

RITS-46
JEE ADVANCED-2019
ANSWER KEY
Code: 120737

MATHEMATICS		PHYSICS		CHEMISTRY	
1	CD	1	ABC	1	BCD
2	B	2	AB	2	AC
3	ABC	3	BC	3	ABD
4	BCD	4	AD	4	ABC
5	AB	5	ABD	5	ABC
6	AD	6	CD	6	ABC
7	ABC	7	B	7	B
8	AD	8	B	8	A
9	BC	9	D	9	AD
10	C	10	ACD	10	BD
11	A	11	CD	11	C
12	BD	12	A	12	D
1	6	1	3	1	4
2	1	2	4	2	5
3	0	3	1	3	5
4	2	4	4	4	2
5	2	5	5	5	6
6	4	6	3	6	6
7	5	7	2	7	5
8	7	8	3	8	5
9	2	9	4	9	4
10	1	10	1	10	8

MATHEMATICS

1. $\cos B \cos C + \sin B \sin C \sin^2 A = 1 \dots\dots (I)$

We know that $\sin^2 A \leq 1$ $\sin B \sin C \sin^2 A \leq \sin B \sin C$

$$\cos B \cos C + \sin B \sin C \sin^2 A \leq \cos B \cos C + \sin B \sin C$$

$$1 \leq \cos(B-C)$$

But $\cos(B-C)$ cannot be greater than 1

So $\cos(B-C) = 1 \quad B-C=0 \quad B=C \quad \angle B = \angle C$

Put B=C in eq(1)

$$\cos^2 B + \sin^2 B \sin^2 A = 1 \quad \sin^2 B \sin^2 A = 1 - \cos^2 B \quad \sin^2 B \sin^2 A = \sin^2 B$$

$$\sin^2 A = 1$$

$$A = 90^\circ$$

$$\angle A = 90^\circ \quad \angle B = \angle C \quad (c) \& (d) \text{ correct answer}$$

2. A and B are two square matrix $A^2 B = BA$

$$(AB)^2 = AB \cdot AB \quad (AB)^2 = AA^2 B \cdot B \quad (AB)^2 = A^3 B^2 = A^{2^2-1} B^2$$

$$(AB)^3 = AB \cdot A^3 B^2 = A(BA) A^2 B^2 = AA^2 B A^2 B^2 = A^3 (BA) AB^2 = A^3 A^2 (BA) B^2$$

$$A^5 A^2 B \cdot B^2 = A^7 B^3 \quad (AB)^3 = A^{2^3-1} B^3 \quad (AB)^4 = A^{2^4-1} B^4 \quad (AB)^{10} = A^{2^{10}-1} B^{10}$$

$$= A^{1023} B^{10} \quad (b) \text{ so } K=1023$$

3. $f(x+y) = f(x)f(y) \quad f(0) = 1 \quad f'(0) = 2$

Diff w.r to x keeping y as constant

$$f'(x+y) = f'(x) \cdot f(y)$$

$$\text{put } x=0, y=x$$

$$f'(x) = f'(0) f(x) \quad \int \frac{f'(x) dx}{f(x)} = 2 \int dx \quad \log f(x) = 2x + c$$

$$f(x) = e^{2x+c} \quad \text{Put } x=0 \quad f(0) = e^c \quad 1 = e^c$$

$$\text{So } c=0 \quad f(x) = e^{2x}$$

a) $\int_0^{\ln 3} [f(x) \cdot e^{-x}] dx = \int_0^{\ln 3} [e^x] dx = \ln 2 + 2(\ln 3 - \ln 2) = \ln 4.5$

b) $L_{t \rightarrow 0^+} [e^{2x}] = 1 \quad L_{t \rightarrow 0^-} [e^{2x}] = 0 \quad L_{t \rightarrow 0} [e^{2x}] \text{ does not exist}$

c) $f(x) = e^{2x} \text{ so } f^{-1}(x) = \ln \sqrt{x} \quad x > 0$

d) $e^{2x} < e^{x^2-4x} \quad 2x < x^2 - 4x \quad x^2 - 6x > 0 \quad x > 6 \text{ or } x < 0$

So a,b&c are correct answer

4. Ans: (bcd)

$$L_1 \equiv \frac{x-1}{1} = \frac{y-1}{0} = \frac{z-0}{-1} \quad L_2 \equiv \frac{x-0}{1} = \frac{y-1}{1} = \frac{z-1}{0}$$

Shortest distance between the line

$$d = \frac{\begin{vmatrix} -1 & 0 & 1 \\ 1 & 0 & -1 \\ 1 & 1 & 0 \end{vmatrix}}{\sqrt{1+1+1}} \quad d = \frac{-1(1)-0+1}{\sqrt{3}} = 0$$

General point on L1

$$\frac{x-1}{1} = \frac{y-1}{0} = \frac{z-0}{-1} = \lambda \quad x = 1 + \lambda \quad y = 1 \quad z = -\lambda$$

It satisfy the second line

$$\frac{1+\lambda}{1} = 0 = \frac{-\lambda-1}{0} \quad \lambda = -1$$

Point of intersection $x = 0, y = 1, z = 1$

(j+k) (b)

$$\overrightarrow{op} = j + k$$

Projection of \overrightarrow{op} an $i + j + k$ $\frac{2}{\sqrt{3}}$ (d)

5. $\frac{\log a}{b-c} = \frac{\log b}{c-a} = \frac{\log c}{a-b} = \lambda$

$$(b+c)\log a = \lambda(b^2 - c^2) \quad \log a^{b+c} = \lambda(b^2 - c^2) \quad (1) \quad \log b^{c+a} = \lambda(c^2 - a^2) \quad (2)$$

$$\log c^{a+b} = \lambda(a^2 - b^2) \quad (3) \quad \text{Add eq (1) (2) and (3)} \quad a^{b+c} \cdot b^{c+a} \cdot c^{a+b} = 1 \quad (a)$$

$$A.M \geq G.M \frac{a^{b+c} + b^{c+a} + c^{a+b}}{3} \geq 3\sqrt[3]{a^{b+c}b^{c+a}c^{a+b}} \quad a^{b+c} + b^{c+a} + c^{a+b} \geq 3(b)$$

6. $(\sin^{-1} x + \sin^{-1} y)(\sin^{-1} y + \sin^{-1} z) = \pi^2 \quad \sin^{-1} x + \sin^{-1} w = \sin^{-1} y + \sin^{-1} z = \pi$

$$\sin^{-1} x + \sin^{-1} w = \sin^{-1} y + \sin^{-1} z = -\pi \quad x = y = z = w = 1 \quad x = y = z = w = -1$$

Hence maximum value of $\begin{vmatrix} x^{N_1} & y^{N_2} \\ z^{N_3} & w^{N_4} \end{vmatrix} = \begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix} = 2$

And minimum value=-2

Passage-1

7. Required probability $= \frac{1}{5} \times \frac{1}{15} = \frac{1}{75}$

8. $P(E_{22}) = P(\text{scoring } 0, 0, 3, 3 \text{ marks})$

$$= \left(\frac{4}{5}\right)^2 \times \left(\frac{1}{15}\right)^2 = \left(\frac{16}{3^2 \times 5^4}\right)$$

$P(E_{31}) = P(\text{scoring } 1, 1, 1, 3)$

$$= \left(\frac{1}{5}\right)^3 \times \left(\frac{1}{15}\right) = \frac{1}{1875} \neq 0$$

$P(E_{13}) = P(\text{scoring } 0, 3, 3, 0 \text{ or } 0, 3, 0, 3 \text{ or } 0, 0, 3, 3) \neq 0$

Passage-2

$$f(x) = \begin{cases} x+a & x < 0 \\ |x-1| & x \geq 0 \end{cases} \quad f(x) = \begin{cases} x+a & \text{if } x < 0 \\ 1-x & 0 \leq x < 1 \\ x-1 & x \geq 1 \end{cases}$$

$$g(x) = \begin{cases} (x+1) & x < 0 \\ (x-1)^2 + b & x \geq 0 \end{cases} \quad a, b \geq 0 \quad g[f(x)] = \begin{cases} f(x)+1 & f(x) < 0 \\ [f(x)-1]^2 & f(x) \geq 0 \end{cases}$$

$$= \begin{cases} x+a+1 & x+a < 0 \\ [x+a-1]^2 + b & x+a \geq 0 \\ [|x-1|-1]^2 + b & |x-1| \geq 0 \end{cases} \quad g[f(x)] = \begin{cases} x+a+1 & x < -a \\ [x+a-1]^2 + b & -a \leq x < 0 \\ [|x-1|-1]^2 + b & x \geq 0 \end{cases}$$

$$g[f(x)] = \begin{cases} x+a+1 & x < -a \\ [x+a-1]^2 b & -a \leq x < 0 \\ [1-x-1]^2 + b & 0 \leq x < 1 \\ [x-2]^2 + b & x \geq 1 \end{cases} \quad g[f(x)] = \begin{cases} x+a+1 & x < -a \\ [x+a-1]^2 + b & -a \leq x < 0 \\ x^2 + b & 0 \leq x < 1 \\ (x-2)^2 + b & x \geq 1 \end{cases}$$

$\therefore g[f(x)]$ is continuous $\forall x$

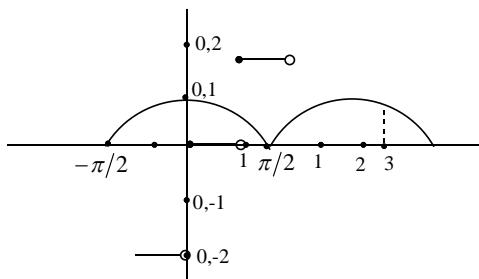
9. So $a=1$ and $b=0$

$$10. \quad g[f(x)] = \begin{cases} x+2 & x < -1 \\ x^2 & -1 \leq x < 0 \\ x^2 & 0 \leq x < 1 \\ (x-2)^2 & x \geq 1 \end{cases} = \begin{cases} x+2 & x < -1 \\ x^2 & -1 \leq x \leq 1 \\ (x-2)^2 & x \geq 1 \end{cases}$$

Passage-3

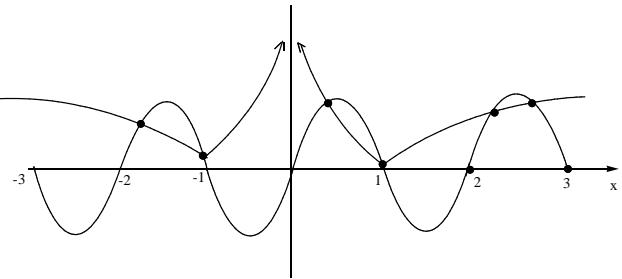
11. Number of solution of the equation

$$|\cos x| = [2x]$$



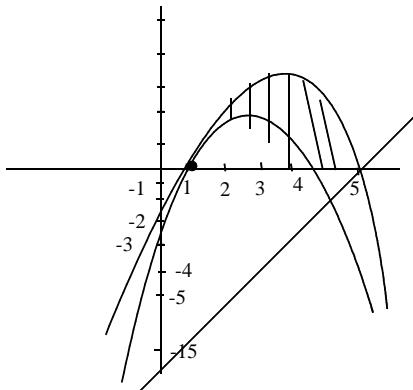
From the graph it is clear that the equation $|\cos x| = [2x]$ has no solution

12. The number of solution of the equation $\sin \pi = |\ln|x||$



The graph of $|\ln|x||$ cut the graph of $\sin\pi$ at 6 points so number of solution of the equation is 6

13. The area bounded by the curve $y = -x^2 + 6x - 5$, $y = -x^2 + 4x - 3$ and the line $y = 3x - 15$ is $73/\lambda$ where $x > 1$ then the value of λ is.....



$$\text{Area} \left| \int_1^5 (6x - x^2 - 5) dx - \int_1^3 (4x - x^2 - 3) dx \right| + \left| \int_3^4 (4x - x^2 - 3) dx + \int_4^5 (3x - 15) dx \right| = \frac{73}{6}$$

14. Let the point on the curve is (x, y) equation of normal is $Y - y = -\frac{1}{m}(X - x)$
 $X + mY - (x + my) = 0$ -----1

Perpendicular distance from $(0, 0)$ to equation

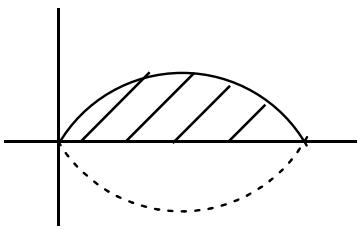
$$\left| \frac{x + my}{\sqrt{1+m^2}} \right| = |y| \quad (x + my)^2 = y^2(1 + m^2) \Rightarrow x^2 + 2mxy = y^2$$

$$m = \frac{y^2 - x^2}{2xy} \Rightarrow \frac{dy}{dx} = \frac{y^2 - x^2}{2xy} \quad y = vx, v + x \cdot \frac{dv}{dx} = \frac{dy}{dx}$$

$$v + x \frac{dv}{dx} = \frac{v^2 - 1}{2v} \quad x \frac{dv}{dx} = \frac{-1 - v^2}{2v} \Rightarrow \int \frac{2v}{v^2 + 1} dv = - \int \frac{dx}{x}$$

$$x \frac{dv}{dx} = \frac{v^2 - 1}{2v} - v$$

$$\log(v^2 + 1) = -\log x + \log c \quad \log\left(\frac{y^2}{x^2} + 1\right) + \log x = \log c \quad \log\left(\frac{y^2 + x^2}{x^2}\right)x = \log c$$



$$x^2 + y^2 = cx$$

It passes through the point(1,1) $1+1=c=2 \rightarrow c=2$

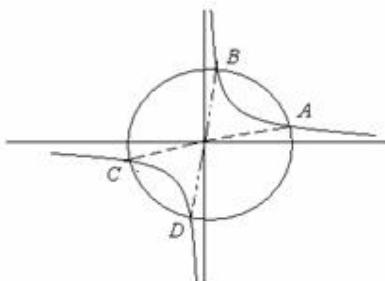
Equation of curve is $x^2 + y^2 - 2x = 0$

i.e. circle whose centre is(1,0) and radius 1 and area bounded by curve and above x-axis

$$\frac{\pi}{2} = \frac{k\pi}{2} \quad k=1$$

15. $z^2 = (\bar{z})^2 + 4i \Rightarrow \left(\frac{z+\bar{z}}{2}\right)\left(\frac{z-\bar{z}}{2i}\right) = 1$ or $xy=1$ (where $z=x+iy$)

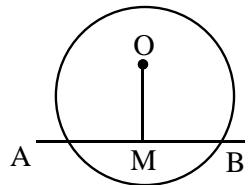
The circle $x^2 + y^2 = 4$ intersects the rectangular hyperbola in four points, which are symmetrical about the origin in parts.



16. $x^2 + y^2 = 4$

$$x + y = n$$

OM is the perpendicular from (0,0) to the line



$$x + y = n$$

$$OM = \left| \frac{n}{\sqrt{2}} \right| \quad AM = \sqrt{4 - 0m^2}$$

$$AB^2 = (2AM)^2 = 4AM^2 \quad AB^2 = 4 \left(4 - \frac{n^2}{2} \right) = 2(8 - n^2) \quad \therefore n \in N$$

So AB^2 exist for n=1 and n=2

$$\text{Hence } p = 2(8 - 1^2 + 8 - 2^2) = 22 \quad \frac{P}{11} = \frac{22}{11} = 2$$

17. Coefficient of x^{50} is the expansion

$$(1+x)^{1000} + 2x(1+x)^{999} + 3x^2(1+x)^{998} + \dots + 1001x^{1000}$$

$$\text{Sol:- } S = (1+x)^{1000} + 2x(1+x)^{999} + 3x^2(1+x)^{998} + \dots + 1001x^{1000}$$

$$\frac{x}{1+x}S = x(1+x)^{999} + 2x^2(1+x)^{998} + \dots + 1000x^{1000} + \frac{1001x^{1001}}{1+x}$$

$$S\left(1 - \frac{x}{1+x}\right) = (1+x)^{1000} + x(1+x)^{999} + x^2(1+x)^{998} + \dots + x^{1000} - \frac{1001x^{1001}}{1+x}$$

$$\frac{S}{1+x} = \frac{(1+x)^{1000} \left[1 - \left(\frac{x}{1+x} \right)^{1001} \right]}{1 - \frac{x}{1+x}} - \frac{1001x^{1001}}{1+x}$$

$$\frac{S}{1+x} = \frac{\left[(1+x)^{1001} - x^{1001} \right]}{1+x-x} - \frac{1001x^{1001}}{1+x}$$

$$S = (1+x)^{1002} - (1+x)x^{1001} - 1001x^{1001}$$

Coeff of x^{50} in $(1+x)^{1002}$ is ${}^{1002}C_{50}$

$${}^{1002}C_{50} = {}^a C_b$$

$$a = 1002, b = 50 \quad \frac{a-2}{10.b} = \frac{1002-2}{10 \times 50} = \frac{1000}{500} = 2$$

$$18. \int_{-1}^1 [\sin^{-1} x] dx = \int_{-1}^{-\sin 1} (-2) dx + \int_{-\sin 1}^0 (-1) dx + \int_0^{\sin 1} (0) dx + \int_{\sin 1}^1 (1) dx$$

$$= -1$$

$$\therefore I = \pi + 1 \text{ and } [I] = 4$$

$$19. \sum_{r=1}^7 \tan^2 \frac{r\pi}{16}$$

$$\tan^2 \frac{\pi}{16} + \tan^2 \frac{2\pi}{16} + \tan^2 \frac{3\pi}{16} + \tan^2 \frac{4\pi}{16} + \dots + \tan^2 \frac{7\pi}{16}$$

$$\tan^2 \frac{\pi}{16} + \tan^2 \frac{2\pi}{16} + \tan^2 \frac{3\pi}{16} + 1 + \cot^2 \frac{3\pi}{16} + \dots + \cot^2 \frac{\pi}{16}$$

$$\tan^2 \frac{\pi}{16} + \cot^2 \frac{\pi}{16} + \tan^2 \frac{2\pi}{16} + \cot^2 \frac{2\pi}{16} + \tan^2 \frac{3\pi}{16} + \cot^2 \frac{3\pi}{16} + 1$$

$$\begin{aligned}
& \left(\cot \frac{\pi}{16} - \tan \frac{\pi}{16} \right)^2 + 2 + \left(\cot \frac{\pi}{8} - \tan \frac{\pi}{8} \right)^2 + 2 + \left(\cot \frac{3\pi}{16} - \tan \frac{3\pi}{16} \right)^2 + 2 + 1 \\
& \because \cot A - \tan A = 2 \cot 2A \\
& \left(2 \cot \frac{\pi}{8} \right)^2 + \left(2 \cot \frac{\pi}{4} \right)^2 + \left(2 \cot \frac{3\pi}{8} \right)^2 + 7 \\
& 4 \left[\cot^2 \frac{\pi}{8} + \cot^2 \frac{3\pi}{8} \right] + 4 + 7 \quad 4 \left[\cot^2 \frac{\pi}{8} + \tan^2 \frac{\pi}{8} \right] + 11 \quad 4 \left[\left(\cot \frac{\pi}{8} - \tan \frac{\pi}{8} \right)^2 + 2 \right] + 11 \\
& 4 \left[\left(2 \cot \frac{\pi}{4} \right)^2 + 2 \right] + 11 \quad 4[6] + 11 = 35 \quad 35 = 7K \quad K=5
\end{aligned}$$

20. O, A, B, C are concyclic. Consider B = (x, y),

$$|\underline{AOB}| = |\underline{ACB}| = \theta \Rightarrow \tan \theta = \frac{y}{x} = \frac{4}{3}$$

\therefore B lies on $4x - 3y = 0$

$$a = 4, b = 3 \text{ and } |a + b| = 7$$

$$21. \begin{vmatrix} a^2 & (s-a)^2 & (s-a)^2 \\ (s-b)^2 & b^2 & (s-b)^2 \\ (s-c)^2 & (s-c)^2 & c^2 \end{vmatrix} = ks^3(s-a)(s-b)(s-c)$$

Where $2s = a+b+c$ then the numerical quantity k should be----

$$s-a = x \quad s-b = y \quad s-c = z$$

$$3s - (a+b+c) = x+y+z \quad 3s - 2s = x+y+z, \quad s = x+y+z$$

$$a = s-x = y+z, b = s-y = z+x, c = s-z = x+y$$

$$\begin{vmatrix} (y+z)^2 & x^2 & x^2 \\ y^2 & (z+x)^2 & y^2 \\ z^2 & z^2 & (x+y)^2 \end{vmatrix} = k(x+y+z)^3 xyz$$

Put $x = y = z = 1$. Then we get $k = 2$

22. The equation $ax^2 + bx + b = 0$ has imaginary roots or real and equal roots

$$f(x) \geq 0 \quad \forall x \in R \quad \text{for } a > 0$$

$$f(3) \geq 0 \quad 9a + 3b + 6 \geq 0 \quad 3[3a + b + 2] \geq 0 \quad 3a + b + 2 \geq 0 \quad 3a + b + 3 \geq 1$$

Least value is (1)

PHYSICS

23. Ans : (a,b,c)

For H_2 like atom $r_n \propto n^2$ (a) is correct. So $\frac{r_n}{r_i} = n^2$, hence $\log\left(\frac{r_n}{r_i}\right) = 2\log n$ so graph

is straight line passing through origin thus option (b) is correct. If radius of an orbit is equal to r, then area

$A = \pi r^2$ so $A \propto n^4$ hence $\frac{A_n}{A_1} = n^4$ or $\log\left[\frac{A_n}{A_1}\right] = 4\log n$ so (c) is also correct.

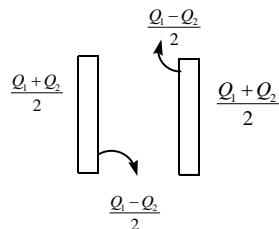
Frequency of revolution $f = \frac{n\hbar}{4\pi^2 mr^2} \Rightarrow f \propto \frac{1}{n^3} \Rightarrow \frac{f_n}{f_1} = \frac{1}{n^3}$

24. Ans : (a,b)

$$T \sin 30^\circ = 20 \text{ N} \quad \text{---(1)} \rightarrow \frac{20}{\sin 30^\circ}$$

$$T \cos 30^\circ = mg \quad \text{---(2)} \quad mg = 3.5 \text{ kg}$$

25. Ans: (b,c)



Initially the charge distributed as shown. charge on outer surface $\frac{Q_1 + Q_2}{2}$ is

constant. Potential difference across the plates is given by $\frac{Q_1 - Q_2}{2C}$ and is independent of charge on outer surface. When capacitor is discharge, charge on inner surface decreasing as per equation $q_2 = \left(\frac{Q_1 - Q_2}{2}\right) e^{\frac{-t}{RC}}$

Then total charge on left plates $q_1 = \frac{Q_1 + Q_2}{2} + \left(\frac{Q_1 - Q_2}{2}\right) e^{\frac{-t}{RC}}$

On the right plates $q_2 = \frac{Q_1 + Q_2}{2} - \left(\frac{Q_1 - Q_2}{2}\right) e^{\frac{-t}{RC}}$

26. (A, D) Along the cylinder $F_x = ma \cos \theta$

For rolling of cylinder $a = a_m + R_\alpha$, $a_y = \frac{F_y}{m} + 2\frac{F_r}{m}$, $F_y = \frac{ma \sin \theta}{3}$

27. Ans: (a,b,d)

$$0 \leq x \leq a, v_x = \left[- \int_a^x E_x dx \right] + V_0 = 0 \text{ as } E_x = 0$$

$$x \geq a, v_x = - \int_a^x E_x dx + V_{(a)} = - \int_a^x \frac{\sigma}{\epsilon_0} dx + V_{(a)} = - \frac{\sigma}{\epsilon_0} (x - a)$$

$$x \leq 0, v_x = - \int_0^x E_x dx + V_{(0)} = - \left[- \frac{\sigma}{\epsilon_0} x \right] + V_{(0)} = \frac{\sigma}{\epsilon_0} x$$

28. Ans:(c,d) Conceptual

29. (B)

$$F = \int_0^H (egh) \cdot (Ldh)$$

30. (B)

$$N = \int_0^H egh L dh (H - h)$$

31. (D)

$$pgl \frac{H^2}{2} \times z = pgl \frac{H^3}{6} \Rightarrow z = \frac{H}{3}$$

32. Ans; a,c,d

33. Ans: c,d

34. Ans: a

(1) At "P" central maxima is formed so net path difference is zero

$$d \sin \phi - d \sin \theta (x_0 + Kt) = 0$$

$$(2) \text{ For velocity } \frac{dy}{dt} = \frac{d}{dt} \left[\frac{D \sin \phi}{(x_0 + Kt)} \right] = - \frac{D \sin \phi K}{(x_0 + Kt)^2}$$

$$(3) \text{ For acceleration } a = \frac{d^2 y}{dt^2}$$

$$d \sin \phi - \mu b + (x_0 + Kt)b = 0 \text{ for central maxima at "O"}$$

35. Ans: N=3

Consider cylinder is composed of thin disc of width dx connected in series. The

$$\text{resistance g-disc at } x \text{ distance } dR = \frac{dx}{\sigma(x) A} = \frac{\sqrt{x} dx}{Al\sigma_0} \Rightarrow R = \int_0^\ell dR = \frac{2\sqrt{\ell}}{3A\sigma_0}$$

$$\text{Current density } = \frac{I}{A} = \frac{3\sigma_0 V_0}{2\sqrt{\ell}} \quad E = \frac{J}{\sigma(x)} = \frac{3V_0 \sqrt{x}}{2\ell^{3/2}}$$

36. Ans: $\beta = 4$

Force due to pressure difference is $F = P \times A$

$$F = \frac{1}{2} \rho (V_2^2 - V_1^2) \times \pi R^2 = \frac{1}{2} \rho (14 - 7) \pi R^2 = \frac{7\pi\rho R^2}{2}$$

For translation $F - f = ma \dots\dots (1)$

For rotation $f \times R = I \frac{a}{R}$ --- (2)

$$\text{Solve (1) \& (2)} \quad f = \pi \rho R^2 = \mu Mg \quad \mu = \frac{\pi \rho R^2}{Mg} = \frac{1}{4} \Rightarrow \beta = 4$$

37. (1) they meet at $CM = \frac{d}{2}$

$$\frac{d}{2} = \frac{1F}{2m} t^2$$

$$t = \sqrt{\frac{md}{F}}$$

$$38. \quad V_{\max} = \frac{3}{2} \sqrt{gL}, \quad w = \sqrt{\frac{K}{m}} = 2\sqrt{\frac{g}{L}} \quad \text{Amplitude } A = \frac{V_{\max}}{w} = \frac{3}{4} L$$

Time taken from start of compression till the block reaches mean position is given by

$$x = A \sin wt \text{ where } x = \frac{L}{4} \quad \text{So } t = \sqrt{\frac{L}{4g}} \sin^{-1}\left(\frac{1}{3}\right)$$

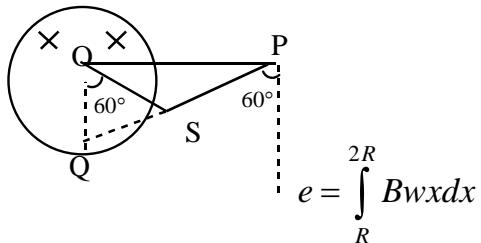
Time taken by block from mean position to bottom most position is $\frac{T}{4} = \frac{\pi}{4} \sqrt{\frac{L}{g}}$

$$x = 4$$

$$39. \quad f = f_0 \left(\frac{v - \frac{v}{3} \cos 60^\circ}{v - \frac{v}{2}} \right) = f_0 \left(\frac{v - \frac{v}{6}}{\frac{v}{2}} \right) = f_0 \left(\frac{\frac{5v}{6}}{\frac{v}{2}} \right) = \frac{5f_0}{3}$$

40. Ans:-3

emf is included due to motion if rod in B filed

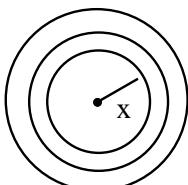


$$e = \int_R^{2R} B w x dx$$

$$= B w \left[\frac{3R^2}{2} \right] \text{ here } B = a + b \left(\frac{\pi}{3w} \right)$$

$$y = 3$$

41. Ans:2



$$\text{Included } E = \frac{x}{2} \frac{dB}{dt} \quad \text{E-field } E = \frac{3kxt^2}{2}$$

$$\text{For small elemental part } d\tau = \frac{3kxt^2 q}{2} q \times \frac{2\pi x dx}{\pi r^2} x$$

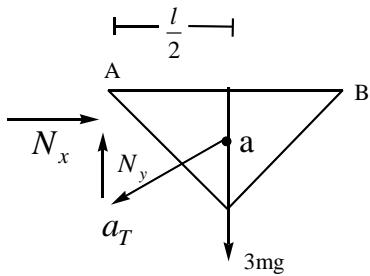
$$d\tau = \frac{3kt^2 q}{r^2} \int_0^r x^3 dx = \frac{3kqt^2 r^2}{4}$$

$$\text{Torque due to friction force } \tau = \int_0^r d\tau = \frac{2}{3} \mu m g r$$

$$\frac{3kqt^2 r^2}{4} = \frac{2}{3} \mu m g r \Rightarrow t = 2 \text{ sec}$$

42. Ans:-3

when the nail at B is removed



$$3mg \times \frac{l}{2} = I_A \alpha = \frac{3}{2} Ml^2 (\alpha)$$

$$3g = 3l\alpha \Rightarrow \frac{g}{l} \quad \dots \dots \dots 1$$

$$\text{Also } N_x = 3m(a_T \cos 60^\circ) \quad \dots \dots \dots 2$$

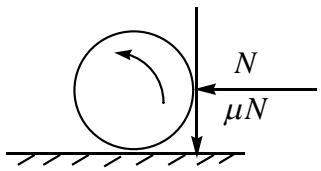
$$3Mg - N_y = 3M(a_T \sin 60^\circ) \quad \dots \dots \dots 3$$

$$\text{Also } a_T = \alpha \times \frac{l}{\sqrt{3}} = \frac{g}{l} \cdot \frac{l}{\sqrt{3}} = \frac{g}{\sqrt{3}}$$

$$\text{Then } N_x = \frac{3Mg}{\sqrt{3}} \propto \frac{1}{2} \text{ and } N_y = 3Mg - 3M(a_T \sin 60^\circ)$$

$$N_y = 3Mg - 3M\left(\frac{g}{\sqrt{3}}\right)\left(\frac{\sqrt{3}}{2}\right) \quad N = \sqrt{N_x^2 + N_y^2} = \sqrt{3}mg = 3$$

43. Ans: 4



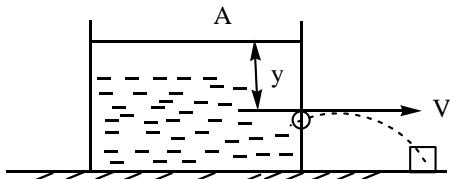
$$F = \sqrt{N^2 + \mu^2 N^2} \quad \dots \dots \dots 1$$

$$\tau = NR - \mu NR = 2mR^2 \left(\frac{a}{R}\right) \quad \dots \dots \dots 2$$

Solving 1 and 2 $\mu = 2.6$ and $\mu = 0.36$

$$\mu = 2.6 \text{ is not a possible solution} \quad \mu = 0.36 \quad \frac{36}{100} \Rightarrow \frac{9 \times 4}{100} \Rightarrow p = 4$$

44. Ans:-1 m/s



$$\text{Velocity of efflux } v = \sqrt{2gy} \quad \text{Range } x = \sqrt{2gy} \times \sqrt{\frac{2h}{g}}$$

Velocity of block must be

$$V_b = \frac{dx}{dt} = \sqrt{\frac{2h}{g}} \times \sqrt{2g} \times \frac{1}{2\sqrt{y}} \frac{dy}{dt} = \sqrt{\frac{h}{y}} \frac{dy}{dt} \quad \dots \dots 1$$

$$\text{Using equation of continuity } A \frac{dx}{dt} = a \sqrt{2gy} \quad \dots \dots 2$$

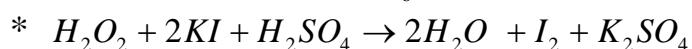
$$\text{From 1\&2 } V_b = \sqrt{\frac{h}{g}} \times \frac{a}{A} \sqrt{2gy} = \sqrt{2gh} \times \frac{a}{A} = 20 \times \frac{1}{20} = 1 \text{ m/s} \quad V_b = 1 \text{ m/s}$$

CHEMISTRY

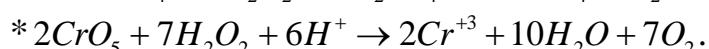
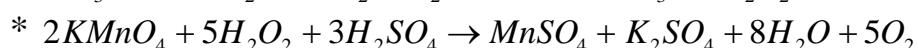
45.

	Iso electric point	Given PH		
Alanine	6	3	$PH < I.P$	$NH_3^+ - CH - COOH$ CH_3 incorrect
Leucine	6	10	$PH > I.P$	$NH_2 - CH - COO^-$ ↖ correct
Aspartic acid	3	9	$PH > I.P$	correct
Lysine	9.8	3	$PH < I.P$	correct

46. * $K_4[Fe(CN)_6] + H_2O_2 + H_2SO_4 \rightarrow K_2[Fe(CN)_6] + K_2SO_4 + 2H_2O$ H_2O_2 does not react with $K_2[Fe(CN)_6]$



$O_3 + KI + H_2O \rightarrow I_2 + O_2 + 2KOH$ O_3 & H_2O_2 both reacts with KI.



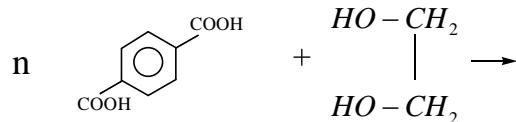
47. A) Formation of chemical bonds & formation of unimolecular layer makes chemisorption specific in nature
- B) Colloidal solutions are heterogeneous in nature and size of particles & the no. of solute particles are responsible for colligative pressure .Osmotic pressure is a colligative property $\pi = iCRT$
- C) Physical adsorption is exothermic but $\Delta H = -20 \text{ to } -40 \text{ KJ / mole}$,
 $\Delta G = \Delta H - T\Delta S$ Moreover entropy increases $\Delta S < 0$. Hence for ΔG to be negative(spontaneous) low temperature favors physical adsorption
 $\Delta G = \Delta H - T\Delta S = -ve - T(-ve) = -ve + T(+ve)$



D) (Sol) presence excess of S^{2-} ions makes the colloidal particles -vely charged.

48. Co polymers are the polymers formed by the polymerisation of two different compounds

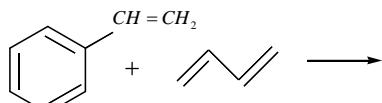
A) TERYLENE



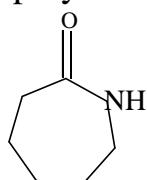
B) BUNA-N



C) BUNA-S



D) NYLON-6 is a polymer of caprolactum

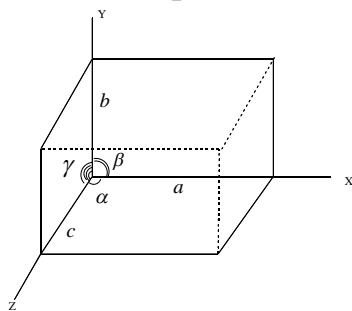


49. A) Cubic lattice $a = b = c, \alpha = \beta = \gamma = 90^\circ$
 B) Orthorhombic $a \neq b \neq c, \alpha = \beta = \gamma = 90^\circ$
 C) Hexagonal $a = b \neq c, \alpha = \beta = 90^\circ, \gamma = 120^\circ$

D) Rhombohedral

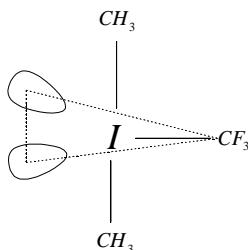
$$a = b = c \quad \alpha = \beta = \gamma \neq 90^\circ$$

Here $a, b, c, \alpha, \beta, \gamma$ are called lattice parameters



α, β & γ are interfacial angles, in the crystal lattice.

50. Structure of $I(CF_3)(CH_3)_2$ can be drawn as

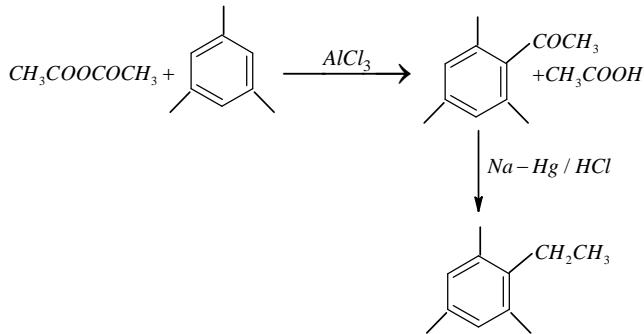


Triagonal bipyramidal or T-shaped.

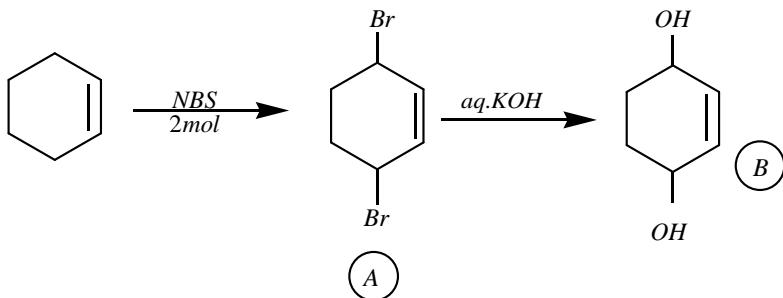
* 'I' (iodine atom=central atom) is sp^3d hybridized.

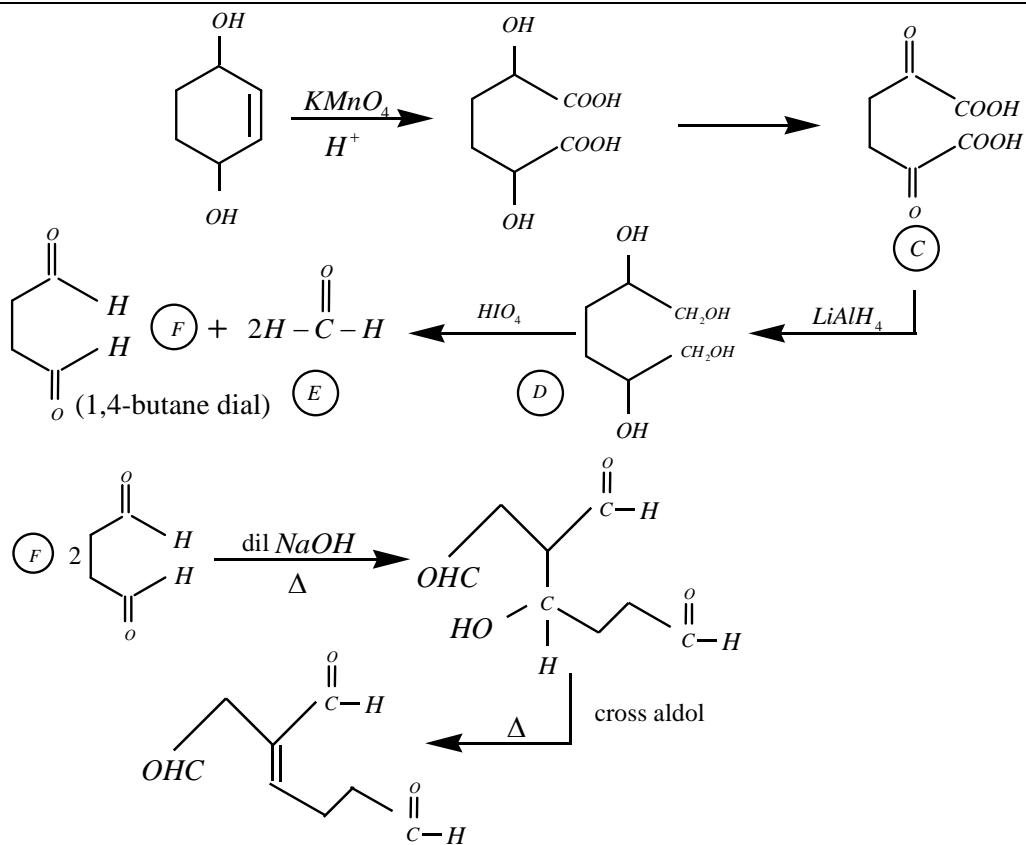
* d_{z^2} (or $d_{x^2-y^2}$) is involved in hybridization.

- 51-52. $CH_3COOH \xrightarrow{AlPO_4} CH_2=C=O \xrightarrow{CH_3COOH} CH_3COOCOCH_3$

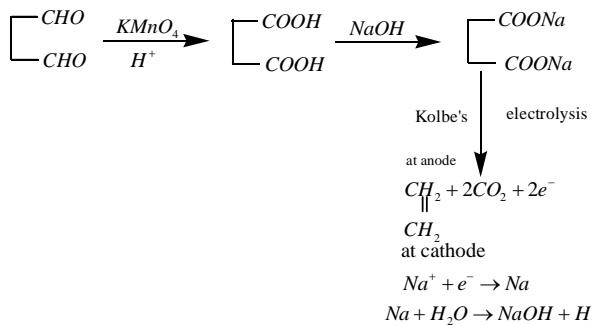


- 53.





54.



55. Back bonding & M-C bond order & C-O bond length

$$\alpha \frac{1}{z^* \text{ (Effective nuclear Charge)}}$$

56. Back bonding & M-C bond order & C-O bond length

$$\alpha \frac{1}{z^* \text{ (Effective nuclear Charge)}}$$

57.



Initially 1 -

after 10 sec $1 - \alpha$ 2α α

Acc to Graham's law

$$\frac{r_B}{r_A} = \frac{P_B}{P_A} \sqrt{\frac{M_A}{M_B}}$$

$$\frac{2}{1} = \frac{2\alpha}{1-\alpha} \sqrt{\frac{16}{4}}$$

$$2 = \frac{2\alpha}{1-\alpha} \times 2 = 2\alpha = 1 - \alpha$$

$$\boxed{\alpha = \frac{1}{3}}$$

\therefore pan

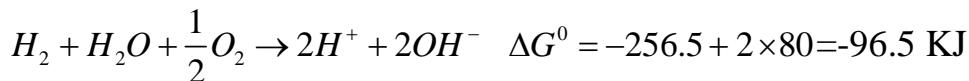
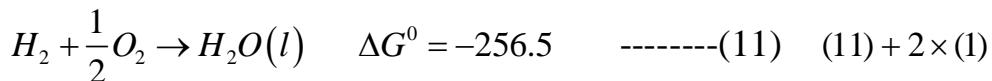
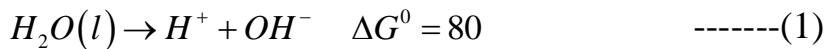
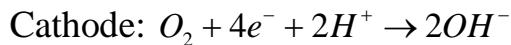
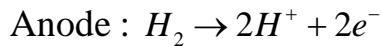
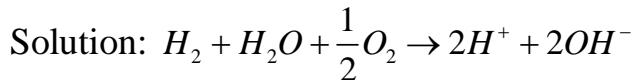
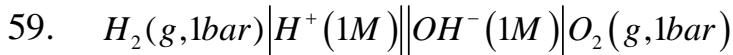
Rate constant for the first order reaction

$$K = \frac{1}{t} \ln \frac{a}{a-X} = \frac{1}{t} \ln \frac{1}{1-\alpha} \quad (t=10 \text{ sec given})$$

$$K = \frac{1}{10} \ln \frac{1}{1-\frac{1}{3}} \quad K = \frac{1}{10} \ln \frac{3}{2} = \frac{1}{10} [\ln 3 - \ln 2] = \frac{1.1 - 0.7}{10} = \frac{0.4}{10} = 0.04$$

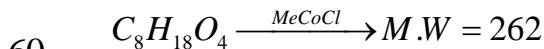
$$0.04 \times 100 = 4$$

58. Ans=5 Cerrusite, Galena, Anglesite, lanarkite(Pbo.PbsO₄), Crocosite(Pbcro₄) are the minerals of Pb.



$$-\Delta G^0 = -nFE^0 \quad -96.5 \times 1000 = -2 \times 96500 \times E^0$$

$$E^0 = 0.5 \text{ volts} \quad \text{Ans} = 0.5 \times 10 = 5.$$



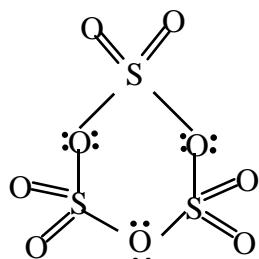
$$262 - 178 = 84 = n \times 42$$

$$CH_3 - C = 43$$

$$H=1 \quad +43 - 1 = 42$$

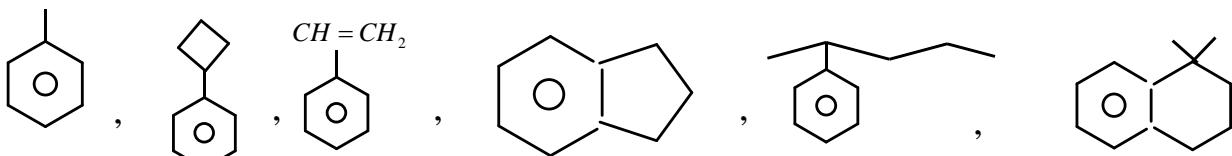
$$n=2$$

61.

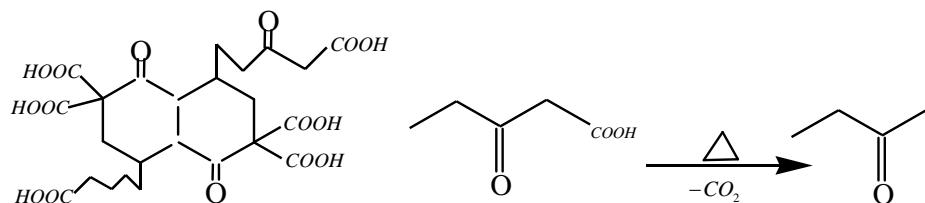


3 S are sp^3 , 3 O atom of ring are sp^3 . Total 6 atom sp^3

62. There should be H atom on α carbon of benzene



63.



Electron withdrawing group on β carbon gives decarboxylation.

64. First element of each transition series show only +3 oxidation state.

65.

$$\Delta T_b = iK_b \cdot m$$

$$AB_{2(s)} \rightarrow A^{+2} \text{ (aq)} + 2B^- \text{ (aq)}, \quad i = 3$$

$$0.0015 = 3 \times K_b \cdot m, \quad 15 \times 10^{-4} = 3(0.5) \times m$$

$$m = \frac{15 \times 10^{-4}}{1.5} = 10^{-3} = 's'$$

molality = molarity for weak electrolyte,

$$\therefore \text{for } AB_2 \text{ salt} = K_{sp} = 4S^3 = 4(10^{-3})^3 = 4 \times 10^{-9}$$

$$(4 \times 10^{-9}) \times 10^9 = 4$$

66. Hydrolysis of PCl_5 given one mole

H_3PO_4 and 5 moles of HCl

$$H_3PO_4 \rightarrow 1 \text{ mole} = 3 \text{ eq}$$

$$5HCl \rightarrow 5 \text{ mole} = 5 \text{ eq}$$

\therefore no. of moles of $NaOH$ required (base) = no. of eq of acid

No.of eq of NaOH per mole of NaOH=1

\therefore no.of moles of NaOH=no.of eq of acid

$$(\text{eq}) = (3+5)\text{eq} = 8\text{eq}$$

