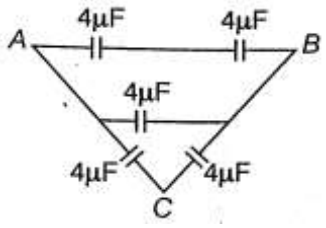
Physics

1. Equivalent capacitance between A and B in the figure is.



(a) 20μ F (b) 8μ F
(c) 12μ F (d) 16μ F

2. Two wires of same radius having lengths l_1 and l_2 and resistivities ρ_1 and ρ_2 are connected in series. The equivalent resistivity will be.

(a) $\frac{\rho_1 l_2+\rho_2 l_1}{\rho_1+\rho_2}$ (b) $\frac{\rho_1 l_1+\rho_2 l_2}{l_1+l_2}$
(c) $\frac{\rho_1 l_1-\rho_2 l_2}{l_1-l_2}$ (d) $\frac{\rho_1 l_2+\rho_2 l_1}{l_1+l_2}$

3. A hollow metal sphere of radius R is charged with a charge Q. The electric potential and intensity inside the sphere are respectively.

(a) $\frac{Q}{4\pi\varepsilon_0 R^2}$ and $\frac{Q}{4\pi\varepsilon_0 R}$
(b) $\frac{Q}{4\pi\varepsilon_0 R}$ and zero
(c) zero and zero
(d) $\frac{4\pi\varepsilon_0 Q}{R}$ and $\frac{Q}{4\pi\varepsilon_{1j} R^2}$

4. The potential difference V required for accelerating an electron to have the de-Broglie wavelength of 1Å is.

(a) 100 V (b) 125 V
(c) 150 V (d) 200 V

5. The work function of Cesium is 2.27 eV . The cut-off voltage which stops the emission of electrons from a cesium cathode irradiated with light of 600 nm wavelength is.

(a) 0.5 V (b) -0.2 V
(c) -0.5 V (d) 0.2 V

6. The number of de-Broglie wavelengths contained in the second Bohr orbit of hydrogen atom is.

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

7. The wavelength of second Balmer line in hydrogen spectrum is 600 nm . The wavelength for its third line in Lyman series is.

(a) 800 nm (b) 600 nm
(c) 400 nm (d) 120 nm

8. A ray of light strikes a glass plate at an angle of 60°. If the reflected and refracted rays are perpendicular to each other, the refractive index of glass is.

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

9. Light travels through a glass plate of thickness t and having refractive index μ. If c be the velocity of light in vacuum, time taken by the light to travel through this thickness of glass is.

(a) $\frac{t}{\mu c}$ (b) $\frac{tc}{\mu}$
(c) $\frac{\mu t}{c}$ (d) μ tc

10. If $x = at + bt^2$, where x is in metre (m) and t is in hour (h), then unit of b will be.

(a) $\frac{m^2}{h}$ (b) m
(c) $\frac{m}{h}$ (d) $\frac{m}{h^2}$

11. The vectors A and B are such that $|\mathbf{A}+\mathbf{B}| = |\mathbf{A}-\mathbf{B}|$. The angle between the two vectors

will be.

(a) 0°. (b) 60°

(c) 90° (d) 45°

12. At a particular height, the velocity of an ascending body is u. The velocity at the same height while the body falls freely is.

(a) $2\mathbf{u}$ (b) $-\mathbf{u}$

(c) $\boldsymbol{u}$ (d) $-2\mathbf{u}$

13. Two bodies of masses m_1 and m_2 are separated by a distance R. The distance of the centre of mass of the bodies from the mass m_1 is.

(a) $\frac{m_2 R}{m_1+m_2}$ (b) $\frac{m_1 R}{m_1+m_2}$

(c) $\frac{m_1 m_2}{m_1+m_2} R$ (d) $\frac{m_1+m_2}{m_1} R$

14. The velocity of sound in air at $20^\circ\mathrm{C}$ and 1 atm pressure is $344.2\ \mathrm{m/s}$. At $40^\circ\mathrm{C}$ and 2 atm pressure, the velocity of sound in air is approximately.

(a) 350 m/s

(b) 356 m/s

(c) 363 m/s

(d) 370 m/s

15. The perfect gas equation for 4 g of hydrogen gas is.

(a) $pV = RT$

(b) $pV = 2RT$

(c) $pV = \frac{1}{2}RT$

(d) $\rho V = 4RT$

16. If the temperature of the Sun gets doubled, the rate of energy received on the Earth will increase by a factor of.

(a) 2 (b) 4

(c) 8 (d) 16

17. A particle vibrating simple harmonically has an acceleration of $16\mathrm{cms}^{-2}$ when it is at a distance of 4 cm from the mean position. Its time period is.

(a) 1 s

(b) 2.572 s

(c) 3.142 s

(d) 6.028 s

18. Work done for a certain spring when stretched through 1 mm is 10 joule. The amount of work that must be done on the spring to stretch it further by 1 mm is.

(a) 30 J (b) 40 J

(c) 10. J (d) 20 J

19. If the rms velocity of hydrogen gas at a certain temperature is c, then the rms velocity of oxygen gas at the same temperature is.

(a) $\frac{C}{8}$ (b) $\frac{C}{10}$

(c) $\frac{c}{4}$ (d) $\frac{C}{2}$

20. For air at room temperature, the atmospheric pressure is $1.0 \times 10^5 \mathrm{Nm}^{-2}$ and density of air is $1.2\mathrm{kgm}^{-3}$. For a tube of length 1.0 m , closed at one end, the lowest frequency generated is 84 Hz . The value of γ (ratio of two specific heats) for air is.

(a) 2.1 (b) 1.5

(c) 1.8 (d) 1.4

21. A gas bubble of 2 cm diameter rises through a liquid of density $1.75\ \mathrm{g\ cm}^{-3}$ with a fixed speed of $0.35\mathrm{cms}^{-1}$. Neglect the density of the gas. The coefficient of viscosity of the liquid is.

(a) 870 poise

(b) 1120 poise

(c) 982 poise

(d) 1089 poise

22. The temperature of the water of a pond is $0^\circ\mathrm{C}$ while that of the surrounding atmosphere is

-20°C. If the density of ice is ρ, coefficient of thermal conductivity is k and latent heat of melting is L, then the thickness Z of ice layer formed increases as a function of time t is.

(a) $Z^2 = \frac{60k}{\rho L}t$ (b) $Z = \sqrt{\frac{40k}{\rho L}t}$

(c) $Z^2 = \frac{40K}{\rho L}\sqrt{t}$ (d) $Z^2 = \frac{40k}{\rho L}t$

23. 1000 droplets of water having 2 mm diameter each coalesce to form a single drop. Given the surface tension of water is 0.072Nm^{-1}. The energy loss in the process is.

(a) 8.146×10^{-4} J

(b) 4.4×10^{-4} J

(c) 2.108×10^{-5} J

(d) 4.7×10^{-1} J

24. A Zener diode having break-down voltage 5.6 V is connected in reverse bias with a battery of emf 10 V and a resistance of 100Ω in series. The current flowing through the Zener diode is.

(a) 88 mA (b) 0.88 mA

(c) 4.4 mA (d) 44 mA

25. In case of a bipolar transistor $\beta = 45$. The potential drop across the collector resistance of $1\text{k}\Omega$ is 5 V . The base current is approximately.

(a) 222μ A

(b) 55μ A

(c) 111μ A

(d) 45μ A

26. An electron enters an electric field having intensity $\text{E} = 3\hat{\text{i}} + 6\hat{\text{j}} + 2\hat{\text{k}}\text{Vm}^{-1}$ and magnetic field having induction $\text{B} = 2\hat{\text{i}} + 3\hat{\text{j}}$ T with a velocity $\text{v} = 2\hat{\text{i}} + 3\hat{\text{j}}\ \text{ms}^{-1}$. The magnitude of the force acting on the electron is (Given, $e = -1.6 \times 10^{-19}\text{C}$)

(a) 2.02×10^{-18} N

(b) 5.16×10^{-16} N

(c) 3.72×10^{-17} N

(d) 1.79×10^{-18} N

27. Two coils of self-inductances 6 mH and 8 mH are connected in series and are adjusted for highest coefficient of coupling. Equivalent self-inductance L for the assembly is approximately.

(a) 50 mH

(b) 36 mH

(c) 28 mH

(d) 18 mH

28. A 1μ F capacitor C is connected to a battery of 10 V through a resistance $1\text{M}\Omega$. The voltage across C after 1 s is approximately.

(a) 5.6 V

(b) 7.8 V

(c) 6.3 V

(d) 10 V

29. Two equal resistances, 400Ω each, are connected in series with a 8 V battery. If the resistance of first one increases by 0.5%, the change required in the resistance of the second one in order to keep the potential. difference across it unaltered is to.

(a) increase it by 1Ω

(b) increase it by 2Ω

(c) increase it by 4Ω

(d) decrease it by 4Ω

30. Angle between an equipotential surface and electric lines of force is.

(a) 0° (b) 90°

(c) 180° (d) 270°

31. A current $I = I_0 e^{-\lambda t}$ is flowing in a circuit consisting of a parallel combination of resistance R and capacitance C. The total charge over the entire pulse period is.

(a) $\frac{I_0}{\lambda}$ (b) $\frac{2I_0}{\lambda}$

(c) $1_0\lambda$ (d) $e^{10\lambda}$

32. For Fraunhoffer diffraction to occur.
(a) Light source should be at infinity
(b) Both source and screen should be at infinity
(c) Only the source should be at finite distance
(d) Both source and screen should be at finite distance

33. The temperature of a blackbody radiation enclosed in a container of volume V is increased from $100^{\circ}C$ to $1000^{\circ}C$. The heat required in the process is.
(a) 4.79×10^{-4}cal
(b) 9.21×10^{-5}cal
(c) 2.17×10^{-4}cal
(d) 7.54×10^{-4}cal,

34. A mass of 1 kg is suspended by means of a thread. The system is (i) lifted up with an acceleration of $4.9\ ms^{-2}$. (ii) lowered with an acceleration of $4.9\ ms^{-2}$. The ratio of tension in the first and second case is.
(a) 3:1 (b) 1:2
(c) 1:3 (d) 2:1

35. The effective resistance between A and B in the figure is $\frac{7}{12}\Omega$ if each side of the cube has 1Ω resistance. The effective resistance between the same two points, when the link AB is removed, is.
(a) $\frac{7}{12}\Omega$ (b) $\frac{5}{12}\Omega$
(c) $\frac{7}{5}\Omega$ (d) $\frac{5}{7}\Omega$

Category III (Q. 36 to Q. 40) One or more answer (s) is (are) correct.

36. A charged particle of mass m_1 and charge q_1 is revolving in a circle of radius r. Another charged particle of charge q_2 and mass m_2 is situated at the centre of the circle. If the velocity and time period of the revolving particle be v and T respectively, then.
(a) $v = \sqrt{\frac{q_1 q_2 r}{4\pi\varepsilon_0 m_1}}$ (b) $v = \frac{1}{m_1}\sqrt{\frac{q_1 q_2}{4\pi\varepsilon_0!}}$
(c) $T = \sqrt{\frac{16\pi^3\varepsilon_0 m_1^2 r^3}{q_1 q_2}}$ (d) $T = \sqrt{\frac{16\pi^3\varepsilon_0 m_2 r^3}{q_1 q_2}}$

37. The distance between a light source and photoelectric cell is d. If the distance is decreased to $\frac{d}{2}$, then.
(a) the emission of electron per second will be four times
(b) maximum kinetic energy of photoelectrons will be four times
(c) stopping potential will remain same
(d) the emission of electrons per second will be doubled

38. A train moves from rest with acceleration α and in time t_1 covers a distance x. It thdecelerates to rest at constant retardation β for distance y in time t_2. Then,
(a) $\frac{x}{y} = \frac{\beta}{\alpha}$ (b) $\frac{\beta}{\alpha} = \frac{t_1}{t_2}$.
(c) $x = y$ (d) $\frac{x}{y} = \frac{\beta t_1}{\alpha t_2}$

39. A drop of water detaches itself from the exit of a tap when (σ = surface tension of water, ρ = density of water, R = radius of the tap exit, r = radius of the drop).
(a) $r > \left(\frac{2}{3}\frac{R\sigma}{\rho g}\right)^{1/3}$
(b) $r = \frac{2}{3}\frac{\sigma}{\rho g}$
(c) $\frac{2\sigma}{r} >$ atmospheric pressure
(d) $r > \left(\frac{2}{3}\frac{R\sigma}{\rho g}\right)^{2/3}$

40. A rectangular coil carrying-current is placed in a non-uniform magnetic field. On that coil, the total.
(a) force is non-zero
(b) force is zero

(c) torque is zero
(d) torque is non-zero

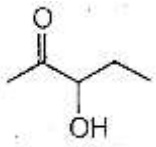
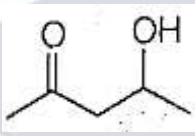
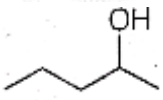
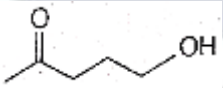
Chemistry

41. Amongst the following compounds, the one that will not respond to Cannizzaro reaction upon treatment with alkali is.
(a) Cl_3CCHO
(b) Me_3CCHO
(c) C_6H_5CHO
(d) $HCHO$

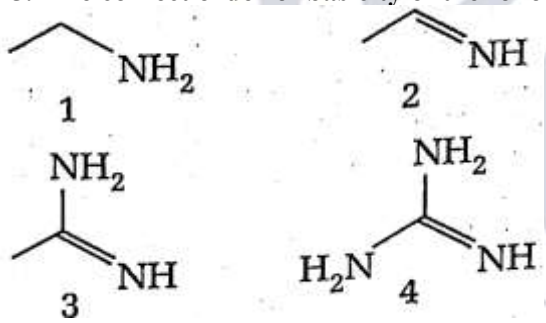
42. Which of the following compounds would not react with Lucas reagent at room temperature?
(a) $H_2C = CHCH_2OH$
(b) $C_6H_5CH_2OH$
(c) $CH_3CH_2CH_2OH$
(d) $(CH_3)_3COH$

43. Amongst the following compounds, the one which would not respond to iodoform test is.
(a) $CH_3CH(OH)CH_2CH_3$
(b) $ICH_2COCH_2CH_3$
(c) CH_3COOH
(d) CH_3CHO

44. Which of the following will be dehydrated most readily in alkaline medium?

(a) 
(b) 
(c) 
(d) 

45. The correct order of basicity of the following compounds is.

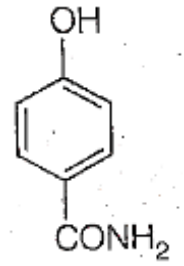


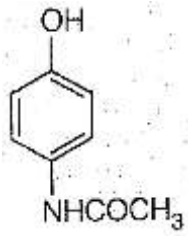
(a) $1 < 2 < 3 < 4$
(b) $1 < 2 < 4 < 3$
(c) $2 < 1 < 3 < 4$
(d) $4 < 3 < 2 < 1$

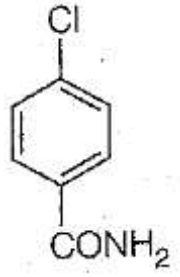
46. Which of the following reactions will not result in the formation of carbon-carbon bonds?
(a) Cannizzaro reaction
(b) Wurtz reaction
(c) Reimer-Tiemann reaction
(d) Friedel-Crafts acylation

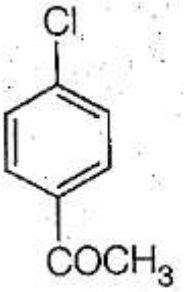
47. Point out the false statement.
(a) Colloidal sols are homogeneous
(b) Colloids carry + ve or - ve charges
(c) Colloids show Tyndall effect
(d) The size range of colloidal particles is $10 - 1000Å$

48. The correct structure of the drug paracetamol is

(a) 

(b) 

(c) 

(d) 

49. Which of the following statements regarding Lanthanides is false?
(a) All lanthanides are solid at room temperature
(b) Their usual oxidation state is +3
(c) They can be separated from one another by. ion-exchange method
(d) Ionic radii of trivalent lanthanides steadily increases with increase in atomic number

50. Nitrogen dioxide is not produced on heating.
(a) KNO_3
(b) $Pb(NO_3)_2$
(c) $Cu(NO_3)_2$
(d) $AgNO_3$

51. The boiling points of HF, HCl, HBr and HI follow the order
(a) $HF > HCl > HBr > HI$
(b) $HF > HI > HBr > HCl$
(c) $HI > HBr > HCl > H$
(d) $HCl > HF > HBr > HI$

52. In the solid state, PCl_5 exists as.
(a) $[PCl_4]^-$and $[PCl_6]^+$ions
(b) covalent PCl_5 molecules only
(c) $[PCl_4]^+$and $[PCl_6]^-$ions
(d) covalent P_2Cl_{10} molecules only

53. Which statement is not correct for ortho and para hydrogen?
(a) They have different boiling points
(b) Ortho-form is more stable than para-form
(c) They differ in their nuclear spin
(d) The ratio of ortho to para hydrogen changes with change in temperature

54. The acid in which $O-O$ bonding is present is.
(a) $H_2\ S_2O_3$
(b) $H_2\ S_2O_6$
(c) $H_2\ S_2O_8$
(d) $H_2\ S_4O_6$

55. The metal which can be used to obtain metallic Cu from aqueous $CuSO_4$ solution is.
(a) Na (b) Ag
(c) Hg (d) Fe

56. If radium and chlorine combine to form radium chloride, the compound would be.
(a) half as radioactive as radium
(b) twice as radioactive
(c) as radioactive as radium
(d) not radioactive

57. Which of the following arrangements is correct in respect of solubility in water?

(a) $CaSO_4 > BaSO_4 > BeSO_4 > MgSO_4 > SrSO_4$
(b) $BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4 > BaSO_4$
(c) $BaSO_4 > SrSO_4 > CaSO_4 > MgSO_4 > BeSO_4$
(d) $BeSO_4 > CaSO_4 > MgSO_4 > SrSO_4 > BaSO_4$

58. The energy required to break one mole of hydrogen-hydrogen bonds in H_2 is 436 kJ . What is the longest wavelength of light required to break a single bydrogenhydrogen bond?
(a) 68.5 nm (b) 137 nm
(c) 274 nm (d) 548 nm

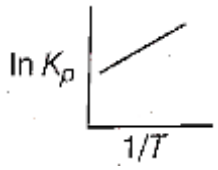
59. The correct order of $O-O$ bond length in O_2, H_2O_2 and O_3 is.
(a) $O_2 > O_3 > H_2O_2$
(b) $H_2O_2 > O_3 > O_2$
(c) $O_3 > O_2 > H_2O_2$
(d) $O_3 > H_2O_2 > O_2$

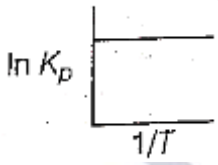
60. The number of σ and π bonds between two carbon atoms in calcium carbide are.
(a) one σ, one π
(b) one σ, two π
(c) two σ, one π
(d) one $\sigma, 1\frac{1}{2}\pi$

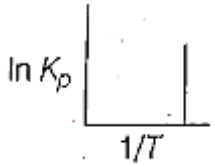
61. An element E loses one α and two β particles in three successive stages. The resulting element will be.
(a) an isobar of E
(b) an isotone of E
(c) an isotope of E
(d) E itself

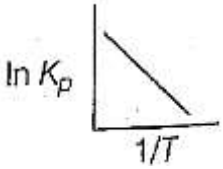
62. An element X belongs to fourth period and fifteenth group of the periodic table. Which of the following statements is true?.
(a) It has completely filled s-orbital and a partially filled d-orbital
(b) It has completely filled s-and p-orbitals and a partially filled d-orbital
(c) It has completely filled s - and p-orbitals and a half filled d-orbital
(d) It has a half filled ρ-orbital and completely filled s-and d-orbitals

63. Which of the following plots represent an exothermic reaction?

(a) 

(b) 

(c) 

(d) 

64. If p° and p are the vapour pressure of the pure solvent and solution and n_1 and n_2 are the moles of solute and solvent respectively in the solution then the correct relation between p and p° is.
(a) $p^\circ = p\left[\frac{n_1}{n_1+n_2}\right]$
(b) $p^\circ = p\left[\frac{n_2}{n_1+n_2}\right]$
(c) $p = p^\circ\left[\frac{n_2}{n_1+n_2}\right]$
(d) $p = p^\circ\left[\frac{n_1}{n_1+n_2}\right]$

65. Ionic solids with Schottky defect may contain in their structure
(a) cation vacancies only
(b) cation vacancies and interstitial cations

(c) equal number of cation and anion vacancies
(d) anion vacancies and interstitial anions

66. The condition for a reaction to occur spontaneously is.

(a) ΔH must be negative
(b) ΔS must be negative
(c) $(\Delta H - T\Delta S)$ must be negative
(d) $(\Delta H + T\Delta S)$ must be negative

67. The order of equivalent conductances at infinite dilution for LiCl, NaCl and KCl is

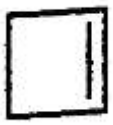
(a) $\mathrm{LiCl} > \mathrm{NaCl} > \mathrm{KCl}$
(b) $\mathrm{KCl} > \mathrm{NaCl} > \mathrm{LiCl}$
(c) $\mathrm{NaCl} > \mathrm{KCl} > \mathrm{LiCl}$
(d) $\mathrm{LiCl} > \mathrm{KCl} > \mathrm{NaCl}$

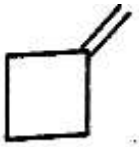
68. The molar solubility (in mol^{-1}) of a sparingly soluble salt MX_4 is ' S '. The corresponding solubility product is K_{sp} . S in terms of ' K_{sp} ' is given by the relation.

(a) $S = \left(\frac{K_{sp}}{128}\right)^{1/4}$
(b) $S = \left(\frac{K_{sp}}{256}\right)^{1/5}$
(c) $S = \left(256K_{sp}\right)^{1/5}$
(d) $S = \left(128K_{sp}\right)^{1/4}$

69. Ozonolysis of an alkene produces only one dicarbonyl compound. The structure of the alkene is.

(a) $\mathrm{H_3C - CH = CH - CH_3}$

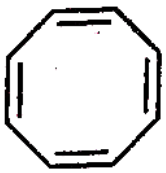
(b) 

(c) 

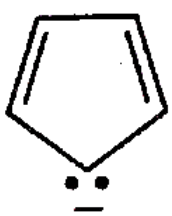
(d) $\mathrm{CH_3 - CH = CH - CH = CH_2}$

70. From the following compounds, choose the one which is not aromatic.

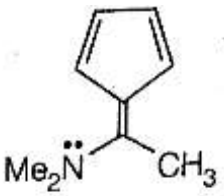
(a)



(b)

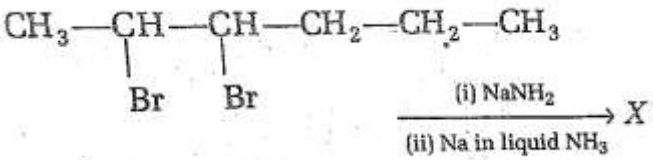


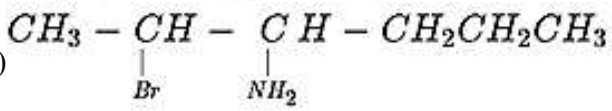
(c)

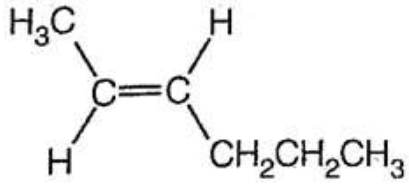


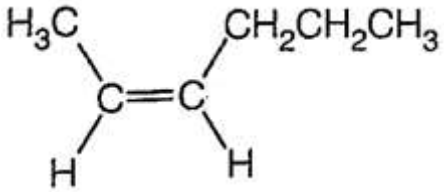
(d)

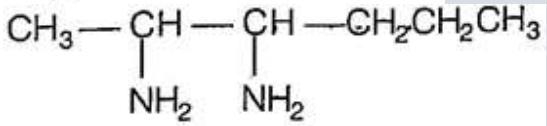
71. Identify X in the following sequence of reactions.



(a)


(b)


(c)


(d)


72. Compound *X* is tested and the results are shown in the table.

Test	Result
Aqueous sodium hydroxide is added then heated gently	Gas given off which turns damp red litmus paper blue.
Dilute hydrochloric acid is added.	Effervescence, gas given off which turns lime water milky and acidified $K_2Cr_2O_7$ paper green

Which ions are present in compound *X* ?

(a) Ammonium ions and sulphite ions
(b) Ammonium ions and carbonate ions
(c) Sodium ions and carbonate ions
(d) Ammonium ions and sulphate ions

73. The time taken for an electron to complete one revolution in Bohr orbit of hydrogen atom is.

(a) $\frac{4m^2\pi r^2}{n^2h^2}$ (b) $\frac{n^2h^2}{4mr^2}$
(c) $\frac{4\pi^2mr^2}{nh}$ (d) $\frac{nh}{4\pi^2mr^2}$

74. Amongst the following, which should have the highest rms speed at the same temperature?

(a) SO_2 (b) CO_2
(c) O_2 (d) H_2

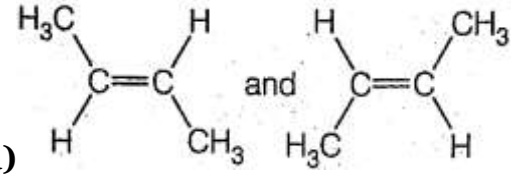
75. The major products obtained during ozonolysis of 2, 3-dimethyl-1-butene and subsequent reductions with Zn and H_2O are

(a) methanoic acid and 2-methyl-2-butanone
(b) methanal and 3-methyl-2-butanone

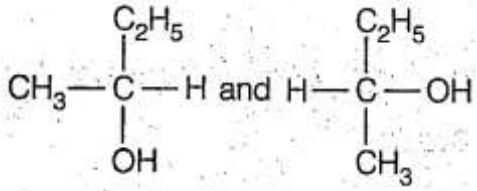
(c) methanol and 2,2-dimethyl-3-butanone
(d) methanoic acid and 2-methyl-3-butanone

Category III (Q. 36 to Q. 40) One or more answer (s) is (are) correct.

76. Choose the correct statement(s) among the following.

(a)  are enantiomers

(b) CH_3CHO on reaction with HCN gives racemic mixture

(c)  are enantiomers

(d) $CH_3 - CH = NOH$ shows geometrical isomerism

77. Which of the following statement(s) is (are) correct when a mixture of NaCl and $K_2Cr_2O_7$ is gently warmed with conc. H_2SO_4 ?

(a) A deep red vapour is evolved
(b) The vapour when passed through NaOH solution, gives a yellow solution
(c) Chlorine gas is also evolved
(d) Chromyl chloride is formed

78. Of the following molecules, which have shape similar to CO_2 ?

(a) $HgCl_2$ (b) $SnCl_2$
(c) C_2H_2 (d) NO_2

79. In which of the following mixed aqueous solutions, pH = pK_α at equilibrium?

(1) 100 mL of $0.1M CH_3COOH$ + 100 mL of $0.1M CH_3COONa$
(2) 100 mL of $0.1M CH_3COOH$ + 50 mL of 0.1 M NaOH
(3) 100 mL of $0.1M CH_3COOH$ + 100 mL of 0.1 M NaOH
(4) 100 mL of $0.1M CH_3COOH$ + 100 mL of $0.1M NH_3$

(a) (1) is correct
(b) (2) is correct
(c) (3) is correct
(d) Both (1) and (2) are correct

80. Amongst the following compounds, the one(s) which readily react with ethanolic KCN.

(a) Ethyl chloride
(b) Chlorobenzene
(c) Benzaldehyde
(d) Salicylic acid

Mathematics

81. If the solution of the differential equation $x\frac{dy}{dx} + y = xe^x$ be $xy = e^x\phi(x) + C$, then $\phi(x)$ is equal to.

(a) $x + 1$ (b) $x - 1$
(c) $1 - x$ (d) x

82. The order of the differential equation of all parabolas whose axis of symmetry along X-axis is.

(a) 2 (b) 3
(c) 1 (d) None of these

83. The line $y = x + \lambda$ is tangent to the ellipse $2x^2 + 3y^2 = 1$. Then, λ is.

(a) -2 (b) 1
(c) $\sqrt{\frac{5}{6}}$ (d) $\sqrt{\frac{2}{3}}$

84. The area enclosed by $y = \sqrt{5 - x^2}$ and $y = |x - 1|$ is.

(a) $\left(\frac{5\pi}{4}-2\right)$ sq units
(b) $\left(\frac{5\pi-2}{2}\right)$ sq units
(c) $\left(\frac{5\pi}{4}-\frac{1}{2}\right)$ sq units
(d) $\left(\frac{\pi}{2}-5\right)$ sq units

85. Let S be the set of points, whose abscissae and ordinates are natural numbers. Let $P \in S$, such that the sum of the distance of P from $(8,0)$ and $(0,12)$ is minimum among all elements in S. Then, the number of such points P in S is.
(a) 1 (b) 3
(c) 5 (d) 11

86. Time period T of a simple pendulum of length l is given by $T = 2\pi\sqrt{\frac{l}{g}}$. If the length is increased by 2%, then an approximate change in the time period is .
(a) 2% (b) 1%
(c) $\frac{1}{2}\%$ (d) None of these

87. The cosine of the angle between any two diagonals of a cube is.
(a) $\frac{1}{3}$ (b) $\frac{1}{2}$
(c) $\frac{2}{3}$ (d) $\frac{1}{\sqrt{3}}$

88. If x is a positive real number different from 1 such that $\log_a x, \log_b x, \log_c x$ are in AP, then.
(a) $b = \frac{a+c}{2}$
(b) $b = \sqrt{ac}$
(c) $c^2 = (ac)^{\log_a b}$
(d) None of these

89. If a, x are real numbers and $|a| < 1, |x| < 1$, then $1 + (1+a)x + (1+a+a^2)x^2 + \cdots \infty$ is equal to.
(a) $\frac{1}{(1-a)(1-ax)}$ (b) $\frac{1}{(1-a)(1-x)}$
(c) $\frac{1}{(1-x)(1-ax)}$ (d) $\frac{1}{(1+ax)(1-a)}$

90. If $\log_{0.3}(x-1) < \log_{0.09}(x-1)$, then x lies in the interval.
(a) $(2,\infty)$ (b) $(1,2)$
(c) $(-2,-1)$ (d) None of these

91. The value of $\sum_{n=1}^{13}\left(i^n + i^{n+1}\right), i = \sqrt{-1}$ is.
(a) i (b) $i-1$
(c) 1 (d) 0

92. If z_1, z_2, z_3 are imaginary numbers such that $|z_1| = |z_2| = |z_3| = \left|\frac{1}{z_1}+\frac{1}{z_2}+\frac{1}{z_3}\right| = 1$, then $|z_1 + z_2 + z_3|$ is.
(a) equal to 1
(b) less than 1
(c) greater than 1
(d) equal to 3

93. If p, q are the roots of the equation $x^2 + px + q = 0$, then.
(a) $p = 1, q = -2$
(b) $p = 0, q = 1$
(c) $p = -2, q = 0$
(d) $p = -2, q = 1$

94. The number of values of k, for which the equation $x^2 - 3x + k = 0$ has two distinct roots lying in the interval $(0,1)$, are.
(a) three
(b) two

(c) infinitely many
(d) no value of k satisfies the requirement

95. The number of ways in which the letters of the word ARRANGE can be permuted such that the R's occur together, is.

(a) $\frac{7!}{2!2!}$ (b) $\frac{7!}{2!}$
(c) $\frac{6!}{2!}$ (d) $5! \times 2!$

96. If $\frac{1}{{}^5C_r} + \frac{1}{{}^6C_r} = \frac{1}{{}^4C_r}$, then the value of r is.

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

97. 1%. For positive integer $n, n^3 + 2n$ is always divisible by.

(a) 3 (b) 7
(c) 5 (d) 6

98. In the expansion of $(x-1)(x-2)\ldots(x-18)$, the coefficient of x^{17} is.

(a) 684 (b) -171
(c) 171 (d) -342

99. $1 + {}^nC_1\cos\theta + {}^nC_2\cos 2\theta + \cdots + {}^nC_n\cos n\theta$ equals.

(a) $\left(2\cos\frac{\theta}{2}\right)^n \cos\frac{n\theta}{2}$. (b) $2\cos^2\frac{n\theta}{2}$
(c) $2\cos^{2n}\frac{\theta}{2}$ (d) $\left(2\cos^2\frac{\theta}{2}\right)^n$

100. If x, y and z are greater than 1 , then the value of $\begin{vmatrix} 1 & \log_x y & \log_x z \\ \log_y x & 1 & \log_y z \\ \log_z x & \log_z y & 1 \end{vmatrix}$ is.

(a) $\log x \cdot \log y \cdot \log z$
(b) $\log x + \log y + \log z$
(c) 0
(d) $1 - \{(\log x) \cdot (\log y) \cdot (\log z)\}$

101. Let A be a 3×3 matrix and B be its adjoint matrix. If $|B| = 64$, then $|A|$ is equal to.

(a) ± 2 (b) ± 4
(c) ± 8 (d) ± 12

102. Let $Q = \begin{pmatrix} \cos\frac{\pi}{4} & -\sin\frac{\pi}{4} \\ \sin\frac{\pi}{4} & \cos\frac{\pi}{4} \end{pmatrix}$ and $x = \begin{pmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{pmatrix}$, then Q^3x is equal to.

(a) $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$ (b) $\begin{pmatrix} -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{pmatrix}$
(c) $\begin{pmatrix} -1 \\ 0 \end{pmatrix}$ (d) $\begin{pmatrix} -\frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} \end{pmatrix}$

103. Let R be a relation defined on the set Z of all integers and xRy, when $x + 2y$ is divisible by 3 , Then.

(a) R is not transitive
(b) R is symmetric only
(c) R is an equivalence relation
(d) R is not an equivalence relation

104. If $A = \{5^n - 4n - 1 : n \in N\}$ and $B = \{16(n-1) : n \in N\}$, then.

(a) $A = B$
(b) $A \cap B = \phi$
(c) $A \subseteq B$
(d) $B \subseteq A$

105. If the function $f : R \to R$ is defined by $f(x) = (x^2 + 1)^{35}, \forall x \in R$, then f is.

(a) one-one but not onto
(b) onto but not one-one

(c) neither one-one nor onto
(d) both one-one and onto

106. Standard deviation of n observations $a_1, a_2, a_3, \ldots, a_n$ is σ. Then, the standard deviation of the observations $\lambda a_1, \lambda a_2, \ldots, \lambda a_n$ is.

(a) $\lambda\sigma$ (b) $-\lambda\sigma$
(c) $|\lambda|\sigma$ (d) $\lambda^n\sigma$

107. Let A and B be two events such that $P(A \cap B) = \frac{1}{6}, P(A \cup B) = \frac{31}{45}$ and $P(\bar{B}) = \frac{7}{10}$, then.

(a) A and B are independent
(b) A and B are mutually exclusive
(c) $P\left(\frac{A}{B}\right) < \frac{1}{6}$
(d) $P\left(\frac{B}{A}\right) < \frac{1}{6}$

108. The value of $\cos 15^\circ \cos 7\frac{1^\circ}{2} \sin 7\frac{1^\circ}{2}$ is.

(a) $\frac{1}{2}$ (b) $\frac{1}{8}$
(c) $\frac{1}{4}$ (d) $\frac{1}{16}$

109. The smallest positive root of the equation $\tan x - x = 0$ lies in.

(a) $\left(0, \frac{\pi}{2}\right)$ (b) $\left(\frac{\pi}{2}, \pi\right)$
(c) $\left(\pi, \frac{3\pi}{2}\right)$ (d) $\left(\frac{3\pi}{2}, 2\pi\right)$

110. If in a $\triangle ABC$, AD, BE and CF are the altitudes and R is the circumradius, then the radius of the circumcircle of $\triangle DEF$ is.

(a) $\frac{R}{2}$ (b) $\frac{2R}{3}$
(c) $\frac{R}{3}$ (d) None of these

111. The points $(-a, -b), (a, b), (0, 0)$ and $(a^2, ab), a \neq 0, b \neq 0$ are always.

(a) collinear
(b) vertices of a parallelogram
(c) vertices of a rectangle
(d) lie on a circle

112. The line AB cuts off equal intercepts $2a$ from the axes. From any point P on the line AB perpendiculars PR and PS are drawn on the axes. Locus of mid-point of RS is.

(a) $x - y = \frac{a}{2}$
(b) $x + y = a$
(c) $x^2 + y^2 = 4a^2$
(d) $x^2 - y^2 = 2a^2$

113. $x + 8y - 22 = 0, 5x + 2y - 34 = 0, 2x - 3y + 13 = 0$ are the three sides of a triangle. The area of the triangle is.

(a) 36 sq units
(b) 19 sq units
(c) 42 sq units
(d) 72 sq units

114. The line through the points (a, b) and $(-a, -b)$, passes through the point.

(a) $(1,1)$ (b) $(3a, -2b)$
(c) (a^2, ab) (d) (a, b)

115. The locus of the point of intersection of the straight lines $\frac{x}{a} + \frac{y}{b} = K$ and $\frac{x}{a} - \frac{y}{b} = \frac{1}{K}$, where K is a non-zero real variable, is given by.

(a) a straight line
(b) an ellipse
(c) a parabola
(d) a hyperbola

116. The equation of a line parallel to the line $3x + 4y = 0$ and touching the circle $x^2 + y^2 = 9$

in the first quadrant, is.

(a) $3x + 4y = 15$

(b) $3x + 4y = 45$

(c) $3x + 4y = 9$

(d) $3x + 4y = 27$

117. A line passing through the point of intersection of $x + y = 4$ and $x - y = 2$ makes an angle $\tan^{-1}\left(\frac{3}{4}\right)$ with the X-axis. It intersects the parabola $y^2 = 4(x - 3)$ at points (x_1, y_1) and (x_2, y_2), respectively. Then, $|x_1 - x_2|$ is equal to.

(a) $\frac{16}{9}$ (b) $\frac{32}{9}$

(c) $\frac{40}{9}$ (d). $\frac{80}{9}$

118. The equation of auxiliary circle of the ellipse $16x^2 + 25y^2 + 32x - 100y = 284$ is.

(a) $x^2 + y^2 + 2x - 4y - 20 = 0$

(b) $x^2 + y^2 + 2x - 4y = 0$

(c) $(x + 1)^2 + (y - 2)^2 = 400$

(d) $(x + 1)^2 + (y - 2)^2 = 225$

119. If PQ is a double ordinate of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ such that $\triangle OPQ$ is equilateral. O being the centre. Then, the eccentricity e satisfies.

(a) $1 < e < \frac{2}{\sqrt{3}}$ (b) $e = \frac{2}{\sqrt{2}}$

(c) $e = \frac{\sqrt{3}}{2}$. (d) $e > \frac{2}{\sqrt{3}}$

120. If the vertex of the conic $y^2 - 4y = 4x - 4a$ always lies between the straight lines $x + y = 3$ and $2x + 2y - 1 = 0$, then.

(a) $2 < a < 4$

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

(c) $0 < a < 2$

(d) $-\frac{1}{2} < a < \frac{3}{2}$

121. A straight line joining the points $(1, 1, 1)$ and $(0, 0, 0)$ intersects the plane $2x + 2y + z = 10$ at.

(a) (1,2,5) (b) (2,2,2)

(c) (2,1,5) (d) (1,1,6)

122. Angle between the planes $x + y + 2z = 6$ and $2x - y + z = 9$ is.

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{6}$

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

123. If $y = (1 + x)(1 + x^2)(1 + x^4) \dots (1 + x^{2n})$, then the value of $\left(\frac{dy}{dx}\right)$ at $x = 0$ is.

(a) 0 (b) -1

(c) 1 (d) 2

124. If $f(x)$ is an odd differentiable function defined on $(-\infty, \infty)$ such that $f'(3) = 2$, then $f'(-3)$ is equal to.

(a) 0 (b) 1

(c) 2 (d) 4

125. $\lim_{x \to 1} \left(\frac{1+x}{2+x}\right)^{\frac{(1-\sqrt{x})}{(1-x)}}$ is equal to.

(a) 1 (b) does not exist

(c) $\sqrt{\frac{2}{3}}$ (d) $\ln 2$

126. If $f(x) = \tan^{-1}\left[\frac{\log\left(\frac{e}{x^2}\right)}{\log(ex^2)}\right] + \tan^{-1}\left[\frac{3+2\log x}{1-6\log x}\right]$,

then the value of $f''(x)$ is equal to.

(a) x^2 (b) x

(c) 1 (d) 0

127. $\int \frac{\log\sqrt{x}}{3x} dx$ **is equal to.**

(a) $\frac{1}{3}(\log\sqrt{x})^2 + C$

(b) $\frac{2}{3}(\log\sqrt{x})^2 + C$

(c) $\frac{2}{3}(\log x)^2 + C$

(d) $\frac{1}{3}(\log x)^2 + C$

128. $\int 2^x[f'(x) + f(x)\log 2]dx$ **is equal to.**

(a) $2^x f'(x) + C$

(b) $2^x \log 2 + C$

(c) $2^x f(x) + C$

(d) $2^x + C$

129. $\int_0^1 \log\left(\frac{1}{x} - 1\right) dx$ **is equal to.**

(a) 1 (b) 0

(c) 2 (d) None of the above

130. The value of

$\lim_{n\to\infty}\left\{\frac{\sqrt{n+1}+\sqrt{n+2}+\cdots+\sqrt{2n-1}}{n^{3/2}}\right\}$ **is**

(a) $\frac{2}{3}(2\sqrt{2} - 1)$. (b) $\frac{2}{3}(\sqrt{2} - 1)$

(c) $\frac{2}{3}(\sqrt{2} + 1)$ (d) $\frac{2}{3}(2\sqrt{2} + 1)$

131. The sum of n terms of the following series $1^3 + 3^3 + 5^3 + 7^3 + \cdots$ is.

(a) $n^2(2n^2 - 1)$

(b) $n^3(n - 1)$.

(c) $n^3 + 8n + 4$

(d) $2n^4 + 3n^2$

132. If α and β are roots of $ax^2 + bx + c = 0$, then the equation whose roots are α^2 and β^2, is.

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

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

(c) $a^2x^2 + (b^2 + ac)x + c^2 = 0$

(d) $a^2x^2 + (b^2 + 2ac)x + c^2 = 0$

133. If ω is an imaginary cube root of unity, then the value of $(2 - \omega)(2 - \omega^2) + 2(3 - \omega)(3 - \omega^2) + \cdots + (n - 1)(n - \omega)(n - \omega^2)$ is.

(a) $\frac{n^2}{4}(n + 1)^2 - n$ (b) $\frac{n^2}{4}(n + 1)^2 + n$

(c) $\frac{n^2}{4}(n + 1)^2$ (d) $\frac{n^2}{4}(n + 1) - n$

134. If ${}^nC_{r-1} = 36$, ${}^nC_r = 84$ and ${}^nC_{r+1} = 126$, then the value of ${}^nC_8$ is.

(a) 10 (b) 7

(c) 9 (d) 8

135. In a group of 14 males and 6 females. 8 and 3 of the males and females, respectively are aged above 40 yr . The probability that a person selected at random from the group is aged above 40 yr given that the selected person is a female, is.

(a) $\frac{2}{7}$ (b) $\frac{1}{2}$

(c) $\frac{1}{4}$ (d) $\frac{5}{6}$

136. The equation $x^3 - yx^2 + x - y = 0$ represents.

(a) a hyperbola and two straight lines

(b) a straight line

(c) a parabola and two straight lines

(d) a straight line and a circle

137. **The locus of the mid-points of chords of the circle $x^2 + y^2 = 1$, which subtends a right angle at the origin, is.**

(a) $x^2 + y^2 = \frac{1}{4}$

(b) $x^2 + y^2 = \frac{1}{2}$

(c) $xy = 0$

(d) $x^2 - y^2 = 0$

138. **The locus of the mid-points of all chords of the parabola $y^2 = 4ax$ through its vertex is another parabola with directrix.**

(a) $x = -a$ (b) $x = a$

(c) $x = 0$ (d) $x = -\frac{a}{2}$

139. **If $[x]$ denotes the greatest integer less than or equal to x, then the value of the integral $\int_0^2 x^2[x]dx$ equals.**

(a) $\frac{5}{3}$ (b) $\frac{7}{3}$

(c) $\frac{8}{3}$ (d) $\frac{4}{3}$

140. **The number of points at which the function $f(x) = \max\{a - x, a + x, b\}, -\infty < x < \infty, 0 < a < b$ cannot be differentiable, is.**

(a) 0 (b) 1

(c) 2 (d) 3

141. **For non-zero vectors a and b, if $|a + b| < |a - b|$, then a and b are.**

(a) collinear

(b) perpendicular to each other

(c) inclined at an acute angle

(d) inclined at an obtuse angle

142. **General solution of $y\frac{dy}{dx} + by^2 = a\cos x, 0 < x < 1$ is.**

(a) $y^2 = 2a(2b\sin x + \cos x) + ce^{-2bx}$

(b) $(4b^2 + 1)y^2 = 2a(\sin x + 2b\cos x) + ce^{-2bx}$

(c) $(4b^2 + 1)y^2 = 2a(\sin x + 2b\cos x) + ce^{2bx}$

(d) $y^2 = 2a(2b\sin x + \cos x) + ce^{-2bx}$

143. **The points of the ellipse $16x^2 + 9y^2 = 400$ at which the ordinate decreases at the same rate at which the abscissa increases is/are given by.**

(a) $\left(3, \frac{16}{3}\right)$ and $\left(-3, -\frac{16}{3}\right)$

(b) $\left(3, -\frac{16}{3}\right)$ and $\left(-3, \frac{16}{3}\right)$

(c) $\left(\frac{1}{16}, \frac{1}{9}\right)$ and $\left(-\frac{1}{16}, -\frac{1}{9}\right)$

(d) $\left(\frac{1}{16}, -\frac{1}{9}\right)$ and $\left(-\frac{1}{16}, \frac{1}{9}\right)$

144. **The letters of the word COCHIN are permuted and all permutations are arranged in an alphabetical order as in an English dictionary. The number of words that appear before the word COCHIN is**

(a) 96 (b) 48

(c) 183 (d) 267

145. **If the matrix $A = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 2 & 0 & 2 \end{bmatrix}$, then $A^n = \begin{bmatrix} a & 0 & 0 \\ 0 & a & 0 \\ b & 0 & a \end{bmatrix}, n \in N$, where**

(a) $a = 2n, b = 2^n$

(b) $a = 2^n, b = 2n$

(c) $a = 2^n, b = n2^{n-1}$

(d) $a = 2^n, b = n2^n$

Category III (Q. 66 to Q. 75) One or more answer (s) is (are) correct.

146. **On the ellipse $4x^2 + 9y^2 = 1$, the points at which the tangents are parallel to the line $8x =$**

$9y$, Are.

(a) $\left(\frac{2}{5},\frac{1}{5}\right)$ (b) $\left(-\frac{2}{5},\frac{1}{5}\right)$

(c) $\left(-\frac{2}{5},-\frac{1}{5}\right)$ (d) $\left(\frac{2}{5},-\frac{1}{5}\right)$

147. If $\phi(t)=\begin{cases}1, \text{ for } 0\le t<1\\ 0, \text{ otherwise}\end{cases}$, then $\int_{-3000}^{3000}\left(\sum_{r'=2014}^{2016}\phi(t-r')\phi(t-2016)\right)dt$ is.

(a) a real number (b) 1

(c) 0 (d) does not exist

148. If the equation $x^2+y^2-10x+21=0$ has real roots $x=\alpha$ and $y=\beta$, then.

(a) $3\le x\le 7$

(b) $3\le y\le 7$

(c) $-2\le y\le 2$

(d) $-2\le x\le 2$

149. If $z=\sin\theta-i\cos\theta$, then for any integer n,.

(a) $z^n+\frac{1}{z^n}=2\cos\left(\frac{n\pi}{2}-n\theta\right)$

(b) $z^n+\frac{1}{z^n}=2\sin\left(\frac{n\pi}{2}-n\theta\right)$

(c) $z^n-\frac{1}{z^n}=2i\sin\left(n\theta-\frac{n\pi}{2}\right)$

(d) $z^n-\frac{1}{z^n}=2i\cos\left(\frac{n\pi}{2}-n\theta\right)$

150. Let $f: X\to X$ be such that $f[f(x)]=x$, for all $x\in X$ and $X\subseteq R$, then.

(a) f is one-to-one

(b) f is onto

(c) f is one-to-one but not onto

(d) f is onto but not one-to-one

151. If A, B are two events such that $P(A\cup B)\ge\frac{3}{4}$ and $\frac{1}{8}\le P(A\cap B)\le\frac{3}{8}$, then.

(a) $P(A)+P(B)\le\frac{11}{8}$

(b) $P(A)\cdot P(B)\le\frac{3}{8}$

(c) $P(A)+P(B)\ge\frac{7}{8}$

(d) None of the above

152. If the first and ($2n-1$)th terms of an AP, GP and HP are equal and their nth terms are respectively a, b, c, then always.

(a) $a=b=c$

(b) $a\ge b\ge c$

(c) $a+c=b$

(d) $ac-b^2=0$

153. The coordinates of a point on the line $x+y+1=0$, which is at a distance $\frac{1}{5}$ unit from the line $3x+4y+2=0$, are.

(a) $(2,-3)$

(b) (-3.2)

(c) $(0,-1)$

(d) $(-1,0)$

154. If the parabola $x^2=ay$ makes an intercept of length $\sqrt{40}$ units on the line $y-2x=1$, then a is equal to.

(a) 1 (b) -2

(c) -1 (d) 2

155. If $f(x)$ is a function such that $f'(x)=(x-1)^2(4-x)$, then.

(a) $f(0)=0$

(b) $f(x)$ is increasing in $(0,3)$

(c) $x=4$ is a critical point of $f(x)$

(d) $f(x)$ is decreasing in $(3,5)$