SOLVED PAPER VITEEE 2011

PART - I (PHYSICS)

1. A glass rod rubbed with silk is used to change a gold leaf electroscope and the leaves are observed to diverge. The electroscope thus charged is exposed to X-rays for a short period. Then
(a) the divergence of leave will not affected
(b) the leaves will diverge further
(c) the leaves will collapse
(d) the leaves will melt

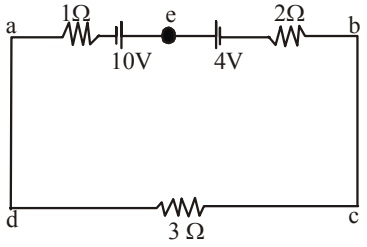
2. An infinite number of charge, each of charge 1 μC are placed on the x-axis with coordinates x=1, 2, 4, 8,.....∞. If a charge of 1C is kept at the origin, then what is the net force acting on 1C charge?
(a) 9000 N (b) 12000 N
(c) 24000 N (d) 36000 N

3. A cube of side ℓ is placed in a uniform field E, where $E = E_i$. The net electric flux through the cube is
(a) zero (b) l^2E
(c) $4l^2E$ (d) $6l^2E$

4. The capacity of a capacitor is 4×10^{-6} F and its potential is 100 V. The energy released on discharging it fully will be
(a) 0.02 J (b) 0.04 J
(c) 0.025 J (d) 0.05 J

5. Dimensions of a block are 1cm×1cm×100cm. If specific resistance of its material is $3\times10^{-7}\ \Omega$ m, then the resistance between the opposite rectangular faces is
(a) $3\times10^{-7}\ \Omega$ (b) $3\times10^{-9}\ \Omega$
(c) $3\times10^{-5}\ \Omega$ (d) $3\times10^{-3}\ \Omega$

6. The magnitude and direction of the current in the circuit shown will be



(a) 7/3 A from a to b through e
(b) 7/3 A from b to a through e
(c) 1A from b to a through e
(d) 1A from a to b through e

7. An electric bulb of 100 W is connected to a supply of electricity of 220 V. Resistance of the filament is
(a) 484 Ω (b) 100 Ω
(c) 22000 Ω (d) 242 Ω

8. Pick out the wrong statement.
(a) In a simple battery circuit, the point of lowest potential is the negative terminal of the battery.
(b) The resistance of an incandescent lamp is greater when the lamp is switched off.
(c) An ordinary 100W lamp has less resistance than a 60 W lamp.
(d) At constant voltage, the heat developed in a uniform wire varies inversely as the length of the wire used.

9. The electrochemical equivalent of magnesium is 0.126 mg/C. A current of 5A is passed in a suitable solution for 1h. The mass of magnesium deposited will be
(a) 0.0378 g (b) 0.227 g
(c) 0.378 g (d) 2.27 g

10. In producing chlorine through electrolysis 100 W power at 125 V is being consumed. How much chlorine per minute is leberated? (ECE of chlorine is 0.367×10^{-6} kg/C)
(a) 24.3 mg (b) 16.6 mg
(c) 17.6 mg (d) 21.3 mg

11. A particle carrying a charge to 100 times the charge on an electron is rotating per second in a circular path of radius 0.8 m. The value of the magnetic field produced at the centre will be
(μ_0= permeability for vacuum)
(a) $\dfrac{10^{-7}}{\mu_0}$ (b) $10^{-17}\ \mu_0$
(c) $10^{-6}\ \mu_0$ (d) $10^{-7}\ \mu_0$

12. A rectangular loop carrying a current i is placed in a uniform magnetic field B. The area enclosed by the loop is A. If there are n turns in the loop, the torque acting on the loop is given by

(a) $ni\mathbf{A}\times\mathbf{B}$ (b) $ni\mathbf{A}\cdot\mathbf{B}$

(c) $\frac{1}{n}(i\mathbf{A}\times\mathbf{B})$ (d) $\frac{1}{n}(i\mathbf{A}\cdot\mathbf{B})$

13. In a magnetic field of 0.05 T, area of a coil changes from 101 cm^2 to 100 cm^2 without changing the resistance which is 2 Ω. The amount of charge that flow during this period is

(a) 2.5×10^{-6} C (b) 2×10^{-6} C

(c) 10^{-6} C (d) 8×10^{-6} C

14. A solenoid has 2000 turns wound over a length of 0.30 m . The area of its cross-section is 1.2×10^{-3} m^2. Around its central section, a coil of 300 turn is wound. If an initial current of 2A in the solenoid is reversed in 0.25 s, then the emf induced in the coil is

(a) 6×10^{-4} V (b) 4.8×10^{-3} V

(c) 6×10^{-2} V (d) 48mV

15. An inductive circuit contains a resistance of 10 Ω and an inductance of 2.0 H. If an AC voltage of 120 V and frequency of 60 Hz is applied to this circuit, the current in the circuit would be nearly

(a) 0.32 A (b) 0.16 A

(c) 0.43 A (d) 0. 80 A

16. In a Millikan's oil drop experiment the charge on an oil drop is calculated to be 6.35×10^{-19} C. The number of excess electrons on the drop is

(a) 3.2 (b) 4

(c) 4.2 (d) 6

17. The values $+\frac{1}{2}$ and $-\frac{1}{2}$ of spin quantum number show

(a) rotation of electron clockwise and anti-clockwise directions respectively

(b) rotation of electron anti-clockwise and clockwise directions respectively

(c) rotation in any direction according to convention

(d) None of the above

18. The frequency of incident light falling on a photosensitive metal plate is doubled, the kinetic energy of the emitted photoelectrons is

(a) double the earlier value

(b) unchanged

(c) more than doubled

(d) less than doubled

19. Light of two different frequencies whose photons have energies 1 eV and 2.5 eV, respectively, successively illuminate a metal whose work function is 0.5 eV. The ratio of the maximum speed of the emitted electrons will be

(a) 1:5 (b) 1:4

(c) 1:2 (d) 1:1

20. An electron accelerated under a potential difference V volt has a certain wavelength λ. Mass of proton is some 2000 times of the mass of the electron. If the proton has to have the same wavelength λ, then it will have to be accelerated under a potential difference of

(a) V volt (b) 2000 V volt

(c) $\frac{V}{2000}$ volt (d) $\sqrt{2000}$ V volt

21. The ratio of momentum of an electron and α -particle which are accelerated from rest by a potential difference of 100 V is

(a) 1 (b) $\sqrt{(2m_e/m_a)}$

(c) $\sqrt{(m_e/m_\alpha)}$ (d) $\sqrt{(m_e/2m_\alpha)}$

22. Sky wave propagation is used in

(a) radio communication

(b) satellite communication

(c) T V communication

(d) Both T V and satellite communication

23. The frequency of an FM transmitter without signal input is called

(a) the centre frequency

(b) modulation

(c) the frequency deviation

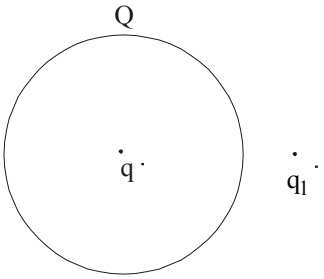
(d) the carrier sweing

24. What is the age of an ancient wooden piece if it is known that the specific activity of C^{14} nuclide in its amounts is 3/5 of that in freshly grown trees? Given the half of C nuclide is 5570 yr.

(a) 1000 yr (b) 2000 yr

(c) 3000 yr (d) 4000 yr

25. A thin metallic spherical shell contains a charge Q on it. A point charge q is placed with the centre of the shell and another charge q_1s placed outside it as shown in the figure. All the three charges are positive.

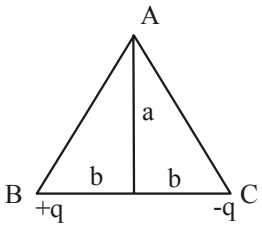


The force on the charge at the centre is

(a) towards left (b) towards right

(c) upward (d) zero

26. As shown in the figure, charges + q and – q are placed at the vertices B and C of an isosceles triangle. The potential at the vertex A is



(a) $\frac{1}{4\pi\varepsilon_0}\cdot\frac{2a}{\sqrt{a^2+b^2}}$ (b) zero

(c) $\frac{1}{4\pi\varepsilon_0}\cdot\frac{q}{\sqrt{a^2+b^2}}$ (d) $\frac{1}{4\pi\varepsilon_0}\cdot\frac{(-q)}{\sqrt{a^2+b^2}}$

27. On moving a charge of 20 C by 2 cm, 2 J of work is done, then the potential difference between the points is

(a) 0.1 V (b) 8 V

(c) 2 V (d) 0.5 V

28. The insulation property of air breaks down at 3×10^6 V/m. The maximum charge that can be given to a sphere of diameter 5 m is nearly

(a) 2×10^{-2}C (b) 2×10^{-3}C

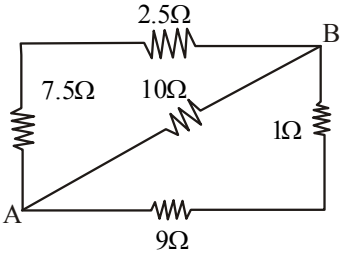
(c) 2×10^{-4}C (d) 2×10^{-5}C

29. Two capacitors of capacities C and 2C are connected in parallel and then connected in series with a third capacitor of capacity 3C. The combination is charged with V volt. The charge on capacitor of capacity C is

(a) $\frac{1}{2}$CV (b) CV

(c) 2CV (d) $\frac{3}{2}$CV

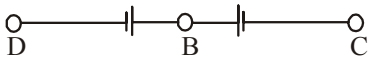
30. Five resistances are connected as shown in the figure. The effective resistance between points A and B is



(a) $\frac{10}{3}\Omega$ (b) $\frac{10}{17}\Omega$

(c) 40Ω (d) 45Ω

31. A potentiometer is connected across A and B and a balance is obtained at 64.0 cm. When potentiometer lead to B is moved to C, a balance is found at 8.0 cm. If the potentometer is now connected across B and C, a balance will be found at



(a) 8.0 cm (b) 56.0 cm

(c) 64.0 cm (d) 72.0 cm

32. In an electromagnetic wave, the average energy density associated with magnetic field is

(a) $L i_0^2/2$ (b) $B^2/2\mu_0$

(c) $\mu_0 B^2/2$ (d) $\mu_0/2B^2$

33. An electromagnetic wave going through vacuum is described by

$E=E_0 \sin(kx-\omega t)$

Which of the following is/are independent of the wavelength?

(a) k (b) ω^2

(c) k/ω (d) $k\omega^2$

34. An ammeter reads upto 1A. Its internal resistance is 0.81 Ω . To increase the range to 10 A, the value of the required shunt is

(a) 0.09 Ω (b) 0.03 Ω

(c) 0.3 Ω (d) 0.9 Ω

35. A coil of resistance 10Ω and inductance 5 H is connected to a 100 V battery. Then the energy stored in the coil is

(a) 250 J (b) 250 erg

(c) 125 J (d) 125 erg

36. A nucleus $^{A}_{Z}X$ emits an α - particle. The resultant nucleus emits a β^+ – particle. The respective atomic and mass number of final nucleus will be

(a) Z–3, A–4 (b) Z–1, A–4

(c) Z–2, A–4 (d) Z, A–2

37. In Young's double slit experiment, the intensity of light at a point on the screen where the path difference is $\lambda = I$. The intensity of light at a point where the path difference becomes $\lambda/3$ is

(a) I / 4 (b) I / 3

(c) $\frac{I}{2}$ (d) I

38. Polarising angle for water is 53°4'. If light is incident at this angle on the surface of water and reflected the angle of refraction is

(a) 53°4' (b) 126°56'

(c) 36°56' (d) 30°4'

39. A 2V battery, a 15 Ω resistor and a potentiometer of 100 cm length, all are connected in series. If the resistance of potentiometer wire is 5 Ω, then the potential gradient of the potentiometer wire is

(a) 0.005 V/cm (b) 0.05 V/cm

(c) 0.02 V/cm (d) 0.2 V/cm

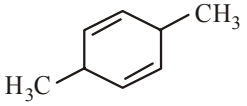
40. The output voltage of a transformer connected to 220 V line is 1100 V at 2 A current. Its efficiency is 100%. The current coming from the line is

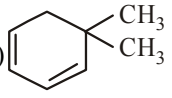
(a) 20A (b) 10A

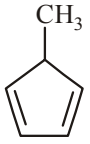
(c) 11A (d) 22A

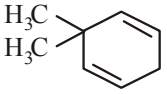
PART - II (CHEMISTRY)

41. An alkene having molecular formula C_8H_{12} on ozonolysis yields glyoxal and 2, 2-dimethyl butane-1, 4-dial. The structure of alkene is

(a) 

(b) 

(c) 

(d) 

42. Amongst $Ni(CO)_4$, $[Ni(CN)_4]^{2-}$ and $\left[NiCl_4^{2-}\right]$

(a) $Ni(CO)_4$ and $NiCl_4^{2-}$ are diamagnetic but $[Ni(CN)_4]^{2-}$ is paramagnetic

(b) $Ni(CO)_4$ and $[Ni(CN)_4]^{2-}$ are diamagnetic but $NiCl_4^{2-}$ is paramagnetic

(c) $NiCl_4^{2-}$ and $[Ni(CN)_4]^{2-}$ are diamagnetic but $Ni(CO)_4$ is paramagnetic

(d) $Ni(CO)_4$ is diamagnetic but $NiCl_4^{2-}$ and $[Ni(CN)_4]^{2-}$ is paramagnetic

43. The equivalent conductances of two ions at infinite dilution in water at 25ºC are given below

$\Lambda^{o}_{Ba^{2+}} = 127.00\ Scm^2/equiv.$

$\Lambda^{o}_{Cl^-} = 76.00\ Scm^2/equiv.$

The equivalent conductance (in S cm^2/equiv) of $BaCl_2$ at infinite dilution will be

(a) 203 (b) 279

(c) 205.5 (d) 139.5

44. The product formed when phthalimide is treated with a mixture of Br_2 and strong NaOH solution is

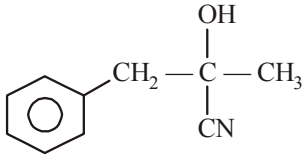
(a) aniline (b) phthalamide

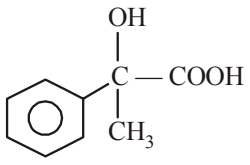
(c) phthalic acid (d) anthranilic acid

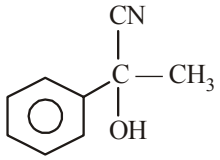
45. In a set of reactions acetic acid yielded a product D.

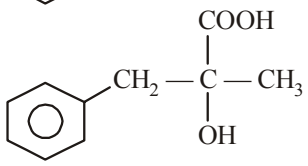
$$CH_3COOH \xrightarrow{SOCl_2} A \xrightarrow[\text{anhy. } AlCl_3]{\text{Benzene}} B \xrightarrow{HCN} C \xrightarrow{H_2O} D$$

The structure of D would be

(a) 

(b) 

(c) 

(d) 

46. The alcohol having molecular formula C_4H_9OH, when shaken with a mixture of anhydrous $ZnCl_2$ and conc. HCl gives an oily layer product after five minutes. The alcohol is

(a) $H_3C — (CH_2)_3 — OH$

(b) $(CH_3)_2CH — CH_2OH$

(c) $(CH_3)_3C — OH$

(d) $H_3C — CH(OH)\,CH_2 — CH_3$

47. *p*-toluidine and benzyl amine can be distinguished by

(a) Sandmeyer's reaction

(b) Dye test

(c) Molisch test

(d) Gattermann reaction

48. CH_3CH_2Br undergoes Wurtz reaction. We may expect some of the following product

A : $CH_3CH_2CH_2CH_3$

B : $CH_2 = CH_2$

C : $CH_3 — CH_3$

Select correct product.

(a) Only A (b) A and B

(c) A, B and C (d) A and C

49. Sometimes explosion occurs while distilling ethers. It is due to the presence of

(a) peroxides (b) oxides

(c) ketones (d) aldehydes

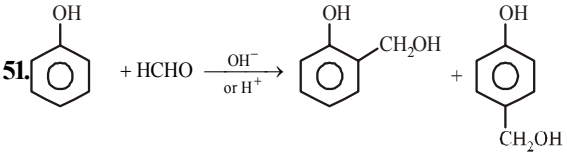
50. Glycerine is used as a preservative for fruits and eatables because

(a) it makes them sweet

(b) it acts as an insecticide

(c) it keeps the food moist

(d) all of the above

51. 

This reaction is called

(a) Reimer-Tiemann reaction

(b) Lederer-Manasse reaction

(c) Sandmeyer reaction

(d) Kolbe's reaction

52. $CH_3 - \overset{\overset{O}{\|}}{C} - CH_3 \xrightarrow{SeO_2} X + Se + H_2O : X$

(a) $CH_3 - \overset{\overset{O}{\|}}{C} - \overset{\overset{O}{\|}}{C} - H$ (b) $CH_3 - \overset{\overset{O}{\|}}{C} - OCH_3$

(c) $CH_3 - \overset{\overset{O}{\|}}{C} - CH_2OH$ (d) None of the above

53. Which of the following will give Cannizzaro reaction?

(a) CH_3CHO (b) CH_3COCH_3

(c) $(CH_3)_3C - CHO$ (d) CH_3CH_2CHO

54. The secondary structure of a protein refers to

(a) α-helical backbone

(b) hydrophobic interactions

(c) sequence of α-amino acids

(d) fixed configuration of the polypeptide backbone

55. Self condensation of two moles of ethyl acetate in the presence of sodiumethoxide after acidification yields

(a) acetic acid (b) acetoacetic ester

(c) ethyl propionate (d) ethyl butyrate

56. Which one of the following will be most basic?

(a) Aniline (b) *p*-methoxyaniline

(c) *p*-methyl aniline (d) Benzylamine

57. Mn_2O_7 dissolves in water to give an acid. The colour of the acid is

(a) green (b) blue

(c) purple (d) red

58. "925 fine silver" means an alloy of

(a) 7.5% Ag and 92.5% Cu

(b) 92.5% Ag and 7.5% Cu

(c) 80% Ag and 20% Cu

(d) 90% Ag and 10% Cu

59. In which of the following octahedral complexes of Co (At. no. 27), will the magnitude of Δ_0 be the highest?
(a) $[Co(CN)_6]^{3-}$ (b) $[Co(C_2O_4)_3]^{3-}$
(c) $[Co(H_2O)_6]^{3+}$ (d) $[Co(NH_3)_6]^{3+}$

60. **Assertion (A)** Cu^{2+} and Cd^{2+} are separated by first adding KCN solution and then passing H_2S gas.
Reason (R) KCN reduces Cu^{2+} to Cu^{+} and forms a complex with it.
The correct answer is
(a) Both (A) and (R) are true and (R) is the correct explanation of (A)
(c) Both (A) and (R) are true but (R) is not the correct explanation of (A)
(c) (A) is true but (R) is not true
(d) (A) is not true but (R) is true

61. The effective atomic number of cobalt in the complex $[Co(NH_3)_6]^{3+}$ is
(a) 36 (b) 24
(c) 33 (d) 30

62. The IUPAC name for the complex $[Co(NO_2)(NH_3)_5]Cl_2$ is
(a) nitrito-N-pentammine cobalt (III) chloride
(b) nitrito-N-pentammine cobalt (II) chloride
(c) pentaminenitrito-N-cobalt (II) chloride
(d) pentaminenitrito-N-cobalt (III) chloride

63. The radio-isotope used for treatment of thyroid disorders is
(a) Na-24 (b) P-32
(c) Co-60 (d) I-131

64. Tetragonal crystal system has the following unit cell dimensions
(a) $a = b = c, \alpha = \beta = \gamma = 90^\circ$
(b) $a = b \neq c, \alpha = \beta = \gamma = 90^\circ$
(c) $a \neq b \neq c, \alpha = \beta = \gamma = 120^\circ$
(d) $a = b \neq c, \alpha = \beta = 90^\circ, \gamma = 120^\circ$

65. A crystalline solid
(a) changes rapidly from solid to liquid
(b) has no definite melting point
(c) undergoes deformation of its geometry easily
(d) soften easily

66. Two glass bulbs A and B are connected by a very small tube having a stop-cock. Bulb A has a volume of 100 cm^3 and contained the gas while bulb B was empty. On opening stop-clock, the pressure fell down to 40%. The volume of the bulb B must be
(a) 75 cm^3 (b) 125 cm^3
(c) 150 cm^3 (d) 250 cm^3

67. 20 mL of 0.2 M NaOH is added to 50 mL of 0.2 M acetic acid. The pH of this solution after mixing is $(K_a = 1.8 \times 10^{-5})$
(a) 4.5 (b) 2.3
(c) 3.8 (d) 4

68. Consider the following equation, which represents a reaction in the extraction of chromium from its ore

$$2Fe_2O_3 \cdot Cr_2O_3 + 4Na_2CO_3 + 3O_2 \longrightarrow 2Fe_2O_3 + 4Na_2CrO_4 + 4CO_2$$

Which one of the following statements about the oxidation states of the substances is correct?
(a) The iron has been reduced from +3 to +2 state.
(b) The chromium has been oxidised from +3 to +6 state.
(c) The carbon has been oxidised from +2 to +4 state.
(d) There is no change in the oxidation state of the substances in the reaction.

69. The freezing point of a solution composed of 10.0 g of KCl in 100 g of water is 4.5°C. Calculate the van't Hoff factor, i for this solution.
(a) 2.50 (b) 1.8
(c) 1.2 (d) 1.3

70. In the reversible reaction,

$$2NO_2 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} N_2O_4$$

the rate of disappearance of NO_2 is equal to
(a) $\frac{2k_1}{k_2}[NO_2]^2$
(b) $2k_1[NO_2]^2 - 2k_2[N_2O_4]$
(c) $2k_1[NO_2]^2 - k_2[N_2O_4]$
(d) $(2k_1 - k_2)[NO_2]$

71. A chemical reaction was carried out at 300 K and 280 K. The rate constants were found to be k_1 and k_2 respectively. Then
(a) $k_2 = 4k_1$ (b) $k_2 = 2k_1$
(c) $k_2 = 0.25\, k_1$ (d) $k_2 = 0.5\, k_1$

72. The rate constant of a reaction at temperature 200 K is 10 times less than the rate constant at 400 K. What is the activation energy of the reaction?
(a) 1842.4 R (b) 460.6 R
(c) 230.3 R (d) 921.2 R

73. A vessel at 1000 K contains CO_2 with a pressure of 0.5 atm. Some of the CO_2 is converted into CO on the addition of graphite. The value of K if the total pressure at equilibrium is 0.8 atm, is

(a) 1.8 atm (b) 3 atm
(c) 0.3 atm (d) 0.18 atm

74. For the reaction $2A + B \rightleftharpoons C$, $\Delta H = x$ cal, which one of the following conditions-would favour the yield of C on the basis of Le-Chatelier principle?
(a) High pressure, high temperature
(b) Only low temperature
(c) High pressure, low temperature
(d) Only low pressure

75. The EMF of the cell,
$Mg|Mg^{2+}(0.0IM) \parallel Sn^{2+}(0.1\ M)|Sn$ at 298K is

$\left(E^{o}_{Mg^{2+}/Mg} = -2.34V, E^{o}_{Sn^{2+}/Sn} = -0.14V\right)$

(a) 2.17V (b) 2.23V
(c) 2.51V (d) 2.45V

76. Heat of formation, ΔH^{o}_{f} of an explosive compound like NCl_3 is
(a) positive (b) negative
(c) zero
(d) positive or negative

77. For the reaction,

$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(l)$$

at constant temperature, $\Delta H - \Delta E$ is
(a) RT (b) $-3RT$
(c) 3RT (d) $-RT$

78. The favourable conditions for a spontaneous reaction are
(a) $T\Delta S > \Delta H$, $\Delta H = +$ ve, $\Delta S = +$ve
(b) $T\Delta S > \Delta H$, $\Delta H = +$ ve, $\Delta S = -$ve
(c) $T\Delta S = \Delta H$, $\Delta H = -$ve, $\Delta S = -$ve
(d) $T\Delta H = \Delta H$, $\Delta H = +$ ve, $\Delta S = +$ve

79. Compound A and B are treated with dil. HCl separately. The gases liberated are Y and Z respectively. Y turns acidified dichromate paper green while Z turns lead acetate paper black. The compound A and B are respectively.
(a) Na_2CO_3 and NaCl
(b) Na_2SO_3 and Na_2S
(c) Na_2S and Na_2SO_3
(d) Na_2SO_3 and Na_2SO_4

80. Which of the following is correct comparison of the stability of the molecules?
(a) $CN < O_2^+$ (b) $CN = N_2$
(c) $N_2 < O_2$ (d) $H_2^+ > He_2^+$

PART - III (MATHEMATICS)

81. To the lines $ax^2 + 2hxy + by^2 = 0$, the line $a^2x^2 + 2h(a+b)xy + b^2y^2 = 0$ are
(a) equally inclined
(b) perpendicular
(c) bisector of the angle
(d) None of the above

82. If R be a relation from $A=\{1, 2, 3, 4\}$ to $B=\{1, 3, 5\}$ such that $(a, b) \in R \Leftrightarrow a < b$, then ROR^{-1} is
(a) $\{(1,3), (1, 5), (2, 3), (2, 5), (3, 5), (4, 5)\}$
(b) $\{(3, 1), (5, 1), (3, 2), (5, 2), (5, 3), (5, 4)\}$
(c) $\{(3, 3), (3, 5), (5, 3), (5, 5)$
(d) $\{(3, 3), (3, 4), (4, 5)\}$

83. If $x + iy = (1 - i\sqrt{3})^{100}$, then find (x, y).
(a) $\left(2^{99}, 2^{99}\sqrt{3}\right)$ (b) $\left(2^{99}, -2^{99}\sqrt{3}\right)$
(c) $\left(-2^{99}, 2^{99}\sqrt{3}\right)$ (d) None of these

84. For a GP, $a_n = 3\left(2^n\right)$, $\forall\ n \in N$. Find the common ratio.
(a) 2 (b) 1/2
(c) 3 (d) 1/3

85. If a, b, c are in HP, then $\frac{a}{b+c}, \frac{b}{c+a}, \frac{c}{a+b}$ will be in
(a) AP (b) GP
(c) HP (d) None of these

86. If $\frac{x^2 + 2x + 7}{2x + 3} < 6, x \in R$, then
(a) $x > 11$ or $x < -\frac{3}{2}$
(b) $x > 11$ or $x < -1$
(c) $-\frac{3}{2} < x < -1$
(d) $-1 < x < 11$ or $x < -\frac{3}{2}$

87. The number of ways of painting the faces of a cube of six different colours is
(a) 1 (b) 6
(c) 6! (d) 36

88. A line passes through (2, 2) and is perpendicular to the line 3x+y=3. What is its y-intercept?
(a) 1/3 (b) 2/3
(c) 1 (d) 4/3

89. The number of common tangents to the circles $x^2 + y^2 = 4$ and $x^2 + y^2 - 6x - 8y = 24$ is
(a) 0 (b) 1
(c) 3 (d) 4

90. If D is the set of all real x such that $1 - e^{(1/x)-1}$ is positive, then D is equal to
(a) $(-\infty, 1]$ (b) $(-\infty, 0)$
(c) $(1, \infty)$ (d) $(-\infty, 0) \cup (1, \infty)$

91. Find the value of the limit $\lim_{x \to 0} \frac{\sqrt{1-\cos x}}{x}$
(a) 0 (b) 1
(c) $\sqrt{2}$ (d) does not exist

92. Evaluate $\int \frac{x^2+4}{x^4+16} dx$.
(a) $\frac{1}{2\sqrt{2}} \tan^{-1}\left(\frac{x^2-4}{2x\sqrt{2}}\right) + c$
(b) $\frac{1}{2\sqrt{2}} \tan^{-1}\left(\frac{x^2-4}{2\sqrt{2}}\right) + c$
(c) $\frac{1}{2\sqrt{2}} \tan^{-1}\left(\frac{x^2-4}{x\sqrt{2}}\right) + c$
(d) None of the above

93. Evaluate $\int_{\pi/4}^{3\pi/4} \frac{1}{1+\cos x} dx$
(a) 2 (b) –2
(c) 1/2 (d) –1/2

94. If one AM 'A' and two GM p and q are inserted between two given numbers, then find the value of $\frac{p^2}{q} + \frac{q^2}{p}$
(a) A (b) 2A
(c) 3A (d) 4A

95. If the roots of the equation $x^2 + ax + b = 0$ are c and d, then one of the roots of the equation $x^2 + (2c + a)x + c^2 + ac + b = 0$ is
(a) c (b) $d - c$
(c) $2d$ (d) $2c$

96. The sum of the coefficients of $(6a-5b)^n$, where n is a positive integer, is
(a) 1 (b) –1
(c) 2^n (d) 2^{n-1}

97. Find the value of $(7.995)^{1/3}$ correct to four decimal places.
(a) 1.9995 (b) 1.9996
(c) 1.9990 (d) 1.9991

98. The values of constants a and b, so that $\lim_{x \to \infty} \left(\frac{x^2+1}{x+1} - ax - b\right) = 0$ are
(a) $a = 0, b = 0$ (b) $a = 1, b = -1$
(c) $a = -1, b = 1$ (d) $a = 2, b = -1$

99. The projection of the vector $\boldsymbol{i} - 2\boldsymbol{j} + \boldsymbol{k}$ on the vector $4\boldsymbol{i} - 4\boldsymbol{j} + 7\boldsymbol{k}$ is
(a) $\frac{5\sqrt{6}}{10}$ (b) $\frac{19}{9}$
(c) $\frac{9}{19}$ (d) $\frac{\sqrt{6}}{19}$

100. If $\boldsymbol{a}, \boldsymbol{b}, \boldsymbol{c}$ are three non-zero vectors such that $\boldsymbol{a} + \boldsymbol{b} + \boldsymbol{c} = 0$ and $m = \boldsymbol{a}.\boldsymbol{b} + \boldsymbol{b}.\boldsymbol{c} + \boldsymbol{c}.\boldsymbol{a}$, then
(a) $m < 0$ (b) $m > 0$
(c) $m = 0$ (d) $m = 3$

101. A line making angles $45°$ and $60°$ with the positive directions of the axes of x and y makes with the positive direction of z-axis, an angle of
(a) $60°$ (b) $120°$
(c) $60°$ or $120°$ (d) None of these

102. If $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, $J = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$, then B is equal to
(a) $I\cos\theta + J\sin\theta$ (b) $I\sin\theta + J\cos\theta$
(c) $I\cos\theta - J\sin\theta$ (d) $-I\cos\theta + J\sin\theta$

103. Which of the following is correct?
(a) Determinant is a square matrix
(b) Determinant is a number associated to a matrix
(c) Determinant is a number associated to a square matrix
(d) All of the above

104. If α, β and γ are the roots of $x^3 + ax^2 + b = 0$, then the value of $\begin{vmatrix} \alpha & \beta & \gamma \\ \beta & \gamma & \alpha \\ \gamma & \alpha & \beta \end{vmatrix}$ is

(a) $-a^3$ (b) $a^3 - 3b$
(c) a^3 (d) $a^2 - 3b$

105. If the axes are shifted to the point $(1, -2)$ without solution, then the equation $2x^2 + y^2 - 4x + 4y = 0$ becomes

(a) $2X^2 + 3Y^2 = 6$ (b) $2X^2 + Y^2 = 6$
(c) $X^2 + 2Y^2 = 6$ (d) None of these

106. If $f(x) = \begin{cases} x^2, & x \le 0 \\ 2\sin x, & x > 0 \end{cases}$, then $x = 0$ is

(a) point of minima
(b) point of maxima
(c) point of discontinuity
(d) None of the above

107. In a group $(G, *)$, then equation $x * a = b$ has a

(a) unique solution $b * a^{-1}$
(b) unique solution $a^{-1} * b$
(c) unique solution $a^{-1} * b^{-1}$
(d) many solutions

108. A die is rolled twice and the sum of the numbers appearing on them is observed to be 7. What is the conditional probability that the number 2 has appeared at least once?

(a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{2}{3}$ (d) $\frac{2}{5}$

109. The locus of the mid-points of the focal chord of the parabola $y^2 = 4ax$ is

(a) $y^2 = a(x - a)$ (b) $y^2 = 2a(x - a)$
(c) $y^2 = 4a(x - a)$ (d) None of these

110. Find the value of $\sin 12° \sin 48° \sin 54°$.

(a) $\frac{1}{2}$ (b) $\frac{1}{4}$
(c) $\frac{1}{6}$ (d) $\frac{1}{8}$

111. In an equilateral triangle, the inradius, circumradius and one of the exradii are in the ratio

(a) 2 : 3 : 5 (b) 1 : 2 : 3
(c) 1 : 3 : 7 (d) 3 : 7 : 9

112. Let p and q be two statements. Then, $p \vee q$ is false, if

(a) p is false and q is true
(b) both p and q are false
(c) both p and q are true
(d) None of the above

113. In how many ways 6 letters be posted in 5 different letter boxes?

(a) 5^6 (b) 6^5
(c) 5! (d) 6!

114. If A and B be two sets such that A×B consists of 6 elements. If three elements A × B are (1, 4), (2, 6) and (3, 6), find B×A.

(a) {(1, 4), (1, 6), (2, 4), (2, 6),(3, 4), (3, 6)}
(b) {(4, 1), (4, 2), (4, 3), (6, 1),(6, 2), (6, 3)}
(c) {(4, 4), (6, 6)}
(d) {(4, 1), (6, 2), (6, 3)}

115. Let $f: R \to R$ be defined as $f(x) = x^2 + 1$, find $f^{-1}(-5)$.

(a) $\{\phi\}$ (b) ϕ
(c) {5} (d) $\{-5, 5\}$

116. If X is a poisson variate such that $P(X = 1) = P(X = 2)$, then $P(X = 4)$ is equal to

(a) $\frac{1}{2e^2}$ (b) $\frac{1}{3e^2}$
(c) $\frac{2}{3e^2}$ (d) $\frac{1}{e^2}$

117. The area enclosed by $y = 3x - 5$, $y = 0$, $x = 3$ and $x = 5$ is

(a) 12 sq units (b) 13 sq units
(c) $13\frac{1}{2}$ sq units (d) 14 sq units

118. The order and degree of the differential equation $\left(1 + 4\frac{dy}{dx}\right)^{2/3} = 4\frac{d^2y}{dx^2}$ are respectively

(a) $1, \frac{2}{3}$ (b) $3, 2$
(c) $2, 3$ (d) $2, \frac{2}{3}$

119. The solution of the differential equation $\frac{dy}{dx} = (4x + y + 1)^2$, is

(a) $(4x + y + 1) = \tan(2x + C)$
(b) $(4x + y + 1)^2 = 2\tan(2x + C)$
(c) $(4x + y + 1)^3 = 3\tan(2x + C)$
(d) $(4x + y + 1) = 2\tan(2x + C)$

120. The system of equations $2x + y - 5 = 0$, $x - 2y + 1 = 9$, $2x - 14y - a = 0$, is consistent. Then, a is equal to

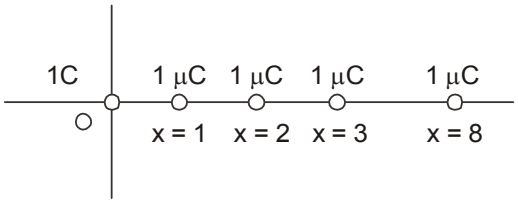
(a) 1 (b) 2
(c) 5 (d) None of these

SOLUTIONS

PART - I (PHYSICS)

1. (b) As charge on glass rod is +(ve) so charge on gold leaves will also be +(ve). Due to X-rays more electrons from leaves will be emitted, so leaves becomes more positive and diverge further.

2. (b) In figure there is the schematic diagram of distribution of charges on x-axis



Using principle of superposition total force acting on 1 C charge

$$F = \frac{1}{4\pi\varepsilon_0}\left[\frac{1\times1\times10^{-6}}{(1)^2}+\frac{1\times1\times10^{-6}}{(2)^2}+\frac{1\times1\times10^{-6}}{(4)^2}+\frac{1\times1\times10^{-6}}{(8)^2}+...\infty\right]$$

$$=\frac{10^{-6}}{4\pi\varepsilon_0}\left[\frac{1}{1}+\frac{1}{4}+\frac{1}{16}+\frac{1}{64}+...\infty\right]$$

$$=9\times10^{-6}\times10^{9}\left(\frac{1}{1-\frac{1}{4}}\right)$$

$$=9\times10^{9}\times10^{-6}\times\frac{4}{3}=12000\,\text{N}$$

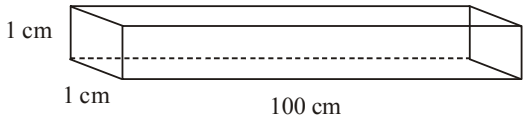
3. (a) Here, net flux is zero, as there is no charge residing inside the cube.

4. (a) Energy released on discharge of capacitor

$$U=\frac{1}{2}CV^2$$

$$=\frac{1}{2}\times4\times10^{-6}\times(100)^2=0.02\text{J}$$

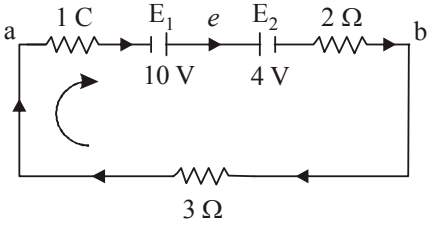
5. (a) Here length $l = 1\text{ cm} = 10^{-2}\text{ m}$
Area of cross-section, A = 1 cm × 100 cm
$= 10^{-2}\text{ m}^2$



Resistance, $R = \rho\frac{\ell}{A} = 3\times10^{-7}\times\frac{10^{-2}}{10^{-2}}$

$= 3\times10^{-7}\Omega$

6. (d) The current in the circuit will be clockwise
Since E_1 (10 V) > E_2 (4V)



Applying Kirchhoff's junction rule
$-1\times i-10-4\times-2\times i-3i=0$
$i =$ 1A (a to b via e)

Current $I=\frac{V}{R}=\frac{10-4}{6}=1\,\text{A}$

7. (a) Power $P=\frac{V^2}{R}=\frac{220\times220}{100}=484\text{ W}$

8. (b) When switched off, resistance of an incandescent lamp increases.

9. (d) Using Faraday's law of electrolysis,
Mass m = Zit
$=0.216\times10^{-3}\times5\times3600$
$=2.27\text{ g}$

10. (c) P = 100 W and V = 125 V

$P=VI\Rightarrow I=\frac{P}{V}=\frac{100}{125}A$

Mass of chlorine liberated = zit

$=0.367\times10^{-6}\times\frac{100}{125}\times60=17.6\text{ mg}$

11. (b) Current, $i = \frac{q}{t} = 100 \times e$

Magnetic field, $B_{centre} = \frac{\mu_0}{4\pi} \cdot \frac{2\pi i}{r}$

$= \frac{\mu_0}{4\pi} \cdot \frac{2\pi \times 100e}{r}$

$\frac{\mu_0 \times 200 \times 1.6 \times 10^{-19}}{4 \times 0.8} = 10^{-17}\mu_0$

12. (a) Torque, $T = ni\,(A \times B)$

13. (a) Magnetic Flux, $\phi = B \cdot A$

Change in flux, $d\phi = B \cdot dA$

$= 0.05(101 - 100) \times 10^{-4}$

$= 5 \times 10^{-6}$ Wb

Charge $dQ = \frac{d\phi}{R}$

$= \frac{5 \times 10^{-6}}{2} = 2.5 \times 10^{-6} C$

14. (d) Induced emf $e = M\frac{di}{dt}$

$= \frac{\mu_0 N_1 N_2 A}{l} \cdot \frac{di}{dt}$

$= \frac{4\pi \times 10^{-7} \times 2000 \times 300 \times 1.2 \times 10^{-3}}{0.30} \times \frac{|2-(-2)|}{0.25}$

$= 48.2 \times 10^{-3}$ V $= 48$ mV

15. (b) Here, impedence $z = \sqrt{R^2 + X_L^2}$

$= \sqrt{(10)^2 + (2\pi \times 60 \times 2)^2} = 753.7$

$\therefore$ Current $i = \frac{V}{Z} = \frac{120}{753.7} = 0.159$ A

16. (b) As we know, $Q = ne$

Number of electron $n = \frac{Q}{e}$

$\frac{6.35 \times 10^{-19}}{1.6 \times 10^{-19}} = 3.9 = 4$

17. (c)

18. (b) Since, $\lambda_r > \lambda_y > \lambda_g$

the wevelength of red light is greater than threshold wavelength and hence no electrons are emitted.

19. (c) If E is the energy of incident photon and W_0 the work function, then

Available energy $= E - W_0$

$E - W_0 = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2(E - W_0)}{m}}$

$\frac{v_1}{v_2} = \sqrt{\frac{1 - 0.5}{2.5 - 0.5}} = \frac{1}{2}$

20. (c) According to question $\lambda_e = \lambda_P$

or $\frac{h}{\sqrt{2m_e Q_e V}} = \frac{h}{\sqrt{2m_p Q_p V_p}}$

$\therefore \quad m_e Q_e V = m_p Q_p V_p$

$\therefore \quad V_p = \left(\frac{m_e}{m_p}\right)\left(\frac{Q_e}{Q_p}\right)V$

$= \left(\frac{1}{2000}\right)(1)V$

$= \frac{V}{2000} volt$

21. (d) As we know, $\frac{1}{2}mv^2 = eV$

$\Rightarrow \quad v = \sqrt{\frac{2eV}{m}}$

$p = mv = \sqrt{2meV}$

Now, $p_e = \sqrt{2m_e \times e \times 100}$

and $p_\alpha = \sqrt{4m_\alpha \times e \times 100}$

$\therefore \quad \frac{p_e}{p_\alpha} = \sqrt{\frac{m_e}{2m_\alpha}}$

22. (a)

23. (c) Frequency deviation is the frequency of an FM transmitter without signal input.

24. (d) Here, $N_0 = \frac{3}{5}N_0 e^{-\lambda t}$

$e\lambda^t = \frac{5}{3}$

$\therefore \quad \log\ e^{\lambda t} = \log_e \frac{5}{3}$ or $\lambda t = \log_e \frac{5}{3}$

or $\quad t = \frac{1}{\lambda}\log_e \frac{5}{3}$

$= \frac{T}{0.693} \times 0.5 \qquad \left(\because T = \frac{0.693}{\lambda}\right)$

$= \frac{5570 \times 0.5}{0.693} yr = 4018.7 yrs$

25. (d) Field inside the metallic shell is zero.

26. (b) Potential at A

$= +\frac{q}{\sqrt{a^2+b^2}} - \frac{q}{\sqrt{a^2+b^2}} = 0$

27. (a) Potential difference between two points in an electric field

$V_A - V_B = \frac{W}{q_0}$

where W is work done by moving charge q_0 from point A to B

Here, W = 2J, q_0 = 20 c

$V_A - V_B = \frac{2}{20} = 0.1$ volt

28. (b) Maximum electric field, $E_{max} = \frac{1}{4\pi\varepsilon_0}\frac{Q_{max}}{R^2}$

$3 \times 10^6 = \frac{9 \times 10^9 \times Q_{max}}{2.5 \times 2.5}$

or $\quad Q_{max} = \frac{3 \times 10^6 \times 2.5 \times 2.5}{9 \times 10^9}$

$= 2 \times 10^{-3}$ C

29. (a) In parallel combination, the potential difference across each individual capacitor is the same as the potenital difference across the combination.

So, potential difference across capacitor of capacity C is $\frac{V}{2}$.

Charge on capacitor, $C = \frac{Q}{V}$

$\therefore$ Charge on capacitor of capacity $C = \frac{CV}{2}$

30. (a) It is a parallel combination of three resistances, each of 10 Ω.

$\therefore$ The effective resistance between points A and B.

$\frac{1}{R} = \frac{1}{10} + \frac{1}{10} + \frac{1}{10}$

or $\quad R = \frac{10}{3}\Omega$

31. (b) Here, $E_1 \propto 64$

$E_1 - E_2 \propto 8$

$E_2 \propto l$

$\therefore \quad 64 - l = 8$ or $l = 64 - 8 = 56$ cm

32. (b) $E_{mag} = \frac{B^2}{2\mu_0}$

33. (c) $\frac{k}{\omega}$ is independent of λ

34. (a) Shunt $S = \frac{GI_g}{I - I_g}$

$= \frac{0.81 \times 1}{10 - 1} = \frac{0.81}{9}\Omega = 0.09\Omega$

35. (a) Final current, $I = \frac{E}{R} = 10$ A

Energy stored in the magnetic field

$U = \frac{1}{2}Li$

$\frac{1}{2} \times 5 \times (10)^2 = 250$ J

36. (a) ${}^{A}_{Z}X \rightarrow {}^{4}_{2}He + {}^{A-2}_{Z-2}Y$

${}^{A-4}_{Z-2}Y \rightarrow e^+ + {}^{A-4}_{Z-3}Y'$

During β^+ emission.

${}_1p^1 \rightarrow {}_0n^1 + \beta^+$

The proton changes into neutron. So, charge number decreases by 1 but mass number remains unchanged.

37. (a) Intensity, $I \propto 4a^2 \cos^2 \frac{\phi}{2}$

In the first case, $\phi = 2\pi$

$\therefore \quad I' \propto 4a^2$

In the second case, $\phi = -\frac{2\pi}{3}$

$\therefore \quad I' \propto 4a^2 \cos^2 \frac{2\pi}{3}$ or $I' \propto a^2$

$\frac{I'}{I} = \frac{1}{4}$ or $I' = \frac{1}{4}$

38. (c) Here, $\theta p + r = 90°$

$\Rightarrow \quad r = 90° - \theta p$

or $\quad r = 90° - 53° 4' = 36°56$

39. (a) Potential gradient $\frac{dv}{dx} = \frac{e}{(R + R_h + r)} \cdot \frac{R}{L}$

$= \frac{2}{(15+5+0)} \times \frac{5}{1} = 0.5 \ \ V/m$

$= 0.005$ V/cm

40. (b) For 100% efficiency

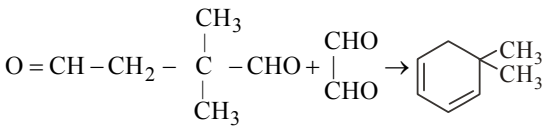
$V_s i_s = V_p i_p$

$1100 \times 2 = 220 \times i_p$

i.e., Primary current, $i_p = 10$A

PART - II (CHEMISTRY)

41. (b) The products formed as a result of ozonolysis suggests



2, 2 - dimethyl butane glyoxal (C_8H_{12})
1, 4 - dial

42. (b) The electronic configuration of Ni is

Ni(28) = [Ar] $3d^8, 4s^2$

Ni^{2+} = [Ar] $3d^8$

Both Ni and Ni^{2+} have two unpaired electrons.

CO and CN^- are strong field ligands and thus unpaired electrons get paired. Hence, $Ni(CO)_4$ and $[Ni(CN)_4]^{2-}$ are diamagnetic. Cl^- is a weak field ligand hence, no pairing of e^- will take place. hence $NiCl_4^{2-}$ is paramagnetic.

43. (b) The equivalent conductance of $BaCl_2$ can be calculated as

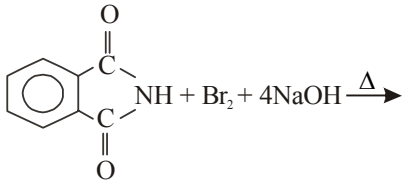
$\Lambda^{\infty}_{(BaCl_2)} = \Lambda^{\infty}_{(Ba^{2+})} + 2\Lambda^{\infty}_{(Cl^-)}$

$= 127 + 2 \times 76$

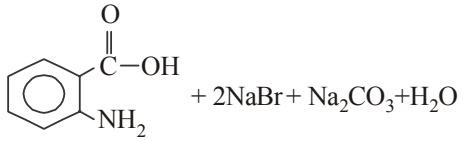
$= 127 + 152$

$= 279$ Scm^2/equiv.

44. (d)

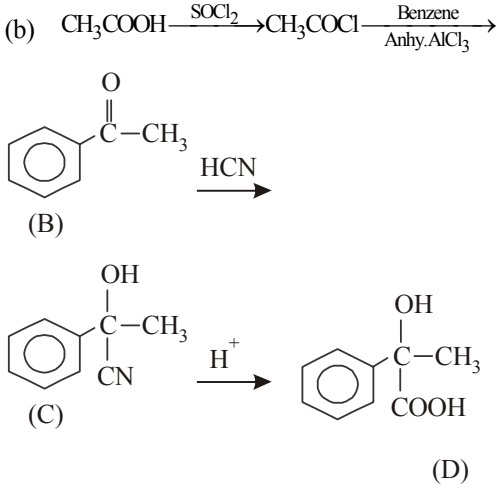


phthalimide



anthranilic acid

45. (b)

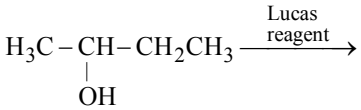


(B)

(C)

(D)

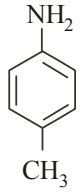
46. (d) Secondary alcohol, when shaken with a mixture of anthydrous $ZnCl_2$ and conc. HCl (Lucas regent) gives an oily layer product after five minutes.



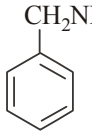
oily layer product after 5 min.

The amines in which amino group is directly attached to benzene ring undergo diazotisation reaction.

47. (b) *p*-toluidine contains amino group attached directly to benzene ring, thus undergo diazotisation reaction and gives red dye. In benzyl amine, the amino group is not directly attached to benzene ring. Hence, it will not undergo diazotisation reaction.



p-toluidine



benzyl amine

Thus, these two can be distinguished by dye test.

48. (c) $C_2H_5Br + Na^{\bullet} \longrightarrow CH_3CH_2^{\bullet} + NaBr$

Intermediate free radical $CH_3CH_2^{\bullet}$ combines to form $CH_3CH_2 - CH_2CH_3$ (as a main product) and also $CH_2 == CH_2$ and CH_3CH_3 by disproportion

$$CH_3CH_2^{\bullet} + CH_3CH_2^{\bullet} \rightarrow \underset{\text{n-butane}}{CH_3CH_2-CH_2CH_3}$$

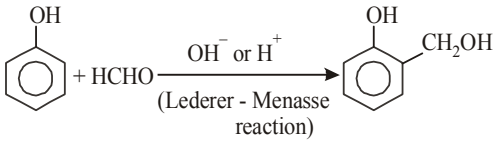
$$CH_3CH_2^{\bullet} + CH_3CH_2^{\bullet} \longrightarrow CH_2 = CH_2 + CH_3 - CH_3$$

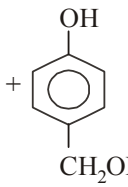
(disproportion reaction)

49. (a) Ethers, In the presence of air and light form peroxides

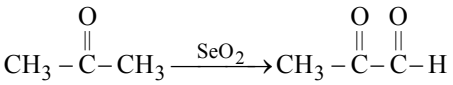
50. (c) Glycerine is used as a preservative because it keeps the fruit moist.

51. (b)



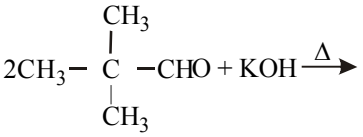


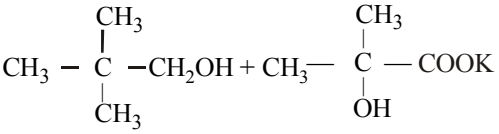
52. (a) In presence of SeO_2 compounds containing active methylene (i.e., CH_2 next to the carbonyl group) oxidises to another CO group.



$+Se + H_2O$

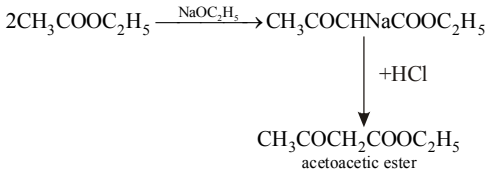
53. (c) Aldehydes which have no α-H atom give Cannizzaro's reaction, $(CH_3)_3C - CHO$ does not contain α-H atom, hence it will give Cannizzaro reaction.





54. (a) Secondary structure involves α-helical and β-pleated sheet like structure. Where as Primary strucure involves sequence of α-amino acids polypeptide chain.

55. (b)



56. (d) In aniline, *p*-methoxyaniline and *p*-methyl aniline, the lone pair of electrons on the N-atom is delocalised on the benzene ring while in benzylamine it is delocalised, and more available for donation. Hence benzylamine is most basic among the given.

57. (c) Mn_2O_7 dissolves in water to give permanganic acid which is purple in colour.

$$Mn_2O_7 + H_2O \longrightarrow \underset{\text{Purple}}{2HMnO_4}$$

58. (b) "925 fine silver" means 925 parts of pure Ag in 1000 parts of an alloy. Therefore, in terms of percentage, it will be 92.5% Ag and 7.5% Cu.

59. (a) Spectrochemical series. According to the strength of splitting is as:

$$CO > CN^- > NO_2^- > en > NH_3 > py > NCS^-$$
$$> H_2O > O^{2-} > ox^{2-} > OH^- > F > Cl^-$$
$$> SCN^- > S^{2-} > Br^- > I^-$$

Crystal field stabilisation energy (CFSE) for octahedral complex, Δ° depends on the strength of negative ligand. [Higher the strength more will be the CFSE]

60. (b) KCN forms complex with Cu^+ and Cd^{2+} as $K_3[Cu(CN)_4]$ and $K_2[Cd(CN)_4]$ respectively. On passing H_2S, only Cd^{2+} complex gets decomposed to yellow CDS.

61. (a) EAN =at. no. of central atom – oxidation state +2 (number of ligands)
$= 27 - 3 + 2(6)$
$= 27 - 3 + 12 = 36$

62. (d) $[Co(NO_2)(NH_3)_5]Cl_2$
Pentamminenitrito-N-cobalt (III) chloride.

63. (d) I-131 radio-isotope is used for thyroid disorders.

64. (b) Tetragonal crystal system has the unit cell dimensions
$a = b \neq c, \alpha = \beta = \gamma = 90^\circ$

65. (c) A crystalline solid undergoes deformation of its geometry by application of pressure or heat.

66. (c) $\therefore \quad 100 \times p = V_2 \times \dfrac{40p}{100}$

$V_2 = 250$ cc (Total volume)
Volume of bulb B $= 250 - 100 = 150$ cc

67. (a) $NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$

m mol added	$20 \times 0.2 = 4$	$50 \times 0.2 = 10$	0	0
m mol after reaction	0	6	4	4

$$[CH_3COOH = \frac{6}{70} \quad : \quad [CH_3COONa] = \frac{4}{70}$$

Now since for a basic buffer

$$pH = -\log k_a + \log \frac{[salt]}{[base]}$$

$$\therefore \quad pH = -\log (1.8 \times 10^{-5}) + \log \frac{4/70}{6/70}$$
$$= 4.56$$

68. (b) $2\overset{+3}{Fe_2}O_3 \cdot \overset{+3}{Cr_2}O_3 + 4Na_2CO_3 + 3O_2$
$\rightarrow 2\overset{+3}{Fe_2}O_3 + 4Na_2\overset{+6}{Cr}O_4 + 4CO_2$

Hence, the oxidation state of chromium increase from + 3 to + 6.

69. (b) $\Delta T_f = iK_f m$

$$m = \frac{10 \times 1000}{74.55 \times 100} = 1.34\text{m}$$

[Molecular Mass of KCl = 74.55]

$$i = \frac{\Delta T_f}{K_f m} = \frac{4.5^\circ C}{(1.86^\circ C/m)(1.34m)} = 1.8$$

70. (c) $2NO_2 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} N_2O_4$

$$\text{Rate} = -\frac{1}{2}\frac{d[NO_2]}{dt} = k_1[NO_2]^2 - k_2[N_2O_4]$$

$\therefore$ Rate of disappearance of NO_2 i.e.,

$$-\frac{d[NO_2]}{dt} = 2k_1[NO_2]^2 - k_2[N_2O_4]$$

71. (c) For every 10° rise in temperture, Rate gets double. Hence, in this case rate constant will become four time. (d) *i*.e.,
$k_1 = 4k_2$
$k_2 = 0.25k_1$
as the Rise in temperature given is 20°C

72. At $T_1 = 200$ K, if $k_1 = k$
then at $T_2 = 400$ K, $k_2 = 10k$

$$\log \frac{10k}{k} = \frac{E_a}{2.303R}\left(\frac{400 - 200}{400 \times 200}\right)$$

$E_a = 921.2R$

73. (a) $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$

Initial pressure	0.5 atm		
At equi	$(0.5 - x)$		

$\therefore$ Total no. of moles at equilibrium
$= (0.5 - x) + 2x = 0.8$

$\therefore \quad x = 0.3$ atm.

$\therefore \quad p_{CO_2} = 0.5 - 0.3 = 0.2$
$P_{CO} = 2x = 2 \times 0.3 = 0.6$ atm

$$K = \frac{p_{CO}^2}{p_{CO_2}} = \frac{(0.6)^2}{0.2} = 1.8 \text{ atm}$$

74. (a) $2A + B \rightleftharpoons C$, $\Delta H = x$ cals.

Since the reaction is endothermic and $n_p < n_r$. Hence, high pressure and high temperature will favour forward reaction.

75. (b) The cell reaction is

$Mg + Sn^{2+} \rightarrow Mg^{2+} + Sn$

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{2}\log\frac{[Mg^{2+}]}{[Sn^{2+}]}$$

$$= (2.34 - 0.14) - \frac{0.0591}{2}\log\frac{10^{-2}}{10^{-1}} = 2.23\ V$$

76. (a) Explosive compound has high heat content i.e., it is formed by absorption of heat. Hence, ΔH°_f is positive.

77. (b) $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$

$\Delta n_g = n_p - n_r$

$= 3 - 6 = -3$

$\Delta H = \Delta E + \Delta n_g RT$

$\Delta H = \Delta E - 3RT$

$\Delta H - \Delta E = -3RT$

78. (a) $\because \Delta G = \Delta H - T\Delta S$

For a spontaneous reaction, ΔG should be negative. Hence, ΔH = +ve, ΔS = +ve and $T\Delta S > \Delta H$

79. (b) Gas (Y) SO_2 which can be obtained from Na_2SO_3(A) and gas (Z) is H_2S which can be obtained from Na_2S(B).

This can be easily understood by the following reactions.

$Na_2SO_3 + 2HCl \rightarrow 2NaCl + SO_2 + H_2O$

(A) (Y)

$Na_2S + 2HCl \rightarrow 2NaCl + H_2S$

(B) (Z)

$K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$

$Pb(CH_3COO)_2 + H_2S \rightarrow \underset{\text{black}}{PbS\downarrow} + 2CH_3COOH$

80. (d) Higher the bond order higher will be the stability.

When the bond order of two molecules are same, the molecule with least number of antibonding electrons is more stable.

Molecular orbital configuration of H_2^+ is

$H_2^+(1) = \sigma 1s^1$

$$BO = \frac{1-0}{2} = 0.5$$

Molecular orbital configuration of He_2^+ is

$He_2^+(3) = \sigma 1s^2, \overset{*}{\sigma} 1s^1$

$$BO = \frac{2-1}{2} = 0.5$$

Hence, stability of H_2^+ > stability of He_2^+.

PART - III (MATHEMATICS)

81. (a) The equation of the bisectors of the angle between the lines given by $ax^2 + 2hxy + by^2 = 0$ is

$$\frac{x^2 - y^2}{a - b} = \frac{xy}{h} \quad \text{...(i)}$$

And the equation of the bisectors of the angle between the lines given by $a^2x^2 + 2h(a + b)xy + b^2y^2 = 0$ is

$$\frac{x^2 - y^2}{a^2 - b^2} = \frac{xy}{h(a+b)}$$

$$\Rightarrow \frac{x^2 - y^2}{a - b} = \frac{x}{h} \quad \text{...(ii)}$$

From eqs. (i) and (ii), it is clear that both the pair of straight lines have the same bisector, hence, the given two pairs of straight lines are equally inclined.

82. (c) $A = \{1, 2, 3, 4\}$ and $B = \{1, 3, 5\}$

$\therefore R = \{(1,3), (1,5), (2,3), (2,5), (3,5), (4,5)\}$ and $R^{-1} = \{(3,1), (5,1), (3,2), (5,2), (5,3), (5,4)\}$

$\therefore ROR^{-1} = \{(3,3), (3,5), (5,3), (5,5)\}$

83. (c) $$(1 - i\sqrt{3})^{100} = 2^{100}\left(-\frac{1}{2} + \frac{i\sqrt{3}}{2}\right)^{100}$$

$$= 2^{100}\,\omega^{100} = 2^{100}\,\omega$$

$$= 2^{100}\left(-\frac{1}{2} + \frac{\sqrt{3}i}{2}\right) = -2^{99} + 2^{99}\sqrt{3}i$$

Now, $x + iy = (1 - i\sqrt{3})^{100}$

$= -2^{99} + 2^{99}\sqrt{3}i$

$\Rightarrow x = -2^{99}, y = 2^{99}\sqrt{3}$

$\therefore (x, y) = (-2^{99}, -2^{99}\sqrt{3})$

84. (a) Given, $a_n = 3(2^n)$

$a_{n+1} = 3(2^{n+1})$

$\therefore r = \frac{a_{n+1}}{a_n} = \frac{3(2^{n+1})}{3(2^n)} = 2$

85. (c) a, b, c are in HP.

$\Rightarrow \frac{1}{a}, \frac{1}{b}, \frac{1}{c}$ are in AP.

$\Rightarrow \frac{a+b+c}{a}, \frac{a+b+c}{b}, \frac{a+b+c}{c}$ are in AP.

$\Rightarrow 1+\frac{b+c}{a}, 1+\frac{a+c}{b}, 1+\frac{a+b}{c}$ are in AP.

$\Rightarrow \frac{b+c}{a}, \frac{a+c}{b}, \frac{a+b}{c}$ are in AP.

$\Rightarrow \frac{a}{b+c}, \frac{b}{c+a}, \frac{c}{a+b}$ are in HP.

86. (d) $\frac{x^2+2x+7}{2x+3} < 6$

$\Rightarrow \frac{x^2+2x+7}{2x+3} - 6 < 0$

$\Rightarrow \frac{x^2-10x-11}{2x+3} < 0$

$\Rightarrow \frac{(x-11)(x+1)}{2x+3} < 0$

$\Rightarrow \frac{(x-11)(x+1)(2x+3)}{(2x+3)^2} < 0$

$\Rightarrow (x-11)(x+1)(2x+3) < 0$

$\Rightarrow x \in \left(-\infty, -\frac{3}{2}\right) \cup (-1, 11)$

87. (a) The number of faces is equal to the number of colours.
Therefore the number of ways of painting them is 1.

88. (d) Equation of line perpendicular to $3x + y - 3 = 0$ is
$x - 3y + c = 0$
Since, it passes through (2, 2).
$\therefore c = 4$
$\therefore$ Equation of line perpendicular to $3x + y - 3 = 0$ is $x - 3y + 4 = 0$
For y - intercept, put $x = 0$

$\therefore y = \frac{4}{3}$

89. (b) The centres of the given circles $x^2 + y^2 = 4$ and $x^2 + y^2 - 6x - 8y = 24$ are $C_1(0, 0)$ and $C_2(3, 4)$ respectively. Their radii are $r_1 = 2$ and $r_2 = 7$ respectively.
$C_1C_2 = 5 <$ sum of radii
But $C_1C_2 =$ difference of radii
Thus, the given circles touch each other internally.
Hence, number of common tangent is only one.

90. (d) $1 - e^{\frac{1}{x-1}} > 0$

$\Rightarrow e^{\frac{1}{x-1}} < 1 \quad \Rightarrow \frac{1}{x} - 1 < \log 1$

$\Rightarrow \frac{1}{x} - 1 < 0 \Rightarrow \frac{1}{x} < 1$

$\Rightarrow x \in (-\infty, 0) \cup (1, \infty)$

91. (d) $\lim_{x\to 0} \frac{\sqrt{1-\cos x}}{x} = \lim_{x\to 0} \frac{\sqrt{2}\left|\sin\frac{x}{2}\right|}{x}$

$= \sqrt{2} \lim_{x\to 0} \frac{\left|\sin\frac{x}{2}\right|}{x}$

It can be easily seen that LHL at $x = 0$ is $x = -\frac{1}{\sqrt{2}}$ and RHL at $x = 0$ is $\frac{1}{\sqrt{2}}$.

Hence, $\lim_{x\to 0} \frac{\sqrt{1-\cos x}}{x}$ does not exist.

92. (a) Let $I = \int \frac{x^2+4}{x^4+16} dx$

$= \int \frac{1+\frac{4}{x^2}}{x^2+\frac{16}{x^2}} dx = \int \frac{1+\frac{4}{x^2}}{\left(x-\frac{4}{x}\right)^2+8} dx$

Putting $x - \frac{4}{x} = t$,

So that $\left(1+\frac{4}{x^2}\right) dx = dt$

$$\therefore I = \int \frac{dt}{t^2 + (2\sqrt{2})^2}$$

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

$$\Rightarrow I = \frac{1}{2\sqrt{2}} \tan^{-1}\left(\frac{x - \frac{4}{x}}{2\sqrt{2}}\right) + C$$

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

93. (a) $\int_{\pi/4}^{3\pi/4} \frac{1}{1+\cos x} dx = \int_{\pi/4}^{3\pi/4} \frac{1-\cos x}{\sin^2 x} dx$

$= \int_{\pi/4}^{3\pi/4} (\text{cosec}^2 x - \cot x \text{ cosec } x)\, dx$

$= \left[-\cot x + \text{cosec } x\right]_{\pi/4}^{3\pi/4}$

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

94. (b) Let a and b are two numbers.

Then, $A = \frac{a+b}{2}$ ...(i)

Also, a, p, q, b are in GP.

$\therefore \frac{p}{a} = \frac{q}{p} = \frac{b}{q}$

$\Rightarrow \frac{p^2}{q} = a$ and $\frac{q^2}{p} = b$

$\therefore \frac{p^2}{q} + \frac{q^2}{p} = a + b = 2A$ [Using eq. (i)]

95. (b) $f(x) = x^2 + ax + b$, then
$f(x + c) = (x + c)^2 + a(x + c) + b$
$= x^2 + (2c + a)x + c^2 + ac + b$
which shows that the roots of f (x) are transformed to (x – c) i.e., roots of $f(x + c) = 0$ are c – c and d – c.
Hence, one of the roots of the equation $f(x + c)$ is (d – c).

96. (a) For the sum of the coefficients in the expansion of $(6a - 5b)^n$, put a = b = 1
$\therefore$ Sum of the coefficients $= (6 - 5)^n$
$= 1^n = 1$

97. (b) $(7.995)^{1/3} = (8 - 0.005)^{1/3}$

$= 2\left(1 - \frac{0.005}{8}\right)^{1/3}$

$= 2\left[1 + \left(\frac{1}{3}\right)\left(-\frac{0.005}{8}\right)\right] = 2[1 - 0.000208]$

$= 1.9996$

98. (b) $\lim_{x\to\infty}\left(\frac{x^2+1}{x+1} - ax - b\right) = 0$

$\Rightarrow \lim_{x\to\infty}\left[\frac{x^2(1-a) - (a+b)x - b + 1}{x+1}\right] = 0$

$\Rightarrow 1 - a = 0$ and $a + b = 0 \Rightarrow a = 1, b = -1$

99. (b) Let $\mathbf{a} = \mathbf{i} - 2\mathbf{j} + \mathbf{k}$ and $\mathbf{b} = 4\mathbf{i} - 4\mathbf{j} + 7\mathbf{k}$, then projection of $\mathbf{a}$ on $\mathbf{b}$ is equal to

$$\frac{\mathbf{a}.\mathbf{b}}{|\mathbf{b}|} = \frac{4 + 8 + 7}{\sqrt{16 + 16 + 49}} = \frac{19}{9}$$

100. (a) Here, $\mathbf{a} + \mathbf{b} + \mathbf{c} = 0$
$\Rightarrow |\mathbf{a} + \mathbf{b} + \mathbf{c}|^2 = 0$
$\Rightarrow |\mathbf{a}|^2 + |\mathbf{b}|^2 + |\mathbf{c}|^2 + 2\{\mathbf{a}.\mathbf{b} + \mathbf{b}.\mathbf{c} + \mathbf{c}.\mathbf{a}\} = 0$
$\Rightarrow \mathbf{a}.\mathbf{b} + \mathbf{b}.\mathbf{c} + \mathbf{c}.\mathbf{a}$

$= -\frac{1}{2}\{|\mathbf{a}|^2 + |\mathbf{b}|^2 + |\mathbf{c}|^2\} < 0$

$\Rightarrow m < 0$

101. (a) Let γ is the required angle, then
$\cos^2 45° + \cos^2 60° + \cos^2\gamma = 1$

$\Rightarrow \frac{1}{2} + \frac{1}{4} + \cos^2\gamma = 1$

$\Rightarrow \cos^2\gamma = 1 - \frac{3}{4} = \frac{1}{4}$

$\Rightarrow \cos\gamma = \frac{1}{2} \Rightarrow \gamma = 60°$

102. (a) $B = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$

$= \begin{bmatrix} \cos\theta & 0 \\ 0 & \cos\theta \end{bmatrix} + \begin{bmatrix} 0 & \sin\theta \\ -\sin\theta & 0 \end{bmatrix}$

$= \cos\theta \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} + \sin\theta \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$

$= I\cos\theta + J\sin\theta$

103. (c) According to the definition of determinant, determinant is a number associated to a square matrix.

104. (c) α, β, γ are the roots of given equation,
Therefore $\alpha+\beta+\gamma=-a$
$\alpha\beta+\beta\gamma+\gamma\alpha=0$
and $\alpha\beta\gamma=-b$

Now, $\begin{vmatrix}\alpha & \beta & \gamma\\ \beta & \gamma & \alpha\\ \gamma & \alpha & \beta\end{vmatrix}=-(\alpha+\beta+\gamma)$

$(\alpha^2+\beta^2+\gamma^2-\alpha\beta-\beta\gamma-\gamma\alpha)$
$=-(\alpha+\beta+\gamma)[(\alpha+\beta+\gamma)^2$
$-3(\alpha\beta+\beta\gamma+\gamma\alpha)]$
$=-(-a)(a^2-0)=a^3$

105. (b) Substituting $x = X + 1$ and $y = Y - 2$ in given equation, we get
$2(X+1)^2+(Y-2)^2-4(X+1)+4(Y-2)=0$
$\Rightarrow 2X^2+Y^2=6$

106. (a) Given $f(x)=\begin{cases} x^2, & x\le 0\\ 2\sin x, & x>0,\end{cases}$

$f'(x)=\begin{cases} 2x, & x<0\\ \text{non differentiable}, & x=0\\ 2\cos x, & x>0\end{cases}$

So, $x=0$ is a critical point $f(0^-)>0$ as well as $f(0^+)>0$ and $f(0)=0$
Hence, it is a point of minima.

107. (a) $x * a = b \Rightarrow (x * a) * a^{-1} = b * a^{-1}$
$\Rightarrow x *(a * a^{-1}) = b * a^{-1}$
$\Rightarrow x *e = b * a^{-1}$
$\Rightarrow x = b * a^{-1}$

108. (b) Let A and B be two events such that
A= getting number 2 at least once
B = getting 7 as the sum of the numbers on two dice
Here,
A = {(2, 1), (2, 2), (2, 3), (2, 4), (2, 5), (2, 6), (1, 2), (3, 2), (4, 2), (5, 2), (6, 2)}
and
B = {(2, 5), (5, 2), (6, 1), (1, 6), (3, 4), (4, 3)}

$\therefore P(A)=\frac{11}{36}, P(B)=\frac{6}{36}$

$P(A\cap B)=\frac{2}{36}$

$\therefore$ Required probability

$P(A/B)=\frac{P(A\cap B)}{P(B)}=\frac{2/36}{6/36}=\frac{2}{6}=\frac{1}{3}$

109. (b) Any chord PQ which bisected point R (h, k) is T = S
i.e., $ky-2a(x+h)=k^2-4ah$
Since, it is a focal chord, so it must pass through focus (a, 0).
$\therefore k(0)-2a(a+h)=k^2-4ah$
$\Rightarrow k^2=2ah-4a^2$
Hence, locus is
$y^2=2a(x-a)$

110. (d) $\sin 12^\circ \sin 48^\circ \sin 54^\circ$
$=\sin 12^\circ \sin(60^\circ-12^\circ)\sin(90^\circ-36^\circ)$

$=\frac{\sin 12^\circ \sin(60^\circ-12^\circ)\sin 72^\circ \cos 36^\circ}{\sin 72^\circ}$

$=\frac{[\sin 12^\circ \sin(60^\circ-12^\circ)\sin(60^\circ+12^\circ)\cos 36^\circ]}{\sin 72^\circ}$

$=\frac{\sin 12^\circ(\sin^2 60^\circ-\sin^2 12^\circ)\cos 36^\circ}{\sin 72^\circ}$

$=\frac{\sin 12^\circ\left(\frac{3}{4}-\sin^2 12^\circ\right)\cos 36^\circ}{\sin 72^\circ}$

$=\frac{3\sin 12^\circ-4\sin^3 12^\circ)}{4}.\frac{\cos 36^\circ}{\sin 72^\circ}$

$=\frac{\sin 36^\circ \cos 36^\circ}{4\sin 72^\circ}=\frac{1}{2}\frac{\sin 72^\circ}{4\sin 72^\circ}=\frac{1}{8}$

111. (b) We have, $\Delta=\frac{\sqrt{3}}{4}a^2, s=\frac{3a}{2}$

Inradius $r=\frac{\Delta}{s}=\frac{a}{2\sqrt{3}}$

Circumradius $R=\frac{abc}{4\Delta}=\frac{a^3}{\sqrt{3}a^2}=\frac{a}{\sqrt{3}}$

and exradii $r_1=\frac{\Delta}{s-a}=\frac{\sqrt{3}/4a^2}{a/2}$

$=\frac{\sqrt{3}}{2}a$

$\therefore$ Required ratio $= r : R : r_1$

$=\frac{a}{2\sqrt{3}}:\frac{a}{\sqrt{3}}:\frac{\sqrt{3}}{2}a=1:2:3.$

112. (b) $p\vee q$ is false only when both p and q are false.

113. (a) Since, each letter can be posted in any one of the five different letter boxes. So, a letter can be posted in 5 ways. Since, there are six letters and each can be posted in 5 ways. So, total number of ways
$= 5 \times 5 \times 5 \times 5 \times 5 \times 5 = 5^6$

114. (b) Since, (1, 4), (2, 6) and (3, 6) are the elements of A × B, therefore 1, 2, 3 are the elements of A and 4, 6 are the elements of B.
Also, A × B has 6 elements
$\therefore$ A = {1, 2, 3}
and B = {4, 6}
$\therefore$ B × A = {(4, 1), (4, 2), (4, 3), (6, 1), (6, 2), (6, 3)}

115. (b) Let $f^{-1}(-5) = x$. Then, $f(x) = -5$
$\Rightarrow x^2 + 1 = -5 \Rightarrow x^2 = -6 \Rightarrow x = \pm\sqrt{-6}$
which does not belong to R.
$\therefore f^{-1}(-5) = \phi$

116. (c) Given : $P(X = 1) = P(X = 2)$

$$\frac{e^{-\lambda}\lambda}{1!} = \frac{e^{-\lambda}\lambda^2}{2!}$$

$\Rightarrow \lambda = 2$

$$\therefore P(X = 4) = \frac{e^{-2}2^4}{4!} = \frac{2}{3e^2}$$

117. (d) Required area $= \int_3^5 (3x - 5)dx$

$$= \left[\frac{3x^2}{2} - 5x\right]_3^5 = \left[\frac{75}{2} - 25\right] - \left[\frac{27}{2} - 15\right]$$

$$= \frac{48}{2} - 10 = 14 \text{ sq units}$$

118. (c) Given differential equation is

$$\left(1 + 4\frac{dy}{dx}\right)^{\frac{2}{3}} = 4\frac{d^2y}{dx^2}$$

$$\left(1 + 4\frac{dy}{dx}\right)^2 = 4^3\left(\frac{d^2y}{dx^2}\right)^3$$

Here, order is 2 and degree is 3.

119. (d) $\frac{dy}{dx} = (4x + y + 1)^2$ …(i)
Put $4x + y + 1 = v$

$$\Rightarrow \frac{dy}{dx} = \frac{dv}{dx} - 4$$

$$\frac{dv}{dx} - 4 = v^2 \qquad (\because \text{ From eq. (i)})$$

$$\Rightarrow \frac{dv}{v^2 + 4} = dx$$

$$\Rightarrow \frac{1}{2}\tan^{-1}\left(\frac{v}{2}\right) = x + C$$

$$\Rightarrow \tan^{-1}\left(\frac{4x + y + 1}{2}\right) = 2x + C$$

$\Rightarrow 4x + y + 1 = 2\tan(2x + C)$

120. (d) Given system of equations are
$2x + y - 5 = 0$ ...(i)
$x - 2y + 1 = 0$ ...(ii)
and $2x - 14y - a = 0$ ...(iii)
This system is consistent

$$\therefore \begin{vmatrix} 2 & 1 & -5 \\ 1 & -2 & 1 \\ 2 & -14 & -a \end{vmatrix} = 0$$

$\Rightarrow 2(2a + 14) - 1(-a - 2) - 5(-14 + 4) = 0$
$\Rightarrow 4a + 28 + a + 2 + 50 = 0$
$\Rightarrow 5a = -80 \Rightarrow a = -16$