Normal reaction offered by ground to the wedge is :

(A) M g (B) (M + m)g $\cot\theta$ (C) mg $\sin^2\theta$ + Mg (D) (M + m)g

Comprehension : 3

Three identical uniform blocks of mass m each and length L are placed on a smooth fixed horizontal surface as shown. There is friction between A and B (Friction cofficient μ) while there is no friction between A and C.

At the instant shown, that is at t = 0; the block A has horizontal velocity of magnitude u towards right, whereas speed of B and C is zero. At the instant block A has covered a distance L relative to block B velocity of all blocks are same.



37. The speed of block A when it just looses contact with B is :

(A) $\frac{u}{2}$ (B) $\frac{u}{3}$ (C) $\frac{u}{4}$ (D) $\frac{2u}{3}$

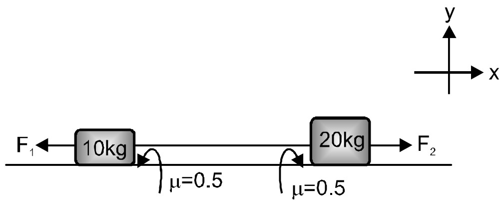
38. The magnitude of total work done by friction on system of three blocks is :

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

39. The value of μ is

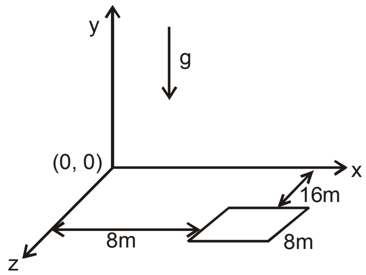
(A) $\mu = \frac{3}{2}\frac{u^2}{gL}$ (B) $\mu = \frac{1}{2}\frac{u^2}{gL}$ (C) $\mu = \frac{u^2}{gL}$ (D) $\mu = \frac{2}{3}\frac{u^2}{gL}$

40. Initially both blocks are at rest on a horizontal surface and string is just tight. At t = 0, two constant horizontal forces F_1 and F_2 start acting on blocks as shown. f_1 and f_2 are friction forces acting on 10 kg and 20 kg block (co–efficient of friction between blocks and ground are 0.5). Values of F_1 and F_2 are given in column–I. Then match magnitudes of f_1, f_2 and direction of $\vec{f}_1$ with corresponding values of F_1 and F_2 given in column–I [g = 10 m/s^2].



Column–I	Column–II
(A) F_2 = 120 N, F_1 = 40 N	(p) f_2 = 100 N , f_1 = 20 N
(B) F_2 = 160 N, F_1 = 40 N	(q) f_2 = 20 N , f_1 = 50 N
(C) F_2 = 60 N, F_1 = 90 N	(r) f_2 = 70 N , f_1 = 50 N
(D) F_2 = 20 N, F_1 = 90 N	(s) unit vector in direction of $\vec{f}_1$ is $\hat{i}$
	(t) unit vector in direction of $\vec{f}_1$ is $-\hat{i}$

41. A square platform of side length 8 m is situated in x–z plane such that it is at 16 m from the x–axis and 8 m from the z-axis as shown in figure. A particle is projected with velocity $\vec{v} = (v_2\hat{i} + 25\hat{j})$ m/s relative to wind from origin and at the same instant the platform starts with acceleration $\vec{a} = (2\hat{i} + 2.5\hat{j})$ m/s^2. Wind is blowing with velocity $v_1\hat{k}$. (g = 10 m/s^2)



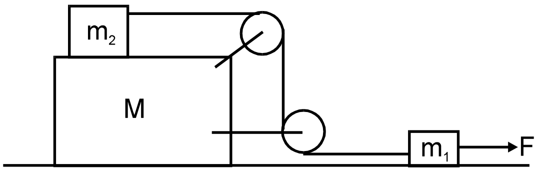
	List I	**List II**
(P)	Least possible values of v_2 (in m/s) so that particle hits the platform or edge of platform is	(1) 4
(Q)	Least possible value of v_1 (in m/s) so that particle hits the platform or edge of platform is	(2) 6
(R)	If t is the time (in second) after particle hits the platform then 2t is equal to	(3) 8
(S)	Value of displacement with respect to ground (in m) of the particle in y–direction, when v_2 has its minimum possible value is (till particle hits the platform or edge of platform)	(4) 20

Codes :

	P	Q	R	S
(A)	2	4	3	1
(B)	2	1	3	4
(C)	2	3	4	1
(D)	2	1	4	3

42. **Match the following :**

Three blocks of masses m_1, m_2 and M are arranged as shown in figure. All the surfaces are frictionless and string is inextensible. Pulleys are light. A constant force F is applied on block of mass m_1. Pulleys and string are light. Part of the string connecting both pulleys is vertical and part of the strings connecting pulleys with masses m_1 and m_2 are horizontal.



(P) Acceleration of mass m_1	(1) $\frac{F}{m_1}$
(Q) Acceleration of mass m_2	(2) $\frac{F}{m_1+m_2}$
(R) Acceleration of mass M	(3) zero
(S) Tension in the string	(4) $\frac{m_2F}{m_1+m_2}$

	P	Q	R	S
(A)	2	2	3	4
(B)	2	1	3	4
(C)	2	2	4	1
(D)	2	1	3	1

Today's Quote : Enthusiasm is most powerful engines of success. When you do a thing, do it with all your might, Put your whole soul into it. Stamp it with your own personality. Be active, be energetic and faithful, and you will accomplish your object. Nothing great was ever achieve without enthusiasm.

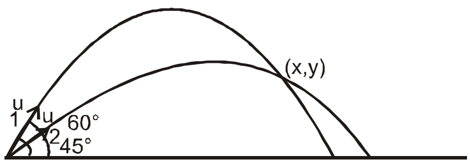
ANSWER KEY OF DPP No. # 01

1.	(B)	**2.**	(B)	**3.**	(C)	**4.**	(D)	**5.**	(B)	**6.**	(C)	**7.**	(A)
8.	(B)	**9.**	(C)	**10.**	(C)	**11.**	(B)	**12.**	(A)	**13.**	(B)	**14.**	(D)
15.	(B)	**16.**	(B)	**17.**	(B)	**18.**	(A,B,C)	**19.**	(A,C)	**20.**	(B,C)	**21.**	(A,D)
22.	(A,B,D)			**23.**	(A,B,C,D)	**24.**	6	**25.**	40	**26.**	65	**27.**	1
28.	6	**29.**	12	**30.**	60	**31.**	07	**32.**	6	**33.**	(A)	**34.**	(D)
35.	(C)	**36.**	(A)	**37.**	(B)	**38.**	(C)	**39.**	(A)	**40.**	(B)	**41.**	(C)
42.	(D)	**43.**	(B)	**44.**	(A)	**45.**	(D)						

PHYSICS

1. For particle -1 $y = \sqrt{3}\,x - \dfrac{gx^2}{2u^2(1/4)} \Rightarrow y = \sqrt{3}\,x - \dfrac{2gx^2}{u^2}$

For particle-2 $y = x - \dfrac{gx^2}{2u^2(1/2)} \Rightarrow y = x - \dfrac{gx^2}{u^2}$



$x - \dfrac{gx^2}{u^2} = \sqrt{3}\,x - \dfrac{2gx^2}{u^2}$

$x(\sqrt{3}-1) = \dfrac{gx^2}{u^2} \Rightarrow x = \dfrac{u^2}{g}(\sqrt{3}-1)$

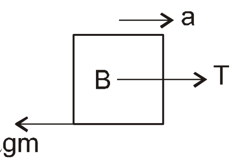
for particle -1

$u(1/2)\,t_1 = \dfrac{u^2}{g}(\sqrt{3}-1) \Rightarrow t_1 = \dfrac{2u}{g}(\sqrt{3}-1)$

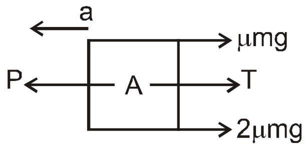
$u(1/\sqrt{2})\,t_2 = \dfrac{u^2}{g}(\sqrt{3}-1) \Rightarrow t_2 = \dfrac{\sqrt{2}u}{g}(\sqrt{3}-1)$

$\Delta t = u/g\ (2-\sqrt{2})\,(\sqrt{3}-1) = 10.9 \text{ sec} \simeq 11 \text{ sec.}$

2. **Case-I**



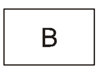
$T - \mu mg = ma$ .... (1)



$P - T - 3\,\mu mg = ma$
puting value of T from (1)
$P - ma - \mu mg - 3\mu mg = ma$
$P - 4\,\mu mg$
$a = -\,2\mu g$ .... (2)

Case-II

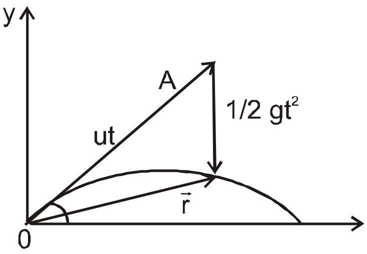
Rest



$a = \dfrac{P - 3\mu mg}{m}$ .... (3)

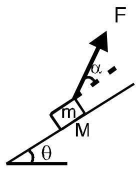
According to Q.
accelaration is same in both cases
Hence equating the equation (2) & (3)
$P = 2\mu mg$

3.



AB = 1/2 g(T/2)^2 = 1/8 gT^2
CD = 1/2 gT^2
CD/AB = 4

4. F cosα – μN – mg sinθ = 0 .... (i)
& N + F sinα – mg cos θ = 0 .... (ii)
Solving (i) & (ii)



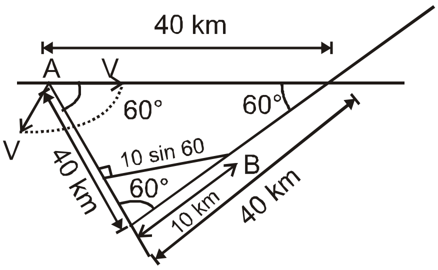
$$F = \frac{mg\sin\theta + \mu mg\cos\theta}{\cos\alpha + \sin\alpha}$$

$$F_{min} = \frac{mg\sin\theta + \mu mg\cos\theta}{\sqrt{1+\mu^2}}$$ **Ans**

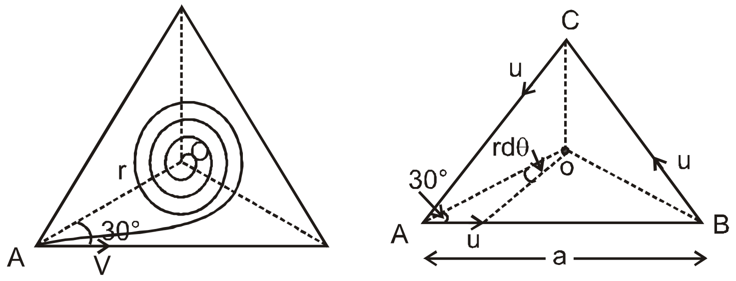
& tanα = μ $\Rightarrow$ $\alpha = \tan^{-1}\mu$ **Ans**

5. Let consider B as observer

d_{min} = 10 sin 60 km = $5\sqrt{3}$



6.



$$\frac{dr}{dt} = -\text{v}\cos 30° = -\frac{\sqrt{3}}{2}\text{V}$$

$$r\frac{d\theta}{dt} = \text{v}\sin 30° = \text{v}/2$$

$$\frac{1}{r}\frac{dr}{d\theta} = -\sqrt{3}$$

$$\int_{r_0}^{r}\frac{dr}{r} = -\sqrt{3}\int_0^{\theta} d\theta \Rightarrow \quad r = r_0\, e^{-\sqrt{3}\theta}$$

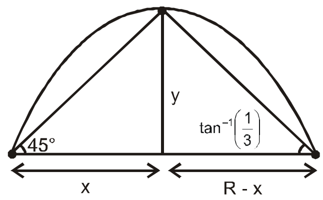
When A completes one revolution $\theta = 2\pi$

Time taken $t = \dfrac{r_0(1-e^{-2\sqrt{3}\pi})}{\sqrt{3}\text{v}/2}$

Distance travelled $D = \text{v}t = \dfrac{2r_0}{\sqrt{3}}(1-e^{-2\sqrt{3}\pi})$

$$D = \frac{2a}{3}(1-e^{-2\sqrt{3}\pi})$$

7. equation $y = x\tan\theta\left(1-\frac{x}{R}\right)$



at B x = y

$\tan\theta = \frac{R}{R-y}$ ..... (i)

$\tan 45° = \frac{y}{x}$

x = y ..... (ii)

$\left(\frac{1}{3}\right) = \frac{y}{R-x}$ ..... (iii)

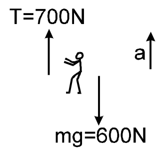
Solving equation 2 and 3
R = 4y = 4x Put in (i)

$\tan\theta = \frac{R}{R-\frac{R}{4}}$

$\tan\theta = \frac{4}{3}$

$\theta = 53°$

8. For student A to just lift off the floor, tension T in string must be greater than or equal to 700 N.
The F.B.D. of student B is
Applying Newton's second law



$T - mg = ma \Rightarrow 700 - 600 = 60\,a$

or $a = \frac{5}{3}$ m/s^2

9. The magnitude of the force (from the string) is T = 30N.
The x-component = T sinθ = 30 × 3/5 = 18N.
The y-component = T cosθ = 30 × 4/5 = 24N.
The total force on the block is:
the x-component = 18N.
the y-component = 24 – mg = 24 – 20 = 4N.
The x-component of the acceleration = 18N/2kg = 9m/s^2.
The y-component of the acceleration = 4N/2kg = 2m/s^2.

10. If stone always moves away from thrower then

$\Rightarrow \frac{d|\vec{r}\,|}{dt} > 0$

$\Rightarrow \vec{r}.\,\vec{v} > 0 \quad \vec{r} = u\cos\theta\, t\,\hat{i} + \left(u\sin\theta\, t - \frac{1}{2}gt^2\right)\hat{j}$

$\vec{v} = u\cos\theta\,\hat{i} + (u\sin\theta - gt)\,\hat{j}$

$\vec{r}.\vec{v} = u^2t - \frac{3}{2}\,ug\sin\theta\, t^2 + \frac{g^2}{2}t^3 > 0$

$\Rightarrow \frac{g^2}{2}t^2 - \frac{3}{2}\,ug\sin\theta\, t + u^2 > 0$

$\sin^2\theta < \frac{8}{9} \Rightarrow \theta < \sin^{-1}\left(\frac{2\sqrt{2}}{3}\right)$

11. Let total distance travelled is 4s.

$2s \rightarrow V_1 \rightarrow t_1 = \dfrac{2s}{V_1}$

$s \rightarrow V_2 \rightarrow t_2 = \dfrac{s}{V_2}$

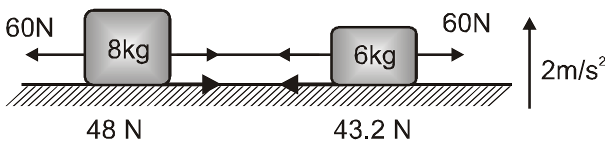
$s\begin{cases} V_1 \rightarrow t_0 \\ V_2 \rightarrow t_0 \end{cases}$ $\qquad (V_1 + V_2)\, t_0 = s \Rightarrow t_0 = \dfrac{s}{V_1 + V_2}$

$$< V > = \frac{4s}{t_1 + t_2 + 2t_0} = \frac{4s}{\frac{2s}{V_1} + \frac{s}{V_2} + \frac{2s}{V_1 + V_2}}$$

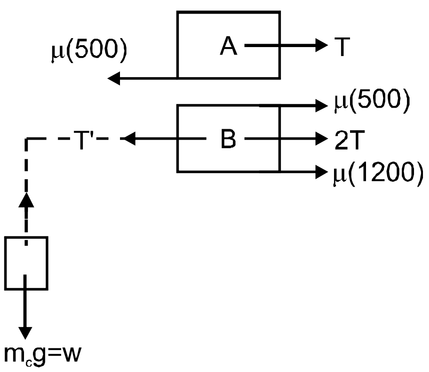
$$= \frac{4V_1V_2(V_1 + V_2)}{2V_2(V_1 + V_2) + V_1(V_1 + V_2) + 2V_1V_2}$$

$$= \frac{4V_1V_2(V_1 + V_2)}{2V_1V_2 + 2V_2^2 + V_1^2 + V_1V_2 + 2V_1V_2} = \frac{4V_1V_2(V_1 + V_2)}{V_1^2 + 2V_2^2 + 5V_1V_2}$$

12. f_R for 8 kg = 0.5 × 8(10 + 2) = 48 N
f_R for 6 kg = 0.6 × 6 (10 + 2) = 43.2 N
It can be verified that limiting friction will act on 6 kg
From FBD, tension = 16.8 N



13.



$3T + 0.3 \times 1200 = m_cg = W$ and $T = \mu(500) = 0.3 \times 500$
$W = m_0g = 810$ N.

14. For motion between AB

$$ma = mg \sin\alpha - \frac{\tan\alpha}{2} mg \cos\alpha$$

$$a = \frac{g\sin\alpha}{2} \text{(downward)}$$

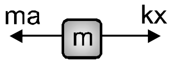
For motion between BO

$$ma = \frac{3\tan\alpha}{2} mg \cos\alpha - mg \sin\alpha$$

$$a = \frac{g\sin\alpha}{2} \text{(upward)}$$

The velocity increases from zero to maximum value at B and then starts decreasing with same rate and finally becomes zero at O.

15. $mv\dfrac{dv}{dx} = ma - kx$

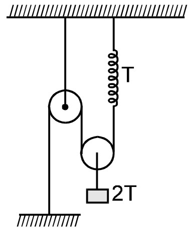


$$\int_0^0 mvdv = \int_0^x (ma - kx)dx$$

$$x = \frac{2ma}{k}.$$

17. Initially the block is at rest under action of force 2T upward and mg downwards. When the block is pulled downwards by x, the spring extends by 2x. Hence tension T increases by 2kx. Thus the net unbalanced force on block of mass m is 4kx.

$\therefore$ acceleration of the block is = $\dfrac{4kx}{m}$



18. $mg - T = 2ma$ ....(i)

$2T - mg = ma$ ....(ii)

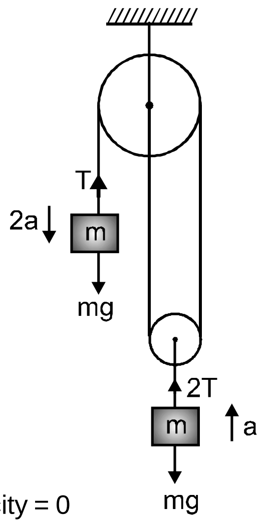
Solving,

$mg = 5\ ma$

$a = \dfrac{g}{5}$

$T = mg - 2ma$

$= mg - 2m\dfrac{g}{5} = \dfrac{3mg}{5}.$



19. **(i)** Relative initial velocity = 5 m/s, relative final velocity = 0

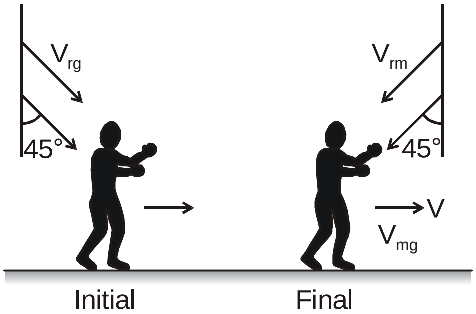
Relative displacement = 50 m

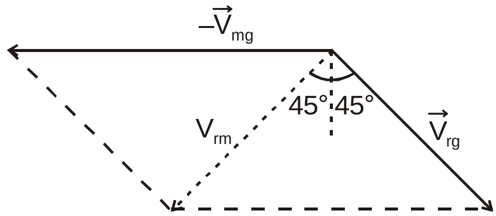
Relative acceleration = constant

$\Rightarrow \quad 50 = \left(\dfrac{5+0}{2}\right)t \quad \Rightarrow \quad t = 20$ sec. **Ans.**

(ii) Distance of dead line from car $C_1 = \left(\dfrac{25+0}{2}\right) \times 20 = 250$ m. **Ans.**

20.





$\vec{V}_{rg} = \vec{V}_{rm} + \vec{V}_{mg}$

$\vec{V}_{rm} = \vec{V}_{rg} - \vec{V}_{mg}$

$V_{rm} \cos 45° = V_{rg} \cos 45°$

$V_{rm} = 2\sqrt{2}$ m/s $= V_{rg}$

$V_{rm} \cos 45° = V_{mg} - V_{rg} \cos 45°$

$$V_{mg} = 2\sqrt{2}\frac{1}{\sqrt{2}} + 2\sqrt{2}\frac{1}{\sqrt{2}} = 4 \text{ m/s}$$

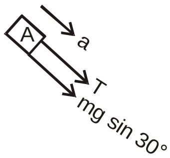
using $v^2 = u^2 + 2as$ for the motion of man,

s = 16 m.

21. Let a be acceleration of system and T be tension in, the string.

F.B.D of block A

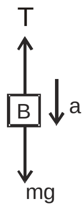
mg sin 30° + T = ma



$\frac{mg}{2} + T = ma$ ..... (i)

F.B.D of block B

mg – T = ma ..... (ii)



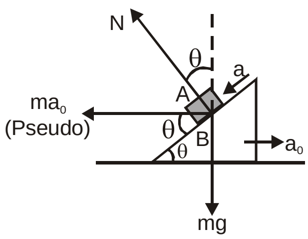
Adding equation (i) & (ii); we get

$$2ma = \frac{3mg}{2} \Rightarrow a = \frac{3}{4}g$$

from equation (i);

$$T = \frac{mg}{4}$$

22.



$ma_0 \sin\theta + N = mg \cos\theta \Rightarrow N = mg\cos\theta - ma_0 \sin\theta$

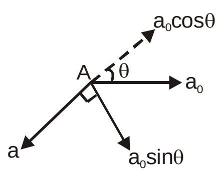
$\Rightarrow$ $N < mg \cos\theta$

Hence, (D) is true.

$ma_0 \cos\theta + mg \sin\theta = ma$

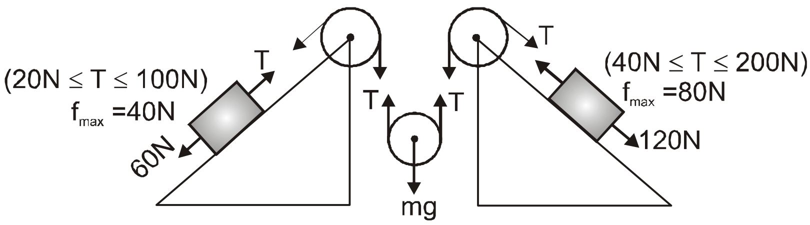
$\Rightarrow$ $a = g \sin\theta + a_0 \cos\theta$

Hence acceleration of A



$$= \sqrt{(a - a_0 \cos\theta)^2 + (a_0 \sin\theta)^2} > g\sin\theta.$$

23. $T = \dfrac{mg}{2}$

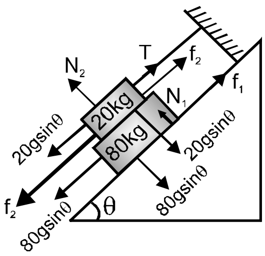


For the equilibrium of 10kg block tension in string should be between 20 N to 100 N, while for the equilibrium of 20 kg range of tension is 40 N to 200 N, so for the equilibrium of system, tension in the string must be between 40 N to 100 N and mass of block must be between 8 kg to 20 kg.

24. $20g\sin\theta + f_2 = T$

$20g\sin\theta + \mu(20g\cos\theta) = T$

$80g\sin\theta = \mu(100g\cos\theta) + \mu(20g\cos\theta)$



$\tan\theta = \dfrac{3}{8}$

$T = 20g\sin\theta + \mu\, 20g\cos\theta$

$= 20g\sin\theta + \dfrac{1}{4} \times 20 \times g \times \dfrac{8}{3}\sin\theta$

$= \left(\dfrac{100}{3} g\sin\theta\right)N$

Net friction on 80 kg $= f_1 + f_2 = 80\, g\sin\theta$

force on 80 kg due to 20 kg is $\sqrt{(20g\cos\theta)^2 + (\mu 20g\sin\theta)^2}$ ..

25. Impulse $= \int \vec{F}dt = m(\vec{v}_f - \vec{v}_i)$

$-mg \times$ Area under $\mu - t$ graph $= m(v_f - 20.5)$

$-mg \times \left[\dfrac{1}{2}(0.4+0.3)\times 1 + 0.4\times 2 + \dfrac{1}{2}(0.4+0.2)\times 1\right] = m(v_f - 20.5)$

$v_f = 6$m/s

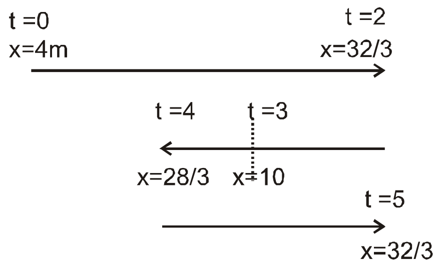
26. $x = t^3/3 - 3t^2 + 8t + 4$

$v = t^2 - 6t + 8 = (t-2)(t-4)$

$a = 2(t-3)$

		2	3	4
V	+	–	–	+
a	–	–	+	+

$S_1 = \left(\dfrac{32}{3} - 4\right) + \left(\dfrac{32}{3} - \dfrac{28}{3}\right) + \left(\dfrac{32}{3} - \dfrac{28}{3}\right) = \dfrac{20}{3} + \dfrac{8}{3} = \dfrac{28}{3}$ m.



$S_2 = \left(\dfrac{32}{3} - 4\right) + \left(10 - \dfrac{28}{3}\right) = \dfrac{20}{3} + \dfrac{2}{3} = \dfrac{22}{3}$ m

$\dfrac{S_1}{S_2} = \dfrac{28}{22} = \dfrac{14}{11} = \dfrac{3\alpha + 2}{11} \Rightarrow \alpha = 4$

27. The block begins to slide if

F cos 37° = μ (mg – F sin 37°)

5t [cos 37° + μ sin 37°] = μ mg

$5t\left[\frac{4}{5}+\frac{3}{5}\right] = 70$ or $t = 10$ second

28. Taking block + wedge as system and applying NLM in horizontal direction

$f_2 = m_1 a \cos\theta$

$= m_1 [g(\sin\theta - \mu_1 \cos\theta)] \cos\theta$ .... (1)

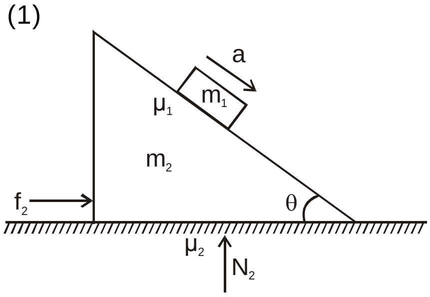
Again applying NLM in vertical direction

$(m_1 + m_2)g - N_2 = m_1 a \sin\theta$

$N_2 = (m_1 + m_2)g - m_1 \sin\theta(g \sin\theta - \mu_1 g \cos\theta)$

For limiting condition $f_2 = \mu_2 N_2$ .... (2)

From (1) and (2)



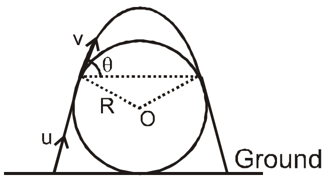
$$\mu_2 = \frac{m_1\cos\theta(g\sin\theta - \mu_1 g\cos\theta)}{(m_2 + m_2)g - m_1\sin\theta(gsn\theta - \mu_1 g\cos\theta)}$$

Using values

$\mu_2 = \frac{1}{8} = 125 \times 10^{-3}$

Ans. 125

29.



$$\frac{2v^2\sin\theta\cos\theta}{g} = 2R\sin\theta \Rightarrow v^2 = \frac{Rg}{\cos\theta}$$

$u^2 = v^2 + 2gR(1 + \cos\theta)$

$$u^2 = \frac{Rg}{\cos\theta} + 2gR + 2gR\cos\theta$$

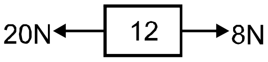
$$u^2 = Rg\left(\frac{1+2\cos^2\theta}{\cos\theta}\right) + 2gR$$

for u to be minimum $\frac{1+2\cos^2\theta}{\cos\theta} = \min$

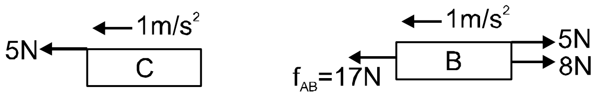
$\Rightarrow \quad \cos\theta = \frac{1}{\sqrt{2}} \quad \Rightarrow \quad \theta = \pi/4$

$u_{min} = \sqrt{\sqrt{2}Rg + 2gR + \sqrt{2}Rg} = \sqrt{2gR(\sqrt{2}+1)}$

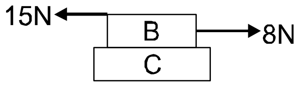
30. Let everything moves together
Then,



$a = \frac{12}{12} = 1\ m/s^2$



But $f_{AB\ maximum} = 15N$
So, sliding occurs.
Now, see if B and C move together.



$a = \frac{15-8}{9} = \frac{7}{9}\ m/s^2$

So, friction acting between B and C is $\frac{7}{9} \times 5\ m/s^2$.

31. a = b + c

Net acceleration of A = $\sqrt{a^2 + c^2 + 2ac\cos(\pi - \theta)} = \sqrt{(b+c)^2 + c^2 - 2(b.+c).c.\cos\theta.} = \sqrt{3}$

33. For block B. ;

$2ma_B = F - \frac{mg}{2}$

$a_B = g$

For block A ;

$ma_A = mg$

$a_A = g/2$

$a_{AB} = -g/2$

$L = \frac{1}{2}\frac{g}{2}.t_1^2$

$t_1 = \sqrt{\frac{2}{5}}s$

time of flight $t_2 = \sqrt{\frac{2h}{g}} = \frac{1}{\sqrt{10}}s$

Velocity when A leaves B. ;

$V_A = g/2\ t_1 = g/2 \times \sqrt{\frac{4L}{g}} = \sqrt{10}\ m/s$

$S_x = V_A t_2 = 1m$

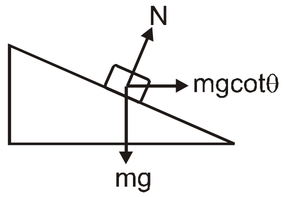
$S_y = \frac{1}{2}\frac{g}{2}\frac{2h}{g} = \frac{1}{4}m$

$\frac{S_x}{S_y} = 4$

$\vec{a}_A = \frac{g}{2}\hat{j} - g\hat{k}$

$\vec{a}_B = \frac{5g}{4}\hat{i}, |\vec{a}_{AB}| = \left(\sqrt{\frac{1}{4} + 1 + \frac{25}{16}}\right)g$

34 to 36. If we draw FBD of block w.r.t wedge



$N + F_s \sin\theta = mg \cos\theta$

$\Rightarrow$ $N = 0$

so w.r.t ground block will fall freely.

$h = \frac{1}{2}gt^2$ and $h = \ell \sin\theta$

37. to 39

From conservation of momentum

$3mv = mu$ or $v = \frac{u}{3}$

Net workdone by friction = $\frac{1}{2}3m\left(\frac{u}{3}\right)^2 - \frac{1}{2}mu^2 = -\frac{1}{3}mu^2$

net work done by friction = $\int_{\ell}^{0} \mu(x\lambda g)(-dx) = -\mu\lambda g\frac{L^2}{2}$

Also magnitude of net work done by friction = $\mu\lambda g\frac{L^2}{2} = \mu mg\frac{L}{2}$

$\therefore \frac{1}{3}mu^2 = \mu mg\frac{L}{2}$ or $\mu = \frac{2}{3}\frac{u^2}{gL}$

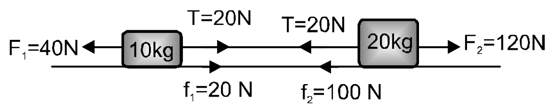
$3mv = mu$ or $v = \frac{u}{3}$

40. $\left|\vec{F}_1 + \vec{F}_2\right| < |f_1|_{max} + |f_2|_{max}$

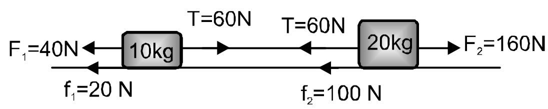
So, both blocks not move in any case.

$|f_1|_{max} = 50$ N ; $|f_2|_{max} = 100$ N

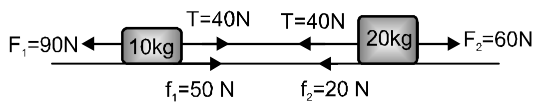
(A)



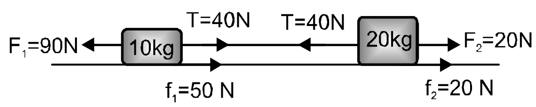
(B)



(C)



(D)



41. $\vec{V}_{P,P} = V_2\hat{i} + 25\hat{j} + V_1\hat{k}$

$\vec{a}_{P,P} = -2\hat{i} - 12.5\hat{j}$

$\vec{V}_{P,P}$ = Velocity of particle relative to platform

Time $= \dfrac{2 \times 25}{12.5}$ = 4 sec.

$8 \le V_2 \times 4 - \dfrac{1}{2} \times 2 \times 4^2 \le 16$

$6 \le V_2 \le 8$

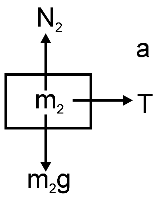
$16 \le V_1 \times 4 \le 24$

$4 \le V_1 \le 6$

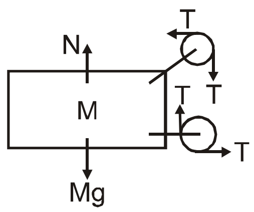
$Y = 25 \times 4 - \dfrac{1}{2} \times 10 \times 4^2 = 100 - 80 = 20\text{m}$

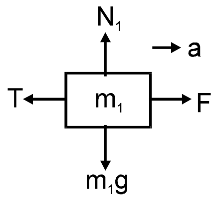
42. (A) Q (b) Q (C) R (D) S

FBD's



$T = m_2a.$





$F - T = m_1a$

$F = (m_1 + m_2)a$

$\because \quad T = m_2a$

$\Rightarrow \quad a = \dfrac{F}{m_1 + m_2} \qquad \because\ T = \dfrac{m_2F}{m_1 + m_2}. \qquad F_x = 0,\ a_M = 0$