JEE-MAIN

TOPIC

N.L.M, FRICTION

SOLUTIONS

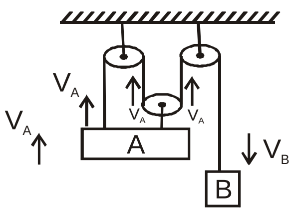
NEWTONS LAWS OF MOTION, FRICTION

Exercise-I

. **(B)**

2. **(B)**
Action and Reaction are equal and opposite

3. **(C)**
V = Constant a = 0
$F_{net} = 0$

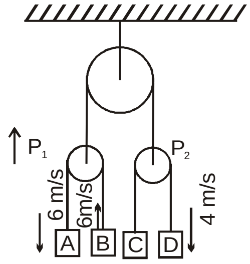


P - 300 = 0
P = 300N
2000-2S = 0
$\Rightarrow$ S = 1000N

4. **(A)**
$-v_A - v_A - v_A + v_B = 0$
From constrained
$-5-5-5+v_B = 0$
$v_B = 15$ m/s $\downarrow$

5. **(A)**
From constrained
$+2 - v_B - v_B + 1 = 0$
$v_B = 3/2 \, m/s \uparrow$

6. **(B)**

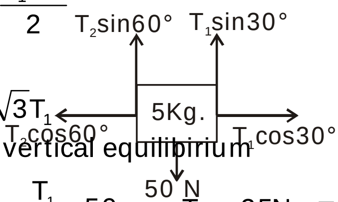


$$v_{p_1} = \frac{-6+6}{2} = 0$$

$\Rightarrow |v_{p_1}| = |v_{p_2}| = 0$
$v_D = -v_C$
$\therefore$ velocity of C is
= 4 m/s

7. **(B)**
From horizontal equilibirium

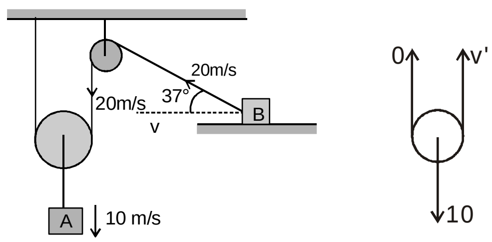
$$\frac{T_2}{2} = \frac{T_1\sqrt{3}}{2}$$



$T_2 = \sqrt{3} T_1$
From vertical equilibirium

$$\frac{T_2\sqrt{3}}{2} + \frac{T_1}{2} = 50 \quad \Rightarrow T_1 = 25\text{N}, \; T_2 = 25\sqrt{3}\text{N}$$

8. **(A)**

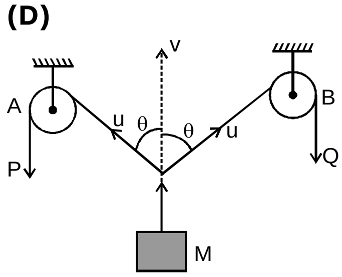


$$\frac{v'+0}{2} = 10$$

Here Resultant vel. of block 'B' is v
So component of resultant in the direction of v' is
v cos 37° = v' , v cos 37° = 20

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

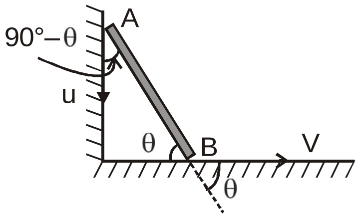
9. **(D)**



From constrained
The resultant vel. of the Block M is v in vertical direction.
So component of 'v' is direction of u is

$v \cos\theta = u \Rightarrow v = \dfrac{u}{\cos\theta}$

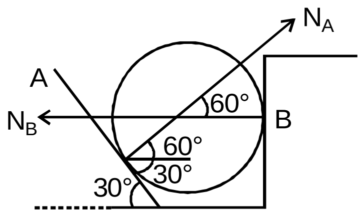
10. (C)



From constrained Motion - (along the rod vel of each particle is same so component of the velocity in the direction rod is)
$v \cos\theta = u \sin\theta$
$v = u \tan\theta$

11. (B)
Component of force
in y direction is $N_A \sin 60° = 500$

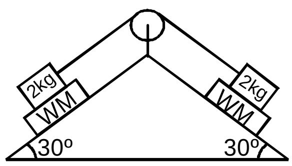
$N_A = \dfrac{1000}{\sqrt{3}}$



Component of force
in x direction is

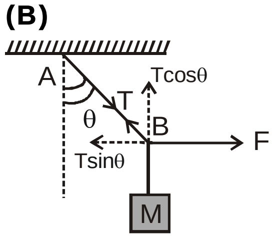
$N_A \cos 60° = N_B \Rightarrow N_B = \dfrac{500}{\sqrt{3}}$

12. (A)
Weighing Machine
always Measure
Normal froce



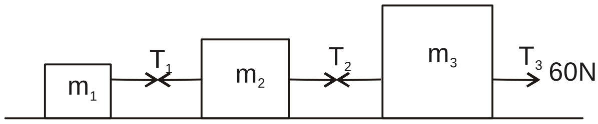
$N = 20 \cos 30° = 10\sqrt{3}$

13. (B)



$T \cos\theta = Mg \quad , \quad T = \dfrac{Mg}{\cos\theta}$

14. (C)

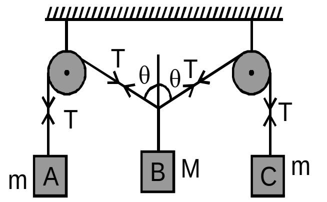


Take a system $(m_1 + m_2 + m_3)$
$T_3 = (m_1 + m_2 + m_3)\, a$
$60 = 60\, a$

$a = \dfrac{60}{60} = 1 m/s^2$

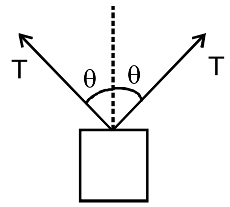
For body m_3
$T_3 - T_2 = m_3 a$
$60 - T_2 = 30$
$T_2 = 30N$

15. (B)



$T = mg$ ...(i)
$2T \cos\theta = Mg$ ...(ii)
From equation (i) and (ii)
$\Rightarrow 2mg \cos\theta = Mg$
θ always > 0 so $M < 2$ m

16. (C)



(A) $2T = W$, $T = W/2$
(B) $W = 2T \cos\theta$

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

In (C) option θ is greater so
$\sec\theta \uparrow$, $T \uparrow$
If tension is more then string may be break-

17. (B)

$F = \dfrac{dP}{dt} \Rightarrow \int F dt = \Delta P$

$\Rightarrow \int_0^8 F dt = 0$

$\Delta P = 0$

18. (C)

$\vec{F} = \dfrac{d\vec{P}}{dt}$, $\quad \vec{F} = \dfrac{d}{dt}(2\cos t\,\hat{i} + 2\sin t\,\hat{j})$

$\vec{F} = -2\sin t\,\hat{i} + 2\cos t\,\hat{j}$

$\vec{P} = 2\cos t\,\hat{i} + 2\sin t\,\hat{j}$

$\vec{F}.\vec{P} = FP\cos\theta$

$-4\cos t\sin t + 4\cos t\sin t = FP\cos\theta$

$\cos\theta = 0$

$\theta = 90°$

19. **(A)**
Relative acceleration Man and car is zero during the journey
N = 0

20. **(A)**

At t = 2 sec $\Rightarrow a = \dfrac{10}{2} = 5\ m/s^2$

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

At t = 4 sec

a = 0 So F = 0

$\Rightarrow$ At t = 6 sec,

$\Rightarrow$ a = – 5 m/s^2 $\Rightarrow$ F = – 0.25 N

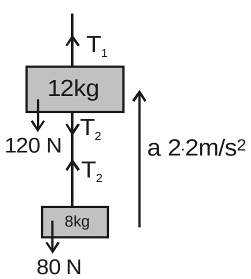
21. **(B)**

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

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

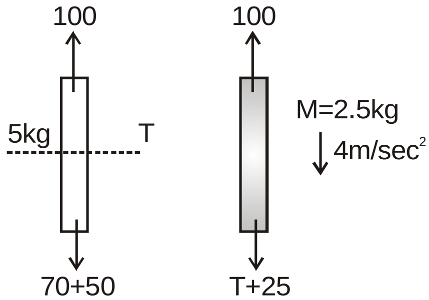
$N_2 = \dfrac{2mF}{3m} = \dfrac{2}{3}F \Rightarrow \therefore N_1 : N_2 = 1 : 2$

22. **(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/s^2]



T_1 = 240 N $\Rightarrow$ T_2 = 96 N

23. **(B)**



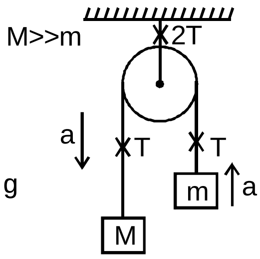
120 – 100 = 5a ....(i)

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

T + 25 – 100 = 2.5 × 4 ....(ii)

T = 85 N

24. **(C)**
T – mg = ma ...(1)
Mg – T = Ma ...(2)
from (1) and (2)



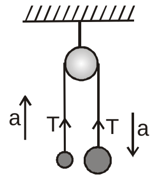
$a = \left(\dfrac{M-m}{M+m}\right)g$

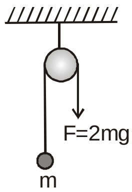
Put M >> m $\Rightarrow$ a = g

$\therefore$ T = 2 mg,

2T = 4mg

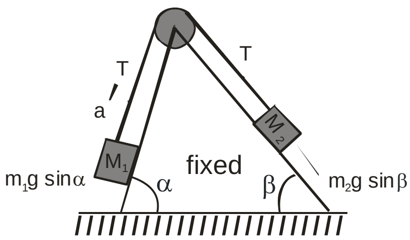
25. **(C)**
Case (i)
T – mg = ma
2mg – T = 2ma
On solving
a = g/3
case (ii) here F = T





T – mg = ma
T = 2 mg , a = g
On comparing a of case of (i) < case of (ii)

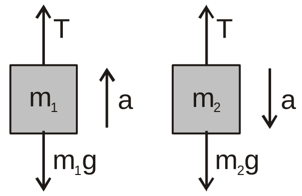
26. **(C)**



Let $M_1 > M_2$
M_1 g sin α – T = M_1 a ...(i)
T – M_2 g sin β = M_2 a ...(ii)

On solving T = $\dfrac{M_1M_2(\sin\alpha + \sin\beta)g}{M_1 + M_2}$

27. **(C)**



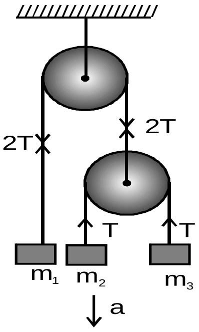
$T - m_1g = m_1a$ ....(i)
$m_2g - T = m_2a$ ....(ii)
On solving equation (i) and (ii)

$$a = \left(\frac{m_2 - m_1}{m_1 + m_2}\right) g$$

28. **(B)**
Acceleration of B and C is sance so they can be treated as a system. a = (2m - m)

$g = \frac{g}{3}$
mg - T = mg
T = 2mg/3 = 40/3 ≈ 13N

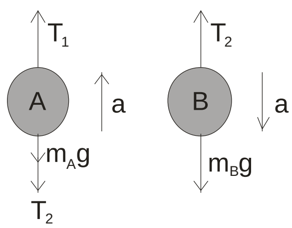
29. **(C)**



$2T = m_1 g$ ...(1)
$m_2g - T = m_2a$ ...(2)
$T - m_3g = m_3 a$ ...(3)
on solving

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

30. **(A)**



$$T_1 - T_2 - m_Ag = m_Aa$$

$$T_2 - m_Bg = m_Ba$$

$$T_1 - (m_A + m_B)g = (m_A + m_B)$$

$$T_2 = m_B(a + g)$$

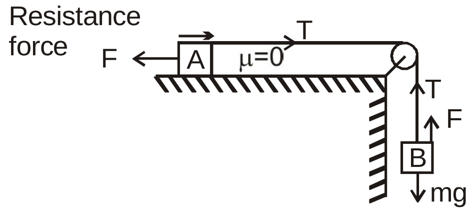
$$\frac{T_1}{T_2} = \frac{m_A + m_B}{m_B}$$

31. **B**

$$T = \frac{2m_1m_2g}{(m_1 + m_2)} \Rightarrow T = \frac{2 \times 5 \times 1 \times 10}{6} = \frac{50}{3}$$

$2T = \frac{100}{3} \approx 33.3\text{kg}$
The spring balance reads
2T = 33.33kgwt < 60kgwt

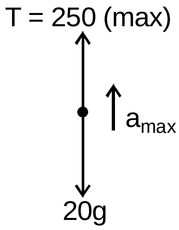
32. **(B)**



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

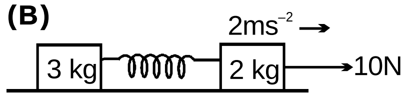
$T = \frac{mg}{2}$

33. **(D)**

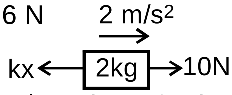


$T_{max} = m_{max}g$
= 25 × 10 = 250
$250 - 200 = 20\ a_{max}$
$a_{max} = 2.5\ m/s^2$

34. **(B)**

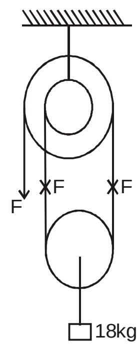


10 – kx = 2 × 2
kx = 6 N



∴ Acceleration of 3 kg = $\frac{6}{3}$ = 2 m/s²

35. **(B)**
18kg at rest => 180 = 2F
F = 90N



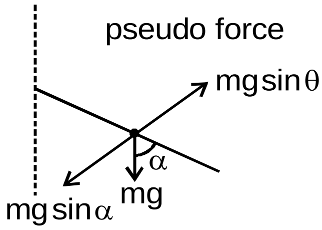
36. **(C)**
(a) T = mg + ma
(b) T = mg – ma
T = mg

37. **(A)**

$\theta = \downarrow \quad \Rightarrow \quad \sin\theta\downarrow$

$mg\sin\theta\downarrow$

38. **(A)**

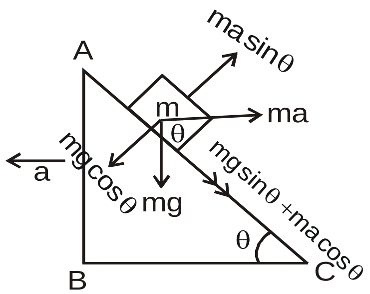


From trolley frame

$mg\sin\alpha = mg\sin\theta$

$\theta = \alpha$

39. **(C)**



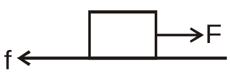
Mass m falls freely

$N = 0$

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

$a = g\cot\theta$

40. **(A)**



$F < f_{smax}$

friction=F

For $F > f_{max}$

friction constant

41. **(A)**

42. **(D)**

$m_A g\sin 30 = \mu m_A g\cos30$

$m_B g\sin40 = \mu m_B g\cos40$

Does not depend on mass so all three are possible.

43. **(C)**

$v = u + at \quad \Rightarrow \quad a_A = -\mu g$

$a_B = -\mu g \quad \Rightarrow \quad a = \text{same} \quad \Rightarrow \quad u = \text{same}$

Time taken to stop is also same

Does not depend on mass.

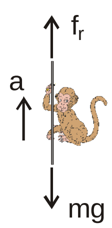
44. **(A)**

Monkey is moving up due to friction force

$f_r - mg = ma$

$f_r = m(a+g)$

towards up.



45. **(B)**

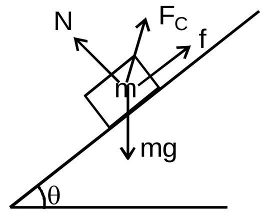
$f_{max} > mg\sin\theta$

$\theta\uparrow \sin\theta\uparrow$

at this condition block remains rest when

$mg\sin\theta > f_{max}$

sliping slant



For θ < angle of repose

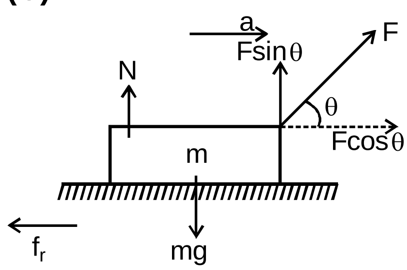
$F_c = mg$

For θ > angle of repose

as $\theta\uparrow \quad f = \mu mg\cos\theta\downarrow$

$N = mg\cos\theta\downarrow$

46. **(C)**



$F\sin\theta + N = mg$

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

$f_r = \mu N \quad \ldots(2)$

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

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

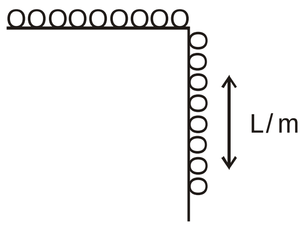
$$a = \frac{F\cos\theta - \mu(mg - F\sin\theta)}{m}$$

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

47. **(B)**

$$\mu\lambda L\left(1 - \frac{1}{n}\right)g = \lambda\frac{L}{n}g$$

$$\mu = \frac{1}{n-1}$$



48. **(A)**

move with a constant velocity

So $\quad ma = m\mu g$ (in negative direction)

$a = \mu g$

$\Rightarrow \quad v^2 - u^2 = 2as \quad v_f^2 = v_i^2 + 2as$

$v = \sqrt{2\mu gs}$ here $v_f = 0$, $v_i = v$

49. **B**

$f_{max} = \mu\, mg\cos\theta$

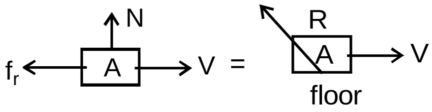
$$f_{s_{max}} = 0.7\times2\times9.8\times\frac{\sqrt3}{2} = 7\sqrt3$$

$mg\sin\theta = 9.8$

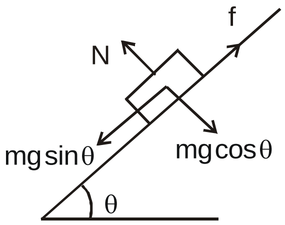
As $mg\sin\theta < f_{smax}$ so friction requird is $mg\sin\theta$.

50. **(C)**

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



51. **(A)**



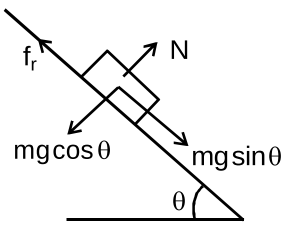
$N = mg\cos\theta$

$f_s \le \mu N$

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

$\mu \ge 1$

52. **(A)**



Let length is ℓ of inclined plane, then

$f_r = \mu N = \mu\, mg\cos\theta$ (when friction is present)

$mg\sin\theta - f_r = ma$

$a = g(\sin\theta - \mu\cos\theta)$

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

Now

$$\ell = \frac{1}{2}at_1^2 = \frac{1}{2}g(\sin\theta - \mu\cos\theta)t_1^2$$

Now $\ell_1 = \ell_2 = \ell$

Without friction

$ma = mg\sin\theta$, $a = g\sin\theta$

$$\ell_2 = \ell = \frac{1}{2}g\sin\theta\, t_2^2$$

$t_1 = 2t_2$, $t_1^2 = t$ and $t_2 = t/2$

$$\frac{1}{2}g(\sin\theta - \mu\cos\theta)t^2 = \frac{1}{2}g(\sin\theta - 0\times\cos\theta)\left(\frac{t^2}{4}\right)$$

$$4(\sin\theta - \mu\cos\theta) = \sin\theta \Rightarrow \mu = \frac{3}{4} = 0.75$$

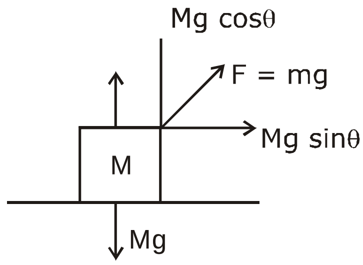
53. **(D)**

$N = Mg - Mg\cos\theta$, $f_{max} = \mu N$

$f_{max} = \mu Mg(1-\cos\theta)$

$Mg\sin\theta \ge f_{max}$

$Mg\sin\theta \ge \mu Mg(1-\cos\theta)$



$\mu \le \sin\theta/(1-\cos\theta)$

$$\mu \le \frac{2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{2\cos^2\frac{\theta}{2}}$$

$$\mu \le \tan\frac{\theta}{2}$$

54. **(A)**

$$V^2 = 2\times g\sin o\times l$$

$$\frac{v^2}{n^2} = 2\times(g\sin\theta - \mu g\cos\theta)l$$

$$\sin\theta\left(1-\frac{1}{n^2}\right) = \mu\cos\theta$$

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

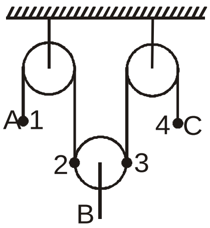
55. **A**

Friction not depend on surface Area so angle remain same.

$\therefore$ Angle = 30°

Exercise-II

1. **(A)**



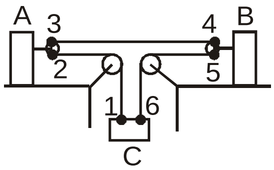
From constrained

$a_1 + a_2 + a_3 + a_4 = 0$

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

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

2. **(A)**



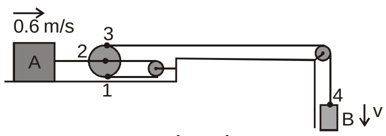
From constrained

$a_1+a_2+a_3+a_4+a_5+a_6 = 0$

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

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

3. **(A)**



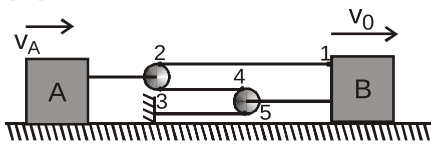
From constrained

$v_1 + v_2 + v_3 + v_4 = 0$

$v - 0.6 - 0.6 - 0.6 = 0$

$V = 1.8\ m/s$

4. **(B)**



From constrained

$v_1 + v_2 + v_3 + v_4 + v_5 = 0$

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

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

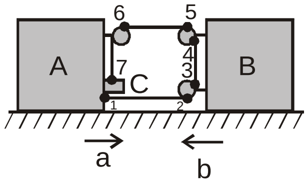
$$= \frac{V_0}{2}\text{(towards Right)}$$

5. **(A)**

Let

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

$C_x = a \rightarrow$



From constrained

$a_1 + a_2 + a_3 + a_4 + a_5 + a_6 + a_7 = 0$

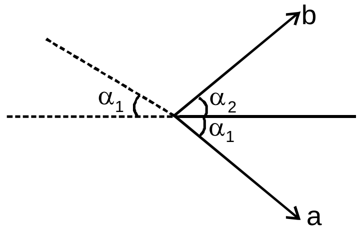
$-a - b + 0 + 0 - b - a + c = 0$

$c_y = (2a+2b)\downarrow$ (By constrain Motion)

In ground frame

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

6. **(A)**

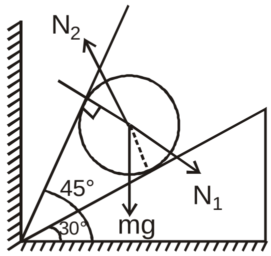


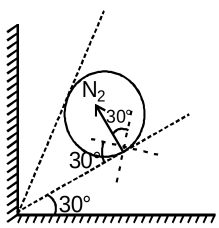
In horizontal direction net acceleration is zero.

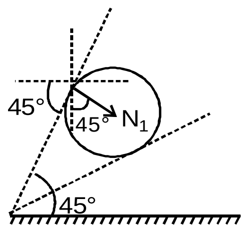
So, $b\cos\alpha_2 = a\cos\alpha_1$

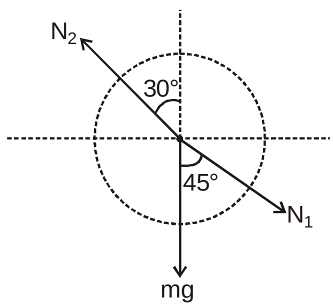
$$b = \frac{a\cos\alpha_1}{\cos\alpha_2}$$

7. **(A)**









In vertical direction

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

In horizontal direction

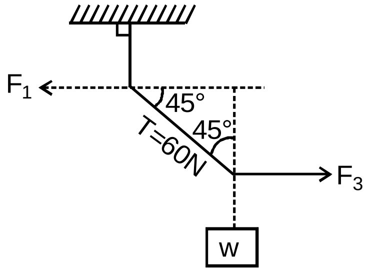
$$\frac{N_1}{\sqrt{2}}=\frac{N_2}{2} \qquad \ldots(2)$$

On solving eq^n (1) and (2) we get N_1 and N_2

N_1 = 96.59 N, N_2 = 136.6 N

8. **(D)** &

9. **(A)**

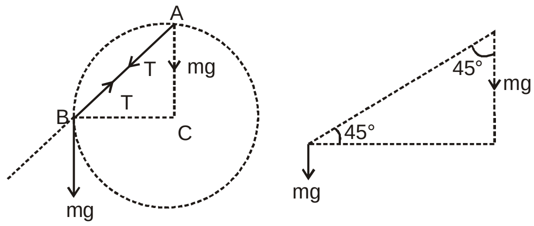


$$F_1 = F_3 = T\cos 45° = 60 \times \frac{1}{\sqrt{2}} = \frac{60}{\sqrt{2}}\text{N}$$

$$w = T\cos 45° = \frac{T}{\sqrt{2}} = \frac{60}{\sqrt{2}}$$

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

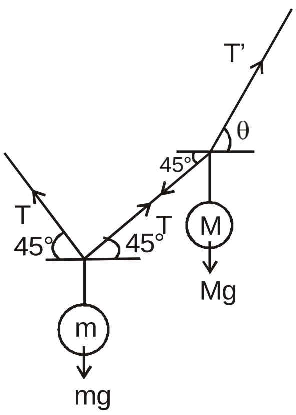
10. **(B)**



Force along the rod is same

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

11. **(A)**



$$\frac{2T}{\sqrt{2}}=mg \Rightarrow T = \frac{mg}{\sqrt{2}} \qquad \ldots(i)$$

$$T'\cos\theta=\frac{T}{\sqrt{2}} \qquad \ldots(ii)$$

$$\Rightarrow T'\sin\theta=\frac{T}{\sqrt{2}}+Mg \qquad \ldots(iii)$$

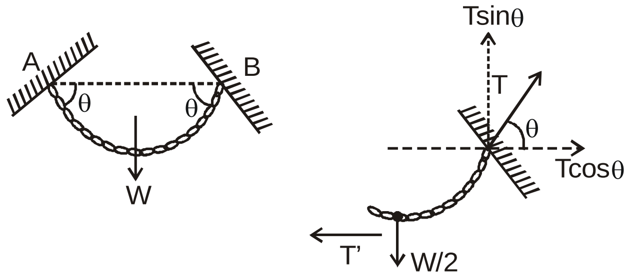
from eq^n (ii) and (iii)

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

from eq^n (i) and (iv) we get

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

12. **(C)**



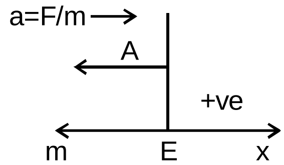
$$T\cos = T' \qquad \ldots(i)$$

$$T\sin\theta = \frac{W}{2} \qquad \ldots(ii)$$

From equation (i) and (ii) we get

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

13. **(A)**



$$A = \frac{1}{2}at^2 \Rightarrow t=\sqrt{\frac{2}{a}A} \Rightarrow \text{Here } a = \frac{F}{m}$$

So

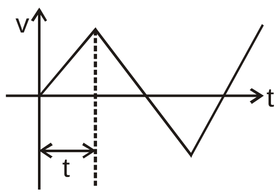
$$\therefore \quad t=\sqrt{\frac{2mA}{F}} \quad \therefore F = ma$$

Total time T = 4t

(for one oscillation/ period of motion)

$$\therefore \; T = 4\left(\sqrt{\frac{2mA}{F}}\right)$$

14. **(A)**



v = u + at

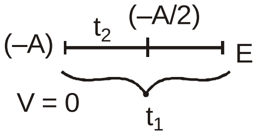
(initial velocity u = 0)

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

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

15. **(B)**

$t_1 \rightarrow$ to reach (– A) to 0



$t_1 = \sqrt{\frac{2mA}{F}} \Rightarrow t_2 \rightarrow$ to reach (–A) to –A/2

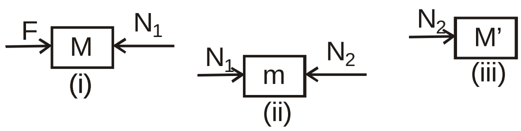
$\frac{A}{2} = \frac{1}{2} a t_2^2$

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

So time to reach $\left(-\frac{A}{2}\right)$ to '0' is

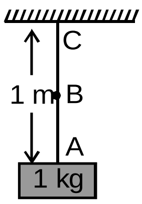
$\Rightarrow t_1 - t_2 = \sqrt{\frac{mA}{F}}(\sqrt{2}-1)$

16. **(B)**



$F - N_1 = Ma$ ....(i)
$N_1 - N_2 = ma$ ....(ii)
$N_2 = M'a$ ....(iii)
From eq^n (i), (ii) and (iii) we get
F = (M + m + M') a
Put in eq^n (i)
$N_1 = (M' + m)\, a$
$\therefore M' > M \quad \Rightarrow N_1 > N_2$

17 **(A)**



Tension at A
$T_A = mg = 10$ N

18. **(B)**

Tension at B

(mass of length AB = $\frac{1}{2}$ Kg)

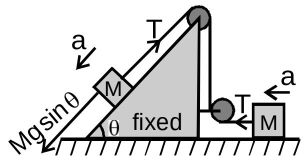
$T_B = 1\,g + 0.5\,g = 15$ N

19. **C**

(mass of length AC = 1 Kg)
Force exertd by support = T_C
= 1 g + 1 g = 20 N

20. **(C)**

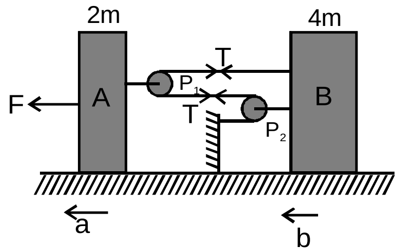
$Mg \sin\theta - T = Ma$ ...(1)
$T = Ma$ ...(2)
Now eq. (1) – eq. (2)



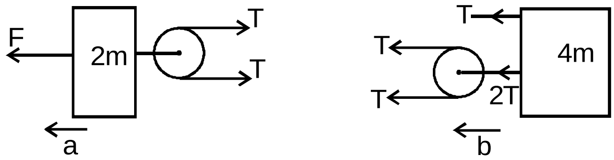
$Mg \sin\theta - 2T = 0$

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

21. **(A)**



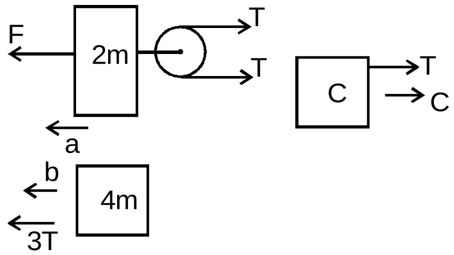
From Constrain equation
2a = 3b ..(1)



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

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

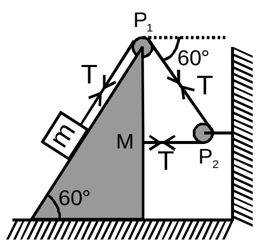
22. **(B)**



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

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

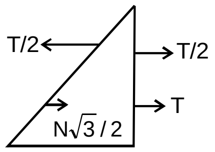
23. **(A)**



From Constrain equation

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

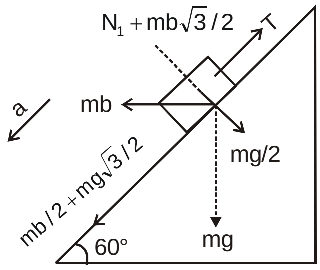
$$a = \frac{3b}{2} \qquad ..(1)$$

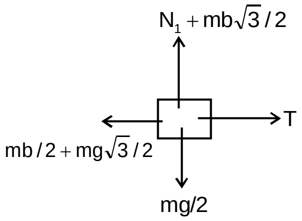


F.B.D of 8 kg block

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

F.B.D of 2 kg block





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

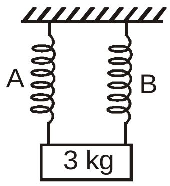
$$N + mb\frac{\sqrt{3}}{2} = \frac{mg}{2} \qquad ...(4)$$

On solving above four equation, we get

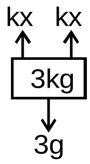
$$b = \frac{30\sqrt{3}}{23}\ m/s^2$$

24. **(A)**

Before cutting



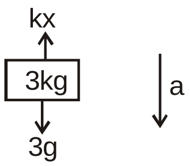
After cutting



$2kx = 3g$

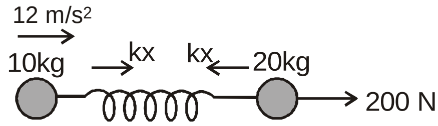
$kx = 15$

after cut the spring A.

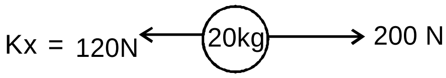


$$a = \frac{3g - kx}{3} = \frac{15}{3} = 5\,m/s^2$$

25. **(B)**

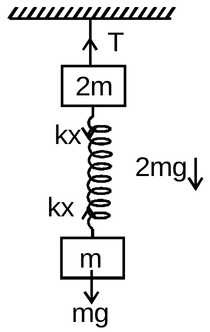


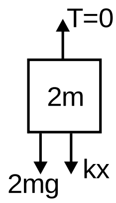
Force on 10 kg block Kx = ma
= 12 × 10 = 120 N
So



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

26. **(B)**





T = Kx + 2 mg ....(i)

Kx = mg ....(ii)

T = 3 mg

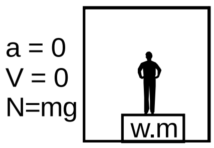
After cutting T = 0

downwards net force

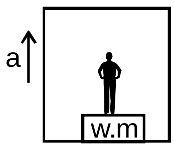
$$\therefore \quad a = \frac{3mg}{2m} = \frac{3g}{2}$$

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

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

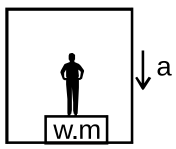


(b)



N = mg + ma

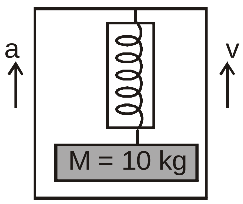
(c)



N = mg – ma

Independent of the direction of velocity.

28. (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 $= 2\text{m/s}^2$
$w = m\ (g + a)$
$= 120$ N

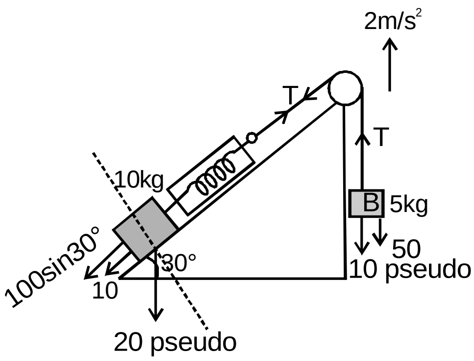
(c) $v = 0$ or $v =$ constant
$a =$ downward $= 2\text{m/s}^2$
$w = m\ (g - a)$
$= 80$ N

29. (A)
S_1 is accelerating frame so psuedo force act opposite to frame acceleration
F_{Pseudo} = mass of analyzing body × acceleration of frame
$= 2(-5\hat{i} - 10\hat{j}) = -10\hat{i} - 20\hat{j}$

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

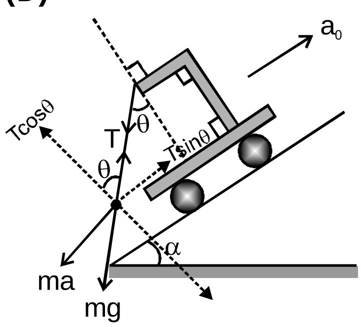
31. (A)
With respect to S_1 frame
Net force = zero.

32. (C)



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

33. (D)

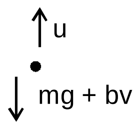


$T \cos\theta = mg \cos(\alpha)$ ....(i)
$T \sin\theta = ma_0 + mg \sin(\alpha)$ ....(ii)
(ii) / (i)

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

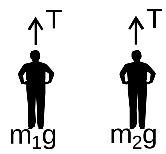
34. (C)
Pulley is fixed from the ceiling
If pulley is fricitonless then there is no effect of mass of pulley.

35. (B)



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

36. (A, B, D)



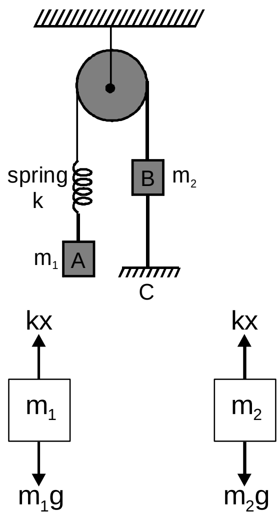
(A) $T = m_1g < m_2g$
∴ Acceleration of m_2 is ↓
(B) $T = m_2 g > m_1g$
∴ acceleation of m_1 is ↑
(C) Masses is different
∴ Not possible
(D) $T - m_1g = m_1a$
$m_2g - T = m_2a$

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

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

38. (B)
If v = 0 or v = constant then frame is inertial.

39. (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

40. **(A, B, C)**

$F = \alpha t$

$ma = \alpha t$

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

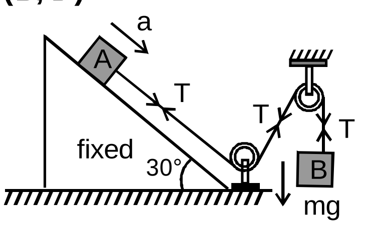
$\dfrac{dv}{dt} = \dfrac{\alpha t}{m} \Rightarrow v = \dfrac{\alpha}{m}\dfrac{t^2}{2}$

$\Rightarrow v \propto t^2$ ...(2) Parabola

on solving (1) & (2)

$v \propto a^2$ Parabola.

41. **(B, D)**



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

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

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

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

42. **(A, B, C)**

Slope of x – t curve gives velocity

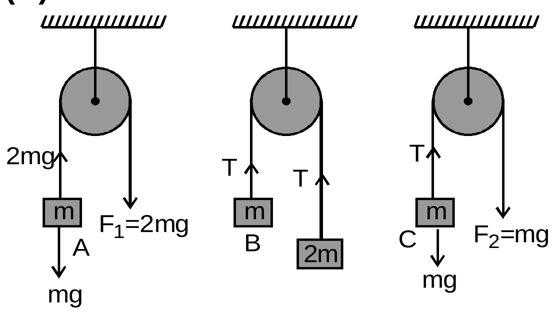
In region AB, BC, CD have constant slope.

$\Rightarrow a = 0 \Rightarrow$ net force = 0

43. **(B)**

F_1 may be equal to F_2

44. **(B)**

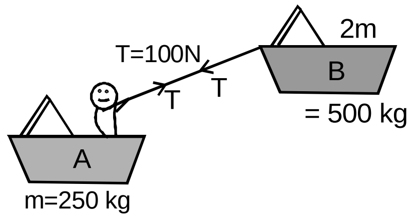


$a_1 = g \quad 2mg - T = 2\,ma \quad a_3 = 0$

$T - mg = ma \quad a_2 = g/3$

$\therefore a_1 > a_2 > a_3$

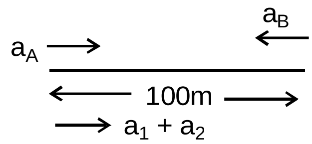
45. **(B)**



M = 250 kg

$a_A = \dfrac{F}{m} = \dfrac{100}{250} = \dfrac{2}{5}$ and $a_B = \dfrac{100}{500} = \dfrac{1}{5}$

Now



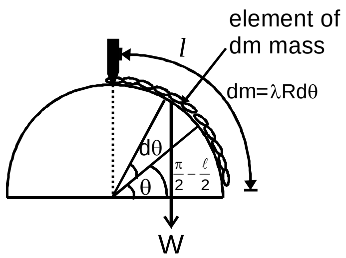
$a_{AB} = a_1 + a_2 = \dfrac{2}{5} + \dfrac{1}{5} = \dfrac{3}{5}$

$100 = \dfrac{1}{2}(a_1 + a_2)t^2 \Rightarrow 100 = \dfrac{1}{2}\left(\dfrac{3}{5}\right)t^2$

$t^2 = 333.33$

$t = 18.25 = 18.3$ sec

46. **(B)**



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

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

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

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

47. **(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) $\Rightarrow \vec{a} = 4\hat{i}$

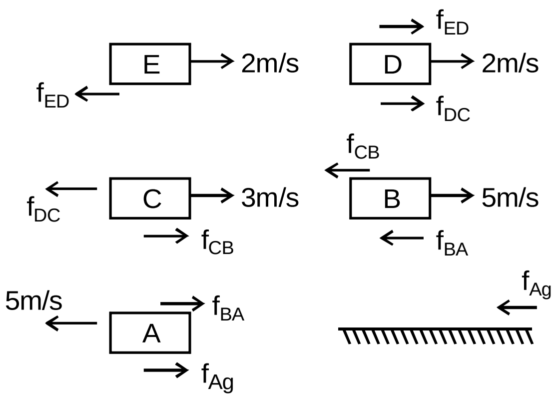
(1) – (3) $\Rightarrow \vec{b} = 3\hat{i} - 24\hat{j}$

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

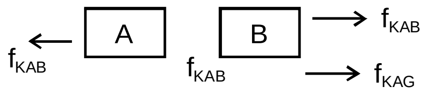
$|\vec{a} + \vec{b}| = \sqrt{49 + (24)^2} = 25$

FRICTION

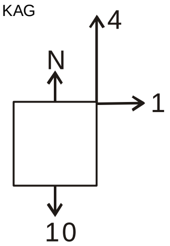
48.



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



50. **(A)**



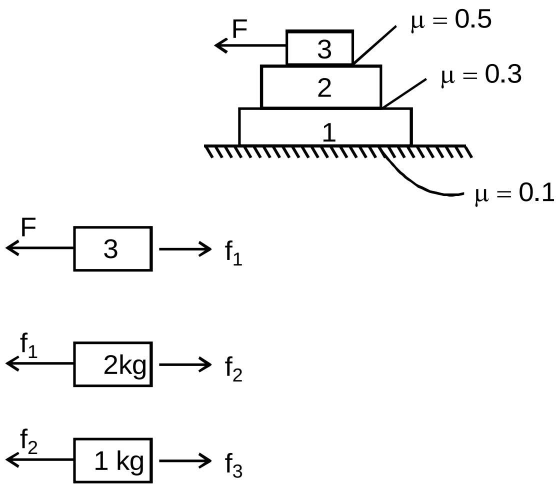
N = 10 – 4 = 6 N

f_{max} = 0.3 × 6 = 1.8 N

But required = 1 N $\leftarrow$

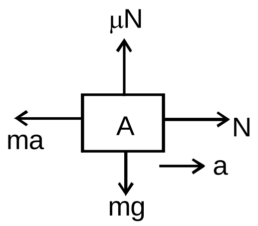
Force of friction = $-\hat{i}$

51. **(C)**



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

52. **(C)**



If A and B are moving without slipping

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

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

w.r.t. B

$m_c g = (3m + m_c)a$, $\mu = g/a$

So $m_c = \left(\dfrac{3m + m_c}{\mu}\right)$; $m_c = \dfrac{3m}{\mu - 1}$

N = ma

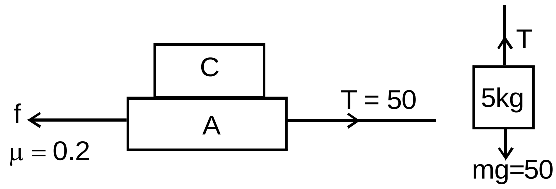
$m_c g = \mu ma \Rightarrow a = g/a$

$mcg - \dfrac{3mg}{u} = m_c g/\mu \Rightarrow m_c = \dfrac{3m}{\mu - 1}$

53. **(A)**

System is at rest contract

So,



At rest

f = T = μN

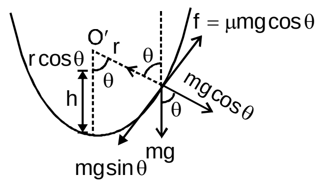
N = 50/0.2 = 250 newton

$m_A g + m_c g = 250$

$10 \times 10 + m_c \times 10 = 250$

so m_c = 15 kg

54. **(B)**



$h = r - r\cos\theta$

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

$\tan\theta = u$

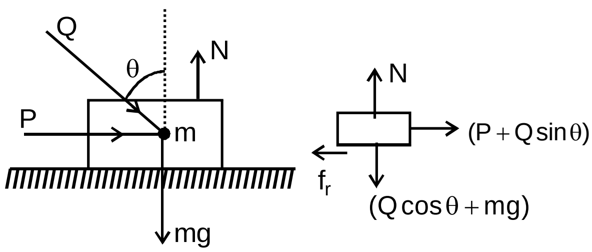
$\cos\theta = \dfrac{1}{\sqrt{1+\mu^2}}$

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

55. **(B)**

$\dfrac{1}{2}mv_0^2 = \mu mgL$; $v_0 = \sqrt{2\mu gL}$

56. **(A)**

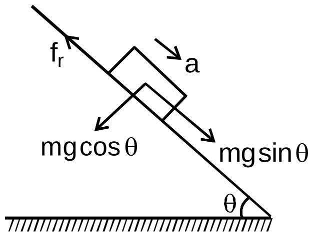


$f_r = \mu N = \mu(mg + Q\cos\theta)$

$f_r = P + Q\sin\theta$

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

57. (A)



$mg \sin\theta - \mu mg \cos\theta = m$

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

$a = \frac{vdv}{dx}$

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

[Here v = 0]
[Here initial & final velocity is zero]

$\therefore \quad g[\sin\theta x - \mu_0 \frac{x^2}{2}\cos\theta] = 0 \quad \Rightarrow \quad x = \frac{2}{\mu_0}\tan\theta$

58. (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

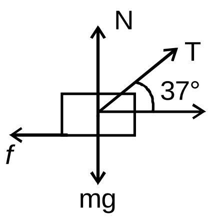
$x = \frac{2}{\mu_0}\tan\theta \Rightarrow v = \sqrt{\frac{g\tan\theta\sin\theta}{\mu_0}}$

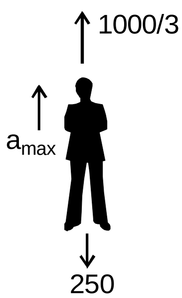
59. (D)

$a = g\sin\theta - \mu g\cos\theta$
At the x increases, $\mu \uparrow a \downarrow$
so when a = 0 instant give maximum speed
$g\sin 37° - (0.3)\, xg\cos 37° = 0$

$6 - \frac{3}{10}\times x \times 8 = 0 \Rightarrow x = \frac{60}{3\times 8} = \frac{20}{8} = 2.5m$

60. (B)





$T\cos 37° = f$
$N + T\sin 37° = mg$

$\therefore N = 100g - T\sin 37° = 100g - \frac{3T}{5}$

and $\quad T\cos 37° = \mu N$

$\qquad T\cos 37° = \mu(100g - \frac{3T}{5})$

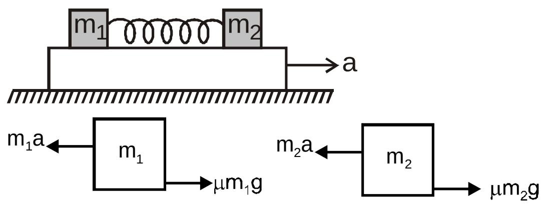
on solving $T = \frac{1000}{3} \quad (\mu = \frac{1}{3})$

$T - Mg = ma_{max}$

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

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

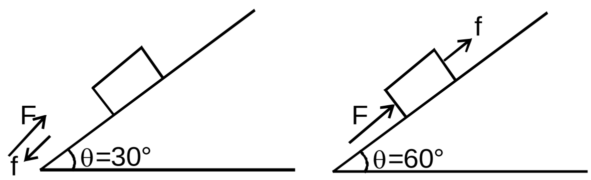
61. (D)



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

$\therefore f_r$ 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)

62. (C)



$F = mg\sin 30° + \mu mg\cos 30°$

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

$F + f = mg\sin 60°$

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

Now (1) = (2)

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

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

(a) $\quad T - mg\sin 45° = ma$

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

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

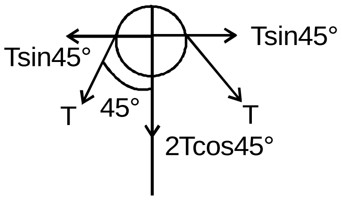
(b) $\quad 3mg\sin 45° - T - \mu N = 3ma$

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

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

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

(c)

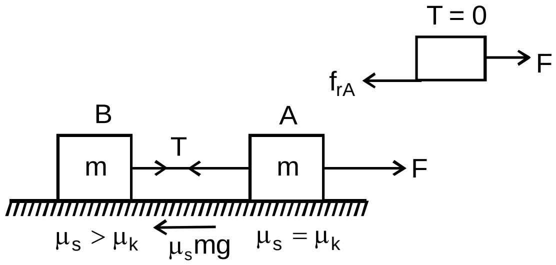


So $2T\cos 45° = F$

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

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

64. (A)



Initially

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

[till or $f_{rB} = \mu_s mg$ $\quad t - \mu_s mg = \mu_s\, mg$

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

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

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

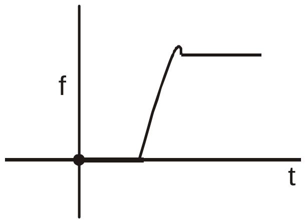
$t = \mu_s mg$ block be will not move

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

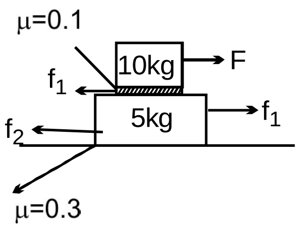
after $t > 2\mu_s mg$ kinetic friction will work

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

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



65. (A)



$f_{1\,max} = 10$ N $\Rightarrow$ $f_{2\,max} = 45$ N

66. (A)

If F = 2 N

there will be no motion

the required frictional force is 2 N

67. (A)

There will be no motion of 5 kg because ($f_2 > f_1$)

The maximum F which will not cause motion

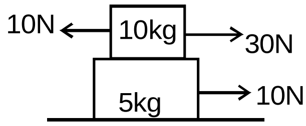
F = 10 N

68. (C)

Acceleration is zero

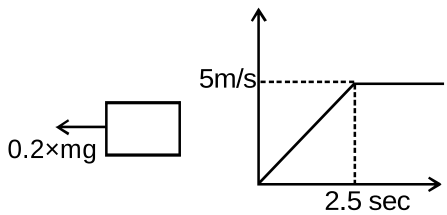
(For any value of F 5kg block will not move)

69. (A)



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

70. (C)



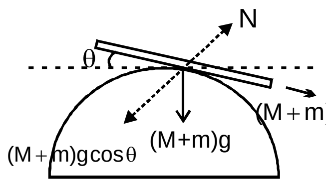
For $t < 1$ sec $\therefore a_B = 2\ m/s^2$

and velocity of truck is 5 m/s

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

$5 = 2 \times t$, $\quad t = 2.5$ sec.

71. (A)



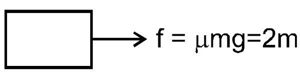
For equilibrium condition

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

$\tan\theta = \mu$

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

72. (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

73. (A, B)

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

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

Now let μ_k then

$15 - f_r = ma \quad \Rightarrow 15 - \mu_k\, 25 = 2.5\, a$

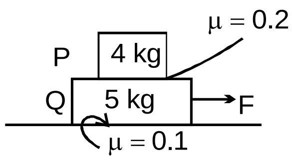
$\mu_k = \dfrac{15 - 2.5a}{2.5}$ ...(1)

Now $x = ut + \dfrac{1}{2} at^2 \Rightarrow 10 = 0 + \dfrac{1}{2} \times a \times (5)^2$

$\Rightarrow a = \dfrac{10 \times 2}{5 \times 5} = \dfrac{4}{5} \Rightarrow a = \dfrac{4}{5} m/s^2$

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

74. (C)



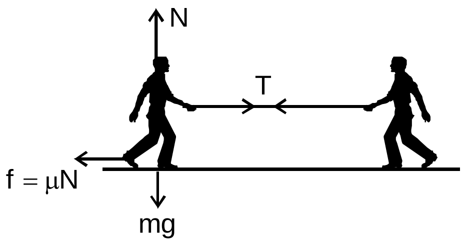
$f_1 = 0.2 \times 40 = 8$ N

$f_2 = 0.1 \times 90 = 9$ N

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

Minimum force needed to cause system to move = 9 N

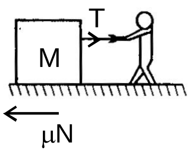
75. (B)



Friction force will more then man will not slip.

N is More

76. (A, B, C)



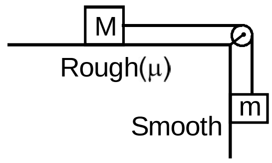
$T - \mu N = ma$

As T ↑ man

Can have tendency

to move

77. (C)



$mg > \mu M g$

$m > \mu M$

78. (A, C)

(A) $m < \mu M$

system is at rest T = mg

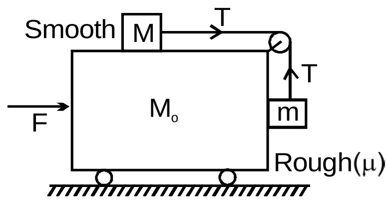
$mg - T = ma \Rightarrow T = mg - ma$

& $T - \mu Mg = Ma$ $\{m > \mu M\}$

$\Rightarrow$ $T = Ma + \mu M g$

on analysing $\mu Mg < T < mg$

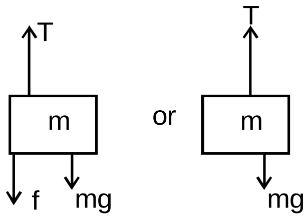
79. (A, D)



(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

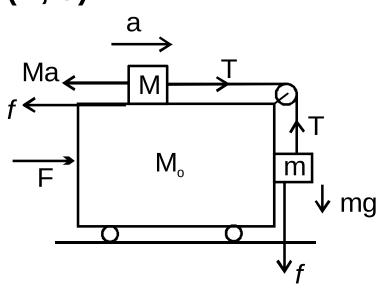


(C) Limiting friction between M_0 & m is μ ma

$\therefore$ Dependent on a

(D) When Pseudo acts on M is equal to T then f = 0

80. (B, C)



Use Pseudo concept

T = Ma ...(1)

$T = f + mg \Rightarrow T = \mu\, ma + ma$ ...(2)

On using (1) & (2)

$Ma = \mu\, ma + mg$

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

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

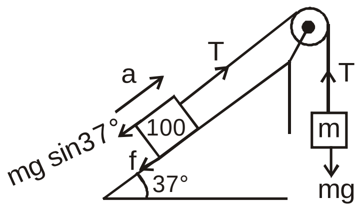
(A) Net Possible becouse T > 0
(only Possible when T = 0 at m block)
μ ma = mg $\Rightarrow$ a = g/u
but T > 0, to move the upper block.
(C) When f = 0
T = Ma, T = mg,   a = mg/M

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

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

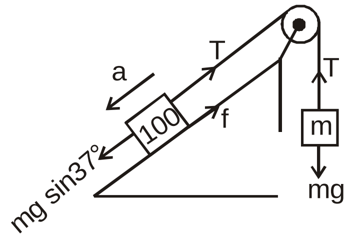
81. **(A, B)**
(A) If F = 0, the block connot remains stationary
(B) For one unique value of F, the blocks M and m remain stationary with respect to block M_0.

82. **(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 $\Rightarrow$ m = 82.33 = 83 kg

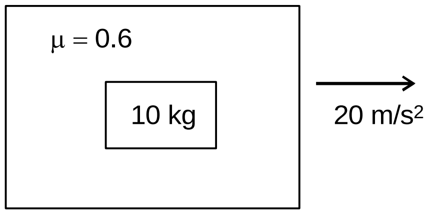
(b)



T + f = ma
T + 235.2 = 588
T = 588 – 235.2 = 352.8
m = 35.28 kg

83. **(B, D)**
f_c = N   (Given)
$\therefore\ f_c = \sqrt{N^2 + f^2}$
Acceleration to condition f = 0 $\Rightarrow f_c$ = N

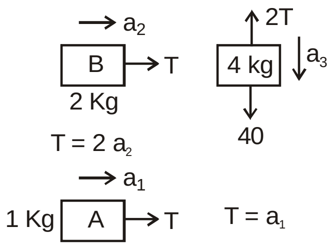
84. **(A, B, C, D)**



(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) $f_{required} = mg = 10 \times 10 = 100$ N
(C) $f_c = \sqrt{f^2 + N^2} = \sqrt{(100)^2 + (200)^2} = 100\sqrt{5}\,N$

Exercise-III Level - I

1.



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

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

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

$a_3 = \frac{3}{2}\ a_2$ ....(4)

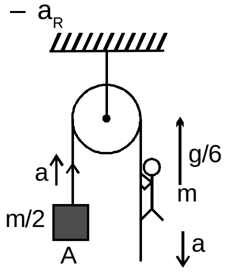
Solving eq^n (1) (2) (3) and (4) We get

$T = 8$ N, $a_1 = 8$ m/s^2

$a_2 = 4$ m/s^2

$a_3 = 6$ m/s^2

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

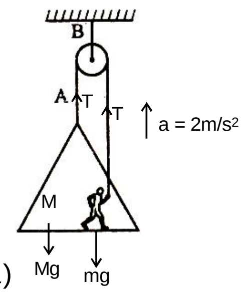
$2T = 200$ N

$T_A = 100$ N

(ii) $2T - (M + m)$

$g = (M + m)\ a$

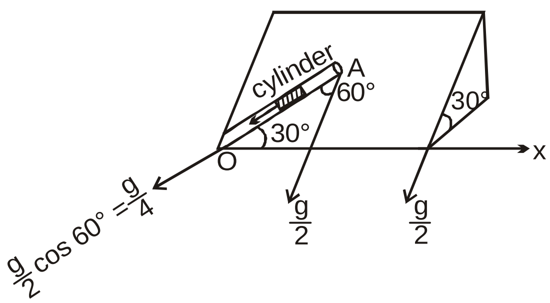
$2T = (M + m)\ (g + a)$



$T = \frac{20(10+2)}{2}$ $\Rightarrow$ $T_A = 120$ N

$T_B = 2T_A = 240$ N

4.



length of oA = 5, $a = \frac{g}{4}$

$s = \frac{1}{2}\ at^2 \Rightarrow 5 = \frac{1}{2}\times\frac{g}{4}.t^2$ $\Rightarrow$ $t = 2$ sec

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

(b) $T - 20 = 2a$ $\Rightarrow$ $30 - T = 3a$

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

$T = 24\ N = kx_2$

(c) $T - 10 = a$

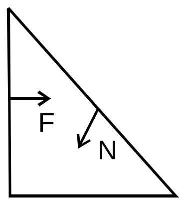
$20 - T = 2a$

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

So $x_1 = \frac{20}{K}$, $x_2 = \frac{24}{K}$, $x_3 = \frac{13.3}{K}$

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

6.

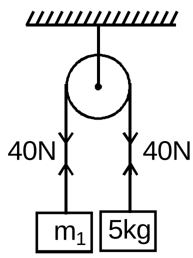


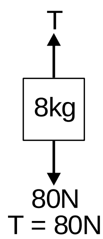
$N = mg\cos\theta = 2.5\ g\cos 37°$

$N\sin 37° = F$

$F = 2.5 \times 10 \times \cos 37° \times \sin 37° = 12$ Newton

7.





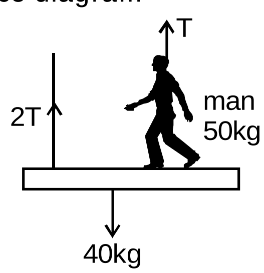
$50 - 40 = 5 \times a$

$a = 2$ m/s^2

$40 - m_1 g = m_1 \times 2$

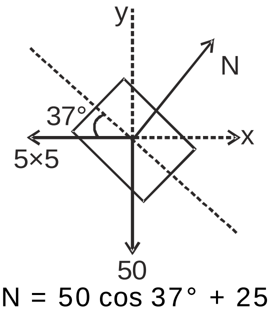
$m_1 = \frac{10}{3}$kg

8. Net force diagram



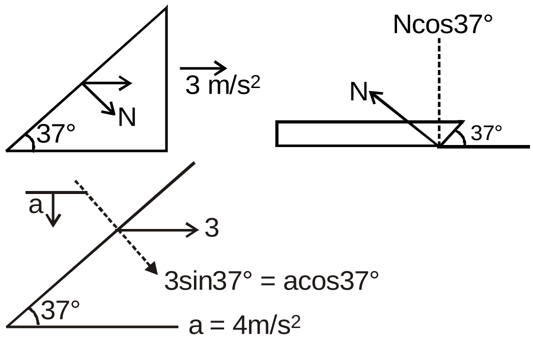
$3T = 900$ N, $T = 300$ N

9.



$N = 50 \cos 37° + 25 \sin 37° = 55$

10.



$a = \frac{9}{4}\ m/s^2$

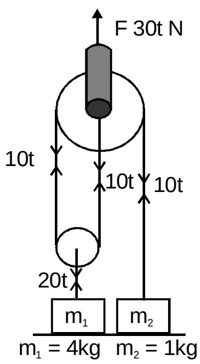
$N \sin 37° = 1 \times 3$

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

$mg - 5 \cos 37° = m \times \frac{9}{4}$

$m = \frac{16}{31} Kg$

11.



$20\ t = 40 \Rightarrow t = 2$ 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 $\quad F_2 = 10$; $F_1 = 30$; $a_{net} = \frac{11}{4}$ m/sec^2

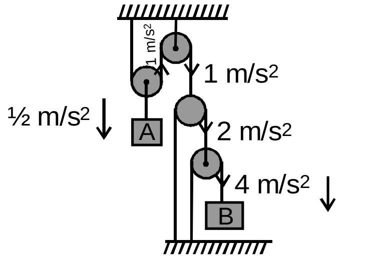
t = 4 sec $\quad F_2 = 20$; $F_1 = 30$; $a_{net} = \frac{10}{4}$ m/sec^2

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

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

v = 12 m/s

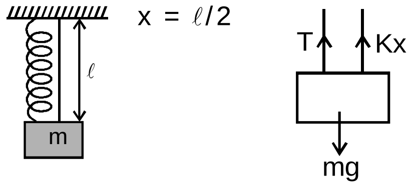
13.



$y_A = \frac{t^2}{4}$, $\quad V_A = \frac{t}{2}$

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

14. $x = \ell/2$



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

If $K > 2\ mg/\ell$, $Kx > mg$

T = 0

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

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

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

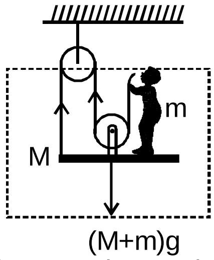
$= 330 + 22.5 - 20$

$= 332.5$ N

Where $m_T \rightarrow$ Total mass = 10 + 15 + 18=33 Kg.

$a_c = 0\ m/s^2$

16. (a)

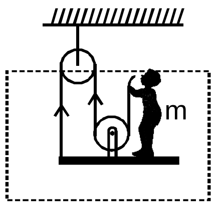


$2T - (m + M)g = (m+M)\ a$, $\quad T = \frac{(m+M)(g+a)}{2}$

(b)

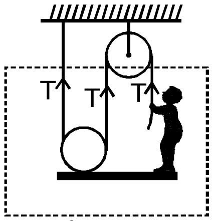
$N - (mg + T) = ma$

(c)



$2T = mg$, $T = \frac{mg}{2}$(yes)

(d)



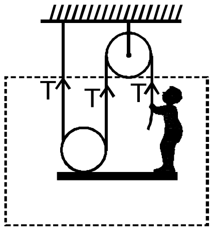
$3T - (m + M)g$

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

(e)

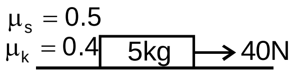
$N + T - mg = ma$

(f)



$3T - mg = 0$, $T = \frac{mg}{3}$(yes)

17. (A)

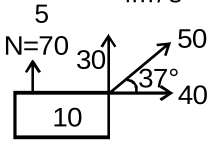


$\leftarrow f_{static} = 25$ N

$\leftarrow f_{kinetic} = 20$ N

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

(B)

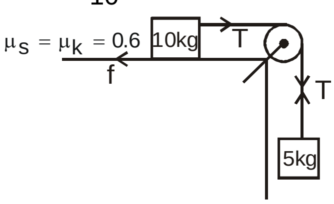


$\mu_s = 0.5$, $\mu_k = 0.4$

$f_{static} = 35$ N, $f_{kinetic} = 28$ N

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

(C)



$f_{max} = 0.6 \times 10 \times 10 = 60$

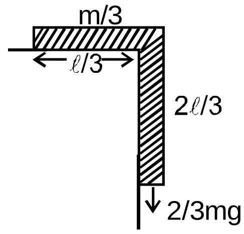
$T = 5g$ $\Rightarrow$ $T = 50$

$f_{max} > T$

$a = 0 \; m/s^2$

18. $N = \frac{m}{3} g$ $\Rightarrow$ $f = \mu m$

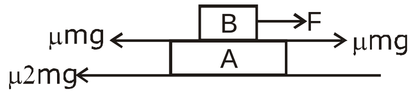
If friction coefficient is



μ then $\mu \frac{m}{3} g = \frac{2}{3} mg$

$\mu = 2$

19.



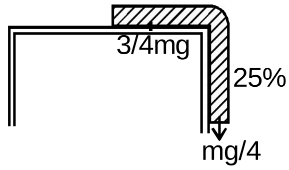
When $F \geq \mu_s mg$

Then block B is move

$F - \mu_k mg = ma$

Block a does not move for any value of F

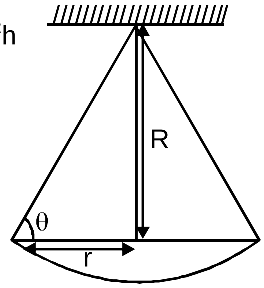
20.



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

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

21. θ = angle of Repose



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

$h = r \tan \theta$

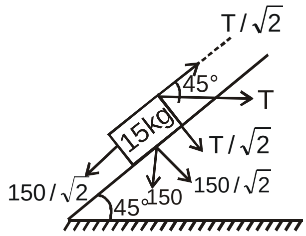
and for just sliding

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

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

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

22.



T = 50 N

Component of force (in y direction)

$N = \frac{T}{\sqrt{2}} + \frac{150}{\sqrt{2}}$ $\Rightarrow$ $N = 200 / \sqrt{2}$

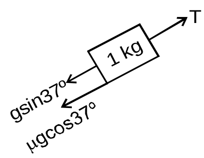
$f = \mu \frac{200}{\sqrt{2}}$

Component of force in x direction

$\frac{150}{\sqrt{2}} = \frac{T}{\sqrt{2}} + f_r$

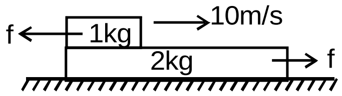
$\frac{150}{\sqrt{2}} - \frac{50}{\sqrt{2}} = \frac{\mu \times 200}{\sqrt{2}}$ $\Rightarrow$ $\mu = \frac{1}{2}$

23.



$T = g \sin 37° + \mu g \cos 37°$, $T = mg$

$m = \sin 37° + \mu \cos 37° = 1$ Kg

24. 

f = 5 N

Acc. of block 1 Kg = 5

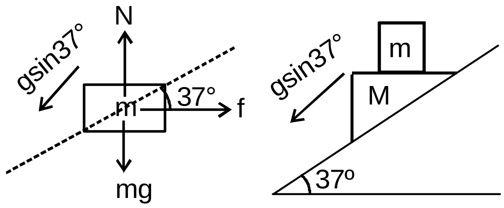
Acc. of block 2 Kg = $\frac{5}{2}$

final velocities block

Here 1 Kg is v_1 and 2 Kg is v_2 and $v_2 = \frac{5}{2}t$

and $v_1 = 10 - 5t$

$v_2 = v_1 \Rightarrow \frac{5}{2} \times t = 10 - 5t$, $t = \frac{4}{3}$ sec.

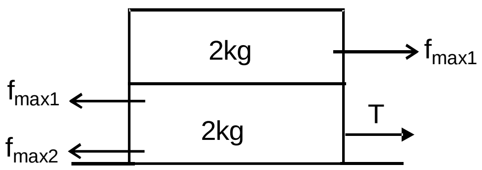
25. 

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

N. sin 37° = – f cos 37°

N. $\frac{3}{5}$ = – μ. N. $\frac{4}{5}$

N. $\frac{3}{5}$ = – μ.N. $\frac{4}{5}$ $\Rightarrow$ $\mu = \frac{3}{4}$

26. 

$f_{max\ 1} = 20 \times 0.6 = 12$ N

$f_{max\ 2} = 40 \times 0.4 = 16$ N

$T - 12 - 16 = 2 \times a \Rightarrow T - 28 = 2a$

$f_{max1} = 2a_{max}$

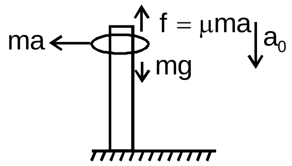
[12 = 2a, a = 6m/s²]

T = 40 N

27. W.r.t train

$mg - \mu ma = ma_0$

$(\because a = 4), \left(\because \mu = \frac{1}{2}\right)$



$a_0 = g - \mu \times 4 = 10 - 2 = 8$ m/s²

$S = ut + \frac{1}{2}at^2 \Rightarrow 1 = \frac{1}{2} \times 8 \times t^2$

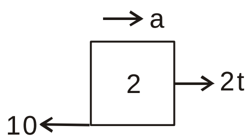
t = 2 sec

28. Condition for move the body

$2t = \mu m g = \frac{1}{2} \times 2 \times 10$

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

5 sec < t < 10 sec



2t = 10 + 2a

$a = (t - 5) \Rightarrow \frac{dv}{dt} = t - 5$

$v = \frac{t^2}{2} - 5t + \frac{25}{2} \Rightarrow x = \frac{t^3}{6} - \frac{5t^2}{2} + \frac{25}{2}t$

at t = 5 sec.

$x = \frac{125}{6}$ m

29. f = 0.8 × 50 = 40 N

50 – T – 40 = 5a

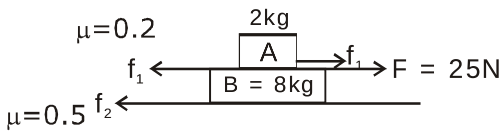
T – 40 = 4a $\Rightarrow$ a = – ve

∴ this direction is not possible

40 – T = 4a $\Rightarrow$ T – 90 = 5a

a = – ve ∴ this direction is not possible.

∴ a = 0 $\Rightarrow$ ∴ f = 10 $\hat{i}$

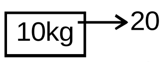
30. 

$f_{1max} = 0.2 \times 2 \times 10 = 4$

$f_{2max} = 0.5 \times 10 \times 10 = 50$

firstly applied f_2 then f_1

Here $f_{2max} > 25 \Rightarrow$ So $f_1 = 0$

31. 

$a_{max} = 2$ m/s²

$F = m_s \times a_{max}$ (block moves together)

F = 15 × 2 = 30 N

Exercise-III Level - II

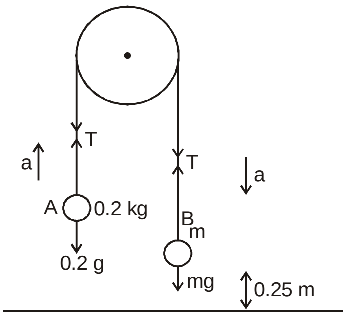
1. $T - 0.2\,g = 0.2\,a$ ...(1)

$mg - T = ma$ ...(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



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

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

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

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

We get a = 2m/sec², T = 2.4 N

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

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

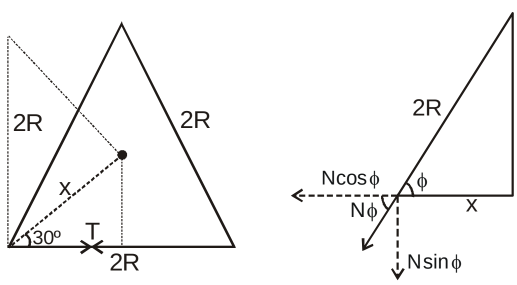
It move upward untill the velocity of A is zero.

$\Rightarrow \quad 0 = 1 - gt, \quad t = 0.1$ sec

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

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

2.



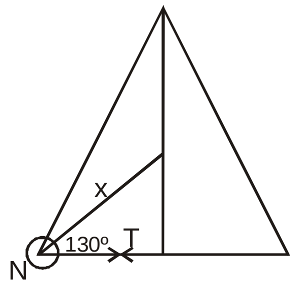
$x\cos\theta = R$

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

Now $3N\sin\phi = mg$

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

N = 2N



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

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

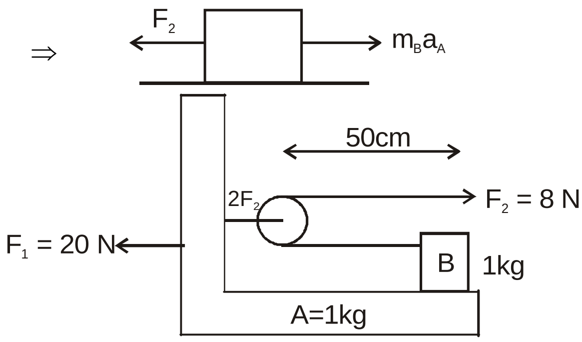
3. First find out acceleration of A so for this

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

$a_A = 4 \text{ m/s}^2$

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

$\Rightarrow$



$\Rightarrow \quad 8 - 4 = 4\text{m/s}^2$

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

$t = \frac{1}{2} = 0.5\text{sec}$

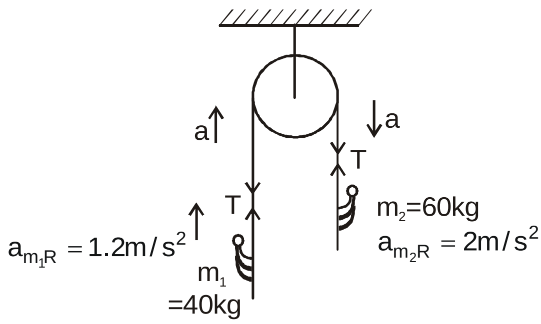
4. for man of mass m_1 $\quad a_{m_1G} = a_{m_2R} + a_{RG}$

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

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

= (2 – a), So now

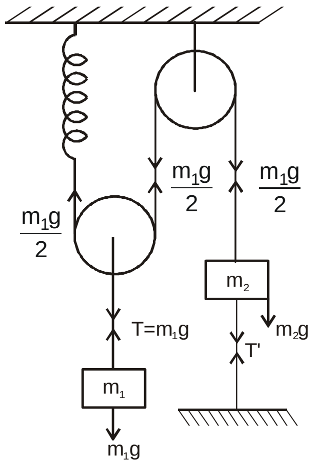
$T - mg = m_1(1.2 + a)$ ...(1)



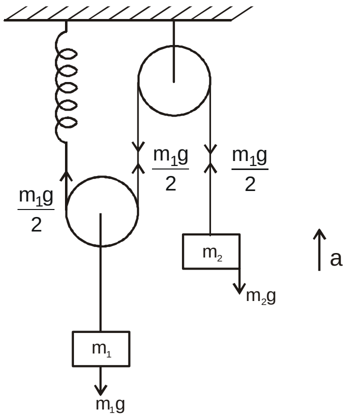
$$T - mg = m_2(2 - a) \qquad \ldots(2)$$

Solve eq. (1) & (2) and put m_1 = 40 kg
m_2 = 60 kg
you get $a = 2.72\ m/s^2$
$T = 556.8\ N$

5. Initial $m_1 > 2m_2$

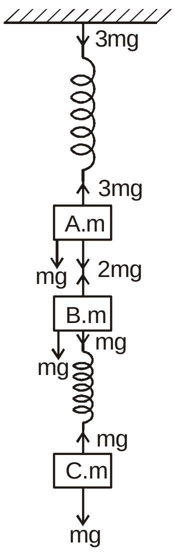


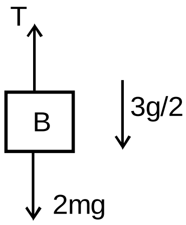
after cutting



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

6 **Initial After cutting**

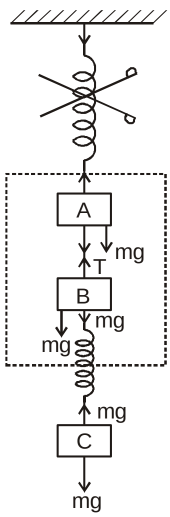




2mg – T = 3mg/2

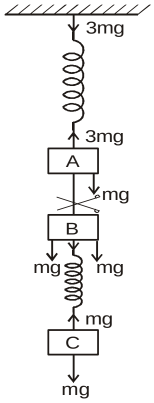
T = 2mg – 3mg/2

= mg/2



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

(b)

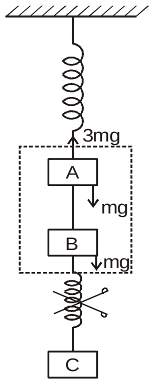


$$a_A = \frac{3mg - mg}{m} = 2g \uparrow$$

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

$$a_C = 0,\ T = 0$$

(c)



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

$$T - mg = mg/2$$

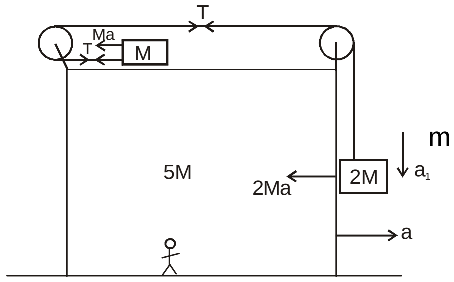
$$T = 3mg/2$$

$$a_c = g$$

7 $\Rightarrow\ T + Ma = Ma_1 \qquad \ldots(1)$

$2Mg - T = 2Ma_1 \qquad \ldots(2)$

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



$T = 7Ma \qquad \ldots(3)$

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

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

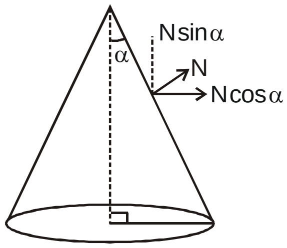
8. $\int dN \sin\alpha = \int dmg \qquad \ldots(1)$

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

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

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

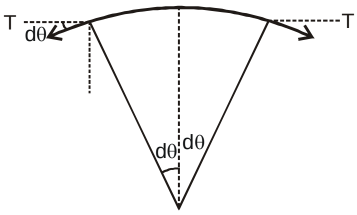
$$2T(\pi R/R) = N\cos\alpha$$



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

from (1) & (2)

$\Rightarrow T = \dfrac{\cos\alpha\, mg}{2\pi}$



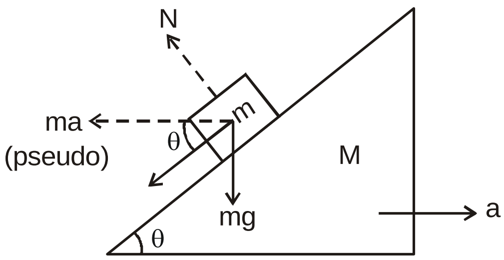
15 _____ 10 cm

$\Rightarrow$ T ____ $\dfrac{10}{15}\times T$ cm

$\dfrac{10}{15}\times\dfrac{\cot\alpha\, mg}{2\pi} = 1\text{cm}$

9 **(a)** Using pseudo concept

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



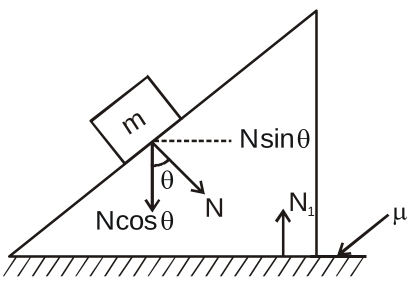
When N = 0

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

(b)

$\Rightarrow$ $N_1 = N\cos\theta + Mg$ $\Rightarrow$ $f = \mu N_1$

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



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

Wedge not move when

$f = N\sin\theta = mg\cos\theta\sin\theta$

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

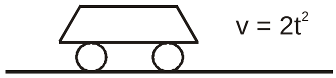
$$\mu = \frac{Mg\cos\theta\sin\theta}{Mg\cos^2\theta + Mg}$$

10 at t = 1 sec it start slipping so.

at this moment acceleration of block = $\mu_s g$

t = 1 sec   a = 4(t) = 4(1) = 4 m/s^2

$\Rightarrow$ 4 = $\mu_s g$ $\Rightarrow$ μ_s = 0.4



after that at t = 1 sec   v = 2m/sec.

at   t = 2sec   v = 8 m/sec

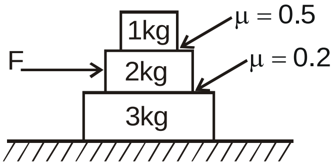
after wards a = 0 so at   t = 3 sec v = 8 m/sec

$a_\mu = \mu_k g$ (sliding),   v = u + at

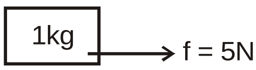
$\Rightarrow$ $8 = 2 + 10\mu_k(2)$ $\Rightarrow$ $\dfrac{6}{10\times 2} = \mu_k$,

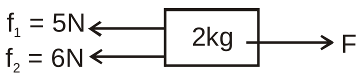
$\mu_k = 0.3\text{sec} =$

11

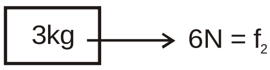


force on 1kg block





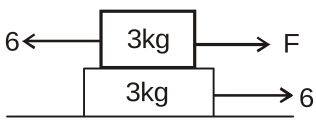
force on 3 kg block



maximum acceleration of block of mass 1 kg = 5/1 = 5 m/s^2

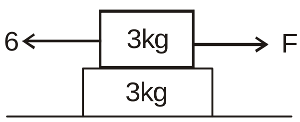
maximum acceleration of block of mass 3 kg = 6/3 = 2 m/s^2

So block move together only when acceleration of all the block is not greater than 2 m/s^2



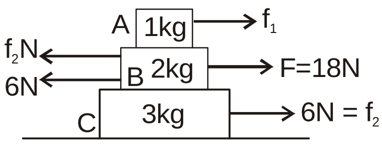
F – 6 = 3 × 2 $\Rightarrow$ F = 12 N

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

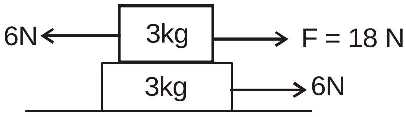


F – 6 = 3 × 5 $\Rightarrow$ F = 21 N

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



So



$a_c = 6/3 = 2\ m/s^2$ f = 6 N

common acceleration = 18 – 6 = 3 × a

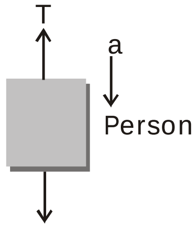
$\Rightarrow$ $a = 4 m/s^2$

$\Rightarrow$

$f_i = 4N$

Exercise-IV Level - I

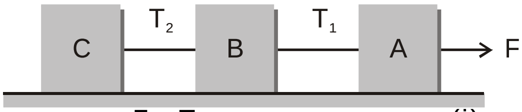
1. (C)
The free body diagram of the person can be drawn as
Let the person move down with an acceleration a then



$60g - T = 60 \Rightarrow \quad 60g - T_{max} = 60\ a_{min}$

or $a_{min} = \dfrac{60g - 360}{60} = 4ms^{-2}$

2. (B)
The system of masses is shown below. From the figure.



$F - T_1 = ma$ ...(i)

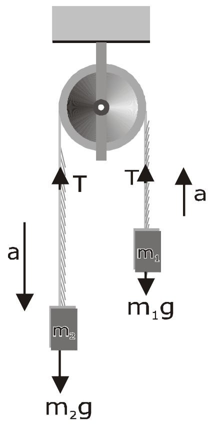
and $T_1 - T_2 = ma$ ...(ii)

Eq. (i) gives,

$10.2 - T_1 = 2 \times 0.6$

$\Rightarrow \quad T_1 = 10.2 - 1.2 = 9$ N

3. (C)
As the string is inextensible, both masses have the same acceleration a. Also, the pulley is massless and frictionless, hence the tension at both ends of the string is the same. Suppose the mass m_2 is greater than mass m_1, so the heavier mass m_2 is accelerating downward and the lighter mass m_1 is accelerating upwards.



Therefore, by Newton's 2nd law

$T - m_1g = m_1a$ ...(i)

$m_2g - T = m_2a$ ...(ii)

After solving Eqs. (i) and (ii)

$$a = \frac{(m_2 - m_1)}{(m_2 + m_1)}.g = \frac{g}{8} \quad \text{(given)}$$

So, $\dfrac{g}{8} = \dfrac{m_2(1 - m_1/m_2)}{m_2(1 + m_1/m_2)}.g$ ...(iii)

Let, $\dfrac{m_1}{m_2} = x$

Thus, Eq. (iii) becomes

$$\frac{1-x}{1+x} = \frac{1}{8}$$

or $x = \dfrac{7}{9}$ or $\dfrac{m_1}{m_2} = \dfrac{9}{7}$

So, the ratio of the masses is 9:7.

4. (B)
Using the relation

$$\frac{mv^2}{r} = \mu R, R = mg$$

$\Rightarrow \quad \dfrac{mv^2}{r} = \mu mg$ or $v^2 = \mu rg$

$\Rightarrow \quad v^2 = 0.6 \times 150 \times 10$

or $v = 30ms^{-1}$

Again from Eq. (ii), we get

$9 - T_2 = 2 \times 0.6$

$\Rightarrow T_2 = 9 - 1.2 = 7.8N$

5. (A)
The particle remains stationary under the acting of three forces $\vec{F}_1, \vec{F}_2$ and $\vec{F}_3$, it means resultant force is zero,

$\vec{F}_1 = -(\vec{F}_2 + \vec{F}_3)$

Since, in second case F_1 is removed (in terms of magnitude we are talking now), the forces acting are F_2 and F_3 the resultant of which has the magnitude as F_1, so acceleration of particle is $\dfrac{F_1}{m}$ in the direction opposite to that of $\vec{F}_1$.

6. (B)
$A + B = 18$ ....(i)

$12 = \sqrt{A^2 + B^2 + 2AB\cos\theta}$ ...(ii)

$$\tan\alpha = \frac{B\sin\theta}{A + B\cos\theta}$$

$$\Rightarrow \quad \tan 90^0 = \frac{B\sin\theta}{A + B\cos\theta}$$

$\Rightarrow \quad \cos\theta = \dfrac{-A}{B}$ ...(iii)

Solving Eqs. (i), (ii) and (iii), A = 5N, B = 13N

7. (C)
Apparent weight of ball

w' = w -R

R = ma (acting upward)

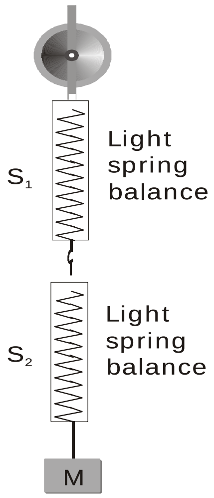
w' = mg-ma

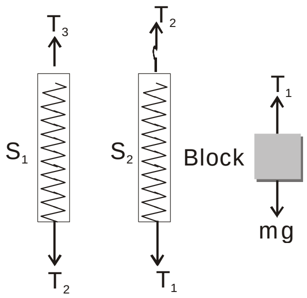
= m(g-a)

Hence, apparent acceleration in the lift is g-a. Now, if the man is standing stationary on the ground, then the apparent acceleration of the falling ball is g.

8. (A)
Here, thrust force is responsible to accelerate the rocket, so initial thrust of the blast
= ma
$= 3.5 \times 10^4 \times 10$
$= 3.5 \times 10^5$ N

9. (A)
The arrangement is shown in figure. Now, draw the free body diagram of the spring balances and block.
for equilibrium of block,
$T_1 = Mg$
where T_1 = Reading of S_2 For equilibrium of S_2.
$T_2 = T_1$
Where, T_2 = Reading of S_1 For equilibrium of S_1,
$T_2 = T_3$

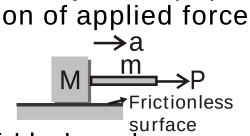




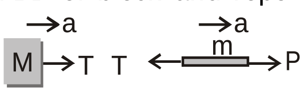
Hence $T_1 = T_2 = Mg$
So, both scales read M kg.

10. (D)
Let acceleration of system (rope + block) along the direction of applied force. Then

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



Draw the FBD of block and rope as shown in figure



Where, T is the required parameter.
For block,
T = Ma

$$\Rightarrow \quad T = \frac{MP}{M+m}$$

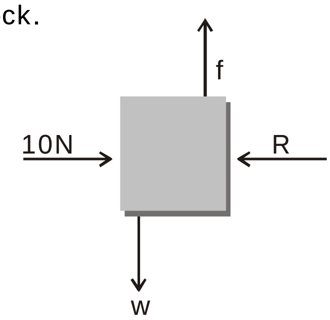
11. (C)
Here B is implying A but A is not implying B, as kinetic energy of a system of particles is zero means speed of each and every Particle is zero. which says that momentum of every particle is zero.

But statement A means linear momentum of a system of particles is zero, which may be true even if particles have equal and opposite momentums and hence, having non-zero kinetic energy.

12. (C)
Let coefficient of friction be μ, then retardation will be μg.
From equation of motion.
$v = u + at$
$\Rightarrow \; 0 = 6 - \mu g \times 10$

or $\mu = \frac{6}{100} = 0.06$

13. (D)
Let R be the normal contact force by wall on the block.

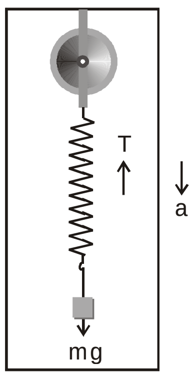


R = 10N
f_L = w and $f = \mu R$
$\therefore \; \mu R = w$
or $w = 0.2 \times 10 = 2N$

14. (D)
Resultant force is zero, as three forces on the particle can be represented in magnitude and direction by three sides of a triangle in same order. Hence, by Newton's 2nd law $\left(\vec{F} = m\frac{d\vec{v}}{dt}\right)$, Particle velocity ($\vec{v}$) will be same.

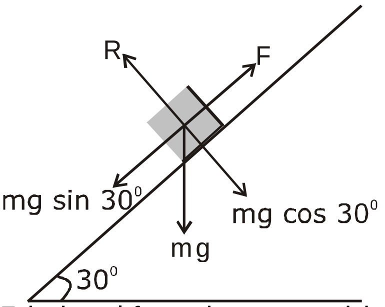
15. (A)
In stationary position, spring balance reading => mg = 49

or $m = \frac{49}{9.8} = 5\,kg$



When lift moves downward.
mg - T = ma
Reading of balance
T = mg - ma
= 5(9.8-5)
$= 5 \times 4.8$
= 24.0 N

16. (A)
Let mass of the block be m.

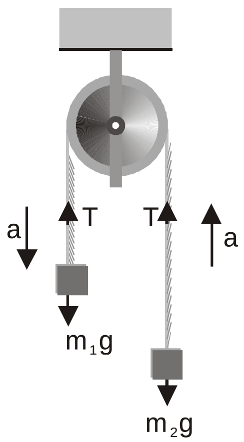


Frictional force in rest position
$F = mg \sin 30^0$
[This is static frictional force and may be less than the limiting frictional force]

$\therefore \quad 10 = m \times 10 \times \frac{1}{2}$ or $m = \frac{2 \times 10}{10} = 2kg$

17. (A)
On releasing, the motion of the system will be according to figure.
$m_1g - T = m_1a$ ...(i)
and $T - m_2g = m_2a$ ...(ii)
On solving

$a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)g$ ...(iii)



Here
$m_1 = 5kg$, $m_2 = 4.8kg$,
$g = 9.8\ ms^{-2}$

$\therefore a = \left(\frac{5 - 4.8}{5 + 4.8}\right) \times 9.8$

$= \frac{0.2}{9.8} \times 9.8 = 0.2\ ms^{-2}$

18. (D)
The force exerted by machine gun on man's hand in firing a bullet.
= change in momentum per second on a bullet or rate of change of momentum

$= \left(\frac{40}{1000}\right) \times 1200 = 48N$

The force exerted by man on machine gun
= force exerted on man by machine gun
= 144 N

19. (C)
According to work - energy theorem,
$W = \Delta K = 0$
=> work done by friction
+ work done by gravity = 0

$\Rightarrow -(\mu mg \cos\phi)\frac{l}{2} + mgl\sin\phi = 0$

or $\quad \frac{\mu}{2}\cos\phi = \sin\phi$

or $\quad \mu = 2\tan\phi$

20. (A)
When friction is absent
$a_1 = g\sin\theta$

$\therefore \quad s_1 = \frac{1}{2}a_1t_1^2$ ...(i)

When friction is present
$a_2 = g\sin\theta - \mu_k g\cos\theta$

$\therefore \quad s_2 = \frac{1}{2}a_2t_2^2$ ...(ii)

From Eqs. (i) and (ii)

$\frac{1}{2}a_1t_1^2 = \frac{1}{2}a_2t_2^2$

$a_1t_1^2 = a_2(nt_1)^2 \quad (\because t_2 = nt_1)$
or $a_1 = n^2a_2$

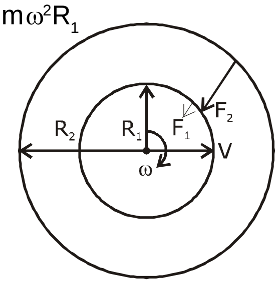
$\Rightarrow \frac{a_2}{a_1} = \frac{g\sin\theta - \mu_k g\cos\theta}{g\sin\theta} = \frac{1}{n^2}$

$\frac{g\sin 45^0 - \mu_k g\cos 45^0}{g\sin 45^0} = \frac{1}{n^2}$

or $\quad 1 - \mu_k = \frac{1}{n^2} \quad$ or $\quad \mu_k = 1 - \frac{1}{n^2}$

21. (D)
Since ω is constant, v would also be constant. So, no net force or torque is acting on ring. The force experienced by any particle is only along radial direction, or we can say the centripetal force.
The force experienced by inner part, $F1 = m\omega^2R_1$
and the force experienced by outer part,
$F_2 = m\omega^2R_2$

$\Rightarrow \quad \frac{F_1}{F_2} = \frac{R_1}{R_2}$



22. (D)
Given, m = 0.3 kg, x = 20 cm
and k = 15 N/m
$F = -kx$ ...(i)
and $F = ma$ ...(ii)
$\therefore \quad ma = -kx$

$\Rightarrow a = -\frac{15}{0.3} \times 20 \times 10^{-2}$

$a = -\frac{15}{3} \times 2 = -10\ ms^{-2}$

$\therefore$ Initial acceleration, $a = 10\ ms^{-2}$

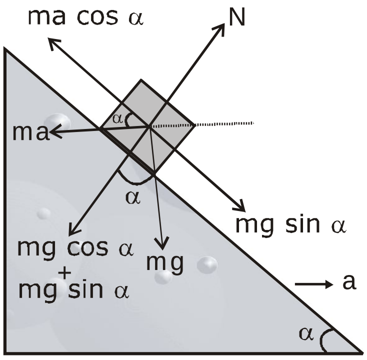
23. (B)

$$s = \frac{v^2}{2\mu_k g} = \frac{100 \times 100}{2 \times 0.5 \times 10}$$

$$= \frac{100 \times 100}{5 \times 2} = 1000\ \text{m}$$

24. (D)

In the frame of wedge, the force diagram of block is shown in figure. From free body diagram of wedge.



For block to remain stationary.

ma cos α = mg sin α

or a = g tan α

25. (C)

This is the question based on impulse momentum theorem.

$$|F.\Delta t| = |\text{change in momentum}|$$

$$\Rightarrow F \times 0.1 |P_f - P_i|$$

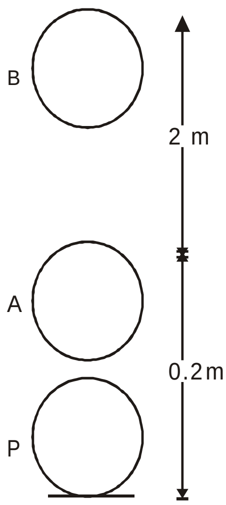
As the ball will stop after catching ;

$P_i = mv_i = 0.15 \times 20 = 3$, $P_f = 0$

$\Rightarrow$ F × 0.1 = 3 $\Rightarrow$ F = 30N

26. (D)

The situation is shown in figure. At initial time, the ball is at P, then under the action of a force (exerted by hand) from P to A and then from A to B let acceleration of ball during PA is a ms^{-2} [assumed to be constant] in upward direction and velocity of ball at A is v m/s.



Then for PA,

$v^2 = 0^2 + 2a \times 0.2$

For AB, $0 = v^2 - 2 \times g \times 2$

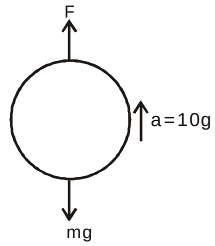
=> $v^2 = 2g \times 2$

From above equations,

a = 10g = 100ms^{-2}

Then for PA, FBD of ball is F - mg = ma

[F is the force exted by hand on ball]



=> F = m(g+a)

= 0.2(11g)

= 22 N

Alternate using work energy theorem

$W_{mg} + W_F = 0$

=> -mg × 2.2 +F × 0.2 = 0

or F = 22N

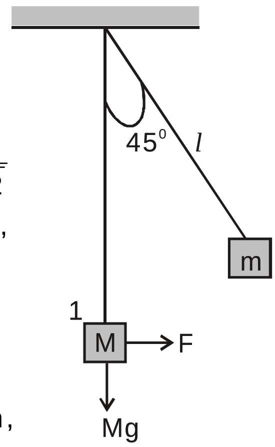
27. (D)

Here, the constant horizontal force required to take the body from position 1 to position 2 can be calculated by using work-energy theorem. Let us assume that body is taken slowly so that its speed does not change, then

$\Delta K = 0$

$= W_F + W_{Mg} + W_{tension}$

[symbols have their usual meanings]



$W_F = F \times l \sin 45^0 = \frac{Fl}{\sqrt{2}}$

$W_{Mg} = Mg\,(l - l\cos 45^0)$,

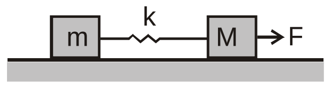
$W_{tension} = 0$

$\therefore F = Mg(\sqrt{2} - 1)$

28. (C)

Acceleration of system,

$$a = \frac{F}{m + M}$$



So, force acting on mass,

F = ma

$$= \frac{mF}{m + M}$$

29. (D)

mg sinθ = ma

$\therefore$ a = g sin θ

where a is along the inclined plane

$\therefore$ Vertical component of acceleration is gsin$^2\theta$

$\therefore$ Relative vertical acceleration of A with respect to B is

g (sin$^2 60^0$-sin$^2 30^0$)

$$= \frac{g}{2} = 4.9\,\text{ms}^{-2}$$ (In vertical direction)

30. (B)

From the graph, it is a straight line so, uniform motion, Because of impulse direction of velocity changes as can be seen from the slope of the graph

Initial velocity $v_1 = \frac{2}{2} = 1ms^{-1}$

Final velocity $v_2 = \frac{2}{2} = -1ms^{-1}$

$\vec{P}_i = mv_1 = 0.4N - s$

$\vec{P}_f = mv_2 = -0.4N - s$

$\vec{J} = \vec{P}_f - \vec{P}_i = -0.4 - 0.4 = -0.8N - s$

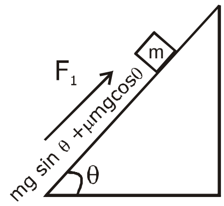
($\vec{j}$ = impulse)

$\therefore |\vec{J}| = 0.8N - s$

31. (D)

$F_1 = mg(\sin\theta + \mu\cos\theta)$

$F_2 = mg(\sin\theta - \mu\cos\theta)$

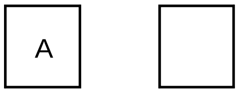


$$\therefore \frac{F_1}{F_2} = \frac{\sin\theta + \mu\cos\theta}{\sin\theta - \mu\cos\theta}$$

$$= \frac{\tan\theta + \mu}{\tan\theta - \mu} = \frac{2\mu + \mu}{2\mu - \mu} = 3$$

Exercise-IV Level - II

1. w.r.t B



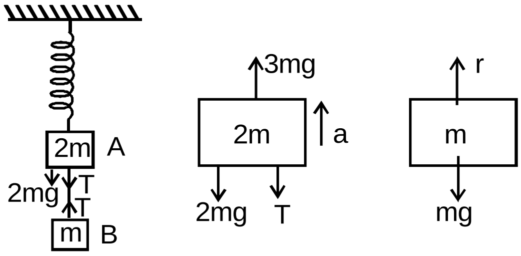
$0.1\times10\times\cos45°$

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

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

t = 2 sec

2. **(B)**



when string cut T = 0

$\Rightarrow ma_2 = mg$

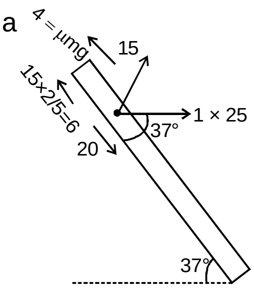
$a_2 = g$

$3mg - 2\,mg = 2ma_\perp$

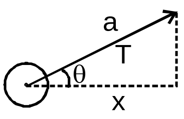
$a_\perp = g/2$

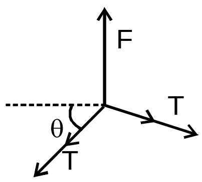
3. $20 - 6 - 4 = 1 \times a$

$a = 10\ m/s^2$



4. **(B)**





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

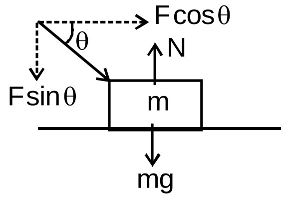
$$a = \frac{F}{2\sin\theta}.\frac{\cos\theta}{m} = \frac{F}{2m}\cot\theta$$

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

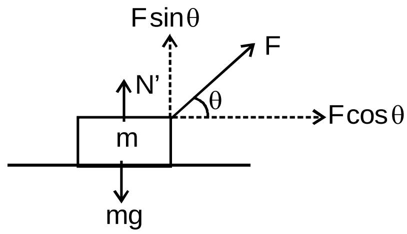
5. **(B)**

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

6. **(B)**



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



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

$f = \mu N$

7. **(B)**

8. **(A)**

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

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

$\sin\theta = \cos\theta$ at 45°

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

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

N = 10

$\mu = 5$

10. **(A, C)**

Components of 1N force : $1\cos\theta$ along the incline opposite to $mg\sin\theta$ and $1\sin\theta$ perpendicular to the incline.

If $\theta = 45$ the $\cos\theta = \sin\theta$.

If $\theta > 45$ then $\cos\theta < \sin\theta$ so frictional force acts towards Q.

If $\theta < 45$ then $\cos\theta > \sin\theta$ so frictional force acts towards P.