SRMJEEE

Practice Paper-2

EXAM DATE
15th to 25th April

Time : 2:30 Hours *Max. Marks : 315*

PART 1 : PHYSICS

1. If the error in measuring the radius of the sphere is 2% and that in measuring its mass is 3%, then the error in measuring the density of material of the sphere is
(a) 5% (b) 7% (c) 9% (d) 11%

2. The only mechanical quantity which has negative dimension of mass is
(a) angular momentum
(b) torque
(c) coefficient of thermal conductivity
(d) gravitational constant

3. If C be the capacitance and V be the electric potential, then the dimensional formula of CV^2 is
(a) $[\mathrm{M^1L^2T^{-2}A^0}]$ (b) $[\mathrm{M^1L^1T^{-2}A^{-1}}]$
(c) $[\mathrm{M^0L^1T^{-2}A^0}]$ (d) $[\mathrm{M^1L^{-3}T^1A^{-1}}]$

4. Which two of the following five physical parameters have the same dimensions ?
1. Energy density
2. Refractive index
3. Dielectric constant
4. Young's modulus
5. Magnetic field

(a) 1 and 4 (b) 1 and 5
(c) 2 and 4 (d) 3 and 5

5. A particle moves in a straight line so that its displacement x m in t s is given by $x^2 = t^2 + 1$ Its acceleration in m s^{-2} is
(a) $\frac{1}{x^3}$ (b) $-\frac{t^2}{x^2}$
(c) $\frac{1}{x} - \frac{1}{x^2}$ (d) $-\frac{t^2}{x^3}$

6. The equation of a projectile is $y = \sqrt{3}x - \frac{gx^2}{2}$. The angle of projection is given by
(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{2}$ (d) zero

7. A particle of mass m moves with constant speed along a circular path of radius r under the action of force F. Its speed is
(a) $\sqrt{\frac{Fr}{m}}$ (b) $\sqrt{\frac{F}{r}}$
(c) $\sqrt{Fmr}$ (d) $\sqrt{\frac{F}{mr}}$

8. Two small satellites move in circular orbits around the earth, at distances r and $(r + \Delta r)$ from the centre of the earth. Their time periods of rotation are T and $(T + \Delta T)$. $(\Delta r << r, \Delta T << T)$. Then
(a) $\Delta T = \frac{3}{2}T\frac{\Delta r}{r}$ (b) $\Delta T = -\frac{3}{2}T\frac{\Delta r}{r}$
(c) $\Delta T = \frac{2}{3}T\frac{\Delta r}{r}$ (d) $\Delta T = T\frac{\Delta r}{r}$

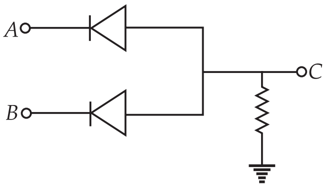
9. When the temperature increases, the viscosity of
(a) gases decreases and liquid increases
(b) gases increases and liquids decreases
(c) gases and liquids increases
(d) gases and liquids decreases

10. A metal wire of length L, area of cross-section A and Young's modulus Y behaves as a spring of spring constant k. Then
(a) $k = YA/L$ (b) $k = 2YA/L$
(c) $k = YA/2L$ (d) $k = YL/A$

11. Two simple harmonic motions are represented by $y_1 = 5[\sin 2\pi t + \sqrt{3}\cos 2\pi t]$ and $y_2 = 5\sin\left(2\pi t + \frac{\pi}{4}\right)$.
The ratio of their amplitudes is
(a) 1 : 1 (b) 2 : 1
(c) 1 : 3 (d) $\sqrt{3} : 1$

12. The successive resonance frequencies in an open organ pipe are 1944 Hz and 2600 Hz. If the speed of sound in air is 328 m s^{-1}, then the length of the pipe is
(a) 0.40 m (b) 0.04 m
(c) 0.50 m (d) 0.25 m

13. In the circuit below, A and B represent two inputs and C represents the output. The circuit represents



(a) OR gate (b) NOR gate
(c) AND gate (d) NAND gate

14. All particles of a body are situated at a distance R from the origin. The distance of the centre of mass of the body from the origin is
(a) $= R$ (b) $\leq R$ (c) $> R$ (d) $\geq R$

15. A body possessing kinetic energy T moving on a rough horizontal surface is stopped in a distance y. The frictional force exerted on the body is
(a) Ty (b) $\frac{\sqrt{T}}{y}$ (c) $\frac{T}{y}$ (d) $\frac{T}{\sqrt{y}}$

16. The pressure and density of a diatomic gas $\left(\gamma = \frac{7}{5}\right)$ change adiabatically from (P, ρ) to (P', ρ'). If $\frac{\rho'}{\rho} = 32$, then $\frac{P'}{P}$ is
(a) $\frac{1}{128}$ (b) 32 (c) 128 (d) 256

17. The ratio of root mean square velocities of O_3 and O_2 is
(a) 1 : 1 (b) 2 : 3 (c) 3 : 2 (d) $\sqrt{2} : \sqrt{3}$

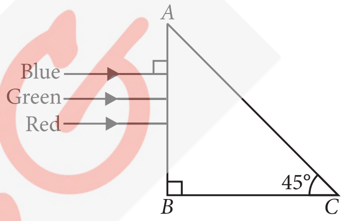
18. When the gas expands with temperature using the relation $V = KT^{2/3}$ for the temperature change of 40 K, the work done is
(a) $20.1R$ (b) $30.2R$
(c) $26.6R$ (d) $35.6R$

19. 5.6 litre of helium gas at STP is adiabatically compressed to 0.7 litre. Taking the initial temperature to be T_1, the work done in the process is
(a) $\frac{9}{8}RT_1$ (b) $\frac{3}{2}RT_1$
(c) $\frac{15}{8}RT_1$ (d) $\frac{9}{2}RT_1$

20. The average kinetic energy of the molecules of a low density gas at 27°C is
(Boltzmann constant = 1.38×10^{-23} J K^{-1})
(a) 3.1×10^{-20} J (b) 3.5×10^{-21} J
(c) 5.3×10^{-18} J (d) 6.21×10^{-21} J

21. A concave mirror of focal length f produces a real image n times the size of the object. The distance of the object from the mirror is
(a) $(n - 1)f$ (b) $(n + 1)f$
(c) $\frac{(n+1)f}{n}$ (d) $\frac{(n-1)f}{n}$

22. A beam of light consisting of red, green and blue colours is incident on a right angled prism. The refractive index of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively.



The prism will
(a) not separate the three colours at all
(b) separate the red colour part from the green and blue colours
(c) separate the blue colour part from the red and green colours
(d) separate all the three colours from one another.

23. A narrow slit of width 2 mm is illuminated by monochromatic light of wavelength 500 nm. The distance between the first minima on either side on a screen at a distance of 1 m is
(a) 5 mm (b) 0.5 mm
(c) 1 mm (d) 10 mm

24. Two charges $+q$ and $-q$ are kept apart. Then at any point on the right bisector of line joining the two charges
(a) the electric field strength is zero.
(b) the electric potential is zero.
(c) both electric potential and electric field strength are zero.
(d) both electric potential and electric field strength are non-zero.

25. Resistances P, Q, S and R are arranged in a cyclic order to form a balanced Wheatstone's network. The ratio of power consumed in the branches $(P + Q)$ and $(R + S)$ is

(a) 1 : 1 (b) $R : P$
(c) $P^2 : Q^2$ (d) $P^2 : R^2$

26. A rectangular coil of length 0.12 m and width 0.1 m having 50 turns of wire is suspended vertically in a uniform magnetic field of strength 0.2 Wb m^{-2}. The coil carries a current of 2 A. If the plane of the coil is inclined at an angle of 30° with the direction of the field, the torque required to keep the coil in stable equilibrium will be
(a) 0.24 N m (b) 0.12 N m
(c) 0.15 N m (d) 0.20 N m

27. The magnetic flux across a loop of resistance 10 Ω is given by $\phi = (5t^2 - 4t + 1)$ weber. How much current is induced in the loop after 0.2 s?
(a) 0.4 A (b) 0.2 A
(c) 0.04 A (d) 0.02 A

28. In an AC generator, when the plane of the armature is perpendicular to the magnetic field
(a) both magnetic flux and emf are maximum
(b) both magnetic flux and emf are zero
(c) magnetic flux is maximum and emf is zero
(d) magnetic flux is zero and emf is maximum.

29. If the work functions of three photosensitive materials are 1 eV, 2 eV and 3 eV respectively, then the ratio of the respective frequencies of light that produce photoelectrons of maximum kinetic energy of 1 eV from each of them is
(a) 1 : 2 : 3 (b) 2 : 3 : 4
(c) 1 : 1 : 1 (d) 3 : 2 : 1

30. Hydrogen atom in ground state is excited by a monochromatic radiation of λ = 975 Å. Number of spectral lines in the resulting spectrum emitted will be
(a) 3 (b) 2 (c) 6 (d) 10

31. The ratio of the de Broglie wavelengths of proton and α particle which have been accelerated through same potential difference is
(a) $2\sqrt{3}$ (b) $3\sqrt{2}$ (c) $2\sqrt{2}$ (d) $3\sqrt{3}$

32. In a sample of radioactive substance, what fraction of the initial nuclei will remain undecayed after half of a half-life of the sample?
(a) $\frac{1}{\sqrt{2}}$ (b) $\frac{1}{2\sqrt{2}}$ (c) $\frac{1}{4}$ (d) $\frac{1}{\sqrt{2}-1}$

33. In a *p-n* junction photodiode, the value of the photo electromotive force produced by monochromatic light is proportional to
(a) the barrier voltage at *p-n* junction
(b) the intensity of light falling on the cell
(c) the frequency of light falling on the cell
(d) the voltage applied at the *p-n* junction.

34. A full wave *p-n* diode rectifier uses a load resistor of 1500 Ω. No filter is used. The forward bias resistance of the diode is 10 Ω. The efficiency of the rectifier is
(a) 81.2% (b) 40.6% (c) 80.6% (d) 40.2%

35. The gap between the frequency of the side bands in an amplitude modulated wave is
(a) twice that of the carrier signal
(b) twice that of the message signal
(c) the same as that of the message signal
(d) the sum or difference of the frequencies of carrier and message signal

PART 2 : CHEMISTRY

36. Fructose gives the silver mirror test because it
(a) contains an aldehyde group
(b) contains a keto group
(c) undergoes rearrangement under the alkaline conditions of the reagent to form a mixture of glucose and mannose
(d) none of these.

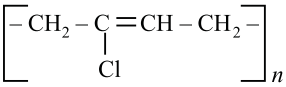
37. Arrange the following oxides in order of increasing acidic character Na_2O, Cl_2O_7, As_2O_3, N_2O.
(a) $Na_2O < As_2O_3 < N_2O < Cl_2O_7$
(b) $Na_2O < N_2O < As_2O_3 < Cl_2O_7$
(c) $N_2O < Cl_2O_7 < Na_2O < As_2O_3$
(d) $Cl_2O_7 < N_2O < As_2O_3 < Na_2O$

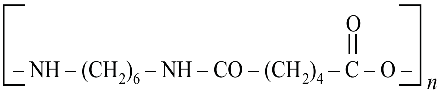
38. In the dichromate dianion,
(a) 4 Cr — O bonds are equivalent
(b) 6 Cr — O bonds are equivalent
(c) all Cr — O bonds are equivalent
(d) all Cr — O bonds are nonequivalent.

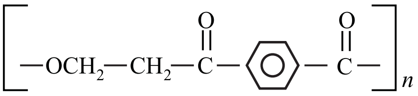
39. Which one of the following is paramagnetic and has bond order 1/2?
(a) H_2 (b) H_2^+ (c) N_2 (d) F_2

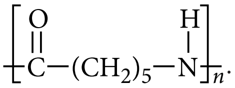
40. How many isomers are possible for alkane (molecular weight = 86)?
(a) 4 (b) 3 (c) 5 (d) 6

41. Which of the following is not correctly matched?

(a) Neoprene :

$\left[-CH_2-\underset{\underset{Cl}{|}}{C}=CH-CH_2-\right]_n$

(b) Nylon-6,6 :

$\left[-NH-(CH_2)_6-NH-CO-(CH_2)_4-\overset{\overset{O}{||}}{C}-O-\right]_n$

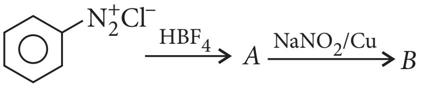
(c) Terylene :

$\left[-OCH_2-CH_2-\overset{\overset{O}{||}}{C}-C_6H_4-\overset{\overset{O}{||}}{C}-\right]_n$

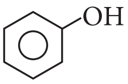
(d) Nylon-6 :

$\left[\overset{\overset{O}{||}}{C}-(CH_2)_5-\overset{\overset{H}{|}}{N}\right]_n$.

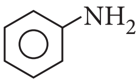
42. 1.00 g of $BaCl_2$ is treated with excess of aqueous $AgNO_3$ and all chlorine is recovered as 1.38 g of AgCl. What is the atomic weight of Ba? (Cl = 35.5, Ag = 108)
(a) 137 (b) 172.5 (c) 33 (d) 68.5

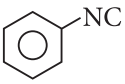
43. Which one of the following pairs is not correctly matched?
(a) $>C=O \xrightarrow{\text{Clemmensen's reduction}} >CH_2$
(b) $>C=O \xrightarrow{\text{Wolff-Kishner reduction}} >CHOH$
(c) $-COCl \xrightarrow{\text{Rosenmund's reduction}} CHO$
(d) $-C\equiv N \xrightarrow{\text{Stephen reduction}} CHO$

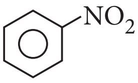
44. Relationship between atomic radius and the edge length a of a body-centred cubic unit cell is
(a) $r = a/2$ (b) $r = \sqrt{a/2}$
(c) $r = \frac{\sqrt{3}}{4}a$ (d) $r = \frac{3a}{2}$

45. Product of the following reaction is


(a)


(b)


(c)


(d)


46. Nitrogen and hydrogen in the molar ratio 1 : 3 was allowed to equilibrate. If 50% of each reacts at the total pressure of P, then K_p for the reaction, $N_2 + 3H_2 \rightleftharpoons 2NH_3$ is
(a) $\frac{16}{3P^2}$ (b) $\frac{3P^2}{16}$ (c) $8P^2$ (d) $\frac{8}{P^2}$

47. Which of the following is not an emulsion?
(a) Butter (b) Ice cream
(c) Milk (d) Cloud

48. 1 mol of a substance (X) was treated with an excess of water. 2 mol of readily combustible gas were produced along with solution which when reacted with CO_2 gas produced a white turbidity. The substance (X) could be
(a) Ca (b) CaH_2
(c) $Ca(OH)_2$ (d) $Ca(NO_3)_2$

49. Which of the following reagents can be used to distinguish a phenol and an alcohol?
(a) Ammoniacal $AgNO_3$
(b) Ammoniacal Cu_2Cl_2
(c) Aqueous ferric chloride
(d) Neutral ferric chloride

50. What is the general outer electronic configuration of the coinage metals?
(a) ns^2np^6 (b) $(n-1)d^{10}\,ns^1$
(c) $(n-1)d^{10}\,ns^2$ (d) $(n-1)d^9\,ns^2$

51. $(CH_3)_4N^+$ is 1 neither an electrophile, nor a nucleophile because it
(a) does not have electron pair for donation as well as can not attract electron pair
(b) neither has electron pair available for donation nor can accommodate electron since all shells of nitrogen are fully occupied
(c) can act as Lewis acid and base
(d) none of these.

52. Which one has the highest osmotic pressure?
(a) M/10 HCl (b) M/10 Urea
(c) M/10 $BaCl_2$ (d) M/10 Glucose

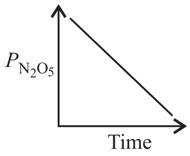
53. An ester (A) with molecular formula, $C_9H_{10}O_2$ was treated with excess of CH_3MgBr and the complex so formed, was treated with H_2SO_4 to give an olefin (B). Ozonolysis of (C) gave a ketone with molecular formula C_8H_8O which shows +ve iodoform test. The structure of (*A*) is

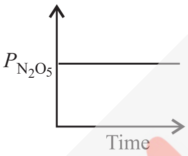
(a) $H_3CCH_2COC_6H_5$ (b) $C_2H_5COOC_6H_5$
(c) $C_6H_5COOC_2H_5$
(d) *p*-$H_3CO-C_6H_4-COCH_3$

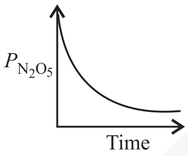
54. 0.40 g of helium in a bulb at a temperature of *T* K had a pressure of *P* atm. When the bulb was immersed in hotter bath at temperature 50 K more than the first one, 0.08 g of gas had to be removed to restore the original pressure. *T* is

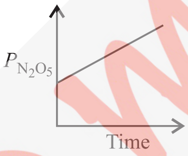
(a) 100 K (b) 200 K
(c) 300 K (d) 500 K

55. Which of the following graphs will show the variation of partial pressure of N_2O_5 decomposing into NO_2 and O_2 following the first order kinetics?

(a)


(b)


(c)


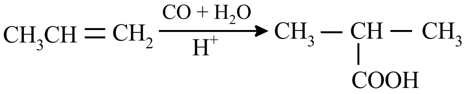
(d)


56. Consider the following reaction,

The final product '*X*' is a medicine. Which of the following is incorrect regarding *X*?

(a) It has analgesic as well as antipyretic properties.
(b) It is used in arthritis.
(c) It suppresses the gastric anomalies.
(d) It is antirheumatic drug.

57. The reaction



$$CH_3CH=CH_2 \xrightarrow[H^+]{CO + H_2O} CH_3-\underset{\displaystyle |\atop \displaystyle COOH}{CH}-CH_3$$

is known as

(a) Wurtz reaction (b) Koch reaction
(c) Clemmensen's reduction
(d) Kolbe's reaction.

58. A golf ball has a mass of 40 g, and a speed of 45 m/s. If the speed can be measured within accuracy of 2%, calculate the uncertainty in the position.

(a) 1.46×10^{-33} m (b) 1.46×10^{-33} cm
(c) 1.59×10^{-33} m (d) 1.39×10^{33} km

59. Calculate the cell potential in which the following reaction takes place

$$Mg_{(s)} + Zn^{2+}_{(aq)}\ (0.1\ M) \longrightarrow Mg^{2+}_{(aq)}\ (0.01\ M) + Zn_{(s)}$$

if $E°_{(cell)} = 1.61V$

(a) 1.6395 V (b) 0.6395 V
(c) 0.06395 V (d) –1.6395 V

60. In the following radioactive decay, $^{232}_{92}X \rightarrow ^{220}_{89}Y$, how many α and β particles are ejected from *X* to form *Y*?

(a) 3α and 5β (b) 5α and 3β
(c) 3α and 3β (d) 5α and 5β

61. In an octahedral crystal field, the t_{2g} orbitals are

(a) raised in energy by 0.4 Δ_o
(b) lowered in energy by 0.4 Δ_o
(c) raised in energy by 0.6 Δ_o
(d) lowered in energy by 0.6 Δ_o.

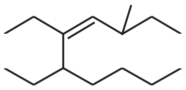
62. What percentage of β-D-(+) glucopyranose is found at equilibrium in the aqueous solution?

(a) 50% (b) ≈100% (c) 36% (d) 64%

63. Among the following mixtures, dipole-dipole as the major interaction, is present in

(a) benzene and ethanol
(b) acetonitrile and acetone
(c) KCl and water
(d) benzene and carbon tetrachloride.

64. The correct IUPAC name of the compound,



is

(a) 5,6-Diethyl-8-methyldec-6-ene
(b) 6-Butyl-5-ethyl-3-methyloct-4-ene
(c) 5,6-Diethyl-3-methyldec-4-ene
(d) 2,4,5-Triethylnon-3-ene.

65. Ethyl chloride is converted into diethyl ether by

(a) Perkin's reaction (b) Grignard reagent
(c) Wurtz reaction
(d) Williamson's synthesis.

66. Phenol reacts with bromine in carbon disulphide at low temperature to give
(a) *m*-bromophenol
(b) *p*-bromophenol
(c) *o*-and *p*-bromophenol
(d) 2, 4, 6-tribromophenol.

67. Hess's law is based on
(a) first law of thermodynamics
(b) law of conservation of mass
(c) law of conservation of energy
(d) none of the above.

68. $C_4H_{11}N$ on reaction with HNO_2 forms tertiary alcohol. Thus, $C_4H_{11}N$ is
(a) primary amine
(b) secondary amine
(c) tertiary amine
(d) quarternary ammonium salt.

69. Kjeldahl's method cannot be used for the estimation of nitrogen in
(a) pyridine (b) nitrocompounds
(c) azo compounds (d) all of these.

70. In both DNA and RNA, heterocyclic base and phosphate ester linkages are at
(a) C_5 and C_2 respectively of the sugar molecule
(b) C_2 and C_5 respectively of the sugar molecule
(c) C_1 and C_5 respectively of the sugar molecule
(d) C_5 and C_1 respectively of the sugar molecule.

PART 3 : MATHEMATICS

71. If $\sum_{i=1}^{25} a_i = 625$ such that $a_1, a_2, a_3 \ldots \in$ A.P. then $\sum_{j=1}^{13} a_{2j-1}$ equals
(a) 25 (b) 15625
(c) 325 (d) 125

72. If a, b, c are roots of $y^3 - 3y^2 + 3y + 26 = 0$ and ω is cube roots of unity, then the value of $\frac{a-1}{b-1}+\frac{b-1}{c-1}+\frac{c-1}{a-1}$ equals
(a) $-3\omega^2$ (b) $3\omega^2$ (c) ω^2 (d) $2\omega^2$

73. If $\int_0^1 \frac{dt}{e^t + e^{-t}} = \tan^{-1}p$ then p equals
(a) $\frac{e^2-1}{e^2+1}$ (b) $\frac{e-1}{e+1}$
(c) $\frac{1-e}{1+e}$ (d) $\frac{e^2+1}{e-1}$

74. The line $(x+g)\cos\theta + (y+f)\sin\theta = k$ touches the circle $x^2+y^2+2gx+2fy+c=0$ only if
(a) $g^2+f^2=c+k^2$
(b) $g^2+f^2=c^2+k^2$
(c) $g^2+f^2=c^2-k^2$
(d) $g^2+f^2=c-k^2$

75. The system $AX = B$ of $(n-1)$ equations in $(n-1)$ unknowns has infinitely many solutions if
(a) det $A = 0$, (adj A) $(B) = 0$
(b) $|A| \neq 0$, (adj A) $(B) = 0$
(c) $|A| = 0$, (adj A) $(B) \neq 0$
(d) None of these

76. Let R be a relation defined by $R = \{(9, 8), (1, 9), (9, 6), (7, 6), (2, 7)\}$ then $R^{-1}oR$ is given by
(a) $\{(1, 1), (9, 9), (7, 9), (9, 7), (7, 7), (2, 2)\}$
(b) $\{(1, 1), (9, 9), (7, 9), (9, 7), (7, 7)\}$
(c) $\{(1, 8), (1, 6), (2, 6)\}$
(d) None of these.

77. In a football championship, there were 153 matches played. Every team played one match with each other. The number of teams participating in the championship is
(a) 17 (b) 18 (c) 9 (d) 13

78. The lines $2x + y - 1 = 0$, $ax + 3y - 3 = 0$ and $3x + 2y - 2 = 0$ are concurrent then 'a' satisfies the condition
(a) a can assume any real value
(b) $a \in [-2, 3]$
(c) $a \geq 0$
(d) $a \leq 0$

79. If $a \in [-10, 0]$, then the probability that the graph of the function $y = x^2 + 2(a+3)x - (2a+6)$ is strictly above x-axis, is
(a) $\frac{3}{5}$ (b) $\frac{2}{5}$
(c) $\frac{1}{5}$ (d) None of these

80. If α, β are roots of the equation $x^2 - 15x + 1 = 0$, then the value of $\left(\frac{1}{\alpha}-15\right)^{-2}+\left(\frac{1}{\beta}-15\right)^{-2}$ is
(a) 225 (b) 900
(c) 223 (d) None of these

81. The coefficient of x^{53} in

$$\sum_{m=0}^{100} {}^{100}C_m (x-3)^{100-m} 2^m \text{ is}$$

(a) ${}^{100}C_{53}$ (b) ${}^{101}C_{53}$

(c) $-{}^{100}C_{53}$ (d) ${}^{100}C_{47}$

82. If ASC is a focal chord of the parabola $y^2 = 4ax$ and $AS = 5$, $SC = 9$ then length of latus rectum of the parabola equals

(a) $\frac{90}{7}$ (b) $\frac{7}{90}$

(c) $\frac{45}{14}$ (d) None of these

83. The solution of the equation

$\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 13y = 0$ is given by

(a) $e^{-2x}(A\cos x + B\sin x)$

(b) $e^{-2x}(A\cos 3x + B\sin 3x)$

(c) $e^{2x}(A\cos 3x + B\sin 3x)$

(d) None of these

84. In ΔABC, $(a+b-c)\tan\left(\frac{C}{2}\right) =$

(a) $\frac{\Delta}{s}$ (b) $\frac{2\Delta}{s}$ (c) Δ (d) 2Δ

85. The position vector of the foci of an ellipse are $\vec{b}$ and $-\vec{b}$, and the length of major axis is $2a$. The equation of ellipse is

(a) $a^4 - a^2(\vec{r}^2 + \vec{b}^2) + (\vec{b}\times\vec{r})^2 = 0$

(b) $a^4 - a^2(\vec{r}^2 + \vec{b}^2) + (\vec{b}\cdot\vec{r})^2 = 0$

(c) $a^4 + \vec{a}^2(\vec{r}^2 + \vec{b}^2) + (\vec{b}\cdot\vec{r})^2 = 0$

(d) $a^4 - a^2(\vec{r}^2 - \vec{b}^2) + (\vec{b}\cdot\vec{r})^2 = 0$

86. If the value of $\Delta = \begin{vmatrix} a^n & a^{n+2} & a^{2n} \\ 1 & a^p & p \\ a^{n+5} & a^{p+6} & a^{2n+5} \end{vmatrix} = 0$,

then p equals to

(a) a^n (b) $n+1$

(c) either (a) or (b) (d) both (a) and (b)

87. Let $x^{18} = y^{21} = z^{28}$, then $3, 3\log_y x, 3\log_z y, 7\log_x z$ are in

(a) H.P. (b) A.P.

(c) G.P. (d) None of these

88. The equation of the plane through the line of intersection of planes $ax + by + cz + d = 0$, $a'x + b'y + c'z + d' = 0$ and parallel to the lines $y = 0 = z$ is

(a) $(ab' - a'b)x + (bc' - b'c)y + (ad' - a'd) = 0$

(b) $(ab' - a'b)y + (ac' - a'c)z + (ad' - a'd) = 0$

(c) $(ab' - a'b)x + (bc' - b'c)z + (ad' - a'd) = 0$

(d) None of these.

89. Let $f : R - \{n\} \rightarrow R$ be a function defined by

$f(x) = \frac{x-m}{x-n}$ such that $m \neq n$ then

(a) f is one-one into function

(b) f is one-one onto function

(c) f is many one into function

(d) f is many one onto function

90. If $n(U) = 700$, $n(A) = 200$, $n(B) = 240$, $n(A \cap B) = 100$, then $n(A' \cup B')$ is equal to

(a) 260 (b) 560 (c) 360 (d) 600

91. $\sum_{r=0}^{n-1} \frac{{}^nC_r}{{}^nC_r + {}^nC_{r+1}}$ is equal to

(a) $\frac{n(n+1)}{2}$ (b) $\frac{n+1}{n-1}$

(c) $\frac{n+1}{2}$ (d) $\frac{n}{2}$

92. The minimum value of $x^2 - x + 1 + \sin x$ is given by

(a) $\frac{1}{4}$ (b) $\frac{3}{4}$ (c) $-\frac{1}{4}$ (d) $\frac{7}{4}$

93. The area bounded by two branches of the curve $(y - x)^2 = x^3$ & $x = 1$ equals

(a) $\frac{3}{5}$ (b) $\frac{5}{4}$ (c) $\frac{6}{5}$ (d) $\frac{4}{5}$

94. If $\sin^{-1}x + \cos^{-1}(1-x) = \sin^{-1}(-x)$, then x satisfies the equation

(a) $2x^2 - x + 2 = 0$ (b) $2x^2 - x = 0$

(c) $2x^2 + x - 1 = 0$ (d) $2x^2 - 2x = 3$

95. The ratio of the areas of a triangle formed with vertices $A(at_1^2, 2at_1)$, $B(at_2^2, 2at_2)$ and $C(at_3^2, 2at_3)$ lies on the parabola $y^2 = 4ax$ and triangle formed by the tangents at A, B, C is

(a) 1 : 2 (b) 2 : 1 (c) 2 : 3 (d) 3 : 2

96. Let $P(n) : n^3 + n = 3m$ where m is a positive integer, then which of the following is true ?

(a) $P(1)$ (b) $P(2)$ (c) $P(3)$ (d) $P(4)$

97. Two of the straight lines given by $8x^3 + 8x^2y - 8xy^2 + dy^3 = 0$ are at right angles then 'd' equals

(a) 1 (b) – 8

(c) 8 (d) None of these

98. The value of the expression

$$2^k\binom{n}{0}\binom{n}{k} - 2^{k-1}\binom{n}{1}\binom{n-1}{k-1} - 2^{k-2}\binom{n}{2}\binom{n-2}{k-2} \ldots + (-1)^k\binom{n}{k}\binom{n-k}{0} \text{ is}$$

(a) $\begin{pmatrix} n \\ k \end{pmatrix}$ (b) $\begin{pmatrix} n+1 \\ k \end{pmatrix}$

(c) $\begin{pmatrix} n+1 \\ k+1 \end{pmatrix}$ (d) $\begin{pmatrix} n-1 \\ k-1 \end{pmatrix}$

99. If $\log_3 2$, $\log_3(2^x - 5)$ and $\log_3\left(2^x - \frac{7}{2}\right) \in$ A.P., then x equals
(a) 3 (b) 4 (c) 2 (d) 0

100. In a bag, there are 21 balls marked by numbers 1, 2, 3, ..., 21. Two balls are drawn one by one with replacement. What is the probability that from drawn balls first shows odd number and second shows even number ?
(a) $\frac{55}{441}$ (b) $\frac{110}{441}$ (c) $\frac{10}{441}$ (d) $\frac{121}{441}$

101. The solution of the differential equation
$\frac{dy}{dx} = e^{x-y} + x^2 e^{-y}$ is
(a) $e^x = \frac{y^3}{3} + e^y + c$ (b) $e^y = \frac{x^2}{3} + e^x + c$
(c) $e^y = \frac{x^3}{3} + e^x + c$ (d) None of these

102. If α, β, γ are roots of $x^3 + 4x + 1 = 0$, then $(\alpha + \beta)^{-1} + (\beta + \gamma)^{-1} + (\gamma + \alpha)^{-1}$ equals
(a) 2 (b) 3 (c) 4 (d) 5

103. The value of α for which the lines
$\frac{x-1}{2} = \frac{2y-1}{3} = \frac{1-3z}{\alpha}$ and
$\frac{x+1}{2} = \frac{3y-5}{2} = \frac{z-4}{3}$ are
perpendicular to each other, is
(a) 3 (b) 2 (c) -3 (d) 5

104. Length of intercept made by the circle $x^2 + y^2 - 16x + 4y - 36 = 0$ on x-axis is
(a) 20 (b) 10
(c) 5 (d) None of these

105. The mean deviation of items $x, x + y, x + 2y, ..., x + 2ny$ from mean is
(a) $\frac{n(n+1)y}{2n+1}$ (b) $\frac{(n+1)y}{2n+1}$
(c) $\frac{ny}{2n+1}$ (d) $\frac{(2n+1)y}{n(n+1)}$

PART 4 : BIOLOGY

71. A system of classification, in which a large number of traits are considered, is
(a) Synthetic system
(b) Natural system
(c) Phylogenetic system
(d) Artificial system.

72. In the members of Family Malvaceae, anthers are described as
(a) diadelphous and dithecous
(b) diadelphous and monothecous
(c) monadelphous and dithecous
(d) monadelphous and monothecous.

73. The type of placentation in which ovary is syncarpous, unilocular and ovules on sutures is called
(a) marginal placentation
(b) apical placentation
(c) parietal placentation
(d) superficial placentation.

74. Ground tissue includes
(a) all tissues external to endodermis
(b) all tissues except epidermis and vascular bundles
(c) epidermis and cortex
(d) all tissues internal to endodermis.

75. The casparian strip is found in
(a) endosperm (b) endodermis
(c) pericycle (d) pith.

76. Interfascicular cambium develops from the cells of
(a) endodermis
(b) pericycle
(c) medullary rays
(d) xylem parenchyma.

77. Periderm is produced from
(a) cork cambium (b) pro-cambium
(c) secondary cortex (d) vascular cambium.

78. The change in single base pair
(a) results in new species
(b) always changes the polypeptide chain
(c) may not change the phenotype
(d) always changes the phenotype.

79. Sickle cell anaemia is caused due to the substitution of
(a) valine at the 6th position of beta globin chain by glutamine
(b) valine at the 6th position of alpha globin chain by glutamic acid
(c) glycine at the 6th position of alpha globin chain by glutamic acid
(d) glutamic acid at the 6th position of beta globin chain by valine.

80. Double lines in pedigree analysis show
(a) unaffected offspring
(b) sex unspecified
(c) normal mating
(d) consanguineous marriage.

81. Base composition in RNA is
(a) A + T = G + C (b) A + G = T + C
(c) A + U = G + C (d) A + G = U + C.

82. Okazaki fragments are
(a) large DNA segments having promoter, initiation, coding and terminator regions
(b) short segments of replicated DNA formed from DNA template with polarity $5' \rightarrow 3'$
(c) additional nucleotides added to the ends of RNA
(d) short segments of wrong bases introduced during replication.

83. A transgenic food crop which may help in solving the problem of night blindness in developing countries is
(a) *Bt* soybean
(b) golden rice
(c) flavr savr tomatoes
(d) starlink maize.

84. In crop improvement programmes, virus-free clones can be obtained through
(a) embryo culture
(b) shoot apex culture
(c) grafting
(d) hybridisation.

85. Totipotency of plants was discovered by
(a) Haberlandt (b) Darwin
(c) Lamarck (d) Mendel.

86. In genetic engineering recombinant DNA means
(a) DNA with a piece of foreign DNA
(b) DNA with a piece of RNA
(c) DNA which takes part in recombination
(d) DNA not associated with recombination

87. Cyclic photophosphorylation results in the formation of
(a) ATP and NADPH
(b) ATP, NADPH and O_2
(c) ATP
(d) NADPH.

88. C_4 cycle is found in
(a) fir (b) sugarcane
(c) mango (d) none of these.

89. Oxidative phosphorylation refers to
(a) anaerobic production of ATP
(b) the citric acid cycle production of ATP
(c) production of ATP by chemiosmosis
(d) alcoholic fermentation.

90. The enzyme that converts glucose to glucose 6-phosphate is
(a) phosphatase
(b) phosphorylase
(c) hexokinase
(d) glucose synthetase.

91. A hormone delaying senescence is
(a) auxin (b) cytokinins
(c) ethylene (d) gibberellin.

92. How many molecules of pyruvic acid are formed during glycolysis?
(a) 1 (b) 2 (c) 3 (d) 4.

93. Growth movements in response to light are called
(a) photoperiodism (b) photolysis
(c) photosynthesis (d) phototropism.

94. Parasitic alga is
(a) *Cephaleuros* (b) *Vaucheria*
(c) *Volvox* (d) *Oedogonium*.

95. Pesticides are generally
(a) highly selective (b) selective
(c) non selective (d) none of these.

96. Resin and turpentine are products of
(a) teak (b) oak
(c) Eucalyptus (d) pine.

97. Brunner's glands are found in
(a) mucosa of duodenum
(b) mucosa of ileum
(c) submucosa of duodenum
(d) submucosa of ileum.

98. The volume of air which remains in the conducting airways and is not available for gas exchange is called
(a) vital capacity
(b) functional residual capacity
(c) forced expiratory volume
(d) anatomic dead space.

99. Choose the correctly matched pair.
(a) CAD - Atherosclerosis
(b) Tetany - Disorder of neuromuscular junction
(c) Gout - Rapid spasms in muscles
(d) Goitre - Hyperthyroidism

100. Glucose and amino acids are reabsorbed in the
(a) proximal tubule (b) distal tubule
(c) collecting duct (d) loop of Henle.

101. The human vertebra is
(a) amphicoelous (b) acoelus
(c) proceolous (d) heterocoelous.

102. Which is not a basic renal function ?
(a) Reabsorption (b) Secretion
(c) Perfusion (d) Filtration

103. End plate junction is present between
(a) neuron and striated muscle
(b) neuron and neuron
(c) muscle and muscle
(d) both (b) and (c).

104. An endocrine gland in human, which plays an important role in the regulation of rhythm of the body is
(a) adrenal gland (b) pineal gland
(c) thymus (d) thyroid gland.

105. *cry*II*Ab* and *cry*I*Ab* produce toxins that control:
(a) cotton bollworms and corn borer respectively
(b) corn borer and cotton bollworms respectively
(c) tobacco budworms and nematodes respectively
(d) nematodes and tobacco budworms respectively.

106. Global warming can be controlled by
(a) increasing deforestation, slowing down the growth of human population
(b) increasing deforestation, reducing efficiency of energy usage.
(c) reducing deforestation, cutting down use of fossil fuel.
(d) reducing reforestation, increasing the use of fossil fuel.

107. Which is a connecting link between mammals and reptiles?
(a) *Peripatus* (b) *Balanoglossus*
(c) *Ornithorhyncus* (d) *Archaeopteryx*

108. Biological concept of species is mainly based on
(a) morphology and methods of reproduction
(b) methods of reproduction only
(c) morphological features only
(d) reproductive isolation.

109. Match the types of WBC listed in Column I with the shape of nucleus given under Column II. Choose the answer which gives the correct combination of alphabets of the two columns.

Column I (Types of WBC)	Column II (Shape of nucleus)
i. Neutrophils	p. Kidney-shaped
ii. Eosinophils	q. S-shaped
iii. Basophils	r. 3 to 5 lobes
iv. Monocytes	s. 2 lobes
	t. Disc-shaped

	(i)	(ii)	(iii)	(iv)
(a)	r	t	p	q
(b)	t	r	q	s
(c)	q	p	t	r
(d)	r	s	q	p

110. The segment of antigen that are specifically recognised by individual antibody is known as
(a) memory regions (b) epitopes
(c) non determinants (d) self limitation.

111. Allergens
(a) increase secretions of IgE antibodies and histamines
(b) increase secretion of IgM antibodies and histamines
(c) are non infectious and decrease secretion of IgG antibodies
(d) are infectious and increase secretion of IgE antibodies.

112. What is true about T-lymphocytes in mammals ?
(a) There are three main types – cytotoxic T-cells, helper T-cells and suppressor T-cells.
(b) These originate in lymphoid tissues.
(c) They scavenge damaged cells and cellular debris.
(d) These are produced in thyroid.

113. Match the disease in column I with the appropriate items (pathogen/prevention/treatment) in column II

Column I	**Column II**
(A) Amoebiasis	(i) *Treponema pallidum*
(B) Diphtheria	(ii) Use only sterilised food and water
(C) Cholera	(iii) DPT Vaccine
(D) Syphilis	(iv) Use oral rehydration therapy

(a) A – (ii), B – (i), C – (iii), D – (iv)
(b) A – (ii), B – (iii), C – (iv), D – (i)
(c) A – (i), B – (ii), C – (iii), D – (iv)
(d) A – (ii), B – (iv), C – (i), D – (iii)

114. Prophage refers to
(a) viral genome outside the host-cell
(b) viral genome incorporates & integrates with bacterial genome
(c) viral genome inoculated to bacterial genome
(d) freshly synthesised viral genome within the host cell

115. Identify a micro-organism that can produce biomass of protein.
(a) *Methylophilus methylotrophus*
(b) *Monoscus purpureas*
(c) *Trichoderma polysporum*
(d) *Aspergillus niger*

116. The causative agent of Hansen's disease is
(a) *Mycobacterium tuberculosis*
(b) *Mycobacterium leprae*
(c) *Cornybacterium diphtheriae*
(d) *Clostridium tetani.*

117. Which of the following fish was introduced in India by foreigners?
(a) Pomphret (b) *Mystus singhala*
(c) *Labeo rohita* (d) *Clarius batrachus.*

118. The process of mating of individuals, which are more closely related than the average of the population to which they belong, is called
(a) heterosis (b) self breeding
(c) inbreeding (d) hybridisation.

119. Holstein-Friesian, Brown Swiss and Jersey are all well known
(a) exotic breeds of cow
(b) exotic breeds of goat
(c) exotic breeds of poultry
(d) animal husbandry scientists.

120. The crystal of lead zirconate is a key component of
(a) electroencephalography
(b) electrocardiography
(c) magnetoencephalography
(d) sonography.

ANSWER KEY

PART 1 : PHYSICS

1. (c)	**2.** (d)	**3.** (a)	**4.** (a)	**5.** (a)	**6.** (b)	**7.** (a)	**8.** (a)
9. (b)	**10.** (a)	**11.** (b)	**12.** (d)	**13.** (c)	**14.** (b)	**15.** (c)	**16.** (c)
17. (d)	**18.** (c)	**19.** (a)	**20.** (d)	**21.** (c)	**22.** (b)	**23.** (b)	**24.** (b)
25. (b)	**26.** (d)	**27.** (b)	**28.** (c)	**29.** (b)	**30.** (c)	**31.** (c)	**32.** (a)
33. (b)	**34.** (c)	**35.** (b)					

PART 2 : CHEMISTRY

36. (c)	**37.** (a)	**38.** (b)	**39.** (b)	**40.** (c)	**41.** (c)	**42.** (a)	**43.** (b)
44. (c)	**45.** (d)	**46.** (a)	**47.** (d)	**48.** (b)	**49.** (d)	**50.** (b)	**51.** (b)
52. (c)	**53.** (c)	**54.** (b)	**55.** (c)	**56.** (c)	**57.** (b)	**58.** (a)	**59.** (a)
60. (c)	**61.** (b)	**62.** (d)	**63.** (b)	**64.** (c)	**65.** (d)	**66.** (c)	**67.** (c)
68. (a)	**69.** (d)	**70.** (c)					

PART 3 : MATHEMATICS

71. (c)	**72.** (b)	**73.** (b)	**74.** (a)	**75.** (a)	**76.** (a)	**77.** (b)	**78.** (a)
79. (c)	**80.** (c)	**81.** (c)	**82.** (a)	**83.** (b)	**84.** (b)	**85.** (b)	**86.** (d)
87. (b)	**88.** (b)	**89.** (a)	**90.** (d)	**91.** (d)	**92.** (c)	**93.** (d)	**94.** (b)
95. (b)	**96.** (c)	**97.** (b)	**98.** (a)	**99.** (a)	**100.** (b)	**101.** (c)	**102.** (c)
103. (d)	**104.** (a)	**105.** (a)					

PART 4 : BIOLOGY

71. (b)	**72.** (d)	**73.** (c)	**74.** (b)	**75.** (b)	**76.** (c)	**77.** (a)	**78.** (c)
79. (d)	**80.** (d)	**81.** (d)	**82.** (b)	**83.** (b)	**84.** (b)	**85.** (a)	**86.** (a)
87. (c)	**88.** (b)	**89.** (c)	**90.** (c)	**91.** (b)	**92.** (b)	**93.** (d)	**94.** (a)
95. (c)	**96.** (d)	**97.** (c)	**98.** (d)	**99.** (a)	**100.** (a)	**101.** (b)	**102.** (c)
103. (a)	**104.** (b)	**105.** (a)	**106.** (c)	**107.** (c)	**108.** (d)	**109.** (d)	**110.** (b)
111. (a)	**112.** (a)	**113.** (b)	**114.** (b)	**115.** (a)	**116.** (b)	**117.** (a)	**118.** (c)
119. (a)	**120.** (b)						

explanations

PART 1 : PHYSICS

1. **(c)** : As density $= \dfrac{\text{mass}}{\text{volume}}$

$$\therefore \quad \rho = \frac{M}{\frac{4}{3}\pi R^3} = \frac{3}{4}\frac{M}{\pi R^3}$$

$\therefore$ The percentage error in density is

$$\frac{\Delta\rho}{\rho}\times 100\% = \left(\frac{\Delta M}{M} + 3\frac{\Delta R}{R}\right)\times 100\%$$

$$= 3\% + 3(2\%) = 3\% + 6\% = 9\%$$

2. **(d)** : $F = \dfrac{G m_1 m_2}{r^2}$ or $G = \dfrac{Fr^2}{m_1 m_2}$

$$[G] = \left[\frac{\text{MLT}^{-2}\,\text{L}^2}{\text{M}^2}\right] \text{ or } [G] = [\text{M}^{-1}\text{L}^3\,\text{T}^{-2}]$$

3. **(a)** : Energy stored in a capacitor is $U = \dfrac{1}{2}CV^2$

$\therefore \quad [CV^2] = [U] = [\text{M}^1\text{L}^2\text{T}^{-2}\text{A}^0]$

4. **(a)** : Energy density $= \dfrac{\text{Energy}}{\text{Volume}} = \dfrac{[\text{ML}^2\text{T}^{-2}]}{[\text{L}^3]}$

$= [\text{ML}^{-1}\text{T}^{-2}]$

$$\text{Young's modulus} = \frac{\text{Force}}{\text{Area}} \times \frac{\text{Original length}}{\text{Change in length}}$$

$$= \frac{[\text{MLT}^{-2}][\text{L}]}{[\text{L}^2]\,[\text{L}]} = [\text{ML}^{-1}\text{T}^{-2}]$$

The dimensions of 1 and 4 are the same.

5. **(a)** : Given, $x^2 = t^2 + 1$

Differentiating with respect to t on both sides, we get

$$2x\frac{dx}{dt} = 2t \text{ or } xv = t \quad \left(\because \quad v = \frac{dx}{dt}\right) \quad \text{...(i)}$$

Again differentiating w.r.t. t on both sides, we get

$$x\frac{dv}{dt} + v\frac{dx}{dt} = 1 \text{ or } x\frac{dv}{dt} = 1 - v^2$$

$$\text{or} \quad \frac{dv}{dt} = \frac{1-v^2}{x} = \frac{1-\frac{t^2}{x^2}}{x} = \frac{x^2-t^2}{x^3} \text{ (Using (i))}$$

But $x^2 - t^2 = 1 \quad \therefore \quad \dfrac{dv}{dt} = \dfrac{1}{x^3}$

or Acceleration, $a = \dfrac{dv}{dt} = \dfrac{1}{x^3}$

6. **(b)** : Here, the equation of projectile is

$$y = \sqrt{3}x - \frac{gx^2}{2}$$

Comparing the given equation with

$$y = x\tan\theta - \frac{gx^2}{2v^2\cos^2\theta},$$

we get, $\tan\theta = \sqrt{3} \Rightarrow \theta = \tan^{-1}(\sqrt{3}) = \dfrac{\pi}{3}$

7. **(a)** : Centripetal force, $F = \dfrac{mv^2}{r} \quad \therefore \; v = \sqrt{\dfrac{Fr}{m}}$

8. **(a)** : As $T^2 \propto r^3$ or $T^2 = kr^3$ ...(i)

Differentiating both sides, we get

$2T\Delta T = 3kr^2\,\Delta r$ ...(ii)

Dividing (ii) by (i), we get

$$\frac{2T\Delta T}{T^2} = \frac{3kr^2\Delta r}{kr^3}$$

$$\text{or} \quad \frac{2\Delta T}{T} = \frac{3\Delta r}{r}$$

$$\text{or} \quad \Delta T = \frac{3}{2}T\frac{\Delta r}{r}$$

9. **(b)** : Viscosity of liquids decreases with increase in temperature whereas viscosity of gases increases with increase in temperature.

10. **(a)** : Let the extension of wire be x for an external force F. Then,

$$\text{Stress} = \frac{F}{A} \text{ and strain} = \frac{x}{L}$$

By definition, $Y = \dfrac{\text{stress}}{\text{strain}}$

$$\therefore \quad Y = \frac{F/A}{x/L} = \frac{FL}{xA}$$

Equivalent force constant $= k = \dfrac{F}{x} = \dfrac{YA}{L}$

11. **(b)** : $y_1 = 5\,[\sin 2\pi t + \sqrt{3}\cos 2\pi t]$

$$= 10\left[\frac{1}{2}\sin 2\pi t + \frac{\sqrt{3}}{2}\cos 2\pi t\right]$$

$$= 10\left[\cos\frac{\pi}{3}\sin 2\pi t + \sin\frac{\pi}{3}\cos 2\pi t\right]$$

$$=10\left[\sin\left(2\pi t+\frac{\pi}{3}\right)\right]$$

$\therefore \quad A_1 = 10$

$$y_2 = 5\sin\left(2\pi t+\frac{\pi}{4}\right)$$

$\therefore \quad A_2 = 5,$ Hence, $\dfrac{A_1}{A_2}=\dfrac{10}{5}=\dfrac{2}{1}$

12. **(d) :** Let L be the length of the open pipe. The resonance frequencies of vibration in the open pipe are

$$\upsilon_n = \frac{nv}{2L};\ n = 1, 2, 3, \ldots\ldots..$$

where v is the speed of sound in air.

And the difference between successive frequencies is

$$\Delta\upsilon = \upsilon_{n+1} - \upsilon_n$$

$$= \frac{(n+1)v}{2L} - \frac{nv}{L} = \frac{v}{2L}$$

or $\quad L = \dfrac{v}{2\Delta\upsilon}$

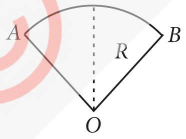
Here, $v = 328\ \text{m s}^{-1}$

$$\Delta\upsilon = 2600\ \text{Hz} - 1944\ \text{Hz} = 656\ \text{Hz}$$

$\therefore \quad L = \dfrac{328\ \text{m s}^{-1}}{2(656\ \text{Hz})} = \dfrac{1}{4}\ \text{m} = 0.25\ \text{m}$

13. **(c) :** The given circuit represents AND gate.

14. **(b) :** Suppose along arc AB, there is a large number of particles.



If arc $AB \to 0$, the position of centre of mass will be at distance R from the origin.

If arc length AB increases, centre of mass of the system starts moving down ($< R$).

15. **(c) :** According to work-energy theorem, $T = fy$

where f is the frictional force exerted on the body.

or $\quad f = \dfrac{T}{y}$

Note : One can also verify that $\dfrac{T}{y}$ has the dimensions of force.

i.e. $\quad \dfrac{[\text{T}]}{[y]} = \dfrac{[\text{ML}^2\text{T}^{-2}]}{[\text{L}]} = [\text{MLT}^{-2}]$

16. **(c) :** Here, $\gamma = \frac{7}{5}, P_1 = P, \rho_1 = \rho, P_2 = P', \rho_2 = \rho'$

For an adiabatic process, PV^γ = constant

$$\therefore \quad P_1V_1^\gamma = P_2V_2^\gamma \quad \text{or} \quad \frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^\gamma$$

But $V \propto \dfrac{1}{\rho}$ (for a given mass)

$$\therefore \quad \frac{P_2}{P_1} = \left(\frac{\rho_2}{\rho_1}\right)^\gamma \quad \text{or} \quad \frac{P'}{P} = \left(\frac{\rho'}{\rho}\right)^{7/5} = (32)^{7/5}$$

or $\quad \dfrac{P'}{P} = (2^5)^{7/5} = 2^7 = 128$

17. **(d) :** As $v_{\text{rms}} = \sqrt{\dfrac{3RT}{M}}$

or $\quad v_{\text{rms}} \propto \dfrac{1}{\sqrt{M}}$ (At a given temperature T)

$$\therefore \quad \frac{(v_{\text{rms}})_{O_3}}{(v_{\text{rms}})_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{O_3}}} = \sqrt{\frac{32}{48}} = \sqrt{\frac{2}{3}}$$

18. **(c) :** Given : $V = KT^{2/3}$ ...(i)

Differentiating both sides, we get

$\Delta V = \dfrac{2}{3}KT^{-1/3}\Delta T$ (As K is a constant) ...(ii)

According to ideal gas equation for 1 mole

$$PV = RT$$

or $\quad P = \dfrac{RT}{V}$ ...(iii)

Work done by the gas is

$$W = P\Delta V$$

$= \dfrac{RT}{V}\dfrac{2}{3}KT^{-1/3}\Delta T$ (Using (ii) and (iii))

$$= \frac{2}{3}\frac{RKT^{2/3}}{V}\Delta T$$

$= \dfrac{2}{3}\dfrac{RKT^{2/3}}{KT^{2/3}}\Delta T$ (Using (i))

$$= \frac{2}{3}R\Delta T = \frac{2}{3}\times R\times 40 = 26.6R$$

19. **(a) :** Here, $V_1 = 5.6$ litre, $V_2 = 0.7$ litre, $W = ?$

Helium is a monatomic gas,

$\therefore \quad \gamma = \dfrac{5}{3}$

For an adiabatic process, $TV^{\gamma-1}$ = Constant

$$\therefore \quad T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1} \quad \text{or} \quad T_2 = T_1\left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

or $\quad T_2 = T_1\left(\frac{5.6}{0.7}\right)^{\left(\frac{5}{3}-1\right)} = T_1(8)^{2/3} = 4T_1$

No. of moles of helium, $n = \frac{5.6 \text{ litre}}{22.4 \text{ litre}} = \frac{1}{4}$

Work done during an adiabatic process is

$$W = \frac{nR(T_1 - T_2)}{(\gamma - 1)} = \frac{\frac{1}{4}R(T_1 - 4T_1)}{\left(\frac{5}{3}-1\right)} = -\frac{9}{8}RT_1$$

Here (–ve) sign shows that work is done on the gas.

20. **(d) :** Average kinetic energy = $\frac{3}{2}k_BT$

$= \frac{3}{2}(1.38\times10^{-23})(300)$

$= 6.21 \times 10^{-21}$ J

21. **(c) :** As the image is real and size of image is n times the size of object,

$\therefore$ Magnification, $m = -\frac{v}{u} = -n$

or $\quad v = un$

According to mirror formula

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

$$\therefore \quad \frac{1}{un} + \frac{1}{u} = \frac{1}{f}$$

or $\quad \frac{1+n}{nu} = \frac{1}{f}$ or $\frac{nu}{1+n} = f$

or $\quad u = \frac{(n+1)f}{n}$

22. **(b) :** As beam of light is incident normally on the face AB of the right angled prism ABC, so no refraction occurs at face AB and it passes straight and strikes the face AC at an angle of incidence $i = 45°$.

For total reflection to take place at face AC,

$i > C$ or $\sin i > \sin C$

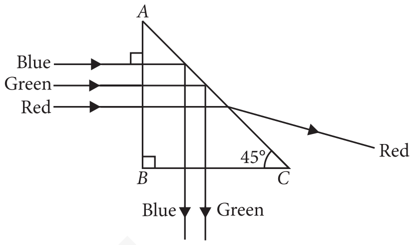
where C is the critical angle.

But as here $i = 45°$ and $\sin C = \frac{1}{\mu}$

$\therefore \quad \sin 45° > \frac{1}{\mu}$ or $\frac{1}{\sqrt{2}} > \frac{1}{\mu}$

or $\quad \mu > \sqrt{2} = 1.414$

As $\mu_{red} (= 1.39) < \mu (= 1.414)$ while $\mu_{green} (= 1.44)$ and $\mu_{blue} (= 1.47) > \mu$ (= 1.414), so only red colour will be transmitted through face AC while green and blue colours will suffer total internal reflection. So the prism will separate red colour from the green and blue colours as shown in the following figure.



23. **(b) :** Here, $a = 2$ mm $= 2 \times 10^{-3}$ m

$\lambda = 500$ nm $= 500 \times 10^{-9}$ m $= 5 \times 10^{-7}$ m

$D = 1$ m

The distance between the first minima on either side on a screen is

$$\Delta x = \frac{2\lambda D}{a} = \frac{2\times5\times10^{-7}\times1}{2\times10^{-3}} = 5 \times 10^{-4} \text{ m}$$

$= 0.5 \times 10^{-3}$ m $= 0.5$ mm

24. **(b)**

25. **(b) :** For balanced Wheatstone's bridge

$$\frac{P}{Q} = \frac{R}{S} \qquad \text{...(i)}$$

Power dissipation P in resistance R with voltage V is V^2/R.

$$\therefore \quad \frac{P_{(P+Q)}}{P_{(R+S)}} = \frac{R+S}{P+Q} \qquad \text{...(ii)}$$

From eqn. (i),

$$\frac{P}{Q} + 1 = \frac{R}{S} + 1$$

or $\quad \frac{P+Q}{Q} = \frac{R+S}{S}$ or $\frac{R+S}{P+Q} = \frac{S}{Q}$

Using (i), we get

$$\frac{R+S}{P+Q} = \frac{R}{P}$$

$$\therefore \quad \frac{P_{(P+Q)}}{P_{(R+S)}} = \frac{R}{P}$$

26. **(d) :** The required torque is

$\tau = NIAB\sin\theta$

Here, $N = 50$, $I = 2$ A, $A = 0.12$ m × 0.1 m $= 0.012$ m^2

$B = 0.2$ Wb m^{-2} and $\theta = 90° - 30° = 60°$

$\therefore \quad \tau = (50)(2\text{ A})(0.012\text{ m}^2)(0.2\text{ Wb m}^{-2})\sin60°$

$= 0.20$ N m

27. **(b) :** As magnetic flux, $\phi = (5t^2 - 4t + 1)$ Wb

$$\therefore \quad \frac{d\phi}{dt} = 10t - 4 \ \text{Wb s}^{-1}$$

The induced emf is

$$\varepsilon = -\frac{d\phi}{dt} = -(10t - 4)$$

At $t = 0.2$ s,

$$\varepsilon = -(10 \times 0.2 - 4) = 2 \text{ V}$$

The induced current is

$$I = \frac{\varepsilon}{R} = \frac{2 \text{ V}}{10 \, \Omega} = 0.2 \text{ A}$$

28. **(c) :** Magnetic flux, $\phi = BA\cos\theta$

where θ is the angle between normal to the plane of the coil and magnetic field.

Induced emf, $\varepsilon = BA\sin\theta$

Here, $\theta = 0°$

$\therefore$ Magnetic flux is maximum and induced emf is zero.

29. **(b) :** According to Einstein's photoelectric equation the maximum kinetic energy of electrons emitted from a photosensitive material is

$$K_{\text{max}} = h\upsilon - \phi_0$$

where h is Planck's constant, υ is the frequency of light and ϕ_0 is the work function of the material.

$$\therefore \quad h\upsilon = K_{\text{max}} + \phi_0$$

If υ_1, υ_2 and υ_3 are the required frequencies of light, then as per question

$$h\upsilon_1 = 1 \text{ eV} + 1 \text{ eV} = 2 \text{ eV}$$

$$h\upsilon_2 = 1 \text{ eV} + 2 \text{ eV} = 3 \text{ eV}$$

and $h\upsilon_3 = 1 \text{ eV} + 3 \text{ eV} = 4 \text{ eV}$

So the ratio of $\upsilon_1 : \upsilon_2 : \upsilon_3 = 2 : 3 : 4$

30. **(c) :** Energy of the photon,

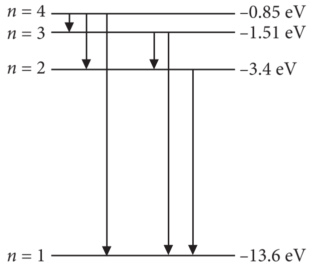
$$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{975 \times 10^{-10}} \text{ J}$$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{975 \times 10^{-10} \times 1.6 \times 10^{-19}} \text{ eV} = 12.75 \text{ eV}$$

After absorbing a photon of energy 12.75 eV, the electron will reach to third excited state of energy –0.85 eV, since energy difference corresponding to $n = 1$ and $n = 4$ is 12.75 eV.

$\therefore$ Number of spectral lines emitted

$$= \frac{(n)(n-1)}{2} = \frac{(4)(4-1)}{2} = 6$$



31. **(c) :** de Broglie wavelength of a charged particle of charge q, mass m being accelerated through potential difference V is

$$\lambda = \frac{h}{\sqrt{2mqV}}$$

$$\therefore \quad \lambda_p = \frac{h}{\sqrt{2m_p q_p V_p}} \text{ and } \lambda_\alpha = \frac{h}{\sqrt{2m_\alpha q_\alpha V_\alpha}}$$

Thus, $\dfrac{\lambda_p}{\lambda_\alpha} = \sqrt{\dfrac{m_\alpha q_\alpha V_\alpha}{m_p q_p V_p}}$

Here, $\dfrac{m_\alpha}{m_p} = 4$, $\dfrac{q_\alpha}{q_p} = 2$, $\dfrac{V_\alpha}{V_p} = 1$

$$\therefore \quad \frac{\lambda_p}{\lambda_\alpha} = \sqrt{4 \times 2 \times 1} = \sqrt{8} = 2\sqrt{2}$$

32. **(a) :** The fraction of nuclei which remain undecayed after time t is

$$f = \frac{N}{N_0} = \frac{N_0 e^{-\lambda t}}{N_0} = e^{-\lambda t} = e^{-\frac{\ln 2}{T_{1/2}}t} \quad \left(\because \lambda = \frac{\ln 2}{T_{1/2}}\right)$$

At $t = \dfrac{T_{1/2}}{2}$

$$f = e^{-\left(\frac{\ln 2}{T_{1/2}}\right)\left(\frac{T_{1/2}}{2}\right)} = e^{-\frac{\ln 2}{2}} = e^{-\ln\sqrt{2}}$$

$$= \frac{1}{e^{\ln\sqrt{2}}} = \frac{1}{\sqrt{2}}$$

33. **(b) :** In a photodiode, the photoelectromotive force is produced by photo-voltaic action *i.e.* a potential difference is created between two points whose magnitude depends upon the intensity of incident light.

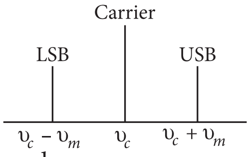
34. **(c) :** Here, $r_i = 10 \, \Omega$, $R_L = 1500 \, \Omega$

Efficiency of the full wave rectifier is

$$\eta = \frac{P_{\text{dc}}}{P_{\text{ac}}} = \frac{(2I_m/\pi)^2 R_L}{(I_m/\sqrt{2})^2 (r_f + R_L)}$$

$$= \frac{0.812 \, R_L}{r_f + R_L} = \frac{0.812 \times 1500}{10 + 1500} = 0.806 = 80.6\%$$

35. (b) : The frequency spectrum of an amplitude modulated wave is shown in the figure. The gap between the frequency of the side bands (*i.e.* upper side band and lower side band) is called bandwidth and it is given by



Bandwidth = $\upsilon_{USB} - \upsilon_{LSB}$

$= (\upsilon_c + \upsilon_m) - (\upsilon_c - \upsilon_m) = \upsilon_c + \upsilon_m - \upsilon_c + \upsilon_m = 2\upsilon_m$

i.e., Bandwidth = Twice of the frequency of the message signal.

PART 2 : CHEMISTRY

36. (c) : Under alkaline conditions of the reagent, fructose gets converted into a mixture of glucose and mannose (Lobry de Bruyn - van Ekenstein rearrangement) both of which contain the –CHO group and hence reduce Tollen's reagent to give silver mirror test.

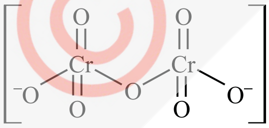
37. (a) : In a period, the nature of oxide varies from basic to acidic and in a group, basic nature increases or acidic nature decreases.

$Na_2O \Rightarrow$ Strongly basic
$Cl_2O_7 \Rightarrow$ Strongly acidic
$N_2O \Rightarrow$ Neutral oxide
$As_2O_3 \Rightarrow$ Slightly basic

Thus, acidic character

$Na_2O < As_2O_3 < N_2O < Cl_2O_7$.

38. (b) : The structure of $Cr_2O_7^{2-}$ is



In it all the six normal Cr—O bonds are equivalent and two bridged Cr—O bonds are equivalent. The normal Cr—O bonds (161 pm) are different from bridged Cr—O bonds (180 pm).

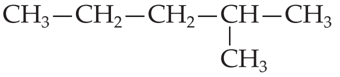
39. (b) : Electronic configuration of H_2^+ is $\sigma 1s^1$

Bond order = 1/2(1 – 0) = 1/2.

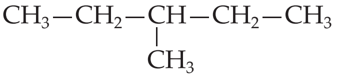
40. (c) : Molecular weight 86 represents C_6H_{14}.

Isomers possible of C_6H_{14} are :

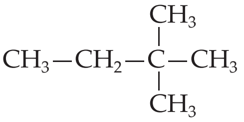
$CH_2—CH_2—CH_2—CH_2—CH_2—CH_3$ *n*-hexane



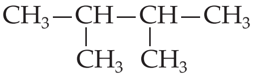
$CH_3—CH_2—CH_2—\underset{\underset{CH_3}{|}}{CH}—CH_3$ 2-methyl pentane



$CH_3—CH_2—\underset{\underset{CH_3}{|}}{CH}—CH_2—CH_3$ 3-methyl pentane

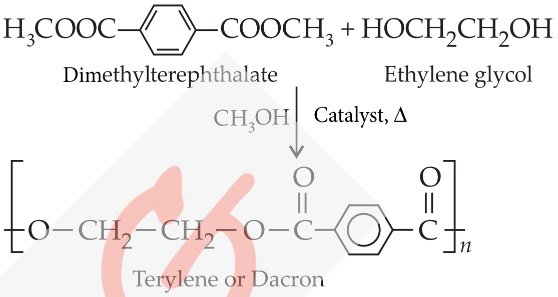


$CH_3—CH_2—\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}—CH_3$ 2,2-dimethyl butane



$CH_3—\underset{\underset{CH_3}{|}}{CH}—\underset{\underset{CH_3}{|}}{CH}—CH_3$ 2,3-dimethyl butane

41. (c) : Terylene is an example of condensation polymer formed by the condensation of dimethylterephthalate and ethylene glycol.



42. (a) : $BaCl_2 + 2AgNO_3 \longrightarrow 2AgCl + Ba(NO_3)_2$
1 g 1.38 g

All chlorine atoms are recovered as AgCl hence number of moles of chlorine on both sides must be equal.

2 × number of moles of $BaCl_2$
= 1 × number of moles of AgCl

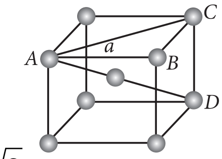
$$2 \times \frac{1}{(x + 35.5 \times 2)} = 1 \times \frac{1.38}{(108 + 35.5)}$$

(Say atomic mass of Ba = x)

$x \approx 137$

43. (b) : $\rangle C{=}O \xrightarrow{\text{Wolff-Kishner reduction}} \rangle CH_2$

44. (c) : Distance between nearest neighbours,



$$d = \frac{AD}{2}$$

In right angled ΔABC,

$AC^2 = AB^2 + BC^2$

$AC^2 = a^2 + a^2$ or $AC = \sqrt{2}a$

Now in right angled ΔADC,

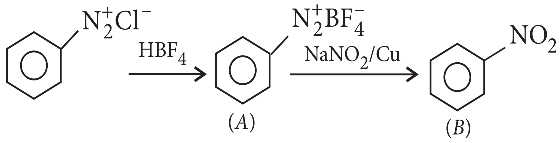
$AD^2 = AC^2 + DC^2$

$$AD^2 = (\sqrt{2}a)^2 + a^2 = 3a^2 \Rightarrow AD = \sqrt{3}a$$

$$\therefore \quad d = \frac{\sqrt{3}a}{2}$$

$$\text{Radius, } r = \frac{d}{2} = \frac{\sqrt{3}}{4}a$$

45. (d) :



46. (a) : $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

At equilibrium $(n - 0.5n)$ $(3n - 1.5n)$ n

Total no. of moles $= n - 0.5n + 3n - 1.5n + n = 3n$

$$x_{N_2} = \frac{0.5n}{3n} = \frac{1}{6},\ x_{H_2} = \frac{1.5n}{3n} = \frac{1}{2},\ x_{NH_3} = \frac{n}{3n} = \frac{1}{3}$$

$$K_p = \frac{(p_{NH_3})^2}{(p_{N_2})(p_{H_2})^3} = \frac{\left(\frac{1}{3}\cdot P\right)^2}{\left(\frac{1}{6}P\right)\cdot\left(\frac{1}{2}P\right)^3}$$

$$= \frac{1}{9} \times 6 \times 8P^{-2} = \frac{16}{3P^2}$$

47. (d) : In an emulsion both adsorbate phase and adsorption medium are liquid.

	Adsorbate phase	**Medium**
Butter	Water	Oil (Milk fat)
Ice-cream	Oil	Water
Milk	Oil	Water
Cloud	Solid	Gas

So, cloud is the only one which is not an example of emulsion.

48. (b) : The reactions given are summerized as:

$$\underset{\text{excess}}{X + H_2O} \longrightarrow 2Y + \underset{\text{readily combustible gas}}{\text{Solution }(Z)}$$

$$\text{Solution }(Z) + CO_2 \longrightarrow \text{White turbidity}$$

$$\underset{X}{CaH_2} + 2H_2O \longrightarrow Ca(OH)_2 + \underset{\text{Combustible gas}}{2H_2}$$

$$Ca(OH)_2 + CO_2 \longrightarrow \underset{\text{White turbidity}}{CaCO_3 + H_2O}$$

49. (d) : Neutral ferric chloride gives characteristic colouration with phenol while alcohol remains unaffected. The colour is due to the formation of a complex as shown below :

$$C_6H_5OH + Fe^{3+} \underset{\substack{\text{(Neutral}\\ \text{medium)}}}{\rightarrow} \underset{\substack{\text{Coloured}\\ \text{complex}\\ \text{(violet)}}}{[Fe(OC_6H_5)_6]^{3-}} + 6H^+$$

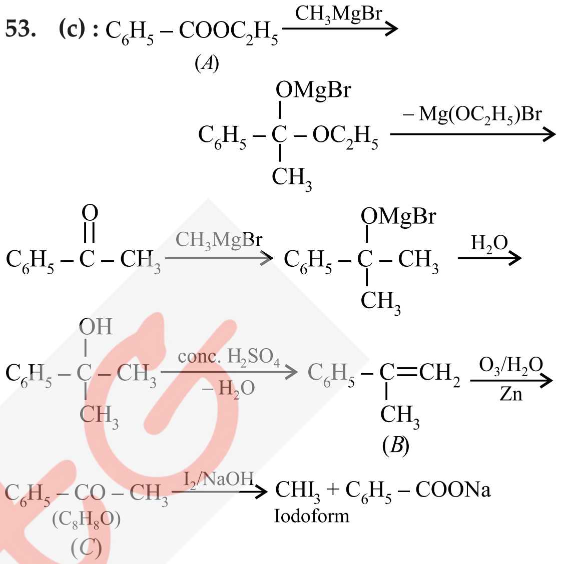
50. (b) : Group-11 elements (Cu, Ag, Au) are called coinage metals and have general electronic configuration $(n - 1)d^{10}ns^1$.

51. (b) : $(CH_3)_4N^+$ has no electron pair available for donation to act as nucleophile. Valence shell of nitrogen is completely filled and has no scope for acceptance of extra electrons to act as electrophile.

52. (c) : $\pi = iCRT$

For $BaCl_2$, i is maximum, $i = 3$ hence possesses highest osmotic pressure.

53. (c) :



$$\underset{(A)}{C_6H_5-COOC_2H_5} \xrightarrow{CH_3MgBr} C_6H_5-\overset{\overset{\large OMgBr}{|}}{\underset{\underset{\large CH_3}{|}}{C}}-OC_2H_5 \xrightarrow{-Mg(OC_2H_5)Br}$$

$$C_6H_5-\overset{\overset{\large O}{||}}{C}-CH_3 \xrightarrow{CH_3MgBr} C_6H_5-\overset{\overset{\large OMgBr}{|}}{\underset{\underset{\large CH_3}{|}}{C}}-CH_3 \xrightarrow{H_2O}$$

$$C_6H_5-\overset{\overset{\large OH}{|}}{\underset{\underset{\large CH_3}{|}}{C}}-CH_3 \xrightarrow[-H_2O]{\text{conc. }H_2SO_4} \underset{(B)}{C_6H_5-\underset{\underset{\large CH_3}{|}}{C}=CH_2} \xrightarrow[Zn]{O_3/H_2O}$$

$$\underset{\substack{(C_8H_8O)\\(C)}}{C_6H_5-CO-CH_3} \xrightarrow{I_2/NaOH} \underset{\text{Iodoform}}{CHI_3} + C_6H_5-COONa$$

54. (b) : As P and V remains constant, $n_1T_1 = n_2T_2$

$$n_1 = \frac{0.4}{4} = 0.1,\ T_1 = T\text{ K};\ n_2 = \frac{0.40 - 0.08}{4} = 0.08$$

$T_2 = (T + 50)$ K.

On putting the values,

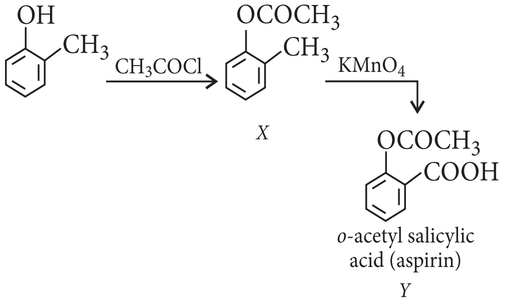
$0.1 \times T = 0.08 \times (T + 50)$

$\Rightarrow$ $0.1T = 0.08T + 4$ $\Rightarrow$ $0.1T - 0.08T = 4$

$\Rightarrow$ $0.02T = 4$ $\Rightarrow$ $T = 200$ K

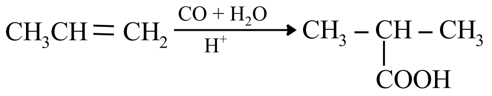
55. (c) : For first order, partial pressure or conc. of the reactant decreases exponentially with time.

56. (c) :



The product, aspirin is a medicine, used as analgesic and antipyretics. It is used in arthritis and is an antirheumatic.

57. (b) :



$$CH_3CH{=}CH_2 \xrightarrow[H^+]{CO + H_2O} CH_3-\underset{\displaystyle COOH}{\underset{|}{CH}}-CH_3$$

Koch reaction

58. (a) : The uncertainty in the speed is 2%, *i.e.*,

$$45\times\frac{2}{100} = 0.9 \text{ m s}^{-1}$$

Using the equation, $\Delta v = \frac{h}{4\pi m\Delta v}$

$$= \frac{6.626\times10^{-34}\text{ J s}}{4\times3.14\times40\times10^{-3}\text{ kg }(0.9\text{ m s}^{-1})}$$

$= 1.46 \times 10^{-33}$ m

This is nearly ~ 10^{18} times smaller than the diameter of a typical atomic nucleus. For large particles, the uncertainty principle sets no meaningful limit to the precision of measurements.

59. (a) : The cell can be written as

$Mg\,|\,Mg^{2+}(0.01\text{ M})\,||\,Zn^{2+}(0.1\text{ M})\,|\,Zn$

$$E_{cell} = E°_{cell} - \frac{0.059V}{2}\log_{10}\frac{[Mg^{2+}]}{[Zn^{2+}]}$$

$$= 1.61V - \frac{0.059V}{2}\log_{10}\frac{0.01}{0.1}$$

$= 1.61V + 0.0295$ V $= 1.6395$ V

60. (c) : $^{232}_{92}X \to {}^{220}_{89}Y \to m\,{}^4_2\alpha + n\,{}^{0}_{-1}\beta$

$\Rightarrow\quad 232 = 220 + 4m \;\Rightarrow\; m = 3;\ 92 = 89 + 2m - n$

$\Rightarrow\quad n = 89 + 6 - 92 = 3$

Hence 3α and 3β particles are ejected.

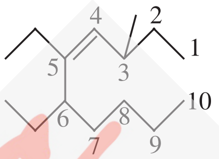
61. (b) : In an octahedral crystal field, t_{2g} orbitals are lowered in energy by 0.4 Δ_o.

62. (d) : Ordinary glucose is α-glucose, with a fresh aqueous solution has specific rotation, [α]D = +110°. On keeping the solution for sometimes, α-glucose slowly changes into an equilibrium mixture of α-glucose (36%) and β-glucose(64%) and the mixture has specific roation + 52.5°.

63. (b) : Dipole-dipole interactions occur among the polar molecules. Polar molecules have permanent dipoles. The positive pole of one molecule is thus attracted by the negative pole of the other molecule. The magnitude of dipole-dipole forces in different polar molecules is predicted on the basis of the polarity of the molecules, which in turn depends upon the electronegativities of the atoms present in the molecule and the geometry of the molecule (in case of polyatomic molecules, containing more than two atoms in a molecule).

Molecules	**Interaction**
Benzene and ethanol	dispersion force
Acetonitrile and acetone	dipole-dipole
KCl and water	ion-dipole
benzene and CCl_4	dispersion force

64. (c) :



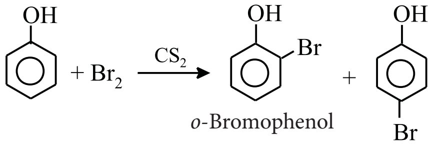
5, 6-diethyl-3-methyldec-4-ene

65. (d) : Diethyl ether can be prepared by heating alkyl halide with sodium or potassium ethoxide. This method of preparation of ether is called "Williamson's synthesis".

$$C_2H_5ONa + C_2H_5I \to C_2H_5OC_2H_5 + NaI$$

Sodium ethoxide   Diethyl ether

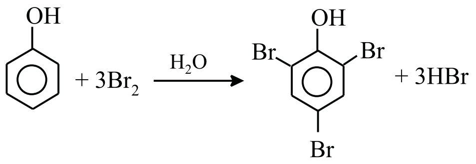
66. (c) : Phenol reacts with bromine in CS_2 (or $CHCl_3$) at low temperature to form a mixture of *ortho* and *para* bromophenols.



o-Bromophenol

p-Bromophenol

Phenol forms a white precipitate with excess of bromine water yielding 2,4,6-tribromophenol.



2,4,6-Tribromophenol

67. (c) : Hess's law is based on the law of conservation of energy.

68. (a) : $C_4H_{11}N \xrightarrow{HNO_2} 3°$ alcohol

Thus, $C_4H_{11}N$ has $-NH_2$ group and, it is 1° amine. Since product is 3° alcohol, hence $C_4H_{11}N$ is 3° butyl amine.

69. **(d) :** Kjeldahl's method for estimation of nitrogen fails for compound containing nitrogen in the ring (pyridine) and compounds containing nitrogen directly linked to oxygen atom (nitro compounds) or another nitrogen atom (azo compounds).

70. **(c) :** In both DNA and RNA, heterocyclic base and phosphate ester linkages are at C_1 and C_5 respectively of the sugar molecule.

PART 3 : MATHEMATICS

71. **(c) :** Given, $\sum_{i=1}^{25} a_i = a_1 + a_2 + a_3 + \ldots + a_{25}$

$$= \frac{25}{2}(a_1 + a_{25})$$

$$\Rightarrow \quad 625 = \frac{25}{2}(a_1 + a_{25})$$

$$\therefore \quad a_1 + a_{25 = 50}$$

Now, $2(a_1 + a_2 + \ldots + a_{12}) + a_{13} = 625$

or $\quad 2 \times 6 \times 50 + a_{13} = 625$ or $a_{13} = 25$

$$\therefore \quad \sum_{j=1}^{13} a_{2j-1} = a_1 + a_3 + a_5 + \ldots + a_{25}$$

$$= 6(a_1 + a_{25}) + a_{13} = 6 \times 50 + 25 = 325$$

72. **(b) :** Given equation is $(y-1)^3 = -27$

$$\Rightarrow \left(\frac{y-1}{-3}\right)^3 = 1$$

$$\Rightarrow \frac{y-1}{-3} = (1)^{1/3} \Rightarrow \frac{y-1}{-3} = 1, \omega, \omega^2$$

As a, b, c are roots. So, $a - 1 = -3$, $b - 1 = -3\omega$, $c - 1 = -3\omega^2$

$$\therefore \frac{a-1}{b-1} + \frac{b-1}{c-1} + \frac{c-1}{a-1} = \frac{1}{\omega} + \frac{1}{\omega} + \frac{\omega^2}{1}$$

$$= \omega^2 + \omega^2 + \omega^2 = 3\omega^2$$

73. **(b) :** $\int_0^1 \frac{1 \cdot dt}{e^t + e^{-t}} = \int_0^1 \frac{e^t\, dt}{1 + e^{2t}}$

$$\left\{\begin{array}{l}\text{Put } e^t = z \Rightarrow e^t dt = dz \\ \text{when } t = 0, z = 1 \\ t = 1, z = e\end{array}\right.$$

$$= \left(\tan^{-1} z\right)_1^e$$

$$= \tan^{-1} e - \tan^{-1} 1 = \tan^{-1}\left(\frac{e-1}{1+e}\right)$$

74. **(a) :** Given equation is $x\cos\theta + y\sin\theta + g\cos\theta + f\sin\theta - k = 0$, this line will touch the circle if perpendicular distance from $(-g, -f)$ to the line will be equal to the radius of circle $d = \sqrt{g^2 + f^2 - c}$

$$\Rightarrow \sqrt{g^2 + f^2 - c}$$

$$= \frac{|-g\cos\theta - f\sin\theta + g\cos\theta + f\sin\theta - k|}{\sqrt{\sin^2\theta + \cos^2\theta}}$$

$$\Rightarrow \quad g^2 + f^2 - c = k^2 \Rightarrow g^2 + f^2 = k^2 + c$$

75. **(a) :** $AX = B \Rightarrow X = A^{-1} B$

$$\Rightarrow \quad X = \frac{1}{|A|}(\text{adj } A)(B)$$

For infinitely many solutions

$|A| = 0$ and $(\text{adj } A)(B) = 0$

76. **(a) :** Given, $R = \{(9, 8), (1, 9), (9, 6), (7, 6), (2, 7)\}$

$\therefore R^{-1} = \{(8, 9), (9, 1), (6, 9), (6, 7), (7, 2)\}$

$\therefore R^{-1} oR = \{(9, 9), (1, 1), (9, 7), (7, 9), (7, 7), (2, 2)\}$

77. **(b) :** Let there are n teams

Each team played with every other team = ${}^nC_2$

$\Rightarrow \quad {}^nC_2 = 153 \qquad$ (given)

$$\Rightarrow \quad \frac{n!}{(n-2)!2!} = 153$$

$\Rightarrow \quad n(n-1) = 306 \quad \Rightarrow \quad n^2 - n - 306 = 0$

$\Rightarrow \quad (n-18)(n+17) = 0$

$\Rightarrow \quad n = 18 \quad$ (n is never negative)

78. **(a) :** As lines are concurrent

$$\therefore \quad \begin{vmatrix} 2 & 1 & -1 \\ a & 3 & -3 \\ 3 & 2 & -2 \end{vmatrix} = 0$$

which is true in all conditions as $C_2 \sim C_3$ so 'a' can assume any real value.

79. **(c) :** (i) As $f(x) = y = x^2 + 2(a+3)x - 2a - 6 > 0$ $\forall x \in R$

(ii) $f(x) > 0$, coefficient of x^2 is $1 > 0$

(iii) $D < 0$

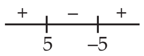
$\therefore \quad 4(a+3)^2 - 4(-2a - 6) < 0$

$\Rightarrow \quad (a+3)^2 + 2a + 6 < 0$

$\Rightarrow \quad a^2 + 8a + 15 < 0$

$\Rightarrow \quad (a+3)(a+5) < 0$

$\Rightarrow \quad -5 < a < -3$



Now, $n(S)$ = length of interval, as $n \in [-10, 0]$

$= 0 - (-10) = 10 \therefore n(S) = 10$

$n(A)$ = length of interval, when $-5 < a < -3$

$= -3 - (-5) = 2$

$$\therefore \quad \text{Required probability} = \frac{n(A)}{n(S)} = \frac{2}{10} = \frac{1}{5}$$

80. **(c) :** Since α, β are roots of $x^2 - 15x + 1 = 0$

$\therefore \quad \alpha + \beta = 15, \alpha\beta = 1 \qquad$ ...(i)

$$\text{Now, } \left(\frac{1}{\alpha} - 15\right)^{-2} + \left(\frac{1}{\beta} - 15\right)^{-2}$$

$= (\beta - 15)^{-2} + (\alpha - 15)^{-2}$ (From (i))

$= (-\alpha)^{-2} + (-\beta)^{-2}$

(From (i))

$$= \left(\frac{1}{-\alpha}\right)^2 + \left(-\frac{1}{\beta}\right)^2 = \frac{1}{\alpha^2} + \frac{1}{\beta^2}$$

$= (\alpha + \beta)^2 - 2\alpha\beta$ $(\because \alpha\beta = 1)$

$= 225 - 2 = 223.$

81. **(c) :** $\sum_{m=0}^{100} {}^{100}C_m (x-3)^{100-m} 2^m$

$= [(x-3)+2]^{100}$

$= (x-1)^{100} = (1-x)^{100}$

Now, $T_{r+1} = {}^{100}C_r(-x)^r$ ...(A)

$\therefore$ For coefficient of x^{53}, putting $r = 53$ in (A), we get

Coefficient of x^{53} is $= {}^{100}C_{53}(-1)^{53} = -{}^{100}C_{53}$

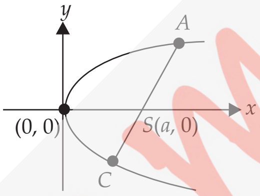
82. **(a) :** Semi-latus rectum of a parabola is the harmonic mean between the segment of any focal chord of a parabola.

Now, $\dfrac{1}{a} = \dfrac{1}{AS} + \dfrac{1}{SC}$

$\Rightarrow \quad \dfrac{1}{a} = \dfrac{SC + AS}{AS \cdot SC}$

$\Rightarrow \quad a = \dfrac{AS \cdot SC}{AS + SC}$

$\Rightarrow \quad a = \dfrac{5 \times 9}{5 + 9} = \dfrac{45}{14}$



$\therefore$ Length of latus rectum, $4a = \dfrac{90}{7}$

83. **(b) :** Given equation is $\dfrac{d^2y}{dx^2} + 4\dfrac{dy}{dx} + 13y = 0$

Put $\dfrac{d}{dx} = D$, we get

$(D^2 + 4D + 13)y = 0$

$\Rightarrow \quad D^2 + 4D + 13 = 0$ ...(*)

Roots of (*) are $D = -2 \pm 3i$

$\therefore$ Required solution is

$y = e^{-2x}(A \cos 3x + B \sin 3x)$

84. **(b) :** We have, $(a + b - c)\tan\left(\dfrac{C}{2}\right)$

$$= (a + b + c - 2c)\sqrt{\frac{(s-a)(s-b)}{s(s-c)}}$$

$$= (2s - 2c)\sqrt{\frac{s(s-a)(s-b)(s-c)}{s^2(s-c)^2}}$$

$$= \frac{2(s-c)\Delta}{(s-c)s} = \frac{2\Delta}{s}$$

85. **(b) :** Since $|\vec{r} + \vec{b}| + |\vec{r} - \vec{b}| = 2a$

$\Rightarrow \quad |\vec{r} + \vec{b}|^2 = \{2a - |\vec{r} - \vec{b}|\}^2$

$\Rightarrow \quad a^2 - \vec{r} \cdot \vec{b} = a|\vec{r} - \vec{b}|$

On squaring, we get

$a^4 - a^2(\vec{r}^2 + \vec{b}^2) + (\vec{r} \cdot \vec{b})^2 = 0$

86. **(d) :** Here C_1 and C_3 becomes equal for $p = a^n$ and R_1, R_3 becomes equal for $p = n + 1$

87. **(b) :** Let $x^{18} = y^{21} = z^{28} = k$

$\therefore \quad 18 \log x = 21 \log y = 28 \log z = \log k.$

$\therefore \quad \log x = \dfrac{\log k}{18} = \dfrac{p}{18}$, where $p = \log k$

$\log y = \dfrac{\log k}{21} = \dfrac{p}{21}$

$\log z = \dfrac{\log k}{28} = \dfrac{p}{28}$

Now $3, 3\log_y x, 3\log_z y, 7\log_x z$

or $\quad 3, \dfrac{3\log x}{\log y}, \dfrac{3\log y}{\log z}, \dfrac{7\log z}{\log x}$

or $\quad 3, \dfrac{3 \times 21}{18}, \dfrac{3 \times 28}{21}, \dfrac{7 \times 18}{28}$

or $\quad 3, \dfrac{7}{2}, 4, \dfrac{9}{2}$

which are in A.P. as $\dfrac{7}{2} - 3 = 4 - \dfrac{7}{2} = \dfrac{9}{2} - 4 = \dfrac{1}{2}$

88. **(b) :** Equation of planes passing through the intersection of the planes $ax + by + cz + d = 0$ and $a'x + b'y + c'z + d' = 0$ is

$(a'x + b'y + c'z + d') + \lambda(ax + by + cz + d) = 0$ ...(*)

which is parallel to $y = 0 = z$

means parallel to x-axis

$\therefore \quad (a' + a\lambda)1 + 0(b' + b\lambda) + 0(c' + c\lambda) = 0$

$\Rightarrow \quad a\lambda = -a'$ or $\lambda = -\dfrac{a'}{a}.$

Putting $\lambda = -\dfrac{a'}{a}$ in (*), we have

$a(a'x + b'y + c'z + d') - a'(ax + by + cz + d) = 0$

$\Rightarrow \quad y(a'b - ab') + z(a'c - ac') + a'd - ad' = 0$

89. **(a) :** Given, $f(x) = \dfrac{x - m}{x - n}$, where $m \neq n$, $\forall\ x \in R - \{n\}$

Let $x_1, x_2 \in R \quad \therefore \quad f(x_1) = f(x_2)$

$\Rightarrow \quad \dfrac{x_1 - m}{x_1 - n} = \dfrac{x_2 - m}{x_2 - n} \Rightarrow x_1 = x_2$

$\therefore$ f is one-one.

Let $\lambda \in R$ such that $f(x) = \lambda$

$\therefore \quad \dfrac{x - m}{x - n} = \lambda$

$\therefore \quad x = \dfrac{m - n\lambda}{1 - \lambda}$

x is not defined for $\lambda = 1$, also x is not real.

$\therefore$ $f(x)$ is not onto function.

If a function is not onto it refered that it is into function.

Hence, f is one-one into function.

90. **(d) :** $n(A' \cup B') = n(A \cap B)'$

$= n(U) - n(A \cap B) = n(U) - 100$

$= 700 - 100 = 600$

91. **(d) :** $\displaystyle\sum_{r=0}^{n-1} \frac{{}^nC_r}{{}^nC_r + {}^nC_{r+1}} = \sum_{r=0}^{n-1} \frac{{}^nC_r}{{}^{n+1}C_{r+1}}$

$\displaystyle\sum_{r=0}^{n-1} \frac{1}{\frac{n+1}{r+1}} = \frac{1}{n+1} \sum_{r=0}^{n-1} (r+1)$

$\left(\because \ {}^nC_r = \dfrac{n}{r}\,{}^{n-1}C_{r-1}\right)$

$= \dfrac{1}{n+1}[1 + 2 + 3 + \ldots + n] = \dfrac{1}{n+1} \times \dfrac{n(n+1)}{2} = \dfrac{n}{2}$

92. **(c) :** Given, $f(x) = (x^2 - x + 1) + \sin x$

$f(x) = g(x) + p(x)$, where $g(x) = x^2 - x + 1$, $p(x) = \sin x$

$f(x)$ will be minimum if both $g(x)$ & $p(x)$ are minimum. Now, the minimum $g(x)$ & $p(x)$ is given as

$g(x) = x^2 - x + 1 = x^2 - 2\left(\dfrac{1}{2}\right)x + \dfrac{1}{4} + \dfrac{3}{4}$

$= (x - 1/2)^2 + 3/4$

$\therefore \quad g(x) \geq 3/4 \ \therefore$ Minimum of $g(x) = 3/4$

Again, $p(x) = \sin x$ & $-1 \leq \sin x \leq 1$,

$\therefore$ Minimum of $\sin x = p(x) = -1$

$\therefore$ Minimum of $f(x)$ = Minimum of $p(x)$ + minimum of $g(x)$

$= -1 + 3/4 = -1/4$

93. **(d) :** Given, $(y - x)^2 = x^3$

$\Rightarrow \quad y - x = \pm x^{3/2} \quad \Rightarrow \quad y = x \pm x^{3/2}$

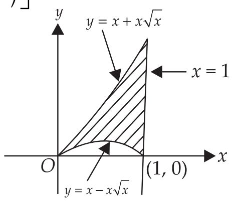
$\therefore \quad y = x + x\sqrt{x}$ & $y = x - x\sqrt{x}$

Required area

$= \displaystyle\int_0^1 \left[\left(x + x\sqrt{x}\right) - \left(x - x\sqrt{x}\right)\right] dx$

$= 2\displaystyle\int_0^1 x^{3/2}\, dx$

$= \dfrac{2 \times 2}{5}\left(x^{5/2}\right)_0^1 = \dfrac{4}{5}$



94. **(b) :** $\sin^{-1} x + \cos^{-1}(1 - x) = \sin^{-1}(-x)$

$\Rightarrow \quad \cos^{-1}(1 - x) = -2\sin^{-1} x$

$\Rightarrow \quad 1 - x = \cos(-2\sin^{-1}x) = \cos(2\sin^{-1}x)$

$= 1 - 2\sin^2(\sin^{-1}x) = 1 - 2x^2$

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

95. **(b) :** Let Δ_1 = Area of triangle ABC w.r.t. vertices

$$\frac{1}{2}\begin{vmatrix} at_1^2 & 2at_1 & 1 \\ at_2^2 & 2at_2 & 1 \\ at_3^2 & 2at_3 & 1 \end{vmatrix} = \frac{1}{2}(2a^2)\begin{vmatrix} t_1^2 & t_1 & 1 \\ t_2^2 & t_2 & 1 \\ t_3^2 & t_3 & 1 \end{vmatrix}$$

$= a^2(t_1 - t_2)(t_2 - t_3)(t_3 - t_1)$ ...(i)

Again area of triangle when tangents intersect at L, M, N then

$L(at_1t_2, a(t_1 + t_2))$, $M(at_2t_3, a(t_2 + t_3))$, $N(at_1t_3, a(t_1 + t_3))$

Δ_2 = Area of triangle LMN

$$= \frac{1}{2}\begin{vmatrix} at_1t_2 & a(t_1 + t_2) & 1 \\ at_2t_3 & a(t_2 + t_3) & 1 \\ at_1t_3 & a(t_1 + t_3) & 1 \end{vmatrix}$$

$$= \frac{1}{2}a^2\begin{vmatrix} t_1t_2 & t_1 + t_2 & 1 \\ t_2t_3 & t_2 + t_3 & 1 \\ t_3t_1 & t_3 + t_1 & 1 \end{vmatrix}$$

$= \dfrac{1}{2}\, a^2(t_1 - t_2)(t_2 - t_3)(t_3 - t_1)$

$\Rightarrow$ Area of triangle LMN = $\dfrac{1}{2}$Area of triangle ABC w.r.t. vertices

$\Rightarrow \quad \dfrac{\Delta_1}{\Delta_2} = \dfrac{2}{1} \Rightarrow \Delta_1 : \Delta_2 = 2 : 1$

96. **(c) :** $P(n) = n^3 + n$

$P(1) = 2$, $P(2) = 2^3 + 2 = 10$

$P(3) = 3^3 + 3 = 27 + 3 = 30$

$P(4) = 4^3 + 4 = 64 + 4 = 68$

Now out of 2, 10, 30, 68, only 30 is divisible by 3.

$\therefore$ only $P(3)$ is true.

97. **(b) :** Since two of the straight lines of $ax^3 + bx^2y + cxy^2 + dy^3 = 0$ are at right angles if $a(a + c) + d(b + d) = 0$

$\therefore \quad 8(8 - 8) + d(8 + d) = 0$

$\therefore \quad d = 0, d = -8$

98. **(a) :** $\sum_{i=0}^{k}\left[{}^{n}C_i(-1)^i\, 2^{k-i}\ {}^{n-i}C_{k-i}\right]$

$$\sum_{i=0}^{k}\left[(-1)^i 2^{k-i}\frac{n!}{i!(n-i)!}\times\frac{(n-i)!}{(k-i)!\,(n-k)!}\right]$$

$$= \sum_{i=0}^{k}(-1)^i 2^{k-i}\frac{n!}{(n-k)!\,(k)!}\times\frac{(k)!}{(k-i)!\,(i)!}\times\frac{2^i}{2^i}$$

$$= 2^k\binom{n}{k}\sum_{i=0}^{k}\left(-\frac{1}{2}\right)^i\binom{k}{i} = 2^k\binom{n}{k}\left(1-\frac{1}{2}\right)^k = \binom{n}{k}$$

99. **(a) :** If $a, b, c \in$ A.P.

Then $2b = a + c$

$\therefore \quad 2\log_3(2^x - 5) = \log_3(2^{x+1} - 7)$

($\because \log(ab) = \log a + \log b$)

$\Rightarrow \quad (2^x - 5)^2 = 2^{x+1} - 7$

$\Rightarrow \quad 2^{2x} - 10 \cdot 2^x + 25 = 2^{x+1} - 7$

$\Rightarrow \quad 2^{2x} - 12 \cdot 2^x + 32 = 0$

$\Rightarrow \quad (2^x - 8)(2^x - 4) = 0$

$\Rightarrow$ either $2^x = 2^3$ or $2^x = 2^2$

$\Rightarrow$ either $x = 3$ or $x = 2$

For $x = 2$, $2^x - 5 < 0$ $\therefore$ it is rejected.

$\therefore \quad x = 3$

100. **(b) :** Total number of balls = 21

Number of balls marked by 2, 4, 6,...20 = 10

Number of balls marked by 1, 3, 5, 7,...21 = 11

$\therefore$ Required Probability = Probability of first ball shows odd × probability of second ball shows even

$$= \frac{11}{21}\times\frac{10}{21} = \frac{110}{441}$$

101. **(c) :** We have $\frac{dy}{dx} = \frac{e^x + x^2}{e^y}$

Using variable separable form, we have

$e^y dy = (e^x + x^2)\,dx$

$\therefore \quad e^y = e^x + \frac{x^3}{3} + c$ (on integrating)

102. **(c) :** If α, β, γ are roots of $x^3 + ax^2 + bx + c = 0$, then $(\alpha + \beta)^{-1} + (\beta + \gamma)^{-1} + (\gamma + \alpha)^{-1} = \frac{a^2 + b}{c - ab}$

Now, in the given problem $a = 0, b = 4, c = +1$

$$\Rightarrow \quad \frac{a^2 + b}{c - ab} = \frac{4}{1}$$

103. **(d) :** Given lines are $\frac{x-1}{2} = \frac{y - \frac{1}{2}}{\frac{3}{2}} = \frac{\left(z - \frac{1}{3}\right)}{-\frac{\alpha}{3}}$

and $\frac{x+1}{2} = \frac{y - \frac{5}{3}}{\frac{2}{3}} = \frac{z-4}{3}$

As lines are perpendicular.

$\therefore \quad 2 \times 2 + \frac{2}{3}\times\frac{3}{2} - \alpha = 0 \Rightarrow \alpha = 5$

104. **(a) :** As the circle meet x-axis at two points so put $y = 0$ in the equation of circle.

$x^2 - 16x - 36 = 0$

(let two roots of the equation are x_1 and x_2)

$\Rightarrow \quad x_1 + x_2 = 16$ and $x_1x_2 = -36$

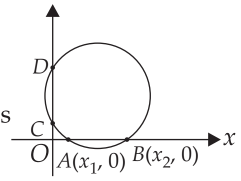
Now $x_1 - x_2 = \sqrt{(x_1 + x_2)^2 - 4x_1x_2}$

$= \sqrt{(16)^2 + 4\times 36}$

$= \sqrt{400}$

$= 20 =$ intercept on x-axis

$= AB = |x_2 - x_1|$



105. **(a) :** Here,

$$\overline{x} = \frac{x + (x + y) + (x + 2y) + \ldots\ldots + (x + 2ny)}{2n + 1}$$

$$= \frac{(2n+1)}{2}\frac{(x + x + 2ny)}{(2n+1)} \text{ using } S_n = \frac{N}{2}[a + l]$$

$= x + ny$

$\therefore$

x_i	$d = \lvert x_i - \overline{x} \rvert$
x	ny
$x + y$	$(n - 1)\,y$
$x + 2y$	$(n - 2)\,y$
$x + 3y$	$(n - 3)\,y$
.	.
.	.
.	.
$x + ny$	0
$x + (n + 1)y$	y
.	.
.	.
.	.
$x + 2ny$	ny
	$\Sigma\lvert d\rvert = 2[ny + (n - 1)\,y + \ldots + y]$

$$\Sigma d = \frac{2 \cdot y \cdot n(n+1)}{2} = ny(n+1)$$

$$\therefore \text{ Mean deviation} = \frac{\Sigma|d|}{2n+1} = \frac{ny(n+1)}{2n+1}$$

PART 4 : BIOLOGY

71. **(b) :** There are three systems of classification - artificial, natural and phylogenetic. In the natural system of classification the organisms are arranged on the basis of all known taxonomic characters instead of one or first few. These include morphological, anatomical, cytological, physiological and biochemical characters of the organisms. The artificial system is based on one or a few characters that are easily observable. The phylogenetic system tries to organise organisms on the basis of their genetic and phylogenetic relationships besides taxonomic characters.

72. **(d) :** In Family Malvaceae the androecium has many stamens with single anther lobe and filaments united into a tube this condition is known as monadelphous and monothecous.

73. **(c) :** In parietal placentation the ovary is unilocular but has two or more longitudinal placentae attached to wall due to pistil being syncarpous, *e.g.*, mustard. Whereas in marginal placentation ovary is unilocular bearing a single longitudinal placenta in the region of ventral suture, *e.g.*, pea. In apical placentation a single ovule is born near the upper end of unilocular ovary, *e.g.*, *Cannabis*. In superficial placentation the ovules are borne all over the inner surface of the ovary including the septa in case of multilocular condition, *e.g.*, *Butomus* (unilocular), *Nymphaea* (multilocular).

74. **(b)**

75. **(b) :** Endodermis is also termed as starch sheath. A special thickened band is present on radial and tangential walls of endodermal cells. This is called casparian strip. This is made up of lignin, suberin and cutin.

76. **(c) :** In dicot stems, the cells of cambium present between primary xylem and primary phloem is the intrafascicular cambium. The cells of medullary rays, adjoining these intrafascicular cambium become meristematic and form the interfascicular cambium. Thus, a continuous ring of cambium is formed.

77. **(a)**

78. **(c) :** The change in single base pair may not change the phenotype due to degeneracy of codon.

79. **(d)**

80. **(d) :** Double lines in pedigree analysis represent mating between relatives, *i.e.*, consanguineous mating. Normal mating is shown by single line. Symbol "◇" represents sex unspecified. Unaffected offspring are depicted by open and clear symbols (*i.e.*, □ for male and ○ for female).

81. **(d) :** In RNA, Thymine is replaced by uracil. Hence, base composition of RNA is A + G = U + C.

82. **(b)**

83. **(b) :** Golden rice is rich in vitamin A. So, it is helpful in solving problem of night-blindness.

84. **(b) :** Virus free clones can be obtained from shoot apex culture.

85. **(a)**

86. **(a) :** Recombinant DNA technology is an important aspect of genetic engineering. It is employed for combining DNA from two different organisms to produce recombinant DNA. This technology includes techniques of cutting DNA into specific fragments using enzyme restriction endonuclease and joining the fragments with the help of enzyme, ligase.

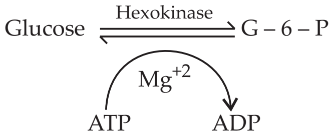
87. **(c) :** Photophosphorylation is the light driven or light energised synthesis of ATP. It was discovered by Arnon *et al* in 1954. It is of two main types. cyclic and non- cyclic. In cyclic photophosphorylation PS I takes part and only ATP is formed. In non- cyclic, PS I and PS II both take part in which ATP and $NADPH_2$ formed.

88. **(b) :** In C_4 plants (sugarcane, maize) CO_2 combines with a 3-carbon compound phosphoenol pyruvate (PEP) to form 4-carbon compound oxaloacetic acid. This reaction is catalysed by PEP carboxylase and takes place in mesophyll cells.

$$\text{PEP} + CO_2 + H_2O \xrightarrow{\text{PEP carboxylase}} \text{Oxaloacetic acid} + H_3PO_4$$

89. **(c) :** The chemiosmotic coupling hypothesis of oxidative phosphorylation proposed by Mitchell, explains the process of ATP formation and states that it is linked to development of a proton gradient across a membrane. ATP synthase, required for ATP synthesis is located in F_1 particles present in the inner mitochondrial membrane and becomes active only when there is high concentration of proton on F_0 side as compared to F_1 side. The flow of proton through F_0 channel induces F_1 particle to function as ATP synthase and the energy of proton gradient produces ATP by attaching a phosphate radical to ADP.

90. **(c) :** Glycolysis is the breakdown of glucose and occurs in cell cytoplasm. End product is 2 molecules of pyruvate. The first step of glycolysis is phosphorylation of glucose by which glucose is converted into glucose 6-phosphate –



91. **(b) :** The major physiological function of cytokinin is to enhance cell division and delay senescence of plant organs. In tissue culture the undifferentiated mass of cells formed in the culture tubes is called callus. The callus may remain in the undifferentiated condition or differentiation may take place in this. If it is differentiated, then root and shoot may be formed. Skoog and Miller had reported that cytokinins induce shoot formation and auxins induce root formation.

92. **(b) :** The common aerobic respiration consists of three steps - glycolysis, Krebs cycle and terminal oxidation. Glycolysis is the process of breakdown of glucose or similar hexose sugar to two molecules of pyruvic acid through a series of enzyme mediated reactions (occurs in cytosol) releasing some energy (as ATP) and reducing power (as $NADH_2$). It is common to both plant and animal cells and to both aerobic and anaerobic modes of respiration.

93. **(d) :** Phototropism is a paratonic directional growth movement of curvature which is induced and determined by the direction of light stimulus.

94. **(a) :** *Cephaleuros virescens* grows as a parasite on the leaves of tea and causes red rust of tea.

95. **(c) :** Pesticides are non selective in their mode of action, so these also kill useful organisms along with harmful and thus equilibrium state of ecosystem is disturbed.

96. **(d)**

97. **(c) :** The Brunner's glands are found only in the duodenum and are located in the submucosa. They secrete a little enzyme and mucus. The mucus protects the duodenal wall from getting digested. Digestion of most of nutrients takes place in the duodenum under the action of various enzymes. The Brunner's glands open into the crypts of Lieberkuhn.

98. **(d)** **99.** **(a)**

100. **(a) :** Glucose and amino acids are reabsorbed in PCT by secondary active transport. Water, sodium and chloride ions are reabsorbed in DCT. It is permeable to water. Maximum reabsorption takes place within the PCT. Humans are ureotelic and excrete out 25-30 gm of urea per day.

101. **(b) :** Acoelous vertebra is that vertebra in which the centrum is flat at both the ends without a concavity or convexity, *e.g.*, vertebrae of mammals.

102. **(c) :** The basic renal function consists mainly of three process, ultrafiltration or glomerular filtration, tubular reabsorption and tubular secretion.

103. **(a) :** The skeletal muscles fibres are innervated by large, myelinated nerve fibres that originate from large motor neurons in the anterior horns of spinal cord. Each nerve ending makes a junction, called the neuromuscular junction with the muscle fibre near its midpoint. The area of the plasma membrane of a muscle cell that lies immediately beneath a motor nerve ending at a neuromuscular junction is called end plate junction. The action potential initiated in the muscle fibre by the nerve signal travel towards the muscle fibre ends.

104. **(b) :** Pineal gland (epiphysis) is a small rounded body, which is located between the two cerebral hemispheres of the brain, at the tip of a short pineal stalk, arising from the roof of the diencephalon. Pineal gland is involved in regulating cyclic phenomenon in the body. Melatonin is the hormone produced by pineal gland which plays a role in the regulation of sleep cycles *i.e.*, circadian rhythms in humans and various other animals.

105. (a) : Through genetic engineering Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into several crop plants. The choice of gene depends upon the crop and targeted pest, as most *Bt* toxins are insect group specific. The toxin is coded by a gene *cry*. *cry*IAc and *cry*IIAb protect against cotton bollworm and *cry*IAb introduced in *Bt* corn protect from corn borer.

106. (c)

107. (c) : *Ornithorhyncus* is an egg laying mammal and is considered as connecting link between mammals and reptiles.

108. (d) : Species is a natural inbreeding or panmictic population or group of natural population which have essentially similar morphological traits, are genetically distinct and reproductively isolated from others. Reproductive isolation or absence of interbreeding maintains the identity of different species.

109. (d)

110. (b) : That part of an antigen, recognised by an antigen receptor is epitope.

111. (a) : Allergen is a foreign substance or agent that produces hypersensitivity in an individual, *e.g.*, pollen, spores, dust, scent, wool, silk, drug, fur, feathers, etc.

112. (a) : In mammals, T-lymphocytes are of three main types- cytotoxic T-cells, helper T-cells and suppressor T-cells. The function of cytotoxic T-cells is mainly in destroying virus infected cells and tumor cells. Helper T-cells help in the antibody production by B-cells. Suppressor T-cells suppress the activity of B-cells.

113. (b) : Amoebiasis – Use only sterilised food and water
Diphtheria – DPT Vaccine
Cholera – Use oral rehydration therapy
Syphilis – *Treponema pallidum*

114. (b) : After infecting the bacterium, the viruses can follow lysogenic cycle in which bacterial DNA is not destroyed, instead the viral DNA is incorporated into it and attached to the bacterial DNA in a specific manner and replicates along with this. In this condition the viral DNA is transmitted to the progeny of bacteria such a virus is known as provirus or prophage. Bacteria which carry a provirus are called lysogenic bacteria and virus whose chromosome become prophages are called lysogenic viruses.

115. (a)

116. (b) : Hensen's disease or leprosy is a chronic communicable bacterial disease caused by the *Mycobacterium leprae*.

117. (a) : The fish, Pomphret is a marine fish and was introduced in India by foreigners. This fish is called exotic fish.

118. (c) : Inbreeding is the mating of individuals which are more closely related by ancestry. Inbreeding is used in developing pure lines or homozygous lines.

119. (a) : Exotic breeds are the selected breeds that have been successfully introduced in India for cross breeding. They are Jersey, Holstein-Friesian and Brown Swiss. Jersey breed has been brought from Jersey (USA), Holstein-Friesian from Holland and Brown Swiss from Switzerland. New improved breeds of cows have been developed in our country at National Dairy Research Institute (NDRI), Haryana. The new varieties produced are : Jersey, Karan Swiss, Friesian-Sahiwal, Holstein-Friesian and Karan Friesian. The Holstein-Friesian and Karan-Friesian yield more than two or three times the quantity of milk as compared to that of the indigenous cows.

120. (b) : The crystal of lead zirconate is a key component of electrocardiography. It is a piezoelectric material (the material which has a net dipole moment and which can produce electricity when subjected to pressure or stress), crystal or ceramic in nature. The thickness of this material is the critical factor in allowing proper vibrational frequency, most common material used is lead zirconate titanate. Electrocardiography is a commonly used, non-invasive procedure for recording electrical changes in the heart.

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