MAHESH TUTORIALS SCIENCE

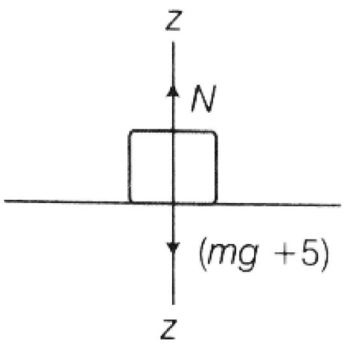
00 – 00		Q. Booklet Serial No: 130915	
Test No : 2217	3 Hrs.		Q. Booklet Version : 11

Hints & Solutions

PART A - PHYSICS

1. **c)** **Both (I) and (II) are correct**
Action and reaciton act on two different bodies and also of same nature. So, statements of Agam Goel and Aditi Mehta are correct.

2 **b)** **15N**

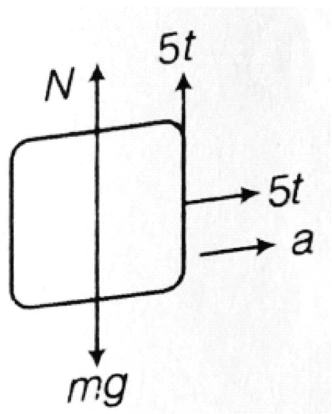


From free body diagram,

$N = mg + 5$

$= 1 \times 10 + 5 = 15$ N

3. **d)** **Both (a) and (c) are correct**
From free body diagram,



$N + 5t = mg$

$\therefore$ $N = mg - 5t$ (g = 10m/s²)

For leaving the surface, N = 0

$t = \frac{mg}{5}$ or $t = \frac{100}{5} = 20$ s

Also, $5t = 10a$, $a = \frac{1}{2}t$

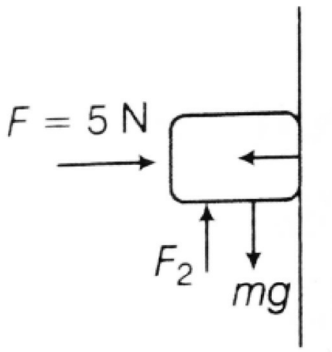
$$\int_0^v dv = \frac{1}{2}\int_0^{20} t\,dt$$

$$v = \frac{1}{2}\left[\frac{t^2}{2}\right]_0^{20}$$

$$= \frac{1}{2}[200 - 0]$$

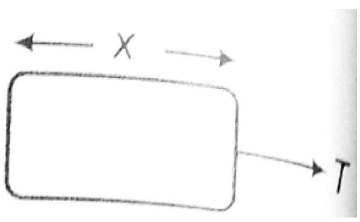
$$= 100 \text{ m/s}$$

4. **b)** **10 N**
From free body diagram of block,



$F_2 = mg = 10N$ ($\because$ g = 10m/s²)

5. **b)** $\lambda \propto \frac{1}{\sqrt{x}}$



Here, T = Ma

$10\sqrt{x}$ = ma

$\Rightarrow$ $m = \frac{10}{a}\sqrt{x}$

or $\frac{dm}{dx} = \frac{10}{a}\frac{d(\sqrt{x})}{dx}$

or $\frac{dm}{dx} = \frac{10}{a}\frac{1}{2\sqrt{x}}$

or $\frac{dm}{dx} = \frac{5}{a\sqrt{x}}$

or $dm = \frac{5}{a\sqrt{x}}dx$

or $\lambda\, dx = \frac{5}{a\sqrt{x}}dx$

$\Rightarrow$ $\lambda = \frac{5}{a\sqrt{x}}$

$\Rightarrow$ $\lambda \propto \frac{1}{\sqrt{x}}$

6. **c)** **2mg sin θ**

From free body diagram of B,

$Mg\sin\theta - T = Ma$ ... (i)

From free body diagram of A,

$T - mg\sin\theta = ma$ ... (ii)

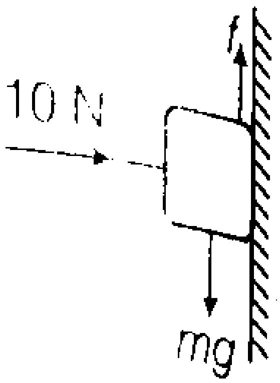
From equation (i) and (ii), we get

$$T = \frac{2mg\sin\theta}{1+\frac{m}{M}}$$

But, m << M

∴ $T = 2\,mg\sin\theta$

7. **d)** **2 N**



In the given situation, the static friction force will balance the weight of the block $f_s = mg$

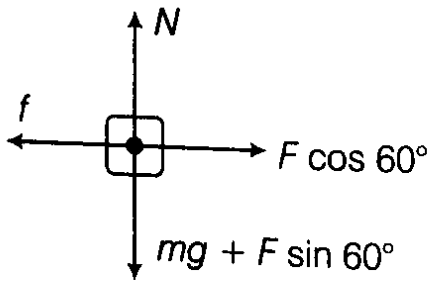
Normal reaction acting on the block N = 10 N

$f_s = \mu s\, N = 0.2 \times 10 = 2$ N

The weight of the block = 2N

8. **a)** **20N**

From free body diagram the block,



$N = mg + F\sin 60^o = \sqrt{3}g + \frac{\sqrt{3}F}{2}$

(in vertical direction)

For no motion, $F\cos 60^o \le \mu N$

∴ $F \le 2g$

∴ $F_{max} = 20N$

9. **d)** **All of the above**

Concept If $F \le \mu_s mg$, applied force F is balanced by static friction. Thus, tension in string is zero.

If $F > \mu_s mg$, friction is limiting friction. Thus, $F = T + f_{max}$,

∴ $T = F - \mu_s mg$.

10. **b)** $\left(\mathbf{3.6\hat{j} - 4.8\hat{k}}\right)\mathbf{m/s^2}$

The normal contact force on the block is 40 N. The resultan force on the block along the plane of wall is

$\sqrt{(10-50)^2 + 30^2}$ = 50N

Thus, acceleration of the block is

$$a = \frac{50-\mu N}{m} = \frac{50-20}{5} = 6m/s^2$$

11. **b) 6.25 m/s**

$F = \mu mg = ma$ or $10 - 2t - 5 = a$

or $5 - 2t = \frac{dv}{dt}$ or $\int_0^v dv = \int_0^{2.5} (5-2t)\,dt$

or $v = \left[5t - t^2\right]_0^{2.5}$

$= 5 \times 2.5 - 6.25$

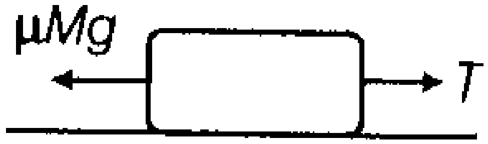
$= 12.5 - 6.25$

$= 6.25 m/s$

12. **b) $10 m/s^2$**

$T_{max} = \mu Mg$

$= 0.5 \times 20 \times 10 = 100$ N



For monkey, $T - mg$

$= ma$ or $T_{max} - mg$

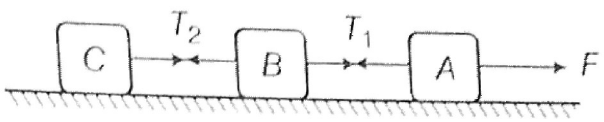
$= ma_{max}$

or $100 - 50 = 5a_{max}$

$\therefore \quad a_{max} = \frac{50}{5} = 10 m/s^2$

13. **b) 7.8**

The system of masses is shown below.



From the figure

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

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

Equation (i) gives,

$10.2 - T_1 = 2 \times 0.6$

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

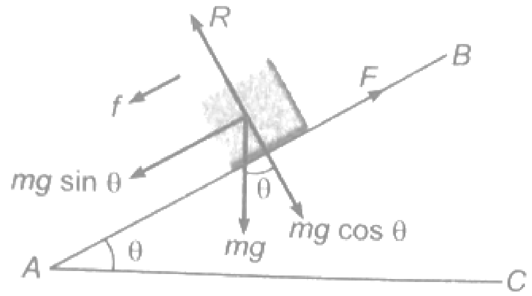
Again, from equation (ii), we get

$9 - T_2 = 2 \times 0.6$

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

14. **b) 0.75**

When a plane is inclined to the horizontal at an angle θ, which is greater than the angle of repose, the body placed on the inclined plane slides down with an acceleration a.



As is clear from figure

$R = mg\cos\theta$ ...(i)

Net force on the body down the inclined plane

$f = mg\sin\theta - F$ ...(ii)

i.e, $f = ma = mg\sin\theta - \mu R \quad \left(\because \mu = \frac{F}{R}\right)$

$\therefore \quad ma = mg\sin\theta - \mu\, mg\cos\theta$

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

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

$\therefore$ Time taken by body to slide down the plane

$$t_1 = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2s}{g(\sin\theta - \mu\cos\theta)}}$$

When friction is absent, then time taken to slide down the plane

$$t_2 = \sqrt{\frac{2s}{g\sin\theta}}$$

$\because \quad t_1 = 2t_2$ (given)

$\therefore \quad t_1^2 = 4t_2^2$

or $\frac{2s}{g(\sin\theta - \mu\cos\theta)} = \frac{2s \times 4}{g\sin\theta}$

or $\sin\theta = 4\sin\theta - 4\mu\cos\theta$

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

$= \frac{3}{4}\tan 45^0 = \frac{3}{4} = 0.75$

15. **c) $6\ kgs^{-1}$**

Thrust on the rocket is the force with which the rocket moves upwards.

Thrust on the rocket at time t is given by

$F = -u\frac{dm}{dt}$

where u is relative velocity of exhaust gases with respect to the rocket.

$\frac{dm}{dt}$ is rate of combustion of fuel at that instant.

$\therefore \quad F = -u = \frac{dm}{dt} mg$

$\Rightarrow \quad -\frac{dm}{dt} = \frac{mg}{u}$

Here, m = 600 kg, u = 1000 ms^{-1}

$\therefore \quad -\frac{dm}{dt} = \frac{600 \times 10}{1000} = 6 \text{ kg s}^{-1}$

16. **a) 20%**

The force of friction should balance the weight of chain hanging. If M is the mass of whole chain of length L and x is the length of chain hanging to balance, then

$\mu \frac{M}{L}(L - x)g = \frac{M}{L}xg$

or $\mu(L - x) = x$

or $x = \frac{\mu L}{\mu + 1} = \frac{0.25L}{1.25}$ (As $\mu = 0.25$)

$\therefore x = \frac{L}{5}$

or $\frac{x}{L} = \frac{1}{5} = \frac{1}{5} \times 100 = 20\%$

17. **b) 40 m**

When static friction is present, then acceleration of body is given by $a = -\mu g$

Here, $u = 72 \text{km h}^{-1} = 72 \times \frac{5}{18} = 20 \text{m/s}$

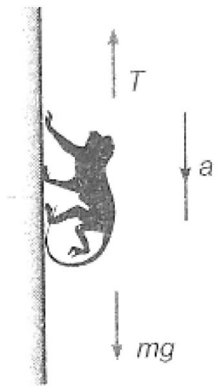
$v = 0$

$\therefore \quad a = -\mu g = -0.5 \times 10 = -5 \text{m/s}^2$

Now, from third equation of motion, i.e., $v^2 = u^2 + 2as$

$s = \frac{v^2 - u^2}{2a} = \frac{0 - (20)^2}{2 \times (-5)} = 40 \text{ m}$

18. **c) $\frac{g}{4}$**



Breaking strength is tension in the branch of tree. Let T be tension in the branch of tree when monkey is descending with acceleration a.

Applying Newton's 2nd law of motion

mg – T = ma

and T = 75% of weight of monkey

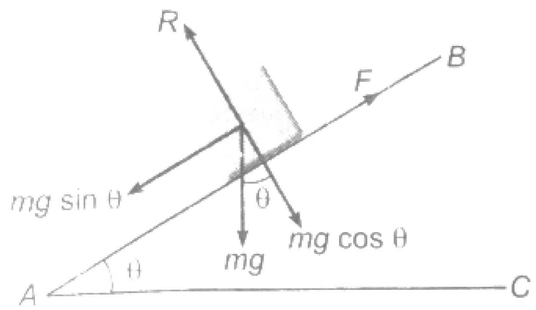
i.e, $T = \left(\frac{75}{100}\right)mg = \frac{3}{4}mg$

$\therefore \quad mg - \frac{3}{4}mg = ma$

or $\quad a = \frac{g}{4}$

19. **d) tan θ**

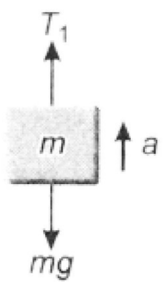
Angle of repose or angle of sliding is defined as the minimum angle of inclination of a plane with the horizontal, such that a body placed on the plane just begins to slide down.



AB is an inclined plane such that a body placed on it just begins to slide down
$\angle BAC = \theta$ = angle of repose
In equilibrium
$F = mg \sin\theta$
and $R = mg\cos\theta$
$\therefore \quad \frac{F}{R} = \frac{mg\sin\theta}{mg\cos\theta} = \tan\theta$
i.e. $\mu = \tan\theta$
Hence, coefficient of kinetic friction between any two surfaces in contact is equal to the tangent of the angle of inclination between them.

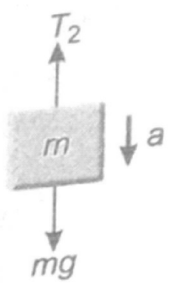
20. **a)** **3 : 1**

i) When mass is lifted upwards with an acceleration a, then apparent weight



$T_1 - mg = ma$
$\Rightarrow T_1 = mg + ma$
T1 = m(g + a)
Substituting the values, we obtain
$\therefore T_1 = (1)(9.8 + 4.9)$
= 14.7N

ii) When mass is lowered downwards with an acceleration a, then



$mg - T_2 = ma$
$\Rightarrow T_2 = mg - ma = m(g - a)$

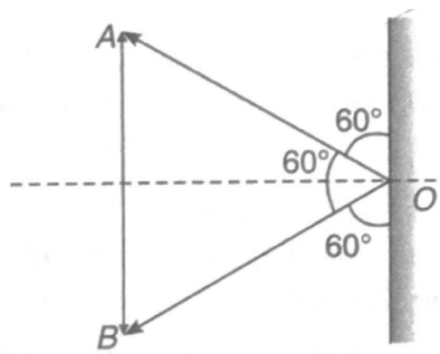
Substituting the values, we have
$T_2 = (1)(9.8 - 4.9) = 4.9N$
Then, ratio of tensions
$\frac{T_1}{T_2} = \frac{14.7}{4.9} = \frac{3}{1}$
$\Rightarrow T_1 : T_2 = 3 : 1$

21. **b)** **187.5 kg s^{-1}**

Thrust force on the rocket
$F_t = v_r\left(-\frac{dm}{dt}\right)$ (upwards)
Weight of the rocket
w = mg (downwards)
Net force on the rocket
$F_{net} = F_t - w$
$\Rightarrow ma = v_r\left(\frac{-dm}{dt}\right) - mg$
$\Rightarrow \left(\frac{-dm}{dt}\right) = \frac{m(g+a)}{v_r}$
$\therefore$ Rate of gas ejected per second
$= \frac{5000(10+20)}{800} = \frac{5000\times 30}{800}$
$= 187.5\text{kg s}^{-1}$

22. **a)** **$1500\sqrt{3}$ N**

The vector $\overrightarrow{OA}$ represents the momentum of the ball before the collision and the vector $\overrightarrow{OB}$ that after the collision. The vector $\overrightarrow{AB}$ represents the change in momentum of the ball $\overrightarrow{\Delta p}$.



As the magnitude of $\overrightarrow{OA}$ and $\overrightarrow{OB}$ are equal the components of $\overrightarrow{OA}$ and $\overrightarrow{OB}$ along the wall are equal and in the same direction while those perpendicular to the wall are equal and opposite. Thus, the change in momentum is due only to the change in direction of the perpendicular components.

Hence, $\overrightarrow{\Delta P}$ = OA sin 60° – (–OB sin 60°)

= mv sin 60° + mv sin 60°

= 2 mv sin 60°

$= 2 \times 3 \times 100 \times \frac{\sqrt{3}}{2}$

$= 300\sqrt{3}$ kg-m/s

The force exerted on the wall

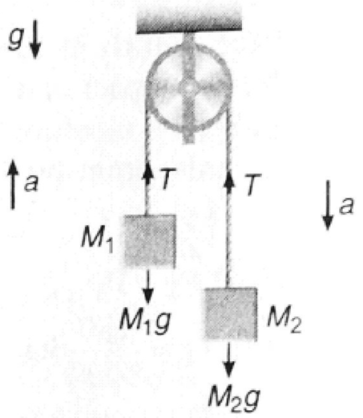
$F = \frac{\overrightarrow{\Delta P}}{\Delta t}$

$= \frac{300\sqrt{3}}{0.2} = 1500\sqrt{3}$ N

23. **c)** $\mathbf{\frac{g}{3}}$

In the case of masses hanging from a pulley by a string, the tension in whole string is same, say equal to T.

As $M_2 > M_1$, so mass M_2 moves down and mass M_1 moves up with the same acceleration a (say). The arrangement of the motion is represented in the figure.



Equation of motion of mass M_2, is

$M_2g - T = M_2a$ .... (i)

Equation of motion of mass M_1 is,

$T - M_1g = M_1a$ .... (ii)

Adding equation (i) and (ii), we get

$(M_2g - T) + (T - M_1g) = (M_1 + M_2)a$

$(M_2 - M_1)g = (M_1 + M_2)a$

$\Rightarrow \quad a = \left(\frac{M_2 - M_1}{M_1 + M_2}\right)g$

Given, M_1 = 5kg, M_2 = 10kg

Hence, $a = \left(\frac{10-5}{5+10}\right) g = \frac{5}{15} g = \frac{g}{3}$

24. **c)** **30 N**

Force imparted = rate of change of momentum

or $F = \frac{\Delta p}{\Delta t}$

or $F = \frac{p_1 - p_2}{\Delta t}$

or $F = \frac{m(v_1 - v_2)}{\Delta t}$

Here, m = 150g = 0.150 kg,

v_1 = 20m/s, v_2 = 0

Δt = 0.1 s

$\therefore \quad F = \frac{0.150 \times (20-0)}{0.1} = 30N$

25. **b)** $\mathbf{18\hat{i} + 6\hat{j}}$

According to Newton's 2nd law, force applied on an object is equal to rate of change of momentum

i.e., $\vec{F} = \frac{d\vec{P}}{dt}$

or $\vec{F} = m\frac{d\vec{v}}{dt}$ ... (i)

Given, m = 3kg, t = 3s, $\vec{F} = \left(6t^2\,\hat{i} + 4t\,\hat{j}\right)N$

Substituting these values in equation (i), we get

$\left(6t^2\,\hat{i} + 4t\,\hat{j}\right) = 3\frac{d\vec{v}}{dt}$

or $d\vec{V} = \frac{1}{3}\left(6t^2\,\hat{i} + 4t\,\hat{j}\right)dt$

Now, taking integration of both sides, we get

$$\int d\vec{V} = \int_0^t \frac{1}{3}(6t^2\,\hat{i} + 4t\,\hat{j})dt$$

$$\vec{V} = \frac{1}{3}\int_0^t (6t^2\,\hat{i} + 4t\,\hat{j})dt$$

but $t = 3$ s

$\therefore$ $\vec{V} = \frac{1}{3}\int_0^3 (6t^2\,\hat{i} + 4t\,\hat{j})dt$

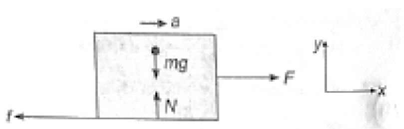
or $\vec{V} = \frac{1}{3}\left[\frac{6t^3}{3}\hat{i} + \frac{4t^2}{2}\hat{j}\right]_0^3$

or $v = v = \frac{1}{3}\left[2(3)^3\,\hat{i} + 2(3)^2\,\hat{j}\right]$

or $\vec{v} = \frac{1}{3}\left[54\,\hat{i} + 18\,\hat{j}\right]$

or $\vec{v} = 18\,\hat{i} + 6\,\hat{j}$

26. **c)** **5m/s²**



From Newton's second law along X-axis

$$\sum F_x = ma$$

ie, $F - f = ma$

or $F - \mu mg = ma$

or $a = \frac{F - \mu mg}{m}$

Given, F = 100 N, m = 0.5, m = 10 kg, g = 10 m/s²

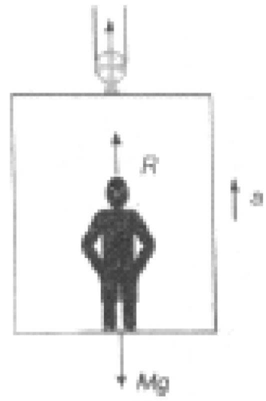
Substituting the value in the above relation for acceleration of block,

$$a = \frac{(100) - (0.5)(10)(10)}{(10)} = 5\text{m/s}^2$$

27. **b)** **1200 N**

Acceleration of lift, a = 5 m/s²

When lift is moving upwards, the reading of weighing scale will be equal to R.



or $R = Mg + Ma = m\,(g + a)$

$\therefore$ $R = 80\,(10 + 5) = 80 \times 15 = 1200$ N

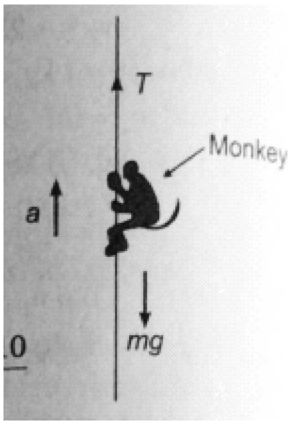
28. **b)** **2.5 m/s²**

Maximum bearable tension in the rope

$$T = 25 \times 10 = 250 \text{ N}$$

From the figure,

$$T - mg = ma$$



or $a = \frac{T - mg}{m}$

Given, m = 20 kg,

g = 10 m/s²,

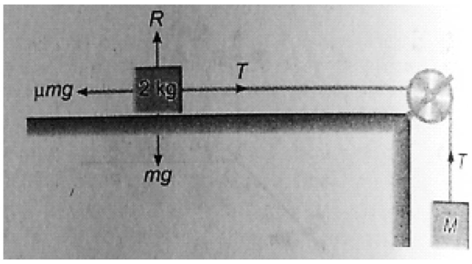
T = 250 N

hence, $a = \frac{250 - 20 \times 10}{20}$

$$= \frac{50}{20} = 2.5 \text{ m/s}^2$$

29. **d)** **0.4 kg**

Let the mass of the block B is M.



In equilibrium,

$$T - mg = 0$$

$\Rightarrow$ $T = Mg$ ...(i)

If blocks do not move, then

$$T = f_s$$

Where f_s = frictional force = $\mu_s R = \mu_s mg$

$\therefore$ $T = \mu_s mg$ ...(ii)

Thus, from Eqs. (i) and (ii), we have

$$Mg = \mu_s mg$$

or $m = \mu_s m$

Given, $\mu_s = 0.2$, m = 2 kg

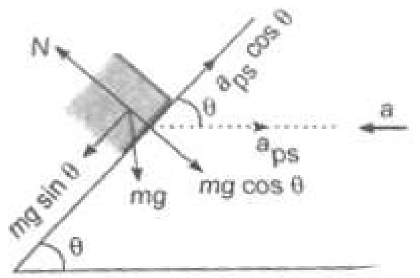
$\therefore$ $M = 0.2 \times 2 = 0.4$ kg

30. **d)** $\mathbf{\frac{mg}{\cos\theta}}$

Let an acceleration to the wedge is given towards left, then the block (being in non-inertial frame) has a pseudo force to the right because of which the block is not slipping

$\therefore$ $mg \sin\theta = a_{pseudo} \cos\theta$

$\Rightarrow$ $a_{pseudo} = \frac{mg\sin\theta}{\cos\theta}$



Hence, total force exerted by the wedge on the block is

$$N = N_1 + N_2$$

$$= mg\cos\theta + a_{pseudo}\sin\theta$$

$$= mg\cos\theta + \frac{mg\sin\theta}{\cos\theta} \times \sin\theta$$

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

$$= \frac{mg}{\cos\theta}$$

31. **a)** $\mathbf{\frac{v}{g\mu}}$

Block B will come to rest, if force applied to it will vanish due to frictional force acting between block B and surface, ie,

frictional force = force applied

ie, $\mu mg = ma$

or $\mu mg = m\left(\frac{v}{t}\right)$

or $t = \frac{v}{\mu g}$

32. **a)** **0.5 N**

$F_{required}$ =[–x component of resultant force]

Now, $\vec{F}_{reqd} = (4-2)\left(\cos 30\,\hat{j} - \sin 30\,\hat{i}\right)$

$$+1\left(\cos 60\,\hat{i} + \sin 60\,\hat{j}\right)$$

$\therefore$ $\vec{F}_{reqd} = -\left[-\hat{i} + \frac{1}{2}\hat{i}\right] = \frac{1}{2}\hat{i}$

33. **d)** $\mathbf{10\sqrt{2}kg}$

Here, $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$

$$|F| = \sqrt{36+64+100}$$

$$= 10\sqrt{2}N$$

$$a = 1\ ms^{-2}$$

$\therefore$ $m = \frac{10\sqrt{2}}{1}$

$$= 10\sqrt{2}\ kg$$

34. **b) push it against the earth with very high velocity**

When the rocket gas pushes it against the earth with high velocity, there is production of reaction force which creates lift for the rocket.

35. **b) 10800 N**

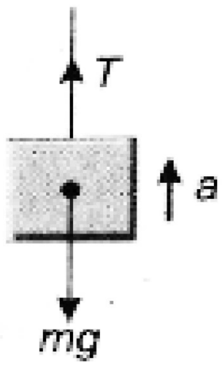
When lift move upwards with same acceleration, then

$T - mg = ma$

or $T = m(g + a)$

Given, $m = 1000$ kg, $a = 1\ m/s^2$,

$g = 9.8\ m/s^2$



Thus, $T = 1000\,(9.8 + 1)$

$= 1000 \times 10.8$

$= 10800$ N

36. **a) $15 \times 10^4\ m/s^2$**

Using the formula, $v^2 = u^2 + 2as$

$$(100)^2 = (200)^2 - 2a \times \frac{10}{100}$$

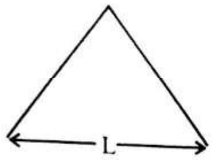
$$2a \times \frac{10}{100} = (200)^2 - (100)^2 = 300 \times 100$$

$$a = \frac{3\times 10^5}{2} = 15 \times 10^4\ m/sec^2$$

37. **b) When the elevator moves downward with constant acceleration**

Person will feel his weight less when the lift goes down with acceleration.

38. **a)**



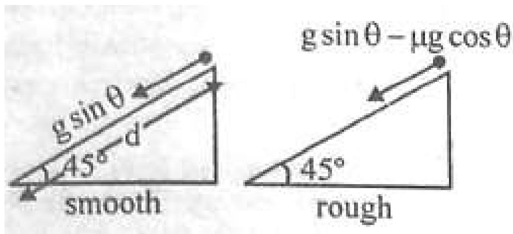
In figure no. (a) and (c), a constant force equal to mg sinθ is required. After reaching the highest point, in case of figure (c), no force is required but in case of figure (a), body travels on its own. So a –ve force is acting on the body. In this way, figure (a) represents the given F – x curve.

39. **b) 1**

Net force of reaction acts on a body in a lift when it is accelerating. If lift moves up or down with uniform speed then acceleration a = 0,

$\therefore$ weight of man = mg is same in ascending or descending hence ratio = 1.

40. **b)** $\mu_k = 1 - \frac{1}{n^2}$



$$d = \frac{1}{2}(g\sin\theta)t_1,$$

$$d = \frac{1}{2}(g\sin\theta - \mu g\cos\theta)t_2,$$

$$t_1 = \sqrt{\frac{2d}{g\sin\theta}}$$

$$t_2 = \sqrt{\frac{2d}{g\sin\theta - \mu g\cos\theta}}$$

According to question, $t_2 = nt_1$

$$n\sqrt{\frac{2d}{g\sin\theta}} = \sqrt{\frac{2d}{g\sin\theta - \mu g\cos\theta}}$$

μ, applicable here, is kinetic friction as the block moves over the inclined plane.

$$n = \frac{1}{\sqrt{1-\mu_k}}\left(\because \cos 45^0 = \sin 45^0 = \frac{1}{\sqrt{2}}\right)$$

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

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

41. **a) 595 N**

The net upward acceleration is

(9.8 – 2.8) = 7m/sec²

Total mass = 80 + 5 = 85 kg

So, net upward force is

F = 85 × 7 = 595 N

42. **a) the ground exerts on it**

As per Newton's third law of motion, when a horse pulls a wagon, the force that causes the horse to move forward is the force the ground exerts on it.

43. **b) 3000 N**

The change in momentum

$\Delta p = m(v_f - v_i)$

$= 0.150\ (60 - (-40))]$

$= 0.150 \times 100 = 15$ N

Thus, $F = \frac{\Delta p}{\Delta t} = \frac{15}{5\times10^{-3}} = 3 \times 10^3$ N

44. **c) 10 N**

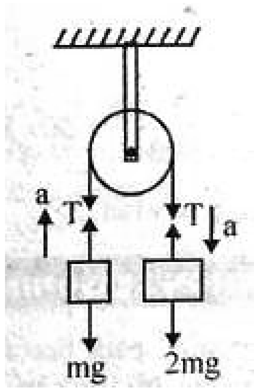
The acceleration of both the blocks

$= \frac{15}{3x} = \frac{5}{x}$

$\therefore$ Force on B $= \frac{5}{x} \times 2x = 10$N

45 **b) g/3, g**

Let a and a′ be the acceleration in both cases respectively. then for fig (a),



T – mg = ma ...(i)

and 2 mg – T = 2ma ...(ii0

Adding (i) and (ii), we get

mg = 3ma

$\therefore \quad a = \frac{g}{3}$

PART B - CHEMISTRY

46. **c) 32.05**

Molarity = mole/litre

∵ 1cc contains 1.17gm

∴ 1000cc contains 1170gm =

No. of moles = $\frac{\text{weight}}{\text{molecular weight}}$

$= \frac{1170}{36.5} = 32.05\text{mole/litre}$

(Mol. wt. of HCl = 36.5)

47. **c) 19**

In $Fe(CNS)_3.\ 3H_2O$

% of $H_2O = \frac{3\times18}{284}\times100 = 19\%$

48. **a) 5L**

$\underset{1l}{C_3H_8} + \underset{5l}{5O_2} \longrightarrow 3CO_2 + 4H_2O$

∴ 1L of propane required 5L of oxygen for combustion.

49. **a) 72 g**

$\underset{1mole}{Mg} + \underset{0.5mole}{\frac{1}{2}O_2} \rightarrow MgO$

0.5 mole of oxygen react with 1 mole of Mg

1.5 mole pf oxygen react with $\frac{1.5}{0.5}$ = 3 mole of Mg

Mass of combined magnesium = 3 × 24 = 72 gm

50. **b) 5.0**

$(H_2SO_4)\ \frac{M_1V_1}{n_1} = \frac{M_2V_2}{n_2}$ (NaOH); V_1 = 5ml.

$M_1 \times n_1 \times V_1 = M_2 \times n_2 \times V_2$

51. **b) 0.05M**

$M = \frac{W\times1000}{\text{mol. mass}\times\text{Volume in ml.}}$

$= \frac{9.8\times1000}{98\times2000} = 0.05M$

52. **a) 0.5**

$M = \frac{W}{\text{m.wt.}}\times\frac{1000}{\text{Volume in ml.}} = \frac{5\times1000}{40\times250}$

= 0.5 M

53. **d) $\frac{N}{40}$**

$NV = N_1V_1 + N_2V_2 + N_3V_3$

or, 1000N

$= 1\times5 + \frac{1}{2}\times20 + \frac{1}{3}\times30 \text{ or } N = \frac{1}{40}$

54. **c) 0.018**

W = 1000 gm (H_2O); n = 1 mole

$N = \frac{W}{M} = \frac{1000}{18} = 55.55$

$X_{solute} = \frac{n}{n+N} = \frac{1}{1+55.55} = 0.018$

55. **b) $\frac{\text{No.of gram equivalent of solute}}{\text{Volume of solution in litre}}$**

56. **b) It shows molal concentration**

57. **c) 500**

Molarity (m)

$\frac{\text{Molarity}}{\text{Density} - \frac{\text{Molarity}\times\text{Molecular mass}}{1000}}$

$= \frac{18}{1.8 - \frac{18\times98}{1000}} = 500$

58. **b) 0.00199**

Mole fraction of glucose = $\frac{n}{n+N}$

$$= \frac{0.01}{0.01+5} = 0.00199$$

59. **a) 0.1M**

$$M = \frac{w+1000}{m \times \text{Volume in ml.}} = \frac{1\times1000}{40\times250} = 0.1M$$

60. **a) 480 g**

Molarity =

$$\frac{\%\text{ by weight of solute} \times \text{density of solution} \times 10 \text{ (in litre)}}{M}$$

when M = mol. weight of the solutr

$$\text{Molarity} = \frac{40\times1.2\times10}{M\times1000} \quad \ldots(i)$$

$$\text{Molarity} = \frac{\text{weight of the solute} / M}{\text{volume of solution(In litre)}} \quad \ldots(ii)$$

From Eqs. (i) and (ii)

$$\frac{\text{weight of the solute}}{M\times1000} = \frac{40\times1.2\times10}{M\times1000}$$

Weight of solute = 480 g.

61. **b) Molality does not change with teperature**

Molarity and normality change with temperature because of expansion or contraction of the liquid with temperature. Howerver, molality does not change with temperature because mass of the solvent does not change with temperature.

62. **c) 0.1 molar**

$$C = \frac{6}{60} = 0.1$$

63. **c) 2/3**

Mole fraction of CO²

$$= \frac{n_{CO_2}}{n_{CO_2}+n_{N_2}} = \frac{\frac{44}{44}}{\frac{44}{44}+\frac{14}{28}} = \frac{2}{3}$$

64. **c) 1.22**

Let the density of solution be 'd' Molarity of solution given = 3.6

i.e., 1 letre of solution contains 3.6 moles of H_2SO_4

or 1 litre of solution contains 3.6 × 98 gms of H_2SO_4

Since, the solution contains 29% by mass

100 gm solution contains 29 gm of H_2SO_4

$\frac{100}{d}$ ml solution contain 29 gm of H_2SO_4

1000 ml solution contains 3.6 × 98 gm of H_2SO_4

$$\therefore \quad 3.6 \times 98 = \frac{29\times d}{100} \times 1000$$

d = 1.22

65. **d) 0.1 molal**

$$w = \frac{0.1\times100\times392}{1000} = 3.92g$$

66. **a) 4.0N H_2SO_4**

From the relation

$$\frac{\text{Normality}}{\text{Molarity}} = \frac{\text{Molecularmass}}{\text{Equivalentmass}} = n$$

For 2 n HCl

$$\text{Molarity} = \frac{\text{Normality} \times \text{Equivalent weight}}{\text{Molecular weight}}$$

$$\text{Molarity} = \frac{2\times36.5}{36.5} = 2$$

$$\text{Molarity} = \frac{\text{Normality} \times \text{Equivalent weight}}{\text{Molecular weight}}$$

Molarity = $\frac{4\times49}{98}=2$

Hence 4 N H_2SO_4 and 2 N HCl solution will have same molar concentration.

67. **c)** **55.5**

Molality is defined as the no. of moles per 1000 gm of solvent.

m = $\frac{1000}{18}=55.5$

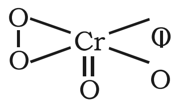
68. **c)** **Cl and O**

$\overset{+1}{K}\overset{+5}{Cl}\overset{-2}{O_3}\longrightarrow\overset{+1}{K}\overset{-1}{Cl}+3\overset{0}{O_2}$

O.N. of Cl changes from + 5 to —1
O.N. of O changes from —2 to 0.

69. **c)** **+ 6**

The structure of CrO_5 is



i.e., it has four peroxide bonds each having an O.N. of — 1 and one double bond in which O.N. of O is — 2. Therfore, the O.N. of Cr in CrO_3 is

$x + 4 \times (-1) + 1 \times (-2) = 0$ or $x = +6$

70. **b)** **+ 3 and + 7**

O.N. of N in NO is

$(1 \times x) + 1 \times (-2) = +1$ or $x = +3$

O.N. of Cl in ClO_4^- is

$(1 \times x) + 4 \times (-2) = -1$ or $x = +7$

71. **c)** **+ 1**

$\overset{+2}{Ba}(\overset{+1}{H_2}\overset{x}{P}\overset{-2}{O_2})_2$

∴ $2 + 2[2 \times (+1) + x + 2 \times (-2)] = 0$
or $2 + 4 + 2x - 8 = 0$ or $x = +1$.

72. **c)** $\mathbf{Cl_2 + 2\underline{KI} \longrightarrow 2KCl + \underline{I_2}}$

a) $\overset{0}{Br_2}\longrightarrow\overset{-1}{HBr}$

b) $\overset{+2}{Hg}Cl_2\longrightarrow\overset{+1}{Hg_2}Cl_2$

c) $2\,\overset{-1}{KI}\longrightarrow\overset{0}{I_2}$

d) $2\,Cu^{2+}\longrightarrow\overset{+1}{Cu_2}I_2$

Only in (c) the O.N. of I increases from — 1 to 0 and hence KI gets oxidised to I_2

73. **c)** **P is both oxidised as well as reduced**

$4\,\overset{0}{P} + 3\,KOH + 3\,H_2O$

$\longrightarrow 3\,KH_2\overset{+1}{P}O_2 + \overset{-3}{P}H_3$

Here,O.N. of P increases from 0 in elemental P to + 1 in KH_2PO_2 and decreases to — 3 in PH_3, therfore, P is both oxidised as well as reduced.

74. **b)** $\mathbf{HNO_2}$

In HNO_2, the O.N. of N is + 3 which os less than the maximum possible O.N. of + 5 and more than the minimum O.N. of — 3, therefore, if can act both as an oxidising as well as a reducing agent.

75. **c)** $\mathbf{H_2S}$

With strong oxidising agents like $KMnO_4$, $K_2Cr_2O_7$ etc. SO_2 acts as a reducing agent but with a weak reducing agents such as H_2S, it acts as an oxidising agent. Thus

$SO_2 + 2\,H_2S \longrightarrow 3S + 2\,H_2O$

76. **c)** $\mathbf{CO_2}$

In CO_2, the O.N. of C, i.e., + 4 is already the maximum and it canot increase its O.N. further and hence does not act as a reducing agent.

77. **a)** **5**

$\underset{+7}{MnO_4^-} + 8H^+ \longrightarrow \underset{+2}{Mn^{2+}}[CrO_4]^{2-} + 4H_2O$

To balance charge add 5 e^- to LHS

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

78. **a)** **5, 1, 6**

$$\overset{-1}{I^-} + \overset{+5}{IO_3^-} + H^+ \longrightarrow \overset{0}{I_2} + H_2O$$

(i) $2I^- \longrightarrow \overset{0}{I_2} \uparrow$ 2 i.e. increase in O.N. = 2

(ii) $2\overset{+5}{IO_3^-} \longrightarrow \overset{0}{I_2} \downarrow$ 10 i.e. decrease in O.N. = 10

To make increase in O.N. = decrease, multiply eqn.

(i) by 5 and add. Hence

$$10I^- + 2\,IO_3^- \longrightarrow 6I_2$$

To balance O atoms, add 6 H2O on RHS. Hence

$$10I^- + 2\,IO_3^- \longrightarrow 6I_2 + 6H_2O$$

To balance H atoms, add 12 H^+ to LHS. Hence

$$10I^- + 2\,IO_3^- + 6\,H^+ \longrightarrow 3I_2 + 6H_2O$$

or $5I^- + IO_3^- + 6\,H^+ \longrightarrow 3I_2 + 3H_2O$

79. **c)** **3**

$$NO_3^- + 4H^+ \longrightarrow 2H_2O + NO$$

In this equation, all the atoms are balanced. To balance charge add 3 e^- to L.H.S., we have

$$NO_3^- + 4H^+ + 3e^- \longrightarrow 2H_2O + NO$$

80. **b)** **2 : 3**

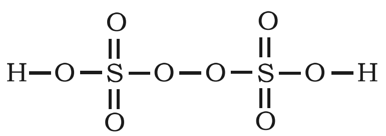
The balanced equation is

$2\,C_2H_6 + 5\,O_2 \longrightarrow 4\,CO_2$ and H_2O

Ratio of the coefficients of CO2 and H2O is 4 : 6 or 2 : 3.

81. **c)** **+ 6**

Structure of $H_2S_2O_8$ is



It contains peroxide linkage for which oxidatio number of these two O-atoms will be —1 each.

∴ 2 × (+ 1) + 2x + 6 × (– 2) + 2 × (– 1) = 0 or 2 + 2x – 12 – 2 = 0 or x = + 6

82. **c)** **1, 3, 4, 5**

$$K\overset{+7}{Mn}O_4 \xrightarrow{+1e^-} (\overset{+6}{Mn}O_4)^{-2}$$

$$K\overset{+7}{Mn}O_4 \xrightarrow{+3e^-} \overset{+4}{Mn}O_2$$

$$K\overset{+7}{Mn}O_4 \xrightarrow{+4e^-} \frac{1}{2}\overset{+3}{Mn_2}O_3$$

(2x – 6 = 0 or x = 3)

$$K\overset{+7}{Mn}O_4 \xrightarrow{+5e^-} \overset{+2}{Mn}$$

83. **b)** **Both oxidised and reduced**

$$H_2 + \overset{0}{Br_2} \longrightarrow \overset{+1-2\;+1}{HOBr} + HBr^{-1}$$

Thus Br_2 has been oxidized as well as reduced.

84. **c)** SO_4^{2-}

$Cr_2O_7^{2-}$ ions in presence of H^+ ions is an oxidizing agent. SO_4^{2-} ions are already in the oxidized state and cannot be further oxidized.

85. **b)** **Two**

86. **d)** **+ 1, –1**

$CaOCl_2$ is actually $Ca^{2+}\,(O\overset{+1}{Cl^-})\overset{-1}{Cl^-}$

Therfore, the O.N. of two Cl atoms are + 1 and –1.

87. **c)** **3**

$$Ca \longrightarrow Ca^{2+} + 2e^-\;]\times 3$$

$$Al^{3+} + 3e^- \longrightarrow Al\;]\times 2$$

On adding the above half reactions, we get

$$3\,Ca + 2\,Al^{3+} \longrightarrow 3Ca^{2+} + 2\,Al$$

Therfore, the stoichiometric coefficient of ca in the given reaction is 3.

88. **a)** **Disproportionation reaction**

Oxidation

$$\overset{0}{P_4} + 3\,NaOH + 3\,H_2O \longrightarrow 3\,NaH_2\overset{+1}{P}O_2 + \overset{-3}{P}H_3$$

Reduction

It is disproportionation reaction.

89. **c)** **+5, + 7, –1, 0**

O.N. of IO_3^- = x + (– 6) = –1

or x = – 1 + 6 = + 5

O.N. of I in IO_4^- = + x + (– 8) = –1

or x = 8 – 1 = + 7

O.N. of I in IO_4^- = = + 1 + x = 0 ∴ x = –1

O.N. of I in I_2 = 0.

90. **b)** **+5, +6, and +6**

O.N. of P in PO_4^{3-}

x + 4 × (– 2) = – 3 or x – 8 = – 3 or x = + 5

O.N.of S in SO_4^{2-}

x + 4 × (– 2) = – 2 or x – 8 = – 2 or x = + 6

O.N. of Cr in $Cr_2O_7^{2-}$

2x + 7 × (– 2) = – 2

or 2x – 14 = –2 or 2x = 12 or x = + 6