FIITJEE

Solutions to JEE (Main)-2021

JEE–Main–2021 –Feb–24–Second–Shift
PHYSICS, CHEMISTRY & MATHEMATICS

PART –A (PHYSICS)

Answers

Section-A

1.	B	**2.**	A	**3.**	B	**4.**	D
5.	B	**6.**	C	**7.**	A	**8.**	D
9.	C	**10.**	C	**11.**	C	**12.**	B
13.	D	**14.**	C	**15.**	B	**16.**	B
17.	D	**18.**	C	**19.**	B	**20.**	A

Section-B

1.	400	**2.**	226	**3.**	8	**4.**	2
5.	900	**6.**	8	**7.**	667	**8.**	5
9.	8	**10.**	2				

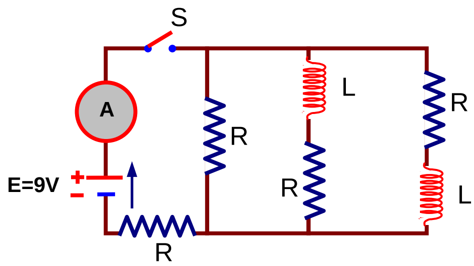
SECTION – A

Sol1. According to KTG, the gas exerts pressure because its molecule:
suffer change in momentum when impinge on the walls of container .

Sol2.
R = 2Ω
L = 2 mH
E = 9V

$$i = \frac{\varepsilon}{2R} = \frac{9v}{4\Omega} = 2.25A$$

Just after the switch 'S' is closed, the inductor acts as open circuit.



Sol3. $T = 2\pi\sqrt{\frac{L}{g}}$ or $T^2 = 4\pi^2\left(\frac{L}{g}\right)$

$$\Rightarrow g = 4\pi^2\left(\frac{L}{T^2}\right)$$

$$\Rightarrow \frac{\Delta g}{g}\% = \left(\frac{\Delta L}{L} + \frac{2\Delta T}{T}\right)\% = \left[\frac{1mm}{1m} + \frac{2\times 0.01}{1.95}\right]\times 100\% = (0.001+0.0102)\times 100 = 1.13\%$$

Sol4. Zener break down occurs in p-n junction having p and n both: Heavily doped and have narrow depletion layer.

Sol5. As we go from pole to equator, acceleration due to gravity decreases. So, weight of the body will also reduces. Thus, weight on equator will be slightly smaller than 49N.
ie, 48.83 N.

Sol6. When a soft ferromagnetic substance is placed in external magnetic field, the size of domain lying in the opposite direction of external magnetic field increases while size of domain lying in the opposite direction of field decreases if field is weak. However, if field is strong then the domain rotate in the direction of external magnetic field due to strong torque.

Sol7. A transistor is formed by doping a semi conducting wafer from one side by N-type dopant (high concentration) while comparatively lower concentration on other side thus forming NPN transistor & vice- versa.
So, statement (I) is false & statement (II) is true.

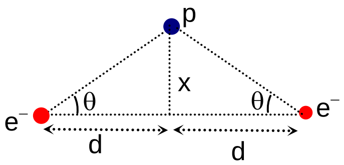
Sol8. F = - $\alpha x^2 \Rightarrow \frac{mvdv}{dx} = -\alpha x^2$

$$\Rightarrow \int_{v_0}^{0} vdv = -\frac{\alpha}{m}\int_0^x x^2 dx \Rightarrow \frac{0^2}{2} - \frac{v_0^2}{2} = \frac{-\alpha}{3m}x^3$$

$$\Rightarrow \frac{-v_0^2}{2} = -\frac{\alpha}{3m}x^3 \Rightarrow x = \left(\frac{3v_0^2 m}{2\alpha}\right)^{1/3}$$

Sol9.

$$F_{net} = \frac{2kee}{\left(d^2 + x^2\right)}\sin\theta = \left(\frac{2ke^2}{\left(d^2 + ^2\right)}\right)\theta$$



[for small displacement i.e, x is small so, sinθ ≈ θ ≈ tanθ]

$$= \frac{2ke^2}{\left(d^2 + x^2\right)}.\frac{x}{d} = 2.\frac{1}{4\pi\varepsilon_0}q^2\frac{x}{d^3} \qquad [\ q = e]$$

$$= \frac{q^2}{2\pi\varepsilon_0 d^3}x = m\omega^2 x$$

$$\therefore \omega = \sqrt{\frac{q^2}{2\pi\varepsilon_0 d^3 m}}$$

Sol10. $\Delta E = hv \rightarrow \left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$

(1) $n_1 = 3$, $n_2 = 2$

$$\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{9-4}{36} = \frac{5}{36}$$

(2) $n_1 = 4$, $n_2 = 3$

$$\left(\frac{1}{3^2} - \frac{1}{4^2}\right) = \frac{16-9}{144} = \frac{7}{144}$$

(3) $n_1 = 2$, $n_2 = 1$

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

(4) $n_1 = 5$, $n_2 = 4$

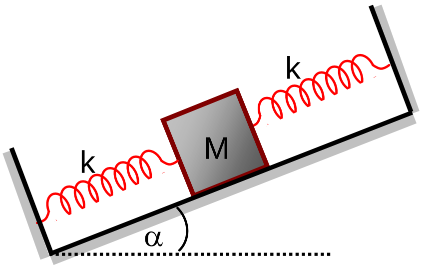
$$\left(\frac{1}{4^2} - \frac{1}{5^2}\right) = \frac{25-16}{400} = \frac{9}{400}$$

Sol11.

Here, $K_{eq} = 2k$

$T = 2\pi\sqrt{\frac{m}{2k}}$

$\therefore f = \frac{1}{2\pi}\sqrt{\frac{2k}{m}}$



Sol12. $V = 1.24 \times 10^6$ volt

$\lambda_{min} = ?$

$\lambda_{min} = \frac{hc}{eV} = \frac{1242nm}{e(1.24\times10^6)} = \frac{1000\times10^{-9}}{10^6} \Rightarrow \lambda_{min} = 10^{-3}$ nm

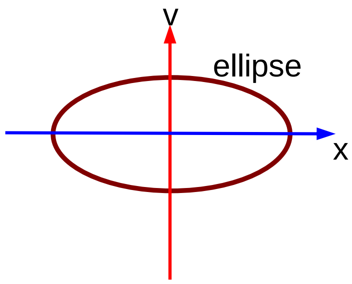
Sol13.

Let $x = A\sin\omega t$ & $v = A\omega\cos\omega t$

$\therefore v = \omega\sqrt{A^2 - x^2}$

$v^2 = \omega^2x^2 - \omega^2A^2$

$\frac{v^2}{\omega^2A^2} + \frac{x^2}{A^2} = 1$



Sol14.

n=1mole

$W_{AB} = nRT\ln\frac{v_2}{v_1} = 1\times RT\ln\frac{2v_1}{v_1} = RT\ln 2$

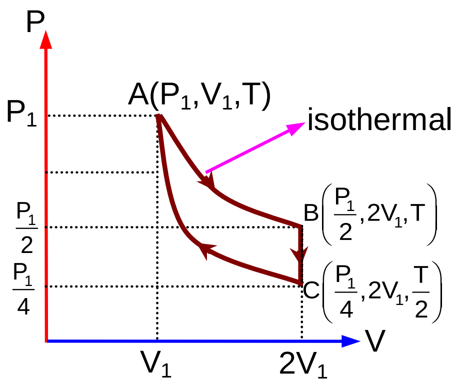
$W_{BC} = 0$

$W_{CA} = \frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{\frac{P_1}{4}\times 2V_1 - P_1\times V_1}{\gamma}$

$\Rightarrow W_{CA} = \frac{\frac{P_1V_1}{2} - P_1V_1}{\gamma - 1} = \frac{-p_1v_1}{2(\gamma-1)} = \frac{-1RT}{2(\gamma-1)}$

$\Rightarrow W_{CA} = \frac{-RT}{2(\gamma-1)}$

$\therefore W_{total} = RT\left[\ell n2 - \frac{1}{2(\gamma-1)}\right]$



Sol15. (A) Source of microwave frequency $\Rightarrow$ Magnetron

(B) Source of infrared frequency $\Rightarrow$ Vibration of atoms and molecules

(C) Source of Gamma rays $\Rightarrow$ Radioactive decay of nucleus

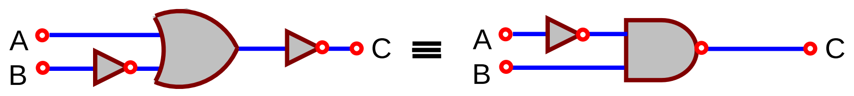
(D) Source of x- rays $\Rightarrow$ inner shell electrons.

Sol16. $\lambda_{Red} > \lambda_{violet}$

$\beta = \frac{\lambda D}{d} \Rightarrow$ Fringe width

If the source of light used in a Young's double slit experiment is changed from red to violet:consecutive fringe lines will come closer.

Sol17.



Truth Table

A	B	C
0	0	0
0	1	1
1	0	0
1	1	0

Sol18.

$$\lambda = \frac{h}{p} \text{ or } \lambda = \frac{h}{mv}$$

$$\lambda_p = \lambda_\alpha \qquad \text{[Given]}$$

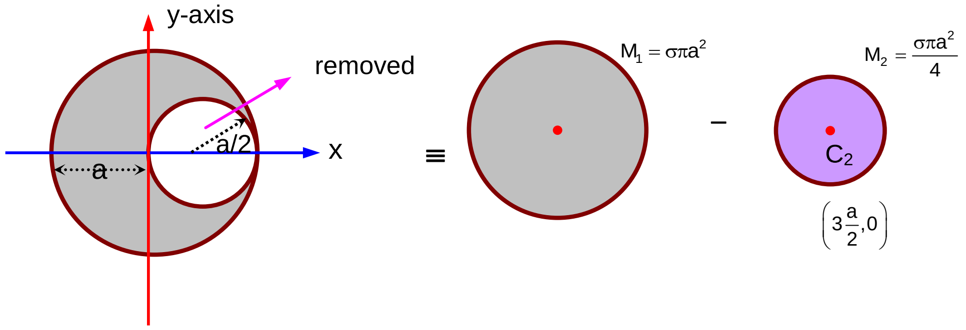
$$\frac{h}{m_p v_p} = \frac{h}{m_\alpha v_\alpha} \Rightarrow \frac{v_p}{v_\alpha} = \frac{m_\alpha}{m_p}$$

$$\Rightarrow \frac{v_p}{v_\alpha} = \frac{4m}{m} = \frac{4}{1} \qquad \text{or } 4:1$$

Sol19. Traveling wave is represented by $f\left(t \pm \frac{x}{v}\right)$

Thus, y = A sin (15x – 2t) represents a travelling wave

Sol20.



$$x_{cm} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$$

$$= \frac{\sigma\pi a^2 \times a - \frac{\sigma\pi a^2}{4} \times \frac{3a}{2}}{\sigma\pi a^2 - \frac{\sigma\pi a^2}{4}} = \frac{\frac{5}{8}\sigma\pi a^3}{\frac{3}{4}\sigma\pi a^2} = \frac{5}{8}\sigma\pi a^2 \times \frac{4}{3}\sigma\pi a^2 = \frac{5}{6}a$$

SECTION - B

Sol1. T= 27°C, P= 1atm = 10^5N/m^2, V_{rms} = 200m/s

As we know

$$v_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow \frac{v_{rms}}{v'_{rms}} = \frac{\sqrt{\frac{3RT}{M}}}{\sqrt{\frac{3RT'}{M}}}$$

$$\frac{200}{V'_{rms}} = \sqrt{\frac{T}{T'}} = \sqrt{\frac{300}{400}}$$

$$V'_{rms} = 200 \times \frac{2}{\sqrt{3}} = \frac{x}{\sqrt{3}}$$

x= 400

Sol2. Flux through the 6 sides of square (i.e cube)

$$\phi_T = \frac{q_{in}}{\varepsilon_0} = \frac{12 \times 10^{-6} C}{\varepsilon_0}$$

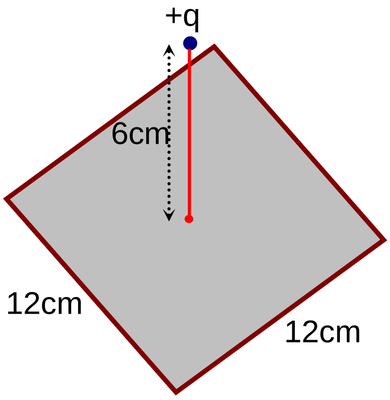
$\therefore$ Flux through a square

$$\phi = \frac{\phi_T}{6} = \frac{12 \times 10^{-6}}{\varepsilon_0 \times 6} = \frac{2 \times 10^{-6}}{\varepsilon_0}$$

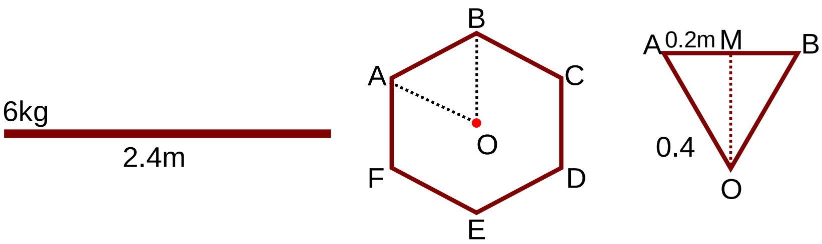
$$\Rightarrow \phi = \frac{2 \times 10^{-6} C}{8.85 \times 10^{-12}} Nm^2 / C^2$$

$$\Rightarrow \phi = 0.22598 \times 10^6$$

$$\Rightarrow \phi = 225.98 \times 10^3 Nm^2 / C \simeq 226 Nm^2 / C$$



Sol3.



Let m_{AB} = m = 1kg

AB = 0.4m = ℓ

d = OM = $\sqrt{0.16 - 0.04} = \sqrt{0.12}$

d = $2\sqrt{3} \times 10^{-1}$

$$I_{AB \text{ about } O} = \frac{m\ell^2}{12} + md^2$$

$$\therefore I_{\text{hexagon, about } O} = 6\left[\frac{m\ell^2}{12} + md^2\right] = \frac{m\ell^2}{2} + 6md^2$$

$$= \frac{1 \times (0.4)^2}{2} + 6 \times 1 \times \left(2\sqrt{3} \times 10^{-1}\right)^2 = \frac{0.16}{2} + 6 \times 4 \times 3 \times 10^{-2}$$

$$= 0.08 + 0.72 = 0.8 kgm^2 = 8 \times 10^{-1} kgm^2$$

Sol4. As we know that

$$Y = \frac{FL}{A\Delta L}$$

$$\Delta L = 0.04m = \frac{FL}{AY} \text{ ....(i)}$$

If length and diameter both are doubled

$$\Delta L' = \frac{F.2L}{4A.Y} = \frac{FL}{2Y} = 0.02m = 2cm$$

Sol5. $\omega_0 = 10^5$ rad / sec

P = 16w , 120v at resonance

$$P = \frac{v^2}{R} \Rightarrow 16 = \frac{(120)^2}{R} \Rightarrow R = \frac{14400}{16} = 900\Omega$$

Sol6. Sound level is given in dB = $10\log\left(\frac{P_0}{P_i}\right)$ or $10 \log\left(\frac{I}{I_0}\right)$

As sound level decreases 5dB every km,

So, in 20 km sound level will decrease by $20 \times 5 = 100$dB.

$$\Delta\beta = \beta_2 - \beta_1 = 10 \log\left(\frac{I_2}{I_1}\right)$$

$$-100 = 10\log\left(\frac{I_2}{I_1}\right)$$

$$-10 = \log\left(\frac{I_2}{I_1}\right)$$

$$10^{-10} = \frac{I_2}{I_1} \Rightarrow I_2 = 10^{-10} I_1$$

$$P_2 = 10^{-10} P_1$$

$$P_2 = 10^{-10} \times \left(0.1 \times 10^3\right) \Rightarrow P_2 = 10^{-8} W = 10^{-x} W$$

$\therefore$ x = 8

Sol7. f = 3GHz = 3×10^9 Hz

$$\lambda_{vacuum} = \frac{v}{f} = \frac{3 \times 10^8 m/s}{3 \times 10^9 /s} = 10^{-1} m = 0.1m$$

$$\lambda_{vacuum} = \frac{\lambda_{vacuum}}{\mu_{medium}} = \frac{0.1}{\mu_{medium}}$$

$$\mu_{medium} = \sqrt{\mu_r \in_r} = \sqrt{1 \times 2.25} = 1.5$$

$$\therefore \mu_{medium} = \frac{0.1m}{1.5} = 0.0667m = 6.67cm = 667 \times 10^{-2} cm$$

Sol8. radius r = 0.5 mm

$$\sigma = 5 \times 10^7 s/m$$

$$\vec{E} = 10 \times 10^{-3} V/m = 10^{-2} V/m$$

As we know

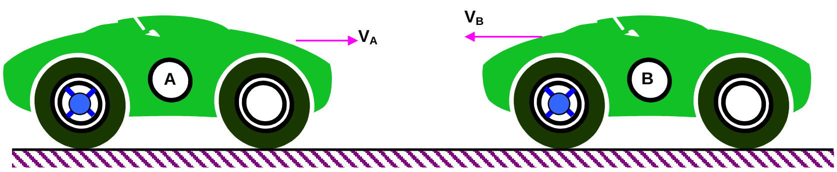
$$J = \sigma E$$

$$J = \frac{i}{A} = \sigma E$$

$$\therefore i = \sigma EA = 5 \times 10^7 \times 10^{-2} \times \pi \times \left(0.5 \times 10^{-3}\right)^2 = 1.25\pi \times 10^{-1} A = 125\pi mA = x^3 \pi \text{ mA}$$

$\therefore$ x = 5

Sol9. $7.2 \times \frac{5}{18} = 2m/s$ **[$V_A = V_B = 2m/s$]**



$$f'_B = f_A\left(\frac{v + v_B}{v - v_A}\right)$$

$\downarrow$

App freq heard by car B

$$f'_B = 676\left[\frac{340 + 2}{340 - 2}\right] = 676 \times \frac{342}{338} = 684 \text{ Hz}$$

Similarly , $f'_A = f_B\left(\frac{v + v_B}{v - v_B}\right) = 684$ Hz

$\therefore$ Beat frequency heard by both = 684 – 676= 8Hz

Sol10. A → $m_A = 1kg$, $P_A = P$

B → $m_B = 2kg$, $P_B = P$

$$\because kE = \frac{P^2}{2m}$$

$$\therefore \frac{kE_A}{kE_B} = \frac{\left(\frac{P^2}{2mA}\right)}{\left(\frac{P^2}{2m_B}\right)} = \frac{m_B}{m_A} = \frac{2}{1}$$

PART –B (CHEMISTRY)

Answers

Section-A

1.	A	**2.**	A	**3.**	D	**4.**	A
5.	D	**6.**	D	**7.**	B	**8.**	C
9.	A	**10.**	A	**11.**	A	**12.**	D
13.	C	**14.**	C	**15.**	C	**16.**	C
17.	A	**18**	A	**19.**	A	**20.**	C

Section-B

1.	3	**2.**	81	**3.**	141	**4.**	8
5.	243	**6.**	5	**7.**	3776	**8.**	855
9.	1	**10.**	1				

SECTION – A

Sol1. Density = $\frac{\text{mass}}{\text{Volume}}$

Cu > Co > Fe > Cr > Zn

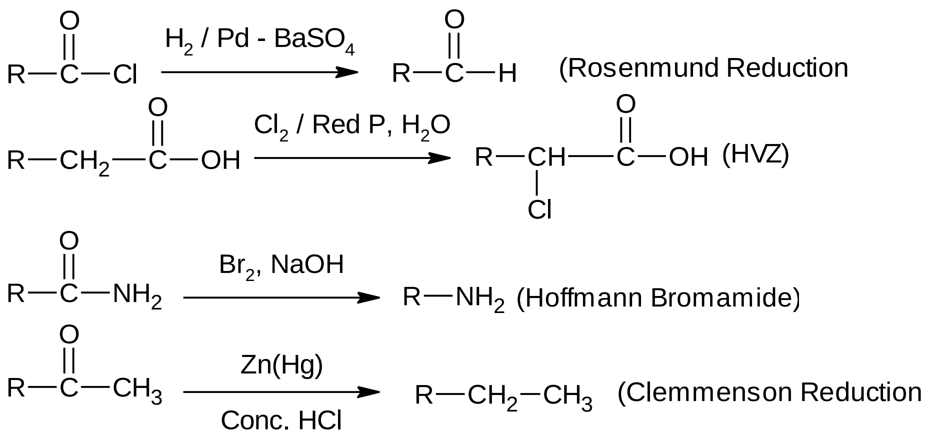
Sol2. Valium – Tranquilizer
Morphine – Analgesic
Norethindrone – Antifertility drug
Vitamin B_{12} – Pernicious anaemia

Sol3. Blood – Negatively charged colloid.
According to Hardy – Schulze Rule
$FeCl_3$ is more efficient for blood clotting

Sol4.

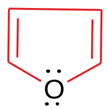
Aluminium	–	Kaolinite
Iron	–	Siderite
Copper	–	Malachite
Zinc	–	Calamine

Sol5.

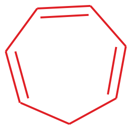


Sol6. $VOSO_4 \rightarrow V^{4+}$ Reducing agent
$Cr_2O_3 \rightarrow$ Amphoteric oxide
Red colour of ruby due to Cr^{3+} present in Al_2O_3
$Ru^{8+} \rightarrow$ oxidizing agent

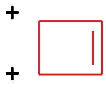
Sol7.



→ Cyclic
→ Planar
→ Follow Huckle Rule
→ Conjugation



→ Conjugation Is not present in whole ring



→ Cycllic
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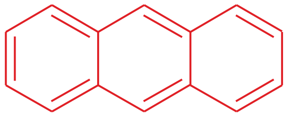


→ Cycllic
→ Planar
→ Follow Huckle Rule
→ Conjugation

Sol8. Hydrogen is most abundant element in earth crust and lightest element. But in troposphere nitrogen gas is most abundant element

Sol9.

LiF → Li^+ + F^- ; LiCl → Li^+ + Cl^-

LiF has more lattice enthalpy than LiCl

MgO → Mg^{2+} + O^{2-} ; NaCl → Na^+ + Cl^-

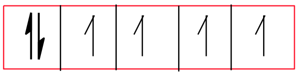
MgO has more lattice enthalpy than NaCl

Sol10.

$[FeCl_4]^{2-} \Rightarrow$

$[Fe] \Rightarrow [Ar]\ 4s^2\ 3d^6 \Rightarrow Fe^{2+} = 4s^0 3d^6$

Cl^- Weak field ligand [Ar]



n = 4

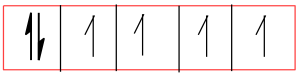
$\mu = \sqrt{4(4+2)}$

= 4.90 BM

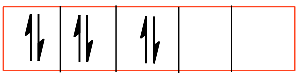
$[Co(C_2O_4)_3]^{3-} \Rightarrow Co^{3+}$

$Co \Rightarrow [Ar]4s^2\ 3d^7$

$Co^{+3} = [Ar]\ 4s^o 3d^6$



$C_2O_4^{-2} \to$ strong field ligand with Co^{+3}



n=0

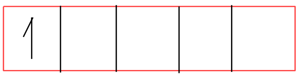
μ = 0 BM

MnO_4^{2-}

$Mn^{6+} \Rightarrow$

$Mn \Rightarrow [Ar]\ 4s^2\ 3d^5$

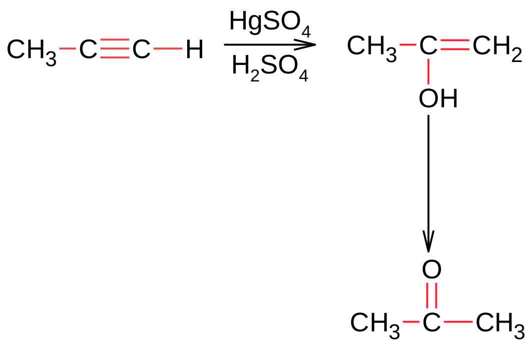
$Mn^{6+} \Rightarrow [Ar]\ 4s^o\ 3d^1$



n=1

$\mu = \sqrt{n(n+2)} = \sqrt{1(3)}$ =1.73BM

Sol11.

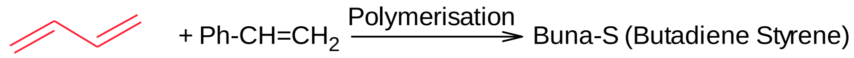


Hence

CH_3–CH_2–CHO can't be formed.

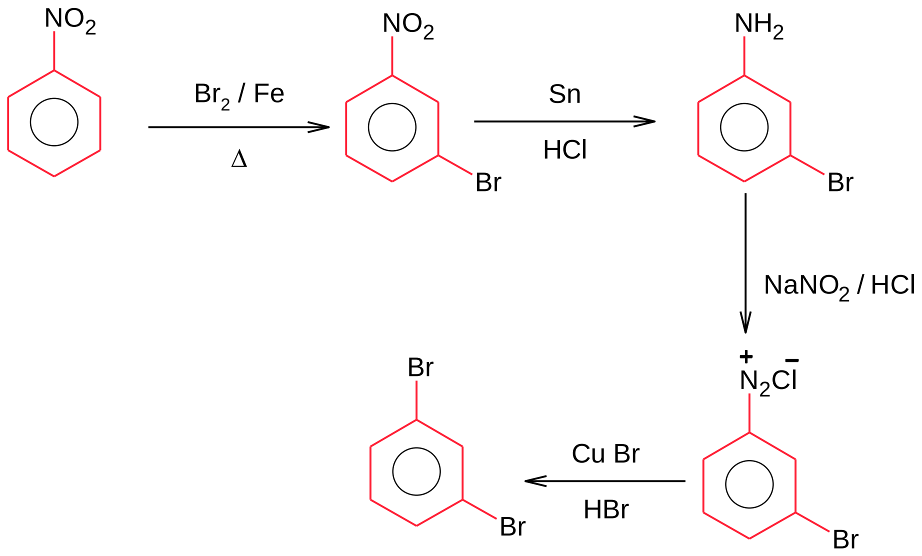
In case of unsymmetrical alkynes, more positive charge stabilizing carbon attacked by H_2O and finally converted into carbonyl.

Sol12. S→ styrene

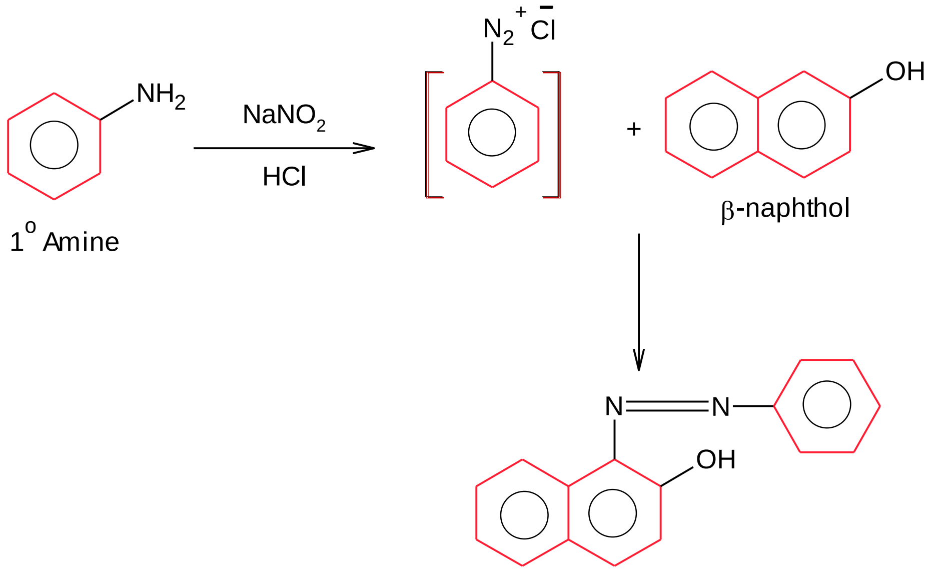


Buta-1,3- diene Styrene

Sol13.

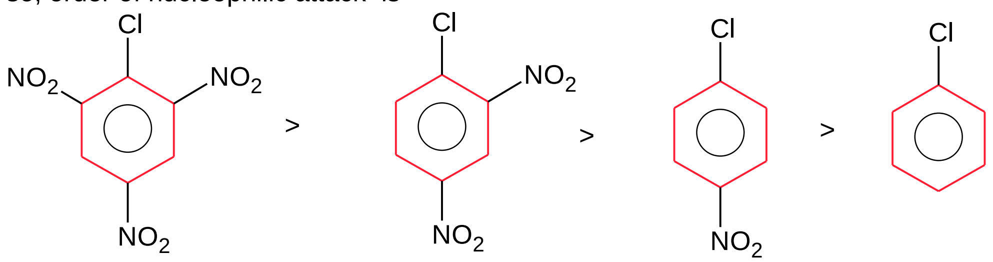


Sol14.



Sol15. Clean water would have BOD Value less than 5ppm, highly polluted water could have BOD value of 17ppm or more.

Sol16. If we add $-NO_2$ group on ortho and para position, then electron deficiency increases in benzene ring so, order of nucleophilic attack is



Sol17. According to Bohr's theory,

$K.E = 13.6\frac{z^2}{n^2}$ frequency (υ) of revolution of electron $\propto \frac{z^2}{n^3}$

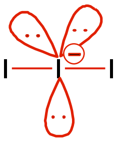
$v = 2.18 \times 10^6 \frac{z}{n}$

$F = \frac{kq_1q_2}{r^2} = \frac{Kze^2}{r^2}\left(r \propto \frac{n^2}{z}\right)$

$F \propto \frac{z^3}{n^4}$

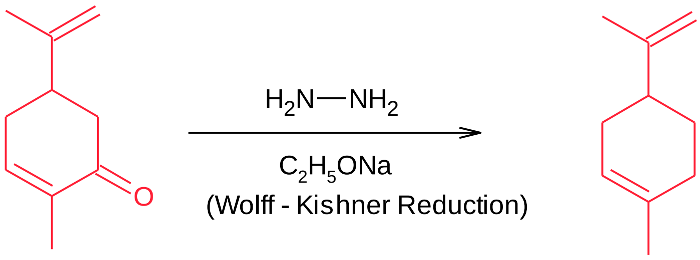
Sol18. Li $\rightarrow$ Crimson Red
Na $\rightarrow$ Yellow
Rb $\rightarrow$ Red violet
Cs $\rightarrow$ Blue
VIBGYOR
Wavelength
Red violet > Crimson Red > Yellow > Blue
↓ ↓ ↓ ↓
780nm 670.8nm 589.2nm 455.5nm

Sol19.



Linear (180°)

Sol20.



SECTION - B

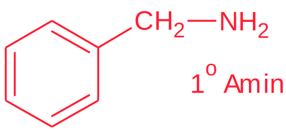
Sol1. Gabriel phthalimide synthesis is used for 1° Aliphatic / alicyclic amine

$$\begin{matrix} H_3C \\ H_3C \end{matrix} \!\!> CH\text{-}CH_2\text{-}NH_2$$

1° Amine

$CH_3-CH_2-NH_2$

1° Amine



1° Amine

Sol2. $C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$
Glucose Fructose

$$K = \frac{2.303}{t}\log\frac{a}{a-x}$$

$$\frac{kt}{2.303} = \log\frac{a}{a-x}$$

$$\frac{\ln 2 \times 9}{\frac{10}{3} \times 2.303} = \log\left(\frac{1}{f}\right)$$

$$\log\left(\frac{1}{f}\right) = 81.24 \times 10^{-2} = 81 \times 10^{-2}$$

Sol3. $PbI_2 \rightleftharpoons Pb^{2+} + 2I^-$ $\quad K_{sp} = 8.0 \times 10^{-9}$

$Pb(NO_3)_2 \rightarrow Pb^{2+} + 2NO_3^-$

0.1M	-	-
-	0.1M	0.1M

$PbI_2 \rightleftharpoons Pb^{2+} + 2I^-$

S 2S

(S+0.1)

$K_{sp} = 8 \times 10^{-9}$; Using $K_{sp} = [Pb^{2+}][I^-]^2$

$8 \times 10^{-9} = 0.1 \times (2S)^2$

$S = 141 \times 10^{-6} M$

Sol4. $C_x H_y (g) + \left(x + \frac{y}{4}\right) O_2(g) \rightarrow xCO_2(g) + \frac{y}{2} H_2O(\ell)$

V	6V	-	-
-	-	4V	

Volume of $CO_2 = 4 \times V_{C_xH_y}$

$Vx = 4V$

$x = 4$

Volume of $O_2 = 6 \times V_{C_xH_y}$

$V\left(x + \frac{y}{4}\right) = 6V$

$4 + \frac{y}{4} = 6$

$\frac{y}{4} = 2$

$y = 8$

Sol5. $C_6H_5NH_2 \xrightarrow{90\%\text{efficiency}} C_6H_5 - NH - \overset{O}{\overset{||}{C}} - CH_3$

Aniline (Acetanilide)

1 mole $C_6H_5NH_2 \rightarrow$ 1 mole $C_6H_5 - NH - \overset{O}{\overset{||}{C}} - CH_3$

$\frac{1.86}{93} = \frac{w}{135}$

W = 2.70g

Mass produced actual = $2.70 \times \frac{90}{100} = 2.43 = 243 \times 10^{-2}$g

Sol6. W = 4.75g

$n = \frac{4.75}{26}$ T = 323K , R = 0.0826

$P = \frac{740}{760}$ atm

$V = \frac{nRT}{P} = \frac{4.75 \times 0.0826 \times 323}{26\left(\frac{740}{760}\right)}$ = 5litre

Sol7. $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$

$E_1 = E^o - \frac{0.059}{5} \log \frac{\left[Mn^{2+}\right]}{\left[MnO_4^-\right]} \left[\frac{1}{H^+}\right]^8$

$[H^+]$ = 1M

$E_1 = E^o - \frac{0.059}{5} \log \frac{\left[Mn^{2+}\right]}{\left[MnO_4^-\right]}$

$[H^+] = 10^{-4}$

$E_2 = E^o - \frac{0.059}{5} \log \frac{\left[Mn^{2+}\right]}{\left[MnO_4^-\right]} \times \left(\frac{1}{10^{-4}}\right)^8$

$= E^o - \frac{0.059}{5} \log \frac{\left[Mn^{2+}\right]}{\left[MnO_4^-\right]} + \frac{0.059}{5} \log 10^{-32}$

So, difference in E_1 & E_2 is
=0.3776 V

$= 3776 \times 10^{-4}\,V$

Sol8. $3CH \equiv CH(g) \rightarrow C_6H_6(\ell)$

$\Delta G^o = -RT\ell nK$ ……….(i)

$\Delta G^o = \Sigma\Delta G^o_P - \Sigma\Delta G^o_R$ ……….(ii)

Equating (i) & (ii)

$-2.303\ RT\log k = 4.88 \times 10^5$

$\log K = \frac{-4.88 \times 10^5}{2.303 \times R \times T} = \frac{-488000}{5705.848} = -85.52 = -855 \times 10^{-1}$

So; magnitude of logK = 855×10^{-1}.

Sol9. $\Delta T_f = k_f.\ m$

$T_f^o - T_f = 5.12 \times \frac{\left(\frac{10}{58}\right)}{\left(\frac{200}{1000}\right)}$

$5.5 - T_f = \frac{5.12 \times 5 \times 10}{58}$

$T_f = 1.086^oC = (1.086)^oC \cong 1^oC$

Sol10. α - sulphar & β- sulphur – Diamagnetic, S_2-form is paramagnetic due to presence of unpaired electron in π^* orbital like O_2.

PART–C (MATHEMATICS)

Answers

Section-A

1.	C	**2.**	A	**3.**	D	**4.**	D
5.	D	**6.**	A	**7.**	C	**8.**	B
9.	C	**10.**	D	**11.**	B	**12.**	D
13.	C	**14.**	B	**15.**	A	**16.**	A
17.	C	**18.**	C	**19.**	C	**20.**	C

Section-B

1.	1	**2.**	**Question Dropped**			**3.**	310
4.	2	**5.**	56	**6.**	3	**7.**	31650
8.	2	**9.**	11	**10.**	**Question Dropped**		

SECTION-A

Sol1. $I=\int_0^2 f(x)dx=\left[xf(x)\right]_0^2-\int_0^2 xf'(x)dx=2e^2-\int_0^2 xf'(x)dx$ ....(A)

Put $I_1=\int_0^2 xf'(x)dx$ ....(i)

Using properties $\int_a^b f(x)dx=\int_a^b f(a+b-x)dx$

$I_1=\int_0^2 (2-x)f'(2-x)dx=\int_0^2 (2-x)f'(x)dx$ ....(ii)

Adding (i) and (ii) we get

$2I_1=2\int_0^2 f'(x)dx \Rightarrow I_1=[f(x)]_0^2$

$f(2)-f(0)=e^2-1$

From (A) $I=2e^2-e^2+1=e^2+1$

Sol2. $I=\int_1^3\left[x^2-2x+1-3\right]dx=\int_1^3\left[(x-1)^2-3\right]dx=\int_1^3\left[(x-1)^2\right]dx-3\int_1^3 dx$ ....(A)

$I_1=\int_1^3\left[(x-1)^2\right]dx$ Put $(x-1)^2=t$

$I_1=\frac{1}{2}\int_0^4 [t]\frac{dt}{\sqrt{t}}$ $2(x-1)dx=dt$

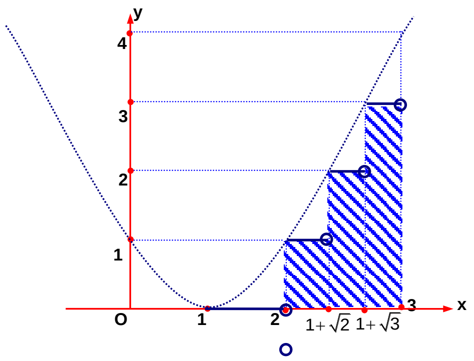
$dx=\frac{dt}{2\sqrt{t}}$

$I_1=\frac{1}{2}\left[0\int_0^1\frac{dt}{\sqrt{t}}+\int_1^2\frac{dt}{\sqrt{t}}+2\int_2^3\frac{dt}{\sqrt{t}}+3\int_3^4\frac{dt}{\sqrt{t}}\right]=\frac{1}{2}\left\{\left|\frac{t^{\frac{-1}{2}+1}}{-\frac{1}{2}+1}\right|_1^2+2\left|\frac{t^{\frac{-1}{2}+1}}{-\frac{1}{2}+1}\right|_2^3+3\left[\frac{t^{\frac{-1}{2}+1}}{-\frac{1}{2}+1}\right]_3^4\right\}=5-\sqrt{2}-\sqrt{3}$

Hence from (A)

$=5-\sqrt{2}-\sqrt{3}-6=-1-\sqrt{2}-\sqrt{3}$

2nd method



$$I=\int_1^3\left(\left[(x-1)^2\right]-3\right)dx=\int_1^3\left[(x-1)^2\right]dx-3\int_1^3 dx$$

$$\int_1^3\left[(x-1)^2\right]dx-6 \ldots\ldots\ldots\ldots\ldots\ldots(A)$$

Let $I_1=\int_1^3\left[(x-1)^2\right]dx$

$$\therefore 0\int_1^2 dx+1\int_2^{1+\sqrt{2}}dx+2\int_{1+\sqrt{2}}^{1+\sqrt{3}}+3\int_{1+\sqrt{3}}^{3}dx$$

$$=\left(1+\sqrt{2}-2\right)+2\left(1+\sqrt{3}-1-\sqrt{2}\right)+3\left(3-1-\sqrt{3}\right)$$

$$=-1+\sqrt{2}+2\sqrt{3}-2\sqrt{2}+6-3\sqrt{3}=5-\sqrt{2}-\sqrt{3}$$

From (A) , $I=5-\sqrt{2}-\sqrt{3}-6=-1-\sqrt{2}-\sqrt{3}$

Sol3. $x-2y=1,\ x-y+kz=-2,\ ky+4z=6$

$x-2y+0.z-1=0$

$x-y+kz+2=0$

$0x+ky+4z-6=0$

$$\Delta=\begin{vmatrix}1 & -2 & 0\\ 1 & -1 & k\\ 0 & k & 4\end{vmatrix}=1\left(-4-k^2\right)-2\left(-4+0\right)=-4-k^2+8=-k^2+4$$

$\therefore k^2=4\Rightarrow k=\pm 2$

For unique solution $\Delta\neq 0\Rightarrow k\neq\pm 2$

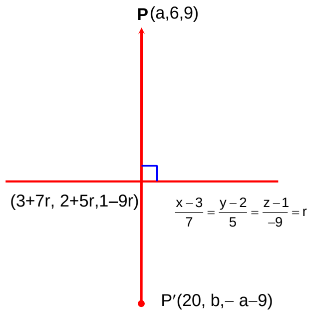
$$\Delta_1=\begin{vmatrix}1 & -2 & 0\\ -2 & -1 & k\\ 6 & k & 4\end{vmatrix}=-(k+10)(k+2)$$

For no solution

$\Delta=0,\Delta_1\neq 0$

k=2

Sol4. $\dfrac{a+20}{2}=3+7r$



$a+20=6+14r$ ....(i)

$\frac{b+6}{2}=2+5r$

$b+6=4+10r$

$b=-2+10r$ ....(ii)

$\frac{9-a-9}{2}=1-9r$

$-a=2-18r$

$a=18r-2$ ....(iii)

Solving (i) and (iii) we get

$20+18r-2=6+14r$

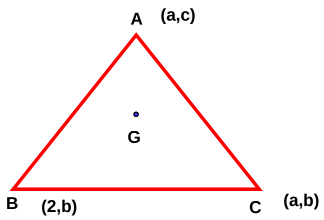
$4r=8-20=-12$

$r=-3$

$\therefore$ a = 14 +14(-3) = -56 and b=-2 –30 = –32

$|a+b|\ \ |-56-32|=88$

Sol5. $\frac{a+2+a}{3}=\frac{10}{3}$



$2a+2=0$

$2a=8\Rightarrow a=4$ ....(i)

and $\frac{c+b+b}{3}=\frac{7}{3}$

$2b+c=7$ ----------------(ii)

Since a, b,c are in A.P

2b = a + c

From (i) $\therefore$ 2b = 4+c...................(iii)

Solving (ii) and (iii)

4+c+c=7

2c = 3

$c=\frac{3}{2}$

$\therefore 2b=4+\frac{3}{2}=\frac{11}{2}$

$\therefore b=\frac{11}{4}$

As per question

$\alpha+\beta=\frac{-b}{a}$ and $\alpha\beta=\frac{1}{a}$

$=\frac{\frac{-11}{4}}{4}=-\frac{11}{16},\quad \alpha\beta=\frac{1}{4}$

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

$=\frac{121}{256}-\frac{3}{4}$

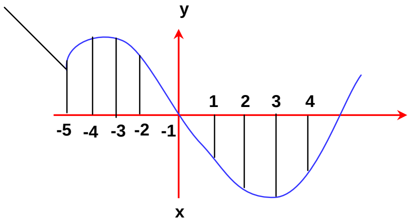
$=\frac{121-192}{256}=\frac{-71}{256}$

Sol6. let f:R→R

$$f'(x)=\begin{cases}-55, & x<-5\\ 6x^2-6x-120, & -5<x<4\\ 6x^2-6x-36, & x>4\end{cases}$$

$$=\begin{cases}-55, & x<-5\\ 6(x-5)(x+4), & -5<x<4\\ 6(x-3)(x+2), & x>4\end{cases}$$

f'(x) increasing in $x\in(-5,-4)\cup(4,\infty)$



Sol7. Total possibilities = $2^5\times 2^5$

Farounable case = ${}^5C_2\times 3^3 = 10\times 3^3$

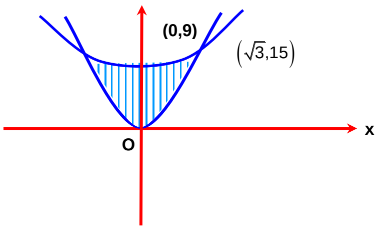
$\therefore$ required probability = $\dfrac{10\times 3^3}{2^5\times 2^5}=\dfrac{5\times 27}{2^9}=\dfrac{135}{2^9}$

Sol8. Area of shaded region

$$2\int_0^{\sqrt{3}}\left(2x^2+9-5x^2\right)dx$$

$$=2\int_0^{\sqrt{3}}\left(9-3x^2\right)dx$$

$$=\int_0^{\sqrt{3}}\left(3-x^2\right)dx=6\left[3x-\frac{x^3}{3}\right]_0^{\sqrt{3}}=6\left[\frac{9\sqrt{3}-3\sqrt{3}}{3}\right]=12\sqrt{3}$$



Sol9. $A^T = A$ and $B^T = -B$

$C = A^2B^2 - B^2A^2$

$C^T = (A^2B^2)^T - (B^2A^2)^T = B^2A^2 - A^2B^2$

$C^T = -C$. Hence C is skew symmetric matrix

$\therefore$ det (C) = 0

Hence system have infinite solutions

Sol10. $x+\sqrt{3}y=2\sqrt{3}$, and $m=-\dfrac{1}{\sqrt{3}}, C=2$

(1) $\dfrac{x^2}{\frac{9}{2}}-\dfrac{y^2}{\frac{1}{2}}=1\Rightarrow c=\sqrt{a^2m^2-b^2}=\sqrt{\dfrac{9}{2}\times\dfrac{1}{3}-\dfrac{1}{2}}=1$, not possible

(2) $y^2=\dfrac{1}{6\sqrt{3}}x$, $c=\dfrac{a}{m}=\dfrac{1}{24\sqrt{3}}\times\left(\dfrac{-1}{\sqrt{3}}\right)=-\dfrac{1}{72}$, not possible

(3) $c=a\sqrt{1+m^2}=\sqrt{7}\times 2=2\sqrt{7}$, not possible

(4) $\dfrac{x^2}{9}+\dfrac{y^2}{1}=1, C=\sqrt{9m^2+1}=\sqrt{9\times\dfrac{1}{3}+1}=2$

Sol11. ${}^{n+1}C_2+2\left({}^2C_2+{}^3C_2+{}^4C_2----+{}^nC_2\right)$

$${}^{n+1}C_2+2\sum_{r=1}^{n-1}{}^{r+1}C_2$$

$$={}^{n+1}C_2+2\sum_{r=1}^{n-1}\frac{(r+1)!}{(r-1)!2!}={}^{n+1}C_2+\sum_{r=1}^{n-1}(r+1)r$$

$$=\frac{(n+1)!}{2!(n+1)!}+\frac{(n-1)n(2(n-1)+1)}{6}+\frac{(n-1)n}{2}=\frac{n(n+1)}{2}+\frac{n(n-1)(2n-1)}{6}+\frac{n(n-1)}{2}$$

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

$$= \frac{n\left(6n+2n^2-3n+1\right)}{6} = \frac{\left(2n^2+3n+1\right)}{6} = \frac{n(2n+1)(n+1)}{6}$$

Sol12. $\vec{r}.\left(\hat{i}+\hat{j}+\hat{k}\right)-1+\lambda\left(\vec{r}.\left(\hat{i}-2\hat{j}\right)+2\right)=0$

$\vec{r}.\left((1+\lambda)\hat{i}+(1-2\lambda)+\hat{j}\right)-1+2\lambda=0$

$\therefore$ point (1,0,2) $=\hat{i}+2\hat{k}$

$\therefore 1+\lambda+2-1+2\lambda=0 \Rightarrow \lambda=-\frac{2}{3}$

$\therefore \vec{r}\left(\frac{\hat{i}}{3}+\frac{7\hat{j}}{3}+\hat{k}\right)-\frac{7}{3}=0$

$\vec{r}.\left(\hat{i}+7\hat{j}+3\hat{k}\right)=7$

Sol13. $\sim(\sim p\wedge(p\vee q))$ $= pV(\sim p\wedge\sim q)$

$= (pv\sim p)\wedge(pv\sim q)$

$= pv\sim q$

Sol14. $\begin{vmatrix} f(X) & f'(x) \\ f'(x) & f''(x) \end{vmatrix}=0$

$f(x)f''(x)=f'(x)f'(x)$

$\frac{f''(x)}{f'(x)}=\frac{f'(x)}{f(x)}$, Integrating on both sides

$\ln|f'(x)|=\ln|f(x)|+\ln|c|$

$f'(x)=cf(x), f'(0)=cf(0)\Rightarrow c=2$

$\frac{f'(x)}{f(x)}=2$, again integrating on both side

$\ln f(x)=2^x+k$

$f(x)=e^{2x+k}$

$f(0)=e^k=e^k=1\Rightarrow k=0$

$\therefore f(x)=e^{2x}$ $\quad\quad [\because e=2.718]$

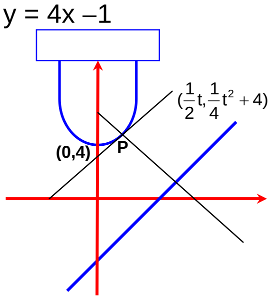
$\therefore e^2\in(6,9)$

Sol15.

y= x^2+4

x^2 = y–4

y = 4x –1



$$PQ=\frac{\left|4\times\frac{1}{2}t-\frac{1}{4}t^2-4-1\right|}{\sqrt{17}}$$

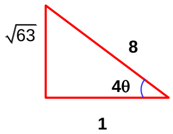
$$p=\frac{\left|t^2-8t-20\right|}{4\sqrt{17}}$$

$\frac{dp}{dt} = \frac{1}{4\sqrt{17}}(2t-8)$ for maximum / minimum , $\frac{dp}{dt} = 0 \Rightarrow t = 4$

also $\frac{d^2p}{dt^2} > 0$ at $t = 4$

hence closest point becomes at t = 4 is (2,8)

Sol16. $\tan\left(\frac{1}{4}\sin^{-1}\frac{\sqrt{63}}{8}\right)$



Put $\frac{1}{4}\sin^{-1}\frac{\sqrt{63}}{8} = \theta$

$\sin 4\theta = \frac{\sqrt{63}}{8} \therefore \cos 4\theta = \frac{1}{8}$

$2\cos^2 2\theta = \frac{1}{8} + 1 \Rightarrow \cos 2\theta = \frac{3}{4}$

$\Rightarrow \frac{1-\tan^2\theta}{1+\tan^2\theta} = \frac{3}{4} \Rightarrow$

(adding 1 both side)

$\frac{2}{\sec^2\theta} = \frac{7}{4}$

$\cos^2\theta = \frac{7}{8} \Rightarrow \sec^2\theta = \frac{8}{7}$

$\tan^2\theta = \frac{8}{7} - 1 = \frac{1}{7}$

$\tan\theta = \frac{1}{\sqrt{7}}$

Sol17. (A)

P	**q**	**~p**	**~q**	**p→q**	**~q∧(p→q)**	**(~q∧(p→q))→ ~p**
T	T	F	F	T	F	T
T	F	F	T	F	F	T
F	T	T	F	T	F	T
F	F	T	T	T	T	T

tautology

(B)

p∨q	**(p∨q)~p**	**((p∨q)∧~p)→q**
T	F	T
T	F	T
T	T	T
F	F	T

tautology

Sol18. $y = ax^2 + bx + c$

$a + b + c = 2$

$\therefore \frac{dy}{dx} = 2ax + b \Rightarrow \left.\frac{dy}{dx}\right|_{(0,0)} = b = 1$

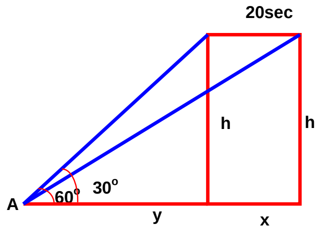
It passes through (0,0),

$0 = 0+0+c \Rightarrow c = 0$

$a = 1$

$\therefore a=1, b=1, c=0$

Sol19. S= 432km/hr



$\tan 60^o = \frac{h}{y}$

$h = \sqrt{3}y$

$\tan 30^o = \frac{h}{x+y}$

$x+y = \sqrt{3}h$

$x+y = \sqrt{3}.\sqrt{3}y$

$x+y = 3y$

$x = 2y$

$\because\ x = 432 \times \frac{1000}{3600} \times 20$

$x = 2400m$

$y = 1200m$

$\therefore h = 1200\sqrt{3}\ m$

Sol20. $x\frac{dy}{dx} + y = bx^4$

$\frac{dy}{dx} + \frac{y}{x} = bx^3$

$I.F. = e^{\int \frac{1}{x}dx} = e^{\ln x} = x$

$xy = b\int x^4 dx = \frac{bx^5}{5} + c$

$at(1,2),\ 1.2 = \frac{b}{5} + c \Rightarrow c = 2 - \frac{b}{5}$

$\therefore \int_1^2 f(x)dx = \int_1^2 \left(\frac{bx^4}{5} + \frac{10-b}{5x}\right)dx = \left[\frac{bx^5}{25} + \left(\frac{10-b}{5}\right)\ln x\right]_1^2$

As per question

$\frac{32b}{25} + (10-b)\ln 2 - \frac{b}{32} = \frac{62}{5}$

$\frac{31}{25}b + (10-b)\ln 2 = \frac{62}{5}$

$(10-b)\ln 2 = \frac{62}{5} - \frac{31}{25}b = \frac{31}{5}\left(2 - \frac{b}{5}\right)$

$\therefore$ b = 10

SECTION – B

Sol1. $L_1 = \frac{x-\lambda}{1} = \frac{y-\frac{1}{2}}{\frac{1}{2}} = \frac{z}{-\frac{1}{2}}$

$L_2 = \frac{x}{1} = \frac{y+2\lambda}{1} = \frac{z-\lambda}{1}$

$SD = \left|\frac{(\vec{a}_1 - \vec{a}_2)\bullet(\vec{b}_1 \times \vec{b}_2)}{|\vec{b}_1 \times \vec{b}_2|}\right|$

$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & -1 \\ 1 & 1 & 1 \end{vmatrix} = 2\hat{i} - 3\hat{j} + \hat{k}$$

$$\frac{\vec{b}_1 \times \vec{b}_2}{\left|\vec{b}_1 \times \vec{b}_2\right|} = \frac{2\hat{i} - 3\hat{j} + \hat{k}}{\sqrt{14}}$$

$$\vec{b}_2 \times \vec{b}_1 = (0-\lambda)\hat{i} + \left(-2\lambda - \frac{1}{2}\right)\hat{j} + (\lambda - 0)\hat{k}$$

$$\therefore SD = \frac{\left|-2\lambda + 3\left(2\lambda + \frac{1}{2}\right) + \lambda\right|}{\sqrt{14}} = \frac{\left|5\lambda + \frac{3}{2}\right|}{\sqrt{14}}$$

$$\therefore \frac{\left|5\lambda + \frac{3}{2}\right|}{\sqrt{14}} = \frac{\sqrt{7}}{2\sqrt{2}} \Rightarrow \left|5\lambda + \frac{3}{2}\right| = \frac{7}{2}$$

$$\therefore 5\lambda + \frac{3}{2} = \frac{7}{2} \Rightarrow \therefore 5\lambda = 2 \Rightarrow \lambda = \frac{2}{5}$$

$$\text{or } 5\lambda + \frac{3}{2} = -\frac{7}{2} \Rightarrow 5\lambda = -5 \Rightarrow \lambda = -1$$

$$\therefore |\lambda| = 1$$

Sol2. $\sum_{i=0}^{k}\binom{10}{i}\binom{15}{k-i} + \sum_{i=0}^{k+1}\binom{12}{i}\binom{13}{k+1-i}$

$$\sum_{i=0}^{k} {}^{10}C_i\,{}^{15}C_{k-i} + \sum_{i=0}^{k+1} {}^{12}C_i\,{}^{13}C_{k+1-i}$$

$${}^{10}C_0\,{}^{15}C_k + {}^{10}C_1\,{}^{15}C_{k-1} + {}^{10}C_2\,{}^{15}C_{k-2} + --- + {}^{10}C_k.{}^{15}C_0$$

Equating the coefficient of x^k in $(1+x)^{10}(x+1)^{15}$

= Equating the coefficient of x^k in $(1+x)^{25} = {}^{25}C_k$ ……………….(i)

$$\sum_{i=0}^{k+1} {}^{12}C_i\,{}^{13}C_{k+1-i}$$

$= {}^{12}C_0\,{}^{13}C_{k+1} + {}^{12}C_1\,{}^{13}C_k + {}^{12}C_{k-1} + ----- + {}^{12}C_{k+1}\,{}^{13}C_0$

= Equating the coefficient of x^{k+1} in $(1+x)^{12}(x+1)^{13}$

= Equating the coefficient of x^{k+1} in $(1+x)^{25} = {}^{25}C_{k+1}$ …………………..(ii)

From (i) and (ii) ${}^{25}C_k + {}^{25}C_{k+1} = {}^{26}C_{k+1}$

Hence $26 \ge k+1 \Rightarrow k \le 25$

But maximum value of k is not defined bonus

Sol3. $\dfrac{2^{21}\left(\frac{-1+i\sqrt{3}}{2}\right)^{21}}{\left(\sqrt{2}\right)^{24}\left(\frac{1-i}{\sqrt{2}}\right)^{24}} + \dfrac{2^{21}\left(\frac{1+\sqrt{3}i}{2}\right)^{21}}{\left(\sqrt{2}\right)^{24}\left(\frac{1+i}{\sqrt{2}}\right)^{24}} = k$

$$2^9\,\frac{e^{14\pi i}}{e^{-i6\pi}} + 2^9\,\frac{e^{i7\pi}}{e^{i6\pi}} = k$$

$$2^9\left[\frac{1}{1} + \frac{-1}{1}\right] = k$$

$$0 = k$$

$$\therefore n = [|k|] = 0$$

$$\sum_{j=0}^{5}(j+5)^2-\sum_{j=0}^{5}(j+5)$$

$$=\sum_{j=0}^{5}(j+5)(j+5-1)=\sum_{j=0}^{5}(j+5)(j+4)$$

$$=\sum_{j=0}^{5}\left(j^2+9\hat{j}+20\right)=\frac{5\times6\times11}{6}+\frac{9\times5\times6}{2}+20\times6$$

$$55+135+120=310$$

Sol4. $(x+1)^2+|x-5|=\frac{27}{4}$

Case I x<5

$$x^2+2x+1-x+5=\frac{27}{4}$$

$$x^2+x+6=\frac{27}{4}\Rightarrow 4x^2+4x-3=0$$

$$(2x+3)(2x-1)=0\Rightarrow x=-\frac{3}{2},\frac{1}{2}$$

Case II $x\geq5$

$$x^2+2x+1+x-5=\frac{27}{4}$$

$$x^2+3x-4=\frac{27}{4}$$

$$4x^2+12x-43=0$$

$$x=\frac{-12\pm\sqrt{144+43\times16}}{2\times4}=\frac{-12\pm\sqrt{832}}{8}$$ (rejected)

Because x > 5

Sol5. Let P(h,k)

$$\sqrt{(h-5)^2+k^2}=3\sqrt{(h+5)^2+k^2}$$

$$h^2-10h+25+k^2=9h^2+90h+225+9k^2$$

$$8h^2+8k^2+100h+200=0$$

$$x^2+y^2+\frac{25}{2}x+25=0$$

$$r^2=\frac{625}{16}-25=\frac{625-400}{16}=\frac{225}{16}$$

$$4r^2=\frac{225}{4}=56.25$$

Sol6. Let a,ar,ar^2,ar^3 are in G.P

$$a+ar+ar^2+ar^3=\frac{65}{12}$$

$$\frac{1}{a}+\frac{1}{ar}+\frac{1}{ar^2}+\frac{1}{ar^3}=\frac{65}{18}$$

$$\frac{\frac{a\left(1-r^4\right)}{1-r}}{\frac{\frac{1}{a}\left(1-\frac{1}{r^4}\right)}{1-\frac{1}{r}}}=\frac{65}{12}\times\frac{18}{65}$$

$$(ar)^2r=\frac{3}{2}\Rightarrow a=\frac{2}{3},r=\frac{3}{2}$$

$\therefore$ third term = $ar^2 = \frac{2}{3} \times \frac{9}{4} = \frac{3}{2}$

$\therefore \alpha = \frac{3}{2} \Rightarrow 2\alpha = 3$

Sol7.

A	B	C
–	–	1
–	–	2
–	–	3

Number of groups = ${}^{10}C_1\left(2^9 - 2\right) = 5100$

Number of groups = ${}^{10}C_2\left(2^8 - 2\right) = 11430$

Number of groups = ${}^{10}C_3\left(2^7 - 2\right) = 15120$

Total number of groups = 31650

Sol8. $af(x) + \alpha f\left(\frac{1}{x}\right) = bx + \frac{\beta}{x}$ ....(i)

Replace x by $\frac{1}{x}$

$af\left(\frac{1}{x}\right) + \alpha f(x) = \frac{b}{x} + \beta x$ ....(ii)

$a\left(f(x) + f(\frac{1}{x})\right) + \alpha(f(x) + f(\frac{1}{x})) = b\left(x + \frac{1}{x}\right) + \beta\left(x + \frac{1}{x}\right)$

$(a+\alpha)\left(f(x) + f\left(\frac{1}{x}\right)\right) = (b+\beta)\left(x + \frac{1}{x}\right)$

$\therefore \frac{f(x) + f\left(\frac{1}{x}\right)}{x + \frac{1}{x}} = \frac{b+\beta}{a+\alpha} = \frac{2}{1} = 2$

Sol9. $\sigma^2 = \frac{\sum x^2}{n} - \left(\frac{\sum x}{n}\right)^2 = \frac{9+k^2}{10} - \left(\frac{9+k}{10}\right)^2 < 10$

$\Rightarrow k < \frac{10\sqrt{10}}{3} + 1 \Rightarrow k \le 11$

$\therefore$ maximum value of k is 11

Sol10. Equation of normal is 4x –3y + 1=0

Equation of tangent is 3x+4y–43 =0

Area of triangle = $\frac{1}{2}\left(\frac{43}{3} + \frac{1}{4}\right) \times 7$

$= \frac{1}{2} \times \left(\frac{172+3}{12}\right) \times 7 = \frac{1225}{24}$

$\therefore$ 24A = 1225