Physics

1. **(b)**
2. **(a)** Stress = Strain × Y

Thus, maximum stress $= \frac{0.2}{100} \times 7 \times 10^9 = 1.4 \times 10^7$

Now, F orce = Stress × Area

Thus, $10^4 = 1.4 \times 10^7 \times A$, or, $A = 7.14 \times 10^{-4}\ m^2$

3. **(d)** Here,

$$E = \frac{81\pi}{7} \times 10^5 Vm^{-1}$$

$v = 2 \times 10^{-3}\ ms^{-1}$

$\eta = 1.8 \times 10^5 Nsm^{-2}$

$\rho = 900 kgm^{-3}$

When the electric field is switched off, let the drop falls with terminal velocity v , then

$v = \frac{2r^2(\rho-\sigma)g}{9\eta}$ or $r = \left[\frac{9v\eta}{2(\rho-\sigma)g}\right]^{\frac{1}{2}}$

$$\therefore q = \frac{1}{E} \times \frac{4}{3}\Pi\rho g\left[\frac{9v\eta}{2(\rho-\sigma)g}\right]$$

$$= \frac{7}{81\Pi \times 10^5} \times \frac{4}{3} \times \pi \times 900 \times 9.8 \times \left[\frac{9 \times 8 \times 10^{-5} \times 2 \times 10^{-3}}{2 \times 900 \times 9.8}\right]^{\frac{3}{2}}$$

On solving we get, $q = 8 \times 10^{-19} C$

4. **(c)**
5. **(a)** Mass of the chain lying freely from the table $= M\frac{1}{L}$

$$= 4\ kg \times \frac{0.6}{2}$$

$= 1.2$ kg

The distance of center of mass of chain from the table $= \frac{1}{2} \times 0.6\ m = 0.3\ m$ Thus the work done in pulling the chain $= mgh = 1.2 \times 10 \times 0.3\ J = 3.6\ J$

6. **(d)** $\alpha = \frac{W_2 - W_1}{t} = \frac{2\pi n_2 - 2\pi n_1}{t}$
7. **(b)** Force due to charge at D and B is along $\overrightarrow{F_O D}$ towards $\vec{B}$

Force due to charge at A and C is along $\overrightarrow{F_O O}$ towards $\vec{A}$.

∴ Resultant

displacement will be along $\vec{F}$ which is perpendicular to AB.

8. (*c*) $\tau = P.E.\ \sin\theta$

9. **(b)** $K.E = \frac{1}{2}mv^2$

$$= \frac{1}{2}\ m\left(0 + \frac{Eq}{m}t\right)^2$$

10. **(b)** $E = K\frac{2p}{r^3} \propto \frac{1}{r^3}$

$$V = K\frac{p\cos\theta}{r^2} \propto \frac{1}{r^2}$$

11. **(a)** $A = 3\ m$

$V_{max} = A\omega = 3 \times 2\pi = 6\pi$

12. **(a)**

13. **(c)**

$$\mu = \frac{V_d}{E} \Rightarrow V_d = \mu E$$

14. **(b)**

15. **(d)** 10 identical cells connected in series.

Potential of each cell $= E$

Internal resistance of each cell $= r$

Total voltage of ten cells $= 10E$

Total resistance of ten cells $= 10r$

Current in the circuit, $I = \frac{10E}{10r} = \frac{E}{r}$

Potentiol difference across 3 cells, $V = I \times 3r = \frac{E}{2} \times 3r = 3E$

Hence, ideal voltmeter will read 3E.

16. **(d)** $i = \frac{e}{T} = ef$

17. **(c)** $\frac{R}{\ell} = \frac{S}{100-\ell}$

If temperature increases, resistance increases.

As R increases, balancing length also increases. It will shift towards Right

18. **(d)** $V = \frac{kq_1}{r_1} + \frac{kq_2}{r_2}$

19. **(d)**

20. **(d)**

21. (c) Here, $I = 2.5$ A, $l = 50$ cm $= 0.50$ m and $n = \frac{100}{0.50} = 200\ \mathrm{m}^{-1}$ $\therefore B = \frac{\mu_0 nI}{2} = \frac{4\pi\times10^{-7}\times200\times2.5}{2} = 3.14\times10^{4}$ T

22. (b) $R' = (n-1)(G+R)$

$$= \left(\frac{30}{20} - 1\right)3000 = 1500\Omega$$

Total resistance $= 2950 + 1500 = 4450\Omega$

23. (a) $B = \frac{\mu_0\ nir^{2}}{2(x^2+r^2)^{3/2}}$

24. (a) $P = \frac{V^2}{R}$

$P \propto V^2$

$$\frac{\Delta P}{P}\times 100 = 2\frac{\Delta V}{V}\times 100$$

$= 2\times 2.5 = 5\%$

25. (a) Let $1_1 = 100, 1_2 = 110$

$R \propto 1^2$

$$\frac{R_2}{R_1} = \left(\frac{1_2}{1_1}\right)^2 = \left(\frac{110}{100}\right)^2 = 1.21$$

$R_2 = 1.21R_1$

Specific resistance remains same

26. (b) $\frac{1}{2}LI_{max}^2 = \frac{q^2}{2C}$

$$\frac{1}{2}LI^2 = \frac{1}{2}\times\frac{1}{2}LI_{max}^2$$

$$I = \frac{I_{max}}{\sqrt{2}}$$

$$I_{max}\sin\omega t = \frac{I_{max}}{\sqrt{2}}$$

$$\omega t = \frac{\Pi}{4}$$

$$t = \frac{\Pi}{4}\sqrt{LC}$$

27. (c)

$$\varphi_1 = BAN = 1 \times 0.01 \times 80$$
$$\varphi_1 = 0.8wb$$
$$\varphi_2 = 0$$
$$e = -\frac{(\varphi_2 - \varphi_1)}{t}$$
$$= -\left(\frac{0 - 0.8}{2}\right) = 4\text{ V}$$

28. (a)
29. (c)
30. (b) $\varphi = 500 \times 4 \times 10^{-3} = 2\text{ Wb}$

$Li = N\varphi$

$L = \frac{2}{2} = 1H$

31. (b)
32. (c) $p = \frac{1}{f} = (\mu - 1)\left(\frac{1}{-R} - \frac{1}{R}\right)$
33. (b) In an equilateral triangle,
Angle or prism is

$\Rightarrow A = 60°$

Given: $i = e = \frac{3}{4}\text{ A}$

$\therefore i = \frac{3}{4} \times 60° = 45°$

The minimum deviation produced by prism is,

$$\delta_m = i + e - A$$
$$\Rightarrow \delta_m = 2i - A$$
$$\Rightarrow \delta_m = 2 \times 45° - A$$
$$\therefore \delta_m = 90° - 60° = 30°$$

34. (c) $u + v = x$

$m = \frac{v}{u}$

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

35. (a)

$$\omega = \frac{1}{\sqrt{LC}}$$
$$\Rightarrow f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi \times 10^{-5}}$$
$$f = \frac{10^5}{2\pi}\text{Hz}$$

36. (a)

$$= \sqrt{R^2 + [X_L - X_c]^2} = \sqrt{R^2 + \left(Lw - \frac{1}{wc}\right)^2}$$
$$= \sqrt{300^2 + \left[900 - \frac{1}{10^3 \times 2 \times 10^{-6}}\right]^2}$$
$$= \sqrt{300^2 + [900 - 500]^2}$$
$$= \sqrt{300^2 + 400^2}$$
$$= 500\Omega$$

37. (d)
38. (d)

$$\beta = \lambda \frac{D}{d}$$

λ_{red} is approximately twice λ_{violet}
So $\frac{\beta_{red}}{\beta_{violet}} = 2:1$
2 times

39. (d) Central bright band having alternate dark and bright bands of decreasing intensity on either side.
40. (d)
41. (c)
42. (b)
43. (d) $\lambda \propto \frac{1}{\sqrt{k}}$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{k_2}{k_1}}, = \sqrt{\frac{k}{4k}} = \frac{1}{2}$$

$$\lambda_2 = 2\lambda$$

44. (d) $r \propto n^2$

$$\frac{r_1}{r_2} = \left(\frac{n_1}{n_2}\right)^2$$

$$0.25 = \frac{1}{{n_2}^2}$$

$${n_2}^2 = \frac{1}{0.25} = \frac{100}{25} = 4$$

$$n_2 = 2$$

45. (b)
46. (a) $r_n = 0.529 \times \frac{n^2}{z} n = 3$

$$= 0.529 \times 9 = 4.761\text{Å}$$

47. (c)

$$\text{BE} = [Zm_p + (A-Z)m_n - m_X] \times 931.5$$
$$\text{Be} = [7.05481 + 7.06069 - 14.0030] \times 931.5$$
$$= 104.7\text{MeV}$$

48. (a)

49. (c) $KE_1 - KE_2 = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2}$

$$\Delta KE = hc\left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right]^2$$

50. (d)

51. (d)

52. (a) This is a case of AND gate. Input and output are shown below

$\therefore y = \overline{\overline{A} + \overline{B}} = \overline{\overline{A}} \cdot \overline{\overline{B}} = AB$ (since $\overline{A + B} = \overline{A} \cdot \overline{B}$)

53. (b) $F = Bil$

$Bil\cos\theta = mg\sin\theta$

$$0.25 \times I \times \frac{\sqrt{3}}{2} = 0.5 \times 10 \times \frac{1}{2}$$

$$I = \frac{5 \times 100}{25 \times \sqrt{3}} = \frac{20}{\sqrt{3}}\ A$$

$I = 11.32\ A$

54. (c) $P = \frac{E}{t} = \frac{m^2}{t} \Rightarrow 10^9 = \frac{m \times 9 \times 10^{16}}{3600}$

$m = 4 \times 10^{-5}$ kg

$m = 4 \times 10^{-5} \times 10^3$ g

$m = 4 \times 10^{-2}$ g

$m = 0.04$ g

55. (b)

56. (b)

57. (d) $\tan\theta = \frac{V^2}{2\,g} = \frac{10 \times 10}{10 \times 10} = 1$

$$\theta = \frac{\Pi}{4}$$

58. (c)

59. (a)

L. C = 1M SD -1 VSD$

or L.C $= \frac{\text{1M SD}}{\text{No. of. vernier scale division}} = \frac{0.05\text{ mm}}{50}$ L.C $= 0.01$ mm

60. (d)

$$t = \sqrt{x} + 3$$
$$\Rightarrow x = (t-3)^2$$
$$v = \frac{dx}{dt} = 2(t-3)$$
$$v = 0 \Longrightarrow t = 3$$

At $t = 3, x = (3-3)^2 = 0$

Chemistry

61. (d) $t_{99.9\%} = 10t_{50\%}$

$= 10 \times 45\text{ min} = 450\text{ min} = 7.5\text{ hours}$

62. (a) 2^{nd} order reaction
63. (c)
64. (c)

$$\lambda_m = \frac{1000k}{C} = \frac{1000 \times 6.3 \times 10^{-2}}{0.1}$$

$= 6300\text{om}^{-1}\text{ cm}^2\text{ mol}^{-1}$

65. (b)
66. (c) $t_{1/2} \propto \frac{1}{a^{n-1}}$
67. (b) $t_{1/2} \propto \frac{1}{a^{n-1}}$; $n = 6$
68. (a)
69. (a)
70. (c) $n = 4 \therefore F^{2+}$
If BM $= \sqrt{24} = \sqrt{4(+2)}$
number of uparied $e = 4$
Then Fe must have +2 charge
71. (d)
72. (b)
73. (c)
74. (d) $(NH_4)_2Cr_2O_7 \xrightarrow{\text{heat}} Cr_2O_3 + 4H_2O + N_2$
$NH_4NO_2 \rightarrow 2H_2O + N_2$
75. (c) $[Pt(NH_3)_6]_{Cl} \rightarrow [Pt(NH_3)_6]^{+4} + 4Cl^-$

Five ions are produced

76. (d) S_N1 reaction proceeds via formation of carbocation. In option B, the alkyl halide (1) is 3° while (2) is 2°.

Therefore, greater the stability of the carbocation, faster is the rate of S_N1 reaction.

Therefore, option D, the compound pair of 2-chloro-2 methylpropane and 2chloroheptane is the correct option.

77. (a)

78. (d) All Cu (II) halides are known except the iodine because Cu^{2+} oxidizes iodine to iodine

$2Cu^{2+} + 4I^{-1} \rightarrow 2CuI_{(S)} + I_2$

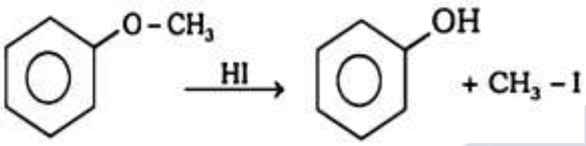
79. (c) $[Pt(NH_3)_2Cl_2]$ = cis-platin

80. (a) $\Delta_t = \frac{4}{9}\Delta_0 = \frac{4}{9} \times 18000\ cm^{-1} = 8000\ cm^{-1}$

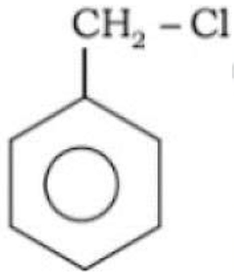
81. (c)

$$CH_3 - CH_2 - OH \underset{443\ K}{\overset{Con(c)\ H_3SO_4}{\rightarrow}} CH_2 = CH_2$$

82. (c)



83. (a)



on solvolysis give more stable benzyl carbocation

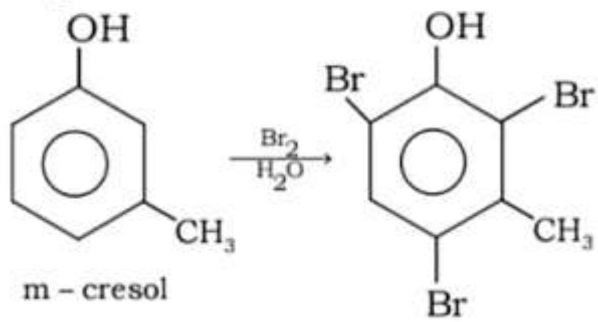
84. (a)

$$R - X + AgCN \rightarrow R - \underset{(A)}{NC} + AgX$$

$$R - X + KCN \rightarrow R - \underset{(B)}{CN} + KX$$

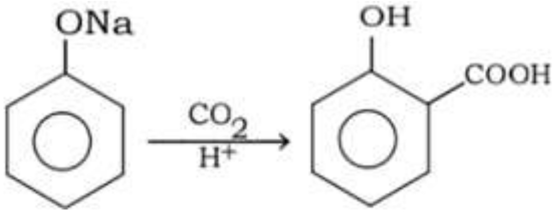
85. (a) Phenols gives characteristic colour with

$FeCl_3$



Meta-derivative of phenol only gives tribromo derivative

86. (c)



87. **(a)** Carbylamine test for primary amines the resulting isocyanide

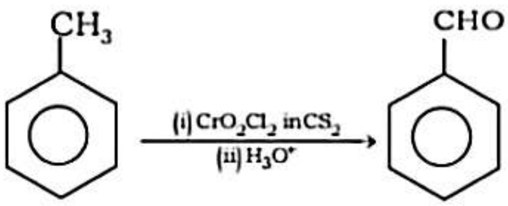
$$CH_3-NH_2 \xrightarrow[NaOH3]{CHCl} CH_3NC$$

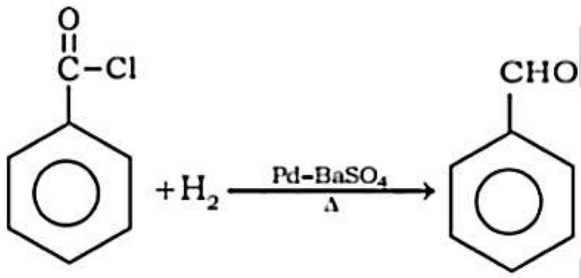
88. **(d)** Carboxylic acid with alpha hydrogen undergoes HVZ reaction

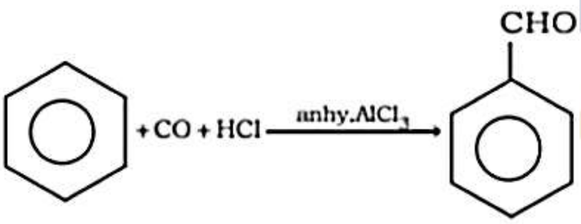
89. **(d)**

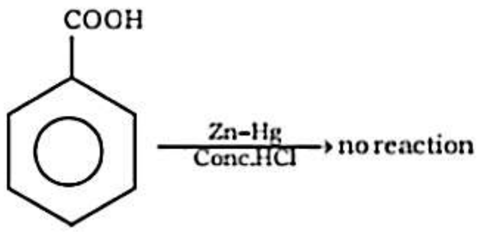
$$R-\overset{O}{\overset{|}{C}}-H+R-OH \rightarrow \underset{\text{Hemiacetal}}{R-\overset{OH}{\overset{|}{C}}H-OR} \xrightarrow{R-OH} \underset{\text{acetal}}{R-\overset{OR}{\overset{|}{C}}H-OR}$$

90. **(d)**

a) 

b) 

c) 

d) 

91. **(b)**

$[CH_3-\overset{O}{\overset{||}{C}}-CH_2-CH_2-CH_3$ /

$CH_3-CH_2-\overset{O}{\overset{||}{C}}-CH_2-CH_3]$

92. (b)

$\left[R-\ddot{N}H-R\right]$

93. (a)
94. (b)
95. (b)
96. (b)
97. (a)
98. (c) $W=-2.303nRT\log V_2/V_1$
99. (c) Molecular weight of $C_2H_5OH = 24+5+16+1=46$

Molecular mass of $H_2O=18$

414 g of C_2H_5OH has $\frac{414}{46}=9$ mole (i.e. $n_1=9$ mole) 18 g of H_2O has $=\frac{18}{18}=1$ mole (i.e. $n_2=1$ mole)

mole fraction of water $=\frac{n_2}{n_1+n_2}=\frac{1}{1+9}$

$=\frac{1}{10}=0.1$

100. **(c)** $\lambda=\frac{h}{mv}=\frac{h}{p}$

$p=\frac{h}{\lambda}=\frac{6.6\times10^{-34}}{2.2\times10^{-11}}=3\times10^{-23}$

101. **(d)** Y would have an ionization potential between those of X and Z
102. **(a)**
103. **(b c)**
104. **(a)** The correct property of CO_2 that makes it biologically and geochemically important is its low solubility in water, which allows it to easily diffuse across cell membranes and be transported in various biological and geochemical processes. So, option (A) is correct.
105. **(b)**

$\overset{5}{C}H_3-{}^4\overset{O}{\overset{||}{C}}-\overset{3}{C}H_2-\overset{2}{C}H_2-{}^1\overset{O}{\overset{||}{C}}-OH$

Since the parent chain has 5 carbon atoms, root word will be pentane and according to the priority of functional groups, - COOH Is the principal functional group in preference to carbony group thus naming will start from COOH side.
Hence the correct IUPAC name is 4-oxopentanoic acid.

106. **(a)**

$2HI \rightleftharpoons H_2 + I_2$
$1 \quad 0 \quad 0$
$0.5 \quad 0.25 \quad 0.25$

$$K_C \frac{[H_2][I_2]}{[HI]^2}$$

$$K_C = \frac{\frac{0.25 \times 0.25}{2}}{\frac{0.5 \times 0.5}{2}} = \frac{1}{4} = 0.25$$

107. **(d)**
108. **(d)**

In NH_2OH oxidation of N is -1
NH_4NO_3 exists as $NH_4^+.NO_3^-$,
thus the oxidation state of N $NH_4^+$is -3 while in $NO_3^-$is +5 .
In N_2H_4 oxidation of N is -2
In N_3H oxidation of N is $\frac{-1}{3}$

109. **(b)** (BH_3) is the chemical formula for the Boron atom. It is surrounded by 6 electrons, so it is electron deficient due to its incomplete octet. B-atom in diborane is sp ^{3} hybridized. B_2H_6 molecule has a total of 8 covalent bonds but only 12 electrons i.e. 6 pairs. So, it has two electron pairs less than the maximum required number for bonding, which makes it electron deficient.

110. **(d)**
111. **(c)**
112. **(b)** There are 8 corners in a cube and hence 8 atoms are placed at the corner of the cube. But these 8 atoms are shared equally by 8 separate units. Therefore, Contribution of atoms placed at the corner $= 8 \times \frac{1}{8} = 1$

There are 4 body diagonals in a cube and the number of atoms at each body diagonal are 2. Since these atoms are within the unit cell and hence are not shared by other units, therefore, Contribution of atoms placed at the body diagonal $= 2 \times 4 = 8$

Hence, total atoms in the cube- based unit cell $= 8 + 1 = 9$

113. **(b)** The statement that is NOT true about amorphous solids is: (C] They are anisotropic in nature.
Amorphous solids do not have a well-defined long-range order like crystalline solids. They have a disordered arrangement of atoms or molecules, resulting in a lack of symmetry in their structure. Due to this lack of long-range order, amorphous solids exhibit isotropic properties, meaning their properties are the same in all directions. In contrast, crystalline solids have a well-defined periodic arrangement and can exhibit anisotropic properties, meaning their properties can vary depending on the direction.
Therefore, amorphous solids are NOT anisotropic in nature.

114. **(b)** Osmotic pressure method is especially suitable for the determination of molecular masses of macromolecules such as protein & polymer because for these substances the value of other colligative properties such as elevation in boiling point or depression in freezing point are too small to be measured on the other hand osmotic pressure of such substances are measurable

115. **(c)** Fuel cells are electrochemical devices that convert the chemical energy of a fuel, such as hydrogen, into electrical energy through an oxidation-reduction (redox) reaction.
Catalysts are used to facilitate the redox reactions occurring at the electrodes of the fuel cell. Platinum and palladium are commonly used as catalysts in fuel cells due to their high catalytic activity, stability, and resistance to corrosion.

116. **(b)** $\Delta_m = \frac{k \times 1000}{M}$

Lower the molarity higher the molar conductivity

117. **(b)** There is large difference in size of cations and anions

118. **(a)**

119. **(d)**

$$\Delta T_b = K_b \cdot m \cdot i \Rightarrow 0.1 = K_b \times \frac{1.8}{180} \times \frac{1000}{100} \times 1$$

$$K_b = 1$$

120. **(a)**

$$\Pi = C \cdot R \cdot T = \frac{w_2}{M_2} \frac{1000}{V(\,m\ell)} \times R \cdot T$$

$$\Rightarrow \frac{3}{180} \times \frac{1000}{60} \times 0.0821 \times 288 = 6.568 \text{ atm}$$

Mathematics

121. **(c)** AKMS

$A \rightarrow 3\,!$

$K \rightarrow 3\,!$

$M \rightarrow 3\,!$

$\text{SAKM} \rightarrow \frac{1}{19}$

122. **(c)** $\frac{a_3}{a_1} = 25$

$$\frac{ar^2}{a} = 25$$

$$r^2 = 5^2$$

$$\frac{a_4}{a_5} = \frac{ar^8}{ar^4} = r^4 = 5^4$$

123. **(c)** The slope of the line $2x - 3y + 17 = 0$ is m_1.

The slope of line joining the points $(7,17)$ and $(15, \beta)$ is $\frac{\beta-17}{15-7} = \frac{\beta-17}{8} = m_2$

From the question given,

$$m_1 m_2 = -1$$

Now,

$$\Rightarrow \frac{2}{3} \times \frac{\beta - 17}{8} = -1$$

$\Rightarrow \beta - 17 = -12$

$\therefore \beta = 5$

124. **(a)** Here x is positive, y is negative and z is negative.

So, it lies in VIII octant.

125. **(c)**

$$\alpha = \lim_{x\to 2^-} f(x) = \lim_{x\to 2} x^2 - 1 = 3$$
$$\beta = \lim_{x\to 2^-} f(x) = \lim_{x\to 2} 2x + 3 = 7$$
$$x^2 - (\alpha+\beta)x + \alpha\beta = 0$$
$$x^2 - 10x + 21 = 0$$

126. **(b)** $3x = 6$

$x = 2$

$4x - y = -1$

$8 - y = -1$

$9 = y$

127. **(d)** $\sigma^2 = 5, \bar{x} = \frac{k}{4}$

$$\frac{1}{4}(1+0+1+k^2) - \frac{k^2}{16} = 5$$

$$\frac{k^2+2}{4} - \frac{k^2}{16} = 5$$

$$\frac{4k^2+8-k^2}{16} = 5$$

$\Rightarrow 3k^2 + 8 = 80$

$3k^2 = 72$

$k^2 = 24$

$k = \pm\sqrt{24} = 2\sqrt{6}$

128. **(a)** $n(A) \neq n(B)$

Number of bijections is zero

129. **(b)** $f(-1) = 3(-1) = -3$

$f(2) = 2^2 = 4$

$f(4) = 2(4) = 8$

$f(-1) + f(2) + f(4)$

$= -3 + 4 + 8 = 9$

130. **(a)** $2b = 27 - 3a$

$b = \dfrac{27 - 3a}{2}$

$R = \{(1,2), (3,9), (5,6), (7,3)\}$

131. **(a)** $\lim\limits_{y \to 0} \frac{3+y^3-3}{y\left(\sqrt{3+y^3}+\sqrt{3}\right)} = \frac{1}{2\sqrt{3}}$

132. **(c)** $(A^2)^{-1} = (A^{-1})^2$

133. **(a)**

$$A = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}$$

$$A^{-1} = \frac{1}{-1}\begin{bmatrix} -2 & 1 \\ -3 & 2 \end{bmatrix} = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix} = A$$

$$A^2 = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}\begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}$$

$$= \begin{bmatrix} 4-3 & -2+2 \\ 6-6 & -3+4 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = I$$

$\therefore A^3 = A$

$$(A^3)^{-1} = A^{-1} = \begin{bmatrix} 2 & -1 \\ 3 & -2 \end{bmatrix}^{-1} = \begin{bmatrix} -2 & 1 \\ -3 & 2 \end{bmatrix}$$

$= -A$

$\therefore (A^3)^{-1} = -A$

134. **(d)** $A^T = -A$ or A^n is slow symmetric if n is odd

$P = A^{2021}$

$P^T = [A^{2021}]^T = [A^T]^{2021} = (-A)^{2021} = -P$

135. **(c)**

$$A = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}$$

$$[aI + bA]^1 = \begin{bmatrix} a & 0 \\ 0 & a \end{bmatrix} + \begin{bmatrix} 0 & b \\ 0 & 0 \end{bmatrix} = \begin{bmatrix} a & b \\ 0 & a \end{bmatrix}$$

$$[aI + IA]^2 = \begin{bmatrix} a & b \\ 0 & a \end{bmatrix}\begin{bmatrix} a & b \\ 0 & a \end{bmatrix} = \begin{bmatrix} a^2 & 2ab \\ 0 & a^2 \end{bmatrix}$$

$$[aI + bA]^3 = \begin{bmatrix} a^2 & 2ab \\ 0 & a^2 \end{bmatrix}\begin{bmatrix} a & b \\ 0 & a \end{bmatrix} = \begin{bmatrix} a^3 & 3^2b \\ 0 & a^3 \end{bmatrix}$$

$$\therefore [aI + bA]^n = \begin{bmatrix} a^n & naa^{n-1}b \\ 0 & a^n \end{bmatrix}$$

$= a^n I + n \cdot a^{n-1} bA$

136. **(b)** $A_{3\times3}$ matrix $|5.\,\text{Adj } A| = 5$

$\Rightarrow 5^3|A|^2 = 5$

$\Rightarrow |A^2| = \frac{1}{5^2}$

$|A| = \pm\frac{1}{5}$

137. **(a)** $\Delta = 1(2a^2 + 4) + 2(4a - 0) + 5(8) = 86$

$2a^2 + 8a + 44 - 86 = 0$

$2a^2 + 8a - 42 = 0$

$a^2 + 4a - 21 = 0$

Sum of numbers $= -4 \left(\therefore -\frac{b}{a} = \alpha + \beta\right)$

138. **(c)**

$\Delta = \frac{1}{2}\begin{vmatrix} -2-3 & -2-1 \\ 6+6 & 6-5 \end{vmatrix} = \frac{1}{5}\begin{vmatrix} -5 & -3 \\ 12 & 1 \end{vmatrix}$

$= \frac{1}{2}|-5+36| = \frac{31}{2} = 15.5$

139. **(d)** $\cos^{-1}[x]$

$-1 \le [x] \le 1$

$\Rightarrow [x] = \{-1,0,1\}$

$x \in [-1,2)$

140. **(a)**

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

$\frac{dy}{dx} = \frac{(1 + x^2)}{1 + x^2} + \tan^{-1} x \cdot (2x) - 1$

$= 2x\tan^{-1} x$

141. **(a)** $x = e^{\theta}\sin\theta = 1$

$y = e^{\theta}\cos\theta = 1, \frac{x}{y} = \tan\theta = 1$

$\Rightarrow \theta = \frac{\pi}{4}$

$\frac{dy}{dx} = \left|\frac{dy/d\theta}{dx/d\theta}\right| = \frac{-e^{\theta}\sin\theta + \cos\theta \cdot e^{\theta}}{e^{\theta}\cos\theta + \sin\theta e^{\theta}} = \frac{\cos\theta - \sin\theta}{\cos\theta + \sin\theta}$

$= \tan\left(\frac{\pi}{4} - \theta\right) = 0$

142. **(a)**

$$e^{x^{\frac{1}{2}\left[1-\frac{1}{2}-\frac{1}{4}-\cdots\right]}} = e^{x^{\frac{1}{2}}} = e^{x^1} = e^x$$
$$\frac{dy}{dx} = e^x$$
$$\frac{d^2y}{dxx^2} = e^x x\log_\varepsilon^3 = e^{\log_\varepsilon^3} =$$

143. (c)

$$f(1) = 1, f'(1) = 3$$
$$\frac{d}{dx}[f(f(f(x))) + (f(x))^2]$$
$$[f'(f(f(x))) \cdot f'f(x) \cdot f'(x) + 2f(x) \cdot f'(x)]$$
$$= f'(f(f(1)))f'(f(1)) \cdot f'(1) + 2f(1) \cdot f'(1)$$
$$f'(f(1))f'(1) \cdot 3 + 2 \cdot (1)3$$
$$= f'(1) \cdot 3 \cdot 3 + 6$$
$$= 27 + 6 = 33$$

144. (b)

$$y = x^{\sin x} + (\sin x)^x$$

$$\frac{dy}{dx} = \left[x^{\sin x}\right]\left[\frac{\sin x}{x} + \cos x \cdot \log x\right] +$$

$$(\sin x)^x[x\cos x + \log\sin x]$$

$$x = \frac{\pi}{2}$$

$$= \frac{\pi}{2}\left[\frac{2}{\pi}\right] + 1[0 + 0] = 1$$

145. (c)

$$A_n = \begin{bmatrix} 1-n & n \\ n & 1-n \end{bmatrix}$$

$$|A_n| = (1-n)^2 - n^2$$

$$= 1 + n^2 - 2n - n^2$$

146. (b)

$$f'(x) = \frac{x^2}{(x+1)(2+x)^2} > 0$$

$$x + 1 > 0 \Rightarrow x > -1$$

147. (b) $\frac{dy}{dx} = -\sqrt{\frac{y}{x}} = -1$

$$y = x$$

$$\sqrt{x} + \sqrt{x} = 6$$

$$x = 9, y = 9$$

148. **(d)** $f'(x) = (12\sin^2 x - 12\sin x + 12)\cos x$

$f'(x) = 12(\sin^2 x - \sin x + 1)\cos x$

$\sin^2 x - \sin x + 1 > 0$

$x \in \left(\frac{\pi}{2}, \pi\right) \cos x < 0$

149. **(a)**

$$\int_0^8 [x]dx = 1 + 2 + 3 + \cdots + 7$$
$$= \frac{7(7+1)}{2} = 28$$

150. **(b)** Put $\sin\theta = t$

$\int_0^1 t^{1/2}(1 - t^2)dt = \frac{8}{21}$

151. **(d)** $x = 0 \Rightarrow y = 1$

$\frac{dy}{dx} = \frac{-y}{e^y + x}$

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

$\left(\frac{d^2y}{dx^2}\right)_{(0,1)} = \frac{1}{e^2}$

152. **(c)**

$$2\int \frac{\cos^2 x - \cos^2\alpha}{\cos x - \cos\alpha}dx = 2\int (\cos x + \cos\alpha)dx$$
$$= 2[\sin x + x\cos\alpha]$$

153. **(d)**

$$\int_0^1 e^x\left[\frac{1}{(x+2)^2} - \frac{2}{(x+2)^3}\right]dx$$
$$= \left[\frac{e^x}{(x+2)^2}\right]_0^1 = \frac{e}{9} - \frac{1}{4}$$

154. **(a)**

$\frac{1}{(x+2)(x^2+1)} = \frac{A}{x+2} + \frac{Bx + C}{x^2 + 1}$

$A = \frac{1}{5}, B = \frac{-1}{5}, C = \frac{2}{5}$

155. **(c)** $A = \int_0^{\pi/3} \tan x dx = \log|\sec x|_0^{\pi/3} = \log 2$

156. **(d)** $I=\left[\frac{x^3}{3}\right]_2^3=\frac{1}{3}(27-8)=\frac{19}{3}$

157. **(d)**

$$\sin x=t$$
$$\frac{\pi}{2}\frac{\cos x\sin x}{1+\sin x}dx$$
$$\Rightarrow\int_0^1\frac{t}{1+t}dt=1-\log 2$$

158. **(c)**

$$y\cdot x=\frac{x^4}{4}+C$$
$$2y(2)-y(1)=\frac{15}{4}$$

159. **(a)** $x+y=z\Rightarrow\frac{dz}{dx}=1+z^2$

$$\int\frac{1}{1+z^2}dz=\int 1dx$$

$\mathrm{Tan}^{-1}(x+y)=x+c$

160. **(d)** $\mathrm{I.F}=\log x$

$y\log x=2x(\log x-1)+c$

If $x=e$ then $y=c$ then $y(e)=2e$

161. **(c)**

$$\left|\frac{\bar{a}}{2}-\frac{\bar{b}}{3}\right|^2=\frac{|\bar{a}|^2}{4}+\frac{|\bar{b}|^2}{9}-2\frac{\bar{a}}{2}\cdot\frac{\bar{b}}{3}=3$$

162. **(b)** $=|\mathbf{a}\times\mathbf{b}|^2+|\mathbf{a}-\mathbf{b}|^2=36$

$|\mathbf{a}|^2|\mathbf{b}|^2=36\Rightarrow b^2=4,|b|=2$

163. **(a)** $\vec{\beta}=\left(\vec{\beta}_1+\vec{\beta}_2\right)$

$\left(\vec{\beta}=\lambda\vec{\alpha}+\vec{\beta}_2\right)\cdot\vec{\alpha}$

$\vec{\alpha}\cdot\vec{\beta}=\lambda|\vec{a}|^2+0$

164. **(b)** $(1+y_1^2)=(y_2)^3$

$2+3=5$

165. **(b)**

166. **(d)** $\cos\theta=\frac{3\times1+5\times4+4\times2}{\sqrt{3^2+5^2+4^2}\times\sqrt{1^2+4^2+2^2}}=\frac{31}{5\sqrt{42}}$

$\theta = \cos^{-1}\dfrac{31}{5\sqrt{42}}$

167. **(d)** At $(0,2),(3,0), z = 12$

Hence minimum at 2 points.

168. **(a)**

169. **(a)** Distance $= \frac{|2-2-4-4|}{\sqrt{1+4+16}} = \frac{(8)}{\sqrt{21}}$

170. **(a)**

X	0	1	2	3
P(x)	1/8	3/8	3/8	1/8

Mean $= \frac{3}{8}+\frac{6}{8}+\frac{3}{8} = \frac{12}{8} = \frac{3}{2} = 1.5$

171. **(a)**

$P(A) = \dfrac{1}{2}, P(B) = \dfrac{1}{3}, P(A \cap B) = \dfrac{1}{4}\times\dfrac{1}{3} = \dfrac{1}{12}$

$P(A \cap B) = P(\overline{A \cup B})$

$P(A \cap B) = 1 - P(A \cup B)$

$P(A \cap B) = 1 - \left[\dfrac{1}{2}+\dfrac{1}{3}-\dfrac{1}{12}\right]$

$P(A \cap B) = 1 - \left[\dfrac{6+4-1}{12}\right]$

$P(A \cap B) = 1 - \dfrac{9}{12}$

$P(A \cap B) = \dfrac{1}{4}$

172. **(a)**

$P(E_1)$ = probability of there is lockdown = 0.7
$P(E_2)$ = probability of there is lockdown = 0.3
A is the event controlled in one month

$P(A/E_1) = 0.8, P(A/E_2) = 0.3$
$P(A) = 0.7(0.8) + (0.3)(0.3)$
$= 0.56 + 0.09 = 0.65$

173. **(c)** $P(A) = \frac{1}{4}, P(B) = \frac{3}{4}, P(A \cup B) = \frac{13}{20}$

$\dfrac{1}{4} + x - \dfrac{1}{4}\cdot x = \dfrac{13}{20}$

$\dfrac{3}{4}x - \dfrac{13}{20} - \dfrac{5}{20} = \dfrac{8}{20}$

$x=\frac{8}{20}\times\frac{4}{3}=\frac{8}{15}$

174. **(a)**

$$\begin{aligned}&n(A)=p, n(B)=q\\&n(A\times B)=7\\&pq=7\\&p^2+q^2=7^2+1^2 \text{ or } 1^2+7^2\\&p^2+q^2=50\end{aligned}$$

175. **(d)** $1-x>0, 1-x\neq 1$

$x-1<0\ x\neq 0\ x+2\geq 0$

$x<1\ x\geq -2$

$\therefore x\in[-2,0)\cup(0,1)$

176. **(d)**

177. **(b)** $\frac{\pi}{32}=\frac{180^\circ}{32}=5^\circ 37' 30''$

178. **(d)**

$$\begin{aligned}&\sin\frac{5\pi}{12}\cdot\sin\frac{\pi}{12}\\&=\frac{1}{2}\sin\frac{\pi}{6}\\&=\frac{1}{2}+\frac{1}{2}=\frac{1}{4}\end{aligned}$$

179. **(c)** $1+\cos\theta=2\cos^2\left(\frac{\theta}{2}\right)$

$$\sqrt{2+\sqrt{2+\sqrt{2+2\cos 8\theta}}}=2\cos\theta$$

180. **(b)** Odd number $=\{1,3,5,7,9\}$

No. of sub sets $=2^5=32$

Biology

181. **(a)**

182. **(b)** George Gamow in 1954, pointed out the possibility of a three-letter code i.e. triplet codon. This will give $4\times4\times4=64$ codons which are more than enough to code for twenty amino acids. Out of these 64 codons, 3 codons are stop codons. Hence, 61 effective codons are there for the synthesis of twenty amino acids.

183. **(d)** Variable Number of Tandem Repeat (VNTR) polymorphism is the basis of DNA fingerprinting which are short nucleotide repeats. DNA of each organism has specific sequences called restriction fragments that can be cleaved by restriction endonuclease enzymes to produce fragments of different lengths.

184. **(d)**

185. **(c)**

186. **(a)**

187. **(c)**

188. **(d)**

189. (d)
190. (a)
191. (b)
192. (a)
193. (d)
194. (c)
195. (c)
196. (b)
197. (b)
198. (b)
199. (d)
200. (b)
201. (c)
202. (c)
203. (c)
204. (d)
205. (b)
206. (c)
207. (c)
208. (a)
209. (d)
210. (b)
211. (d)
212. (b)
213. (d)
214. (b)
215. (a)
216. (a)
217. (b)
218. (b)
219. (a)
220. (c)
221. (d)
222. (a)
223. (b)
224. (b)
225. (c)
226. (c)
227. (d)
228. **(c)** "Isthmus," "Fimbriae," and "Infundibulum" are anatomical terms related to the female reproductive system. The isthmus refers to a narrow portion or constriction, often found in the fallopian tubes. Fimbriae are finger-like projections at the end of the fallopian tubes, responsible for capturing the released egg during ovulation and guiding it into the fallopian tube. The infundibulum is the funnel-shaped opening of the fallopian tube near the ovary, which receives the egg from the ovary. On the other hand, "Labia minora" is a term related to the external genitalia of the female reproductive system. It refers to the inner folds of skin located on either side of the vaginal opening. It is different from the other options, which are specific anatomical structures within the reproductive system.
229. **(d)** The first movements of the fetus, known as "quickening," and the appearance of hair on its head, occur at different times during gestation. The first movements of the fetus are usually felt by the mother between 18 to 25

weeks of gestation. This can vary from woman to woman and pregnancy to pregnancy. Initially, the movements may feel like flutters or gentle taps, and as the fetus grows, the movements become more pronounced and noticeable. As for the appearance of hair on the fetus's head, it typically occurs around the 14th to 16 th week of gestation. This is a developmental milestone when the hair follicles start forming, and fine hair, known as lanugo, begins to grow on the fetus's body, including the scalp. The lanugo hair helps regulate the fetus's body temperature and usually sheds before birth.

Therefore, the appearance of hair on the fetus's head is observed earlier in gestation compared to the first movements, which are felt later in the second trimester.

230. **(c)**
231. **(d)**
232. **(c)**
233. **(a)**
234. **(c)**
235. **(b)**
236. **(c)**
237. **(c)**
238. **(a)**
239. **(d)**
240. **(c)**