MHT-CET 2016

General Instructions

- *This question booklet contains 150 Multiple Choice Questions (MCQs).*
  ***Section-A:** Physics & Chemistry - 50 Questions each and*
  ***Section-B:** Mathematics - 50 Questions.*
- *Choice and sequence for attempting questions will be as per the convenience of the candidate.*
- *Read each question carefully.*
- *Determine the one correct answer out of the four available options given for each question.*
- *Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.*
- *No mark shall be granted for marking two or more answers of same question, scratching or overwriting.*
- *Duration of paper is 3 Hours.*

SECTION-A

PHYSICS

1. In potentiometer experiment, null point is obtained at a particular point for a cell on potentiometer wire x cm long. If the length of the potentiometer wire is increased without changing the cell, the balancing length will (Driving source is not changed)
(a) increase (b) decrease
(c) not change (d) become zero

2. An iron rod is placed parallel to magnetic field of intensity 2000 Am^{-1}. The magnetic flux through the rod is 6×10^{-4} Wb and its cross-sectional area is 3 cm^2. The magnetic permeability of the rod in Wb $A^{-1}m^{-1}$ is
(a) 10^{-1} (b) 10^{-2} (c) 10^{-3} (d) 10^{-4}

3. Alternating current of peak value $\left(\frac{2}{\pi}\right)$ ampere flows through the primary coil of the transformer. The coefficient of mutual inductance between primary and secondary coil is 1 H. The peak emf induced in secondary coil is (Frequency of AC = 50 Hz)
(a) 100 V (b) 200 V (c) 300 V (d) 400 V

4. An electron of mass m has de-Broglie wavelength λ when accelerated through potential difference V. When proton of mass M, is accelerated through potential difference 9 V, the de-Broglie wavelength associated with it will be (Assume that wavelength is determined at low voltage)
(a) $\frac{\lambda}{3}\sqrt{\frac{M}{m}}$ (b) $\frac{\lambda}{3}\frac{M}{m}$ (c) $\frac{\lambda}{3}\sqrt{\frac{m}{M}}$ (d) $\frac{\lambda}{3}\frac{m}{M}$

5. Interference fringes are produced on a screen by using two light sources of intensities I and 9I. The phase difference between the beams is $\frac{\pi}{2}$ at point P and π at point Q on the screen. The difference between the resultant intensities at point P and Q is
(a) 2I (b) 4I (c) 6I (d) 8I

6. From Brewster's law, except for polished metallic surfaces, the polarising angle
(a) depends on wavelength and is different for different colours
(b) independent of wavelength and is different for different colours
(c) independent of wavelength and is same for different colours
(d) depends on wavelength and is same for different colours

7. Two particles X and Y having equal charges after being accelerated through same potential difference enter a region of uniform magnetic field and describe a circular paths of radii r_1 and r_2 respectively. The ratio of the mass of X to that of Y is
(a) $\frac{r_1}{r_2}$ (b) $\sqrt{\frac{r_1}{r_2}}$ (c) $\left[\frac{r_2}{r_1}\right]^2$ (d) $\left[\frac{r_1}{r_2}\right]^2$

8. When an electron in hydrogen atom revolves in stationary orbit, it
(a) does not radiate light though its velocity changes
(b) does not radiate light and velocity remains unchanged
(c) radiates light but its velocity is unchanged
(d) radiates light with the change of energy

9. The magnetic field (B) inside a long, solenoid having n turns per unit length and carrying current/when iron core is kept in it is (μ_0 = permeability of vacuum, x = magnetic susceptibility)
(a) $\mu_0 nl(1-\chi)$ (b) $\mu_0 nl\chi$
(c) $\mu_0 nl^2(1+\chi)$ (d) $\mu_0 nl(1+\chi)$

10. In balanced meter bridge, the resistance of bridge wire is 0.1. Ω cm. Unknown resistance X is connected in left gap and 6 Ω in right gap, null point divides the wire in the ratio 2:3. Find the current drawn from the battery of 5 V having negligible resistance
(a) 1A (b) 1.5A (c) 2A (d) 5A

11. Three parallel plate air capacitors are connected in parallel. Each capacitor has plate area $\frac{A}{3}$ and the separation between the plates is d, $2d$ and $3d$ respectively. The equivalent capacity of combination is (ε_0 = absolute permittivity of free space)
(a) $\frac{7\varepsilon_0 A}{18d}$ (b) $\frac{11\varepsilon_0 A}{18d}$ (c) $\frac{13\varepsilon_0 A}{18d}$ (d) $\frac{17\varepsilon_0 A}{18d}$

12. In an oscillator, for sustained oscillations, Barkhausen criterion is Aβ equal to (A = voltage gain without feedback and β = feedback factor)
(a) zero (b) $\frac{1}{2}$ (c) 1 (d) 2

13. Light of wavelength λ which is less than threshold wavelength is incident on a photosensitive material. If incident wavelength is decreased so that emitted photoelectrons are moving with same velocity, then stopping potential will
(a) increase (b) decrease
(c) be zero (d) become exactly half

14. A ray of light travelling through rarer medium is incident at very small angle i on a glass slab and after refraction its velocity is reduced by 20%. The angle of deviation is
(a) $\frac{i}{8}$ (b) $\frac{i}{5}$ (c) $\frac{i}{2}$ (d) $\frac{4i}{5}$

15. The maximum frequency of transmitted radio waves above which the radio waves are no longer reflected back by ionosphere is (N = maximum electron density of Ionosphere, g = acceleration due to gravity)
(a) gN (b) gN^2 (c) $g\sqrt{N}$ (d) g^2N^2

16. Wire having tension 225 N produces six beats per second when it is tuned with a fork. When tension changes to 256 N, it is tuned with the same fork, the number of beats remain unchanged. The frequency of the fork will be
(a) 186 Hz (b) 225 Hz (c) 256 Hz (d) 280 Hz

17. Assuming the expression for the pressure exerted by the gas on the walls of the container, it can be shown that pressure is
(a) $\left[\frac{1}{3}\right]^{rd}$ kinetic energy per unit volume of a gas
(b) $\left[\frac{2}{3}\right]^{rd}$ kinetic energy per unit volume of a gas
(c) $\left[\frac{3}{4}\right]^{th}$ kinetic energy per unit volume of a gas
(d) $\frac{3}{2}\times$ kinetic energy per unit volume of a gas

18. A mass m_1 connected to a horizontal spring performs SHM with amplitude A. While mass m_1 is passing through mean position, another mass m_2 is placed on it so that both the masses move together with amplitude A_1. The ratio of $\frac{A_1}{A}$ is ($m_2 < m_1$)
(a) $\left[\frac{m_1}{m_1+m_2}\right]^{\frac{1}{2}}$ (b) $\left[\frac{m_1+m_2}{m_1}\right]^{\frac{1}{2}}$
(c) $\left[\frac{m_2}{m_1+m_2}\right]^{\frac{1}{2}}$ (d) $\left[\frac{m_1+m_2}{m_2}\right]^{\frac{1}{2}}$

19. A particle moves along a circle of radius r with constant tangential acceleration. If the velocity of the particle is v at the end of second revolution, after the revolution has started, then the tangential acceleration is
(a) $\frac{v^2}{8\pi r}$ (b) $\frac{v^2}{6\pi r}$ (c) $\frac{v^2}{2\pi r}$ (d) $\frac{v^2}{2\pi r}$

20. Two strings A and B of same material are stretched by same tension. The radius of the string A is double the radius of string B. Transverse wave travels on string A with speed v_A and on string B with speed v_B. The ratio $\frac{v_A}{v_B}$ is
(a) $\frac{1}{4}$ (b) $\frac{1}{2}$ (c) 2 (d) 4

21. Which of the following quantity does not change due to damping of oscillations?
(a) Angular frequency (b) Time period
(c) Initial phase (d) Amplitude

22. If the end correction of an open pipe is 0.8 cm, then the inner radius of that pipe will be
(a) $\frac{1}{3}$cm (b) $\frac{2}{3}$cm (c) $\frac{3}{2}$cm (d) 0.2 cm

23. A progressive wave is represented by $y = 12 \sin (5t - 4x)$ cm. On this wave, how far away are the two points having phase difference of 90°?
(a) $\frac{\pi}{2}$cm (b) $\frac{\pi}{4}$cm (c) $\frac{\pi}{8}$ (d) $\frac{\pi}{16}$

24. Two particles of masses m and 9m are separated by a distance r. At a point on the line joining them the gravitational field is zero. The gravitational potential at that point is (G = universal constant of gravitation)
(a) $-\frac{4Gm}{r}$ (b) $-\frac{8Gm}{r}$
(c) $-\frac{16Gm}{r}$ (d) $-\frac{32Gm}{r}$

25. A black rectangular surface of area A emits energy E per second at 27°C. If length and breadth are reduced to $\frac{1}{3}^{rd}$ of initial value and temperature is raised to 327°C, then energy emitted per second becomes
(a) $\frac{4E}{9}$ (b) $\frac{7E}{9}$ (c) $\frac{10E}{9}$ (d) $\frac{16E}{9}$

26. For a gas $\frac{R}{C_V} = 0.4$, where R is the universal gas constant and C_V is molar specific heat at constant volume. The gas is made up of molecules which are
(a) rigid diatomic (b) monoatomic
(c) non-rigid diatomic (d) polyatomic

27. In vertical circular motion, the ratio of kinetic energy of a particle at highest point to that at lowest paint is
(a) 5 (b) 2 (c) 0.5 (d) 0.2

28. Two wires having same length and material are stretched by same force. Their diameters are in the ratio 1: 3. The ratio of strain energy per unit volume for these two wires (smaller to larger diameter) when stretched is
(a) 3:1 (b) 9:1 (c) 27:1 (d) 81:1

29. A ring and a disc roll on the horizontal surface without slipping, with same linear velocity. If both have same mass and total kinetic energy of the ring is 4 J, then total kinetic energy of the disc is
(a) 3 J (b) 4 J (c) 5 J (d) 6 J

30. When the observer moves towards the stationary source with velocity, v_1 the apparent frequency of emitted note is f_1. When the observer moves away from the source with velocity v_1, the apparent frequency is f_2. If v is the velocity of sound in air and $\frac{f_1}{f_2} = 2$, then $\frac{v}{v_1} = ?$
(a) 2 (b) 3 (c) 4 (d) 5

31. A liquid drop having surface energy E is spread into 512 droplets of same size. The final surface energy of the droplets is
(a) 2E (b) 4E (c) 8E (d) 12E

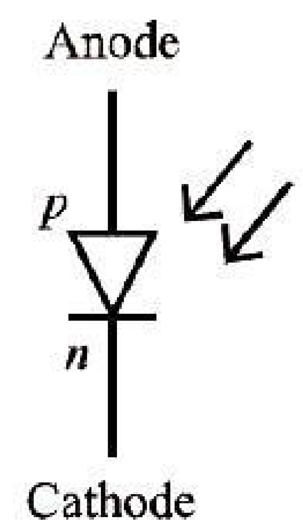
32. Let M be the mass and L be the length of a thin uniform rod. In first case, axis of rotation is passing through centre and perpendicular to the length of the rod. In second case, axis of rotation is passing through one end and perpendicular to the length of the rod. The ratio of radius of gyration in first case to second case is
(a) 1 (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) $\frac{1}{8}$

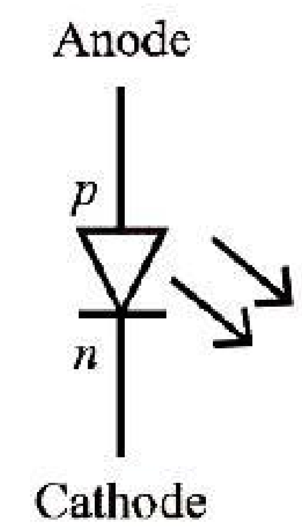
33. A simple pendulum of length l has maximum angular displacement θ. The maximum kinetic energy of the bob of mass m is (g = acceleration due to gravity)
(a) $mgl(1 + \cos\theta)$ (b) $mgl(1 + \cos^2\theta)$
(c) $mgl(1 - \cos 0)$ (d) $mgl(\text{cas } 0 - 1)$

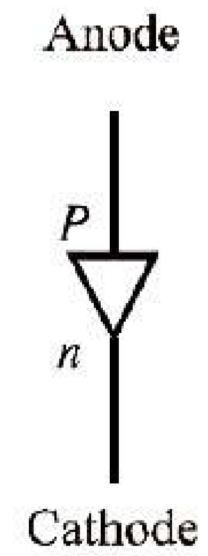
34. Angular speed of hour hand of a clock in degree per second is
(a) $\frac{1}{30}$ (b) $\frac{1}{60}$ (c) $\frac{1}{120}$ (d) $\frac{1}{720}$

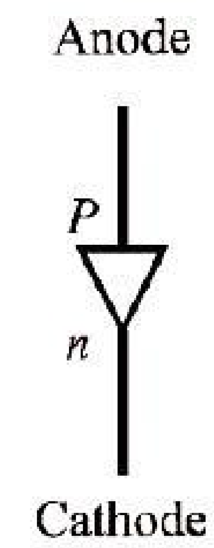
35. The value of gravitational acceleration g at a height h above the earth's surface is $\frac{g}{4}$, then (R = radius of earth)
(a) $h = R$ (b) $h = \frac{R}{2}$
(c) $h = \frac{R}{3}$ (d) $h = \frac{R}{4}$

36. The schematic symbol of light emitting diode (LED) is

(a) 

(b) 

(c) 

(d) 

37. The amount of work done in increasing the voltage across the plates of capacitor from 5 V to 10 V is W. The work done in increasing it from 10 V to 15 V will be

(a) W (b) $0.6\,W$ (c) $1.25\,W$ (d) $1.67\,W$

38. Magnetic flux passing through a coil is initially 4×10^{-4} Wb. It reduces to 10% of its original value in t second. If the emf induced is 0.72 mV then t in second is

(a) 0.3 (b) 0.4 (c) 0.5 (d) 0.6

39. Resolving power of telescope increases when

(a) wavelength of light decreases
(b) wavelength of light increases
(c) focal length of eye-piece increases
(d) focal length of eye-piece decreases

40. When light of wavelength λ is incident on photosensitive surface, the stopping potential is V. When light of wavelength 3λ is incident on same surface, the stopping potential is $\frac{V}{6}$. Threshold wavelength for the surface is

(a) 2λ (b) 3λ (c) 4λ (d) 5λ

41. The bob of a simple pendulum performs SHM with period T in air and with period T_1 in water Relation between T and T_1 is (neglect friction due to water, density of the material of the bob is $= \frac{9}{8} \times 10^3\ \text{kgm}^3$, density of water = 1gcc^{-1})

(a) $T_1 = 3T$ (b) $T_1 = 2T$

(c) $T_1 = T$ (d) $T_1 = \frac{T}{2}$

42. In a capillary tube of radius R, a straight thin metal wire of radius r ($R > r$) is inserted symmetrically and one end of the combination is dipped vertically in water such that the lower end of the combination is at same level. The rise of water in the capillary tube is

[T = surface tension of water, ρ = density of water and g = gravitational acceleration]

(a) $\frac{T}{(R+r)\rho g}$ (b) $\frac{R\rho g}{2T}$

(c) $\frac{2T}{(R-r)\rho g}$ (d) $\frac{(R-r)\rho g}{T}$

43. When open pipe is closed from one end, then third overtone of closed pipe is higher in frequency by 150 Hz than second overtone of open pipe. The fundamental frequency of open end pipe will be

(a) 75 Hz (b) 150 Hz
(c) 225 Hz (d) 300 Hz

44. A disc of radius R and thickness $\frac{R}{6}$ has moment of inertia/about an axis passing through its centre and perpendicular to its plane. Disc is melted and recast into a solid sphere. The moment of inertia of a sphere about its diameter is

(a) $\frac{I}{5}$ (b) $\frac{I}{6}$ (c) $\frac{I}{32}$ (d) $\frac{I}{64}$

45. Let a steel bar of length l, breadth b and depth d be loaded at the centre by a load W. Then the sag of bending of beam is (Y = Young's modulus of material of steel)

(a) $\frac{Wl^3}{2bd^3Y}$ (b) $\frac{Wl^3}{4bd^3Y}$

(c) $\frac{Wl^2}{2bd^3Y}$ (d) $\frac{Wl^3}{4bd^2Y}$

46. In Bohr's theory of hydrogen atom, the electron jumps from higher orbit n to lower orbit p. The wavelength will be minimum for the transition

(a) $n = 5$ to $p = 4$ (b) $n = 4$ to $p = 3$
(c) $n = 3$ to $p = 2$ (d) $n = 2$ to $p = 1$

47. Two identical parallel plate air capacitors are connected in series to a battery of emf V. If one of the capacitor is completely filled with dielectric material of constant K, then potential difference of the other capacitor will become

(a) $\frac{K}{V(K+1)}$ (b) $\frac{KV}{K+1}$

(c) $\frac{K-1}{KV}$ (d) $\frac{V}{K(K+1)}$

48. The L-C parallel resonant circuit
(a) has a very high impedance
(b) has a very high current
(c) acts as resistance of very low value
(d) has zero impedance

49. A galvanometer of resistance 30 Ω is connected to a battery of emf 2 V with 1970 Ω resistance in series. A full scale deflection of 20 divisions is obtained in the galvanometer. To reduce the deflection to 10 divisions, the resistance in series required is
(a) 4030 Ω (b) 4000 Ω
(c) 3970 Ω (d) 2000 Ω

50. Two coherent sources P and Q produce interference at point A on the screen where there is a dark band which is formed between 4th bright band and 5th bright band. Wavelength of light used is 6000 Å. The path difference between PA and QA is
(a) 1.4×10^{-4} cm (b) 2.7×10^{-4} cm
(c) 4.5×10^{-4} cm (d) 6.2×10^{-4} cm

CHEMISTRY

51. If 'n' represents total number of asymmetric carbon atoms in a compound, then the possible number of optical isomers of the compound is
(a) $2n$ (b) n^2 (c) 2^n (d) $2n+2$

52. The equation that represents general van't Hoff equation is
(a) $\pi = \frac{n}{V}RT$ (b) $\pi = nRT$
(c) $\pi = \frac{V}{n}RT$ (d) $\pi = nVRT$

53. Which is the most stable allotrope of sulphur?
(a) Octahedral sulphur
(b) Monoclinic sulphur
(c) Plastic sulphur
(d) Colloidal sulphur

54. Select the correct statement for thermoplastic polymer.
(a) It does not become soft on heating under pressure
(b) It cannot be remoulded
(c) It is either linear or branched chain polymer
(d) It is a cross-linked polymer

55. How many Faradays of electricity are required to deposit 10 g of calcium from molten calcium chloride using inert electrodes? (Molar mass of calcium = 40 g mol^{-1})
(a) 0.5 F (b) 1 F (c) 0.25 F (d) 2 F

56. Name the reagent that is used in leaching of gold.
(a) Carbon (b) Sodium cyanide
(c) Carbon monoxide (d) Iodine

57. Which of the following is an analgesic?
(a) Ofloxacin (b) Penicillin
(c) Aminoglycosides (d) Paracetamol

58. The compound which is not formed when a mixture of n-butyl bromide and ethyl bromide treated with sodium metal in the presence of dry ether is
(a) butane (b) octane
(c) hexane (d) ethane

59. What is the general molecular formula of the products obtained on heating lanthanoids (Ln) with sulphur?
(a) LnS (b) LnS_3 (c) Ln_3S_2 (d) Ln_2S_3

60. Butylated hydroxy anisole is a/an
(a) antioxidant (b) cleansing agent
(c) disinfectant (d) antihistamine

61. In the cell represented by $Pb(s)\,|\,Pb^{2+}(1M)\,||\,Ag^{+}(1M)\,|\,Ag(s)$, the reducing agent is
(a) Pb (b) Pb^{2+} (c) Ag (d) Ag^{+}

62. Which metal crystallises in a simple cubic structure?
(a) Polonium (b) Copper
(c) Nickel (d) Iron

63. The amine 'A' when treated with nitrous acid gives yellow oily substance. The amine A is
(a) triethylamine
(b) trimethylamine
(c) aniline
(d) methylphenylamine

64. The element that does not form acidic oxide is
(a) carbon (b) phosphorus
(c) chlorine (d) barium

65. While assigning R, S configuration, the correct order of priority of groups attached to chiral carbon atom is
(a) $CONH_2 > COCH_3 > CH_2OH > CHO$
(b) $CONH_2 > COCH_3 > CHO > CH_2OH$
(c) $COCH_3 > CONH_2 > CHO > CH_2OH$
(d) $CHO > CH_2OH > COCH_3 > CONH_2$

66. Bulletproof helmets are made from
(a) lexan (b) saran
(c) glyptal (d) thiokol

67. Which metal is refined by Mond's process?
(a) Titanium (b) Copper
(c) Nickel (d) Zinc

68. Isopropyl methyl ether when treated with cold hydrogen iodide gives
(a) isopropyl iodide and methyl iodide
(b) isopropyl alcohol and methyl iodide
(c) isopropyl alcohol and methyl alcohol
(d) isopropyl iodide and methyl alcohol

69. In face centred cubic unit cell, what is the volume occupied?

(a) $\frac{4}{3}\pi r^3$ (b) $\frac{8}{3}\pi r^3$

(c) $\frac{16}{3}\pi r^3$ (d) $\frac{64r^3}{3\sqrt{3}}$

70. Glucose on oxidation with bromine water yields gluconic acid. This reaction confirms the presence of

(a) six carbon atoms linked in straight chain
(b) secondary alcoholic group in glucose
(c) aldehyde group in glucose
(d) primary alcoholic group in glucose

71. How is sodium chromate converted into sodium dichromate in the manufacture of potassium dichromate from chromite ore?

(a) By the action of concentrated sulphuric acid
(b) By roasting with soda ash
(c) By the action of sodium hydroxide
(d) By the action of limestone

72. In dry cell, what acts as a negative electrode?

(a) Zinc (b) Graphite
(c) Ammonium chloride (d) Manganese dioxide

73. Select the compound which on treatment with nitrous acid liberates nitrogen.

(a) Nitroethane (b) Triethylamine
(c) Diethylamine (d) Ethylamine

74. 5.0 g of sodium hydroxide (molar mass 40 g mol^{-1}) is dissolved in little quantity of water and the solution is diluted upto 100 mL. What is the molarity of the resulting solution?

(a) 0.1 mol dm^{-3} (b) 1.0 mol dm^{-3}
(c) 0.125 mol dm^{-3} (d) 1.25 mol dm^{-3}

75. Which of the following compound when treated with dibenzyl cadmium yields benzyl methyl ketone?

(a) Acetone (b) Acetaldehyde
(c) Acetic acid (d) Acetyl chloride

76. Which halide of magnesium has highest ionic character?

(a) Chloride (b) Bromide
(c) Iodide (d) Fluoride

77. The reaction takes place in two steps as

(i) $NO_2Cl(g) \xrightarrow{k_1} NO_2(g) + Cl(g)$,

(ii) $NO_2Cl(g) + Cl(g) \xrightarrow{k_2} NO_2(g) + Cl_2(g)$

Identify the reaction intermediate.

(a) $NO_2Cl(g)$ (b) $NO_2(g)$
(c) $Cl_2(g)$ (d) $Cl(g)$

78. Which of the following amino acid is basic in nature?

(a) Valine (b) Tyrosine
(c) Arginine (d) Leucine

79. The relation between solubility of a gas in liquid at constant temperature and external pressure is stated by which law?

(a) Raoult's law
(b) van't Hoff- Boyle's law
(c) van't Hoff-Charles' law
(d) Henry's law

80. Which among the following phenolic compound is most acidic in nature?

(a) *p*-aminophenol (b) Phenol
(c) *m*-nitrophenol (d) *p*-nitrophenol

81. Which among the following solid is a non-polar solid?

(a) Hydrogen chloride
(b) Sulphur dioxide
(c) Water
(d) Carbon dioxide

82. Identify the metal that forms colourless compounds.

(a) Iron ($Z=26$) (b) Chromium ($Z=24$)
(c) Vanadium ($Z=23$) (d) Scandium ($Z=21$)

83. What is the highest oxidation state exhibited by group 17 elements?

(a) +1 (b) +3 (c) +5 (d) +7

84. Mathematical equation of first law of thermodynamics for isochoric process is

(a) $\Delta U = q_v$ (b) $\Delta U = q_v$
(c) $q = -W$ (d) $\Delta U = W$

85. Name the catalyst used in commercial method of preparation of phenol.

(a) Silica
(b) Calcium phosphate
(c) Anhydrous aluminium chloride
(d) Cobalt naphthenate

86. The rate constant and half-life of a first order reaction are related to each other as

(a) $t_{1/2} = \frac{0.693}{k}$ (b) $t_{1/2} = 0.693k$

(c) $k = 0.693 t_{1/2}$ (d) $kt_{1/2} = \frac{1}{0.693}$

87. What is the combining ratio of glycerol and fatty acid when they combine to form triglyceride?

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

88. The molecular formula of Wilkinson's catalyst used in the hydrogenation of alkenes is

(a) $Co(CO)_8$ (b) $(Ph_3P)_3RhCl$
(c) $[Pt(NH_3)_2Cl_2]$ (d) $K[Ag(CN)_2]$

89. The criterion for a spontaneous process is

(a) $\Delta G > 0$ (b) $\Delta G < 0$
(c) $\Delta G = 0$ (d) $\Delta S_{total} < 0$

90. Brown ring test is used for detection of which radical?

(a) Ferrous (b) Nitrite
(c) Nitrate (d) Ferric

91. The reagent used in Wolff-Kishner reduction is
(a) $NH_2 - NH_2$ and KOH in ethylene glycol
(b) Zn – Hg / conc. HCl
(c) $NaBH_4$
(d) Na – Hg/H_2O

92. Which of the following is a neutral complex?
(a) $[Pt(NH_3)_2Cl_2]$ (b) $[Co(NH_3)_6]Cl_3$
(c) $[Ni(NH_3)_6)Cl_2$ (d) $K_4[Fe(CN)_6]$

93. Identify the compound amongst the following of which 0.1 M aqueous solution has highest boiling point.
(a) Glucose (b) Sodium chloride
(c) Calcium chloride (d) Ferric chloride

94. Which reagent is used in Etard reaction?
(a) Chromyl chloride (b) Ethanoyl chloride
(c) $SnCl_2$ and HCl (d) Cadmium chloride

95. The most abundant noble gas in atmosphere is
(a) neon (b) argon
(c) xenon (d) krypton

96. Identify an extensive property amongst the following.
(a) Viscosity (b) Heat capacity
(c) Density (d) Surface tension

97. Which of the following carboxylic acids is a tricarboxylic acid?
(a) Oxalic acid (b) Citric acid
(c) Succinic acid (d) Adipic acid

98. Average rate of reaction for the following reaction.
$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ is written as
(a) $\frac{\Delta[SO_2]}{\Delta t}$ (b) $-\frac{\Delta[O_2]}{\Delta t}$
(c) $\frac{1}{2}\frac{\Delta[SO_2]}{\Delta t}$ (d) $\frac{\Delta[SO_3]}{\Delta t}$

99. What is the amount of work done when 0.5 mole of methane, CH_4 (g), is subjected to combustion at 300 K? (Given, R = 8.314 $JK^{-1} mol^{-1}$)
(a) -2494 J (b) -4988 J
(c) $+4988$ J (d) $+2494$ J

100. Primary nitroalkanes are obtained in good yield by oxidising aldoximes with the help of
(a) trifluoroperoxy acetic acid
(b) acidified potassium permanganate
(c) concentrated nitric acid
(d) potassium dichromate and dilute sulphuric acid

SECTION-B

MATHEMATICS

1. Let $X \sim B(n, p)$, if $E(X) = 5$, $\text{Var}(X) = 2.5$, then $p(X < 1)$ is equal to
(a) $\left(\frac{1}{2}\right)^{11}$ (b) $\left(\frac{1}{2}\right)^{10}$ (c) $\left(\frac{1}{2}\right)^{6}$ (d) $\left(\frac{1}{2}\right)^{9}$

2. Derivative of $\tan^{-1}\left(\frac{x}{\sqrt{1-x^2}}\right)$ with respect to $\sin^{-1}(3x - 4x^3)$ is
(a) $\frac{1}{\sqrt{1-x^2}}$ (b) $\frac{3}{\sqrt{1-x^2}}$
(c) 3 (d) $\frac{1}{3}$

3. The differential equation of the family of circles touching Y-axis at the origin is
(a) $(x^2 + y^2)\frac{dy}{dx} - 2xy = 0$
(b) $(x^2 - y^2) + 2xy\frac{dy}{dx} = 0$
(c) $(x^2 - y^2)\frac{dy}{dx} - 2xy = 0$
(d) $(x^2 + y^2)\frac{dy}{dx} + 2xy = 0$

4. If $A = \begin{bmatrix} 1 & 1 & 0 \\ 2 & 1 & 5 \\ 1 & 2 & 1 \end{bmatrix}$, then
$a_{11}A_{21} + a_{12}A_{22} + a_{13}A_{23}$ is equal to
(a) 1 (b) 0 (c) –1 (d) 2

5. If Rolle's theorem for $f(x) = e^x(\sin x - \cos x)$ is verified on $\left[\frac{\pi}{4}, \frac{5\pi}{4}\right]$, then the value of c is
(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{2}$ (c) $\frac{3\pi}{3}$ (d) π

6. The joint equation of lines passing through the origin and trisecting the first quadrant is
(a) $x^2 + \sqrt{3}xy - y^2 = 0$
(b) $x^2 - \sqrt{3}xy - y^2 = 0$
(c) $\sqrt{3}x^2 - 4xy + \sqrt{3}y^2 = 0$
(d) $3x^2 - y^2 = 0$

7. If 2 $\tan^{-1}(\cos x) = \tan^{-1}$ (2 cosec x), then $\sin x + \cos x$ is equal to

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

8. Direction cosines of the line $\frac{x+2}{2} = \frac{2y-5}{3}$, $z = -1$ are

(a) $\frac{4}{5}, \frac{3}{5}, 0$ (b) $\frac{3}{5}, \frac{4}{5}, \frac{1}{5}$

(c) $-\frac{3}{5}, \frac{4}{5}, 0$ (d) $\frac{4}{5}, -\frac{2}{5}, \frac{1}{5}$

9. $\int \frac{1}{\sqrt{8+2x-x^2}} dx$ is equal to

(a) $\frac{1}{3}\sin^{-1}\left(\frac{x-1}{3}\right)+c$ (b) $\sin^{-1}\left(\frac{x+1}{3}\right)+c$

(c) $\frac{1}{3}\sin^{-1}\left(\frac{x+1}{3}\right)+c$ (d) $sin^{-1}\left(\frac{x-1}{3}\right)+c$

10. The approximate value of $f(x) = x^3 + 5x^2 - 7x + 9$ at $x = 1.1$ is

(a) 8.6 (b) 8.5 (c) 8.4 (d) 8.3

11. If random variable waiting time in minutes for bus and probability density function of x is given by

$$f(x) = \begin{cases} \frac{1}{5}, & 0 \le x \le 5 \\ 0, & \text{otherwise,} \end{cases}$$

then probability of waiting time not more than 4 minutes is equal to

(a) 0.3 (b) 0.8 (c) 0.2 (d) 0.5

12. In $\Delta ABC, (a-b)^2 \cos^2 \frac{C}{2} + (a+b)^2 \sin^2 \frac{C}{2}$ is equal to

(a) b^2 (b) c^2

(c) a^2 (d) $a^2 + b^2 + c^2$

13. Derivative of log (sec θ + tan θ) with respect to sec θ at $\theta = \frac{\pi}{4}$ is

(a) 0 (b) 1 (c) $\frac{1}{\sqrt{2}}$ (d) $\sqrt{2}$

14. The joint equation of bisectors of angles between lines $x = 5$ and $y = 3$ is

(a) $(x-5)(y-3) = 0$

(b) $x^2 - y^2 - 10x + 6y + 16 = 0$

(c) $xy = 0$

(d) $xy - 5x - 3y + 15 = 0$

15. The point on the curve $6y = x^3 + 2$ at which y-coordinate is changing 8 times as fast as x-coordinate is

(a) (4,11) (b) (4,–11)

(c) (–4, 11) (d) (–4, – 11)

16. If the function $f(x)$ defined by

$$f(x) = \begin{cases} x\sin\frac{1}{x}, & \text{for } x \ne 0 \\ k, & \text{for } x = 0 \end{cases}$$

is continuous at $x = 0$, then k is equal to

(a) 0 (b) 1 (c) –1 (d) $\frac{1}{2}$

17. If $y = e^m \sin^{-1} x$ and $(1-x^2) = Ay^2$, then A is equal to

(a) m (b) –m (c) m^2 (d) $-m^2$

18. $\int\left(\frac{4e^x-25}{2e^x-5}\right)dx = Ax + B\log(2e^x-5)+c$, then

(a) $A = 5$ and $B = 3$ (b) $A = 5$ and $B = -3$

(c) $A = -5$ and $B = 3$ (d) $A = -5$ and $B = -3$

19. $\frac{\tan^{-1}(\sqrt{3}) - \sec^{-1}(-2)}{\text{cosec}^{-1}(-\sqrt{2}) + \cos^{-1}\left(-\frac{1}{2}\right)}$ is equal to

(a) $\frac{4}{5}$ (b) $-\frac{4}{5}$ (c) $\frac{3}{5}$ (d) 0

20. For what value of k, the function defined

by $f(x) = \begin{cases} \frac{\log(1+2x)\sin x^0}{x^2}, & \text{for } x \ne 0 \\ k, & \text{for } x = 0 \end{cases}$

is continuous at $x = 0$?

(a) 2 (b) $\frac{1}{2}$ (c) $\frac{\pi}{90}$ (d) $\frac{90}{\pi}$

21. If $\log_{10}\left(\frac{x^2-y^2}{x^2+y^2}\right) = 2$, then $\frac{dy}{dx}$ is equal to

(a) $\frac{99x}{101y}$ (b) $\frac{99x}{101y}$

(c) $-\frac{99y}{101x}$ (d) $\frac{99y}{101x}$

22. $\int_{-\pi/2}^{\pi/2} \log\left(\frac{2-\sin x}{2+\sin x}\right)$ is equal to

(a) 1 (b) 3 (c) 2 (d) 0

23. $\int\left(\frac{(x^2+2)a^{(x+tan^{-1}x)}}{x^2+1}\right)dx$ is equal to

(a) $\log(a)a^{x+tan^{-1}x}+c$ (b) $\frac{(x+\tan^{-1}x)}{\log a}+c$

(c) $\frac{a^{x+\tan^{-1}x}}{\log a}+c$ (d) $\log a(x+\tan^{-1}x)+c$

24. The degree and order of the differential equation

$\left[1+\left(\frac{dy}{dx}\right)^3\right]^{\frac{7}{3}}=7\left(\frac{d^2y}{dx^2}\right)$ respectively are

(a) 3 and 7 (b) 3 and 2
(c) 7 and 3 (d) 2 and 3

25. The acute angle between the line

$\vec{r}=(\hat{i}+2\hat{j}+\hat{k})+\lambda(\hat{i}+\hat{j}+\hat{k})$ and the plane

$\vec{r}\times(2\hat{i}-\hat{j}+\hat{k})=5$

(a) $\cos^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (b) $\sin^{-1}\left(\frac{\sqrt{2}}{3}\right)$

(c) $\tan^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (d) $\sin^{-1}\left(\frac{\sqrt{2}}{\sqrt{3}}\right)$

26. The area of the region bounded by the curve $y=2x-x^2$ and X-axis is

(a) $\frac{2}{3}$sq units (b) $\frac{4}{3}$sq units

(c) $\frac{5}{3}$sq units (d) $\frac{8}{3}$sq units

27. If $\int\frac{f(x)}{\log(\sin x)}dx=log[\log\sin x]+c$, then $f(x)$ is equal to

(a) $\cot x$ (b) $\tan x$
(c) $\sec x$ (d) $\operatorname{cosec} x$

28. If A and B are foot of perpendicular drawn from point $Q(a, b, c)$ to the planes yz and zx, then equation of plane through the points A, B and O is

(a) $\frac{x}{a}+\frac{y}{b}-\frac{z}{c}=0$ (b) $\frac{x}{a}-\frac{y}{b}+\frac{z}{c}=0$

(c) $\frac{x}{a}-\frac{y}{b}-\frac{z}{c}=0$ (d) $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=0$

29. If $a=\vec{a}=\hat{i}+\hat{j}-2\hat{k}, \vec{b}=2\hat{i}-\hat{j}+\hat{k}$ and $\vec{c}=3\hat{i}-\hat{k}$ and $\vec{c}=m\vec{a}+n\vec{b}$, then $m+n$ is equal to

(a) 0 (b) 1 (c) 2 (d) –1

30. $\int_0^{\frac{\pi}{2}}\left(\frac{\sqrt[n]{\sec x}}{\sqrt[n]{\sec x}+\sqrt[n]{\operatorname{cosec} x}}\right)dx$ is equal to

(a) $\frac{\pi}{2}$ (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{4}$ (d) $\frac{\pi}{6}$

31. If the probability density function of a random variable X is given as

x_1	–2	–1	0	1	2
$P(X=x_1$	0.2	0.3	0.15	0.25	0.1

then $F(0)$ is equal to

(a) $P(X<0)$ (b) $P(X>0)$
(c) $1-P(X>0)$ (d) $1-(X<0)$

32. The particular solution of the differential equation $y(1+\log x)\frac{dx}{dy}-x\log x=0$, when, $x=e, y=e^2$ is

(a) $y=ex\log x$ (b) $ey=x\log x$
(c) $xy=e\log x$ (d) $y\log x=ex$

33. M and N are the mid-points of the diagonals AC and BD respectively of quadrilateral $ABCD$, then AB + AD + CB + CD is equal to

(a) 2 MN (b) 2 NM (c) 4 MN (d) 4 NM

34. If $\sin x$ is the integrating factor (IF) of the linear differential equation $\frac{dy}{dx}+Py=Q$ then P is

(a) $\log\sin x$ (b) $\cos x$
(c) $\tan x$ (d) $\cot x$

35. Which of the following equation does not represent a pair of lines?

(a) $x^2-x=0$ (b) $xy-x=0$
(c) $y^2-x+1=0$ (d) $xy+x+y+1=0$

36. Probability of guessing correctly atleast 7 out of 10 answers in a 'True' or 'False' test is equal to

(a) $\frac{11}{64}$ (b) $\frac{11}{32}$ (c) $\frac{11}{16}$ (d) $\frac{27}{32}$

37. Principal solutions at the equation $\sin 2x+\cos 2x=0$, where $\pi<x<2\pi$ are

(a) $\frac{7\pi}{9},\frac{11\pi}{8}$ (b) $\frac{9\pi}{8},\frac{13\pi}{8}$

(c) $\frac{11\pi}{8},\frac{15\pi}{8}$ (d) $\frac{15\pi}{8},\frac{19\pi}{8}$

38. It line joining points A and B having position vectors $6a - 4b + 4c$ and $-4c$ respectively and the line joining the points C and D having position vectors $-a - 2b - 3c$ and $a + 2b - 5c$ intersect, then point of intersection is

(a) B (b) C (c) D (d) A

39. If $A = \begin{bmatrix} 2 & 2 \\ -3 & 2 \end{bmatrix}$, $B\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$, then $(B^{-1}A^{-1})^{-1}$ is equal to

(a) $\begin{bmatrix} 2 & -2 \\ 2 & 3 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & 2 \\ -2 & 3 \end{bmatrix}$

(c) $\begin{bmatrix} 2 & -3 \\ 2 & 2 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & -1 \\ -2 & 3 \end{bmatrix}$

40. If p : Every square is a rectangle. q : Every rhombus is a kite, then truth values of $p \to q$ and $p \leftrightarrow q$ are___and___respectively.

(a) F, F (b) T, F (c) F, T (d) T, T

41. If $G(\mathbf{g})$, $H(\mathbf{h})$ and $(\mathbf{p})$ are centroid orthocentre and circumcentre of a triangle and $xp + yh + zg = 0$, then (x, y, z) is equal to

(a) 1, 1, –2 (b) 2, 1, –3
(c) 1, 3, –4 (d) 2, 3, –5

42. Which of the following quantified statement is true?

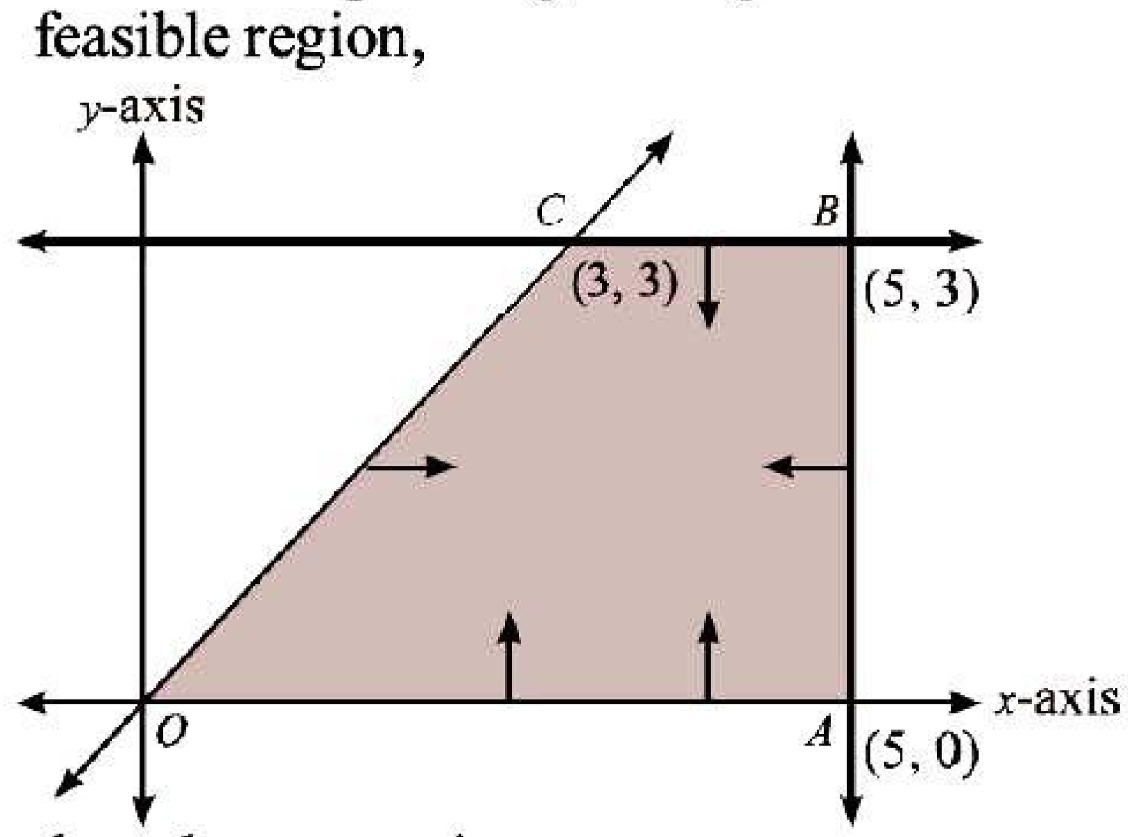
(a) The square of every real number is positive
(b) There exists a real number, whose square is negative
(c) There exists a real number, whose square is not positive
(d) Every real number is rational

43. The general solution of the equation $\tan^2 x = 1$ is

(a) $n\pi + \frac{\pi}{4}$ (b) $n\pi - \frac{\pi}{4}$

(c) $n\pi \pm \frac{\pi}{4}$ (d) $2n\pi \pm \frac{\pi}{4}$

44. The shaded part of given figure indicates in feasible region,



then the constraints are

(a) $x, y \geq 0, x + y \geq 0, x \geq 5, y \leq 3$
(b) $x, y \geq 0, x - y \geq 0, x \leq 5, y \leq 3$
(c) $x, y \geq 0, x - y \geq 0, x \leq 5, y \geq 3$
(d) $x, y \geq 0, x - y \leq 0, x \leq 5, y \leq 3$

45. Direction ratios of the line which is perpendicular to the lines with direction ratios –1, 2, 2 and 0, 2, 1 are

(a) 1, 1, 2 (b) 2, –1, 2
(c) –2, 1, 2 (d) 2, 1, –2

46. If matrix $A = \begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix}$, such that $AX = I$, then X is equal to

(a) $\frac{1}{5}\begin{bmatrix} 1 & 3 \\ 2 & -1 \end{bmatrix}$ (b) $\frac{1}{5}\begin{bmatrix} 4 & 2 \\ 4 & -1 \end{bmatrix}$

(c) $\frac{1}{5}\begin{bmatrix} -3 & 2 \\ 4 & -1 \end{bmatrix}$ (d) $\frac{1}{5}\begin{bmatrix} -1 & 2 \\ -1 & 4 \end{bmatrix}$

47. If $\vec{a} = \hat{i} - \hat{j} + \hat{k}, \vec{b} = 2\hat{i} + \lambda\hat{j} + \hat{k}, \vec{c} = \hat{i} - \hat{j} + 4\hat{k}$ and $\vec{a} \cdot (\vec{b} \times \vec{c}) = 10$, then λ is equal to

(a) 6 (b) 7 (c) 9 (d) 10

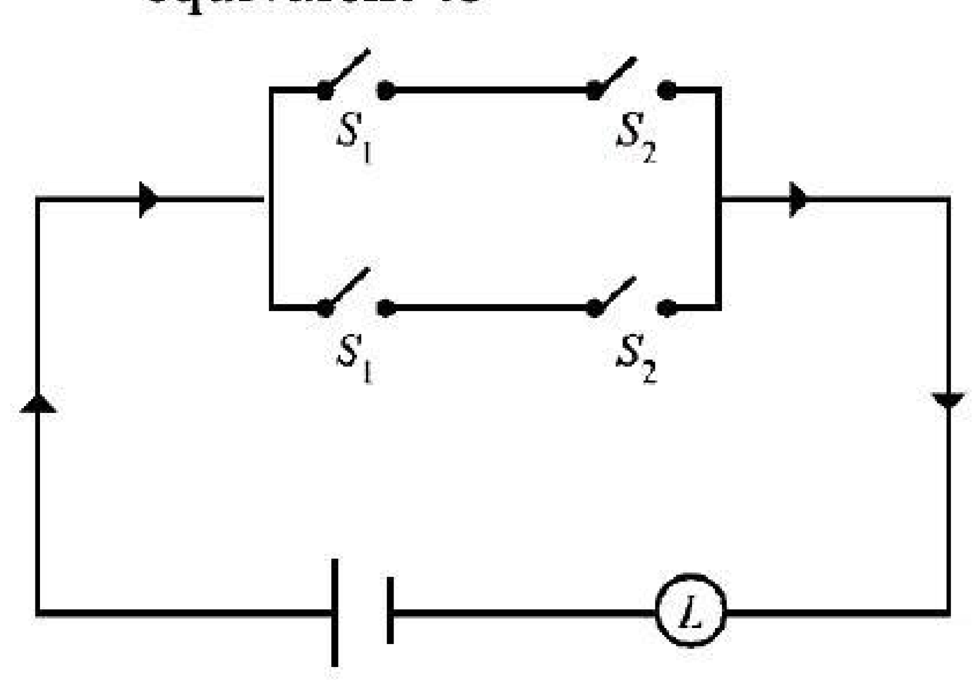
48. If random variable $x \sim b\left(n = 5, P = \frac{1}{3}\right)$, then $P(2 < X < 4)$ is equal to

(a) $\frac{80}{243}$ (b) $\frac{40}{243}$ (c) $\frac{40}{343}$ (d) $\frac{80}{343}$

49. The objective function $Z = x_1 + x_2$, subject to the constraints are $x_1 + x_2 \leq 10, -2x_1 + 3x_2 \leq 15, x_1 \leq 6, x_1, x_2 \geq 0,$ has maximum value ________________ of the feasible region.

(a) at only one point
(b) at only two points
(c) at every point of the segment joining two points
(d) at every point of the line joining two points equivalent to

50.



Symbolic form of the given switching circuit is equivalent to:

(a) $p \vee \sim q$ (b) $p \wedge \sim q$
(c) $p \leftrightarrow q$ (d) None of these

ANSWER KEYS & SOLUTIONS

(MHT-CET 2016)

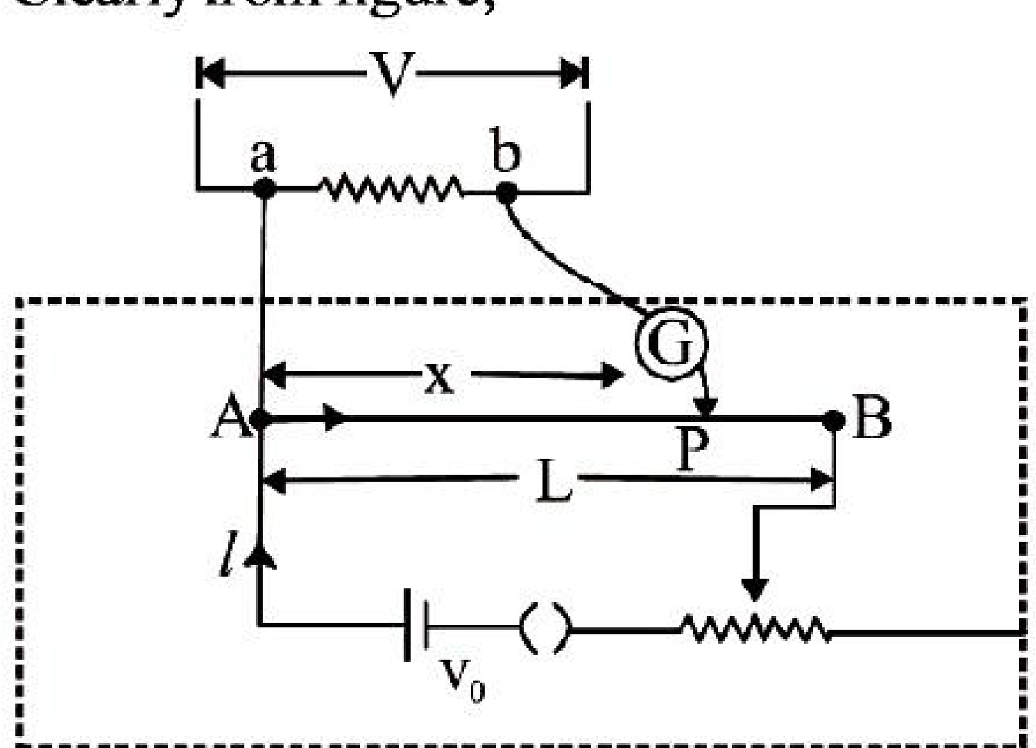
Answer KEYS

SECTION-A																			
PHYSICS																			
1	(a)	**6**	(a)	**11**	(b)	**16**	(a)	**21**	(c)	**26**	(a)	**31**	(c)	**36**	(b)	**41**	(a)	**46**	(a)
2	(c)	**7**	(a)	**12**	(c)	**17**	(b)	**22**	(b)	**27**	(d)	**32**	(b)	**37**	(d)	**42**	(c)	**47**	(b)
3	(b)	**8**	(a)	**13**	(a)	**18**	(a)	**23**	(c)	**28**	(b)	**33**	(c)	**38**	(c)	**43**	(d)	**48**	(a)
4	(c)	**9**	(d)	**14**	(b)	**19**	(a)	**24**	(c)	**29**	(a)	**34**	(c)	**39**	(a)	**44**	(a)	**49**	(c)
5	(c)	**10**	(a)	**15**	(c)	**20**	(c)	**25**	(d)	**30**	(b)	**35**	(a)	**40**	(d)	**45**	(b)	**50**	(b)
CHEMISTRY																			
51	(c)	**56**	(b)	**61**	(a)	**66**	(a)	**71**	(a)	**76**	(d)	**81**	(d)	**86**	(a)	**91**	(a)	**96**	(b)
52	(a)	**57**	(d)	**62**	(a)	**67**	(c)	**72**	(a)	**77**	(d)	**82**	(d)	**87**	(c)	**92**	(a)	**97**	(b)
53	(a)	**58**	(d)	**63**	(d)	**68**	(b)	**73**	(d)	**78**	(c)	**83**	(d)	**88**	(b)	**93**	(d)	**98**	(b)
54	(c)	**59**	(d)	**64**	(d)	**69**	(c)	**74**	(d)	**79**	(d)	**84**	(a)	**89**	(b)	**94**	(a)	**99**	(d)
55	(a)	**60**	(a)	**65**	(b)	**70**	(c)	**75**	(d)	**80**	(d)	**85**	(d)	**90**	(c)	**95**	(b)	**100**	(a)
SECTION-B																			
MATHEMATICS																			
1	(b)	**6**	(c)	**11**	(b)	**16**	(a)	**21**	(a)	**26**	(b)	**31**	(c)	**36**	(a)	**41**	(b)	**46**	(c)
2	(d)	**7**	(b)	**12**	(b)	**17**	(c)	**22**	(d)	**27**	(a)	**32**	(a)	**37**	(c)	**42**	(a)	**47**	(a)
3	(b)	**8**	(a)	**13**	(b)	**18**	(b)	**23**	(c)	**28**	(a)	**33**	(c)	**38**	(a)	**43**	(c)	**48**	(b)
4	(b)	**9**	(d)	**14**	(b)	**19**	(b)	**24**	(b)	**29**	(c)	**34**	(d)	**39**	(a)	**44**	(b)	**49**	(c)
5	(b)	**10**	(a)	**15**	(a)	**20**	(c)	**25**	(b)	**30**	(c)	**35**	(c)	**40**	(a)	**45**	(b)	**50**	(d)

SECTION-A

PHYSICS

1. **(a)** Clearly from figure,



Balancing length x

$$\frac{x}{L} = \frac{V}{V_0} \Rightarrow x = \frac{V \times L}{V_0}$$

here, V_0 = potential difference across potentiometer wire

V = potential to be measured

L = length of the potentiometer wire

$\because x \propto L$

$\therefore$ if length of potentiometer wire is increased the balancing length will also increases.

2. **(c)** Given, B_0 = magnetic field after insertion of iron rod - 2000 Am^{-1}

Magnetic flux, $\phi = 6 \times 10^{-4}$Wb

Area of cross-section, $A = 3\ cm^2 = 3 \times 10^{-4}$ m
magnetic permeability of the rod,

$$\mu_r = \frac{B}{B_0} = \frac{\phi}{A \times B_0} [\because \phi = BA]$$

So, $\mu_r = \dfrac{B}{2000 Am^{-1}}$

$$\therefore \mu_r = \frac{6 \times 10^{-4} Wb}{3 \times 10^{-4} m^2} \times \frac{1}{2000 Am^{-1}}$$

$= 10^{-3} WbA^{-1}m^{-1}$

3. (b) From question, peak value of current

$$I_0 = \sqrt{2} \times I_{rms} = \frac{2}{\pi} A$$

Coefficient of mutual inductance M = 1 H
Induced emf in secondary coil

$$E_s = M.\frac{dI}{dt} \qquad [\because I = I_0 \sin \omega t]$$

$\Rightarrow E_s = M \omega I_0 \cos(\omega t)$

$$= 1 \times 2\pi \times 50 \times \frac{2}{\pi} \cos(2\pi \times 50 \times t)$$

$(\because \omega = 2\pi n)$

For t = 0, $E_s = 2\pi \times 50 \times \dfrac{2}{\pi} = 200V$

4. (c) From de-Broglie relation,

$$\lambda = \frac{h}{p} \Rightarrow \lambda = \frac{h}{\sqrt{2mKE}} = \frac{h}{\sqrt{2mqV}}$$

$$\Rightarrow \lambda \propto \frac{1}{\sqrt{qVm}}$$

For electron $\lambda_e \propto \dfrac{1}{\sqrt{eVm}}$ ...(i)

For proton, $\lambda_p = \dfrac{1}{\sqrt{e9VM}}$ ...(ii)

where, e is the charge on proton, potential difference = 9V and Mass of proton = m
From eqs. (i) and (ii)

$$\frac{\lambda_e}{\lambda_p} = \sqrt{\frac{9VMe}{eVm}} \Rightarrow \lambda_p = \frac{\lambda_e}{3}\sqrt{\frac{m}{M}}$$

5. (c) Resultant intensity of interferring wave at 'P'

$$I_P = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos\phi$$

For $\phi = \dfrac{\pi}{2}, I_p = I + 9I = 10I$

Again resultant intensity at 'Q'

$$I_Q = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos\phi$$

For $\phi = \pi, I_Q = I + 9I + (-2\sqrt{9(I)^2})$
$= 10I - 6I = 4I$
$\therefore$ Difference between the resultant intensity

$$\Delta I = I_P - I_Q = 10I - 4I = 6I$$

6. (a) According to Brewster's law, $\tan i_p = \mu$
Clearly, Polarising angle depends on wavelength and wavelength is different for different colours of light.

7. (a) Force acting on the particle inside magnetic field
$F_B = qvB \sin\theta$
This force F_B provides necessary centripetal force $\dfrac{mv^2}{r}$ for circular motion of the charged particle

$$\therefore \frac{mv^2}{r} = qvB \sin\theta$$

Now, for particles x and y and for $\theta = 90^o$

$$\frac{m_x v_x^2}{r_1} = qv_x B \qquad ...(i)$$

$$\frac{m_y v_y^2}{r_2} = qv_y B \qquad ...(ii)$$

From eqs. (i) and (ii)

$$\frac{m_x v_x}{m_y v_y} = \frac{r_1}{r_2} \Rightarrow \frac{m_x}{m_y} = \frac{r_1}{r_2} \quad \left[\because \frac{v_x}{v_y} = 1\right]$$

8. (a) As per Bohr's quantisation principle, an electron revolving in a stationary orbit which has fixed energy, will not radiate light. Change in velocity, due to change in direction of electron revolving in stationary orbit.

9. (d) Magnetic field inside the solenoid $B = \mu_0 nI$
According to question, change in magnetic field due to insertion of iron core
$B' = \mu B$
$= \mu_0(1+\chi)B \qquad [\therefore \mu = \mu_0(1+\chi)]$
$\therefore B' = \mu_0(1+\chi)nI$

10. (a) For potentiometer,

$$\frac{R_1}{R_2} = \frac{l_1}{l_2} = \frac{2}{3}\left(\because \frac{l_1}{l_2} = \frac{2}{3}\right)$$

$$\frac{x}{6} = \frac{2}{3} \Rightarrow x = 4\Omega m^{-1}$$

Total resistance = 6 + 4 = 10Ω
Resistance of wire 0.1 × 100 = 10Ω

$\therefore \frac{1}{R_{eff}} = \frac{1}{10} + \frac{1}{10} \Rightarrow R_{eff} = 5\Omega$

Current drawn from the battery

$I = \frac{V}{R} = \frac{5}{5} = 1A$

11. (b) As we know, capacitance of parallel plate capacitor $C = \frac{\varepsilon_0 A}{d}$

$\therefore$ Capacitance for

first capacitor, $C_1 = \frac{\varepsilon_0 A}{3d}$

second capacitor, $C_2 = \frac{\varepsilon_0 A}{6d}$

third capacitor, $C_3 = \frac{\varepsilon_0 A}{9d}$

Equivalent capacitance of capacitors C_1, C_2 and C_3 arranged in parallel,

$C_{eq} = C_1 + C_2 + C_3$

$= \frac{\varepsilon_0 A}{d}\left(\frac{1}{3} + \frac{1}{6} + \frac{1}{9}\right) = \frac{\varepsilon_0 A}{d} \times \frac{11}{18} = \frac{11\varepsilon_0 A}{18d}$

12. (c) According to Barkhausen criterion if A is the gain of the amplifying element in the circuit and B is the transfer function of the feedback path, then condition of sustained oscillation is $|\beta A| = 1$

13. (a) According to Einstein's photoelectric equation, $\frac{hc}{\lambda} = \phi + E$

Here

E = kinetic energy

ϕ = work function

If E is constant, then $\frac{1}{\lambda} \propto \phi$

$\therefore$ If wavelength λ is decreased, then stopping potential ϕ will increase such that $\frac{hc}{\lambda} - \phi = \text{constant}$

14. (b) As given in the question, at glass-air interface velocity is reduced by 20% of the velocity of light.

So, deviation δ will be = 20% of i

$= \frac{20 \times i}{100} = \frac{i}{5}$

15. (c) The maximum frequency of radio waves which when sent towards the layer of ionosphere gets reflected back by the ionosphare is given by $g\sqrt{N}$.

16. (a) The fundamental frequency of vibrating wire is given by

$f_1 = \frac{1}{2}\sqrt{\frac{T}{\mu}}$

Here, μ = mass of string per unit length.

T = tension in the wire

Let x be the frequency of tunning fork according to question

$(x - f) = \pm 6$

$\therefore f_1 = \frac{1}{2L}\sqrt{\frac{225}{\mu}}$ and $f_2 = \frac{1}{2L}\sqrt{\frac{256}{\mu}}$

$\therefore \frac{f_1}{f_2} = \frac{15}{16} \Rightarrow f_2 = \frac{16}{15} \times f_1$

$\Rightarrow f_2 = \frac{16}{15}(6 + x)$

Equating the two cases of f_1, we have

$(x + 6) = \frac{16}{15}(x - 6)$

$\therefore 15x + 90 = 16x - 96$

$\therefore x = 186\,Hz$

17. (b) As per kinetic theory of gases, the pressure exerted by the gas on the walls of container (p) is given by

$p = p_0 + p_1 + p_2$

i.e. $p = p_0 + \frac{1}{3}8v^2 + 3gh$

For a container,

$p_1 = \frac{1}{3}\rho v^2 = \frac{1}{3}\frac{m}{v}.v^2 \times \frac{2}{2} = \frac{2}{3}.\frac{1}{2}mv^2.\frac{1}{v}$

$= \frac{2}{3v}KE \qquad \left[\because KE = \frac{1}{2}mv^2\right]$

18. (a) For a given oscillating mass, potential energy is given by

$PE = \frac{1}{2}kx^2$

For a body oscillating at x = A, maximum energy is given by

$E_{max} = \frac{1}{2}kA^2$

Also at mean position x = 0.

So, E = 0

$\therefore \quad A \propto \frac{1}{\sqrt{m}} \qquad \text{...(i)}$

When another mass m_2 is placed on mass m_1. Then, total mass becomes $(m_1 + m_2)$ and at this point E = 0 as x = 0.
When they reach at x = A,

$$A_1 \propto \frac{1}{\sqrt{m_1 + m_2}} \quad ...(ii)$$

Dividing eq. (ii) by eq. (i),

$$\frac{A_1}{A} = \left(\frac{m_1}{m_1 + m_2}\right)^{\frac{1}{2}}$$

19. (a) Using third equation of motion,
$v^2 = u^2 + 2as$ ...(i)
We have given
Initial velocity, u = 0
$S = 2 \times 2\pi r = 4\pi r$

So, $v^2 = 2a \times 4\pi r \Rightarrow a = \frac{V^2}{8\pi r}$ (using (i))

20. (c) The velocity of wave travelling on string (v) is given by

$$v = n\lambda = \frac{\lambda}{2L}\sqrt{\frac{T}{\mu}} \quad \left(\because n = \frac{1}{2L}\sqrt{\frac{T}{\mu}}\right)$$

Here, μ = mass per unit length

$$\therefore\ v = \sqrt{\frac{T}{m/l}} \Rightarrow v = \sqrt{\frac{Tl}{m}}$$

Young's modulus (Y) is given by,

$$Y = \frac{T \times l}{A\Delta L}$$

$$\therefore\ T \times l = YA\,\Delta L$$

$$\therefore\ V \propto \sqrt{A} \quad \text{(A = Area)}$$

The radius of the string A is 2r and string B is r.

$$\therefore\ \frac{v_A}{v_B} = \sqrt{\frac{4r^2}{r^2}} = \sqrt{4} = 2$$

[$\because$ Y is same for both the strings.]

21. (c) The initial phase (ϕ) of a pendulum during damped oscillation remains unchanged.

22. (b) The relation between end correction $(\Delta\ell)$ and inner radius of the organ pipe (r) is given by
$\Delta l = 1.2 \times r$

$$\therefore\ r = \frac{\Delta l}{1.2} = \frac{0.8}{1.2} \quad [\because \Delta l = 0.8]$$

$$= \frac{2}{3}\ \text{cm}$$

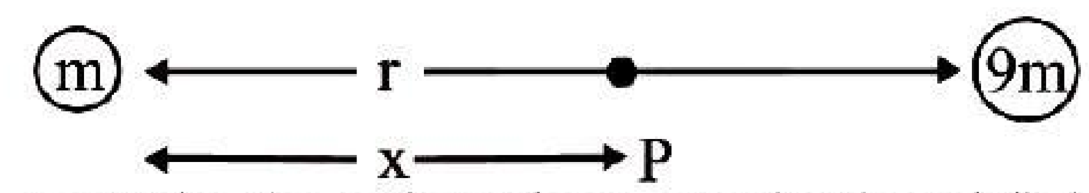
23. (c) We have given $y = 12 \sin(5t - 4x)$ cm
Comparing this equation with standard equation of progressive wave, $y = A\sin(\omega t - kx)$
we get A = 12
$\omega = 5$
$\Rightarrow\ k = 4$

Here, $(\omega t - kx)$ is phase difference $= \frac{\pi}{2}$

$\therefore\ 5t - 4x = \frac{\pi}{2}$ When t = 0, $4x = \frac{\pi}{2}$

$\therefore\ x = \frac{\pi}{8}$ cm

24. (c)



Let P be the point where gravitational field is zero so,

$$\frac{Gm}{x^2} = \frac{G9m}{(r-x)^2} \Rightarrow \frac{1}{x^2} = \frac{9}{(r-x)^2}$$

$$\Rightarrow \sqrt{(r-x)^2} = \sqrt{9x^2} \Rightarrow r - x = 3x$$

$$\Rightarrow x = \frac{r}{4}$$

Now, gravitational potential at this point is

$$-\left(\frac{4Gm}{r} + \frac{G9m \times 4}{3r}\right) \quad \left[r - x = \frac{3r}{4}\right]$$

$$\Rightarrow -\left(\frac{4Gm + 12Gm}{r}\right) \Rightarrow -\left(\frac{16\,Gm}{r}\right)$$

25. (d) According to Stefan's Boltzmann law,
$E = e\sigma A\left(T^4 - T_0^4\right)$
When l and b are changed to $\frac{l}{3}$ and $\frac{b}{3}$, respectively.
Area becomes

$$\frac{l}{3} \times \frac{b}{3} = \frac{lb}{3} = \frac{A}{9} \quad (\because A = lb)$$

Now for two different cases

$$\frac{E'}{E} = \frac{A'}{A}\frac{(227+373)^4}{(27+273)^4} = \frac{1}{9}\left(\frac{600}{300}\right)^4$$

$$\therefore\ E' = \frac{1}{9} \times (2)^4 \times E \Rightarrow E' = \frac{16E}{9}$$

26. (a) We have given

$$\frac{R}{C_v} = 0.4 \quad ...(i)$$

Here, R = universal gas constant

C_v = molar specific heat at constant volume

We know that, $C_p - C_v = R$

$\therefore \frac{C_p - C_v}{C_v} = 0.4 \Rightarrow \frac{C_p}{C_v} = 0.4 + 1 = 1.4$

i.e. $\gamma = 1.4$

The gas is diatomic in nature.

27. (d) We know in vertical circle velocity of a particle at lowest point, $v_l = \sqrt{5gr}$

velocity of particle at highest point, $v_h = \sqrt{rg}$

So, KE at highest point of the vertical circle

$$K_h = \frac{1}{2} m\,rg = \frac{mgr}{2}$$

and KE at lowest point of the vertical circle

$$(K_l) = \frac{1}{2} m\,5gr = \frac{5mgr}{2}$$

So, required ratio $\frac{K_h}{K_l} = \frac{\frac{mgr}{2}}{\frac{5mgr}{2}} = \frac{1}{5} = 0.2$

28. (b) Energy per unit volume in string is given by

$\frac{1}{2} \times \text{stress} \times \text{strain}$

i.e. $\frac{U}{V} = \frac{1}{2} \times \frac{F}{A} \times \frac{\Delta l}{l}$

$= \frac{1}{2} \times Y \times (\text{strain})^2$

$\therefore \quad \frac{U_S}{S_L} = \frac{Y_S}{Y_L} \times \left(\frac{\text{Stress}(S)}{\text{Strain}(L)}\right)^2$

$= \frac{A_L}{A_S} = \left(\frac{l}{l}\right)^2 \Rightarrow \frac{r_L^2}{r_S^2} = \frac{3^2}{1^2} = 9:1$

29. (a) For a rolling disc or ring kinetic energy is given by $KE = \frac{1}{2} mv^2 + \frac{1}{2} I\omega^2$

The ring and disc will have same translational kinetic energy, i.e. $\frac{1}{2} mv^2$

Rotational kinetic energy of the disc

$= \frac{1}{4} mR^2\omega^2$

Rotational kinetic energy of ring

$= \frac{1}{2} mR^2\omega^2$

As for ring, $4\,J = \frac{1}{2} mv^2 + \frac{1}{2} mR^2\omega^2$

$(\because I = mR^2)$

For disc, $\frac{1}{2} mR^2\omega^2 + \frac{1}{4} mR^2\omega^2 = \left(\frac{4}{2} + \frac{4}{4}\right) J = 3J$

30. (b) We have given $\frac{f_1}{f_2} = 2$

f_1 = apparent frequency heard by the listener when velocity v_1 is towards the observer.

f_2 = apparent frequency heard by the listener when velocity v_1 is away from the observer.

Now, the apparent frequency of sound heard by the listener when observer is moving towards the source is given by

$$f_1 = \left(\frac{V}{V - V_1}\right) f_0 \quad \text{...(i)}$$

Similarly when observer is moving away from the source, apparent frequency heard by the listener is given by

$$f_2 = \left(\frac{V}{V + V_1}\right) f_0$$

From eqs. (i) and (ii), we get

$$\frac{f_1}{f_2} = \frac{\left(\frac{V}{V - V_1}\right) f_0}{\left(\frac{V}{V + V_1}\right) f_0} = \frac{V + V_1}{V - V_1} \quad \text{...(ii)}$$

$$\Rightarrow \frac{V + V_1}{V - V_1} = 2 \Rightarrow 2V - 2V_1 = V + V_1$$

$$\Rightarrow V = 3V_1 \Rightarrow \frac{V}{V_1} = 3$$

31. (c) Surface area of the liquid drop $A = 4\pi R^2$

Let E be the surface energy of liquid drop. When the drop splits into 512 droplets, the surface area becomes

$A_2 = 512 \times 4\pi r^2$ [r = radius of smaller drop]

Comparing the volumes of bigger and all smaller droplets, we get

i.e. $\frac{4}{3}\pi R^3 = 512 \times \frac{4}{3}\pi r^3 \Rightarrow r = \frac{R}{8}$

Total area of smaller droplets is

$$A_1 = 512 \times 4 \times \pi \times \left(\frac{R}{8}\right)^2 = 8A$$

Change in surface area $A_2 - A_1$

$$= 4\pi\left(\frac{512\times R^2}{64} - R^2\right)$$

$$= 4\pi\left(8R^2 - R^2\right) = 7R^2$$

Surface energy, E = AT [A = area, T = tension]

So, $$\frac{E_n}{E_0} = \frac{A_1\times T}{A\times T} = \frac{8A}{A} = 8$$

$\therefore$ $E_n = 8E$

32. (b) Moment of inertia of a thin rod whose axis is passing through its middle point and perpendicular to its length is given by

$$I = \frac{ML^2}{12} \quad ...(i)$$

In terms of radius of gyration, it can be written as

$$I = MK_1^2 \quad ...(ii)$$

Comparing equation (i) and (ii), we get

$$MK_1^2 = \frac{ML^2}{12}$$

$$\Rightarrow \quad K_1 = \frac{L}{2\sqrt{3}} \quad ...(iii)$$

Moment of inertia of rod whose axis is passing through one of its end is given by

$$I = \frac{ML^2}{3} \quad ...(iv)$$

In terms of radius of gyration, it can be written as

$$I = MK_2^2 \quad ...(v)$$

Comparing equation (iv) and (v), we get

$$\frac{ML^2}{3} = MK_2^2$$

$$K_2 = \frac{L}{\sqrt{3}} \quad ...(vi)$$

Again taking the ratio of K_1 and K_2 from Eqs. (iii) and (vi),

We get $$\frac{K_1}{K_2} = \frac{L\times\sqrt{3}}{2\sqrt{3}\times L} = \frac{1}{2}$$

33. (c) Potential energy of pendulum, when bob is at rest, is given by

$$(PE) = mgl$$

When bob is displaced by small angular displacement θ, the pendulum will lose PE of bob which gets converted into kinetic energy (KE). So, from conservation of energy

Loss in PE = gain in KE

$\therefore$ KE = $mgl - mgl\cos\theta = mgl(1-\cos\theta)$

34. (c) Total displacement of hour hand of a clock

$$\theta = 2\pi = 360° \; (\because \pi = 180°)$$

Time required for this displacement,

$$t = 12\times 3600 \text{ s}$$

So, angular speed, $\omega = \frac{\theta}{t} = \frac{360}{12\times 3600} = \frac{1}{120}$ degree/s

35. (a) The value of acceleration due to gravity g at a height h is given by

$$g' = g\left(\frac{R_e}{R_e + h}\right)^2$$

Here, Re = radius of earth

g = acceleration due to gravity at earth surface.

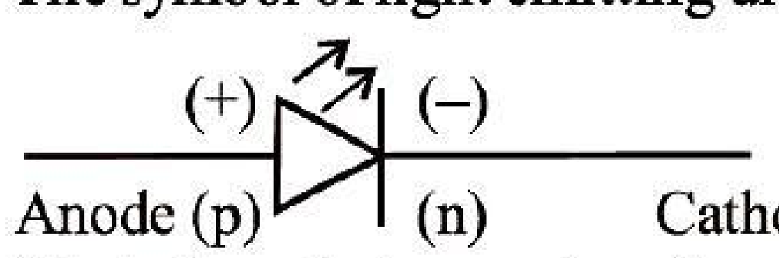
$$g' = \frac{g}{4} \text{ and } R_e = R$$

So, $$\frac{g}{4} = g\left(\frac{R}{R+h}\right)^2$$

$$\frac{1}{2} = \frac{R}{R+h}$$

$$\Rightarrow \quad 2R = R + h \quad \Rightarrow \quad R = h$$

36. (b) The symbol of light emitting diode (LED) is



37. (d) Work done in increasing the voltage from V_1 to V_2 is given by

$$= \frac{1}{2}C\left(V_2^2 - V_1^2\right)$$

putting the values, we get

$$= \frac{1}{2}\times C\times(10^2 - 5^2)$$

$$W = \frac{1}{2}\times C\times 75 = \frac{75C}{2} \quad ...(i)$$

Again work done when the plate voltage is increased from 10 V to 15 V is given by

$$W_1 = \frac{1}{2}\times C\times(15^2 - 10^2)$$

$$\Rightarrow \quad W_1 = \frac{1}{2}\times C\times 125 = \frac{125C}{2} \quad ...(ii)$$

Using eqs. (i) and (ii), we get

$$\frac{W}{W_1} = \frac{75C}{2\times 125C}\times 2 \quad \Rightarrow \quad \frac{W_1}{W} = \frac{125}{75} = \frac{5}{3}$$

$$\Rightarrow W_1 = 1.67\,W$$

38. (c) We have given,
Initial flux (ϕ_1) = 4×10^{-4} Wb

$$\text{Final flux } (\phi_2) = \frac{4\times10^{-4}\times10}{100} = 4\times10^{-5}\text{ Wb}$$

Emf induced (e) is given by

$$e = \left|-\frac{d\phi}{dt}\right|$$

$$\Rightarrow\ 0.72\times10^{-3} = \frac{4\times10^{-4}-4\times10^{-5}}{t}$$

$$\Rightarrow\ t = \frac{4\times10^{-5}\times9}{72\times10^{-5}} = \frac{1}{2} = 0.5\text{ s}$$

39. (a) Resolving power of a telescope is given by

$$RP = \frac{d}{1.22\lambda}$$

As $RP \propto \frac{1}{\lambda}$

∴ On decreasing the wavelength of light, resolving power of a telescope increases.

40. (d) According to Einstein's photoelectric equation

$$\frac{hc}{\lambda} - \phi = eV$$

For wavelength λ, stopping potential is V
Now, equation becomes

$$\frac{hc}{\lambda} - \phi = ev \quad \text{...(i)}$$

For wavelength 3λ, stopping potential is $\frac{V}{6}$
Now equation becomes

$$\frac{hc}{3\lambda} - \phi = \frac{eV}{6}$$

$$\Rightarrow\ \frac{2hc}{\lambda} - \phi = ev \quad \text{...(ii)}$$

Subtracting (i) and (ii)

$$\frac{2hc}{\lambda} = eV + 6\phi \Rightarrow \frac{hc}{\lambda} = eV + \phi$$

$$\frac{hc}{\lambda} = 5\phi \text{ and } \phi = \frac{hc}{\lambda_0}$$

Thus, we get $\lambda_0 = 5\lambda$

41. (a) Time period of simple pendulum in water (T) is given by

$$T = 2\pi\sqrt{\frac{l}{g_{eff}}}$$

[g_{eff} = acceleration due to gravity in water]
Effective value of acceleration due to gravity when bob is immersed in water, is given by

$$\text{As we know, } g_{eff} = g\left(\frac{\sigma-\rho}{\sigma}\right)$$

[Here, σ = density of bob, ρ = density of water]

$$= 9.8\left(\frac{\frac{9}{8}\times10^3 - 10^3}{\frac{9}{8}\times10^3}\right)$$

$$= 9.8\left(\frac{\frac{9}{8}-1}{\frac{9}{8}}\right) = 9.8\left(\frac{1}{8}\times\frac{8}{9}\right) = \frac{9.8}{9}$$

$$\text{So, } T_1 = 2\pi\sqrt{\frac{l\times9}{9.8}} \Rightarrow T_1 = 3T \quad \left[\because T = 2\pi\sqrt{\frac{\ell}{g}}\right]$$

42. (c) Rise of water in the capillary tube (h) is given by

$$h = \frac{2T\cos\theta}{\rho g(R-r)}$$

In the given case,
$\cos\theta = 1$ as $\theta = 0°$

$$\therefore\ h = \frac{2T}{\rho g(R-r)}$$

43. (d) Fundamental frequency of organ pipe (f_0) is given by

$$f_0 = \frac{V_0}{2l}$$

For 2nd overtone, $\frac{3}{2}f_0 = \frac{3V_0}{2l}$

For a closed organ pipe, fundamental frequency is $f = \frac{V_0}{4l}$. Third overtone of closed organ pipe at one end is

$$f_3 = \frac{7}{4}\frac{V_0}{l}$$

We have given, $\frac{7V_0}{4l} - \frac{3V_0}{2l} = 150$

$$\Rightarrow\ \left(\frac{7}{4}-\frac{6}{4}\right)\frac{V_0}{l} = 150$$

$$\Rightarrow\ \frac{V_0}{4l} = 150 \Rightarrow \frac{V_0}{2l} = 300\text{ Hz}$$

44. **(a)** M.O.I. of disc $I=\frac{MR^2}{2}$

When the disc is melted into solid sphere, then volume remains same.

$\therefore$ Volume of disc = Volume of solid sphere

$$\pi R^2\times\frac{R}{6}=\frac{4}{3}\pi r^3$$

$$\Rightarrow\ r^3=\frac{R^3}{8}\ \Rightarrow\ r=\frac{R}{2}$$

M.O.I. of solid sphere $\frac{2}{5}mr^2$.

$$=\frac{2}{5}\times m\times\frac{R^2}{4}=\frac{mR^2}{10}=\frac{I}{5}$$

[I = moment of inertia of disc = $\frac{MR^2}{2}$]

45. **(b)** The sag of bending of beam of length l loaded at free end by weight W is given by

$$\delta=\frac{WL^3}{48YI}$$

I = Moment of inertia of steel bar $=\frac{bd^3}{12}$

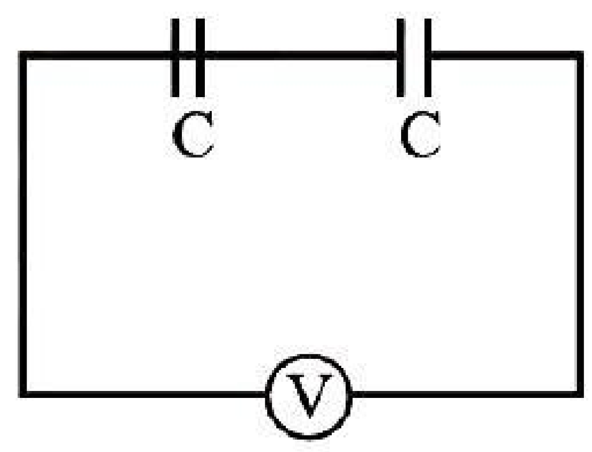
So, $\delta=\frac{Wl^3}{48Ybd^3}\times 12=\frac{Wl^3}{4Ybd^3}$

46. **(a)** According to Bohr's theory, the wavelength of radiation emitted is given by

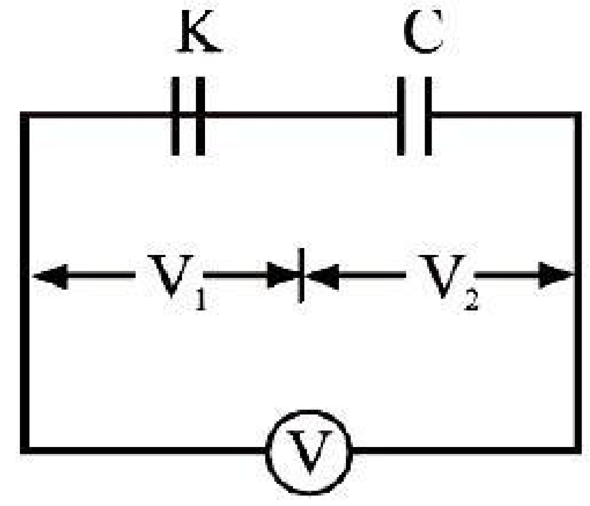
$$\frac{1}{\lambda}=R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$$

As the energy difference $\Delta E = E_5 - E_4$ is very small, so minimum wavelength will take place for transition of electron from n = 5 to $p = 4$.

47. **(b)** When dieletric is not inserted:-



When dielectric is inserted in one of the capacitor,



Given $V_1+V_2=V$

The capacitance of first capacitor becomes kC, so by charge conservation,

$$(kC)V_1 = C\,V_2 \qquad ...(ii)$$

$$\frac{V_1}{V_2}=\frac{1}{K}\Rightarrow\ \frac{V_1+V_2}{V_2}=\frac{1+K}{K}$$

$$\Rightarrow\ V_2=\left(\frac{KV}{1+K}\right)\qquad (\because V_1+V_2=V)$$

48. **(a)** For parallel resonance L-C circuit, the capacitive reaction is equal to inductive reactance.

The total impedance of the circuit increases to infinity means the circuit draws no current from the AC power source.

49. **(c)** Total current through the galvanometer is given by

$$I=\frac{V}{R_{eff}}=\frac{2}{1970+30}=\frac{2}{2000}$$

$$=10^{-3}A$$

As this current provides full scale deflection (i.e. 20 div).

To get the deflection of 10 divisions, value of resistance needed to connect can be obtained as

$$\theta=\frac{nIAB}{K}(\text{i.e.}\ \theta\propto I)$$

$$\Rightarrow\ \frac{\theta_1}{\theta_2}=\frac{I_1}{I_2}=2$$

$$\Rightarrow\ I_2=\frac{I_1}{2}=\frac{10^{-3}}{2}=5\times10^{-4}A$$

Now, $I=\frac{V}{R_{eff}+R_5}$

$$\Rightarrow\ R_5=\frac{V}{I}-R_{eff}=\frac{2}{5\times10^{-4}}-2000$$

$$=4\times10^3-2000=2000\Omega$$

So, the resistance of 1970 Ω is to be replaced by 1970 + 2000 = 3970 Ω.

50. **(b)** As $\Delta x=\frac{\lambda\delta}{2\pi}$

[Where, Δx = path difference]

For 4th dark fringe,

$$\delta=(2n+1)\pi$$

$$\Rightarrow\ \delta=(2\times4+1)\pi=9\pi$$

$$\Delta x=\frac{\lambda.9\pi}{2\pi}=\frac{9}{2}\lambda=\frac{9}{2}\times6\times10^{-7}$$

$=2.7\times10^{-6}m=2.7\times10^{-4}cm$

CHEMISTRY

51. (c) The number of optical isomers depends upon the number of asymmetric centres (n). Possible number of optical isomers of the compound is 2^n.

52. (a) van't Hoff equation is $\pi = \frac{n}{V} RT$

53. (a) Octahedral sulphur (rhombic or α-sulphur) is the most stable allotrope of sulphur.

54. (c) Thermoplastic polymers are the linear or slightly branched polymers in which the intermolecular forces of attraction are intermediate between elastomers and fibres.

55. (a) We require nF to deposit 1 mol or 40 g of Ca.
n = 2 (no. of e^- involved)
$\because$ 10 g Ca is deposited by 0.5 F.

56. (b) Leaching of gold is done with the help of their dissolution in NaCN or KCN or Cu.

57. (d) Paracetamol is an analgesic.

58. (d) When a mixture of n-butyl bromide and ethyl bromide is treated with sodium metal in the presence of dry ether, then ethane cannot be formed because reaction follows Wurtz- Fittig reaction. It is a type of coupling reaction.

$$CH_3CH_2CH_2CH_2Br + CH_3CH_2Br + 2Na \xrightarrow[\text{ether}]{\text{Dry}}$$

$$\underset{\text{Octane}}{C_4H_9—C_4H_9} + \underset{\text{Hexane}}{C_4H_9—C_2H_5} + \underset{\text{Butane}}{C_2H_5—C_2H_5}$$

59. (d) When lanthanoids (Ln) are heated with sulphur, then Ln_2S_3 are formed.

60. (a) Butylated hydroxy anisole is an antioxidant. The conjugated aromatic ring of BHA is able to stabilise free radicals.

61. (a) In the cell represented by
$Pb(s) \mid Pb^{2+} (1M) \parallel Ag^+ (1M) \mid Ag(s)$, the reducing agent is Pb because it readily gets oxidised to Pb^{2+}

62. (a)

63. (d) Secondary amines when treated with nitrous acid give yellow oily substance. So, amine 'A' is methylphenyl amine.

64. (d) The acidic oxides are formed by the non-metals (group 14-17) whereas basic oxides are formed by the metals of group 1 and group 2 elements. Ba belongs to group 2.

65. (b) The correct priority order for the groups attached to chiral carbon atom is
$CONH_2 > COCH_3 > CHO > CH_2OH$

66. (a) Bulletproof helmets are made up of lexan.

67. (c) The Mond's process is used for the purification of Ni.

68. (b) Isopropyl methyl ether when treated with cold hydrogen iodide gives isopropyl alcohol and methyl iodide.

$$(CH_3)_2CH-O-CH_3 + HI \longrightarrow (CH_3)_2CH-OH + CH_3I$$

69. (c) The volume occupied by the face centred

cubic unit cell $= z_{eff} \times \frac{4}{3}\pi r^3$

$= 4 \times \frac{4}{3}\pi r^3$

$= \frac{16}{3}\pi r^3$

70. (c) Glucose on oxidation with bromine water yields gluconic acid. This reaction confirms the presence of aldehyde group in glucose.

$$\underset{\text{Glucose}}{CHO-(CHOH)_4-CH_2OH} + [O] \xrightarrow{Br_2+H_2O} \underset{\text{Gluconic acid}}{COOH-(CHOH)_4-CH_2OH}$$

71. (a) By the action of concentrated sulphuric acid, sodium chromate gets converted into sodium dichromate in the manufacture of potassium dichromate.

72. (a) In a dry cell, zinc acts as a negative electrode.

73. (d) Primary amines on treatment with nitrous acid liberates nitrogen. Ethylamine ($C_2H_5NH_2$) is a primary amine. Hence, liberates nitrogen on treatment with nitrous acid.

$$C_2H_5NH_2 + HNO_2 \xrightarrow{NaNO_2+HCl}$$

$$\underset{\text{Diazonium chloride}}{C_2H_5—\overset{+}{N} \equiv N\overset{-}{Cl}} \xrightarrow{H_2O} C_2H_5OH + N_2\uparrow + HCl$$

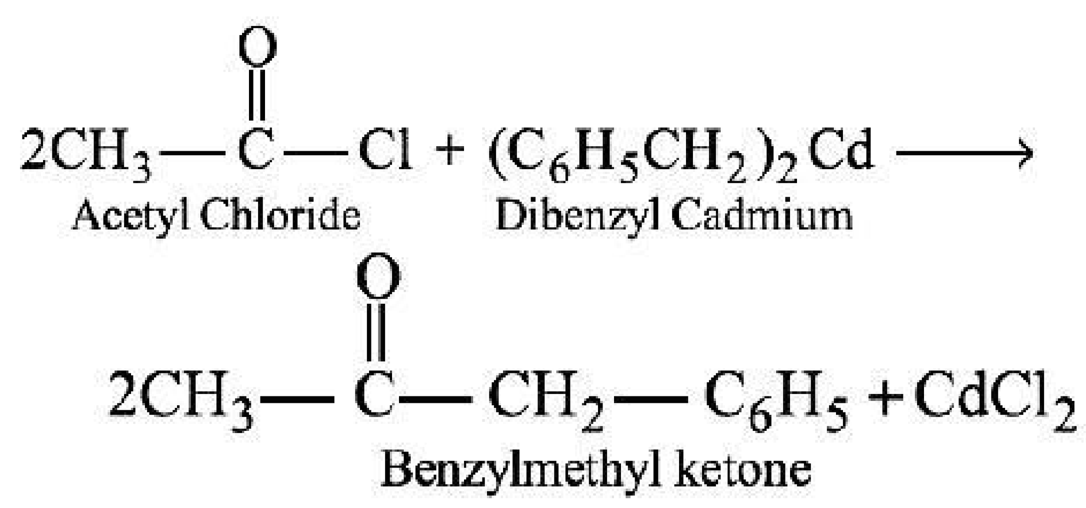
74. (d) Given, W (mass of solute) = 5.0 g
m (molar mass of solute) = 40 g mol^{-1}
Volume = 100 mL
Molarity is given as,

$$M = \frac{\text{Moles of solute}}{\text{Volume of solution (in L)}}$$

$$M = \frac{W \times 1000}{m \times \text{Volume of solution (in mL)}}$$

$$M = \frac{5.0\,g \times 1000}{40 \times 100} = 1.25 \text{ mol dm}^{-3}$$

75. (d) Acetyl chloride when treated with dibenzyl cadmium yeilds benzyl methyl ketone.



Here, Ph = Phenyl group

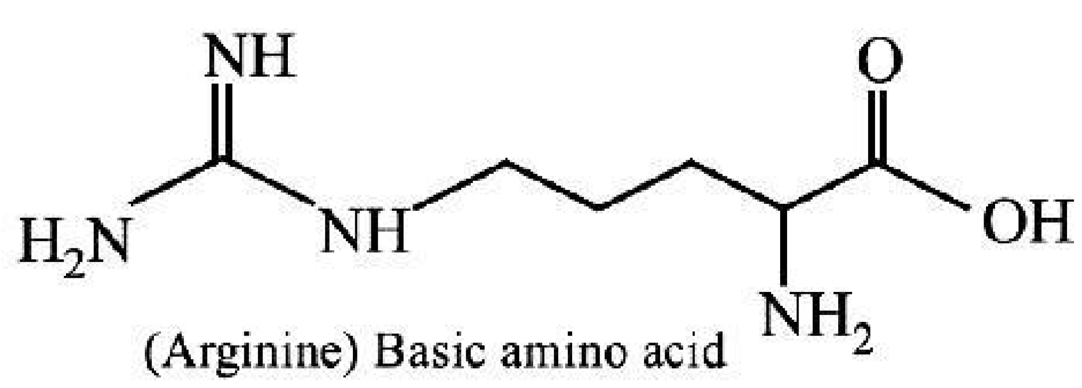
76. (d) Magnesium fluoride (MgF_2) has the highest ionic character.

77. (d) Cl(g) is the reaction intermediate involved in the formation of NO_2(g) and Cl_2(g).

$$NO_2Cl(g) \xrightarrow{k_1} NO_2(g) + Cl(g)$$

$$NO_2Cl(g) + Cl(g) \xrightarrow{k_2} NO_2(g) + Cl_2(g)$$

78. (c) Arginine amino acid is basic in nature.
(Basic due to the presence of 'NH' groups)



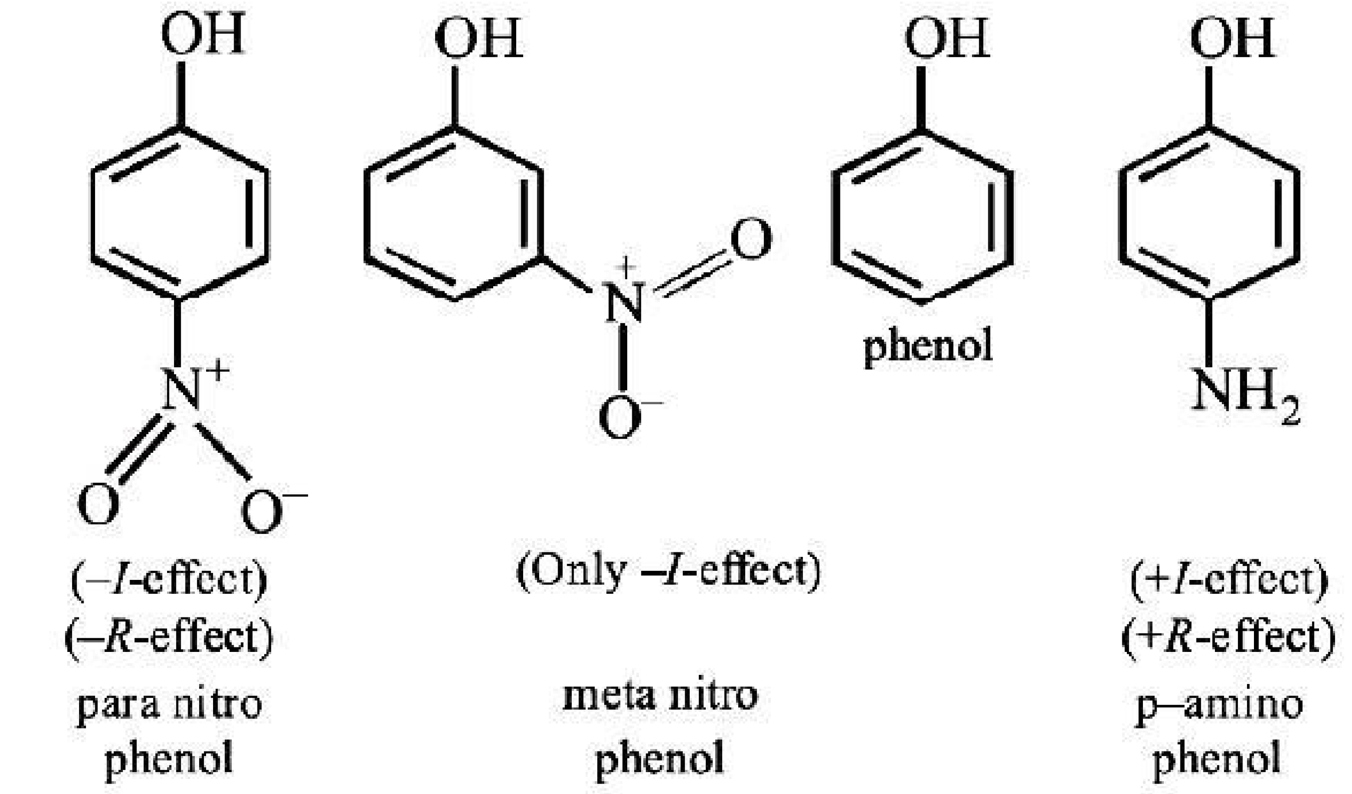
(Arginine) Basic amino acid

79. (d) The relationship between solubility of a gas in liquid at constant temperature and external pressure is given by Henry's law.
x ∝ Partial pressure of the gas, p

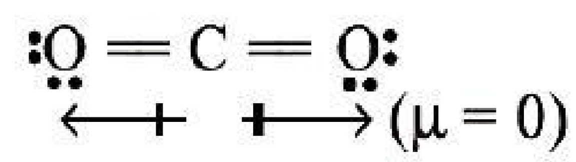
$$p = K_H x$$

Here, K_H = Henry's law constant
More the value of K_H, lower is the solubility of gas.

80. (d) The order for acidity in phenols depends upon the position of electron withdrawing groups. — NH_2 is an electron releasing group. Hence, it decreases the acidity of phenol.
p-nitrophenol > *m*-nitrophenol > phenol > *p*-aminophenol.



81. (d) Carbon dioxide is a non-polar solid because the bonds are linear and dipole moment point in opposite directions, cancel out the dipole moments, leaving a net polarity of zero.



82. (d) For scandium (Z = 21)electronic configuration is $4s^23d^1$. After the removal of 3 electrons; (Sc^{3+}), acquires a stable configuration ($4s^0d^0$).
Hence, it forms colourless compounds.

83. (d) The highest oxidation state exhibited by group 17 elements is + 7.

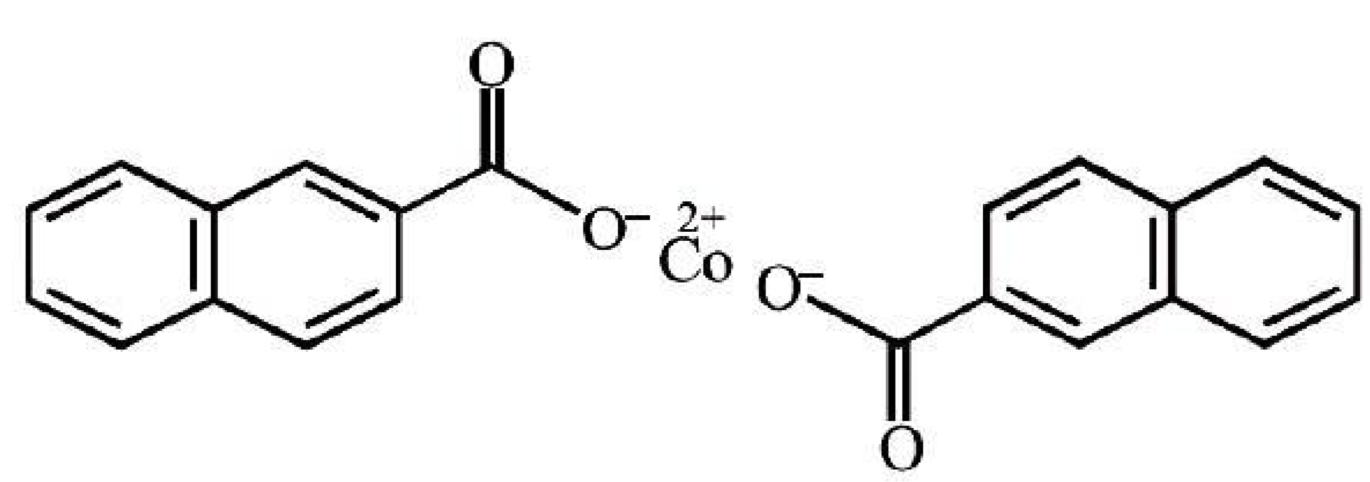
84. (a) For an isochoric process, $\Delta V = 0$
In this process, Acc to the first law of thermodynamics

$$q = \Delta U - W$$
$$q = \Delta U - p\Delta V$$

As $\Delta V = 0$

$$q_V = \Delta U$$

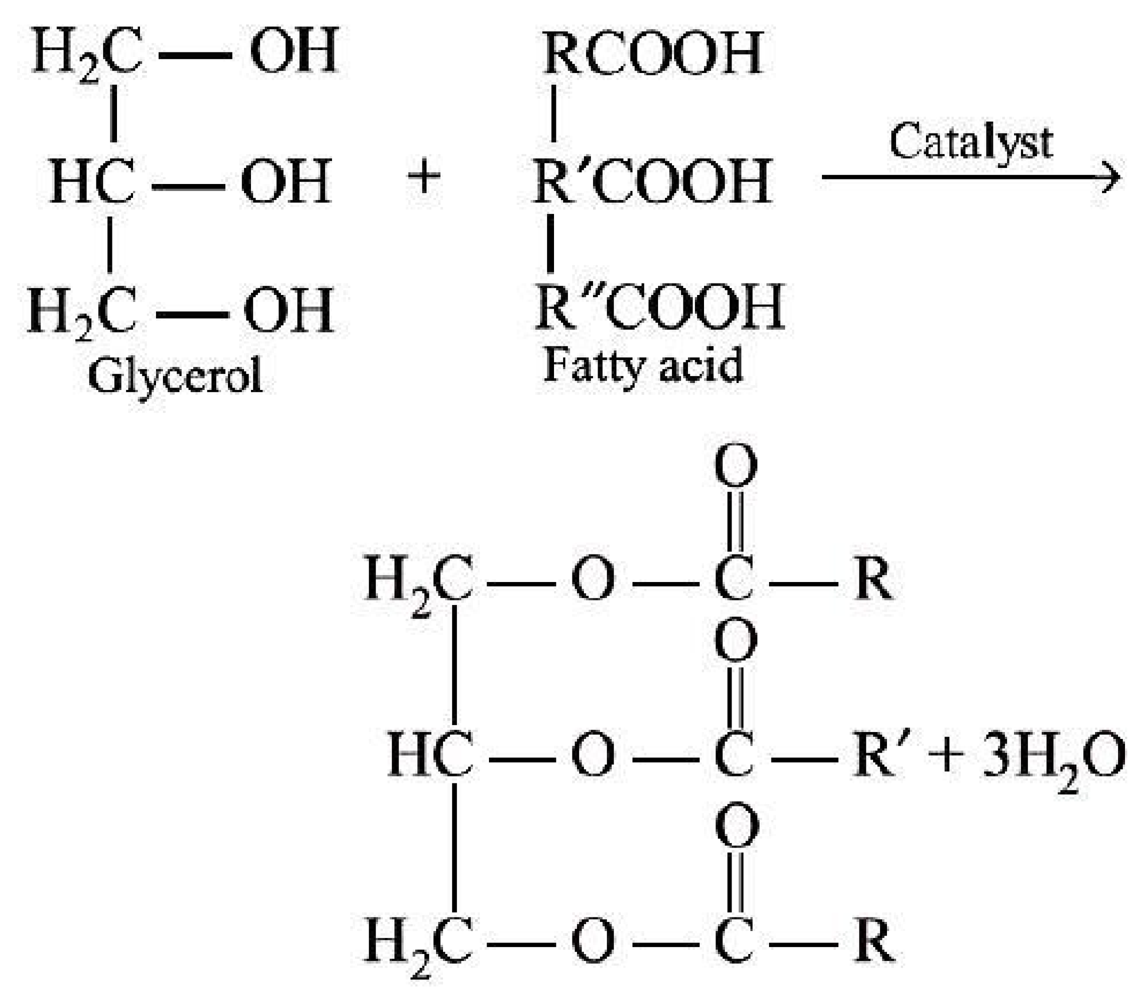
85. (d) Cobalt naphthenate is the catalyst used in the commercial method of preparation of phenol.



(Cobalt naphthenate)

86. (a) $t_{1/2} = \frac{0.693}{k}$

87. **(c)** One molecule of glycerol and three molecules of fatty acids combine to from a triglyceride.



Triglyceride

88. **(b)** The molecular formula of Wilkinson's catalyst is $(Ph_3P)_3$ RhCl

89. **(b)** The criterion for a spontaneous process is $\Delta G < 0$.

90. **(c)** Brown ring test is used for the detection of nitrate radical.

91. **(a)** The reagent used in the Wolff-Kishner reduction is NH_2— NH_2 and KOH in ethylene glycol.

92. **(a)** $[Pt(NH_3)_2 Cl_2]$ is a neutral complex. This complex does not have any charge. Thus, is neutral.

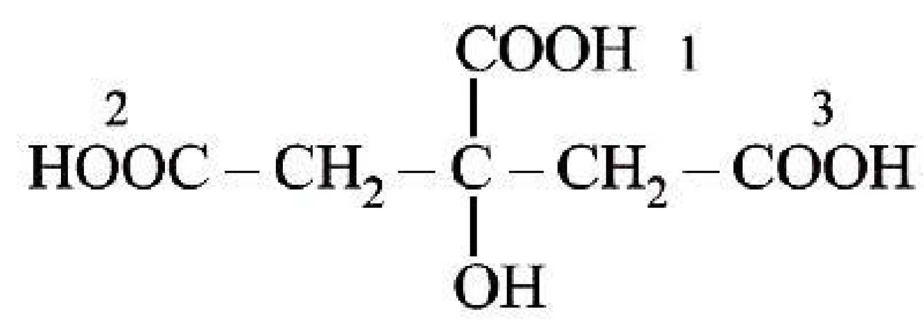
93. **(d)** As all the compounds have same concentration, i.e. 0.1 M. Thus, the compound that will break into the most parts has highest boiling point.
Glucose (1part, covalent; does not ionise)
Sodium chloride (1 Na, 1 Cl; ionises)
Calcium chloride (1Ca, 2Cl; ionises)
Ferric chloride (1Fe, 3Cl; ionises)

94. **(a)** Chromyl chloride is used in Etard reaction.

95. **(b)** Argon is the most abundant noble gas in the atmosphere.

96. **(b)** Heat capacity is an extensive property.

97. **(b)** Citric acid is a tricarboxylic acid.



Citric acid

98. **(b)** For reaction, $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

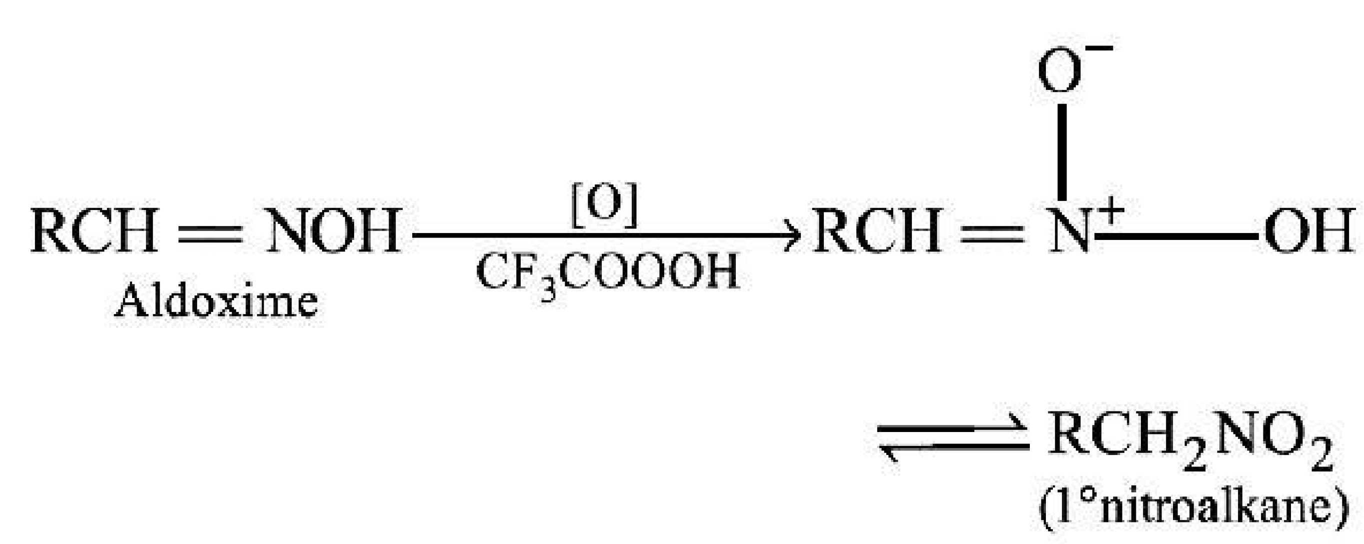
$$-\frac{1}{2}\frac{\Delta[SO_2]}{\Delta t} = \frac{-\Delta[O_2]}{\Delta t} = +\frac{1}{2}\frac{\Delta[SO_3]}{\Delta t}$$

So, average rate of reaction is written as

$$-\frac{\Delta[O_2]}{\Delta t}.$$

99. **(d)** $0.5CH_4(g) + O_2(g) \rightarrow 0.5CO_2(g) + H_2O(l)$
$\Delta n = 0.5 - 1.5 = -1$
Work done
$= -\Delta nRT = -(-1) \times 8.314 \times 300 = 2494$ J

100. **(a)** Primary nitroalkanes are obtained in good yield by oxidising aldoximes with the help of trifluoroperoxy acetic acid.



SECTION-B

MATHEMATICS

1. **(b)** Here, mean $E(X) = 5$
and variance, Var $(X) = 2.5$
$\Rightarrow \quad np = 5$ and $npq = 2.5$

$$\Rightarrow \quad 5q = 2.5 \Rightarrow \quad q = \frac{1}{2}$$

Also, $p + q = 1 \Rightarrow \quad p = 1 - \frac{1}{2} = \frac{1}{2} \because np = 5$

$$\Rightarrow \quad n \times \frac{1}{2} = 5 \Rightarrow n = 10$$

$p(X < 1) = p(X = 0) = {}^nC_r p^r q^{n-r}$

$$= {}^{10}C_0 \left(\frac{1}{2}\right)^0 \left(\frac{1}{2}\right)^{10-0} = 1 \times 1 \times \left(\frac{1}{2}\right)^{10} = \left(\frac{1}{2}\right)^{10}$$

2. **(d)** Let $u = \tan^{-1}\left(\frac{x}{\sqrt{1-x^2}}\right)$ and
$v = \sin^{-1}(3x - 4x^3)$
Now, put $x = \sin\theta \Rightarrow \theta = \sin^{-1}(x)$, then

$$u = \tan^{-1}\left(\frac{\sin\theta}{\sqrt{1-\sin^2\theta}}\right)$$

and $v = \sin^{-1}(3\sin\theta - 4\sin^3\theta)$

$$\Rightarrow \quad u = \tan^{-1}\left(\frac{\sin\theta}{\cos\theta}\right) \text{ and } v = \sin^{-1}(\sin 3\theta)$$

$\Rightarrow \quad u = \tan^{-1}(\tan\theta)$ and $v = \sin^{-1}(\sin 3\theta)$

$\Rightarrow \quad u = \theta$ and $v = 3\theta$

$\Rightarrow \quad u = \sin^{-1}x$ and $v = 3\sin^{-1}x$.

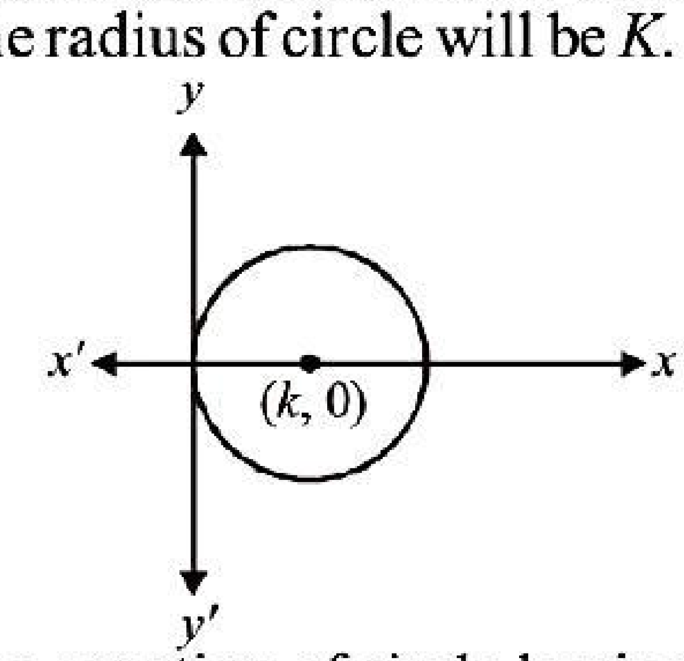
On differentiating both sides w.r.t. x, we get

$$\frac{du}{dx} = \frac{1}{\sqrt{1-x^2}} \text{ and } \frac{dv}{dx} = 3 \times \frac{1}{\sqrt{1-x^2}}$$

$$\therefore \quad \frac{du}{dv} = \frac{\frac{du}{dx}}{\frac{dv}{dx}} = \frac{\frac{1}{\sqrt{1-x^2}}}{\frac{3}{\sqrt{1-x^2}}} = \frac{1}{3}$$

3. **(b)** Let centre of circle on X-axis be $(K, 0)$.

$\therefore$ the radius of circle will be K.



$\therefore$ the equation of circle having centre $(K, 0)$ and radius K is

$(x-K)^2 + (y-0)^2 = K^2$

$\Rightarrow \quad x^2 + K^2 - 2hx + y^2 = K^2$

$\Rightarrow \quad x^2 - 2Kx + y^2 = 0$ ...(i)

On differentiating both sides w.r.t x, we get

$$2x - 2K + 2y\frac{dy}{dx} = 0$$

$$\Rightarrow \quad K = x + y\frac{dy}{dx} \qquad \text{...(ii)}$$

From equations (i) & (ii) we get

$$x^2 - 2\left(x + y\frac{dy}{dx}\right)x + y^2 = 0$$

$$\Rightarrow \quad -x^2 + y^2 - 2xy\frac{dy}{dx} = 0$$

$$\Rightarrow \quad (x^2 - y^2) + 2xy\frac{dy}{dx} = 0$$

4. **(b)** Given, $A = \begin{bmatrix} 1 & 1 & 0 \\ 2 & 1 & 5 \\ 1 & 2 & 1 \end{bmatrix}$

Since, the sum of the product of element other than the corresponding cofactor is zero.

$\therefore \quad a_{11}A_{21} + a_{12}A_{22} + a_{13}A_{23} = 0$

5. **(b)** Given, $f(x) = e^x(\sin x - \cos x)$

$$\Rightarrow f'(x) = e^x\frac{d}{dx}(\sin x - \cos x) + (\sin x - \cos x)\frac{d}{dx}(e^x)$$

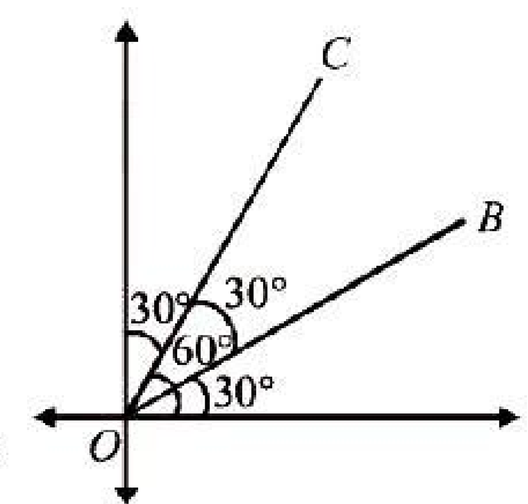
$= e^x(\cos x + \sin x) + (\sin x - \cos x)e^x = 2e^x \sin x$

We know that, if Rolle's theorem is verified, then their exist $c \in \left(\frac{\pi}{4}, \frac{5\pi}{4}\right)$, such that $f'(c) = 0$

$\therefore \quad 2e^c \sin c = 0 \Rightarrow \sin c = 0$

$$\Rightarrow \quad c = \frac{\pi}{2} \in \left(\frac{\pi}{4}, \frac{5\pi}{4}\right)$$

6. **(c)** In a trisection of lines in quadrant, angle 90° is divided into three parts and each part contain 30°, as shown in figure



$\therefore \quad$ Equation of line OB is

$$y = \tan 30° x \Rightarrow y = \frac{1}{\sqrt{3}}x$$

$$x - \sqrt{3}y = 0$$

And equation of line OC is

$y = \tan 60° x \Rightarrow y = \sqrt{3x}$ $(\sqrt{3}x - y) = 0$

$\therefore \quad$ Their combined equation is

$$(x - \sqrt{3}y)(\sqrt{3}x - y) = 0$$

$$\Rightarrow \quad \sqrt{3}x^2 - xy - 3xy + \sqrt{3}y^2 = 0$$

$$\Rightarrow \quad \sqrt{3}x^2 - 4xy + \sqrt{3}y^2 = 0$$

7. **(b)** Here, $2\tan^{-1}(\cos x) = \tan^{-1}(2\operatorname{cosec} x)$

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

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

$$\Rightarrow \quad \frac{\cos x}{\sin x} = 1 \qquad [\because \sin x \neq 0]$$

$$\Rightarrow \quad \cot x = 1 \Rightarrow x = \frac{\pi}{4}$$

Hence, $\sin x + \cos x = \sin\frac{\pi}{4} + \cos\frac{\pi}{4}$

$$= \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}} = \sqrt{2}$$

8. **(a)** Equation of given line is

$$\frac{x+2}{2} = \frac{2y-5}{3}, z+1 = 0$$

or $$\frac{x+2}{2} = \frac{y-\frac{5}{2}}{\frac{3}{2}}, z+1 = 0$$

So, DR of given line are $< 2, \frac{3}{2}, 0 >$

As, $\sqrt{2^2 + \left(\frac{3}{2}\right)^2 + 0} = \sqrt{4 + \frac{9}{4}} = \sqrt{\frac{25}{4}} = \frac{5}{2}$

$\therefore$ DC of given line are $< \frac{2}{5/2}, \frac{3/2}{5/2}, 0 >$ or $< \frac{4}{5}, \frac{3}{5}, 0 >$

9. **(d)** $\int \frac{dx}{\sqrt{8+2x-x^2}} = \int \frac{dx}{\sqrt{8+1-(x^2-2x+1)}}$

$= \int \frac{dx}{\sqrt{3^2-(x-1)^2}} = \sin^{-1}\left(\frac{x-1}{3}\right) + c$

10. **(a)** Since, $f(x) = x^3 + 5x^2 - 7x + 9$

After differentiating on both sides w.r.t. x, we get

$f'(x) = 3x^2 + 10x - 7$

As, $f(x + \Delta x) = f(x) + \Delta x f'(x)$

$= x^3 + 5x^2 - 7x + 9 + \Delta x \times (3x^2 + 10x - 7)$

After putting $x = 1$ and $\Delta x = 0.1$, we get

$f(1 + 0.1)$

$= 1^3 + 5(1)^2 - 7(1) + 9 + 0.1 \times (3 \times 1^2 + 10 \times 1 - 7)$

So, $f(1.1) = 1 + 5 - 7 + 9 + 0.1\,(3 + 10 - 7)$

$= 8 + 0.1(6) = 8.6$

11. **(b)** Since, $f(x) = \begin{cases} \frac{1}{5}, & 0 \le x \le 4 \\ 0, & \text{otherwise} \end{cases}$

So, $P(0 \le x \le 4)$

$= \int_0^4 f(x)\,dx = \int_0^4 \frac{1}{5}\,dx = \frac{1}{5}[x]_0^4$

$= \frac{1}{5}(4-0) = 0.8$

12. **(b)** $(a-b)^2 \cos^2 \frac{C}{2} + (a+b)^2 \sin^2 \frac{C}{2}$

$= (a^2 + b^2 - 2ab) \cos^2 \frac{C}{2} + (a^2 + b^2 + 2ab) \sin^2 \frac{C}{2}$

$= a^2\left(\cos^2\frac{C}{2} + \sin^2\frac{C}{2}\right) + b^2\left(\cos^2\frac{C}{2} + \sin^2\frac{C}{2}\right)$

$- 2ab\left(\cos^2\frac{C}{2} - \sin^2\frac{C}{2}\right)$

$= a^2 + b^2 - 2ab\cos C$

$\left[\because \cos^2\frac{C}{2} - \sin^2\frac{C}{2} = \cos C\right]$

$= a^2 + b^2 - 2ab\left(\frac{a^2+b^2-c^2}{2ab}\right) = c^2$

$\left[\because \cos C = \frac{a^2+b^2-c^2}{2ab}\right]$

13. **(b)** Let $u = \log(\sec\theta + \tan\theta)$ and $v = \sec\theta$

After differentiating on both sides w.r.t. θ, we get

$\frac{du}{d\theta} = \frac{1}{(\sec\theta + \tan\theta)}(\sec\theta\tan\theta + \sec^2\theta)$

$\frac{dv}{d\theta} = \sec\theta\tan\theta$

$\frac{du}{dv} = \frac{\frac{du}{d\theta}}{\frac{dv}{d\theta}} = \frac{\sec\theta(\tan\theta + \sec\theta)}{(\sec\theta + \tan\theta) \times \sec\theta\tan\theta} = \cot\theta$

Hence, $\frac{du}{dv}\Big|_{\left(\theta = \frac{\pi}{4}\right)} = \cot\frac{\pi}{4} = 1$

14. **(b)** The equation of the bisectors of the angle between the lines (x = 5) and (y = 3) is

$\frac{(x-5)}{\sqrt{1^2}} = \pm\frac{y-3}{\sqrt{1^2}} \Rightarrow \frac{x-5}{1} = \pm\frac{y-3}{1}$

$\Rightarrow x - 5 = +(y-3)$ and $x - 5 = -(y-3)$

$\Rightarrow (x - y - 2) = 0$ and $(x + y - 8) = 0$

Hence, combined equation of bisectors of angle between given lines is $(x - y - 2)(x + y - 8) = 0$

$\Rightarrow x^2 + xy - 8x - xy - y^2 + 8y - 2x - 2y - 16 = 0$

$\Rightarrow x^2 - y^2 - 10x + 6y + 16 = 0$

15. **(a)** Since, $6y = x^3 + 2$ ...(i)

and $\Delta y = 8\Delta x$

After differentiating on both sides of eq. (i) w.r.t. x, we get

$\frac{6dy}{dx} = 3x^2 \Rightarrow \frac{dy}{dx} = \frac{1}{2}x^2$

As, $\Delta y = \frac{dy}{dx}\Delta x \Rightarrow 8\Delta x = \frac{1}{2}x^2\Delta x$

So, $x^2 = 16 \Rightarrow x = \pm 4$

When x = 4, then $6y = (4)^3 + 2$

So, $6y = 66 \Rightarrow y = 11$

Hence, required point is (4, 11).

16. **(a)** Given, $f(x) = \begin{cases} x\sin\frac{1}{x}, & \text{for } x \ne 0 \\ k, & \text{for } x = 0 \end{cases}$

As, $f(x)$ is continuous at $x = 0$

So, LHL = RHL = f(0) ....(i)

Now, LHL $= \lim_{x\to 0^-} f(x) = \lim f(0-h)$

$= \lim_{h\to 0}(0-h)\sin\frac{1}{(0-h)} = \lim_{h\to 0}(-h)\sin\left(-\frac{1}{h}\right)$

$= \lim_{h\to 0} h\sin\frac{1}{h} = 0 \times \text{finite value lies between } -1 \text{ and } 1 = 0$

$\left[\because \lim_{h\to 0}\sin\frac{1}{h} = \text{finite value lies between } -1 \text{ and } 1\right]$

and $f(0) = k$

Now, from eq. (i), LHL $= f(0)$
$\Rightarrow 0 = k$
Hence, $k = 0$

17. **(c)** Given, $y = e^{m\sin^{-1}x}$ ...(i)
After differentiating on both sides w.r.t. x, we get

$$\frac{dy}{dx} = e^{m\sin^{-1}x}\frac{d}{dx}(m\sin^{-1}x)$$

$$\Rightarrow \frac{dy}{dx} = e^{m^{\sin^{-1}x}}\left(m\times\frac{1}{\sqrt{1-x^2}}\right)$$

$$\Rightarrow \sqrt{1-x^2}\frac{dy}{dx} = my \quad \text{[From eq. (i)]}$$

After squaring on both sides, we get

$$\left(1-x^2\right)\left(\frac{dy}{dx}\right)^2 = m^2y^2$$

As, $\left(1-x^2\right)\left(\frac{dy}{dx}\right)^2 = Ay^2$
Hence, $A = m^2$

18. **(b)** Consider, $I = \int\left(\frac{4e^x-25}{2e^x-5}\right)dx$

$$= \int\frac{4e^x}{2e^x-5}dx - \int\frac{25}{2e^x-5}dx$$

$$= 4\int\frac{e^x}{2e^x-5}dx - 25\int\frac{e^{-x}}{2-5e^{-x}}dx$$

Let $2e^x - 5 = u$ and $2 - 5e^{-x} = v$
$\Rightarrow 2e^xdx = du$ and $5e^{-x}dx = dv$

$$\Rightarrow e^xdx = \frac{du}{2} \text{ and } e^{-x}dx = \frac{dv}{5}$$

So, $I = 4\int\frac{du}{2u} - 25\int\frac{du}{5v}$
$= 2\log u - 5\log v + c$
$= 2\log(2e^x - 5) - 5\log(2 - 5e^{-x}) + c$

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

$= -3\log(2e^x - 5) + 5x + c$
Therefore, $I = 5x - 3\log(2e^x - 5) + c$
As, $I = Ax + B\log(2e^x - 5) + c$
Hence, $A = 5$ and $B = -3$

19. **(b)** $\dfrac{\tan^{-1}\left(\sqrt{3}\right)-\sec^{-1}(-2)}{\operatorname{cosec}^{-1}\left(-\sqrt{2}\right)+\cos^{-1}\left(-\frac{1}{2}\right)}$

$$= \frac{\tan^{-1}\left(\sqrt{3}\right)-\left(\pi-\sec^{-1}(2)\right)}{-\operatorname{cosec}^{-1}\left(\sqrt{2}\right)+\pi-\cos^{-1}\left(\frac{1}{2}\right)}$$

$$= \frac{\frac{\pi}{3}-\left(\pi-\frac{\pi}{3}\right)}{-\frac{\pi}{4}+\pi-\frac{\pi}{3}} = \frac{-\frac{\pi}{3}}{\frac{12\pi-3\pi-4\pi}{12}} = \frac{-\frac{\pi}{3}}{\frac{5\pi}{12}} = -\frac{4}{5}$$

20. **(c)** Since,

$$p(x) = \begin{cases}\dfrac{\log(1+2x)\sin x^\circ}{x^2}, & \text{for } x \neq 0\\ k, & \text{for } x = 0\end{cases}$$

$$= \begin{cases}\dfrac{\log(1+2x)\sin\frac{\pi x}{180}}{x^2}, & \text{for } x \neq 0\\ k, & \text{for } x = 0\end{cases}$$

As, $f(x)$ is continuous at $x = 0$
So, LHL $= f(0)$

$$\because \text{LHL} = \lim_{x\to0^-} f(x) = \lim_{h\to0} f(0-h)$$

$$= \lim_{h\to0}\frac{\log(1+2(0-h)\sin\frac{\pi}{180^\circ}(0-h))}{(0-h)^2}$$

$$= \lim_{h\to0}\frac{\log(1-2h)\left\{-\sin\frac{\pi h}{180}\right\}}{\text{h}^2}$$

$$= \lim_{h\to0}(-2)\frac{\log(1-2h)}{-2\text{h}}x\lim_{h\to0}\frac{(-)\sin\frac{\pi h}{180}}{\frac{\pi h}{180}}\times\frac{\pi}{180}$$

$$= (-2)\times(-1)\times1\times\frac{\pi}{180} = \frac{\pi}{90}$$

$$\left[\because \lim_{x\to0}\log\frac{1+x}{x} = 1 \text{ and } \lim_{x\to0}\frac{\sin x}{x} = 1\right]$$

21. **(a)** Since, $\log_{10}\left(\frac{x^2-y^2}{x^2+y^2}\right) = 2$

$$\Rightarrow \left(\frac{x^2-y^2}{x^2+y^2}\right) = 10^2$$

$\Rightarrow x^2 - y^2 = 100(x^2 + y^2)$
After differentiating on both sides, we get

$$2x-2y\frac{dy}{dx}=100\left(2x+2y\frac{dy}{dx}\right)$$

$$\Rightarrow x-y\frac{dy}{dx}=100x+100y\frac{dy}{dx}$$

$$\Rightarrow 101y\frac{dy}{dx}=-99x \Rightarrow \frac{dy}{dx}=\frac{-99x}{101y}$$

22. **(d)** Let, $I=\int_{\frac{-\pi}{2}}^{\frac{\pi}{2}} \log\left(\frac{2\ \ \sin x}{2+\sin x}\right)dx$

$$f(x)=\log\left(\frac{2-\sin x}{2+\sin x}\right) \therefore f(-x)=\log\left(\frac{2-\sin(-x)}{2+\sin(-x)}\right)$$

$$=\log\left(\frac{2+\sin x}{2-\sin x}\right)=-\log\left(\frac{2-\sin x}{2+\sin x}\right)=-f(x)$$

So, $f(x)$ is an odd function.

Hence, $\int_{\frac{-\pi}{2}}^{\frac{\pi}{2}} f(x)dx=0$

$\left[\because \text{If } f(x) \text{ is an odd function, then } \int_{-a}^{a} f(x)dx=0\right]$

23. **(c)** Consider, $I=\int \frac{(x^2+2)a^{(x+\tan^{-1}x)}}{x^2+1}dx$

Let $x+\tan^{-1}x=t$

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

So, $I=\int a^t dt=\frac{a^t}{\log a}+c$

$$=\frac{a^{x+\tan^{-1}x}}{\log a}+c$$

24. **(b)** The given differential equation is

$$\left[1+\left(\frac{dy}{dx}\right)\right]^{\frac{7}{3}}=7\left(\frac{d^2y}{dx^2}\right)$$

After cubing on both sides, we get

$$\left[1+\left(\frac{dy}{dx}\right)^3\right]^7=7^3\left(\frac{d^2y}{dx^2}\right)^3$$

As, highest order derivative is 2, and its degree is 3.
Hence, degree = 3 and order = 2

25. **(b)** The angle between the line

$\vec{r}=\vec{a}+\lambda\vec{b}$ and the plane $\vec{r}\cdot\hat{n}=d$ is given by

$$\sin\theta=\frac{\hat{n}\cdot\vec{b}}{|\hat{n}||\vec{b}|}$$

The equation of given line is

$\vec{r}=(\hat{i}+2\hat{j}+\hat{k})+\lambda(\hat{i}+\hat{j}+\hat{k})$ and equation of plane is

$\vec{r}\cdot(2\hat{i}-\hat{j}+\hat{k})=5$

As, $\vec{b}=\hat{i}+\hat{j}+\hat{k}$ and $\hat{n}=2\hat{i}-\hat{j}+\hat{k}$

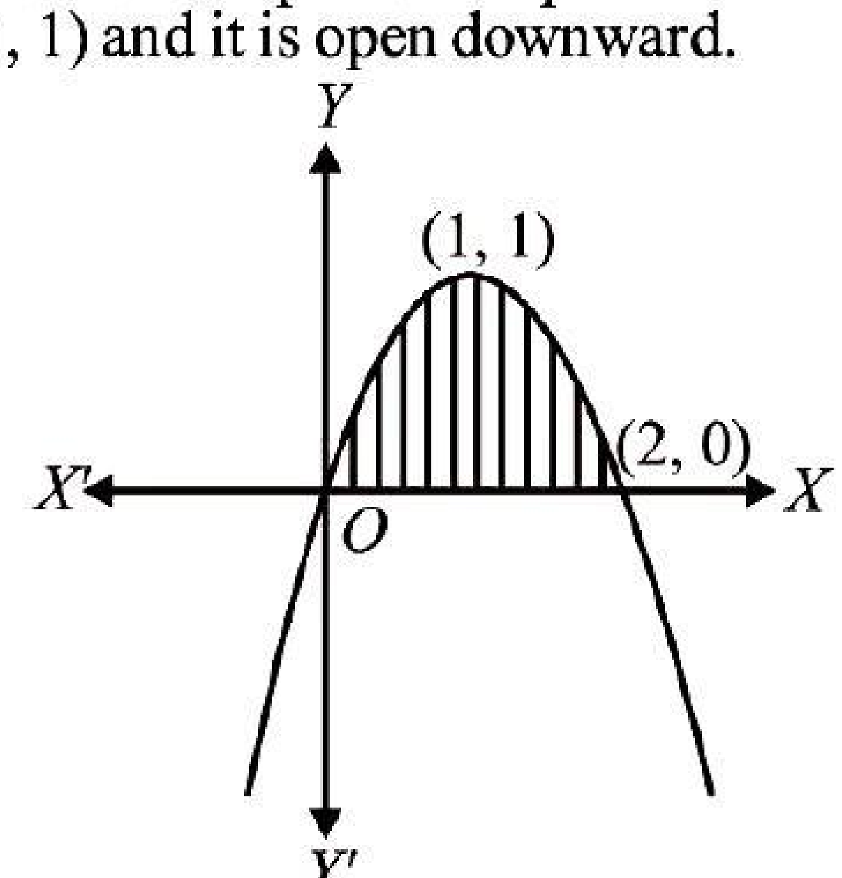
So, $\sin\theta=\frac{(2\hat{i}-\hat{j}+\hat{k})\cdot(\hat{i}+\hat{j}+\hat{k})}{|2\hat{i}-\hat{j}+\hat{k}||\hat{i}+\hat{j}+\hat{k}|}$

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

$$=\frac{2}{\sqrt{4+1+1}\sqrt{1+1+1}}=\frac{2}{\sqrt{6}\sqrt{3}}=\frac{\sqrt{2}}{3}$$

Hence, $\theta=\sin^{-1}\left(\frac{\sqrt{2}}{3}\right)$

26. **(b)** The equation of given curve is $y=2x-x^2$
$\Rightarrow x^2-2x=-y$
$\Rightarrow x^2-2x+1=-y+1$
$\Rightarrow (x-1)^2=-(y-1)$
Which is the equation of parabola whose vertex is (1, 1) and it is open downward.



$y=2x-x^2$

For intersection of the parabola with the X-axis, put $y=0$, then we get
$0=2x-x^2$
$\Rightarrow x(2-x)=0$
$\Rightarrow x=0, 2$
Hence, area of bounded region between the curve and X-axis

$$=\int_0^2 y\,dx$$

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

$$=\left[4-\frac{8}{3}-0-0\right]=\frac{4}{3}\text{ sq units.}$$

27. **(a)** Since, $\int \frac{f(x)}{\log(\sin x)}dx = \log[\log\sin x] + c$

After differentiating on both sides, we get

$$\frac{f(x)}{\log(\sin x)} = \frac{1}{\log\sin x}\frac{d}{dx}(\log\sin x) + 0$$

$$\Rightarrow \frac{f(x)}{\log(\sin x)} = \frac{1}{\log\sin x}\times\frac{1}{\sin x}\times\cos x$$

$\rightarrow f(x) = \cot x$

28. **(a)** It is given that, the foot of perpendicular from point $Q(a, b, c)$ to the yz plane is $A(0, b, c)$ and the foot of perpendicular from point Q to the zx plane is $B(a, 0, c)$.

Let the equation of plane passing through the point (0, 0, 0) be $Ax + By + Cz = 0$ ......(i)

As it is passing through the point $A(0, b, c)$ and $B(a, 0, c)$.

So, $0 + Bb + Cc = 0$ and $Aa + 0 + Cc = 0$

$\Rightarrow Cc = Bb$ and $Cc = -Aa$

Therefore, $-Aa = -Bb = Cc = k$

$$\Rightarrow A = -\frac{k}{a}, B = -\frac{k}{b} \text{ and } C = \frac{k}{c}$$

$$-\frac{k}{a}x - \frac{k}{b}y + \frac{k}{c}z = 0 \text{ [From Eq. (i)]}$$

$$\Rightarrow -\frac{x}{a} - \frac{y}{b} + \frac{z}{c} = 0 \text{ or } \frac{x}{a} + \frac{y}{b} - \frac{z}{c} = 0$$

29. **(c)** Given, $\vec{a} = \hat{i} + \hat{j} - 2\hat{k}, \vec{b} = 2\hat{i} - \hat{j} + \hat{k}, \vec{c} = 3\hat{i} - \hat{k}$

and $\vec{c} = m\vec{a} + n\vec{b}$

As, $3\hat{i} - \hat{k} = m(\hat{i} + \hat{j} - 2\hat{k}) + n(2\hat{i} - \hat{j} + \hat{k})$

$\Rightarrow 3\hat{i} - \hat{k} = (m + 2n)\hat{i} + (m - n)\hat{j} + (-2m + n)\hat{k}$

After equating the coefficient of $\hat{i}, \hat{j}$ and $\hat{k}$, on both sides respectively, we get

$3 = m + 2n$, $0 = m - n$ and $-1 = -2m + n$

$\Rightarrow 3 = n + 2n \Rightarrow n = 1$

$\Rightarrow m = 1$ and $n = 1$

$\Rightarrow m + n = 1 + 1 = 2$

30. **(c)** Let $I = \int_0^{\frac{\pi}{2}} \frac{\sqrt[n]{\sec x}}{\sqrt[n]{\sec x} + \sqrt[n]{\operatorname{cosec} x}}dx$ ...(i)

$$= \int_0^{\frac{\pi}{2}} \frac{\sqrt[n]{\sec\left(\frac{\pi}{2} - x\right)}}{\sqrt[n]{\sec\left(\frac{\pi}{2} - x\right)} + \sqrt[n]{\operatorname{cosec}\left(\frac{\pi}{2} - x\right)}}dx$$

$$= \int_0^{\frac{\pi}{2}} \frac{\sqrt[n]{\operatorname{cosec} x}}{\sqrt[n]{\operatorname{cosec} x} + \sqrt[n]{\sec x}}dx \quad \text{...(ii)}$$

After adding eq. (i) and (ii), we get

$$2I = \int_0^{\frac{\pi}{2}} \frac{\sqrt[n]{\sec x} + \sqrt[n]{\operatorname{cosec} x}}{\sqrt[n]{\sec x} + \sqrt[n]{\operatorname{cosec} x}}dx$$

$$\Rightarrow 2I = \int_0^{\frac{\pi}{2}} dx = [x]_0^{\frac{\pi}{2}}$$

$$\Rightarrow 2I = \frac{\pi}{2} \text{ Hence, } I = \frac{\pi}{4}$$

31. **(c)** Since, cumulative distribution function

$F(x) = P(X \le x)$

So, $F(0) = P(X \le 0)$

$= P(X = 0) + P(X = -1) + P(X = -2)$

$= 0.15 + 0.3 + 0.2 = 0.65$

(a) $P(X < 0) = P(X = -1) + P(X = -2)$

$= 0.3 + 0.2 = 0.5$

Therefore, $P(X < 0) \ne F(0)$

(b) $P(X > 0) = P(X = 1) + P(X = 2)$

$= 0.25 + 0.1 = 0.35$

Thus, $P(X > 0) \ne F(0)$

(c) $1 - P(x > 0) = 1 - 0.35 = 0.65$

Hence, $1 - P(X > 0) = F(0)$

32. **(a)** The given differential equation is

$$y(1 + \log x)\left[\frac{dx}{dy}\right] - x\log x = 0$$

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

After integrating on both sides, we get

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

Let $\log x = t \quad \Rightarrow \frac{1}{x}dx = dt$

So, $\int\frac{1}{t}dt + \int\frac{1}{x}dx = \int\frac{1}{y}dy$

$\Rightarrow \log t + \log x = \log y + \log c$

$\Rightarrow \log tx = \log yc \Rightarrow tx = yc \Rightarrow x\log x = yc$

When $x = e$ then $y = e^2$

Therefore, $e\log e = e^2c$

$$\Rightarrow e \times 1 = e^2c \Rightarrow c = \frac{1}{e}$$

Hence, $x\log x = \frac{y}{e} \Rightarrow y = ex\log x$

33. **(c)** Suppose that the position vectors of A, B, C, D, M and N are **a, b, c, d, m** and **n** respectively.

As, M and N are the mid-points of AC and BD.

So, $\mathbf{m} = \frac{\mathbf{a} + \mathbf{c}}{2}$ and $\mathbf{n} = \frac{\mathbf{b} + \mathbf{d}}{2}$

Then, $\mathbf{AB} + \mathbf{AD} + \mathbf{CB} + \mathbf{CD}$

$= (\mathbf{b} - \mathbf{a}) + (\mathbf{d} - \mathbf{a}) + (\mathbf{b} - \mathbf{c}) + (\mathbf{d} - \mathbf{c})$

$= 2(\mathbf{b} + \mathbf{d}) - 2(\mathbf{a} + \mathbf{c})$

$= 2 \times 2\mathbf{n} - 2 \times 2\mathbf{m} = 4(\mathbf{n}-\mathbf{m}) = 4\mathbf{MN}$

$\Rightarrow 4\lambda + 1 - 7 - 2 - \lambda = 10$

$\Rightarrow 3\lambda = 18 \Rightarrow \lambda = 6$

34. **(d)** Since, IF of $\frac{dy}{dx} + Py = Q$ is given by

$\text{IF} = e^{\int pdx}$

So, $\sin x = e^{\int pdx}$

After differentiating on both sides, we get

$\cos x = e^{\int pdx} \cos x = \sin x\, P \Rightarrow P = \cot x$

35. **(c)** (a) $x^2 - x = 0 \Rightarrow x(x-1) = 0$

$\Rightarrow x = 0$ and $x = 1$,

This represent a pair of lines.

(b) $xy - x = 0 \Rightarrow x(y-1) = 0$

$\Rightarrow x = 0,\ y = 1$,

This represent a pair of lines.

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

$\Rightarrow y^2 = (x-1)$,

This represent a parabola.

Which does not represent a pair of lines.

(d) $xy + x + y + 1 = 0$

$\rightarrow x(y+1) + (y+1) = 0 \rightarrow (y+1)(x+1) = 0$

$\Rightarrow \quad y = -1$ and $x = -1$

This represent a pair of lines.

36. **(a)** In every true and false question, probability of guessing correctly, $p = \frac{1}{2}$ and probability of guessing wrongly, $q = \frac{1}{2}$.

Here, $n = 10$

$\therefore$ The probability of atleast 7 correctly guessing

$= P(X \geq 7)$

$= P(X = 7) + P(X = 8) + P(X = 9) + P(X = 10)$

$$= {}^{10}C_7 \left(\frac{1}{2}\right)^7 \left(\frac{1}{2}\right)^3 + {}^{10}C_8 \left(\frac{1}{2}\right)^8 \left(\frac{1}{2}\right)^2 + {}^{10}C_9 \left(\frac{1}{2}\right)^9 \left(\frac{1}{2}\right)^1 + {}^{10}C_{10} \left(\frac{1}{2}\right)^{10}$$

$$\left[\because P(x = r) = {}^nC_r\, p^r q^{n-r}\right]$$

$$= 120\left(\frac{1}{2}\right)^{10} + 45\left(\frac{1}{2}\right)^{10} + 10\left(\frac{1}{2}\right)^{10} + 1\left(\frac{1}{2}\right)^{10}$$

$$= \frac{120 + 45 + 10 + 1}{2^{10}} = \frac{176}{1024} = \frac{11}{64}$$

37. **(c)** The given equation is $\sin 2x + \cos 2x = 0$

$\Rightarrow \sin 2x = -\cos 2x \Rightarrow \tan 2x = -1$

$$[\because \pi < x < 2\pi \Rightarrow 2\pi < 2x < 4\pi]$$

$$\Rightarrow \quad 2x = 2\pi + \frac{3\pi}{4}, 2\pi + \left(\frac{3\pi}{2} + \frac{\pi}{4}\right)$$

$$\Rightarrow \quad 2x = \frac{11\pi}{8}, \frac{15\pi}{4} \Rightarrow x = \frac{11\pi}{8}, \frac{15\pi}{8}$$

38. **(a)** Coordinates of points A and B are given as $(6, -4, 4)$ and $(0, 0, -4)$ and coordinates of points C and D are given as $(-1, -2, -3)$ and $(1, 2, -5)$.

Now, equation of line which passes through $(0, 0, -4)$ and $(6, -4, 4)$ is

$$\frac{x-0}{6} = \frac{y-0}{-4} = \frac{z+4}{4+4} = k \text{ [Let]}$$

$\Rightarrow \quad x = 6k$, $y = -4k$ and $z = 8k - 4$ ...(i)

The equation of line which passes through $(-1, -2, -3)$ and $(1, 2, -5)$ is

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

$$\Rightarrow \quad \frac{x+1}{2} = \frac{y+2}{4} = \frac{3+3}{-2} \quad \text{...(ii)}$$

As, two lines intersect, so point $(6k, -4k, 8k-4)$ satisfy eq. (ii), we get

$$\frac{6k+1}{2} = \frac{-4k+2}{4} = \frac{8k-4+3}{-2}$$

$\Rightarrow \quad 6k+1 = -2k+1 = -(8k-1)$

$\Rightarrow \quad 6k+1 = -2k+1 \Rightarrow 8k = 0$

$\Rightarrow \quad k = 0$

$\therefore \quad x = 6 \times 0, y = -4 \times 0$ and $z = 8 \times 0 - 4$

$\Rightarrow \quad x = 0,\ y = 0$ and $z = -4$

This is equal to the B coordinate.

39. **(a)** It is given that $A = \begin{bmatrix} 2 & 2 \\ -3 & 2 \end{bmatrix}, B = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$

As, $(B^{-1}A^{-1})^{-1} = (A^{-1})^{-1}(B^{-1})^{-1} = AB$

$$[\because (AB)^{-1} = B^{-1}A^{-1}]$$

$$[\because (A^{-1})^{-1} = A^{-1}]$$

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

40. **(a)** Given, statement p is true (T) and statement q is false (F).

So, $p \rightarrow q \equiv T \rightarrow F = F$ and $p \leftrightarrow q \equiv T \leftrightarrow F = F$

41. **(b)** Since, orthocentre, centroid and circumcentre of a triangle are collinear whereas centroid divides orthocentre and circumcentre in the ratio of 2 : 1.

By internally division formula,

$$\frac{2\mathbf{p} + 1\mathbf{h}}{2+1} = \mathbf{g}$$

$\Rightarrow \quad 2\mathbf{p} + \mathbf{h} - 3\mathbf{g} = 0$

As, $x\,\mathbf{p} + y\,\mathbf{h} + z\,\mathbf{g} = 0$

Hence, $x = 2, y = 1$ and $z = -3$