Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec: Sr.Super60 **(Adv-NM-P1-Model)** **Date: 28-03-2024**

Time: 02.30Pm to 05.30Pm **GTA-20** **Max. Marks:198**

KEY SHEET

MATHEMATICS

1	ABCD	2	BC	3	ABCD	4	AC	5	BC
6	AC	7	722	8	0	9	5	10	6
11	2	12	1	13	1	14	0	15	0
16	7	17	10	18	7	19	28	20	363

PHYSICS

21	B	22	AC	23	ABD	24	AC	25	AC
26	ABC	27	0.60	28	2.88	29	781.25	30	1200
31	4	32	8	33	5	34	5	35	6
36	0	37	1250	38	1050	39	20	40	10

CHEMISTRY

41	ABC	42	AC	43	AC	44	ABCD	45	ABD
46	ACD	47	7	48	5	49	12	50	1.30 to 1.33
51	3	52	5	53	5	54	7	55	6
56	80	57	19.14 - 19.15	58	2	59	6	60	6

SOLUTIONS
MATHEMATICS

1.
$$q = \max_{i \neq j} |x_i - x_j| \text{ and } S^2 = \frac{1}{n-1} \sum_{i=1}^{n} \left(x_i - \bar{x}\right)^2$$

Now, $(x_i - \bar{x})^2 = \left(x_i - \frac{x_1 + x_2 + ... + x_n}{n}\right)^2$

$$= \frac{1}{n^2}\left[(x_i - x_1) + (x_i - x_2) + ... + (x_i - x_{i-1}) + (x_i - x_{i+1}) + ... + (x_i - x_n)\right]^2$$

$\because |x_i - x_j| \le q$ hence $(x_i - \bar{x})^2 \le \frac{1}{n^2}((n-1)q)^2 < q^2$

$$\Rightarrow (x_i - \bar{x})^2 < q^2 \Rightarrow \sum_{i=1}^{n} (x_i - \bar{x})^2 < nq^2$$

$$\Rightarrow \frac{1}{n-1}\sum_{i=t}^{n}(x_i - \bar{x})^2 < \frac{nq^2}{n-1} \qquad \Rightarrow S^2 < \frac{nq^2}{(n-1)} \Rightarrow S < q\sqrt{\frac{n}{n-1}}$$

2. The number of sequences under consideration is equal to 12-element combinations with repetition of elements of set{1, 2 3 …., 50}

Probability = $\frac{{}^{61}C_{12}}{(50)^{12}}$

3.
$$S(n+1) = \sum_{r=0}^{n} (-1)^{n-r} \left\{1 - \frac{1}{r+1}\right\} \frac{(n+1)!}{r!(n+1-r)!}$$

$$= \sum_{r=0}^{n} (-1)^{n-r\,n-1}C_r - \sum_{r=0}^{n} (-1)^{(n-r)} \frac{(n+1)!n+2}{(r+1)!(n+1-r)!} \cdot \frac{1}{n+2}$$

$$= 1 - \frac{1}{n+2}\sum_{r=0}^{n} (-1)^{n-r\; n+2}C_{n+1-r} = 1 - \frac{1 + (-1)^n}{n+2}$$

4.
$$n^2 - 5(2n-5) \le \frac{393(n-5)}{5} \le n^2 - 25$$

$\Rightarrow 73.6 \le n \le 83.6$, n = 80 is only possible value

5. $A' = A(A \text{ is symmetric})$

$B' = -B(B \text{ is skew symmetric})$

$(A+B)(A-B) = (A-B)(A+B)$

$\Rightarrow A^2 - AB + BA - B^2 = A^2 + AB - BA - B^2$

$\Rightarrow 2BA = 2AB \Rightarrow AB = BA$ ………….(1)

Also, $(AB)' = (-1)^k AB$

$\Rightarrow A'B' = (-1)^k AB \Rightarrow -BA = (-1)^k AB$

$\Rightarrow -BA = (-1)^k BA$ using equation (1), we get

k = odd number

6. $|\vec{a}-\vec{b}|^2 + |\vec{b}-\vec{c}|^2 + |\vec{c}+\vec{a}|^2 = 3 \Rightarrow |\vec{a}+\vec{c}-\vec{b}|^2 = 0,\ \vec{a}+\vec{c}=\vec{b} \Rightarrow \vec{a}\cdot\vec{c} = -\frac{1}{2}$

So, $|\vec{a}+\vec{b}+\vec{c}| = 2|\vec{b}| = 2,\ |\vec{a}+2\vec{b}+3\vec{c}| = |3\vec{a}+5\vec{c}| = \sqrt{19}$

7. $P = (2+\sqrt{3})^5$, where $0 < f,\ f' < 1$

Also $f' = (2-\sqrt{3})^n$

Now $I + f + f' = (2+\sqrt{3})^n + (2-\sqrt{3})^n$ =even integer

$\Rightarrow f + f'$ is an integer

But $0 < f + f' < \Rightarrow f + f' = 1$

Now , $\frac{f^2}{1-f} = \frac{f^2}{f'} = \frac{(1-f')^2}{f'} = \frac{\left[1-(2-\sqrt{3})^n\right]^2}{(2-\sqrt{3})^n} = \left[1-(2-\sqrt{3})^n\right]^2 \cdot (2+\sqrt{3})^n$

$(2+\sqrt{3})^n\left[1+(2-\sqrt{3})^{2n} - 2(2-\sqrt{3})^n\right]^2 (2+\sqrt{3})^n + (2-\sqrt{3})^n - 2$

Not put n = 5

$2\left[{}^5C_0 \cdot 2^5 + {}^5C_2 \cdot 2^3 \cdot 3 + {}^5C_4 \cdot 2^1 \cdot 9 - 1\right]$

$2[32 + 10.8.3 + 5.2.9 - 1] = 2[32 + 240 + 90 - 1] = 722$

8. Let $f(r) = \int_0^{\pi/2} x^r \sin x\, dx$

Now, $\int_0^{\pi/2} x^r \cos x dx = \frac{x^{r+1}}{r+1}\cos x \Big|_0^{\pi/2} + \int_0^{\pi/2} \frac{x^{r+1}}{r+1}\sin x dx$

$\Rightarrow \int_0^{\pi/2} x^r \cos x\, dx = \frac{f(r+1)}{(r+1)}$

So, we have $\lim_{r\to\infty} \frac{r^C f(r)(r+1)}{f(r+1)} = L$

Now, consider $f(r) < \int_0^{\pi/2} x^r dx = \frac{\left(\frac{\pi}{2}\right)^{r+1}}{r+1}$

Also as $\sin x > \frac{2x}{\pi} \forall x \in \left(0, \frac{\pi}{2}\right)$

$$f(r) > \int_0^{\pi/2} \frac{2}{\pi} x^{r+1} dx = \frac{\left(\frac{\pi}{2}\right)^{r+1}}{r+2} \quad \Rightarrow \frac{r}{r+2} < r\left(\frac{2}{\pi}\right)^{r+1} f(r) < \frac{r}{r+1}$$

Hence, $\lim\limits_{r\to\infty} \frac{f(r)}{f(r+1)} = \lim\limits_{r\to\infty} \frac{r\left(\frac{2}{\pi}\right)^{r+1} f(r)}{(r+1)\left(\frac{2}{\pi}\right)^{r+2} f(r+1)} \times \frac{2(r+1)}{\pi r} = \frac{2}{\pi}$

Now, $\lim\limits_{r\to} r^c (r+1) \frac{f(r)}{f(r+1)} = L \Rightarrow \lim\limits_{r\to\infty} \frac{2}{\pi} r^C (r+1) = L$

For positive L, we should have c = -1 and $L = \frac{2}{\pi}$

9. Newton Leibnitz Rule

10. Centre of the given circle is O(4, -3)

The circumcircle of ΔPAB will circumscribe the quadrilateral PBOS also, hence one of the diameters must be OP.

Equation of circumcircle of ΔPAB will be $(x-2)(x-4)+(y-3)(y+3)=0$

$\Rightarrow x^2 + y^2 - 6x - 1 = 0$ ....(1)

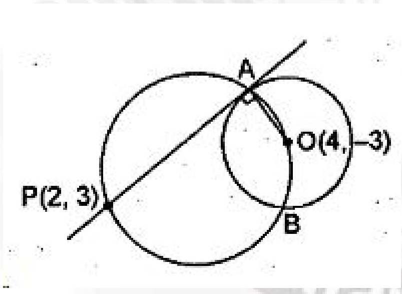
Director circle of given ellipse will be

$(x+5)^2 + (y-3)^2 = 9 + b^2$

$\Rightarrow x^2 + y^2 + 10x - 6y + 25 - b^2 = 0$ ....(2)

From (1) and (2) by applying condition of orthogonally, we get

$2[-3(5)+0(-3)] = -1 + 25 - b^2 \Rightarrow -30 = 24 - b^2$



$b^2 = 54 \Rightarrow \left(\frac{b^2}{9}\right)$ is 6

11. Let the normal to the hyperbola be $3x\cos\theta + y\cot\theta = 10$ ....(i)

and tangent to the parabola be $y = mx + \frac{2\sqrt{5}}{m}$ ....(ii)

Comparing (i) & (ii)

$\frac{-m.\sec\theta}{3} = \tan\theta = \frac{1}{\sqrt{5}m} \Rightarrow \sec\theta = -\frac{3}{\sqrt{5m^2}}$ and $\tan\theta = \frac{1}{\sqrt{5}m}$

Now, $\sec^2\theta = 1 + \tan^2\theta$

$$\Rightarrow \frac{9}{5m^4} = 1 + \frac{1}{5m^2} \Rightarrow 5m^4 + m^2 - 9 = 0$$

$m^2 = \frac{-\pm\sqrt{181}}{10}$ the two real values

12. Case-I:

If $a \in [0,1]$, the curves intersect at $\left(\frac{a}{3}, \frac{a}{3}\right)$ and (a, a). The bounded region is contained in the triangle with vertices (0, 0), $\left(\frac{1}{2}, 0\right)$ and (1, 1) with area = $\frac{1}{4}$

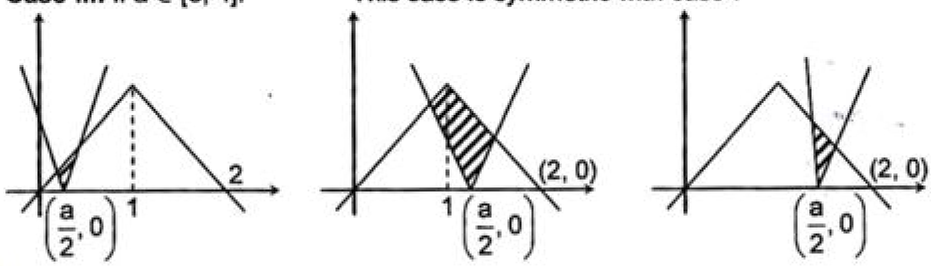
Hence, area cannot exceed $\frac{1}{4}$

Case-II:

If $a \in [1,3]$. In this case the bounded region is a quadrilateral with four vertices $\left(\frac{a}{3}, \frac{a}{3}\right), \left(\frac{a}{2}, 0\right), \left(\frac{a+2}{3}, \frac{4-a}{3}\right)$ and (1,1). In this case area bounded

$$= 1 - \frac{1}{2} \cdot \frac{a}{3} \cdot \frac{a}{2} - \frac{1}{2}\left(\frac{4-a}{3}\right)\left(2 - \frac{a}{2}\right) = \frac{1}{3} - \frac{(a-2)^2}{6} \le \frac{1}{3}$$

Case-III: If $a \in [3, 4]$. This case is symmetric with case-I



13. Here $x > 0$, $\log_2 \frac{x^2+1}{x} = 3x^2 - 2x^3$

$$\Rightarrow \frac{x^2+1}{x} = 2^{3x^2-2x^3}$$

$$\Rightarrow x + \frac{1}{x} = 2^{3x^2-2x^3} \ge 2^1 \ (x + \frac{1}{x} \ge 2 \text{ if } x > 0)$$

$$\Rightarrow 3x^2 - 2x^3 \ge 1$$

Or $(x-1)^2(2x+1) \le 0$

$$\Rightarrow x \in \left(-\infty, -\frac{1}{2}\right] \cup \{1\}$$

But $x > 0$

$x = 1$

14. $\left(z - \in^k\right)\left(\bar{z} - \in^{\bar{k}}\right) \le 1$

$z\bar{z} - z\overline{\in^k} - \bar{Z} \in^k + \in^k \overline{\in^k} \le 1$

$\Rightarrow |z|^2 \le z\overline{\in^k} + \bar{z} \in^k$

Now, sum these relations $\Rightarrow |z|^2 \times n \le z\left(\sum_{k=0}^{n-1} \in^k\right) + \bar{z}\left(\sum_{k=0}^{n-1} \in^k\right)$

$\Rightarrow |z|^2 \cdot n \le 0 \Rightarrow |z| = 0$

15. $\frac{dy}{dx} + y = 4xe^{-x}\sin 2x$

Integrating factor = e^x

Equation becomes $ye^x = 4\int x\sin 2x dx$

$\Rightarrow ye^x = (\sin 2x - 2x\cos 2x) + c$

$f(0) = 0 \Rightarrow c = 0$

$y = f(x) = (\sin 2x - 2x co 2x)e^{-x}$

$f(k\pi) = e^{-k\pi}(0 - 2k\pi(1))$

$f(k\pi) = -2k\pi e^{-k\pi}$

$\lim_{n\to\infty} \sum_{k=1}^{n} f(k\pi) = -2\pi\left(1\cdot e^{-\pi} + 2e^{-2\pi} + 3e^{-3\pi} + ... \text{upto } \infty\right) = \frac{-2\pi e^{\pi}}{\left(e^{\pi} - 1\right)^2}$

16. $A = \begin{bmatrix} 2 & 4 & 5 \\ 8 & 9 & 15 \\ 16 & 81 & 81 \end{bmatrix}$

17. $A = \begin{bmatrix} 2 & 4 & 5 \\ 8 & 9 & 15 \\ 16 & 81 & 81 \end{bmatrix}$

18. $\frac{18}{3!} + \frac{9}{3} + \frac{1}{1} = 7$

19. ${}^8C_2$

20. $3^9 - 3\cdot 2^9 + 3\cdot 1^9$

PHYSICS

21. When the switch 'S' is opened,

$\tau = RC = 1.5\,\text{sec}$

Voltage across the capacitor,

$V_c = 10\left(1 - e^{t/1.5}\right)$ for t<T

The current, $i = \dfrac{dQ}{dt} = C\dfrac{dV_c}{dt}$

$= \dfrac{200}{3} \times 10^{-6}\left(e^{-t/1.5}\right)$ for t<T

Voltage drop across 100 k μ resister,

$V = iR = \dfrac{20}{3}e^{-t/1.5}$ for t < T

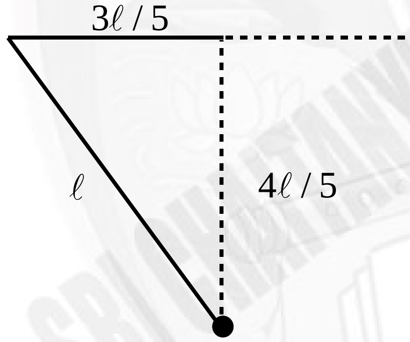
After t = T,

$\tau = 100\,k\Omega \times 10\,\mu F = 1\,\text{sec}$

22. Direction of electromagnetic wave is along $\vec{E} \times \vec{B}$

And $\vec{B}$ and $\vec{E}$ oscillate in same phase

23. Three will be no normal reaction between rod and ring. Because rod is massless. The motion of ring will be free fall under gravity.



Velocity of ring when it leaves contact with rod

$= \sqrt{2 \times g \times \dfrac{4\ell}{5}} = \sqrt{\dfrac{8g\ell}{5}}$

Angular momentum

$= m\dfrac{3\ell}{5}\sqrt{\dfrac{8g\ell}{5}} = m\sqrt{\dfrac{72g\ell^3}{125}}$

24. conceptual

25. $f = \dfrac{330}{(330-10)} \times 640 = \dfrac{330}{320} \times 640 = 660\,\text{Hz}$

26. $q = q_0 \sin\left(\omega t + \dfrac{\pi}{6}\right)$

$i = q_0\omega\cos\dfrac{\pi}{6}$ $\quad i = \dfrac{q_0}{2}\dfrac{\sqrt{3}}{2} \Rightarrow q_0 = \dfrac{24}{\sqrt{3}} = 8\sqrt{3}$

Alternatively $\frac{q_0^2}{2C} = \frac{1\left(4\sqrt{3}\right)^2}{2} + \frac{1}{2}\times 2\times (6)^2$

$q_0 = 8\sqrt{3}$ $\quad \frac{1}{2}Li_0^2 = \frac{q_0^2}{2C} \Rightarrow i_0 = 4\sqrt{3}$

27. $A_t = A_i \frac{2v_2}{(v_1+v_2)} = \frac{2\times 2\times 0.9}{6} = 2\times 0.3 = 0.6$

28. $P = \frac{V^2}{4R} \Rightarrow R = \frac{V^2}{4P} = \frac{48\times 48}{4\times 200} = 2.88\Omega$

29. $E_1 = \frac{r}{2}\cdot\frac{dB}{dt}$ $\quad E_2 = \frac{R^2}{2r}\cdot\frac{dB}{dt}$ $\quad = \frac{3}{2}\times 5\times 10^{-2}\times\frac{25}{2\times 6}\times 5\times 10^{-2}$

$= \frac{25\times 25\times 3\times 10^{-4}}{4\times 6} = 78.125\times 10^{-4} = 781.25\times 10^{-5}$

30. $V_1 = \frac{I}{4\pi\epsilon_0}\times\frac{q}{\sqrt{x^2+R^2}}$

$V_1 = \frac{9\times 10^{+9}\times 10\times 10^{-9}}{3\times 10^{-2}} = 3000$

$V_2 = \frac{9\times 10^{9}\times 10^{-9}\times 10}{5\times 10^{-2}} = 1800$ $\quad , \Delta V = 1200\,V$

31. OE=x $\quad FG = \sqrt{2}a + 2y$

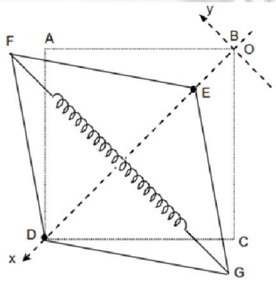
From the property of rhombus, we can write

$\left(\frac{a}{\sqrt{2}}+y\right)^2 + \left(\frac{a}{\sqrt{2}}-\frac{x}{2}\right)^2 = a^2$

Neglecting x^2 and y^2, we have

Using COME, we can write

$\frac{mv^2}{2} + \frac{k}{2}(x)^2 = E = \text{constant} \Rightarrow T = \pi\sqrt{\frac{4m}{k}}$



32. Let in time t, m mass of liquid collides with windshield. So

$F = \left|\frac{p_f - p_i}{t}\right| = \left|\frac{0 - mv}{t}\right| = \frac{mv}{t}$

$\lambda \Rightarrow$ density of liquid molecules in air so

$m = Svt\times\lambda = Sv\lambda t$

Where $S \Rightarrow$ surface area of the windshield

$$F = Sv^2\lambda \Rightarrow \text{Mean pressure} = \frac{F}{S} = \lambda v^2 \quad .....(1)$$

Now as we assumed that λ is the density of liquid molecules of drops in air so in τ time $U\tau S_0$ volume of liquid will strikes on the surface of earth so mass of liquid strikes on the earth in time interval τ will be

$m_0 = S_0 u\tau\lambda$

$\Rightarrow S_0\rho h = S_0 u\tau\lambda$

$\Rightarrow \lambda = \frac{\rho h}{u\tau}$

Putting this value in equation (1), we have

$$\text{Mean pressure} = \frac{\rho h v^2}{u\tau} = \frac{48}{5}$$

33. $P_2 = \rho g(h - x), P_1 = \rho gh$

$V_2 = Ax \qquad V_1 = Ax_0$

Using Boyle's law we can write

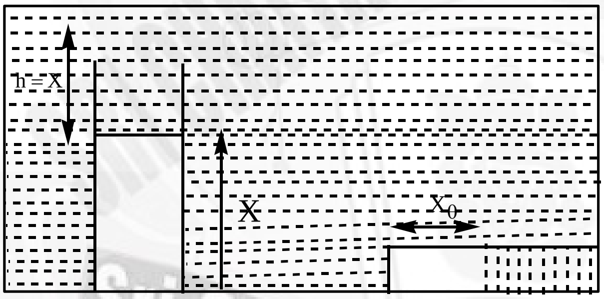
$\rho g(h - x)Ax = \rho gh(Ax_0)$

$$\Rightarrow x^2 - hx + hx_0 = 0 \Rightarrow x = \frac{h}{2} \pm \sqrt{\frac{h^2}{4} - hx_0}$$

$\Rightarrow x = 10m, 90m$

$x < \ell$ (length of pipe)

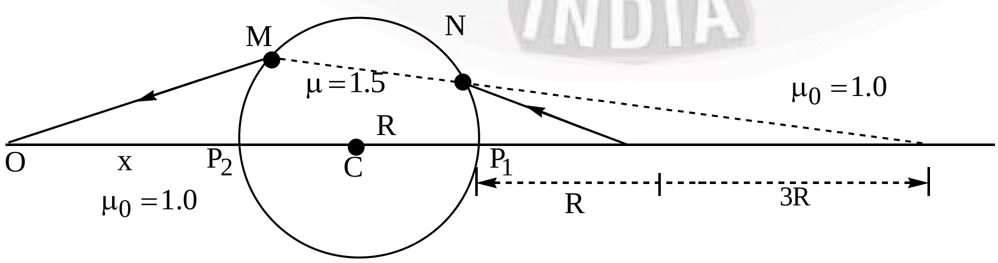
So answer will be x=10m



34. We can reverse the question. Let I behaves as object and O behaves as image, because retracing the path will not alter the distances.

Consider first refraction at point N

$$\frac{1.5}{v} - \frac{1.0}{-R} = \frac{1.5 - 1.0}{+R} \Rightarrow \frac{1.5}{v} = \frac{1}{2R} - \frac{1}{R} \Rightarrow v = -3R$$



$$\frac{1.0}{v} - \frac{1.5}{-5R} = \frac{1.0 - 1.5}{-R}$$

$$\Rightarrow \frac{1}{v}+\frac{3}{10R}=\frac{1}{2R}=\frac{5}{10R}$$

$$\Rightarrow \frac{1}{v}=\frac{5}{10R}-\frac{3}{10R}=\frac{1}{5R}$$

$$\Rightarrow v=5R$$

$$\Rightarrow x=5R\Rightarrow k=5$$

Consider second refraction at point M, for this I, will behaves as normal object so

35. According to Bohr's model

$$\Delta E=E_0\left(1-\frac{1}{n^2}\right)\Rightarrow \Delta E_{min}=\frac{3E_0}{4}$$

During inelastic collision, a part of kinetic energy of colliding particles is converted into internal energy. The internal energy of the system of two hydrogen atoms, considered in the problem cannot be changed less than ΔE_{min}. It means if the change in kinetic energy of system in grour frame is less than ΔE_{min} (or if the kinetic energy of colliding atoms with respect to their centre mass is less than ΔE_{min}), then collision must be an elastic one. Hence considering the critical case

$$\frac{1}{2}m_H\left(\frac{v_0}{2}\right)^2\times 2=\frac{3E_0}{4}\Rightarrow v_0=\sqrt{\frac{3E_0}{m_H}}$$

$$\sqrt{\frac{3\times 2.18\times 10^{-18}}{1.67\times 10^{-27}}}=\sqrt{39.1617}\times 10^4=6.257\times 10^4\,m/s\approx 6.26\times 10^4\,m/s$$

$$\frac{a\times b\times c}{k\times n}=\frac{6\times 2\times 6}{3\times 4}=6$$

36. In the time interval t=0 sec to $t=t_0$ sec, till the time. The relative velocity is not zero the nature of friction will be kinetic.

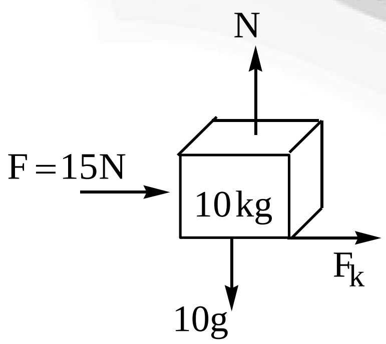
$$\vec{U}_{AB}=0\hat{i}-\left(20\hat{i}\right)=20m/\sec\left(\hat{i}\right)$$

$$N=100N\Rightarrow F_k=0.25\times 100=25N$$

$$\vec{a}_A=4m/\sec^2\left(\hat{i}\right),\vec{a}_B=0m/\sec^2\left(\hat{i}\right)$$

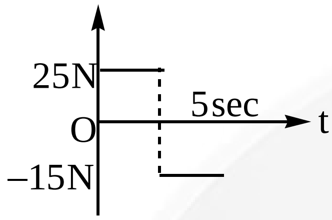
$$\vec{a}_{AB}=\vec{a}_A-\vec{a}_B=4m/\sec^2\left(\hat{i}\right)$$

$$\vec{V}_{AB}=\vec{U}_{AB}+\vec{a}_{AB}t=\vec{o}\Rightarrow t=5sec$$



When the relative motion between block A and belt conveyor will be zero, the nature of friction will be static and its magnitude will equal to magnitude of unbalance external force acting on the block A and its direction will be I the opposite direction of unbalanced external force.

$$\Rightarrow F_r = \text{Frictional force} = \begin{cases} 25N(\hat{i}) \Rightarrow \text{kinetic in nature} \\ 15N(-\hat{i}) \Rightarrow \text{Static in nature} \end{cases}$$



37. In the time interval t=0 sec to $t = t_0$ sec, till the time. The relative velocity is not zero the nature of friction will be kinetic.

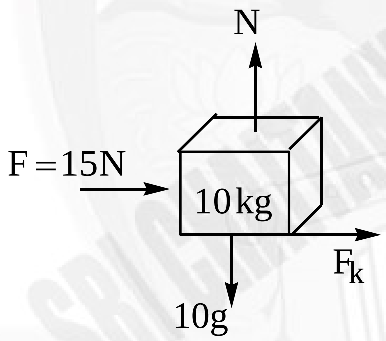
$\vec{U}_{AB} = 0\hat{i} - (20\hat{i}) = 20m/sec(\hat{i})$

$N = 100N \Rightarrow F_k = 0.25 \times 100 = 25N$

$\vec{a}_A = 4m/sec^2(\hat{i}), \vec{a}_B = 0m/sec^2(\hat{i})$

$\vec{a}_{AB} = \vec{a}_A - \vec{a}_B = 4m/sec^2(\hat{i})$

$\vec{V}_{AB} = \vec{U}_{AB} + \vec{a}_{AB}t = \vec{o} \Rightarrow t = 5sec$



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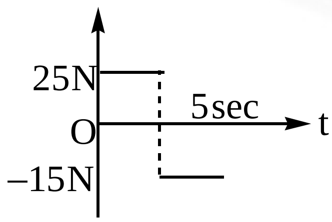


38. In the time interval t=0 sec to $t = t_0$ sec, till the time. The relative velocity is not zero the nature of friction will be kinetic.

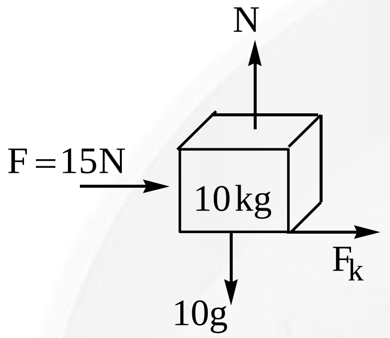
$\vec{U}_{AB} = 0\hat{i} - (20\hat{i}) = 20 m/\sec(\hat{i})$

$N = 100N \Rightarrow F_k = 0.25 \times 100 = 25N$

$\vec{a}_A = 4m/\sec^2(\hat{i}), \vec{a}_B = 0m/\sec^2(\hat{i})$

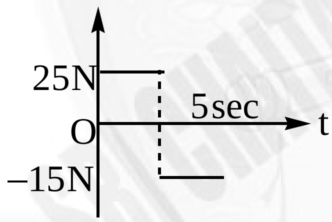
$\vec{a}_{AB} = \vec{a}_A - \vec{a}_B = 4m/\sec^2(\hat{i})$

$\vec{V}_{AB} = \vec{U}_{AB} + \vec{a}_{AB}t = \vec{o} \Rightarrow t = 5\sec$



When the relative motion between block A and belt conveyor will be zero, the nature of friction will be static and its magnitude will equal to magnitude of unbalance external force acting on the block A and its direction will be I the opposite direction of unbalanced external force.

$$\Rightarrow F_r = \text{Frictional force} = \begin{cases} 25N(\hat{i}) \Rightarrow \text{kinetic in nature} \\ 15N(-\hat{i}) \Rightarrow \text{Static in nature} \end{cases}$$



39. $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{30} + \frac{1}{60} \Rightarrow \frac{1}{f} = \frac{1}{20} \Rightarrow f = 20cm$

Focal length of convex mirror

$f = \frac{1}{2}(30 - 10) = 10cm$

40. $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{30} + \frac{1}{60}$

$\Rightarrow \frac{1}{f} = \frac{1}{20} \Rightarrow f = 20cm$

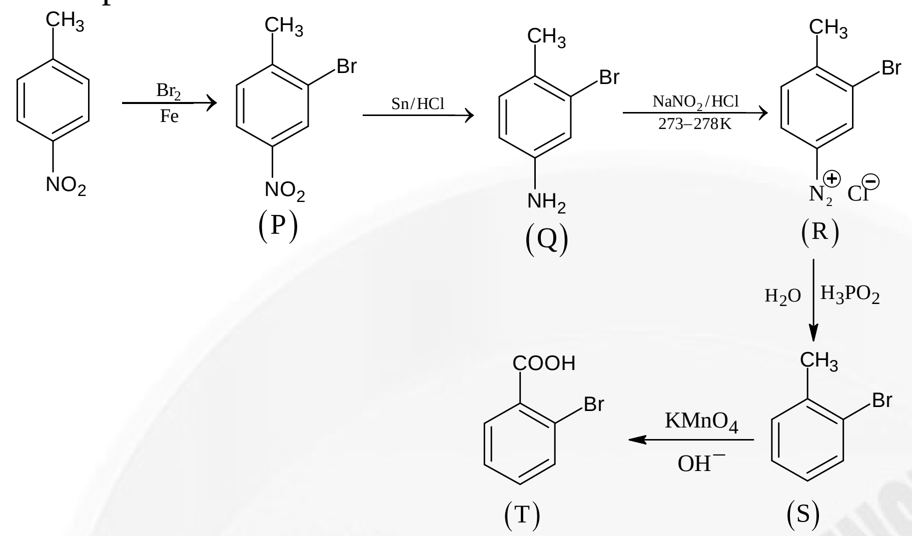
Focal length of convex mirror

$f = \frac{1}{2}(30 - 10) = 10cm\,s$

CHEMISTRY

41. Conceptual

42.



43. Conceptual

44. Conceptual

45. $Pm^{+3} - Ho^{+3} - 4$

$Sm^{+3} - Dy^{+3} - 5$

$Eu^{+3} - Tb^{+3} - 6$

46.

a) due to back bonding $R_3\overset{\oplus}{P}-\overset{\ominus}{O}$ less than $R_3\overset{\oplus}{N}-\overset{\ominus}{O}$

b) $CH_3F < CH_3Cl$

47.

$$\text{Graphite} \rightleftharpoons \text{Diamond}; \Delta G^\circ = 5\,KJ \quad p=1\text{ bar}$$

$$\Delta G = 0 \quad p = ?$$

$$\text{Now, } \Delta G_2 - \Delta G_1 = (V_p - V_G)(P_2 - P_1)$$

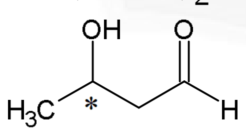
$$\text{Or, } 0 - 5000 = \left[\left(\frac{12}{3.6} - \frac{12}{2.4}\right)\times 10^{-6}\right]\times\left(P_2 - 10^5\right)$$

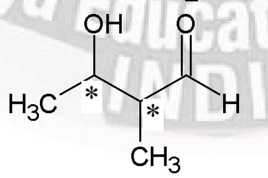
$$\Rightarrow 3\times 10^9 \frac{N}{m^2} \qquad = 3\times 10^4\, bar \qquad Y=3$$

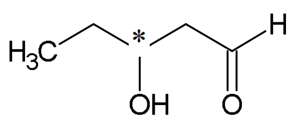
X=4

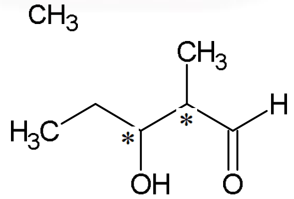
48. $Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow Mg(OH)_2 + 2CaCO_3 + 2H_2O$

49.


(2)


(4)


(2)


(4)

50. $P = C_2H_2, Q = C_6H_6, R = C_6H_5COCH_3, S = C_6H_5CH_2CH_3$

51. $\left[Co(dmg)_2\right] - Co^{+2} - d^7 - S.F - one$

$\left[Mn(CO)_5\right] - Mn^0 - d^5s^2 - S.F - d^7 - one$

$\left[Cu(NH_3)_4\right]^{+2} - Cu^{+2} - d^9 ------ one$

$\left[Ni(NH_3)_6\right]^{+2} - Ni^{+2} - d^8 ----- two$

$\left[Co(NO_2)_6\right]^{-4} - Co^{+2} - d^7 - S.F - one : d^2sp^3$

$\left[Fe(CO)_5\right] - Fe^0 - d^6s^2 - S.F - d^8 - 0$

$\left[Ti(H_2O)_6\right]^{+3} - Ti^{+3} - d^1 --- one$

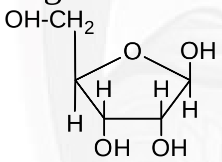
$\left[Ni(CO)_4\right] - Ni^0 - d^8s^2 - S.F - d^{10} - 0$

$\left[Co(H_2O)_6\right]^{3+} - Co^{+3} - d^6 - S.F - 0$

52. arachno boranes - B_nH_{n+6}

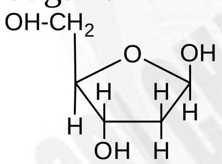
53. (I, II, III, IV, VI)

54. Sugar of RNA is



x=4

Sugar of DNA is



Y=3

X+y=4+3=7

55. Molarity of weak acid = 0.2 M

Now, 10 mL of 0.2 M NaOH +25 mL of 0.2M HA

Salt formed millimoles = $10 \times 0.2 = 2$

Acid reacted in millimoles = $25 \times 0.2 = 5$

Remaining acid left in millimoles = $5 - 2 = 3$

$$\Rightarrow \underset{(\text{acidic buffer})}{pH} = pKa + \log\frac{[salt]}{[Acid]} \Rightarrow 5.82 = pKa + \log\frac{[2/v]}{[3/v]}$$

$$\Rightarrow 5.82 = pKa + \log 2 - \log 3$$

$$\Rightarrow 5.82 = pKa + 0.3 - 0.48 \Rightarrow pKa = 6$$

56. $\frac{E_a}{500} = \frac{E_a - 16}{400} \Rightarrow E_a = 80\,kJ/mol$

57. $\frac{-\Delta H}{2.303R} = 1 \Rightarrow \Delta H = -19.147\ kJ/mol$

58. Given cell

Anode Half cell $H_2 \longrightarrow 2H^+ + 2e^-$, $E^\circ = 0\,V$

Cathode Half cell $Fe^{2+} + 2e^- \longrightarrow Fe$, $E^\circ = -0.44V$

$\Rightarrow E^o_{cell} = \left(E^o_{cathode}\right) - \left(E^o_{anode}\right)$
$= -0.44\,V$

$\Rightarrow$ Nernst equation $E_{cell} = E^o_{cell} - \dfrac{2.303RT}{nF}\log Q$

$$\Rightarrow E_{cell} = -0.44 - \frac{2.303\times(8.314)\times(300)}{(2)(96500)}\log\frac{[Fe]\times\left[H^+\right]}{\left[Fe^{2+}\right][H_2]_P}$$

$$\Rightarrow E_{cell} = -0.44 - (0.0297)\left(10^3 \times \frac{\left(2\times10^{-1}\right)^2}{4}\right)$$

Because $pH = 0.699 = 1 - 0.3010 \Rightarrow -\log\left[H^+\right] = 1 - 0.3010$

$\Rightarrow -\log\left[H^+\right] = \log 2 - \log 10 \Rightarrow \left[H^+\right] = 2\times10^{-1}$

$\Rightarrow E_{cell} = -0.44 - (0.0297)\times\log(10)$

$E_{cell} = -0.4697$

Now , $\Delta G = -nFE_{cell} \;= -(2)(96500)(-0.4697) = 90652\,J\,mol^{-1}$

Now, $\Delta_r G = \Delta_r H - T\Delta_r S$

$\Rightarrow T\Delta_r S = \dfrac{\Delta_r H - \Delta G}{T} = \dfrac{90000 - 90652}{300}$ $\quad \Delta_r S \simeq 2.2\,J$

Clearly the cell is non spontaneous

59. Conceptual

60. $\underset{(B-\text{green ppt})}{CrCl_3 + NaOH \rightarrow Cr(OH)_3}$

$Cr(OH)_3 + \underset{(\text{exess})}{NaOH} \rightarrow \underset{(C-\text{green solution})}{\left[Cr(OH)_4\right]^-}$

$\left[Cr(OH)_4\right]^- + H_2O_2 / OH^- \rightarrow \underset{(D-\text{yellow solution})}{Na_2CrO_4}(Cr = +6)$

$Na_2CrO_4 + H_2O_2 + \text{acid} \rightarrow \underset{(E-\text{deep blue solution})}{CrO_5}$

$CrO_5 \xrightarrow[\text{acidic medium}]{\text{Long standing}} \underset{(A)}{CrCl_3} + \underset{(F)}{O_2}\left(O_2 = \text{antibonding electrons} = 6\right)$