

**ANSWERS KEY**

**CHEMISTRY**

1. b   2. d   3. d   4. c   5. d   6. d   7. d   8. c   9. d   10. b   11. b   12. b   13. d  
14. b   15. b   16. b   17. b   18. c   19. b   20. c   21. d   22. d   23. c   24. b   25. c   26. b  
27. b   28. d   29. b   30. b

**PHYSICS**

1. b   2. a   3. a   4. d   5. d   6. a   7. a   8. b   9. b   10. d   11. a   12. a   13. b  
14. c   15. d   16. c   17. b   18. b   19. d   20. d   21. c   22. b   23. d   24. c   25. a   26. b  
27. c   28. a   29. c   30. c

**MATHEMATICS**

1. a   2. b   3. c   4. b   5. a   6. c   7. a   8. b   9. a   10. d   11. d   12. b   13. a  
14. c   15. a   16. b   17. c   18. b   19. c   20. c   21. a   22. c   23. d   24. a   25. b   26. a  
27. d   28. c   29. d   30. d

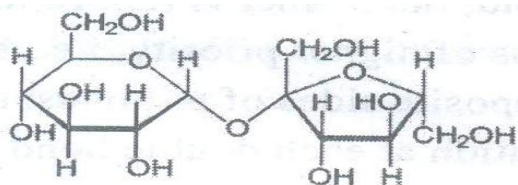
## CHEMISTRY

### Sol 1.

In sucrose, glucose and fructose are linked to each other by covalent linkage.

Cellobiose is a disaccharide, it consists of two glucose molecules linked by a  $\beta$  (1  $\rightarrow$  4) bond.

Maltose also known as maltobiose or malt sugar, is a disaccharide formed from two units of glucose joined with an  $\alpha$  (1  $\rightarrow$  4) bond. Lactose is a disaccharide sugar that is found most notably in cow milk and is formed from linkage of galactose and glucose

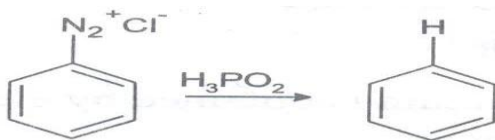


### Sol 2.

Camphor can undergo sublimation whereas caffeine cannot, so it can be separated from the mixture by sublimation.

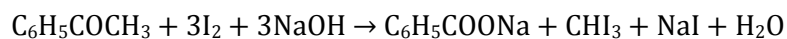
### Sol 3.

The amino group of an aryl amine may be replaced by a 'H' upon reaction of its diazonium salt with  $\text{H}_3\text{PO}_2$ .



### Sol 4.

For the preparation of iodoform, a compound containing  $\text{CH}_3\text{CO}$ - group, a base, and iodine is needed.



### Sol 5.

Aldehydes give silver mirror test with Tollen's reagent which is  $[\text{Ag}(\text{NH}_3)_2]^+$

### Sol 6.

Inert pair effect is shown by Tl.

### Sol 7.

Nessler's reagent is  $\text{K}_2[\text{HgI}_4]$

### Sol 8.

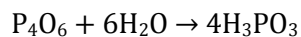
The IUPAC name of  $\text{Na}_3[\text{Co}(\text{NO}_2)_6]$  is Sodium hexanitrocobaltate (III)

**Sol 9.**

Ziegler – Natta catalysts are used to polymerize terminal 1- alkenes. These consist of transition metal catalyst, like  $\text{TiCl}_3$  and  $\text{Al}(\text{C}_2\text{H}_5)_3\text{Cl}$ , or  $\text{TiCl}_4$  with  $\text{Al}(\text{C}_2\text{H}_5)_3$ .

**Sol 10.**

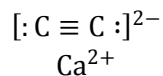
$\text{P}_4\text{O}_6$  reacts with water to form phosphorous acid ( $\text{H}_3\text{PO}_3$ )

**Sol 11.**

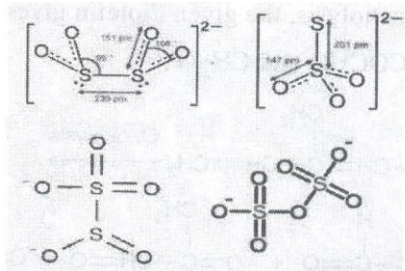
More energy is required to remove an electron from the completely filled or half filled subshells and also from the orbitals which are closer to the nucleus.

**Sol 12.**

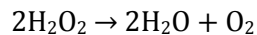
The number and types of bonds between two carbon atoms in  $\text{CaC}_2$  are one sigma and two pi(p).

**Sol 13.**

$\text{S}_2\text{O}_7^{2-}$  has no S-S bond.

**Sol 14.**

1.5 N  $\text{H}_2\text{O}_2$  contains  $17 \times 1.5 = 25.5$  g of  $\text{H}_2\text{O}_2$ . According to the following equation.



$$2 \times 34 \text{ g} \qquad 22.4 \text{ L}$$

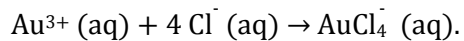
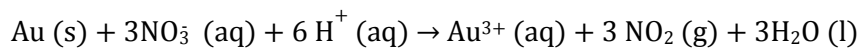
$$68 \text{ g of } \text{H}_2\text{O}_2 = 22.4 \text{ L of } \text{O}_2$$

$$25.5 \text{ g of } \text{H}_2\text{O}_2 = \frac{22.4 \times 25.5}{68} = 8.4 \text{ L}$$

Volume strength of  $\text{H}_2\text{O}_2$  is expressed as the volume of  $\text{O}_2$  that a solution of  $\text{H}_2\text{O}_2$  gives on decomposition by heat. Since 1.5 N  $\text{H}_2\text{O}_2$  solution gives 8.4 L of oxygen at STP so its volume strength is 8.4.

Sol 15.

When gold is dissolved in aqua regia,  $\text{HAuCl}_4$  (chloroauric acid) is formed



Sol 16.

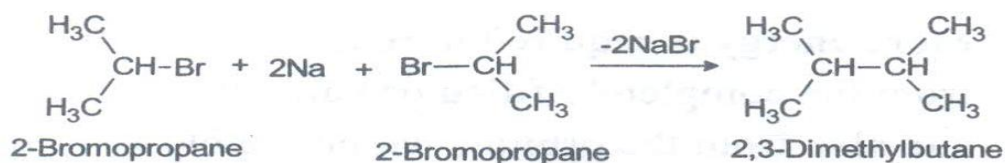
$\text{NaHCO}_3$  acts as an antacid.

Sol 17.

Straight chain hydrocarbons have higher boiling point than branched chain hydrocarbons. Higher hydrocarbons have higher boiling point than lower hydrocarbons

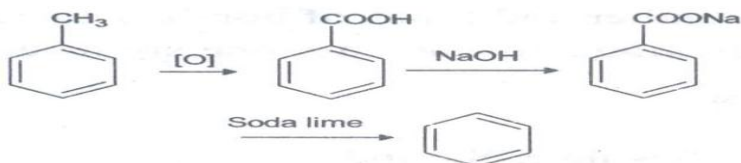
Sol 18.

When isopropyl is subjected to Wurtz reaction, 2,3 - dimethylbutane is formed.



Sol 19.

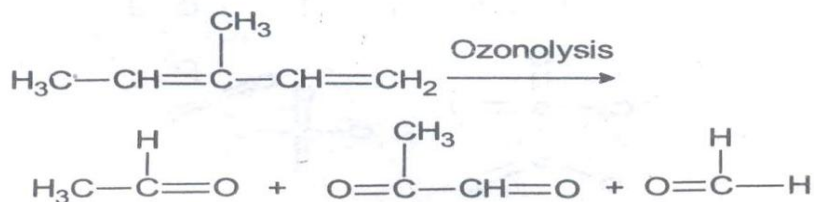
The product C is benzene as shown below.



Sol 20.

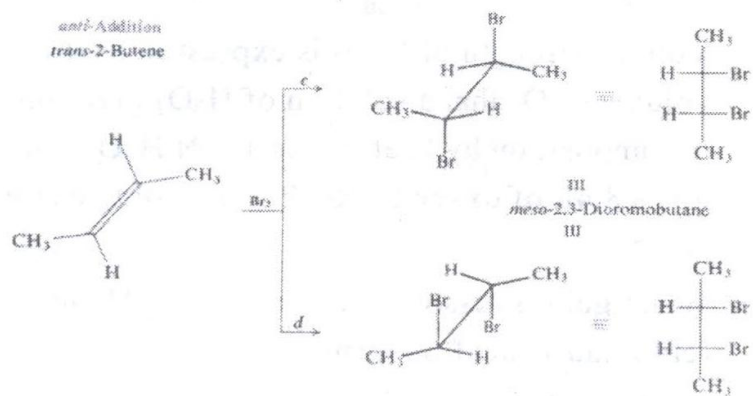
On ozonolysis, the given diolefin gives  $\text{CH}_3\text{CHO}$ ,  $\text{CH}_3\text{COCHO}$  and  $\text{CH}_2\text{O}$

$\text{CH}_3\text{COCHO}$  and  $\text{CH}_2\text{O}$

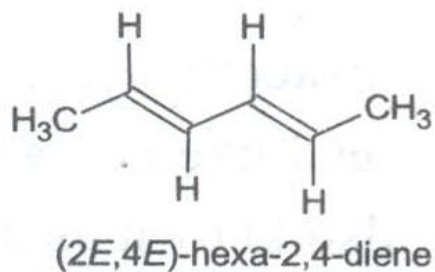


**Sol 21.**

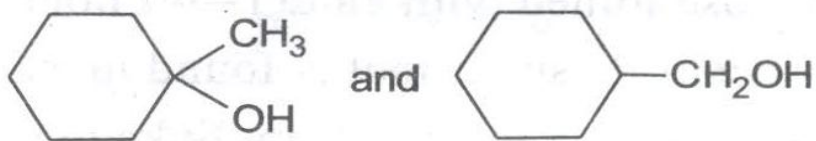
The addition of bromine to alkenes is stereospecific; cis and trans alkenes react differently to give stereochemically different products. Cis-but-2-ene gives a pair of enantiomers, i.e, a racemic mixture whereas trans but-2-ene gives a meso compound

**Sol 22.**

The (E) and (Z) system is based on the assignment of a priority to the substituents on each end of the double bond. If the highest priority atoms or groups are on the opposite sides of pi bond, the isomer is (E) and if these are on the same sides of pi bond, the isomer is (Z). In the given diene the groups of higher priority, i.e., alkyl group are on the opposite sides of pi bonds, so the configuration at each double bond is E.

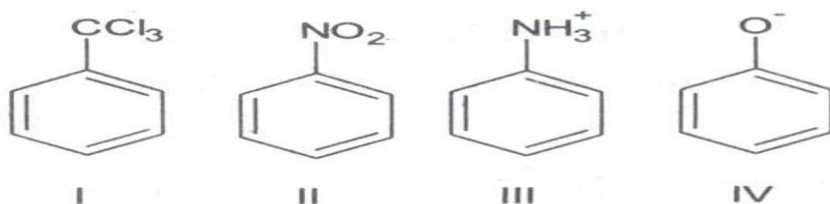
**Sol 23.**

A and B in the given reactions are



**Sol 24.**

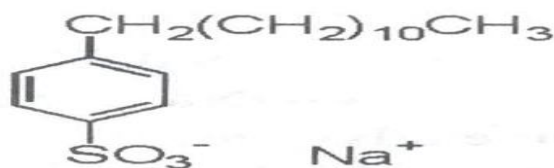
In options I-III,  $\text{CCl}_3$ ,  $\text{NO}_2$  and  $\text{NH}_3^+$  are electron withdrawing groups and meta directing so electrophile in these cases will attack meta positions; in IV it attacks ortho and para positions

**Sol 25.**

Pure aluminium is obtained by electrolysis of fused alumina.

**Sol 26.**

Sodium p-dodecylbenzene sulphonate is an anionic detergent.

**Sol 27.**

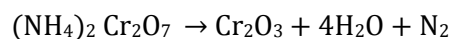
$\text{K}^+$  is detected by flame test, it gives violet pink color,

**Sol 28.**

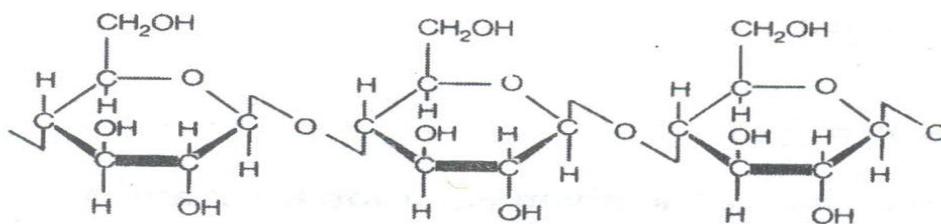
IR radiation are responsible for global warming and UV radiation are responsible for ozone depletion.

**Sol 29.**

Ammonium dichromate is used in some fireworks. The green colored powder blown in the air when ammonium dichromate is used in some fireworks is due to formation of  $\text{Cr}_2\text{O}_3$

**Sol 30.**

Complete hydrolysis of cellulose gives D-glucose. It is a polysaccharide consisting of a linear chain of several hundred to over ten thousand  $\beta$  (1  $\rightarrow$  4) linked D-glucose units



## PHYSICS

**Sol 1.**

Mass of salt =  $\frac{4 \times 6}{100} = \frac{24}{100} = 0.24$  kg After evaporation 0.24 kg salt remains in 5 kg water

$$\therefore \text{Remaining salt} = \frac{0.24}{5} \times 100$$

$$= 4.8\%$$

**Sol 2.**

$$(-4) \vec{P} = 4P (-\vec{P})$$

$\therefore$  The direction is reversed and magnitude is quadrupled

**Sol 3.**

P has a higher momentum. Therefore on exchange of packet from P, Q will be gainer.

**Sol 4.**

As kinetic energy  $\propto u^2$

$\therefore$  The curve is a parabola

**Sol 5.**

Using conservation of Angular Momentum

$$I_1 \omega_1 = I_2 \omega_2$$

$$I_2 = \frac{I_1 \omega_1}{\omega_2}$$

$$\omega_2 = \frac{I_1 \omega_1}{I_2} = \frac{I|I_0|}{2I} = 5 \text{ rad/s}$$

**Sol 6.**

Gravitational force is two body interaction and is independent of presence of other bodies whereas nuclear force is multi body interaction.

$\therefore$  Resultant gravitational force due to number of bodies,  $\vec{F} = \vec{F}_2 + \vec{F}_3 +$

**Sol 7.**

For a perfectly plastic body there is no restoring force, so stress is zero.

$\therefore$  Young's modulus is also zero.

**Sol 8.**

$$\text{Efficiency, } \eta = 1 - \frac{T_2}{T_1} \Rightarrow \eta_1 = 1 - \frac{273}{473} = \frac{200}{473}$$

$$\text{and } \eta_2 = 1 - \frac{73}{70} = \frac{200}{273} \Rightarrow \frac{\eta_1}{\eta_2} = \frac{273}{473} = \frac{1}{1.73}$$

**Sol 9.**

Using  $PV^\gamma = \text{constant}$

$$P_1 V_1^\gamma = P_2 V_2^\gamma \quad \text{Here } \gamma = \frac{5}{3}$$

$$\therefore \frac{P_2}{P_1} = \frac{V_1^\gamma}{V_2^\gamma} = \frac{V_1^{5/3}}{(V_1/8)^{5/3}} = 2^5$$

**Sol 10.**

$$V_m > V_d$$

**Sol 11.**

Apparent frequency will be greater than the frequency of source.

**Sol 12.**

$$\text{As } W = \frac{1}{2} \frac{q^2}{C} \Rightarrow W = \frac{1}{2} \times \frac{(8 \times 10^{18})^2}{100 \times 10^{-6}} = 32 \times 10^{-32} \text{ J}$$

**Sol 13.**

$$\text{Resistance of a part} = \frac{R}{4}$$

$$\therefore \text{Resistance of combination} = \frac{1}{4} \times \frac{R}{4} = \frac{R}{16}$$

**Sol 14.**

$$\text{As } V = \omega r = \frac{2\pi}{T} \times r \Rightarrow T = \frac{2\pi r}{V} = \frac{2\pi m}{qB} = \frac{Km}{q}$$

$$\text{Now } m_\alpha = 4m_p \text{ and } q_\alpha = 2q_p$$

$$\therefore T_p = k \frac{m_p}{q_p}$$

$$\text{and } T_\alpha = k \frac{m_\alpha}{q_\alpha} = k \frac{4m_p}{2q_p} = 2k \frac{m_p}{q_p}$$

$$\Rightarrow T_\alpha = 2T_p \text{ or } T_p = \frac{1}{2} T_\alpha$$



**Sol 15.**

$$\text{Given } B = 6 \times \frac{\mu_0 i}{4\pi r} (\sin \alpha_1 + \sin \alpha_2)$$

$$= 6 \frac{\mu_0}{4\pi} \cdot \frac{l (2 \sin 30^\circ)}{\left(\frac{\sqrt{3}}{2}l\right)}$$

$$= \frac{\sqrt{3}\mu_0 i}{\pi l}$$

$$\text{as } r = \frac{\sqrt{3}}{2} l$$

**Sol 16.**

Considering the given equation for V and I  $E_0 = 100\text{V}$ ,  $I_0 = 100\text{ A}$  and  $Q = \frac{\pi}{3}$

$$\therefore E_{\text{rms}} = \frac{E_0}{\sqrt{2}} = \frac{100}{\sqrt{2}}$$

$$\text{and } I_{\text{rms}} = \frac{I_0}{\sqrt{2}} = \frac{100}{\sqrt{2}}$$

Power dissipated in the circuit will be

$$P = E_{\text{rms}} I_{\text{rms}} \cos \phi$$

$$= \frac{100}{\sqrt{2}} \times \frac{100}{\sqrt{2}} \times \cos \frac{\pi}{2}$$

$$= \frac{100 \times 100}{2} \times \frac{1}{2} = 2500 \text{ W}$$

**Sol 17.**

Both the statements are independently true.

**Sol 18.**

Average energy density of electric field

$$U_E = \frac{1}{2} \epsilon_0 E_0^2 \text{ Average energy density of magnetic field}$$

$$U_B = \frac{B_0^2}{2\mu_0}$$

$$\text{Now } B_0 = \frac{E_0}{c} \text{ and } c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

$$\therefore U_B = \frac{E_0^2}{2\mu_0 c^2} = \frac{E_0^2}{2\mu_0 \times \frac{1}{\mu_0 \epsilon_0}}$$

$$\Rightarrow U_B = \frac{1}{2} \epsilon_0 E_0^2 = U_E$$

**Sol 22.**

$$\text{Using } Q.E = \frac{4\pi}{3} r^3 \rho g$$

$$\Rightarrow Q^1 \times \frac{v^1}{l} = \frac{4\pi}{3} (2r)^3 \rho g$$

$$\text{Dividing } \frac{QV}{Q'V'} = \frac{1}{8} \Rightarrow Q^1 = \frac{QV}{V'} \times 8$$

$$\text{or } Q' = \frac{Q \times 800 \times 8}{3200} = 2Q$$

**Sol 23.**

$U^{235}$  is the fertile material

**Sol 24.**

Another photon must be emitted in Lyman Series

**Sol 25.**

At 0 K, there will be no free electrons

**Sol 26.**

$$\text{Using } d = \sqrt{2r\hbar}$$

$$= \sqrt{2 \times 6.4 \times 10^3 \times 160 \times 10^{-3}}$$

$$= 45 \text{ km}$$

$$\Rightarrow \text{Range} = 2d = 2 \times 45 = 90 \text{ km}$$

$$\text{And area covered} = \pi d^2 = 3.14 \times (45)^2$$

$$= 6359 \text{ km}^2$$

**Sol 27.**

The tube is open initially at the both ends and then it is closed

$$\therefore f_0 = \frac{v}{2l_0} \text{ and } f_c = \frac{v}{4l_c}$$

Given that tube is half dipped in water

$$\text{We have } l_c = \frac{l_0}{2}$$

$$\Rightarrow f_c = \frac{v}{4\left(\frac{l_0}{2}\right)} = \frac{v}{2l_0} = f_0 = f$$

**Sol 28.**

The maximum number of electrons in an orbit are given by  $2n^2$ . If  $n > 4$  is not allowed the number of maximum electron that can be in first four orbits are

$$2(1)^2 + 2(2)^2 + 2(3)^2 + 2(4)^2 = 60$$

⇒ So, these 60 electrons can be arranged in 60 electrons.

**Sol 29.**

The resistivity of conductors increases with increases in temperature whereas the resistivity of semiconductor decreases with increase in temperature. Both statements are self explanatory.

**Sol 30.**

Using law of conservation of mechanical energy

Decrease in kinetic energy = Increase in Potential Energy

$$\Rightarrow \frac{1}{4\pi\epsilon_0} \frac{(Ze)(2e)}{r_{min}} = 5 \text{ MeV} = 5 \times 1.6 \times 10^{-13}$$

$$\therefore r_{min} = \frac{1}{4\pi\epsilon_0} \frac{2ze^2}{5 \times 1.6 \times 10^{-13}}$$

$$= \frac{(9 \times 10^9) \times (2) \times (92) \times (1.6 \times 10^{-19})^2}{5 \times 1.6 \times 10^{-13}}$$

$$= 5.3 \times 10^{-14} \text{ m} = 5.3 \times 10^{-12} \text{ cm}$$

$$\Rightarrow r_{min} = 10^{-12} \text{ cm}$$

**MATHEMATICS****Sol 1.**

Given that  $|z - i\text{Re}(z)| = |z|$

$$\Rightarrow |x + iy - ix| = |x + iy|$$

$$\Rightarrow |x + i(y - x)| = |x + iy|$$

$$\Rightarrow x^2 + (y - x)^2 = x^2 + y^2$$

$$\Rightarrow x^2 - 2xy = 0$$

$$\Rightarrow x(x - 2y) = 0$$

$$\Rightarrow x = 2y \Rightarrow \text{Re}(z) = 2\text{Im}(z)$$

**Sol 2.**

Given equation is  $3^{\log_3(x^2 - 6x + 8)} = -2(x - 2)$

$$\Rightarrow x^2 - 6x + 8 = -2x + 4$$

$$\Rightarrow x^2 - 4x + 4 = 0$$

$$\Rightarrow (x - 2)^2 = 0$$

$$\Rightarrow x = 2, 2$$

**Sol. 3**

$\therefore a, b, c$  are in H.P.

$\therefore a^{-1}, b^{-1}, c^{-1}$  are in A.P.

For any three numbers  $a^{201}, b^{201}, c^{201}$

A.M. > G.M.

$$\Rightarrow \frac{a^{201} + c^{201}}{2} > (\sqrt{ac})^{201} > b^{201} (\because \sqrt{ac} > b)$$

$$\Rightarrow a^{201} + c^{201} - 2b^{201} > 0$$

$$\Rightarrow 2b^{201} - a^{201} - c^{201} > 0$$

Given equation is

$$x^2 - kx + 2b^{201} - a^{201} - c^{201} = 0$$

$$\therefore \text{Product of roots} = \frac{2b^{201} - a^{201} - c^{201}}{1} < 0$$

$\therefore$  Product of roots < 0

**Sol 4.**

5!, 6!, 7! ..... 100! Each is divisible by 15, We know  $1! + 2! + 3! = 33$  and  $15 \times 2 + 3$

Hence required remainder = 3

**Sol 5.**

The coefficient of  $x^2$  in the expansion of  $(1 + ax)^5$

$$\text{is } {}^5C_2 a^2 = 40$$

$$\Rightarrow 10 a^2 = 40 \Rightarrow a^2 = 4 \Rightarrow a = + 2$$

**Sol 6.**

$$\text{Given } f(x) = \begin{vmatrix} \sin x & \cos x \\ \sin 2x & \cos 2x \end{vmatrix}$$

$$\text{Therefore } f'(x) = \begin{vmatrix} \cos x & \cos x \\ 2\cos 2x & \cos 2x \end{vmatrix} + \begin{vmatrix} \sin x & -\sin x \\ \sin 2x & -2\sin 2x \end{vmatrix}$$

$$\Rightarrow f'\left(\frac{\pi}{4}\right) = \begin{vmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ 0 & 0 \end{vmatrix} + \begin{vmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \\ 1 & -2 \end{vmatrix}$$

$$= 0 + \left(\frac{1}{\sqrt{2}}\right) \begin{vmatrix} 1 & -1 \\ 1 & -2 \end{vmatrix}$$

$$= f'\left(\frac{\pi}{4}\right) = \frac{1}{\sqrt{2}} (-2 + 1) = -\frac{1}{\sqrt{2}}$$

**Sol 7.**

$$\text{Given that } A^3 + 3A^2 + 5A - I = 0$$

$$\Rightarrow A^{-1}(A^3 + 3A^2 + 5A - I) = A^{-1} \cdot 0$$

$$\Rightarrow A^{-1}A^3 + 3A^{-1}A^2 + 5A^{-1}A - A^{-1}I = 0$$

$$\Rightarrow A^2 + 3A + 5I = A^{-1}$$

**Sol 8.**

$$\text{Given that } a = \log_3 2, b = \log_5 3, c = \log_7 5 \text{ Therefore } a = \frac{\log 2}{\log 3}, b = \frac{\log 3}{\log 5}, c = \frac{\log 5}{\log 7}$$

$$\Rightarrow abc = \frac{\log 2}{\log 7} \text{ and } ab = \frac{\log 2}{\log 5}$$

$$\log_{210} 60 = \frac{\log 60}{\log 210} = \frac{\log (2^2 \times 3 \times 5)}{\log (2 \times 3 \times 5 \times 7)}$$

$$= \frac{2 \log 2 + \log 3 + \log 5}{\log 2 + \log 3 + \log 5 + \log 7}$$

$$= \frac{2 + \frac{\log 3}{\log 2} + \frac{\log 5}{\log 2}}{1 + \frac{\log 3}{\log 2} + \frac{\log 5}{\log 2} + \frac{\log 7}{\log 2}}$$

$$= \frac{2 + \frac{1}{a} + \frac{1}{ab}}{1 + \frac{1}{a} + \frac{1}{ab} + \frac{1}{abc}}$$

$$= \frac{2ab + b + 1}{abc + bc + c + 1}$$

**Sol 9.**

Odd numbers on dice are 1, 3, 5

The probability that an odd numbers appear in a throw =  $\frac{3}{6} = \frac{1}{2}$

If the dice is thrown  $(2n + 1)$  times, then the probability that faces with odd number appear odd number of times =  $P \{ \text{that an odd number appear once or thrice or five times. . . . . or } (2n + 1) \text{ time} \}$

$$\begin{aligned}
&= {}^{2n+1}C_1 \left(\frac{1}{2}\right) \left(\frac{1}{2}\right)^{2n} + {}^{2n+1}C_3 \left(\frac{1}{2}\right)^3 \left(\frac{1}{2}\right)^{2n-2} + {}^{2n+1}C_5 \left(\frac{1}{2}\right)^5 \left(\frac{1}{2}\right)^{2n-4} + \dots + {}^{2n+1}C_{2n+1} \left(\frac{1}{2}\right)^{2n+1} \left(\frac{1}{2}\right)^0 \\
&= \frac{1}{2^{2n+1}} \{ {}^{2n+1}C_1 + {}^{2n+1}C_3 + {}^{2n+1}C_5 + \dots + {}^{2n+1}C_{2n+1} \} \\
&= \frac{2^{2n}}{2^{2n+1}} = \frac{1}{2}
\end{aligned}$$

**Sol 10.**

$P(\bar{A}) = 0.4$  and  $P(\bar{B}) = 0.3$

$P(A) = .6$  and  $P(B) = 0.7$

The probability tht at least one of them fails =  $1 - P(A \cap B)$

$= 1 - (0.6)(0.7) = 0.58$

**Sol 11.**

For L.H.L., Put  $x = 2 - h$ , where  $0 < h < 1$

As  $-1 < h < 0$ , then  $1 < 2 - h < 2$ . Therefore  $[2-h] = 1$

L.H.L. =  $\text{Lt}_{x \rightarrow 2^-} [x] = \text{Lt}_{h \rightarrow 0^+} [2 - h] = \text{Lt}_{x \rightarrow 0^+} 1 = 1$

For R.H.L., Put  $x = 2+h$ , where  $0 < h < 1$  then  $2 < 2 + h < 3$  Therefore  $[2+h] = 2$

R.H.L. =  $\text{Lt}_{x \rightarrow 2^+} [x] = \text{Lt}_{h \rightarrow 0^+} [2 + h] = \text{Lt}_{x \rightarrow 0^+} 2 = 2$  Now L.H.L.  $\neq$  R.H.L.

Therefore  $\text{Lt}_{x \rightarrow 2} [x]$  does not exist.

**Sol 12.**

$\text{Lt}_{n \rightarrow \infty} \frac{n^p \cos n!}{n+2} = \text{Lt}_{n \rightarrow \infty} \frac{n^p \cos n!}{n \left(1 + \frac{2}{n}\right)}$

$\text{Lt}_{n \rightarrow \infty} \frac{\cos n!}{n^{1-p} \left(1 + \frac{2}{n}\right)}$

$= 0 (\because 0 < \cos n! < 1)$

**Sol 13.**

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

$$= \lim_{h \rightarrow 0} \frac{f(x) + f(h) - f(x)}{h}$$

(because  $f(x+h) = f(x) + f(h)$ )

$$= \lim_{h \rightarrow 0} \frac{f(h)}{h}$$

$$= \lim_{h \rightarrow 0} \frac{h^3 g(h)}{h} \quad (\because f(x) = x^3 g(x))$$

$$= \lim_{h \rightarrow 0} h^2 g(h) = 0$$

**Sol 14.**

Given that  $x^y = y^x$

$\therefore y \log x = x \log y$  Differentiating both sides w.r.t.  $x$

$$y \frac{1}{x} + \log x \frac{dy}{dx} = x \frac{1}{y} \frac{dy}{dx} + 1 \cdot \log y \Rightarrow \left(\log x - \frac{x}{y}\right) \frac{dy}{dx} = \log y - \frac{y}{x}$$

$$\Rightarrow \left(\frac{y \log x - x}{y}\right) \frac{dy}{dx} = \left(\frac{x \log y - y}{x}\right) \Rightarrow \frac{dy}{dx} = \frac{y(x \log y - y)}{x(y \log x - x)}$$

$$\left(\frac{dy}{dx}\right)_{(1,2)} = \frac{2(1 \log 2 - 2)}{1(2 \log 1 - 1)} = \frac{2(\log 2 - 2)}{(0-1)}$$

$$= -2(\log 2 - 2)$$

**Sol 15.**

Given that

$$y = \sqrt{x + \sqrt{x + \sqrt{x + \dots + \infty}}}$$

$$\therefore y = \sqrt{x + y}$$

$y^2 = x + y$  Differentiating both sides

$$2y \frac{dy}{dx} = 1 + \frac{dy}{dx}$$

$$(2y - 1) \frac{dy}{dx} = 1$$

$$\frac{dy}{dx} = \frac{1}{2y-1}$$

**Sol 16.**

Given  $f(x) = \sin\left(\frac{\pi}{x}\right)$  is increasing

$$\therefore f'(x) = \frac{-\pi}{x^2} \cos\left(\frac{\pi}{x}\right) > 0 \therefore \cos\left(\frac{\pi}{x}\right) > 0$$

$$\Rightarrow 2n\pi - \frac{\pi}{2} < \frac{\pi}{x} < 2n\pi + \frac{\pi}{2}$$

$$\Rightarrow (4n-1)\frac{\pi}{2} < \frac{\pi}{x} < (4n+1)\frac{\pi}{2}$$

$$\Rightarrow \frac{2}{(4n-1)\pi} > \frac{x}{\pi} > \frac{2}{(4n+1)\pi}$$

$$\Rightarrow \frac{2}{4n+1} < x < \frac{2}{4n-1}$$

$$\therefore n \in \left(\frac{2}{4n+1}, \frac{2}{4n-1}\right) \forall n \in \mathbb{N}$$

**Sol 17.**

The given function is

$$f(x) = \int_2^x e^{-t^2} (4-t^2) dt$$

$$f'(x) = e^{-x^2} (4-x^2)$$

$$f'(x) = 0 \Rightarrow 4-x^2 = 0$$

$$\Rightarrow x = \pm 2$$

**Sol 18.**

$$I = \int \frac{5+4 \sin x}{(4+5 \sin x)^2} dx$$

$$I = \int \frac{\frac{5+4 \sin x}{\cos^2 x}}{\left(\frac{4+5 \sin x}{\cos}\right)^2} dx$$

$$I = \int \frac{5 \sec^2 x + 4 \sec x \tan x}{(4 \sec x + 5 \tan x)^2} dx$$

Put  $4 \sec x + 5 \tan x = t$

$$\Rightarrow (4 \sec x \tan x + 5 \sec^2 x) dx = dt$$

$$I = \int \frac{dt}{t^2} = -\frac{1}{t} + c$$

$$I = -\frac{1}{4 \sec x + 5 \tan x} + c$$



**Sol 19.**

$$I = \int_0^{\infty} e^{ax^2} dx$$

$$\text{Put } \sqrt{a} x = t \Rightarrow \sqrt{a} dx = dt \Rightarrow dx = \frac{dt}{\sqrt{a}}$$

$$I = \int_0^{\infty} e^{t^2} \frac{dt}{\sqrt{a}}$$

$$= \frac{1}{\sqrt{a}} \int_0^{\infty} e^{t^2} dt$$

$$= \frac{1}{\sqrt{a}} \int_0^{\infty} e^{t^2} dx = \frac{1}{\sqrt{a}} b = \frac{b}{\sqrt{a}}$$

**Sol 20.**

$$\sin x < x \quad (\because x > 0)$$

$$\Rightarrow \frac{\sin x}{x} < 1$$

$$\int_0^{\pi/2} \frac{\sin x}{x} dx < \int_0^{\pi/2} 1 dx = \frac{\pi}{2}$$

$$\therefore \int_0^{\pi/2} \frac{\sin x}{x} dx < \frac{\pi}{2}$$

**Sol 21.**

The given function is

$$y^3 x^3 dx = (ydx - xdy)$$

$$x^4 dx = \frac{x}{y} \left( \frac{ydx - xdy}{y^2} \right)$$

$$x^4 dx = \left( \frac{x}{y} \right) d \left( \frac{x}{y} \right) \text{ On integrating we get}$$

$$\frac{x^5}{5} = \frac{\left( \frac{x}{y} \right)^2}{2} + c \Rightarrow \frac{x^5}{5} - \frac{x^2}{2y^2} = c$$

**Sol 22.**

The image of A (a,b) on  $x = y$  is B (b, a) and the image of B (b, a) on  $x = -y$  line is C (-a, -b)

The mid point of AC is  $\left( \frac{a-a}{2}, \frac{b-b}{2} \right)$

The mid point of AC is (0, 0).

**Sol 23.**

Coefficient of  $x^2$  + Coefficient of  $y^2 = 0$

**Sol 24.**

The equation of the circle is

$$r^2 = 1 - 2r\cos\theta + 3r\cos\theta$$

Put  $x = r\cos\theta$ ,  $y = r\sin\theta$

$$x^2 + y^2 = 1 - 2x + 3y$$

$$x^2 + y^2 + 2x - 3y - 1 = 0$$

Therefore  $g = 1$ ,  $f = \frac{-3}{2}$ ,  $c = -1$

Centre  $(-g, -f)$  i.e. centre  $(-1, \frac{3}{2})$

$$\text{Radius} = \sqrt{g^2 + f^2 - c} = \sqrt{1 + \frac{9}{4} + 1} = \sqrt{\frac{17}{2}}$$

**Sol 25.**

The diameter are conjugate if

$$m_1 m_2 = -\frac{b^2}{a^2} \quad (i)$$

Equation of pair of conjugate diameters is  $4x^2 + xy - 5y^2 = 0$

$$4x^2 + xy - 5y^2 = 0$$

$$(x - y)(4x + 5y) = 0$$

Thus the slope of conjugate diameters are  $1, \frac{-5}{4}$

$$\therefore m_1 = 1, m_2 = -\frac{4}{5}$$

Put values of  $m_1, m_2$  in (i) we get

$$(1) \left(\frac{-4}{5}\right) = -\frac{b^2}{a^2}$$

$$\Rightarrow \frac{4}{5} = \frac{b^2}{a^2}$$

$$e = \sqrt{1 - \frac{b^2}{a^2}} = \sqrt{1 - \frac{4}{5}} = \frac{1}{\sqrt{5}}$$

**Sol 26.**

The given equation of line is

$\frac{x-1}{3} = \frac{y-1}{4} = z$  Any point on given line is  $(3r + 1, 4r + 1, r)$  Its distance from  $(1, 1, 0)$  is

$$(3r)^2 + (4r)^2 + r^2 = (3\sqrt{26})^2$$

$$26r^2 = 9 \times 26$$

$$r^2 = 9 \Rightarrow r = \pm 3$$

Coordinates of points are  $(10, 13, 3)$  and  $(-8, -11, -3)$ .

**Sol 27.**

Given that  $\sin\alpha = \cos\beta$

$$\Rightarrow \sin\alpha = \sin\left(\frac{\pi}{2} - \beta\right) \Rightarrow \sin\alpha - \sin\left(\frac{\pi}{2} - \beta\right) = 0$$

$$\Rightarrow 2 \cos\left(\frac{\alpha + \frac{\pi}{2} - \beta}{2}\right) \sin\left(\frac{\alpha - \frac{\pi}{2} + \beta}{2}\right) = 0 \quad (i)$$

$$\text{Also } \cos\alpha = \sin\beta \Rightarrow \cos\alpha = \cos\left(\frac{\pi}{2} - \beta\right)$$

$$\Rightarrow \cos\alpha - \cos\left(\frac{\pi}{2} - \beta\right) = 0$$

$$\Rightarrow 2 \sin\left(\frac{\alpha + \frac{\pi}{2} - \beta}{2}\right) \sin\left(\frac{\alpha - \frac{\pi}{2} + \beta}{2}\right) = 0 \quad (ii)$$

From (i) and (ii), we get

$$\sin\left(\frac{\alpha - \frac{\pi}{2} + \beta}{2}\right) = 0$$

**Sol 28.**

Given that  $\sin x + \cos x = 1$

$$\frac{1}{\sqrt{2}}\sin x + \frac{1}{\sqrt{2}} \cos x = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \sin x \sin \frac{\pi}{4} + \cos x \cos \frac{\pi}{4} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \sin\left(x + \frac{\pi}{4}\right) = \sin \frac{\pi}{4}$$

$$\Rightarrow x = n\pi + (-1)^n \frac{\pi}{4} - \frac{\pi}{4}, n \in I$$

**Sol 29.**

$$5\vec{a} + 6\vec{b} + 7\vec{c} = 0 \Rightarrow x\vec{a} + y\vec{b} + z\vec{c} = 0; x, y, z, \neq 0$$

$\Rightarrow \vec{a}, \vec{b}, \vec{c}$  are coplanar.

**Sol 30.**

$$\vec{r} = l(\vec{b} \times \vec{c}) + m(\vec{c} \times \vec{a}) + n(\vec{a} \times \vec{b})$$

$$\vec{r} \cdot \vec{a} = l[\vec{a}, \vec{b}, \vec{c}]$$

$$\vec{r} \cdot \vec{a} = l$$

$$\because [\vec{a}, \vec{b}, \vec{c}] = 1$$

$$l = 3$$

$$\therefore \vec{r} \cdot \vec{a} = 3$$

Similarly  $m = 5, n = 7$ .

$$\text{Therefore } \vec{r} = 3(\vec{b} \times \vec{c}) + 5(\vec{c} \times \vec{a}) + 7(\vec{a} \times \vec{b})$$