N.L.M FRICTION

EXERCISE – I   SINGLE CORRECT

1. **A**

From constrained

$-5-5-5+v_B=0$

$v_B = 15\ m/s \downarrow$

2. **A**

From constrained

$+2-v_B-v_B+1=0$

$v_B = 3/2\,m/s \uparrow$

3. A

From constrained

$-a-a_B-a_B+f=0$

$a_B = \left(\frac{f}{2}-\frac{a}{2}\right) = \frac{1}{2}(f-a)\uparrow$

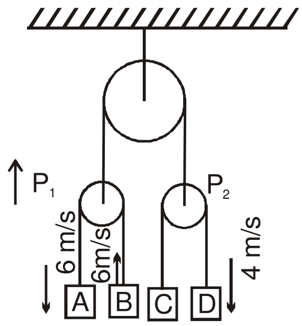
4. A

From constrained

$-a_C+2+2-1-1-a_C=0$

$a_C = 1\ m/s^2 \uparrow$

5. **B**



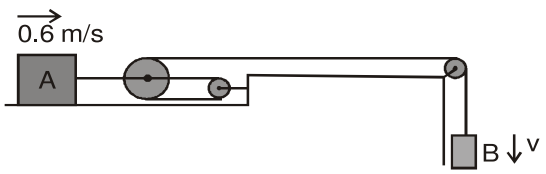
$v_{p_1} = \frac{-6+6}{2} = 0$

$|v_{p_1}| = |v_{p_2}| = 0$

$v_D = -v_C$

$\therefore$ velocity of C is = 4 m/s

6. **A**

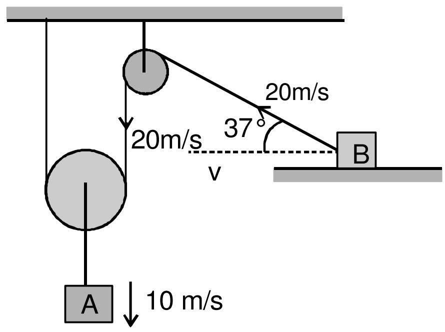


From constrained

$v-0.6-0.6-0.6=0$

V= 1.8 m/s

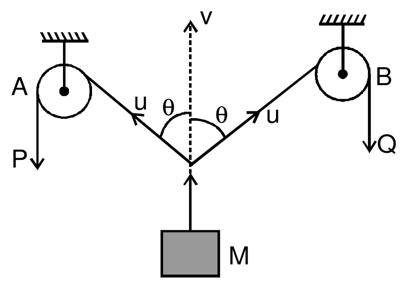
7. **A**



$v\cos 37° = 20$

$v = \frac{20\times 5}{4} = 25\,m/s$

8. D

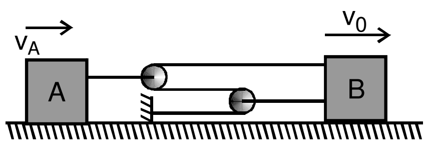


From constrained

$v\cos\theta = u$

$v = \frac{u}{\cos\theta}$

9. B



From constrained

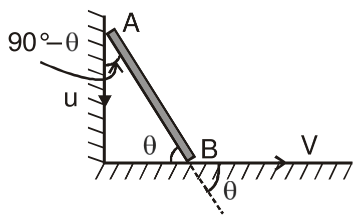
$V_0 - V_A - V_A + V_0 + V_0 = 0$

$V_A = \frac{3V_0}{2}$

$V_{AB} = V_A - V_B = \frac{3V_0}{2} - V_0$

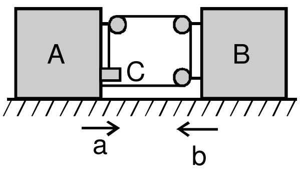
$= \frac{V_0}{2}$ (towards Right)

10. C



From constant
$v \cos \theta = u \sin \theta$
$v = u \tan \theta$

11. A



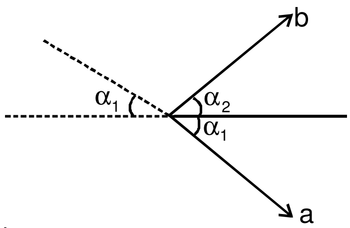
Let

$C = c_x \hat{i} + c_y \hat{j}$

$C_x = a \rightarrow$
$-a - b + 0 + 0 - b - a + c = 0$
$c_y = (2a+2b) \downarrow$ (By constrain Motion)
In ground frame

$\therefore \quad C = a\hat{i} - (2a+2b)\hat{j}$

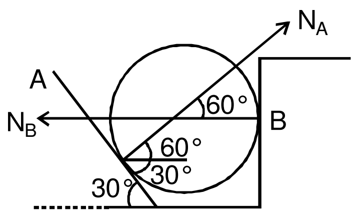
12. **A**



$b \cos \alpha_2 = a \cos \alpha_1$

$$b = \frac{a \cos \alpha_1}{\cos \alpha_2}$$

13. B

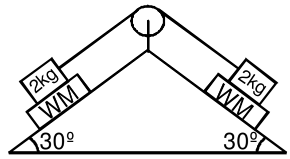


$N_A \sin 60° = 500$

$$N_A = \frac{1000}{\sqrt{3}}$$

$$N_A \cos 60° = N_B \Rightarrow N_B = \frac{500}{\sqrt{3}}$$

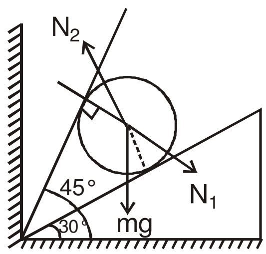
14. **A**

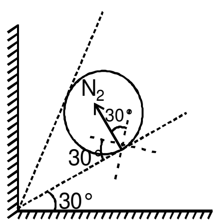


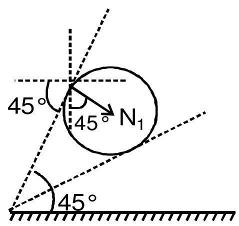
Weighing Machine
always Measure Normal

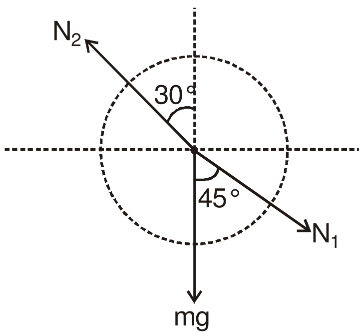
So N = $10\sqrt{3}$

15. A







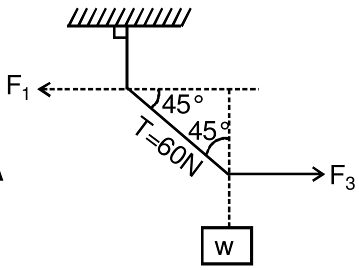


$$50 + \frac{N_1}{\sqrt{2}} = \frac{N_2\sqrt{3}}{2} \qquad ...(1)$$

$$\frac{N_1}{\sqrt{2}} = \frac{N_2}{2} \qquad ...(2)$$

On solving we get
N_1 and N_2
$N_1 = 96.59$ N, $N_2 = 136.6$ N

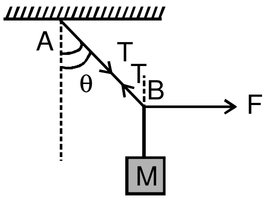
16,17, D,A



$$F_1 = F_3 = T\cos 45° = 60 \times \frac{1}{\sqrt{2}} = \frac{60}{\sqrt{2}}\text{N}$$

$$W = \frac{60}{\sqrt{2}}\text{N}$$

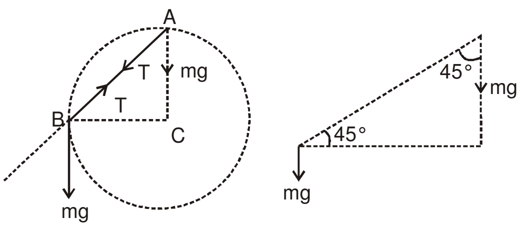
18. **B**



$T\sin\theta = F$

$$T = \frac{F}{\sin\theta}$$

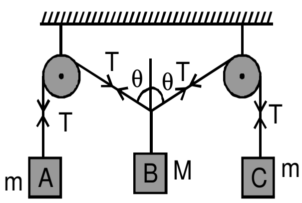
19. B



Force along the rod is same

$$= mg\cos 45° = \frac{mg}{\sqrt{2}}$$

20. B

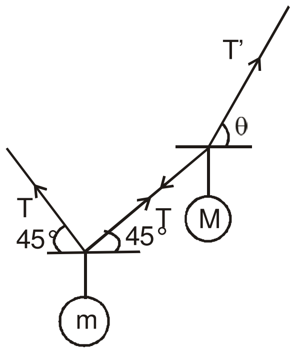


$2T\cos\theta = Mg$

$\Rightarrow$ $2mg\cos\theta = Mg$ ....(1)

θ always > 0 so M < 2 m

21. **A**



$$\frac{2T}{\sqrt{2}} = mg$$

$$T = \frac{mg}{\sqrt{2}}$$

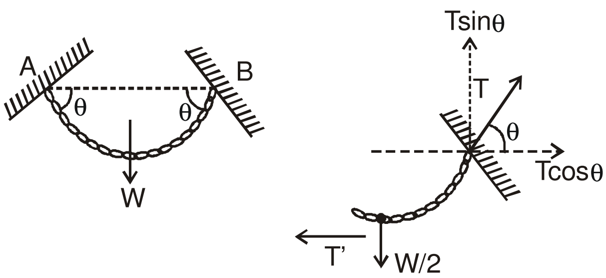
$$T'\cos\theta = \frac{T}{\sqrt{2}}$$

$$T'\sin\theta = \frac{T}{\sqrt{2}} + Mg$$

$$\frac{T}{\sqrt{2}}(\tan\theta - 1) = Mg$$

$$\tan\theta = 1 + \frac{2M}{m}$$

22. **C**

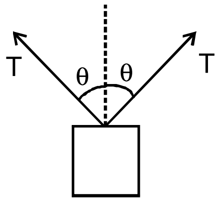


$T\cos = T'$

$$T\sin\theta = \frac{W}{2}$$

$\Rightarrow$ $$T' = \frac{W}{2}\cot\theta$$

23. C



$2T\cos\theta = mg$

$T = \dfrac{mg}{2\cos\theta}$

$\theta\uparrow$, $\cos\theta\downarrow$ and $T\uparrow$

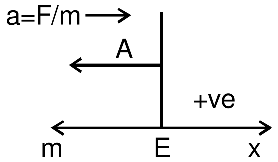
If tension is more than string may be break

24. A

Relative acceleration Man and car is zero during the journey

N = 0

25. A



$A = \dfrac{1}{2}at^2$

$t = \sqrt{\dfrac{2}{a}A}$

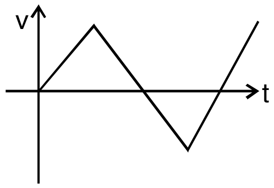
$\therefore\ t = \sqrt{\dfrac{2mA}{F}}\quad \therefore F = ma$

$\therefore\ \text{total} = 4\left(\sqrt{\dfrac{2mA}{F}}\right)$

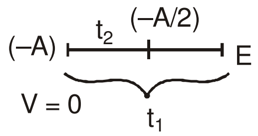
26. A

$v = at \quad \xrightarrow{(+)}$

$v = \dfrac{F}{m}t$



27. B



$t_1 \rightarrow$ to reach (– A) to 0

$t_1 = \sqrt{\dfrac{2mA}{F}}$

$t_2 \rightarrow$ to reach (–A) to –A/2

$t_2 = \sqrt{\dfrac{mA}{F}}$

$t_1 - t_2 = \sqrt{\dfrac{mA}{F}}(\sqrt{2}-1)$

28. A

At t = 2 sec

$a = \dfrac{10}{2} = 5\ m/s^2$

So, $F = ma = \dfrac{50}{1000}\times 5 = 0.25N$

At t = 4 sec

a = 0

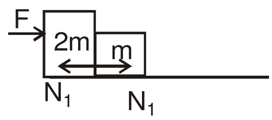
So F = 0

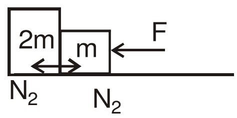
At t = 6 sec,

$a = -5\ m/s^2$

F = – 0.25 N

29. B





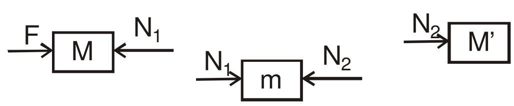
$\text{Acceleration} = \dfrac{F}{3m}$

contact force $N_1 = \dfrac{mF}{3m} = \dfrac{F}{3}$

$N_2 = \dfrac{2mF}{3m} = \dfrac{2}{3}F$

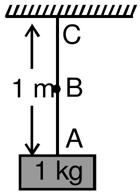
$\therefore N_1 : N_2 = 1 : 2$

30. B



$F - N_1 = Ma$
$N_1 - N_2 = ma$
$N_2 = M'a$
$N_1 = (M' + m)\,a$
$\therefore M' > M \quad \Rightarrow N_1 > N_2$

31 **A**

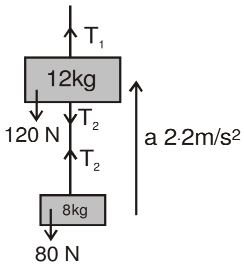


Tension at A
$T_A = mg = 10$ N

32. **B**
Tension at B
$T_B = 1\,g + 0.5\,g = 15$ N

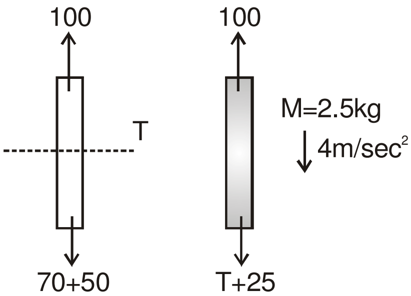
33. **C**
Force exertd by support = T_C
$= 1\,g + 1\,g = 20$ N

34. C



$T_2 - 80 = 8(2.2)$ ...(1)
$T_1 - T_2 - 120 = 12(2.2)$ ...(2)
After solving (1) to (2) [take g = 9.8 m/s²]
$T_1 = 240$ N
$T_2 = 96$ N

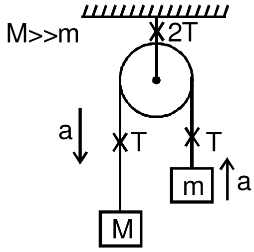
35. B



$a = \dfrac{20}{5} \Rightarrow a = 4\text{m/s}^2$

$T + 25 - 100 = 2.5 \times 4$
$T = 85$ N

36. C

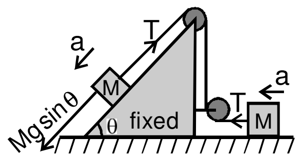


$T - mg = ma$ ...(1)
$Mg - T = Ma$ ...(2)
from (1) and (2)

$$a = \left(\frac{M-m}{M+m}\right)g$$

Put M >> m $\Rightarrow a = g$
$\therefore$ T = 2 mg, 2T = 4mg

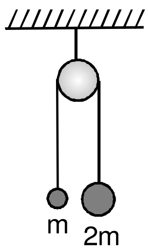
37. **C**



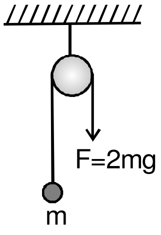
$Mg \sin\theta - T = Ma$ ...(1)
$T = Ma$ ...(2)
Now eq. (1) – eq. (2)
$Mg \sin\theta - 2T = 0$

$$T = \frac{Mg\sin\theta}{2}$$

38. C



Case (i)
$T - mg = ma$
$2mg - T = 2ma$
} $a = g/3$

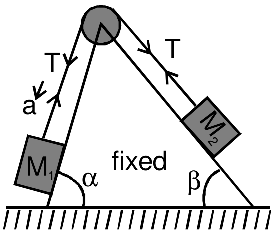


(II)

case (ii)
$T - mg = ma$
$T = 2\,mg$
} g=a

On comparing a of case of (i) < case of (ii)

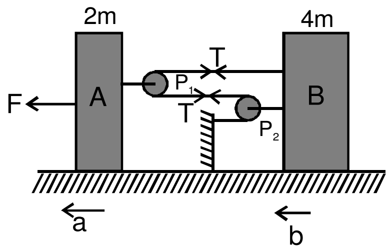
39. C



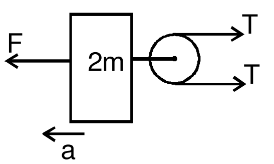
$M_1\, g \sin\alpha - T = M_1\, a$ ...(i)
$T - M_2\, g \sin\beta = M_2\, a$ ...(ii)
On solving

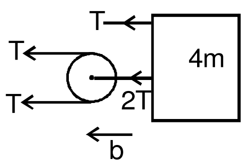
$$T = \frac{M_1 M_2 (\sin\alpha + \sin\beta) g}{M_1 + M_2}$$

40. A



From Constrain equation
$2a = 3b$ ..(1)



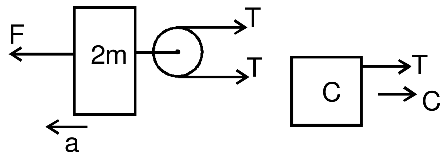


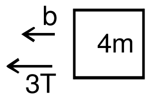
$F - 2T = 2ma$ ...(2)

$3T = 4mb$ ...(3)
On solving (1), (2) & (3)

$$b = \frac{3F}{17}$$

41. B

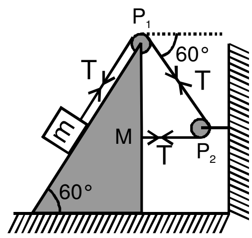




constrain equation $2a = 3b + c$ ..(1)
$F - 2T = 2ma$ ..(2)
$T = mc$ ...(3)
$3T = 4mb$ ...(4)
on solving above four equation

$$b = \frac{3F}{21m} m/s^2$$

42. A

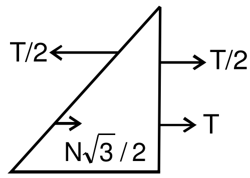


From Constrain equation

$$-b + 0 + 0 - b/2 + b\frac{\sqrt{3}}{2} + a - b\frac{\sqrt{3}}{2} = 0$$

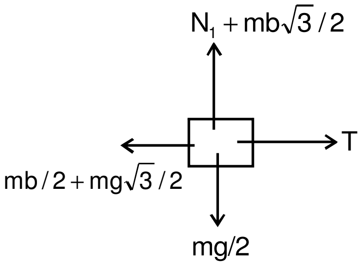
$$a = \frac{3b}{2} \quad ..(1)$$

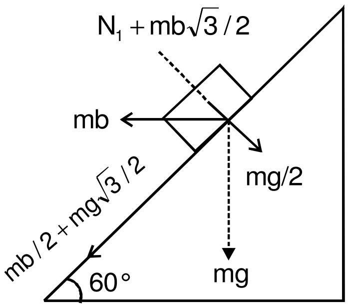
F.B.D of 8 kg block



$$T + \frac{N\sqrt{3}}{2} = 8b \quad ....(2)$$

F.B.D of 2 kg block





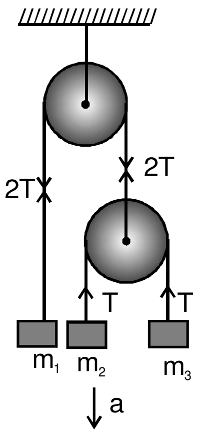
$$mg\frac{\sqrt{3}}{2} + \frac{mg}{2} - T = ma \quad ...(3)$$

$$N + mb\frac{\sqrt{3}}{2} = \frac{mg}{2} \quad ...(4)$$

On solving above four equation, we get

$$b = \frac{30\sqrt{3}}{23b}$$

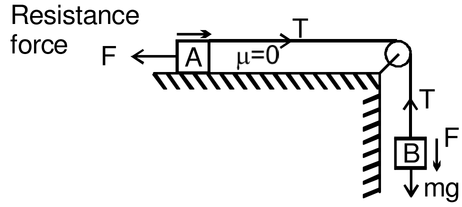
43. C



$2T = m_1 g \quad ...(1)$
$m_2 g - T = m_2 a \quad ...(2)$
$T - m_3 g = m_3 a \quad ...(3)$
on solving

$$\frac{4}{m_1} = \frac{1}{m_2} + \frac{1}{m_3}$$

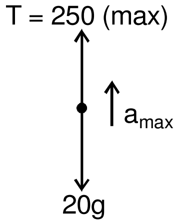
44. B



at Block B
$T + F = mg \quad ...(1)$
at Block A
$T = F \quad ...(2)$

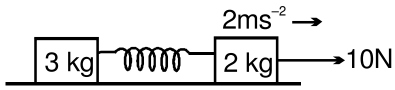
$$T = \frac{Mg}{2}$$

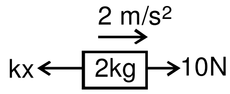
45. D



$250 - 200 = 20\, a_{max}$
$a_{max} = 2.5\ m/s^2$

46. B



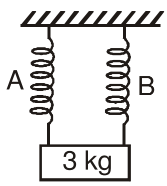


$10 - kx = 2 \times 2$
$kx = 6\ N$

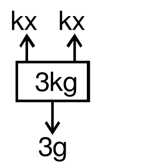
$\therefore$ Acceleration of 3 kg $= \frac{6}{3} = 2\ m/s^2$

47. A

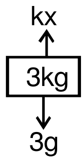
Before cutting



After cutting

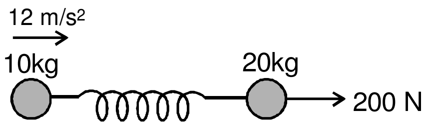


$2kx = 3g$
$kx = 15$

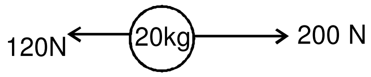


$$a = \frac{3g - kx}{3} = \frac{15}{3} = 5 m/s^2$$

48. B

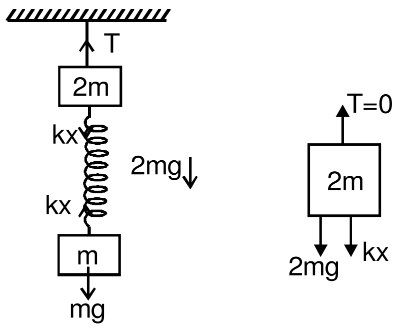


Force on 10 kg block = 12 × 10 = 120 N
So



$$a = \frac{80}{20} = 4 m/s^2$$

49. **B**

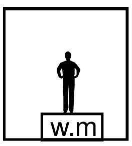


After cutting T = 0

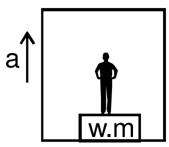
$$\therefore \quad a = \frac{3mg}{2m} = \frac{3g}{2}$$

50. (i) A, (ii) A, (iii) C, (iv) D, (v) B, (vi) D, (vii) B, (viii) B

(a) a = 0
V = 0
N=mg

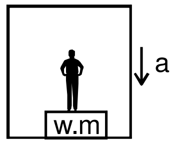


(b)



N = mg + ma

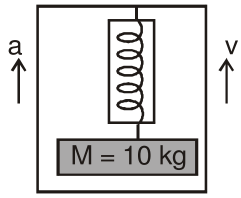
(c)



N = mg – ma

Independent of the direction of velocity.

51. (i) A, (ii) A, (iii) A, (iv) C, (v) B, (vi) C, (vii) C, (viii) B



(a) v = 0 or v = constant , a = 0
w = m(g + a)
= 10 (g + 0)
= 100 N

(b) v = 0 or v = constant
a = upward = $2 m/s^2$
w = m (g + a)
= 120 N

(c) v = 0 or v = constant
a = downward = $2 m/s^2$
w = m (g – a)
= 80 N

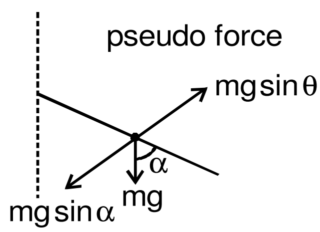
52. A
S_1 is accelerating frame so psuedo force act opposite to frame acceleration
F_{Pseudo} = mass of analyzing body × acceleration of frame

$$= 2(-5\hat{i} - 10\hat{j}) = -10\hat{i} - 20\hat{j}$$

53. B
S_2 is inertial frame
F = ma
So $F = 10\hat{i} + 20\hat{j}$

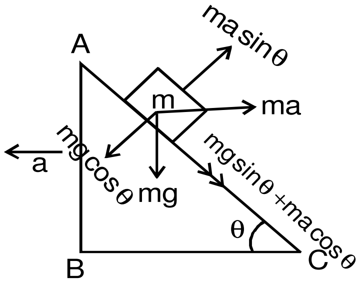
54. A
With respect to S_1 frame
Net force = zero.

55. A



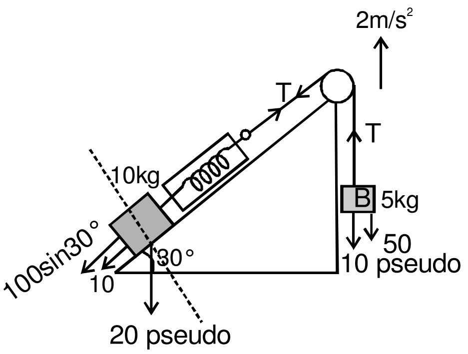
From trolley frame
mg sin α = mg sin θ
θ = α

56. C



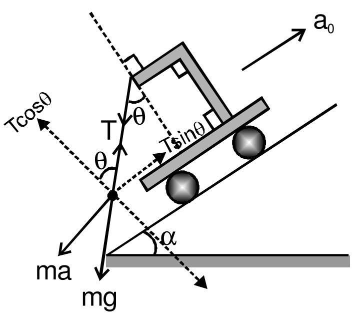
Mass m falls freely
N = 0
mgcos θ = ma sin θ
a = g cot θ

57. C



Tension in the string is 60N.
So spring balance reading
= 6 kg or 60 N

58. D

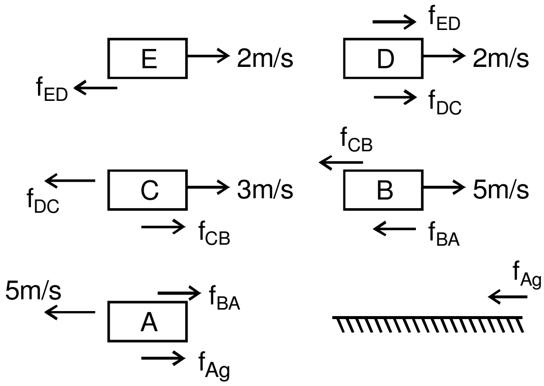


T cosθ = mg cos (α – π)
T sin θ = ma$_0$ + mg sin (α – π)
(2) / (1)

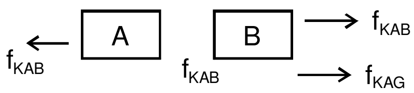
$$\tan\theta = \frac{a_0 + g\sin\alpha}{g\cos\alpha}$$

FRICTION

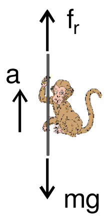
59.



60. Direction of kinetic friction depends on relative velocity, not on the force

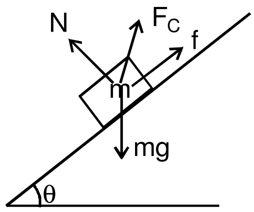


61. A
Monkey is moving up due to friction force



f_r – mg = ma
f_r = m(a+g)
towards up.

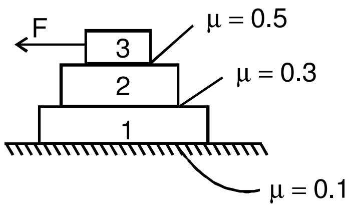
62. B

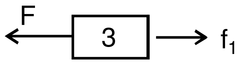


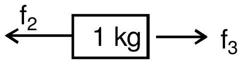
For θ < angle of repose
F_c = mg
For θ > angle of repose
as θ↑ f = µmg cos θ↓
N = mg cos θ↓

63. A
N = 10 – 4 = 6 N
f_{max} = 0.3 × 6 = 1.8 N
But required = 1 N ←
Force of friction = $-\hat{i}$

64. C

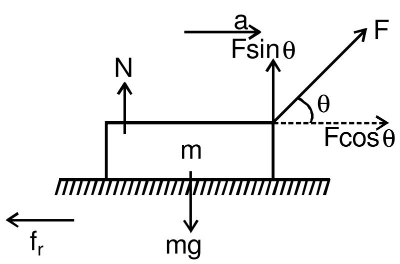






$f_{1\,max} = 15$ N, $f_{2\,max} = 15$ N, $f_{3\,max} = 6$ N

65. C



$F \sin\theta + N = mg$

or $N = mg - F\sin\theta$ ...(1)

$f_r = \mu N$ ...(2)

$F\cos\theta - f_r = ma$ ...(3)

on solving (1), (2) & (3)

$$a = \frac{F\cos\theta - \mu(mg - F\sin\theta)}{m}$$

$$a = \frac{F}{m}(\cos\theta + \mu\sin\theta) - \mu g$$

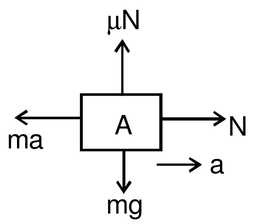
66. C

If A and B are moving without slipping

$m_c g - T = m_c a$ ...(1)

$T = 3ma$ ...(2)

w.r.t. B



$N = ma$

$m_c g = \mu ma$

$a = g/a$

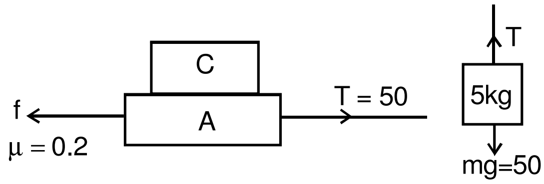
$$mcg - \frac{3mg}{u} = m_c g/\mu$$

$$m_c = \frac{3m}{\mu - 1}$$

67. A

System is at rest contract

So,



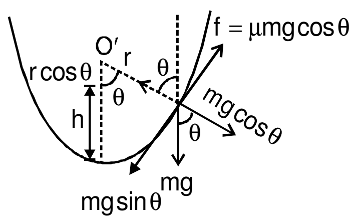
At rest

$f = T = \mu N$

$N = 50/0.2 = 250$ newton

so $m_c = 15$ kg

68. **B**



$h = r - r\cos\theta$

$\mu\, mg\cos\theta = mg\sin\theta$

$\tan\theta = u$

$$\cos\theta = \frac{1}{\sqrt{1+\mu^2}}$$

$$h = r(1 - \cos\theta) = r\left[1 - \frac{1}{\sqrt{1+\mu^2}}\right]$$

69. A

move with a constant velocity

So $ma = m\mu g$

$a = \mu g$

$\Rightarrow$ $v^2 - u^2 = 2as$

$v = \sqrt{2\mu gs}$ If u = 0

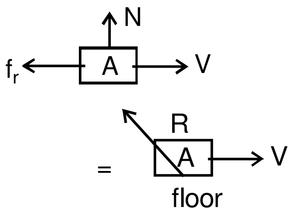
70. B

$$\frac{1}{2}mv_0^2 = \mu mgL$$

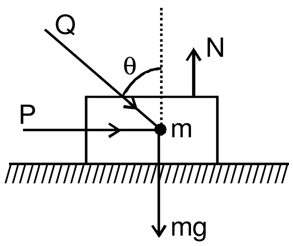
$$v_0 = \sqrt{2\mu gL}$$

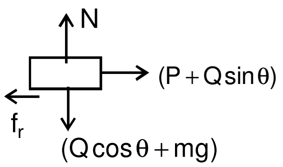
71. C

Floor will provide the normal force and friction force the net reaction is provide by the floor is R.



72. A



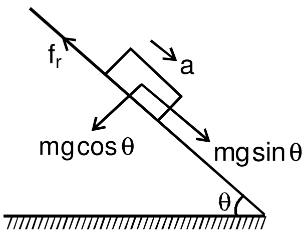


$f_r = \mu N = \mu\,(mg + Q\cos\theta)$

$f_r = P + Q\sin\theta$

$$\mu = \frac{(P + Q\sin\theta)}{(mg + Q\cos\theta)}$$

73. A



$mg\sin\theta - f_r = ma$

$\Rightarrow$ $mg\sin\theta - \mu\, mg\cos\theta = ma$

$g[\sin\theta - \mu\cos\theta] = a$

$\Rightarrow$ $\dfrac{vdv}{dx} = g[\sin\theta - \mu_0 x\cos\theta]$ $\quad [\therefore\ \mu = \mu_0 x]$

and $a = \dfrac{vdv}{dx}$

$$\int_0^x g[\sin\theta - \mu_0 x\cos\theta]\,dx = \int_0^v vdv$$

[Here v = 0]

$\therefore$ $g[\sin\theta x - \mu_0 \dfrac{x^2}{2}\cos\theta] = 0$

$\Rightarrow$ $x = \dfrac{2}{\mu_0}\tan\theta$

74. A

$$\int_0^{x/2} g(\sin\theta - \mu_0 x\cos\theta)\,dx = \int_0^v vdv$$

$$g[\sin\theta.\frac{x}{2} - \frac{\mu_0}{2}\left(\frac{x}{2}\right)^2\cos\theta] = \frac{v^2}{2}$$

Keeping the value

$$x = \frac{2}{\mu_0}\tan\theta$$

$$v = \sqrt{\frac{g\tan\theta\sin\theta}{\mu_0}}$$

75. A

$f_s \le \mu N$

$mg\sin\theta \le \mu\, m g\cos\theta$

$\mu \ge 1$

76. D

At the x increases, u ↑ a ↓

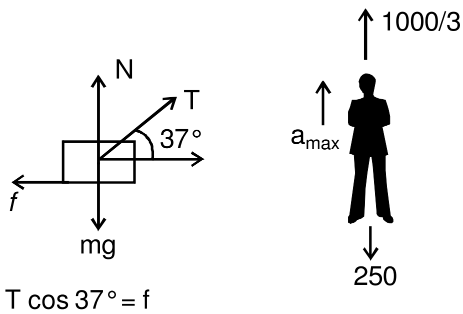
so when a = 0 instant give maximum speed

g sin 37° – (0.3) xg cos 37° = 0

$$6 - \frac{3}{10}\times x \times 8 = 0$$

$$x = \frac{60}{3\times 8} = \frac{20}{8} = 2.5\text{m}$$

77. B



T cos 37° = f

N + T sin 37° = mg

$\therefore$ N = 100 g – T sin 37° = 100 g – $\dfrac{3T}{5}$

and T cos 37° = μ N

T cos 37° = μ(100 g – $\dfrac{3T}{5}$)

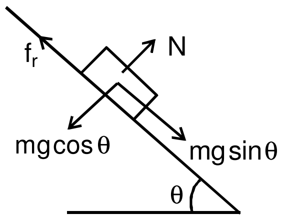
on solving T = $\dfrac{1000}{3}$ $\quad$ ($\mu = \dfrac{1}{3}$)

$T - Mg = ma_{max}$

$$\frac{1000}{3} - 250 = 25 \times a_{max}$$

$$a_{max} = \frac{g}{3} = \frac{10}{3} m/s^2$$

78. **A**



Let length is ℓ of inclined plane, then

$f_r = \mu N = \mu\, mg \cos\theta$

$mg \sin\theta - f_r = ma$

$mg \sin\theta - \mu\, mg \cos\theta = ma$ ...(1)

Now

$$\ell = \frac{1}{2}at^2 = \frac{1}{2}g(\sin\theta - \mu\cos\theta)t^2$$

Now $\ell_1 = \ell_2$

$$\ell_2 = \frac{1}{2}g\sin\theta\left(\frac{t^2}{2}\right)$$

$$\frac{1}{2}g(\sin\theta - \mu\cos\theta)t^2 = \frac{1}{2}g(\sin\theta - 0\times\cos\theta)\left(\frac{t^2}{2}\right)$$

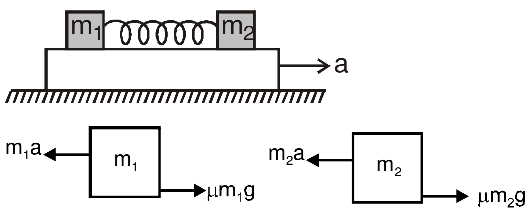
$4(\sin\theta - \mu\cos\theta) = \sin\theta$

$$\mu = \frac{3}{4} = 0.75$$

79. A

Friction not depend on surface Area
so angle remain same.
$\therefore$ Angle = 30°

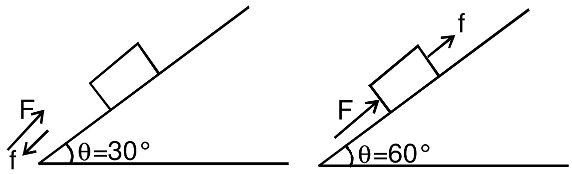
80. D



$a_{net} = a - \mu g$ $a_{net} = a - \mu g$

$\therefore$ f_r static and f_r kinetic
both provide same acceleration
to m_1 and m_2.
So no relative motion between them
$\therefore$ x = 0 (Always)

81. C



$F = mg \sin 30° + \mu\, mg \cos 30°$

$$= \frac{mg}{2}[1 + \mu\sqrt{3}] \quad ...(1)$$

$F + f = mg \sin 60°$

$$F = \frac{mg}{2}[\sqrt{3} - \mu] \quad ...(2)$$

Now (1) = (2)

$1 + \mu\sqrt{3} = \sqrt{3} - \mu$

$$\Rightarrow \quad \mu = \frac{(\sqrt{3}-1)}{(\sqrt{3}+1)}$$

82. (a) B, (b) D, (c) A

(a) $T - mg \sin 45° = ma$

$$T - \frac{mg}{\sqrt{2}} = \frac{mg}{5\sqrt{2}} \quad \text{Given } a = \frac{g}{5\sqrt{2}}$$

$$T = \frac{6}{5}\frac{mg}{\sqrt{2}}$$

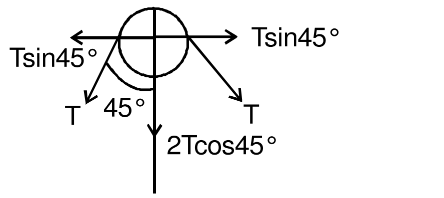
(b) $3\,mg \sin 45° - T - \mu N = 3ma$

$$\frac{3mg}{\sqrt{2}} - \frac{6mg}{5\sqrt{2}} - \frac{3mg}{5\sqrt{2}} = \mu\ (3\,mg\cos 45°)$$

$$3mg\left[\frac{1}{\sqrt{2}} - \frac{2}{5\sqrt{2}} - \frac{1}{5\sqrt{2}}\right] = 3mg \times \frac{\mu}{\sqrt{2}}$$

$$\mu = \frac{2}{5}$$

(c)

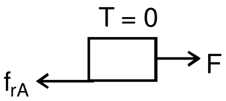


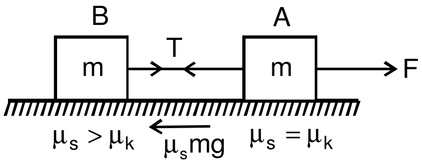
So $2T \cos 45° = F$

$$2 \times \frac{6mg}{5\sqrt{2}} \times \frac{1}{\sqrt{2}} = F$$

$$\therefore F = \frac{6mg}{5} \text{ downward}$$

83. A





Initially

$F - f_{r_A} = 0 \Rightarrow t - \mu_s\, mg = 0 \Rightarrow t = \mu_s\, mg$

[till or $f_{rB} = \mu_s mg$

$t - \mu_s mg = \mu_s\, mg$

$t = 2\,\mu_s\, mg$]

$T = F - f_{rA} = f_{rB}$

$T = t - \mu_s mg = f_{rB}$

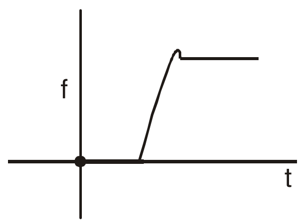
$t = \mu_s mg$ block be will not move

$\mu_s mg < t \le 2\mu_s mg$ block be will not move, static friction will work

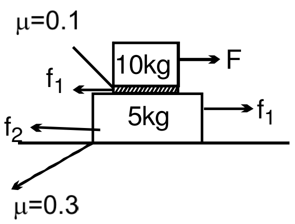
after $t > 2\mu_s mg$ kinetic friction will work

$$a = \frac{F - \mu_s\, mg - \mu_k\, mg}{m}$$

So $T = F - \mu_s\, mg - ma$ after $t = 2\mu_s\, mg$



84. A



$f_{1\,max} = 10$ N

$f_{2\,max} = 45$ N

85. A

If F = 2 N

there will be no motion

the required frictional force is 2 N

86. A

There will be no motion of 5 kg because

$(f_2 > f_1)$

The maximum F which will not cause motion

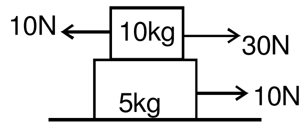
F = 10 N

87. C

Acceleration is zero

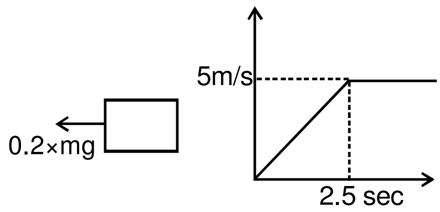
(For any value of F 5kg block will not move)

88. A



$$a_{10kg} = \frac{30-10}{10} = \frac{20}{10} = 2m/s^2$$

89. C



For t < 1 sec

$\therefore\ a_B = 2\ m/s^2$

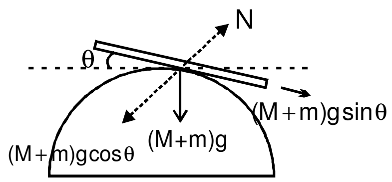
and velocity of truck is 5 m/s

$\therefore$ Friction will act after 1 sec due to relative motion between block and truck

$5 = 2 \times t$

$t = 2.5$ sec.

90. A



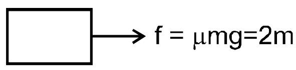
For equilibrium condition

$(M+m)g \sin\theta = \mu\,(M+m)\,g\cos\theta$

$\tan\theta = \mu$

Here $\mu \rightarrow$ coefficient of friction between board & log.

91. **A**



$\{a = \mu g = 0.2 \times 10 = 2\}$

acceleration = 2 m/s^2

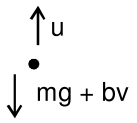
So, $4 = 2 \times t \Rightarrow t = 2$ sec

$$\therefore\ S = \frac{1}{2}.2.(2)^2 = 4\ m$$

EXERCISE – II | MULTIPLE CHOICE QUESTIONS

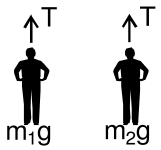
1. C
Pulley is fixed from the ceiling
If pulley is fricitonless then there is no effect of mass of pulley.

2. B



In upward motion
as v ↓
Force ↓
acceleration ↓
and takes less time to reach at top.

3. A,B,D



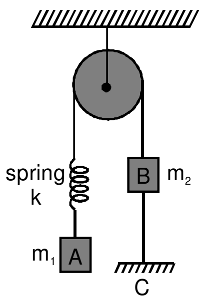
(A) $T = m_1g < m_2g$
∴ Acceleration of m_2 is ↓
(B) $T = m_2 g > m_1g$
∴ acceleation of m_1 is ↑
(C) Masses is different
∴ Not possible
(D) $T - m_1g = m_1a$
$m_2g - T = m_2a$

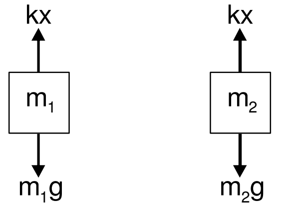
on solving $a = \dfrac{(m_2 - m_1)g}{(m_1 + m_2)}$ Possible

4. C
(A) 40 cos 30° = $20\sqrt{3}$ N
(B) weight = 5 kg
(C) Net = zero

5. **B**
If v = 0 or v = constant then frame is inertial.

6. A,C





$m_1g = kx \qquad a = \dfrac{kx - m_2g}{m_2}$

a = 0
Before Burnt
$T = kx = m_1g$
Just after burning just at 1 sec
(A) m_2 will be upwards.
(B) m_1 will be = 0

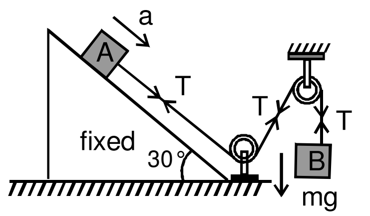
7. A,B,C
$F = \alpha t$
$ma = \alpha t$

$a = \dfrac{\alpha t}{m} \Rightarrow a \propto t$ ....(1) St. line

$\dfrac{dv}{dt} = \dfrac{\alpha t}{m} \Rightarrow v = \dfrac{\alpha}{m}\dfrac{t^2}{2}$

$\Rightarrow v \propto t^2$ ...(2) Parabola
on solving (1) & (2)
$v \propto a^2$ Parabola.

8. B,D



$T + mg \sin\theta = ma$ ....(1)
$mg - T = ma$ ....(2)

on solving (1) & (2) $a = \dfrac{3g}{4}$

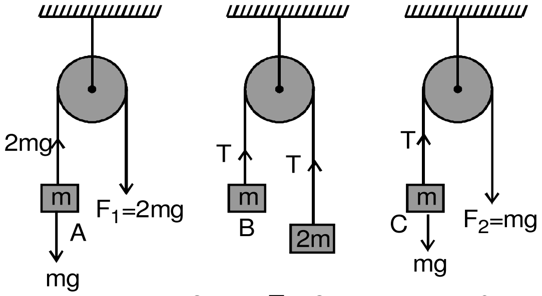
$T = \dfrac{3g}{4}$

9. A,B,C
Slope of x – t curve gives velocity
In region AB, BC, CD have constant slope.
$\Rightarrow a = 0 \Rightarrow$ net force = 0

10. B

F_1 may be equal to F_2

11. B



$a_1 = g$

$2mg - T = 2\,ma$

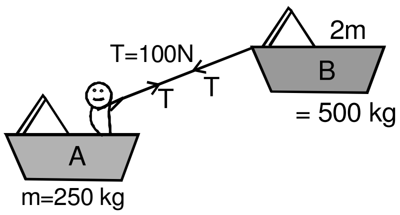
$T - mg = ma$

$a_2 = g/3$

$a_3 = 0$

$\therefore\ a_1 > a_2 > a_3$

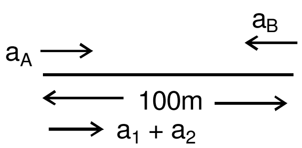
12. B



M = 250 kg

$a_A = \frac{F}{m} = \frac{100}{250} = \frac{2}{5}$ and $a_B = \frac{100}{250} = \frac{1}{5}$

Now



$a_{AB} = a_1 + a_2 = \frac{2}{3} + \frac{1}{5} = \frac{3}{5}$

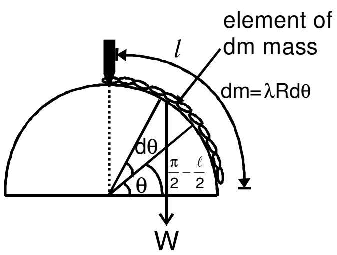
$100 = \frac{1}{2}(a_1 + a_2)t^2$

$100 = \frac{1}{2}\left(\frac{3}{5}\right)t^2$

$t^2 = 333.33$

$t = 18.25 = 18.3$ sec

13. B



$$F = \int_{\pi/2 - l/r}^{\pi/2} \ell r g \cos\theta\, d\theta$$

$$F = \lambda r g\left[1 - \cos\frac{\ell}{r}\right]$$

$$a = \frac{m}{l}.\frac{rg}{m}\left[1 - \cos\frac{\ell}{r}\right]$$

$$a = \frac{rg}{\ell}\left[1 - \cos\frac{\ell}{r}\right]$$

14. C

Given

$\vec{a} + \vec{b} + \vec{c} + \vec{d} + \vec{e} = 3\hat{i}$ ...(1)

$\vec{b} + \vec{c} + \vec{d} + \vec{e} = -\hat{i}$ ...(2)

$\vec{a} + \vec{c} + \vec{d} + \vec{e} = 24\hat{j}$ ...(3)

$(1) - (2) \Rightarrow \vec{a} = 4\hat{i}$

$(1) - (3) \Rightarrow \vec{b} = 3\hat{i} - 24\hat{j}$

Now $\vec{a} + \vec{b} = 7\hat{i} - 24\hat{j}$

$|\vec{a} + \vec{b}| = \sqrt{49 + (24)^2} = 25$

FRICTION

15. A,B

$f_{static_{max}} = 15 = \mu_s N$

$\mu_s = \frac{15}{N} = \frac{15}{mg} = \frac{15}{25} = 0.6$

Now let μ_k then

$15 - f_r = ma$

$15 - \mu_k 25 = 2.5\,a$

$\mu_k = \frac{15 - 2.5a}{2.5}$ ...(1)

Now $x = ut + \frac{1}{2}at^2$

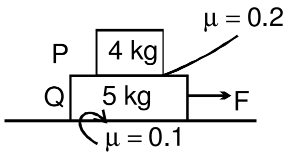
$10 = 0 + \frac{1}{2} \times a \times (5)^2$

$\Rightarrow a = \frac{10 \times 2}{5 \times 5} = \frac{4}{5}$

$\Rightarrow a = \frac{4}{5} m/s^2$

$\therefore\ \mu_k = \frac{15 - 2.5 \times 4/5}{2.5} = 0.52$

16. C

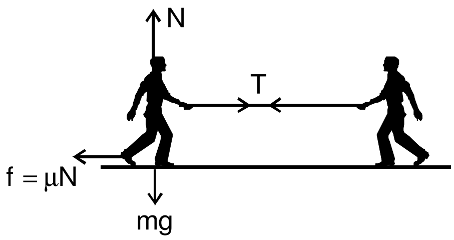


$f_1 = 0.2 \times 40 = 8$ N
$f_2 = 0.1 \times 90 = 9$ N

Max. acceleration for system $a = \frac{8}{4} = 2\ m/s^2$

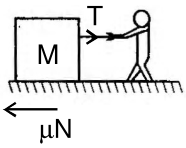
Minimum force needed to cause system to move = 9 N

17. **B**



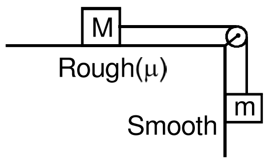
Friction force will more then man will not slip.
N is More

18. A,B,C



$T - \mu N = ma$
As T ↑ man
Can have tendency to move

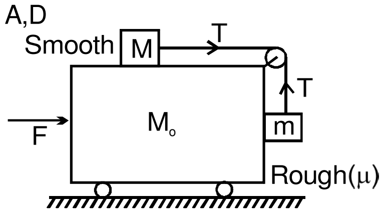
19. **C**



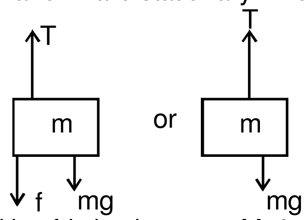
$mg > \mu M g$
$m > \mu M$

20. A,C
(A) $m < \mu M$
system is at rest T = mg
$mg - T = ma \Rightarrow T = mg - ma$
& $T - \mu Mg = Ma$ $\{m > \mu M\}$
$\Rightarrow$ $T = Ma + \mu M g$
on analysing $\mu Mg < T < mg$

21. A,D

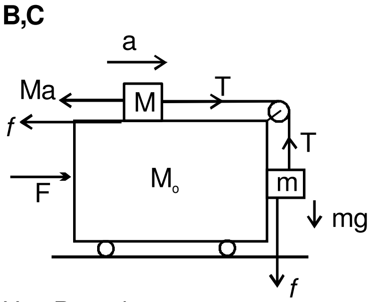


(A) When F = 0
No frictin b/w m & M_0 so system move.
(B) When F is applied then friction develope a range for which M and m are stationary w.r.t M_0, such that



(C) Limiting friction between M_0 & m is μ ma
∴ Dependent on a
(D) When Pseudo acts on M is equal to T
then f = 0

22. **B,C**



Use Pseudo concept
T = Ma ...(1)
$T = f + mg \Rightarrow T = \mu\, ma + ma$ ...(2)
On using (1) & (2)
$Ma = \mu\, ma + mg$

$$a = \frac{Mg}{M - \mu m}$$

(B) then $F = \frac{(M_0 + M + m)mg}{M - um}$

(A) Net Possible becouse T > 0
(only Possible when T = 0 at m block)
$\mu\, ma = mg \Rightarrow a = g/u$
but T > 0, to move the upper block.
(C) When f = 0
T = Ma, T = mg
a = mg/M

$$F = (M_0 + M + m)\ \frac{mg}{M}$$

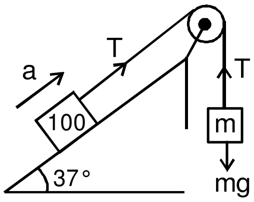
when friction is zero, then only single velue of F for which both M and m are rest w.r.t M_0.

23. A,B

(A) If F = 0, the block connot remains stationary

(B) For one unique value of F, the blocks M and m remain stationary with respect to block M_0.

24. **B,C**



T = mg

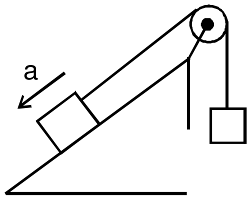
T = 100 mg sin 37° + 0.3 × 100 g cos 37°

[Put g = 9.8]

T = 588 + 235.2

mg = 823.2 ⇒ m = 82.33 = 83 kg

(b)



T + f = ma

T + 235.2 = 588

T = 588 – 235.2 = 352.8

m = 35.28 kg

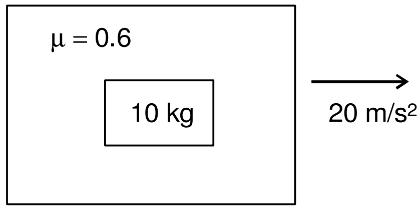
25. B,D

'$_c$ = N (Given)

$\therefore f_c = \sqrt{N^2 + f^2}$

Acceleration to condition f = 0 ⇒ $f_c = N$

26. **A,B,C,D**



(A) Acceleration of box = 20 m/s²

(when consider as system)

Force on Box

F = 200 N

N = 200 N

$f_{max} = \mu N = 0.6 \times 200 = 120$ N

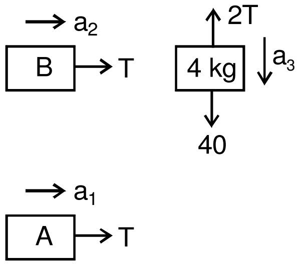
(B) $f_{required} = 100$ N

(C) $f_c = \sqrt{f^2 + N^2} = \sqrt{(100)^2 + (200)^2} = 100\sqrt{5}$ N

EXERCISE – III

SUBJECTIVE PROBLEMS

1.

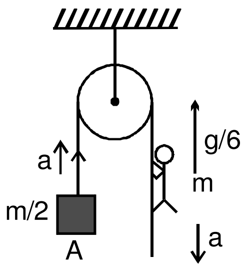


$40 - 2T = 4.\ a_3$ ...(1)

$T = a_1\ T = 2a_2 \Rightarrow a_1 = 2a_2$ ...(2)

$a_3 = \frac{a_1 + a_2}{2}$ ...(3)

2.



$a_{mR} = a_m - a_R$

$a_m = (g/6 - a)$

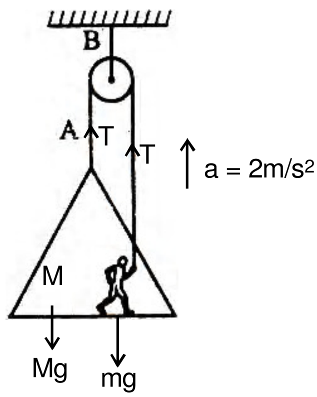
$T - \frac{m}{2}g = \frac{m}{2}a$ ...(1)

$T - mg = m(g/6 - a)$ ...(2)

Eq. (2) – (1)

$a = \frac{4g}{9}$ & $T = \frac{13Mg}{18}$

3.



(i) $M + m = 20$ kg

$(M + m)g = 200$ N

$2T = 200$ N

$T_A = 100$ N

(ii) $2T - (M + m)g = (M + m)\ a$

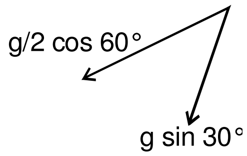
$2T = (M + m)\ (g + a)$

$T = \frac{20(10+2)}{2}$

$T_A = 120$ N

$T_B = 2T_A = 240$ N

4.



$5 = \frac{1}{2} \times \frac{g}{4}.t^2$

t = 2 sec

5. (a) $T_1 = 20\ N = kx_1$

(b) $T - 20 = 2a$

$30 - T = 3a$

On solving $a = 2m/s^2$

$T = 24\ N = kx_2$

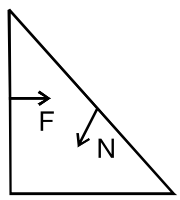
(c) $T - 10 = a$

$20 - T = 2a$

On solving $a = 10/3\ m/s^2$ & $T = \frac{40}{3}\ N = kx_3$

$x_2 > x_1 > x_3$ $\quad x_1 : x_2 : x_3 = 15 : 18 : 10$

6.

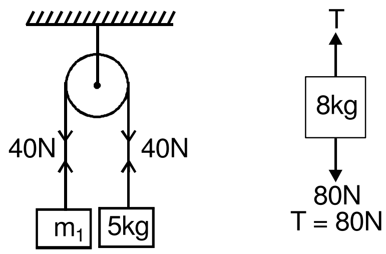


N sin 37° = F

F = 2.5 × 10 × cos 37° × sin 37°

= 12 Newton

7.



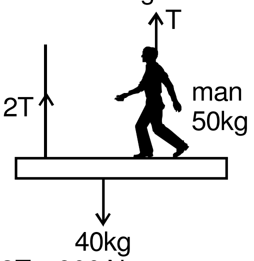
$50 - 40 = 5 \times a$

$a = 2\ m/s^2$

$40 - m_1 g = m_1 \times 2$

$m_1 = \frac{10}{3}$ kg

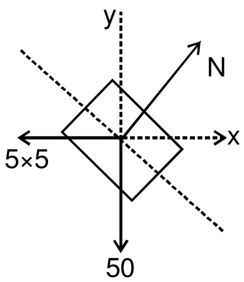
8. Net force diagram



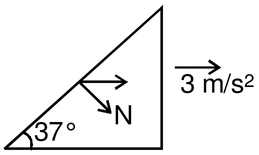
3T = 900 N

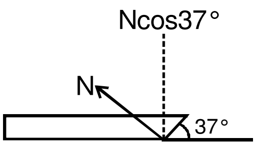
T = 300 N

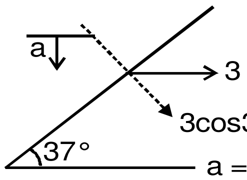
9.



10.







$3\cos 37° = a\sin 37°$

$a = 4 m/s^2$

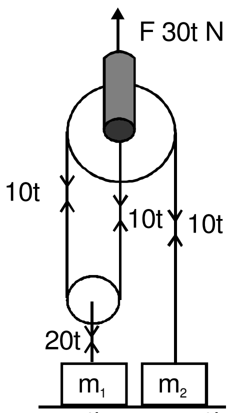
$N \sin 37° = 1 \times 3$

$N \times \frac{3}{5} = 1 \times 3$

N = 5 N

$mg - 5 \cos 37° = m \times 4$

11.



$m_1 = 4kg$ $m_2 = 1kg$

$20\,t = 40 \Rightarrow t = 2$ sec

12. Net force on 40 kg block = $4F_1 - F_2$

so $a_{net} = \frac{4F_1 - F_2}{40}$

at t = 2 sec $F_2 = 10$; $F_1 = 30$; $a_{net} = \frac{11}{4}$ m/sec²

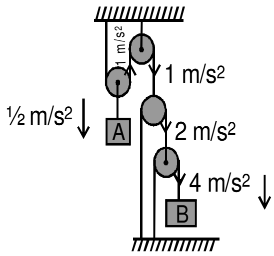
t = 4 sec $F_2 = 20$; $F_1 = 30$; $a_{net} = \frac{10}{4}$ m/sec²

$t = 0 \rightarrow 2$ $v = 1.5 + \frac{11}{4} \times 2 = 7$ m/s

$t = 2 \rightarrow 4$ $v = 7 + \frac{10}{4}.2 = 12$ m/s

v = 12 m/s

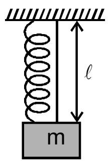
13.



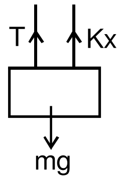
$y = \frac{t^2}{4}$

So $a_A = \frac{1}{2} m/s^2 \downarrow$, $a_B = 4\ m/s^2 \downarrow$

14.



$x = \ell/2$



$T = mg - kx = mg - \frac{k\ell}{2}$

If $K > 2\ mg/\ell$

T = 0

15. $T - m_T\,g = m_T\,a_{cm} = [m_A a_A + m_B a_B + m_c a_c]$

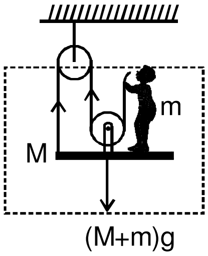
$T = m_T g + m_A\,a_A + m_B a_B + m_C a_C$

$= 330 + 10 \times (-2) + 15 \times 1.5 + 8 \times 0$

$= 330 + 22.5 - 20$

= 332.5 N

16. (a)



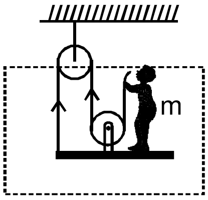
$2T - (m + M)g = (m+M)\,a$

$T = \dfrac{(m+M)(g+a)}{2}$

(b)

$N - (mg + T) = ma$

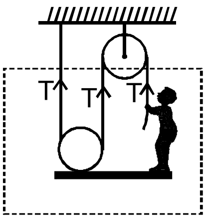
(c)



$2T = mg$

$T = \dfrac{mg}{2}$ (yes)

(d)



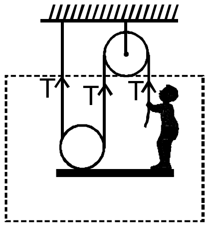
$3T - (m + M)g = (m + M)a$

$T = \dfrac{(m+M)(g+a)}{3}$

(e)

$N + T - mg = ma$

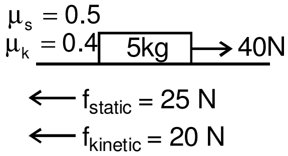
(f)



$3T - mg = 0$

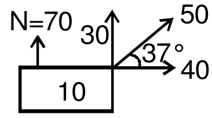
$T = \dfrac{mg}{3}$ (yes)

17. (A)



So $a = \dfrac{40 - 20}{5} = 4 m/s^2$

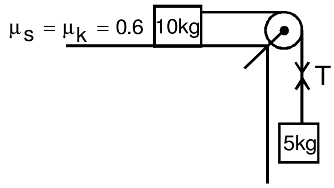
(B)



$\mu_s = 0.5$
$\mu_k = 0.4$
$f_{static} = 35$ N
$f_{kinetic} = 28$ N

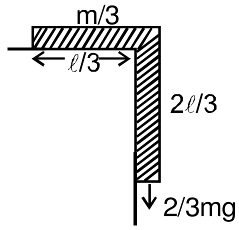
$a = \dfrac{40 - 28}{10} = 1.2 m/s^2$

(C)



$a = 0$ m/s^2

18.



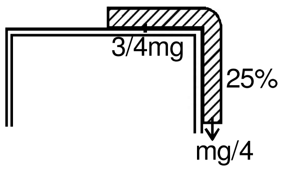
If friction coefficient is μ then

$\mu \dfrac{m}{3} g = \dfrac{2}{3} mg$

$\mu = 2$

19. Do Yourself

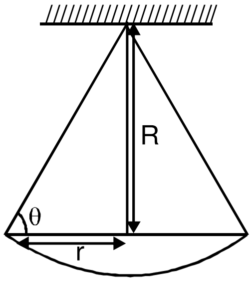
20.



$$\frac{3}{4}\mu mg = mg/4$$

$$\mu = \frac{1}{3} = 0.33$$

21. θ = angle of Repose



volume of cone = $\frac{1}{3}\pi r^2 h$

h = r tan θ

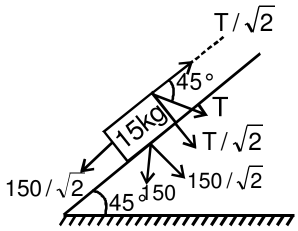
and for just sliding

mg sinθ = μmg cosθ

$$\tan\theta = \mu = \frac{h}{r}$$

$$v = \frac{1}{3}\pi\mu r^3$$

22.



T = 50 N

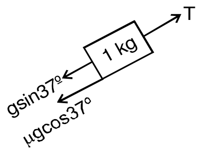
N = 200 / $\sqrt{2}$

$$f = \mu\frac{200}{\sqrt{2}}$$

$$\frac{150}{\sqrt{2}} - \frac{50}{\sqrt{2}} = \frac{\mu \times 200}{\sqrt{2}}$$

$$\mu = \frac{1}{2}$$

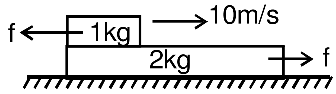
23.



mg = T = g sin 37° + μ g cos 37°

m = 1kg

24.



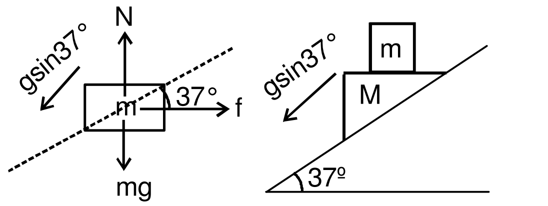
f = 5 N

$v_2 = v_1$

$$\Rightarrow \frac{5}{2}\times t = 10 - 5t$$

$$t = \frac{4}{3}\text{sec}.$$

25.



mg sin 37° – N sin 37° – f cos 37° = mg sin 37°

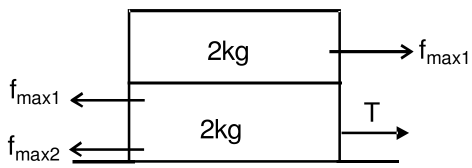
N. sin 37° = – f cos 37°

$$N.\ \frac{3}{5} = -\mu.\ N.\ \frac{4}{5}$$

$$N.\ \frac{3}{5} = -\mu.N.\ \frac{4}{5}$$

$$\mu = \frac{3}{4}$$

26.



$f_{max\ 1}$ = 20 × 0.6 = 12 N

$f_{max\ 2}$ = 40 × 0.4 = 16 N

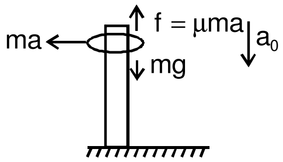
T – 12 – 16 = 2 × a

T – 28 = 12

T = 40 N

[12 = 2a, a = 6m/s^2]

27.



w.r.t train

$a_0 = g - \mu \times 4$

$= 10 - 2$

$= 8\ m/s^2$

$1 = \frac{1}{2} \times 8 \times t^2$

$t = 2$ sec

28. $2t = \mu m g$

$t_0 = 5$ sec $\qquad a = \frac{d^2x}{dt^2}$

5 sec < t < 10 sec $\qquad a = (t - 5)$

29. $f = 0.8 \times 50 = 40$ N

$50 - T - 40 = 5a$

$T - 40 = 4a$

$a = -$ ve

$\therefore$ this direction is not possible

$40 - T = 4a$

$T - 90 = 5a$

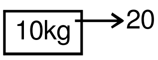
$a = -$ ve $\qquad \therefore$ this direction of not possible.

$\therefore a = 0$

$\therefore f = 10\ \hat{i}$

30. Do your self

31.



$a = 2\ m/s^2$

$F = 15 \times 2 = 30$ N

EXERCISE – IV TOUGH SUBJECTIVE PROBLEMS

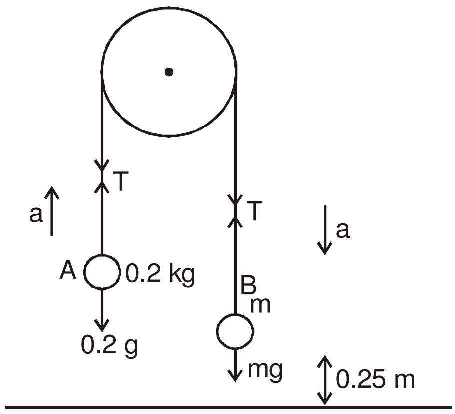
1. $T - 0.2\,g = 0.2\,a$ ...(1)

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

adding (1) and (2) $mg - 2 = (m + 0.2)\,a$

$$a = \frac{mg-2}{m+0.2} \quad ...(3)$$

Particle B moves downwards with a acceleration so



$$0.25 = \frac{1}{2}at^2$$

$$0.25 = \frac{1}{2}\left(\frac{mg-2}{m+0.2}\right)(0.5)^2$$ [Given t = 0.2 sec]

$\Rightarrow \quad m = 0.3\text{kg}$

Now put value m = 0.3 kg is eq. (2) & (1)

We get $a = 2\text{m/sec}^2$

$T = 2.4$ N

When B touch the ground at this time velocity of partical A is

$v = 2(0.5) = 1\text{m/s}^2$

It move upward untill the velocity of A is zero.

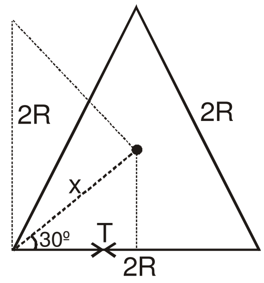
$\Rightarrow \quad 0 = 1 - gt$

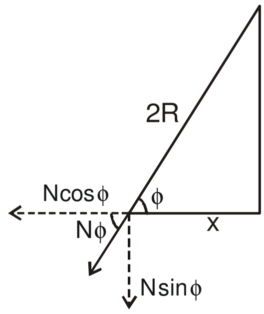
$t = 0.1$ sec

B remain at rest on ground for $t' = 2t$

$t' = 2 \times 0.1 = 0.2\text{sec}$

2.





$x\cos\theta = R$

$x = \frac{2R}{\sqrt{3}}$ $\qquad \cos\phi = \frac{x}{2R} = \frac{1}{\sqrt{3}}$

Now $\quad 3N\sin\phi = mg$

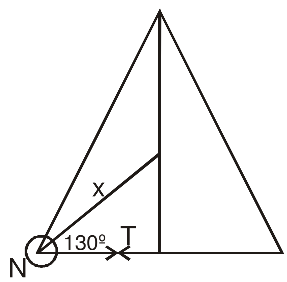
$$\Rightarrow \quad N = \frac{2\sqrt{6}}{3\sin\phi} = \frac{2\sqrt{6}}{3.\frac{\sqrt{2}}{\sqrt{3}}}$$

N = 2N

Now

$2(T\cos 30^\circ)\cos\phi = N$

$$2 \times T \times \frac{\sqrt{3}}{2}\left(\frac{1}{\sqrt{3}}\right) = 2$$



T = 2N

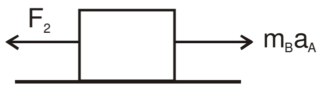
3. First find out acceleration of A so for this

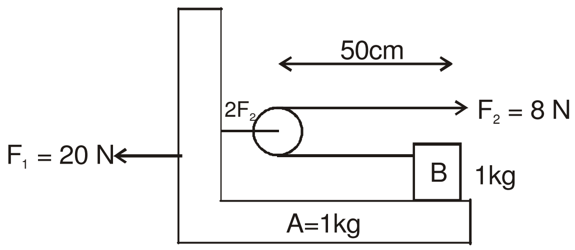
$\Rightarrow \quad a = 20 - 2F_2 = 20 - 2\times 8$

$a_A = 4\ m/s^2$

Now use pseudo concept (in which A is non inertial frame)

$\Rightarrow$





$\Rightarrow \quad 8 - 4 = 4\,m/s^2$

Now $\dfrac{50}{100} = \dfrac{1}{2}\times 4\times t^2$

$t = \dfrac{1}{2} = 0.5\,sec$

4. for man of mass m_1 $\quad a_{m_1G} = a_{m_2R} + a_{RG}$

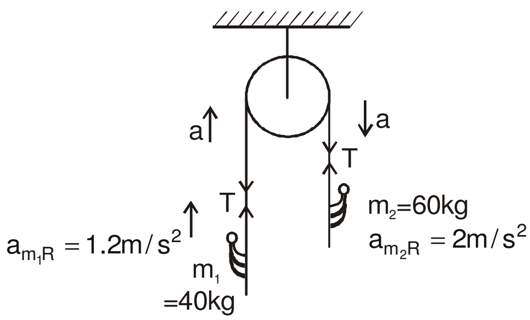
$a_{m_1G} = (1.2 + a)$

for man of mass m_2 $\quad a_{m_2G} = a_{m_2R} + a_{RG}$

$= (2 - a)$

So now

$T - mg = m_1(1.2 + a)$ ...(1)



$T - mg = m_2(2 - a)$

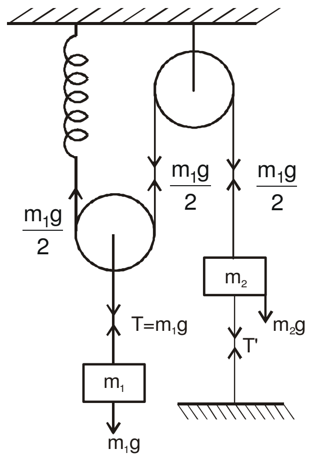
...(2)

Solve eq. (1) & (2) and put $m_1 = 40$ kg $\quad m_2 = 60$ kg

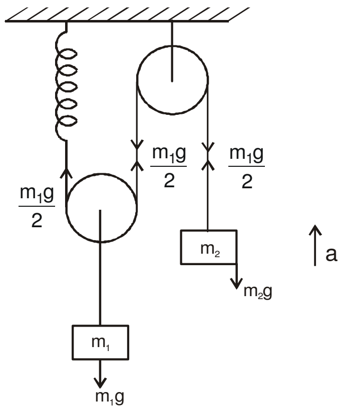
you get $\quad a = 2.72\ m/s^2$

$T = 556.8$ N

5. Initial $\quad m_1 > 2m_2$



after cutting

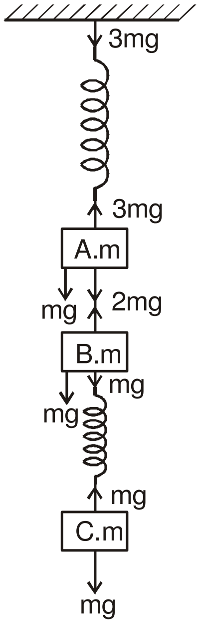


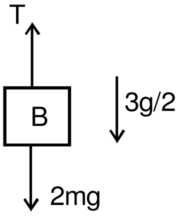
$\Rightarrow \quad m_2a = m_1g/2 - m_2g$

$\Rightarrow \quad a = \left(\dfrac{m_1 - 2m_2}{2m_2}\right)g \quad m/s^2 \uparrow$

6 **initial**

After cutting

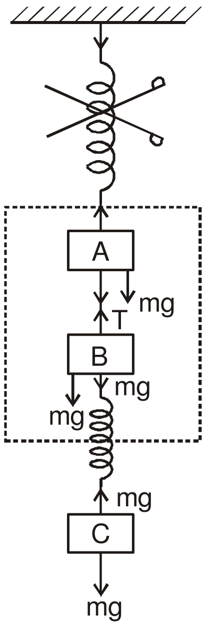




$2mg - T = 3mg/2$

$T = 2mg - 3mg/2$

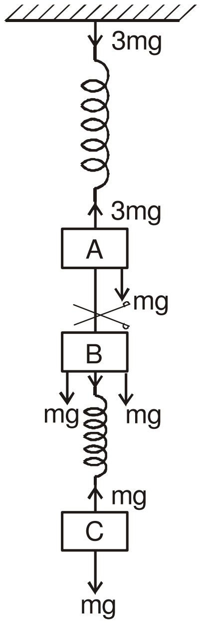
$= mg/2$



$a_A = a_B$

$= \frac{3mg}{2m} = 1.5g$

(b)

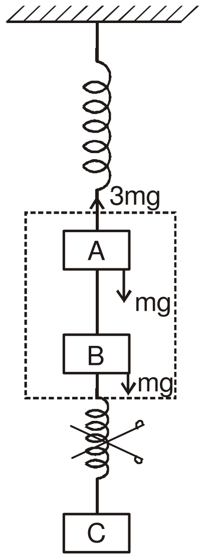


$a_A = \frac{3mg - mg}{m}$

$= 2g \uparrow$

$a_B = \frac{2mg}{m} = 2g \downarrow$ (c)

$a_C = 0, \; T = 0$



$a_A = a_B$

$= \frac{3mg - 2mg}{2m} = \frac{g}{2} \uparrow$

$T - mg = mg/2$

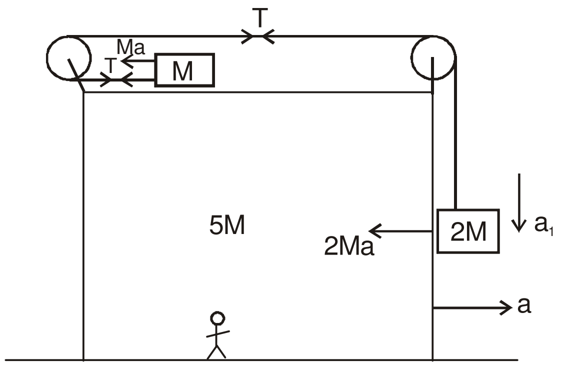
$T = 3mg/2$

$a_c = g$

7 $\Rightarrow \quad T + Ma = Ma_1$ ...(1)

$2Mg - T = 2Ma_1$ ...(2)

$\{N = 2Ma\} \quad T - 2Ma = 5Ma$



$T = 7Ma$ ...(3)

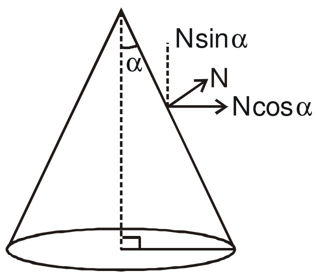
Using eq. (1), (2), (3)

we get $a = \frac{2}{23} g$

8. $\int dN \sin\alpha = \int dmg$ ...(1)

$\sum 2T.\sin d\theta = N\cos\alpha$

$\sum 2T\, d\theta = N\cos\alpha$



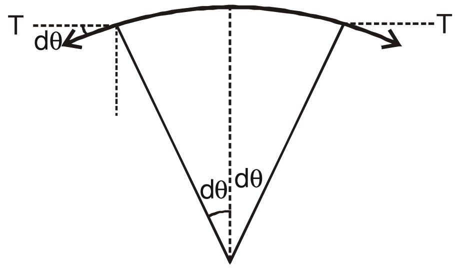
$\sum 2T\left(\frac{dx}{R}\right) = N\cos\alpha$

$2T(\pi R / R) = N\cos\alpha$

$2\pi T = N\cos\alpha$ ...(2)

from (1) & (2)

$\Rightarrow \quad T = \frac{\cos\alpha mg}{2\pi}$



15 ________ 10 cm

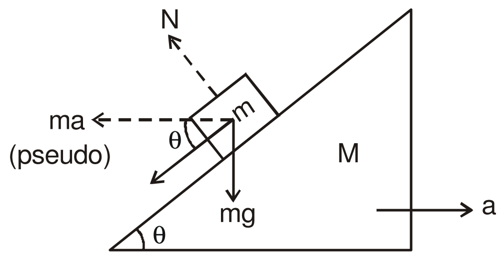
$\Rightarrow$ T ________ $\frac{10}{15} \times T$ cm

$\frac{10}{15} \times \frac{\cot\alpha mg}{2\pi} = 1cm$

9

(a) Using pseudo concept

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



When $N = 0$

$\Rightarrow \quad a = g\cot\theta$

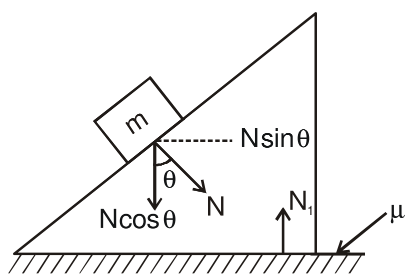
(b)

$\Rightarrow \quad N_1 = N\cos\theta + Mg$

$\Rightarrow \quad f = \mu N_1$

$= \mu(N\cos\theta + Mg)$

$\because \quad N = mg\cos\theta$



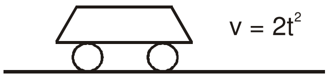
$\Rightarrow \quad f = \mu(mg\cos^2\theta + Mg)$

Wedge not move when $f = N\sin\theta = mg\cos\theta\sin\theta$

$\Rightarrow \quad \mu(mg\cos^2\theta + Mg) = Mg\cos\theta\sin\theta$

$$\mu = \frac{Mg\cos\theta\sin\theta}{Mg\cos^2\theta + Mg}$$

10 at t = 1 sec it start slipping so.
at this moment acceleration of block = $\mu_s g$
t = 1 sec $\quad$ a = 4(t) = 4(1) = 4 m/s^2
$\Rightarrow \quad 4 = \mu_s g \quad \Rightarrow \quad \mu_s = 0.4$



after that at t = 1 sec $\quad$ v = 2m/sec.
at $\quad$ t = 2sec $\quad$ v = 8 m/sec
after wards $\quad$ a = 0 $\quad$ so at $\quad$ t = 3 sec $\quad$ v = 8 m/sec

$a_\mu = \mu_k g$ (sliding)

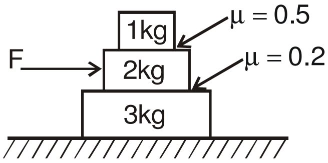
v = u + at

$\Rightarrow \quad 8 = 2 + 10\mu_k(2)$

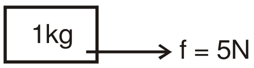
$\Rightarrow \quad \dfrac{6}{10\times 2} = \mu_k$

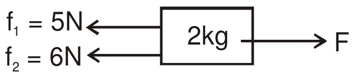
$\mu_k = 0.3$ sec

11

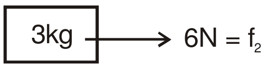


force on 1kg block

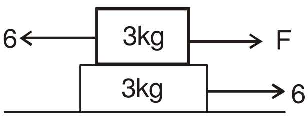




force on 3 kg block

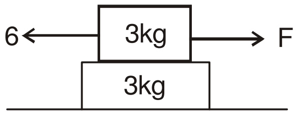


maximum acceleration of block of mass 1 kg = 5/1 = 5 m/s^2
maximum acceleration of block of mass 3 kg = 6/3 = 2 m/s^2
So block move together only when acceleration of all the block is not greater than 2 m/s^2



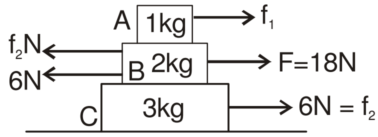
F – 6 = 3 × 2 $\quad \Rightarrow \quad$ F = 12 N

Now sliding starts in both block when acceleration is greater than equal to 5 m/s^2

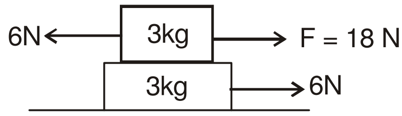


F – 6 = 3 × 5 $\quad \Rightarrow \quad$ F = 21 N

When F = 18 N block 1 kg & 2 kg move together.



So



a_c = 6/3 = 2 m/s^2 $\quad$ f = 6 N
common acceleration = 18 – 6 = 3 × a $\quad \Rightarrow$ a = 4m/s^2

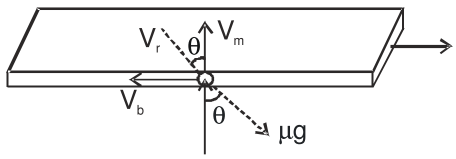
$\Rightarrow$

f_i = 4N

12 $V_r = \sqrt{V_m^2 + V_b^2} \quad \Rightarrow \quad 0 = V_r - \mu g\, t$

$\Rightarrow \quad t = \dfrac{\sqrt{V_m^2 + V_b^2}}{\mu g}$

after time t particle starts slide



$\because \quad \tan\theta = \dfrac{V_b}{V_m}$

$$x = \frac{1}{2}a_x t^2 = \frac{1}{2}\mu g\sin\theta\left(\frac{\sqrt{V_m^2 + V_b^2}}{\mu g}\right)^2$$

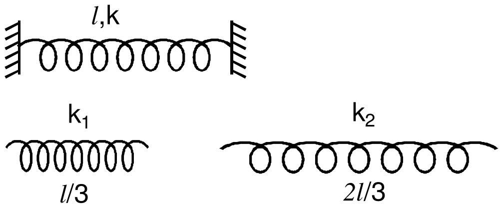
$$x = \frac{V_b}{2\mu g}\sqrt{V_m^2 + V_b^2}$$

In this way $\quad y = \dfrac{V_m}{2\mu g}\sqrt{V_m^2 + V_b^2}$

EXERCISE – V

JEE QUESTIONS

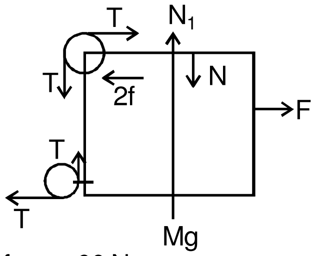
1. B



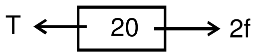
$\Rightarrow$ $K.\ell = K_1 \dfrac{\ell}{3} = K_2 \dfrac{(2\ell)}{3}$ = const.

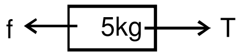
$\Rightarrow$ $K_2 = \dfrac{3}{2}K$

2.



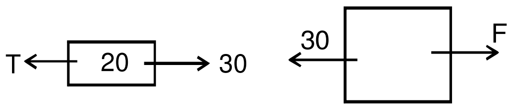
$f_{1\,max} = 60$ N
$f_{2\,max} = 15$ N





F – 2f = 5

It means friction at m_1 is static and m_2 is kinetic means f = 15 N



F – 3= = 50.a ...(i)
30 – T = 20. a ....(2)
T – 15 = 5a ...(3)
On solving F = 60 N T= 18 N; a = 3/5 m/s^2

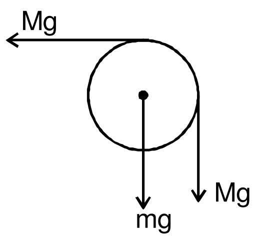
3. C

$2mg \cos\theta = \sqrt{2}$ mg

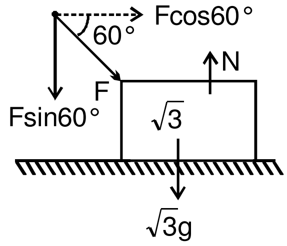
$\theta = 45°$

4. **D**

$\sqrt{((M+m)g)^2 + M^2}\ g$



5. A



$N = \sqrt{3}\,g + F\dfrac{\sqrt{3}}{2}$

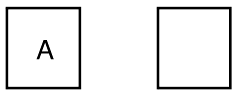
$f = \mu N = \dfrac{F}{2}$

$\Rightarrow$ $2 \times \dfrac{1}{2\sqrt{3}} \times \sqrt{3}(g + F/2) = F$

$\Rightarrow$ F = 2g = 20 N

6.

w.r.t B



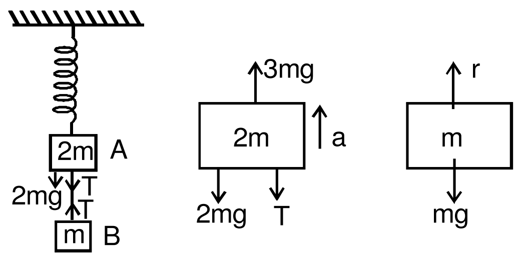
$0.1 \times 10 \times \cos 45°$

$a_{AB} = \dfrac{1}{\sqrt{2}} m/s^2$

$\sqrt{2} = \dfrac{1}{2} \times \dfrac{1}{\sqrt{2}} t^2$

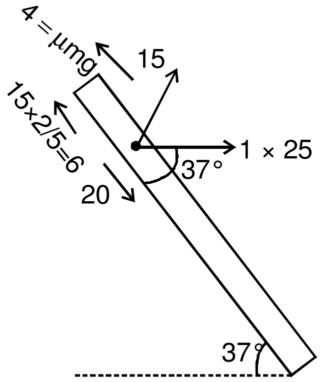
t = 2 sec

7. B



when string cut T = 0
$\Rightarrow ma_2 = mg$
$a_2 = g$
$3mg - 2\,mg = 2ma_{\perp}$
$a_{\perp} = g/2$

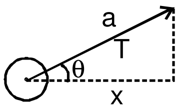
8.

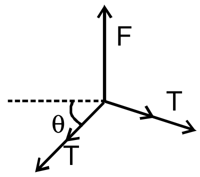


$20 - 6 - 4 = 1 \times a$

$a = 10 \text{ m/s}^2$

9. B





$T \cos\theta = ma$ $\quad\quad$ $F = 2T \sin\theta$

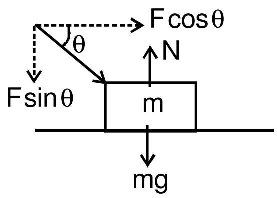
$$a = \frac{F}{2\sin\theta} \cdot \frac{\cos\theta}{m} = \frac{F}{2m}\cot\theta$$

$$a = \frac{F}{2m} \cdot \frac{x}{\sqrt{a^2 - x^2}}$$

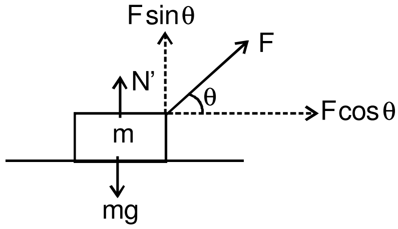
10. B

Due to inertia particles left at their places when we pull the clock suddenly.

11. B



$[N = mg + F \sin\theta]$



$[N' = mg - F \sin\theta]$

$f = \mu N$

12. **B**

13. **A**

14. $mg \sin\theta + \mu mg \cos\theta = 3$

$(mg \sin\theta - \mu mg \cos\theta)$

$\sin\theta = \cos\theta$ at 45°

$1 + \mu = 3 (1 - \mu)$

$4\mu = 2 \Rightarrow \mu = 0.5$

$N = 10$

$\mu = 5$