MATHEMATICS

Section - A (Single Correct Answer)

1. D

Sol. $a + ar + ar^2 + ar^3 + ... + ar^{63}$

$= 7(a + ar^2 + ar^4 ..... + ar^{62})$

$$\Rightarrow \frac{a(1-r^{64})}{1-r} = \frac{7a(1-r^{64})}{1-r^2}$$

$r = 6$

2. D

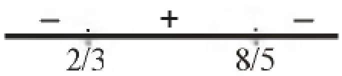
Sol. $a^6 = 2 \Rightarrow a + 5d = 2$

$a_1a_4a_5 = a(a + 3d)(a + 4d)$

$= (2 - 5d)(2 - 2d)(2 - d)$

$f(d) = 8 - 32d + 34d^2 - 20d + 30d^2 - 10d^3$

$f'(d) = -2(5d - 8)(3d - 2)$



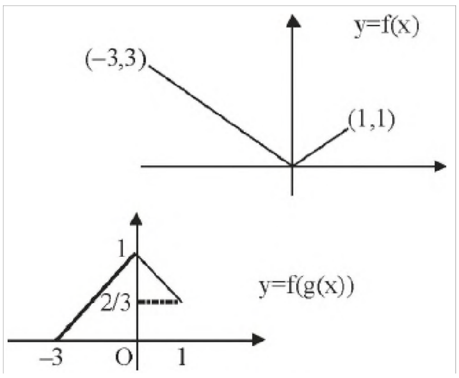
$$d = \frac{8}{5}$$

3. C

Sol. $$f(g(x)) = \begin{cases} 2 + 2g(x) & , \quad -1 \le g(x) < 0 \text{ ......(1)} \\ 1 - \dfrac{g(x)}{3} & , \quad 0 \le g(x) \le 3 \text{ .....(2)} \end{cases}$$

By (1) $x \in \phi$

And by (2) $x \in [-3, 0]$ and $x \in [0, 1]$



Range of f(g(x)) is [0, 1]

4. C

Sol. Required probability =

$$\frac{5}{6}\times\frac{1}{6}+\left(\frac{5}{6}\right)^3\times\frac{1}{6}+\left(\frac{5}{6}\right)^5\times\frac{1}{6}+......$$

$$=\frac{1}{6}\times\frac{\frac{5}{6}}{1-\frac{25}{36}}=\frac{5}{11}$$

5. B

Sol. $z = \frac{1}{2} - 2i$

$$|z+1| = \alpha z + \beta(1+i)$$

$$\left|\frac{3}{2} - 2\right| = \frac{\alpha}{2} - 2\alpha i + \beta + \beta i$$

$$\left|\frac{3}{2} - 2i\right| = \left(\frac{\alpha}{2} + \beta\right) + (\beta - 2\alpha)i$$

$$\beta = 2\alpha \text{ and } \frac{\alpha}{2} + \beta = \sqrt{\frac{9}{4} + 4}$$

$$\alpha + \beta = 3$$

6. C

Sol. Using L'hopital rule

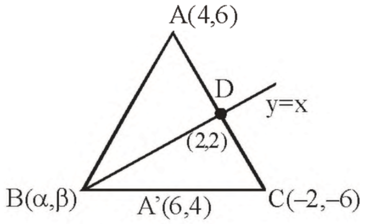
$$= \lim_{x \to \frac{\pi^-}{2}} \frac{0 - \cos x \times 3x^2}{2\left(x - \frac{\pi}{2}\right)}$$

$$= \lim_{x \to \frac{\pi^-}{2}} \frac{\sin\left(x - \frac{\pi}{2}\right)}{2\left(x - \frac{\pi}{2}\right)} \times \frac{3\pi^2}{4}$$

$$= \frac{3\pi^2}{8}$$

7. A

Sol.



AD : DC = 1 : 2

$\frac{4-\alpha}{6-\alpha}=\frac{10}{8}$

$\alpha=\beta$

$\alpha=14$ and $\beta=14$

8. A

Sol. $\vec{a}+5\vec{b}=\lambda\vec{c}$

$\vec{b}+6\vec{c}=\mu\vec{a}$

Eliminating $\vec{a}$

$\lambda\vec{c}-2\vec{b}=\frac{6}{\mu}\vec{c}+\frac{1}{\mu}\vec{b}$

$\therefore \mu=\frac{-1}{5},\ \lambda=-30$

$\alpha=5,\ \beta=30$

9. B

Sol. A(a, –2), B(a, 6), $C\left(\frac{a}{4},\ -2\right)$, $O\left(5,\ \frac{a}{4}\right)$

AO = BO

$(a-5)^2+\left(\frac{a}{4}+2\right)^2=(a-5)^2+\left(\frac{a}{4}-6\right)^2$

a = 8

AB = 8, AC = 6, BC = 10

$\alpha=5,\ \beta=24,\ \gamma=24$

10. D

Sol. $y(x)=\int\frac{(1+\sin^2 x)\cos x}{1+\sin^4 x}dx$

Put sin x = t

$=\int\frac{1+t^2}{t^4+1}dt=\frac{1}{\sqrt{2}}\tan^{-1}\frac{\left(t-\frac{1}{t}\right)}{\sqrt{2}}+C$

$x=\frac{\pi}{2},\ t=1$ $\qquad\therefore C=0$

$y\left(\frac{\pi}{4}\right)=\frac{1}{\sqrt{2}}\tan^{-1}\left(-\frac{1}{2}\right)$

11. C

Sol. $4+5\tan\theta=\sec\theta$

Squaring : $24\tan^2\theta+40\tan\theta+15=0$

$\tan\theta=\frac{-10\pm\sqrt{10}}{12}$

and $\tan\theta=-\left(\frac{10+\sqrt{10}}{12}\right)$ is Rejected.

(C) is correct

12. A

Sol. $\frac{dy}{dx}-\left(\frac{\sin 2x}{1+\cos^2 x}\right)y=\sin x$

I.F. = 1 + $\cos^2 x$

$y\cdot(1+\cos^2 x)=\int(\sin x)dx$

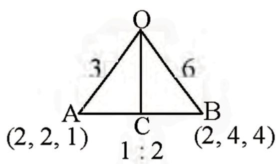
= –cos x + C

x = 0, C = 1

$y\left(\frac{\pi}{2}\right)=1$

13. B

Sol.



length of $OC=\frac{\sqrt{136}}{3}=\frac{2\sqrt{34}}{3}$

14. D

Sol. $f'(x)=12\sqrt{2}x^2-3\sqrt{2}\geq 0$ for $\left[\frac{1}{2},\ 1\right]$

$f\left(\frac{1}{2}\right)<0$

f(1) > 0 $\Rightarrow$ (A) is correct

$f(x)=\sqrt{2}(4x^3-3x)-1=0$

Let $\cos\alpha = x$,

$$\cos 3\alpha = \cos\frac{\pi}{4} \Rightarrow \alpha = \frac{\pi}{12}$$

$$x = \cos\frac{\pi}{12}$$

(D) is correct

15. B

Sol. $|A| = \alpha^2 - \beta^2$

$|2A|^3 = 2^{21} \Rightarrow |A| = 2^4$

$\alpha^2 - \beta^2 = 16$

$(\alpha+\beta)(\alpha-\beta) = 16 \Rightarrow \alpha = 4$ or 5

16. C

Sol. Centroid G divides MR in 1 : 2

G(1, 2, 2)

Point of intersection A of given lines is (2, –6, 0)

$AG = \sqrt{69}$

17. A

Sol. (a, b)R(a, b) as ab – ab = 0

Therefore reflexive

Let (a, b) R(c, d) $\Rightarrow$ ad – bc is divisible by 5

$\Rightarrow$ bc – ad is divisible by 5 $\Rightarrow$ (c, d) R(a, b)

Therefore symmetric

Relation not transitive as (3,1)R(10,5) and (10, 5)R(1, 1) but (3, 1) is not related to (1, 1)

18. A

Sol. $$I = \int_{-\pi/2}^{\pi/2}\left(\frac{x^2\cos x}{1+\pi^x} + \frac{1+\sin^2 x}{1+e^{\sin x^{2023}}}\right)dx$$

$$I = \int_{-\pi/2}^{\pi/2}\left(\frac{x^2\cos x}{1+\pi^{-x}} + \frac{1+\sin^2 x}{1+e^{\sin(-x)^{2023}}}\right)dx$$

On Adding we get

$$2I = \int_{-\pi/2}^{\pi/2}(x^2\cos x + 1 + \sin^2)dx$$

On solving

$$I = \frac{\pi^2}{4} + \frac{3\pi}{4} - 2$$

a = 3

19. C

Sol. $$f'(0) = \lim_{h\to 0}\frac{f(h)-f(0)}{h}$$

$$= \lim_{h\to 0}\frac{(2^h 3^{-h})\tan h\sqrt{\tan^{-1}(h^2-h+1)-0}}{(7h^2+3h+1)^3 h}$$

20. D

$AA^T = 1 = A^TA$

On solving given expression, we get

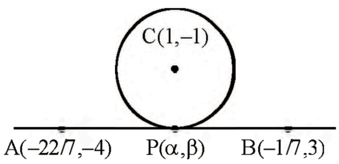
$$\frac{1}{2}A[A^2 + (A^T)^2 + 2AA^T + A^2 + (A^T)^2 - 2AA^T]$$

$= A[A^2 + (A^T)^2] = A^3 + A^T$

<u>Section - B (Numerical Value Type)</u>

21. 2

Sol. Centre of circle is (1, –1)



Equation of AB is 7x – 3y + 10 = 0 ....(i)

Equation of CP is 3x + 7y + 4 = 0 ....(ii)

Solving (i) and (ii)

$$\alpha = \frac{-41}{29},\ \beta = \frac{1}{29} \quad \therefore 17\beta - \alpha = 2$$

22. 553

Sol. Words starting with E = 360

Words starting with GE = 60

Words starting with GN = 60

Words starting with GTE = 24

Words starting with GTN = 24

Words starting with GTT = 24

GTWENTY = 1 Total = 553

23. 13

Sol. $\alpha^6 + \alpha^4 + \beta^4 - 5\alpha^2$

$= \alpha^4(\alpha - 2) + \alpha^4 - 5\alpha^2 + (\beta - 2)^2$

$= \alpha^5 - \alpha^4 - 5\alpha^2 + \beta^2 - 4\alpha + 4$

$= \alpha^3(\alpha - 2) - \alpha^4 - 5\alpha^2 + \beta - 2 - 4\beta + 4$

$= -2\alpha^3 - 5\alpha^2 - 3\beta + 2$

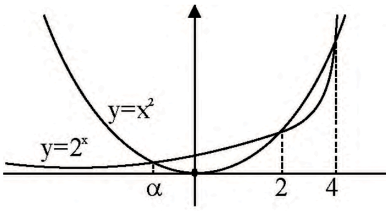
$= -2\alpha(\alpha - 2) - 5\alpha^2 - 3\beta + 2$

$= -7\alpha^2 + 4\alpha - 3\beta + 2$

$= -7(\alpha - 2) + 4\alpha - 3\beta + 2$

$= -3\alpha - 3\beta + 16 = -3(1) + 16 = 13$

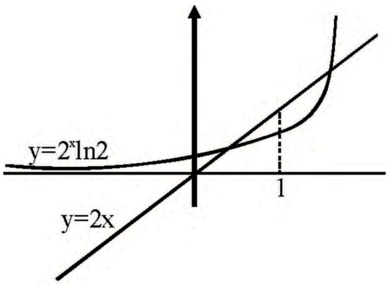
24. 5

Sol. 

$\therefore m = 3$

$f'(x) = 2^x \ln 2 - 2x = 0$

$2x \ln 2 = 2x$



$\therefore n = 2$

$\Rightarrow m + n = 5$

25. 432

Sol. Putting $y^2 = 3x^2$ in both the conics

We get $x^2 = b$ and $\frac{b}{16} + \frac{3}{b} = 1$

$\Rightarrow$ b = 4, 12 (b = 4 is rejected because curves coincide)

$\therefore b = 12$

Hence points of intersection are

$(\pm\sqrt{12}, \ \pm 6) \Rightarrow$ area of rectangle = 432

26. 3

Sol. $\int\left(\frac{1}{x} + \frac{\ln x}{x}\right)dx + \int \frac{dy}{1+y^2} = 0$

$\ln x + \frac{(\ln x)^2}{2} + \tan^{-1} y = C$

Put x = y = 1

$\therefore C = \frac{\pi}{4}$

$\Rightarrow \ln x + \frac{(\ln x)^2}{2} + \tan^{-1} y = \frac{\pi}{4}$

Put x = e

$\Rightarrow y = \tan\left(\frac{\pi}{4} - \frac{3}{2}\right) = \frac{1 - \tan\frac{3}{2}}{1 + \tan\frac{3}{2}}$

$\therefore \alpha = 1, \ \beta = 1$

$\Rightarrow \alpha + 2\beta = 3$

27. 2041

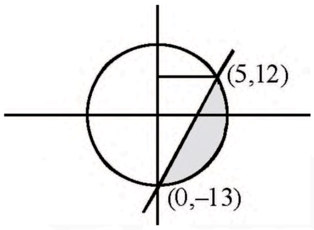
Sol. $\bar{x} = 56$

$\sigma^2 = 66.2$

$\Rightarrow \frac{\alpha^2 + \beta^2 + 25678}{10} - (56)^2 - 66.2$

$\therefore \alpha^2 + \beta^2 = 6344$

28. 171

Sol. 

Area $= \int_{-13}^{12} \sqrt{169 - y^2}\,dy - \frac{1}{2} \times 25 \times 5$

$= \frac{\pi}{2} \times \frac{169}{2} - \frac{65}{2} + \frac{169}{2}\sin^{-1}\frac{12}{13}$

$\therefore \alpha + \beta = 171$

29. 2041

Sol. $\sum_{r=1}^{9} \frac{{}^{11}C_r}{r+1}$

$= \frac{1}{12}\sum_{r=1}^{9} {}^{12}C_{r+1}$

$= \frac{1}{12}[2^{12} - 26] = \frac{2035}{6}$

$\therefore m + n = 2041$

30. 65

Sol. Let P(t, t – 2,t) and Q(2s – 2, s, s)

D.R's of PQ are 2, 1, 2

$\frac{2s - 2 - t}{2} = \frac{s - t + 2}{1} = \frac{s - 1}{2}$

$\Rightarrow$ t = 6 and s = 2

$\Rightarrow$ P(6, 4, 6) and Q(2, 2, 2)

$PQ : \frac{x-2}{2} = \frac{y-2}{1} = \frac{z-2}{2} = \lambda$

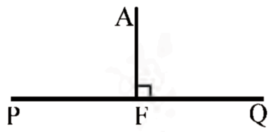
Let $F(2\lambda + 2, \ \lambda + 2, \ 2\lambda + 2)$

$A(1, 2, 12)$

$\overrightarrow{AF} \cdot \overrightarrow{PQ} = 0$

$\therefore \lambda = 2$

So F(6, 4, 6) and $AF = \sqrt{65}$

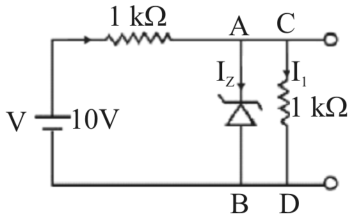


PHYSICS

Section - A (Single Correct Answer)

31. B

Sol.



$V_z = 3V$

Let potential at B = 0 V

Potential at $E(V_E) = 10$ V

$V_C = V_A = 3$ V

$I_z + I_1 = I$

$$I = \frac{10-3}{1000} = \frac{7}{1000} A$$

$$I_1 = \frac{3}{2000} A$$

Therefore $I_z = \frac{7-1.5}{1000} = 5.5$ mA

32. B

Sol. Given that

Current $I = I_0 + \beta t$

$I_0 = 20A$

$\beta = 3 A/s$

$I = 20 + 3t$

$$\frac{dq}{dt} = 20 + 3t$$

$$\int_0^q dq = \int_0^{20} (20+3t)\,dt$$

$$q = \int_0^{20} 20dt + \int_0^{20} 3tdt$$

$$q = \left[20t + \frac{3t^2}{2}\right]_0^{20} = 1000C$$

33. C

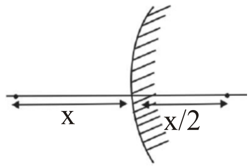
Sol. Surface tension will be less as temperature increases

$$h = \frac{2T\cos\theta}{\rho gr}$$

Height of capillary rise will be smaller in hot water and larger in cold water.

34. A

Sol.



Given R = 30 cm

f = R/2 = +15 cm

Magnification (m) $= \pm\frac{1}{2}$

For convex mirror, virtual image is formed for real object.

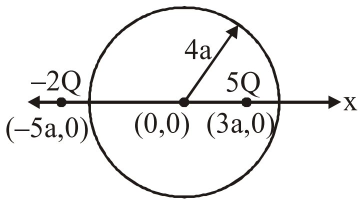
Therefore, m is + ve

$$\frac{1}{2} = \frac{f}{f-u}$$

u = – 15 cm

35. B

Sol.



5Q charge is inside the spherical region flux through sphere $= \frac{5Q}{\varepsilon_0}$

36. B

Sol. S_1 in first (p – 1) sec

S_2 in first p sec

$$S_1 = \frac{1}{2}a(p-1)^2$$

$$S_2 = \frac{1}{2}a(p)^2$$

$$S_1 + S_2 = \frac{1}{2}at^2$$

$$(p-1)^2 + p^2 = t^2$$

$$t = \sqrt{2p^2 + 1 - 2p}$$

37. C

Sol. Given $U = 2x^2 + 3y^3 + 2z$

$$F_x = -\frac{\partial U}{\partial x} = -4x$$

At x = 1 magnitude of F_x is 4N

38. A

Sol. $R = \frac{V}{I}$

According to error analysis

$$\frac{dR}{R} = \frac{dV}{V} + \frac{dI}{I}$$

$$\frac{dR}{R} = \frac{5}{200} + \frac{0.2}{20}$$

$$\frac{dR}{R} = \frac{7}{200}$$

$$\%\ \text{error}\ \frac{dR}{R} \times 100 = \frac{7}{200} \times 100 = 3.5\%$$

39. C

Sol. Given m = 100 kg

s = 10 m

$\mu = 0.4$

As $f = \mu mg = 0.4 \times 100 \times 10 = 400$ N

Now $W = f.s = 400 \times 10 = 4000$ J

40. C

Sol. Ampere - Maxwell law

$$\rightarrow \oint \vec{B} \cdot \vec{dl} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$$

Faraday law $\rightarrow \oint \vec{E} \cdot \vec{dl} = \frac{d\phi_B}{dt}$

Gauss' law for electricity $\rightarrow \oint \vec{E} \cdot \vec{dA} = \frac{Q}{\varepsilon_0}$

Gauss' law for magnetism $\rightarrow \oint \vec{B} \cdot \vec{dA} = 0$

41. A

Sol. Given $m_1 = m_2$

and $\frac{r_1}{r_2} = \frac{3}{4}$

As centripetal force $F = \frac{mv^2}{r}$

In order to have constant (same in this question) centripetal force

$F_1 = F_2$

$$\frac{m_1 v_1^2}{r_1} = \frac{m_2 v_2^2}{r_2}$$

$$\Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{r_1}{r_2}} = \frac{\sqrt{3}}{2}$$

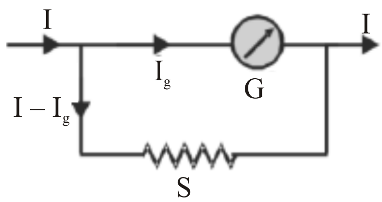
42. C

Sol. Given G = 10 Ω

$I_g = 3$mA

I = 8A

In case of conversion of galvanometer into ammeter.



We have $I_g G = (I - I_g)S$

$$S = \frac{I_g G}{I - I_g}$$

$$S = \frac{(3 \times 10^{-3})10}{8 - 0.003} = 3.75 \times 10^{-3}\ \Omega$$

43. B

Sol. For photon

$$E_p = \frac{hc}{\lambda_p} \Rightarrow \lambda_p = \frac{hc}{E_p}$$

For electron

$$\lambda_c = \frac{h}{m_e v_e} = \frac{hv_e}{2K_e}$$

Given $v_e = 0.25$ c

$$\lambda_e = \frac{h \times 0.25c}{2K_e} = \frac{hc}{8K_e}$$

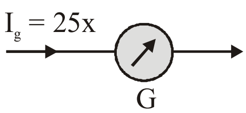
Also $\lambda_p = \lambda_e$

$$\frac{hc}{E_p} = \frac{hc}{8K_e}$$

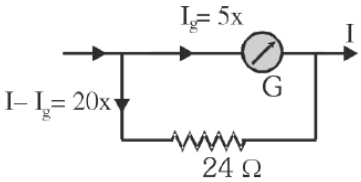
$$\frac{K_e}{E_p} = \frac{1}{8}$$

44. B

Sol. Let x = current/division



After applying shunt



Now 5x × G = 20x × 24
G = 4 × 24
G = 96Ω

45. B

Sol. $\mu_1 = 1.5$
$\mu_m = 1.6$
$f_a = 20$ cm

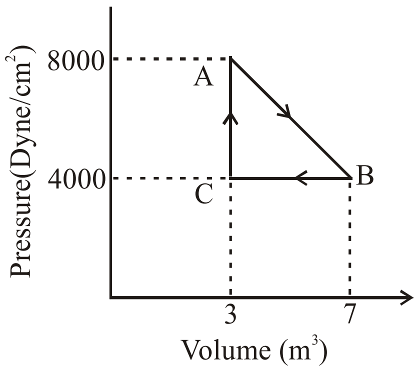
As $\frac{f_m}{f_a} = \frac{(\mu_1 - 1)\mu_m}{(\mu_1 - \mu_m)}$

$$\frac{f_m}{20} = \frac{(1.5-1)1.6}{(1.5-1.6)}$$

$f_m = -160$ cm

46. BONUS

Sol.



Work done

$$AB = \frac{1}{2}(8000 + 6000)\,Dyne/cm^2 \times 4m^3$$

= (6000 Dyne/cm²) × 4m³
Work done BC = – (4000 Dyne/cm²) × 4m³
Total work done = 2000 Dyne/cm² × 4m³

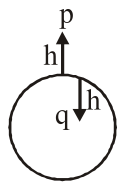
$$= 2 \times 10^3 \times \frac{1}{10^5}\frac{N}{cm^2} \times 4m^3$$

$$= 2 \times 10^{-2} \times \frac{N}{10^{-4} m^2} \times 4m^3$$

= 2 × 10² × 4 Nm = 800 J

47. D

Sol. $g_p = \frac{gR^2}{(R+h)^2}$



$$g_q = g\left(1 - \frac{h}{R}\right)$$

$$g_p = g_q$$

$$\frac{g}{\left(1+\frac{h}{R}\right)^2} = g\left(1 - \frac{h}{R}\right)$$

$$\left(1 - \frac{h^2}{R^2}\right)\left(1 + \frac{h}{R}\right) = 1$$

Take $\frac{h}{R} = x$

So
$x^3 - x + x^2 = 0$

$$x = \frac{\sqrt{5}-1}{2}$$

$$h = \frac{R}{2}\left(\sqrt{5}-1\right)$$

48. B

Sol. By energy conservation

$$\frac{1}{2}CV^2 = \frac{1}{2}LI_{max}^2$$

$$I_{max} = \sqrt{\frac{C}{L}}V$$

$$= \sqrt{\frac{100 \times 10^{-6}}{6.4 \times 10^{-3}}} \times 12$$

$$= \frac{12}{8} = \frac{3}{2} = 1.5A$$

49. D

Sol. ${}_3Li^6 + {}_0n^1 \rightarrow {}_2He^4 + {}_1H^3$
${}_1H^2 + {}_1H^3 \rightarrow {}_2He^4 + {}_0n^1$

${}_3Li^6 + {}_1H^2 \rightarrow 2\,({}_2He^4)$

Energy released in process

$Q = \Delta mc^2$

$Q = [M(Li) + M\ ({}_1H^2) - 2 \times M({}_2He^4)] \times 931.5$ MeV

$Q = [6.01690 + 2.01471 - 2 \times 4.00388] \times 931.5$ MeV

$Q = 22.216$ MeV

$Q = 22.22$ MeV

50. A

Sol. $\frac{P_AV_A}{P_BV_B} = \frac{n_ART_A}{n_BRT_B}$

Given $V_A = V_B$

And $T_A = T_B$

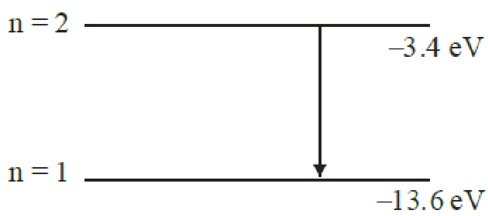
$\frac{P_A}{P_B} = \frac{n_A}{n_B}$

$\frac{P_A}{P_B} = \frac{1/2}{1/32} = 16$

Section - B (Numerical Value Type)

51. 17

Sol.



$\Delta E = 10.2 eV$

Recoil speed(v) $= \frac{\Delta E}{mc}$

$= \frac{10.2 eV}{1.6 \times 10^{-27} \times 3 \times 10^8}$

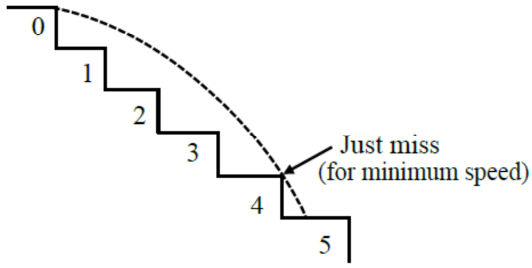
$= \frac{10.2 \times 1.6 \times 10^{-19}}{1.6 \times 10^{-27} \times 3 \times 10^8}$

$v = 3.4\ m/s = \frac{17}{5} m/s$

Therefore, x = 17

52. 2

Sol.



The ball needs to just cross 4 steps to just hit 5th step

Therefore, horizontal range (R) = 0.4 m

R = u.t

Similarly, in vertical direction

$h = \frac{1}{2}gt^2$

$0.4 = \frac{1}{2}gt^2$

$0.4 = \frac{1}{2}g\left(\frac{0.4}{u}\right)^2$

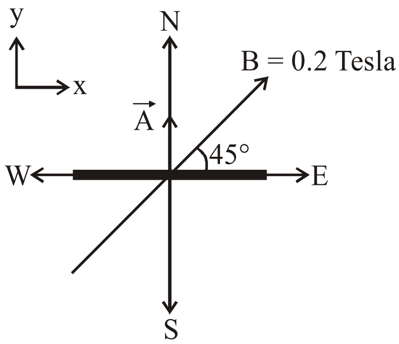
$u^2 = 2$

$u = \sqrt{2}$ m/s

Therefore, x = 2

53. 2

Sol.



$\vec{A} = (0.1)^2\,\hat{j}$

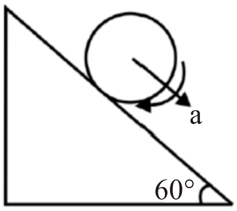
$\vec{B} = \frac{0.2}{\sqrt{2}}\hat{i} + \frac{0.2}{\sqrt{2}}\hat{j}$

Magnitude of induced emf

$e = \frac{\Delta\phi}{\Delta t} = \frac{\vec{B}\cdot\vec{A} - 0}{1} = \sqrt{2} \times 10^{-3}\,V$

54. 10

Sol.



For rolling motion, $a = \frac{g\sin\theta}{1+\frac{I_{cm}}{MR^2}}$

$$a = \frac{g\sin\theta}{1+\frac{1}{2}}$$

$$= \frac{2\times10\times\frac{\sqrt{3}}{2}}{3} = \frac{10}{\sqrt{3}}$$

Therefore x = 10

55. 6

Sol. $V = \frac{\mu_0}{4\pi}\frac{M}{r^2}$

$$\Rightarrow 1.5\times10^{-5} = 10^{-7}\times\frac{M}{\left(20\times10^{-2}\right)^2}$$

$$\Rightarrow M = \frac{1.5\times10^{-5}\times20\times20\times10^{-4}}{10^{-7}}$$

M = 1.5 × 4 = 6

56. 0.20

Sol. Path difference for minima at P

$$2\sqrt{D^2+d^2} - 2D = \frac{\lambda}{2}$$

$$\therefore \sqrt{D^2+d^2} - D = \frac{\lambda}{4}$$

$$\therefore \sqrt{D^2+d^2} = \frac{\lambda}{4} + D$$

$$\Rightarrow D^2 + d^2 = D^2 + \frac{\lambda^2}{16} + \frac{D\lambda}{2}$$

$$\Rightarrow d^2 = \frac{D\lambda}{2} + \frac{\lambda^2}{16}$$

$$\Rightarrow d^2 = \frac{0.2\times400\times10^{-9}}{2} + \frac{4\times10^{-14}}{4}$$

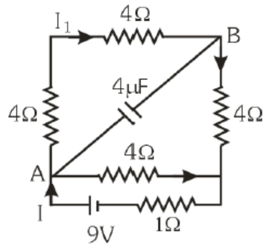
$$\Rightarrow d^2 \approx 400\times10^{-10}$$

$$\therefore d = 20\times10^{-5}$$

$$\Rightarrow \quad d = 0.20\text{mm}$$

57. 81

Sol.



$$I = \frac{V}{R_{eq}} I = \frac{V}{R_{eq}} = \frac{9}{1+\frac{12\times4}{12+4}} = \frac{9}{4}$$

$$I_1 = \frac{9}{4}\times\frac{4}{16} = \frac{9}{16}$$

$$V_A - V_B = I_1\times8 = \frac{9}{16}\times8 = \frac{9}{2}V$$

$$\therefore U = \frac{1}{2}\times4\times\frac{81}{4}\mu J$$

$$\therefore U = \frac{81}{2}\mu J$$

$$\therefore \quad x = 81$$

58. 9

Sol. Let total energy $= E = \frac{1}{2}KA^2$

$$U = \frac{1}{2}K\left(\frac{A}{3}\right)^2 = \frac{KA^2}{2\times9} = \frac{E}{9}$$

$$KE = E - \frac{E}{9} = \frac{8E}{9}$$

$$\text{Ratio } \frac{\text{Total}}{\text{KE}} = \frac{E}{\frac{8E}{9}} = \frac{9}{8}$$

$x = 9$

59. 8

Sol. $u = 1m/s;\ a = \frac{\sigma e}{2\varepsilon_0 m}$

$t = 1$ s

$S = -1$ m

Using $S = ut + \frac{1}{2}at^2$

$$-1 = 1 \times 1 - \frac{1}{2} \times \frac{\sigma e}{2\varepsilon_0 m} \times (1)^2$$

$$\therefore \sigma = 8\frac{\varepsilon_0 m}{e}$$

$\therefore\ \alpha = 8$

60. 810

Sol. $F = \frac{1}{2}\rho\left(v_1^2 - v_2^2\right)A$

$$F = \frac{1}{2} \times 1.2 \times \left(70^2 - 65^2\right) \times 2$$

$= 810$ N

CHEMISTRY

Section - A (Single Correct Answer)

61. **(C)**

Sol. First ionisation energy **increases** along the period. Along the period Z increases which outweighs the shielding effect.

62. **(D)**

Sol. Ziegler catalyst $\rightarrow$ Titanium

Blood pigment $\rightarrow$ Iron

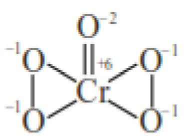
Wilkinson catalyst $\rightarrow$ Rhodium

Vitamin $B_{12} \rightarrow$ Cobalt

63. **(A)**

Sol. $Cl^- + K_2Cr_2O_7 + H_2SO_4 \rightarrow CrO_2Cl_2 \xrightarrow{\text{Basic medium}} \underset{\text{yellow solution}}{CrO_4^{2-}} + Cl^-$

$$\underset{\text{yellow solution}}{CrO_4^{2-}} \xrightarrow[\text{3. 10\% } H_2O_2]{\text{1. Acidification, 2. Amyl alcohol}} \underset{\text{blue compound}}{CrO_5}$$



64. **(B)**

Sol. The difference in energy between the actual structure and the lowest energy resonance structure for the given compound is known as resonance energy.

65. **(A)**

Sol. Gr-14	EN
C	2.5
Si	1.8
Ge	1.8
Sn	1.8
Pb	1.9

The electronegativity values for elements from Si to Pb are almost same. So Statement I is false.

66. **(A)**

Sol. Rb = [Kr] $5s^1$

n = 5

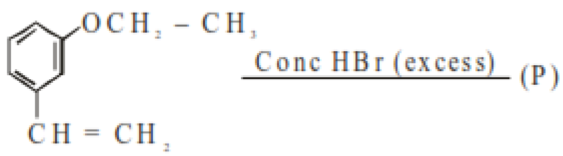
$\ell = 0$

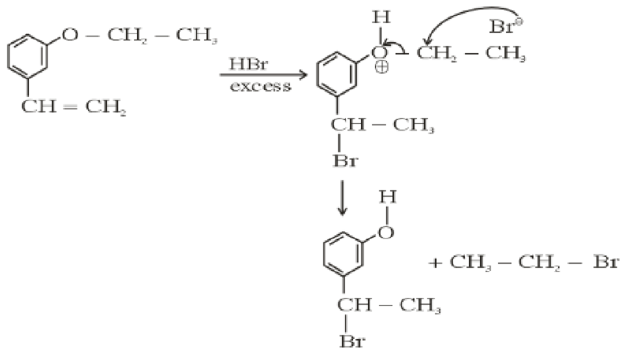
m = 0

s = $+\frac{1}{2}$ or $-\frac{1}{2}$

67. **(D)**

Sol.

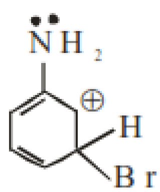




68. **(C)**

Sol. Since $-\ddot{N}H_2$ group is o/p directing hence arenium ion will not be formed by attack at meta position.

i.e.,



Hence Answer is (3).

69. **(C)**

Sol. $Fe^{2+} \xrightarrow[\text{conc. } H_2SO_4]{H^+} Fe^{+3}$

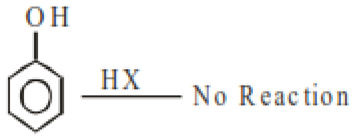
$Fe^{+3} \xrightarrow{^-SCN} Fe(SCN)_3$ (blood red colour)

Appearance of blood red colour indicates presence of both nitrogen and sulphur.

70. **(C)**

Sol. Assertion (A) : Given statement is correct because in phenol hydroxyl group cannot be replaced by halogen atom.

Reason (R) :

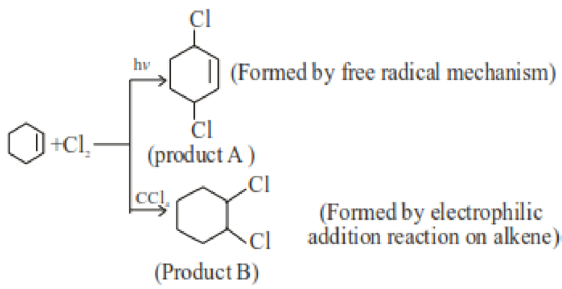


Given reason is false.

Hence Assertion (A) is correct but Reason (R) is false.

71. **(D)**

Sol.



Hence correct Ans. (4).

72. **(A)**

Sol. (1) Fluorspar is CaF_2

73. **(D)**

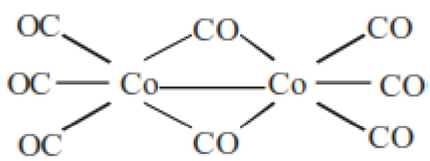
Sol. It is a type of conjugation responsible for resonance.

74. **(D)**

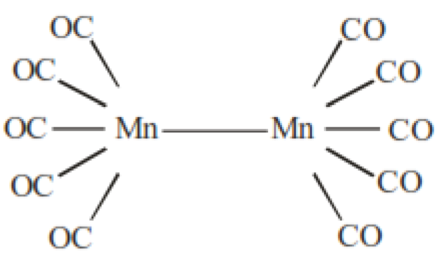
Sol. $KMnO_4 \xrightarrow{\Delta} K_2MnO_4 + MnO_2 + O_2$

75. **(A)**

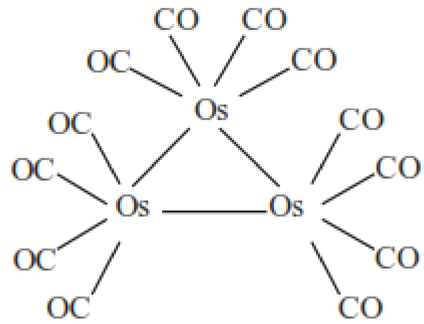
Sol. (1)



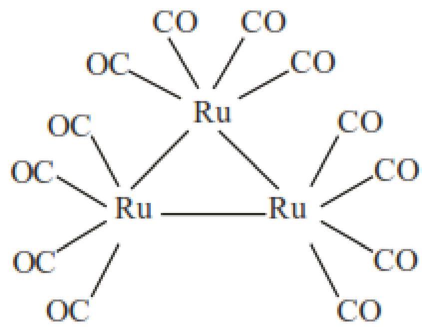
(2)



(3)



(4)



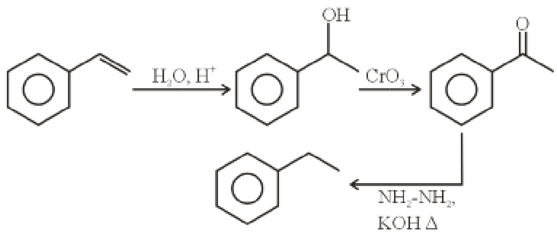
76. **(B)**

Sol. Proteins are natural polymers composed of α-amino acids which are connected by peptide linkages.

Hence proteins upon acidic hydrolysis produce α-amino acids.

77. **(A)**

Sol.

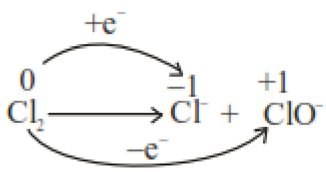


78. **(B)**

Sol. $(\Delta G)_{P,\,T}$ = (+)ve for non-spontaneous process.

79. **(A)**

Sol.



$\Rightarrow Cl_2 + 2\bar{O}H \longrightarrow Cl^- + ClO^- + H_2O$

80. **(D)**

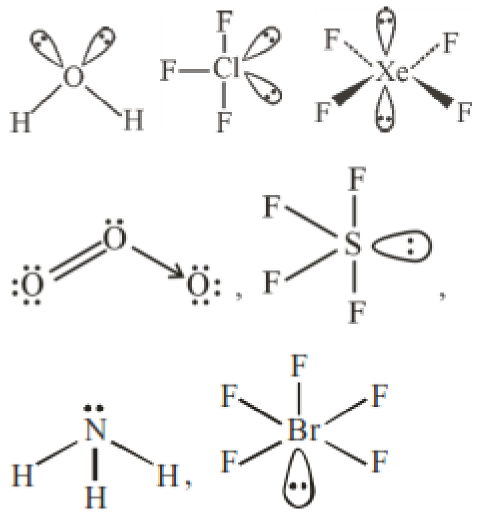
Sol.

$2MnO_4^- + H_2O + I^- \xrightarrow{\text{alkaline medium}} 2MnO_2 + 2OH^- + IO_3^-$

Section - B (Numerical Value Type)

81. **(4)**

Sol.



82. **(45.75) or (46)**

Sol. $Zn^{+2} + 2e^- \longrightarrow Zn$

$W = Z \times i \times t$

$= \frac{65.4}{2 \times 96500} \times 0.015 \times 15 \times 60$

$= 45.75 \times 10^{-4}$ gm

83. **(30)**

Sol. $K = \frac{K_1 \cdot K_2}{K_3} = \frac{A_1 \cdot A_2}{A_3} \cdot e^{\frac{(E_{a_1} + E_{a_2} - E_{a_3})}{RT}}$

$A \cdot e^{-E_a/RT} = \frac{A_1 A_2}{A_3} \cdot e^{\frac{(E_{a_1} + E_{a_2} - E_{a_3})}{RT}}$

$E_a = E_{a_1} + E_{a_2} - E_{a_3} = 40 + 50 - 60 = 30$ kJ/mole

84. **(2)**

Sol. $K_P = K_C \cdot (RT)^{\Delta n_g}$

$\Delta n_g = 1$

$\Rightarrow K_c = \frac{K_P}{RT} = \frac{0.492}{0.082 \times 300} = 2 \times 10^{-2}$

85. **(4)**

Sol. $M = \frac{n_{solute}}{V} \times 1000$

$= \frac{\left(\frac{31.4}{98}\right)}{\left(\frac{100}{1.25}\right)} \times 1000$

$= 4.005 \approx 4$

86. **(72.56) or (73)**

Sol. $\pi = CRT$

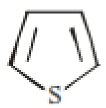
$\Rightarrow \frac{\pi_1}{\pi_2} = \frac{T_1}{T_2}$

$\Rightarrow \pi_2 = \frac{\pi_1 T_2}{T_1} = \frac{7 \times 10^5 \times 283}{273}$

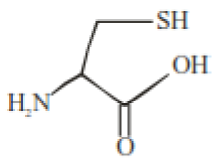
$= 72.56 \times 10^4 \ Nm^{-2}$

87. **(2)**

Sol.



Thiophene ,



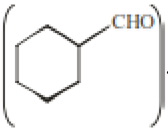
Cysteine

88. **(1)**

Sol.

	Magnetic behaviour	**Bond order**
H_2	Diamagnetic	1
He_2^+	Paramagnetic	0.5
O_2^+	Paramagnetic	2.5
N_2^{2-}	Paramagnetic	2
O_2^{2-}	Diamagnetic	1
F_2	Diamagnetic	1
Ne_2^+	Paramagnetic	0.5
B_2	Paramagnetic	1

89. **(3)**

Sol. Acetaldehyde (CH_3CHO), Methanal ($HCHO$), and cyclohexane carbaldehyde 

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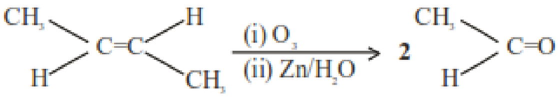
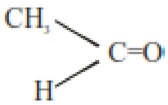
90. **(1)**

Sol. 

Hence total number of oxygen atom present per molecule 

is 1.

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