COMEDK 2013 Question Paper with Solution

Consortium of Medical, Engineering and Dental Colleges of Karnataka
Under Graduate Entrance Test

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SOLVED PAPER – 2013 (COMEDK)

Instructions

- There are 180 questions in all. The number of questions in each section is as given below.

Sections	No. of Questions
Section I : Physics	1–60
Section II : Chemistry	61–120
Section III : Mathematics	121–180

- All the questions are Multiple Choice Questions having four options out of which **ONLY ONE** is correct.
- Candidates will be awarded 1 mark for each correct answer. There will be no negative marking for incorrect answer.
- Time allotted to complete this paper is 3 hrs.

PHYSICS

1. The difference between the apparent frequency of a source of sound as perceived by the observer during its approach and recession is 2% of the frequency of the source. If the speed of sound in air is 300 ms^{-1}, then the velocity of the source is

   a. 15 ms^{-1} b. 12 ms^{-1} c. 6 ms^{-1} d. 3 ms^{-1}

2. Three long straight wires A, B and C are carrying currents as shown in figure, then the resultant force on B is directed
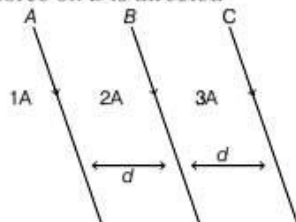

   a. perpendicular to the plane of paper and outward
   b. perpendicular to the plane of paper and inward
   c. towards A
   d. towards C

3. Curie-Weiss law is obeyed by iron
   a. at Curie temperature only
   b. at all temperatures
   c. below Curie temperature
   d. above Curie temperature

4. A magnet N-S is suspended from a spring and when it oscillates, the magnet moves in and out of the coil C. The coil is connected to a galvanometer G, then as the magnet oscillates
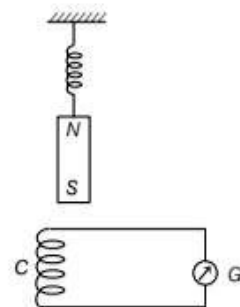
a. G shows no deflection

b. G shows deflection to the left and right but the amplitude steadily decreases

c. G shows deflection to the left and right with constant amplitude

d. G shows deflection on one side

5. The dimensional formula for inductance is

a. $[ML^2T^{-2}A^{-2}]$ b. $[ML^2TA^{-2}]$

c. $[ML^2T^{-1}A^{-2}]$ d. $[ML^2T^{-2}A^{-1}]$

6. The maximum current that can be measured by a galvanometer of resistance $40\,\Omega$, is 10 mA. It is converted into a voltmeter that can read upto 50 V. The resistance to be connected in series with the galvanometer (in Ω) is

a. 2010   b. 4050   c. 5040   d. 4960

7. The spectrum obtained from the chromosphere of the sun at the time of total solar eclipse is

a. line emission spectrum

b. band emission spectrum

c. continuous emission spectrum

d. line absorption spectrum

8. Heavy water is

a. compound of deuterium and oxygen

b. water at 4°C

c. water, in which soap does not lather

d. compound of heavy oxygen and heavy hydrogen

9. The nuclear reactor at Kaiga is a

a. research reactor   b. fusion reactor

c. breeder reactor   d. power reactor

10. When a body moves in a circular path, no work is done by the force since

a. force and displacement are perpendicular to each other

b. the force is always away from the centre

c. there is no displacement

d. there is no net force

11. A bullet moving with a speed of $100\ \mathrm{ms}^{-1}$ can just penetrate two planks of equal thickness, then the number of such planks penetrated by the same bullet when the speed is doubled will be

a. 6   b. 10   c. 4   d. 8

12. Two bodies of masses 1 kg and 2 kg have equal momentum, then the ratio of their kinetic energies is

a. 2 : 1   b. 3 : 1

c. 1 : 3   d. 1 : 1

13. Absorption coefficient of an open window is

a. 1   b. 0.25   c. zero   d. 0.5

14. The loudness and pitch of a sound note depend on

a. intensity and velocity

b. frequency and velocity

c. intensity and frequency

d. frequency and number of harmonics

15. In Melde's experiment in the transverse mode, the frequency of the tuning fork and the frequency of the waves in the string are in the ratio

a. 2 : 1   b. 4 : 1

c. 1 : 1   d. 1 : 2

16. An electron is accelerated through a potential difference of 45.5 V. The velocity acquired by it is (in ms^{-1})

a. 10^6 b. zero

c. 4×10^6 d. 4×10^4

17. An unknown resistance R_1 is connected in series with a resistance of $10\,\Omega$. This combination is connected to one gap of a meter bridge, while a resistance R_2 is connected in the other gap. The balance point is at 50 cm. Now, when the $10\,\Omega$ resistance is removed, the balance point shifts to 40 cm. The value of R_1 (in Ω) is

a. 20   b. 10

c. 60   d. 40

18. In the circuit shown, the internal resistance of the cell is negligible. The steady state current in the $2\,\Omega$ resistor is
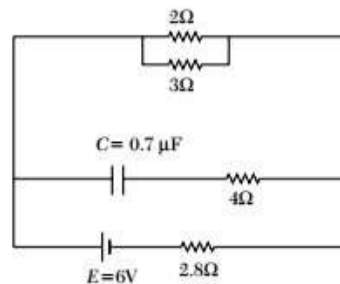
a. 0.6 A   b. 1.2 A

c. 0.9 A   d. 1.5 A

19. A rectangular coil of 300 turns has an average area of 25 cm × 10 cm. The coil rotates with a speed of 50 cps in uniform magnetic field of strength 4×10^{-2} T about an axis perpendicular to the field. The peak value of the induced emf (in V) is

a. $300\,\pi$ b. $3000\,\pi$ c. $3\,\pi$ d. $30\,\pi$

20. In an *L-C-R* circuit, the potential difference between the terminals of the inductance is 60 V, between the terminals of the capacitor is 30 V and that between the terminals of resistance is 40 V. The supply voltage will be equal to

   a. 130 V   *b.* 10 V

   c. 50 V   *d.* 70 V

21. A vertical circular coil of radius 0.1 m and having 10 turns carries a steady current. When the plane of the coil is normal to the magnetic meridian, a neutral point is observed at the centre of the coil. If $B_H = 0.314 \times 10^{-4}$ T, the current in the coil is

   a. 0.5 A   *b.* 0.25 A

   c. 2 A   *d.* 1 A

22. A thread is tied slightly loose to a wire frame as shown in figure and the frame is dipped into a soap solution and taken out. The frame is completely covered with the film. When the portion *A* is punctured with a pin, the thread
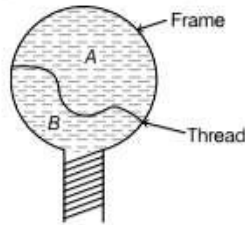

   a. becomes concave towards *A*

   b. becomes convex towards 5*A*

   c. Either (a) or (b) depending on the size of *A* with respect to *B*

   d. remains in the initial position

23. Oxygen is 16 times heavier than hydrogen. Equal volumes of hydrogen and oxygen are mixed. The ratio of speed of sound in the mixture to that in hydrogen is

   a. $\sqrt{8}$ *b.* $\sqrt{2/17}$

   c. $\sqrt{1/8}$ *d.* $\sqrt{32/17}$

24. If two waves of the same frequency and amplitude respectively on superposition produce a resultant disturbance of the same amplitude, the waves differ in phase by

   a. π *b.* zero   *c.* $\pi/3$ *d.* $2\pi/3$

25. A man, standing between two cliffs, claps his hands and starts hearing a series of echoes at intervals of one second. If the speed of sound in air is 340 ms^{-1}, then the distance between the cliffs is

   a. 680 m   *b.* 1700 m   *c.* 340 m   *d.* 1620 m

26. A beam of light of wavelength 600 nm from a source falls on a single slit 1 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance between the first dark fringes on either side of the central bright fringe is

   a. 2.4 cm   *b.* 2.4 mm

   c. 1.2 mm   *d.* 1.2 cm

27. The pair of quantities having same dimensions is

   a. impulse and surface tension

   b. angular momentum and work

   c. work and torque

   d. Young's modulus and energy

28. The displacement *x* (in m) of a particle of mass *m* (in kg) moving in one dimension under the action of a force, is related to time *t* (in s) by $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be

   a. 4 m   *b.* 0   *c.* 6 m   *d.* 2 m

29. Vectors **A**, **B** and **C** are such that $\mathbf{A} \cdot \mathbf{B} = 0$ and $\mathbf{A} \cdot \mathbf{C} = 0$, then the vector parallel to **A** is

   a. $\mathbf{A} \times \mathbf{B}$ *b.* $\mathbf{B} + \mathbf{C}$

   c. $\mathbf{B} \times \mathbf{C}$ *d.* **B** and **C**

30. The primary of a transformer when connected to a DC battery of 10 V draws a current of 1 mA. The number of turns of the primary and secondary windings are 50 and 100, respectively. The voltage in the secondary and the current drawn by the circuit in the secondary are respectively

   a. 20 V and 2.0 mA   *b.* 10 V and 0.5 mA

   c. 0 and 0   *d.* 20 V and 0.5 mA

31. One coolie takes 1 min to raise a suitcase through a height of 2 m but the second coolie takes 30 s to raise the same suitcase to the same height. The powers of two coolies are in the ratio.

   a. 1 : 3   *b.* 2 : 1   *c.* 3 : 1   *d.* 1 : 2

32. An electric dipole of dipole moment *p* is aligned parallel to a uniform electric field *E*. The energy required to rotate the dipole by 90° is

   a. $p^2 E$ *b.* pE *c.* infinity   *d.* pE^2

33. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/s. A bob is suspended from the roof of the car by a light wire of length 1.0 m. The angle made by the wire with the vertical is

   a. $\dfrac{\pi}{3}$ *b.* $\dfrac{\pi}{6}$ *c.* $\dfrac{\pi}{4}$ *d.* 0°

34. The radius of a planet is twice the radius of earth. Both have almost equal average mass-densities. v_p and v_e are escape velocities of the planet and the earth, respectively, then

a. $v_p = 1.5\, v_e$ b. $v_p = 2v_e$
c. $v_e = 3v_p$ d. $v_e = 1.5v_p$

35. If the ratio of diameters, lengths and Young's modulus of steel and copper wires shown in the figure are p, q and s respectively, then the corresponding ratio of increase in their lengths would be
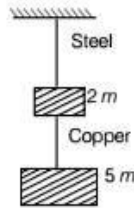

a. $\dfrac{5q}{7sp^2}$ b. $\dfrac{7q}{5sp^2}$

c. $\dfrac{2q}{5sp}$ d. $\dfrac{7q}{5\,sp}$

36. Which of the following relations does not give the equation of an adiabatic process, where terms have their usual meaning?

a. $p^{1-\gamma}T^\gamma = $ constant   b. $pV^\gamma = $ constant

c. $TV^{\gamma-1} = $ constant   d. $p^\gamma T^{1-\gamma} = $ constant

37. A particle of mass m is kept at rest at a height $3R$ from the surface of earth, where R is radius of earth and M is mass of earth. The minimum speed with which it should be projected, so that it does not return back, is (g is acceleration due to gravity on the surface of earth)

a. $\left(\dfrac{GM}{2R}\right)^{1/2}$ b. $\left(\dfrac{gR}{4}\right)^{1/2}$

c. $\left(\dfrac{2g}{R}\right)^{1/2}$ d. $\left(\dfrac{GM}{R}\right)^{1/2}$

38. H-polaroid is prepared by

a. orienting herapathite crystal in the same direction in nitrocellulose
b. using thin tourmaline crystals
c. stretching polyvinyl alcohol and then heated with dehydrating agent
d. stretching polyvinyl alcohol and then impregnating with iodine

39. SI unit of permittivity is

a. $C^2 m^2 N^2$ b. $C^2 m^{-2} N^{-1}$
c. $C^2 m^2 N^{-1}$ d. $C^{-1} m^2 N^{-2}$

40. A spherical drop of capacitance $1\,\mu F$ is broken into eight drops of equal radius, then the capacitance of each small drop is

a. $\dfrac{1}{2}\mu F$ b. $\dfrac{1}{4}\mu F$ c. $\dfrac{1}{8}\mu F$ d. $8\,\mu F$

41. Two equal forces (P each) act at a point inclined to each other at an angle of $120°$. The magnitude of their resultant is

a. $P/2$ b. $P/4$ c. P d. $2P$

42. Threshold wavelength for photoelectric emission from a metal surface is 5200 Å. Photoelectrons will be emitted, when this surface is illuminated with monochromatic radiation from

a. 1 W IR lamp   b. 50 W UV lamp
c. 50 W IR lamp   d. 10 W IR lamp

43. In Young's double slit experiment, if monochromatic light used is replaced by white light, then

a. no fringes are observed
b. only central fringe is white, all other fringes are coloured
c. all bright fringes become white
d. all bright fringes have colours between violet and red

44. Which state of triply ionised Beryllium (Be^{+++}) has the same orbital radius as that of the ground state of hydrogen ?

a. $n = 3$ b. $n = 4$ c. $n = 1$ d. $n = 2$

45. If M is the atomic mass and A is the mass number, packing fraction is given by

a. $\dfrac{M}{M-A}$ b. $\dfrac{M-A}{A}$

c. $\dfrac{A}{M-A}$ d. $\dfrac{A-M}{A}$

46. A count rate meter shows a count of 240 per min from a given radioactive source. One hour later, the meter shows a count rate of 30 per min. The half-life of the source is

a. 80 min   b. 120 min
c. 20 min   d. 30 min

47. Two conductors of the same material have their diameters in the ratio 1 : 2 and their lengths in the ratio 2 : 1. If the temperature difference between their ends is the same, then the ratio of amounts of heat conducted per second through them will be

a. 4 : 1   b. 1 : 4   c. 8 : 1   d. 1 : 8

48. Blowing air with open mouth is an example of

a. isobaric process   b. isochoric process
c. isothermal process   d. adiabatic process

49. Sound waves in air are always longitudinal because
a. of the inherent characteristics of sound waves in air
b. air does not have a modulus of rigidity
c. air is a mixture of several gases
d. density of air is very small

50. An uncharged sphere of metal is placed inside a charged parallel plate capacitor. The lines of force will look like
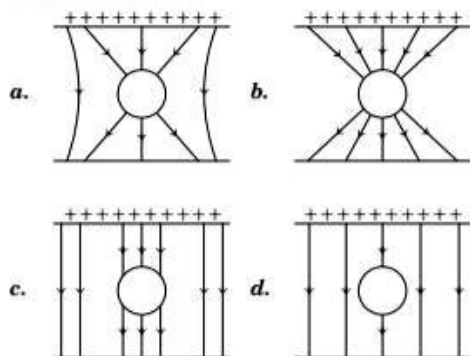
51. A current flows in a conductor from East to West. The direction of the magnetic field at a point above the conductor is
a. towards East
b. towards West
c. towards North
d. towards South

52. A bar magnet is equivalent to
a. toroid carrying current
b. straight conductor carrying current
c. solenoid carrying current
d. circular coil carrying current

53. Excitation energy of a hydrogen like ion in its first excitation state is 40.8 eV. Energy needed to remove the electron from the ion in ground state is
a. 40.8 eV
b. 27.2 eV
c. 54.4 eV
d. 13.6 eV

54. The refractive index of a particular material is 1.67 for blue light, 1.65 for yellow light and 1.63 for red light. The dispersive power of the material is
a. 0.031
b. 1.60
c. 0.0615
d. 0.024

55. An ideal gas heat engine operates in a Carnot's cycle between 227°C and 127°C. It absorbs 6×10^4 J at high temperature. The amount of heat converted into work is
a. 1.6×10^4 J
b. 1.2×10^4 J
c. 4.8×10^4 J
d. 3.5×10^4 J

56. Which one of the following graphs represents the behaviour of an ideal gas ?
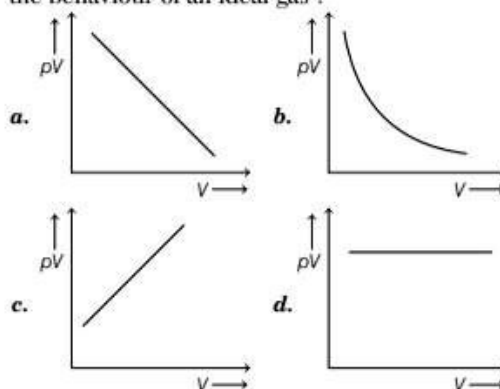
57. Rainbow is formed due to
a. total internal reflection
b. scattering
c. refraction
d. dispersion and total internal reflection

58. A beam of parallel rays is brought to focus by a plano-convex lens. A thin concave lens of the same focal length is joined to the first lens. The effect of this is
a. the focus shifts to infinity
b. the focal point shifts towards the lens by a small distance
c. the focal point shifts away from the lens by a small distance
d. the focus remains undisturbed

59. When a body is earth connected, electrons from the earth flow into the body. This means the body is
a. charged negatively
b. an insulator
c. uncharged
d. charged positively

60. Effective capacitance between A and B in the figure shown is (all capacitances are in μF)
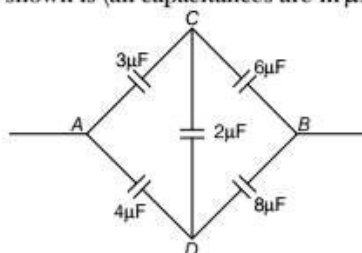
a. $\dfrac{3}{14}$ μF
b. $\dfrac{14}{3}$ μF
c. 21 μF
d. 23 μF

61. A colourless crystalline salt X is soluble in dilute HCl. On adding NaOH solution, it gives a white precipitate which is insoluble in excess of NaOH. X is
   a. $Al_2(SO_4)_3$ *b.* $ZnSO_4$
   c. $MgSO_4$ *d.* $SnCl_2$

62. Which metal is used to make alloy steel for armour plates, safes and helmets ?
   a. Al   *b.* Mn   *c.* Cr   *d.* Pb

63. Iodoform test is not answered by
   a. C_2H_5OH *b.* CH_3OH
   c. CH_3COCH_3 *d.* CH_3—$\underset{\underset{OH}{|}}{CH}$—$CH_3$

64. A gaseous carbon compound is soluble in dilute HCl. The solution on treating with $NaNO_2$ gives off nitrogen leaving behind a solution, which smells of wood spirit. The carbon compound is
   a. HCHO   *b.* CO
   c. $C_2H_5NH_2$ *d.* CH_3NH_2

65. Which of the following statements is incorrect regarding benzyl chloride ?
   a. It gives white precipitate with alcoholic $AgNO_3$.
   b. It is an aromatic compound with substitution in the side chain.
   c. It undergoes nucleophilic substitution reaction.
   d. It is less reactive than vinyl chloride.

66. Enthalpy of formation of HF and HCl are − 161 kJ and − 92 kJ respectively. Which of the following statements is incorrect?
   a. HCl is more stable than HF.
   b. HF and HCl are exothermic compounds.
   c. The affinity of fluorine to hydrogen is greater than the affinity of chlorine to hydrogen.
   d. HF is more stable than HCl.

67. Heat liberated with 100 mL of 1 N NaOH is neutralised by 300 mL of 1 N HCl
   a. 11.56 kJ   *b.* 5.73 kJ
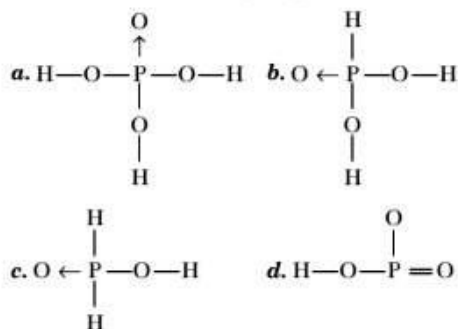   *c.* 22.92 kJ   *d.* 17.19 kJ

68. For a reaction $A + B \longrightarrow C + D$, if concentration of A is doubled without altering that of B, rate doubles. If concentration of B is increased nine-times without altering that of A, rate triples. Order of the reaction is
   a. 2   *b.* 1   *c.* $1\frac{1}{2}$ *d.* $1\frac{1}{3}$

69. In Goldschmidt aluminothermic process, thermite contains
   a. 3 parts of Al_2O_3 and 4 parts of Al
   b. 3 parts of Fe_2O_3 and 2 parts of Al
   c. 3 parts of Fe_2O_3 and 1 part of Al
   d. 1 part of Fe_2O_3 and 1 part of Al

70. The structure of orthophosphoric acid is

a. $H-O-\overset{\overset{O}{\uparrow}}{\underset{\underset{H}{|}}{P}}-O-H$ *b.* $O\leftarrow\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{P}}-O-H$

c. $O\leftarrow\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{P}}-O-H$ *d.* $H-O-\overset{\overset{O}{|}}{P}=O$

71. A galvanic cell is constructed using the redox reaction,
   $$\frac{1}{2}H_2(g) + AgCl(s) \rightleftharpoons H^+(aq) + Cl^-(aq) + Ag(s)$$
   it is represented as
   a. $Pt|\ H_2(g)\ |\ HCl(sol)\,||\,AgNO_3(sol)\,|\ Ag$
   b. $Ag|\ AgCl(s)\,|\ KCl\ (sol)\,||\,HCl(sol),\ H_2(g)\,|\ Pt$
   c. $Pt\ |\ H_2(g)\,|\ KCl(sol)\,||\,AgCl(s)\,|\ Ag$
   d. $Pt|\ H_2(g),\ HCl(sol)\,||\,AgCl(s)\,|\ Ag$
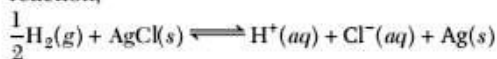
72. Same amount of electric current is passed through solutions of $AgNO_3$ and HCl. If 1.08 g of silver is obtained in the first case, the amount of hydrogen liberated at STP in the second case is
   a. $224\ cm^3$ *b.* 1.008 g
   c. $112\ cm^3$ *d.* $22400\ cm^3$

73. The flame colours of metal ions are due to
   a. Frenkel defect
   b. Schottky defect
   c. metal deficiency defect
   d. metal excess defect

74. The order of reactivities of methyl halides in the formation of Grignard reagent is
   a. $CH_3I > CH_3Br > CH_3Cl$
   b. $CH_3Cl > CH_3Br > CH_3I$
   c. $CH_3Br > CH_3Cl > CH_3I$
   d. $CH_3Br > CH_3I > CH_3Cl$

75. The reaction of an organic compound with ammonia followed by nitration of the product gives a powerful explosive, called RDX. The organic compound is
a. phenol
b. toluene
c. glycerine
d. formaldehyde

76. A signature, written in carbon pencil weighs 1 mg. What is the number of carbon atoms present in the signature?
a. 5.02×10^{23}
b. 5.02×10^{20}
c. 6.02×10^{20}
d. 0.502×10^{20}

77. NH_3 and HCl gas are introduced simultaneously from the two ends of a long tube. A white ring of NH_4Cl appears first
a. nearer to the HCl end
b. at the centre of the tube
c. throughout the tube
d. nearer to the NH_3 end

78. A gas formed by the action of alcoholic KOH on ethyl iodide, decolourises alkaline $KMnO_4$. The gas is
a. C_2H_6
b. CH_4
c. C_2H_2
d. C_2H_4

79. Which of the following is not a characteristic of chemisorption?
a. ΔH is of the order of 400 kJ
b. Adsorption is irreversible
c. Adsorption may be multimolecular layer
d. Adsorption is specific

80. The concentration of electrolyte required to coagulate a given amount of As_2S_3 sol is minimum in the case of
a. magnesium nitrate
b. potassium nitrate
c. potassium sulphate
d. aluminium nitrate

81. Identify the organic compound which, on heating with strong solution of NaOH, partly converted into an acid salt and partly into alcohol
a. benzyl alcohol
b. acetaldehyde
c. acetone
d. benzaldehyde

82. The process by which synthesis of protein takes place based on the genetic information present in m-RNA is called
a. translation
b. transcription
c. replication
d. messenger hypothesis

83. The enthalpies of formation of Al_2O_3 and Cr_2O_3 are -1596 kJ and -1134 kJ respectively. ΔH for the reaction,
$2Al + Cr_2O_3 \longrightarrow 2Cr + Al_2O_3$ is
a. -2730 kJ
b. -462 kJ
c. -1365 kJ
d. $+2730$ kJ

84. The gaseous reaction
$A + B \rightleftharpoons 2C + D + Q$ is most favoured at
a. low temperature and high pressure
b. high temperature and high pressure
c. high temperature and low pressure
d. low temperature and low pressure

85. Temperature coefficient of a reaction is 2. When temperature is increased from 30° C to 100°C, rate of the reaction increases by
a. 128 times
b. 100 times
c. 500 times
d. 250 times

86. The volume of water to be added to $\dfrac{N}{2}$ HCl to prepare 500 cm^3 of $\dfrac{N}{10}$ solution is
a. 450 cm^3
b. 100 cm^3
c. 45 cm^3
d. 400 cm^3

87. The equivalent weight of a certain trivalent element is 20. Molecular weight of its oxide is
a. 152
b. 56
c. 168
d. 68

88. Identify the reaction that doesn't take place during the smelting process of copper extraction
a. $2FeS + 3O_2 \longrightarrow 2FeO + 2SO_2 \uparrow$
b. $Cu_2O + FeS \longrightarrow Cu_2S + FeO$
c. $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2 \uparrow$
d. $FeO + SiO_2 \longrightarrow FeSiO_3$

89. Pick out the complex compound in which the central metal atom obeys EAN rule strictly.
a. $K_4[Fe(CN)_6]$
b. $K_3[Fe(CN)_6]$
c. $[Cr(H_2O)_6]Cl_3$
d. $[Cu(NH_3)_4]SO_4$

90. In a reversible reaction, the catalyst
a. increases the activation energy of the backward reaction
b. increases the activation energy of the forward reaction
c. decreases the activation energy of both, forward and backward reaction
d. decreases the activation energy of forward reaction

91. Solubility product of a salt AB is 1×10^{-8} in a solution in which concentration of A is 10^{-3} M. The salt will precipitate when the concentration of B becomes more than
a. 10^{-4} M
b. 10^{-7} M
c. 10^{-6} M
d. 10^{-5} M

92. The standard reduction potentials of Zn and Ag in water at 298 K are,

$$Zn^{2+} + 2e^- \rightleftharpoons Zn, \quad E^\circ = -0.76 \text{ V}$$

and $\quad Ag^+ + e^- \rightleftharpoons Ag; \quad E^\circ = +0.80 \text{ V}.$

Which of the following reactions take place?

a. $Zn^{2+}(aq) + 2Ag(s) \longrightarrow 2Ag^+(aq) + Zn(s)$
b. $Zn(s) + 2Ag^+(aq) \longrightarrow Zn^{2+}(aq) + 2Ag(s)$
c. $Zn^{2+}(aq) + Ag^+(aq) \longrightarrow Zn(s) + Ag(s)$
d. $Zn(s) + Ag(s) \longrightarrow Zn^{2+}(aq) + Ag^+(aq)$

93. The ratio of cationic radius to anionic radius in an ionic crystal is greater than 0.732. Its coordination number is

a. 6   *b.* 8
c. 1   *d.* 4

94. Dacron is obtained by the condensation polymerisation of

a. dimethyl terephthalate and ethylene glycol
b. terephthalic acid and formaldehyde
c. phenol and phthalic acid
d. phenol and formaldehyde

95. 4-chloro-3, 5-dimethyl phenol is called

a. chloramphenicol   *b.* paracetamol
c. barbital   *d.* dettol

96. The percentage s-character of the hybrid orbitals in methane, ethene and ethyne are respectively

a. 25, 33, 50   *b.* 25, 50, 75
c. 50, 75, 100   *d.* 10, 20, 40

97. In the manufacture of sulphuric acid by contact process, Tyndall box is used to

a. filter dust particles
b. remove impurities
c. convert SO_2 to SO_3
d. test the presence of dust particles

98. The pH value of gastric juice in human stomach is about 1.8 and in the small intestine it is about 7.8. The pK_a value of aspirin is 3.5. Aspirin will be

a. completely ionised in the small intestine and in the stomach
b. unionised in the small intestine and in the stomach
c. ionised in the small intestine and almost unionised in the stomach
d. ionised in the stomach and almost unionised in the small intestine

99. The number of α and β-particles emitted during the transformation of $_{90}Th^{232}$ to $_{82}Pb^{208}$ are respectively

a. 4, 2   *b.* 2, 2   *c.* 8, 6   *d.* 6, 4

100. When chlorine is passed through warm benzene in presence of the sunlight, the product obtained is

a. benzotrichloride   *b.* chlorobenzene
c. gammexane   *d.* DDT

101. Ethyl benzoate reacts with PCl_5 to give

a. $C_2H_5Cl + C_6H_5COCl + POCl_3 + HCl$
b. $C_2H_5Cl + C_6H_5COCl + POCl_3$
c. $CH_3COCl + C_6H_5COCl + POCl_3$
d. $C_2H_5Cl + C_6H_5COOH + POCl_3$

102. Pick out the statement which is not relevant in the discussion of colloids

a. sodium aluminium silicate is used in the softening of hard water.
b. potash alum is used in shaving rounds and as a styptic in medicine.
c. artificial rain is caused by throwing electrified sand on the clouds from an aeroplane.
d. deltas are formed at a place where the river pours its water into the sea.

103. A wooden box excavated from Indus valley had an activity of 1.18×10^{13} disintegration per minute per g of carbon. What is the approximate age of this civilisation?

a. 4000 years   *b.* 5700 years
c. 8100 years   *d.* 6000 years

104. For a reaction, if $K_p > K_C$, the forward reaction is favoured by

a. low pressure   *b.* high pressure
c. high temperature   *d.* low temperature

105. In a lime kiln, to get higher yield of CO_2, the measure that can be taken is

a. to remove CaO
b. to add more $CaCO_3$
c. to maintain high temperature
d. to pump out CO_2

106. What is the volume of '20 volume H_2O_2' required to get 5000 cm^3 of oxygen at STP?

a. 250 cm^3 *b.* 50 cm^3 *c.* 100 cm^3 *d.* 125 cm^3

107. The IUPAC name of $(CH_3)_3C-CH=CH_2$ is

a. 1, 1, 1-trimethyl-2-propene
b. 3, 3, 3-trimethyl-2-propene
c. 2, 2-dimethyl-3-butene
d. 3, 3-dimethyl-1-butene

108. Railway wagon axles are made by heating iron rods embedded in charcoal powder. This process is known as

a. tempering   *b.* case-hardening
c. sherardising   *d.* annealing

109. Thomas slag is
a. $CaSiO_3$
b. $Ca_3(PO_4)_2$
c. $MnSiO_3$
d. $CaCO_3$

110. Urea is preferred to ammonium sulphate as a nitrogenous fertiliser because
a. it is more soluble in water
b. it is cheaper than ammonium sulphate
c. it is quite stable
d. it does not cause acidity in the soil

111. Two gas cylinders having same capacity have been filled with 44 g of H_2 and 44 g of CO_2 respectively. If the pressure in CO_2 cylinder is 1 atmosphere at a particular temperature. The pressure in the hydrogen cylinder at the same temperature is
a. 2 atm
b. 1 atm
c. 22 atm
d. 44 atm

112. Angular momentum of an electron in the nth orbit of hydrogen atom is given by
a. $\dfrac{nh}{2\pi}$
b. nh
c. $\dfrac{2\pi}{nh}$
d. $\dfrac{\pi}{2nh}$

113. The element with atomic number 36 belongs to .... block in the periodic table.
a. p
b. s
c. f
d. d

114. The function of $AlCl_3$ in Friedel-Craft's reaction is
a. to absorb HCl
b. to absorb water
c. to produce nucleophile
d. to produce electrophile

115. An important reaction of acetone is auto-condensation in presence of concentrated sulphuric acid to give the aromatic compound ..... .
a. mesitylene
b. mesityl oxide
c. trioxane
d. phorone

116. Kinetic energy of one mole of an ideal gas at 300 K in kJ is
a. 3.74
b. 348
c. 34.8
d. 3.48

117. The tripeptide hormone present in most living cells is
a. glutathione
b. glutamine
c. oxytocin
d. ptyalin

118. Phenol $\xrightarrow{NaNO_2/H_2SO_4}$ B $\xrightarrow{H_2O}$ C $\xrightarrow{NaOH}$ D

name of the reaction is
a. Liebermann's reaction
b. Phthalein fusion test
c. Reimer-Tiemann reaction
d. Schotten-Baumann reaction

119. Energy is stored in our body in the form of
a. ATP
b. ADP
c. fats
d. carbohydrates

120. An organic compound answers Molisch's test as well as Benedict's test, but it does not answer Scliwanoff's test. Most probably, it is
a. sucrose
b. protein
c. fructose
d. maltose

MATHEMATICS

121. $\sim p \wedge q$ is logically equivalent to
a. $p \to q$
b. $q \to p$
c. $\sim(p \to q)$
d. $\sim(q \to p)$

122. Which of the following is the inverse of the proposition : "If a number is a prime, then it is odd"?
a. If a number is not a prime, then it is odd
b. If a number is not a prime, then it is not odd
c. If a number is not odd, then it is not a prime
d. If a number is odd, then it is a prime

123. What must be the matrix X if
$2X + \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} = \begin{bmatrix} 3 & 8 \\ 7 & 2 \end{bmatrix}$?
a. $\begin{bmatrix} 1 & 3 \\ 2 & -1 \end{bmatrix}$
b. $\begin{bmatrix} 1 & -3 \\ 2 & -1 \end{bmatrix}$

c. $\begin{bmatrix} 2 & 6 \\ 4 & -2 \end{bmatrix}$
d. $\begin{bmatrix} 2 & -6 \\ 4 & -2 \end{bmatrix}$

124. The value of $\begin{vmatrix} 1 & 1 & 1 \\ bc & ca & ab \\ b+c & c+a & a+b \end{vmatrix}$ is
a. 1
b. 0
c. $(a-b)(b-c)(c-a)$
d. $(a+b)(b+c)(c+a)$

125. The value of $\begin{vmatrix} 441 & 442 & 443 \\ 445 & 446 & 447 \\ 449 & 450 & 451 \end{vmatrix}$ is
a. $441 \times 446 \times 4510$
b. 0
c. -1
d. 1

126. $(\mathbf{a} \cdot \hat{\mathbf{i}})\,\hat{\mathbf{i}} + (\mathbf{a} \cdot \hat{\mathbf{j}})\,\hat{\mathbf{j}} + (\mathbf{a} \cdot \hat{\mathbf{k}})\,\hat{\mathbf{k}}$ is equal to

    a. a   *b.* 2a   *c.* 3a   *d.* 0

127. Inverse of the matrix $\begin{bmatrix} \cos 2\theta & -\sin 2\theta \\ \sin 2\theta & \cos 2\theta \end{bmatrix}$ is

    a. $\begin{bmatrix} \cos 2\theta & -\sin 2\theta \\ \sin 2\theta & \cos 2\theta \end{bmatrix}$ *b.* $\begin{bmatrix} \cos 2\theta & \sin 2\theta \\ \sin 2\theta & -\cos 2\theta \end{bmatrix}$

    c. $\begin{bmatrix} \cos 2\theta & \sin 2\theta \\ \sin 2\theta & \cos 2\theta \end{bmatrix}$ *d.* $\begin{bmatrix} \cos 2\theta & \sin 2\theta \\ -\sin 2\theta & \cos 2\theta \end{bmatrix}$

128. If $|\mathbf{a}| = 3, |\mathbf{b}| = 4$, then a value of λ for which $\mathbf{a} + \lambda\mathbf{b}$ is perpendicular to $\mathbf{a} - \lambda\mathbf{b}$ is

    a. $\dfrac{9}{16}$ *b.* $\dfrac{3}{4}$ *c.* $\dfrac{3}{2}$ *d.* $\dfrac{4}{3}$

129. The projection of $\mathbf{a} = 2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - 2\hat{\mathbf{k}}$ on $\mathbf{b} = \hat{\mathbf{i}} + 2\hat{\mathbf{j}} + 3\hat{\mathbf{k}}$ is

    a. $\dfrac{1}{\sqrt{14}}$ *b.* $\dfrac{2}{\sqrt{14}}$ *c.* $\sqrt{14}$ *d.* $\dfrac{-2}{\sqrt{14}}$

130. In the group $(1, 2, 3, 4, 5, 6)$ under multiplication 7, $2^{-1} \times 4$ is equal to

    a. 1   *b.* 4   *c.* 2   *d.* 3

131. The maximum of the function $3\cos x - 4\sin x$ is

    a. 2   *b.* 3   *c.* 4   *d.* 5

132. If the distance 'S' metres traversed by a particle in t seconds is given by $S = t^3 - 3t^2$, then the velocity of the particle when the acceleration is zero, in m/sec is

    a. 3   *b.* -2 *c.* -3 *d.* 2

133. For the curve $y^n = a^{n-1}x$ if the subnormal at any point is a constant, then n is equal to

    a. 1   *b.* 2   *c.* -2 *d.* -1

134. If $x = A\cos 4t + B\sin 4t$, then $\dfrac{d^2x}{dt^2}$ is equal to

    a. $-16x$ *b.* $16x$ *c.* x *d.* $-x$

135. If tangent to the curve $x = at^2, y = 2at$ is perpendicular to X-axis, then its point of contact is

    a. (a, a) *b.* $(0, a)$ *c.* $(0, 0)$ *d.* $(a, 0)$

136. The general solution of the differential equation $\dfrac{dy}{dx} + \dfrac{1 + \cos 2y}{1 - \cos 2y} = 0$ is given by

    a. $\tan y + \cot x = c$ *b.* $\tan y - \cot x = c$

    c. $\tan x - \cot y = c$ *d.* $\tan x + \cot x = c$

137. The degree of the differential equation $\left(1 + \left(\dfrac{dy}{dx}\right)^2\right)^{3/4} = \left(\dfrac{d^2y}{dx^2}\right)^{1/3}$ is

    a. 2   *b.* 4   *c.* 9   *d.* 1

138. The area enclosed between the curves $y = x^3$ and $y = \sqrt{x}$ is, (in square units)

    a. $\dfrac{5}{3}$ *b.* $\dfrac{5}{4}$ *c.* $\dfrac{5}{12}$ *d.* $\dfrac{12}{5}$

139. $\displaystyle\int_0^{\pi/8} \cos^3 4\theta \, d\theta$ is equal to

    a. $\dfrac{5}{3}$ *b.* $\dfrac{5}{4}$ *c.* $\dfrac{1}{3}$ *d.* $\dfrac{1}{6}$

140. $\displaystyle\int_0^{\pi/2} \dfrac{\cos x - \sin x}{1 + \cos x \sin x} dx$ is equal to

    a. 0   *b.* $\dfrac{\pi}{2}$ *c.* $\dfrac{\pi}{4}$ *d.* $\dfrac{\pi}{6}$

141. If $ax^2 - y^2 + 4x - y = 0$ represents a pair of lines, then a is equal to

    a. -16 *b.* 16   *c.* 4   *d.* -4

142. What is the equation of the locus of a point which moves such that 4 times its distance from the X-axis is the square of its distance from the origin?

    a. $x^2 + y^2 - 4y = 0$

    b. $x^2 + y^2 - 4|y| = 0$

    c. $x^2 + y^2 - 4x = 0$

    d. $x^2 + y^2 - 4|x| = 0$

143. Equation of the straight line making equal intercepts on the axes and passing through the point $(2, 4)$ is

    a. $4x - y - 4 = 0$

    b. $2x + y - 8 = 0$

    c. $x + y - 6 = 0$

    d. $x + 2y - 10 = 0$

144. If the area of the triangle with vertices $(x, 0)$, $(1, 1)$ and $(0, 2)$ is 4 sq units, then the value of x is

    a. -2 *b.* -4 *c.* -6 *d.* 8

145. $\displaystyle\lim_{a \to \pi/2} \dfrac{\dfrac{\pi}{2} - \theta}{\cot\theta} =$

    a. 0   *b.* -1 *c.* 1   *d.* ∞

146. The co-axial system of circles given by $x^2 + y^2 + 2gx + c = 0$ for $c < 0$ represents

    a. intersecting circles
    b. non-intersecting circles
    c. touching circles
    d. touching or non-intersecting circles

147. The radius of the circle passing through the point (6, 2) and two of whose diameters are $x + y = 6$ and $x + 2y = 4$ is

    a. 4   **b.** 6   **c.** 20   **d.** $\sqrt{20}$

148. If (0, 6) and (0, 3) are respectively the vertex and focus of a parabola, then its equation is

    a. $x^2 + 12y = 72$ **b.** $x^2 - 12y = 72$
    c. $y^2 - 12x = 72$ **d.** $y^2 + 12x = 72$

149. For the ellipse $25x^2 + 9y^2 - 150x - 90y + 225 = 0$ the eccentricity e is equal to

    a. $\dfrac{2}{5}$ **b.** $\dfrac{3}{5}$ **c.** $\dfrac{4}{5}$ **d.** $\dfrac{1}{5}$

150. If the foci of the ellipse $\dfrac{x^2}{16} + \dfrac{y^2}{b^2} = 1$ and the hyperbola $\dfrac{x^2}{144} - \dfrac{y^2}{81} = \dfrac{1}{25}$ coincide then the value of b^2 is

    a. 1   **b.** 7   **c.** 5   **d.** 9

151. The differential coefficient is $f(\sin x)$ with respect to x where $f(x) + \log x$ is

    a. $\tan x$ **b.** $\cot x$ **c.** $f(\cos x)$ **d.** $\dfrac{1}{x}$

152. If $f(x) = \begin{cases} \dfrac{1-\cos x}{x} & x \neq 0 \\ k & x = 0 \end{cases}$ is continuous at $x = 0$, then the value of k is

    a. 0   **b.** $\dfrac{1}{2}$ **c.** $\dfrac{1}{4}$ **d.** $-\dfrac{1}{2}$

153. If $\omega = \dfrac{-1+\sqrt{3i}}{2}$ then $(3 + \omega + 3\omega^2)^4$ is

    a. 16   **b.** – 16   **c.** $16\,\omega$ **d.** $16\,\omega^2$

154. If $y = \tan^{-1}(\sec x - \tan x)$, then $\dfrac{dy}{dx}$ is equal to

    a. 2   **b.** – 2   **c.** $\dfrac{1}{2}$ **d.** $-\dfrac{1}{2}$

155. If $x + \dfrac{1}{x} = 2\cos\alpha$, then $x^n + \dfrac{1}{x^n}$ is equal to

    a. $2^n \cos\alpha$ **b.** $2^n \cos n\alpha$
    c. $2i\sin n\alpha$ **d.** $2\cos n\alpha$

156. $\displaystyle\int_{-1}^{1} |1 - x|\, dx$ is equal to

    a. – 2   **b.** 0   **c.** 2   **d.** 4

157. $\displaystyle\int \dfrac{dx}{x(x^7 + 1)}$ is equal to

    a. $\log\left(\dfrac{x^7}{x^7+1}\right) + c$

    b. $\dfrac{1}{7}\log\left(\dfrac{x^7}{x^7+1}\right) + c$

    c. $\log\left(\dfrac{x^7+1}{x^7}\right) + c$

    d. $\dfrac{1}{7}\log\left(\dfrac{x^7+1}{x^7}\right) + c$

158. $\displaystyle\int \sqrt{x}\, e^{\sqrt{x}}\, dx$ is equal to

    a. $2\sqrt{x} - e^{\sqrt{x}} - 4\sqrt{x e^{\sqrt{x}}} + c$
    b. $(2x - 4\sqrt{x} + 4)e^{\sqrt{x}} + c$
    c. $(2x + 4\sqrt{x} + 4)\, e^{\sqrt{x}} + c$
    d. $(1 - 4\sqrt{x})\, e^{\sqrt{x}} + c$

159. $\displaystyle\int \dfrac{dx}{x^2 + 2x + 2}$ is equal to

    a. $\sin^{-1}(x+1) + c$ **b.** $\sinh^{-1}(x+1) + c$
    c. $\tanh^{-1}(x+1) + c$ **d.** $\tan^{-1}(x+1) + c$

160. If a tangent to the curve $y = 6x - x^2$ is parallel to the line $4x - 2y - 1 = 0$, then the point of tangency on the curve is

    a. (2, 8)   **b.** (8, 2)
    c. (6, 1)   **d.** (4, 2)

161. 0.5737373 … is equal to

    a. $\dfrac{284}{497}$ **b.** $\dfrac{284}{495}$ **c.** $\dfrac{568}{999}$ **d.** $\dfrac{567}{990}$

162. The number of solutions for the equation $x^2 - 5|x| + 6 = 0$ is

    a. 4   **b.** 3   **c.** 2   **d.** 1

163. How many numbers of 6-digits can be formed from the digits of the number 112233 ?

    a. 30   **b.** 60   **c.** 90   **d.** 120

164. The last digit in 7^{300} is

    a. 7   **b.** 9   **c.** 1   **d.** 3

165. If $\dfrac{\log x}{a-b} = \dfrac{\log y}{b-c} = \dfrac{\log z}{c-a}$, then xyz is equal to

    a. 0   **b.** 1
    c. – 1   **d.** 2

166. The smallest positive integer n for which $(1 + i)^{2n} = (1 - i)^{2n}$ is

a. 1   b. 2

c. 3   d. 4

167. If $\cos^{-1} p + \cos^{-1} q + \cos^{-1} r = \pi$, then $p^2 + q^2 + r^2 + 2pqr$ is equal to

a. 3   b. 1

c. 2   d. -1

168. If $\sin^{-1} \dfrac{x}{5} + \text{cosec}^{-1} \dfrac{5}{4} = \dfrac{\pi}{2}$, then x is equal to

a. 1   b. 4

c. 3   d. 5

169. If $0 \le x \le \pi$ and $81^{\sin^2 x} + 81^{\cos^2 x} = 30$, then x is equal to

a. $\dfrac{\pi}{6}$ b. $\dfrac{\pi}{2}$

c. $\dfrac{\pi}{4}$ d. $\dfrac{3\pi}{4}$

170. The equation of the director circle of the hyperbola $\dfrac{x^2}{16} - \dfrac{y^2}{4} = 1$ is given by

a. $x^2 + y^2 = 16$ b. $x^2 + y^2 = 4$

c. $x^2 + y^2 = 20$ d. $x^2 + y^2 = 12$

171. If Q_1 is the set of all relations other than 1 with the binary operation * defined by $a * b = a + b - ab$ for all a, b in Q_1, then the identity in Q_1 with respect to * is

a. 1   b. 0

c. -1 d. 2

172. The circle $x^2 + y^2 - 8x + 4y + 4 = 0$ touches

a. X-axis

b. Y-axis

c. both axes

d. neither X-axis nor Y-axis.

173. Which of the following is true ?

a. The set of all fourth roots of unity is a multiplicative group

b. The set of all cube roots of unity is an additive group

c. $(ab)^{-1} = a^{-1}b^{-1}$ for all a, b in any group G

d. If $(ab)^2 = a^2 b^2$ for all a, b in any group G, then the group G is non-abelian

174. The set of all integral multiples of 5 is a subgroup of

a. The set of all rational numbers under multiplication

b. The set of all integers under multiplication

c. The set of all non-zero rational numbers under multiplication

d. The set of all integers under addition

175. The value of k so that $x^2 + y^2 + kx + 4y + 2 = 0$ and $2(x^2 + y^2) - 4x - 3y + k = 0$ cut orthogonally is

a. $\dfrac{10}{3}$ b. $-\dfrac{8}{3}$ c. $-\dfrac{10}{3}$ d. $\dfrac{8}{3}$

176. $\lim\limits_{x \to \infty} \left(1 - \dfrac{4}{x-1}\right)^{3x-1}$ is equal to

a. e^{12} b. e^{-12} c. e^4 d. e^3

177. If $A + B + C = 180°$, then $\Sigma \tan \dfrac{A}{2} \tan \dfrac{B}{2}$ is equal to

a. 0   b. 1   c. 2   d. 3

178. In a $\triangle ABC$ if $b = 2$, $B = 30°$ then the area of the circumcircle of $\triangle ABC$ in square units is

a. π b. 2π c. 4π d. 6π

179. If $\sin x + \sin^2 x = 1$, then $\cos^{12} x + 3\cos^{10} x + 3\cos^8 x + \cos^6 x$ is equal to

a. 1   b. 2

c. 3   d. 0

180. If R denotes the set of all real number, then the function $f : R \to R$ defined $f(x) = |x|$ is

a. one-one only

b. onto only

c. both one-one and onto

d. neither one-one nor onto

ANSWERS

Physics

1. (d)	2. (d)	3. (d)	4. (b)	5. (a)	6. (d)	7. (d)	8. (a)	9. (d)	10. (a)
11. (d)	12. (a)	13. (a)	14. (c)	15. (c)	16. (c)	17. (a)	18. (c)	19. (d)	20. (c)
21. (a)	22. (a)	23. (b)	24. (d)	25. (c)	26. (b)	27. (c)	28. (b)	29. (c)	30. (c)
31. (d)	32. (b)	33. (c)	34. (b)	35. (b)	36. (d)	37. (a)	38. (d)	39. (b)	40. (a)
41. (c)	42. (b)	43. (b)	44. (d)	45. (b)	46. (c)	47. (d)	48. (a)	49. (b)	50. (a)
51. (c)	52. (c)	53. (c)	54. (c)	55. (b)	56. (d)	57. (d)	58. (a)	59. (d)	60. (b)

Chemistry

61. (c)	62. (b)	63. (b)	64. (d)	65. (d)	66. (a)	67. (b)	68. (c)	69. (c)	70. (a)
71. (d)	72. (c)	73. (d)	74. (a)	75. (d)	76. (d)	77. (a)	78. (d)	79. (c)	80. (d)
81. (d)	82. (a)	83. (b)	84. (d)	85. (a)	86. (b)	87. (c)	88. (a)	89. (a)	90. (c)
91. (d)	92. (b)	93. (b)	94. (a)	95. (d)	96. (a)	97. (d)	98. (d)	99. (d)	100. (c)
101. (b)	102. (a)	103. (c)	104. (a)	105. (d)	106. (a)	107. (d)	108. (b)	109. (b)	110. (d)
111. (c)	112. (a)	113. (a)	114. (d)	115. (a)	116. (a)	117. (a)	118. (a)	119. (a)	120. (d)

Mathematics

121. (d)	122. (b)	123. (a)	124. (c)	125. (b)	126. (a)	127. (d)	128. (b)	129. (b)	130. (c)
131. (d)	132. (c)	133. (b)	134. (a)	135. (c)	136. (b)	137. (b)	138. (c)	139. (d)	140. (a)
141. (b)	142. (b)	143. (c)	144. (c)	145. (c)	146. (a)	147. (d)	148. (a)	149. (c)	150. (b)
151. (b)	152. (a)	153. (c)	154. (d)	155. (d)	156. (c)	157. (b)	158. (b)	159. (d)	160. (a)
161. (b)	162. (a)	163. (c)	164. (c)	165. (b)	166. (b)	167. (b)	168. (c)	169. (a)	170. (d)
171. (b)	172. (b)	173. (a)	174. (d)	175. (c)	176. (b)	177. (b)	178. (c)	179. (a)	180. (d)

HINTS & SOLUTIONS

Physics

1. (d) If frequency of source be f_s, then

$$f_{approach} - f_{recession} = \frac{2}{100} \times f_o$$

$$\Rightarrow \quad f_s \left(\frac{v + v_s}{v} \right) - f_s \left(\frac{v - v_s}{v} \right) = \frac{f_s}{50}$$

$$\Rightarrow \quad \frac{2v_s}{v} = \frac{1}{50} \Rightarrow \frac{2v_s}{300} = \frac{1}{50}$$

$$\Rightarrow \quad v_s = \frac{300}{2 \times 50} = 3 \text{ ms}^{-1}$$

2. (d) The magnetic force between two current carrying wires for current in same direction is attractive.

Thus, force on B due to the magnetic field produced due to wire A is

$$F_A = B_A I_B l = \frac{\mu_0 \times I_A}{2\pi d} \times I_B \times l$$

$$= \frac{\mu_0 \times 1 \times 2 \times l}{2\pi d} = \frac{2\mu_0 l}{2\pi d}, \text{ towards } A \quad ...(i)$$

Similarly, force due to field of wire C,

$$F_C = B_C I_B l = \frac{\mu_0 I_C I_B l}{2\pi d} = \frac{\mu_0 \times 3 \times 2 \times l}{2\pi d}$$

$$\Rightarrow \quad F_C = \frac{6\mu_0 l}{2\pi d}, \text{ towards } C \quad ...(ii)$$

From Eqs. (i) and (ii) we get
$$F_C > F_A$$

∴ The resultant force on B is directed towards C.

3. (d) Ferromagnetic materials like iron obeys Curie-Weiss law above its Curie temperature.
According to Curie-Weiss law, magnetic susceptiblity (χ) of ferromagnetic material is related with temperature T as

$$\chi = \frac{C}{T - T_C}$$

where, C = Curie constant
and T_C = Curie temperature.

4. (b) As the magnet oscillates about its mean position performing SHM, the magnetic flux of the coil changes and emf is induced in it. So, the galvanometer shows deflection to the left and right for both in and out motion. But due to eddy currents, the velocity of magnet decreases So, the amplitude of deflection also decreases steadily.

5. (a) As we know, magnetic flux, $\phi = LI$

$$\Rightarrow \quad L = \frac{\phi}{I} = \frac{BA}{I}$$

∴ Dimensions of $[L] = \frac{[B][A]}{[I]}$

$$= \frac{[ML^0 T^{-2} A^{-1}][L^2]}{[A]} = [ML^2 T^{-2} A^{-2}]$$

6. (d) Given, $G = 40\,\Omega$, $I_g = 10\,\text{mA} = 10 \times 10^{-3}$ A
$$V = 50 \text{ V}$$

Let R be the resistance connected in series with the galvanometer to convert into voltmeter, then

$$V = I_g(G + R)$$

$$\Rightarrow \quad 50 = 10 \times 10^{-3}(40 + R)$$

$$\Rightarrow \quad \frac{50}{10 \times 10^{-3}} = 40 + R$$

$$\Rightarrow \quad R = 5000 - 40 = 4960\,\Omega$$

7. (d) Chromosphere is the outer region of the sun just above the photosphere. The photosphere emits continuous spectrum that passes through the chromosphere after some absorption. These absorption lines are observed in solar spectrum.

During a total solar eclipse, when the light from photosphere is cut-off, the chromosphere is visible to us. Hence, the line absorption spectrum with continuous background is seen during a total solar eclipse.

8. (a) Heavy water (D_2O) contains heavy hydrogen or deuterium and oxygen.

9. (d) The nuclear reactor at Kaiga is a power reactor and named as Kaiga Atomic Power Station.
It is used for electricity and power generation.

10. (a) In a circular path, the centripetal force acts towards the centre of circle and the displacement is along the tangent to the circle. Hence, $\theta = 90°$

∴ Work done $W = \mathbf{F} \cdot \mathbf{s} = Fs \cos\theta$

$$= Fs \cos 90° = 0$$

11. (d) Given, $u_1 = 100 \text{ ms}^{-1}$

$$\Rightarrow u_2 = 2 \times u_1 = 2 \times 100 = 200 \text{ ms}^{-1}$$

Using equation of motion,
$$v^2 = u^2 - 2as \quad (\because \text{acceleration is negative})$$

As, final velocity, $v = 0$

$$\Rightarrow \quad u^2 = 2as \text{ or } s = \frac{u^2}{2a} \Rightarrow s \propto u^2$$

$$\therefore \quad \frac{s_1}{s_2} = \frac{u_1^2}{u_2^2} = \frac{(100)^2}{(200)^2} = \frac{1}{4}$$

$$\Rightarrow \quad s_2 = 4s_1 = 4 \times 2 \text{ planks} = 8 \text{ planks}$$

12. (a) Given, $m_1 = 1 \text{ kg}$, $m_2 = 2 \text{ kg}$

The kinetic energy is related to momentum of body by the formula given as

$$K = \frac{p^2}{2m}$$

$$\therefore \quad \frac{K_1}{K_2} = \frac{m_2}{m_1} = \frac{2}{1} \quad (\because \text{momentum is same})$$

13. (a) An open window is like a perfectly black body that absorbs completely the quantity being transferred, so its absorption coefficient is unity or 1.

14. (c) The loudness depends on the amplitude of sound wave, thus it depends on its intensity.

The pitch of a sound describes how low or high a note is produced by the instrument. Thus, it depends on the frequency of sound source.

15. (c) In Melde's experiment, the change in frequency is produced when the tension in the string is increased. So, a resonance is required between tuning fork and the frequency of waves produced. For this, the frequencies of both should be same or their ratio be 1 : 1.

16. (c) As we know,

Kinetic energy of electron = Energy acquired due to potential (V_0)

$$\Rightarrow \qquad \frac{1}{2}m_e v^2 = eV_0$$

$$\Rightarrow \qquad v = \sqrt{\frac{2eV_0}{m_e}}$$

$$= \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 45.5}{9.1 \times 10^{-31}}}$$

$$= \sqrt{16 \times 10^{12}} = 4 \times 10^6 \, \text{ms}^{-1}$$

17. (a) In first case, $P = R_1 + 10$, $Q = R_2$, $l = 50$ cm

For balanced condition,

$$\frac{P}{Q} = \frac{l}{100 - l}$$

$$\Rightarrow \qquad \frac{R_1 + 10}{R_2} = \frac{50}{50}$$

$$\Rightarrow \qquad R_1 + 10 = R_2 \qquad \qquad \text{...(i)}$$

Similarly, for second case,

$$P = R_1, Q = R_2, l = 40 \text{ cm}$$

$$\Rightarrow \qquad \frac{R_1}{R_2} = \frac{40}{100 - 40} = \frac{40}{60}$$

$$\Rightarrow \qquad R_2 = \frac{3}{2}R_1 \qquad \qquad \text{...(ii)}$$

Putting value of R_2 from Eq. (ii) in Eq (i), we get

$$R_1 + 10 = \frac{3}{2}R_1$$

$$\Rightarrow \qquad R_1 = 2 \times 10 = 20 \, \Omega$$

18. (c) $2\,\Omega$ and $3\,\Omega$ resistors are in parallel, so their equivalent resistance,

$$R_{eq} = \frac{2 \times 3}{2 + 3} = \frac{6}{5} = 1.2\,\Omega$$

As capacitor blocks DC at steady state, so the resistor $4\,\Omega$ is ineffective.

The R_{eq} and $2.8\,\Omega$ are in series, so total resistance of circuit,

$$R_T = 1.2 + 2.8 = 4\,\Omega$$

Current in circuit, $I = \dfrac{V}{R_T} = \dfrac{6}{4} = 1.5 \text{ A}$

Potential across the combination of $2\,\Omega$ and $3\,\Omega$ resistors $\qquad V' = 1.5 \times 1.2 = 1.8 \text{ V}$

∴ The steady state current in $2\,\Omega$ resistor is

$$I' = \frac{V'}{2} = \frac{1.8}{2} = 0.9 \text{ A}$$

19. (d) Peak value of emf is induced, when longer side of rectangular coil moves perpendicular to the field.

Given, $\qquad f = 50$ cps,

$$A = 25 \times 10 \times 10^{-4}\,\text{m}^2$$

$$= 250 \times 10^{-4}\,\text{m}^2$$

$$B = 4 \times 10^{-2}\,\text{T, and } N = 300$$

Peak value of induced emf, $e_0 = NAB\omega$

$$= 300 \times 250 \times 10^{-4} \times 4 \times 10^{-2} \times 2\pi \times 50$$

$$= 30\pi \text{ V}$$

20. (c) Given, $V_R = 40\,\text{V}, V_L = 60\,\text{V}, V_C = 30$ V

For an L-C-R circuit, the supply voltage

$$V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$= \sqrt{40^2 + (60 - 30)^2}$$

$$= \sqrt{40^2 + 30^2}$$

$$= \sqrt{1600 + 900} = \sqrt{2500} = 50\text{V}$$

21. (a) Given, $R = 0.1$ m, $N = 10$, $B_H = 0.314 \times 10^{-4}$ T

For neutral point, the magnetic field at the centre of coil carrying current is equal to the horizontal component of earth's field.

i.e. $\qquad B_H = \dfrac{\mu_0 NI}{2R}$

$$\Rightarrow \qquad I = \frac{2B_H R}{\mu_0 N}$$

$$= \frac{2 \times 0.314 \times 10^{-4} \times 0.1}{4\pi \times 10^{-7} \times 10}$$

$$= \frac{0.314 \times 10^{-4}}{2 \times 3.14 \times 10^{-7} \times 100} = 0.5 \text{ A}$$

22. (a) When portion A is punctured, the soap solution comes out of the hole. So, due to surface tension, the solution in part B tries to pull it toward itself. Thus, the thread becomes concave towards A.

23. (b) Velocity of sound in a gas is given by

$$v = \sqrt{\frac{\gamma RT}{M}}$$

where, γ = specific heat ratio

and M = molecular mass of gas.

For hydrogen, $v_H = \sqrt{\dfrac{\gamma RT}{M_1}} \qquad \qquad \text{...(i)}$

For mixture of gases, molecular mass,

$$M_{mix} = \frac{n_1 M_1 + n_2 M_2}{n_1 + n_2}$$

Here, $\qquad n_1 = n_2 \qquad \qquad$ (for equal volumes)

and $M_2 = 16M_1$ (given)

$$M_{mix} = \frac{M_1 + 16M_1}{2} = \frac{17M_1}{2}$$

$\therefore$ Velocity of sound, $v_{mix} = \sqrt{\dfrac{\gamma RT}{M_{mix}}}$ ...(ii)

Dividing Eq. (ii) by Eq. (i) we get

$$\frac{v_{mix}}{v_H} = \sqrt{\frac{\gamma RT}{M_{mix}}} \times \sqrt{\frac{M_1}{\gamma RT}}$$

$$= \sqrt{\frac{M_1}{M_{mix}}} = \sqrt{\frac{2}{17}}$$

24. (d) The resultant amplitude after super position of two wave differing in phase by ϕ is given by

$$A_R^2 = A_1^2 + A_2^2 + 2A_1 A_2 \cos\phi$$

Here, $A_1 = A_2 = A_R = A$

$\Rightarrow \qquad A^2 = 2A^2 + 2A^2 \cos\phi$

$\Rightarrow \qquad \cos\phi = -\dfrac{1}{2}$

$\Rightarrow \qquad \phi = \pi - \dfrac{\pi}{3} = \dfrac{2\pi}{3}$

25. (c) Let x be the distance between a cliff and man, then time taken by the echo,

$$t = \frac{2x}{v} = 1 \qquad \text{(given)}$$

$\Rightarrow \qquad x = \dfrac{v}{2} = \dfrac{340}{2} = 170\,\text{m}$

$\therefore$ Distance between two cliffs

$$= 2x = 2 \times 170 = 340\,\text{m}$$

26. (b) Given $\lambda = 600\,\text{nm} = 600 \times 10^{-9}\,\text{m}$

$$D = 2\,\text{m},\, d = 1\,\text{mm} = 1 \times 10^{-3}\,\text{m}$$

The distance of first dark fringe from central bright fringe,

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

$$= \frac{2 \times 600 \times 10^{-9}}{1 \times 10^{-3}} = 1.2\,\text{mm}$$

$\therefore$ Distance between first dark fringe on either side of central bright fringe $= 2y = 1.2 \times 2 = 2.4\,\text{mm}$

27. (c) Impulse = Force $\times$ Time

$$= [MLT^{-2}][T] = [MLT^{-1}]$$

Surface tension $= \dfrac{\text{Force}}{\text{Length}}$

$$= \frac{[MLT^{-2}]}{[L]} = [ML^0 T^{-2}]$$

Angular momentum

= Moment of intertia $\times$ Angular velocity

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

Work = Force $\times$ Distance $= [MLT^{-2}][L] = [ML^2 T^{-2}]$

Torque = Force $\times$ Distance $= [ML^2 T^{-2}]$

Energy $= [ML^2 T^{-2}]$

Young's modulus $= \dfrac{\dfrac{\text{Force}}{\text{Area}}}{\dfrac{\Delta L}{L}}$

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

$\therefore$ Work and torque have same dimensions.

28. (b) Given, $t = \sqrt{x} + 3$

$\Rightarrow \qquad \sqrt{x} = t - 3$

or $\qquad x = (t-3)^2$

Velocity, $v = \dfrac{dx}{dt} = \dfrac{d}{dt}(t-3)^2 = 2(t-3)$

When velocity of particle is zero, then

$$2(t-3) = 0$$

$\Rightarrow \qquad t = 3\,\text{s}$

At $t = 3\,\text{s}$, $x = (3-3)^2 = 0$

29. (c) As per Boolean expressions,

$$\mathbf{A} \times (\mathbf{B} \times \mathbf{C}) = (\mathbf{A} \cdot \mathbf{C})\mathbf{B} - (\mathbf{A} \cdot \mathbf{B})\mathbf{C} = 0 - 0 = 0$$

$\therefore (\mathbf{B} \times \mathbf{C})$ is parallel to $\mathbf{A}$.

30. (c) A transformer does not work on DC supply because mutual induction does not take place due to constant value of current. So, $V_S = 0$ and $I_S = 0$.

31. (d) Here, work done $= mgh$

As, m and h is same, so work done will be same in both cases.

Power, $P = \dfrac{\text{Work done }(W)}{\text{Time taken }(t)}$

$\Rightarrow \qquad \dfrac{P_1}{P_2} = \dfrac{t_2}{t_1} = \dfrac{30}{60} = \dfrac{1}{2}$ or $1:2$

32. (b) Given $\theta_1 = 0°$, $\theta_2 = 90°$

The energy required to rotate the dipole from angle θ_1 to θ_2 is equal to work done.

i.e., $E = W = -pE(\cos\theta_2 - \cos\theta_1)$

$$= -pE(\cos 90° - \cos 0°)$$

$$= -pE(0-1) = pE$$

33. (c) Given, $r = 10\,\text{m}$, $v = 10\,\text{m/s}$

If θ be the angle made by the wire with the vertical, then

$$\tan\theta = \frac{v^2}{rg}$$

$$= \frac{(10)^2}{(10)(10)} = 1$$

$\Rightarrow \qquad \theta = 45°$ or $\dfrac{\pi}{4}$

34. (b) The escape velocity of earth,

$$v_e = \sqrt{\frac{2GM_e}{R_e}} = R_e \sqrt{\frac{8}{3}\pi G \rho_e}$$

Similarly for a planet,

$$v_p = R_p \sqrt{\frac{8}{3}\pi G \rho_p}$$

$$\therefore \qquad \frac{v_e}{v_p} = \frac{R_e}{R_p}\sqrt{\frac{\rho_e}{\rho_p}}$$

Here, $R_p = 2R_e, \rho_e = \rho_p \Rightarrow \frac{v_e}{v_p} = \frac{1}{2}$ or $v_p = 2v_e$

35. *(b)* Young's modulus, $Y = \frac{FL}{A\Delta L} = \frac{4FL}{\pi D^2 \Delta L}$

$$\Rightarrow \qquad \Delta L = \frac{4FL}{\pi D^2 Y}$$

The ratio of increase in length of steel and copper is

$$\frac{\Delta L_s}{\Delta L_c} = \frac{F_s L_s}{D_s^2 Y_s} \times \frac{D_c^2 Y_c}{F_c L_c} = \frac{F_s}{F_c} \times \frac{L_s}{L_c} \times \left(\frac{D_c}{D_s}\right)^2 \times \frac{Y_c}{Y_s}$$

Force on steel wire, $F_s = (2m + 5m)g = 7mg$
Force on copper wire, $F_c = 5mg$

$$\Rightarrow \qquad \frac{F_s}{F_c} = \frac{7}{5}$$

Also, $\qquad \frac{D_s}{D_c} = p, \frac{L_s}{L_c} = q, \frac{Y_s}{Y_c} = s$

$$\therefore \qquad \frac{\Delta L_s}{\Delta L_c} = \frac{7}{5} \times q \times \frac{1}{p^2} \times \frac{1}{s} = \frac{7q}{5sp^2}$$

36. *(d)* For adiabatic process,
$$pV^\gamma = \text{constant}$$

For an ideal gas, $pV = nRT$ or $p = \frac{nRT}{V}$

$$\Rightarrow \qquad \frac{nRT}{V}V^\gamma = \text{constant}$$

$$\Rightarrow \qquad TV^{\gamma-1} = \text{constant}$$

Again, from ideal gas equation,
$$V = \frac{nRT}{p}$$

$$\Rightarrow \qquad p\left(\frac{nRT}{p}\right)^\gamma = \text{constant}$$

$$\Rightarrow \qquad p^{1-\gamma}T^\gamma = \text{constant}$$

Hence, relation shown in option (d) is not for adiabatic process.

37. *(a)* The escape velocity from earth's surface is given by
$$v_e = \sqrt{\frac{2GM}{R+h}}$$

Given, $\qquad h = 3R$

$$\Rightarrow \qquad v_e = \sqrt{\frac{2GM}{4R}} = \sqrt{\frac{GM}{2R}}$$

38. *(d)* H-polaroid is prepared by stretching a thin sheet of polyvinyl alcohol and then impregnating with iodine. In this process, the molecules are oriented in the direction of applied strain.

39. *(b)* From Coulomb's law, force between two charges,
$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$\Rightarrow \qquad \varepsilon_0 = \frac{q_1 q_2}{4\pi r^2 F}$$

$\therefore$ Unit of $\varepsilon_0 = \frac{C \cdot C}{m^2 N} = \frac{C^2}{m^2 N} = C^2 m^{-2} N^{-1}$

40. *(a)* As, the volume remains constant, so
$$\frac{4}{3}\pi R^3 = 8\left(\frac{4}{3}\pi r^3\right)$$

$$\Rightarrow \qquad R = 2r \text{ or } r = \frac{R}{2}$$

Capacitance of spherical capacitor,
$$C = 4\pi\varepsilon_0 R$$

$$\Rightarrow \qquad C \propto R$$

$$\therefore \qquad \frac{C_1}{C_2} = \frac{R}{r} = \frac{2r}{r} = 2 \quad \Rightarrow C_2 = \frac{C_1}{2} = \frac{1}{2}\mu F$$

41. *(c)* The magnitude of resultant of two forces is given by
$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

Given, $\qquad A = B = P$ and $\theta = 120°$

$$\therefore \qquad R = \sqrt{P^2 + P^2 + 2P^2 \cos 120°}$$

$$= \sqrt{2P^2\left(1 - \frac{1}{2}\right)} = P$$

42. *(b)* Given, $\lambda_0 = 5200 \text{Å} = 5200 \times 10^{-10}$ m

$\therefore$ Threshold frequency, $f_0 = \frac{c}{\lambda_0} = \frac{3 \times 10^8}{5200 \times 10^{-10}}$

$$= 5.76 \times 10^{14} \text{ Hz}$$

It lies in the frequency range of UV-rays, so 50 W UV lamp is used for this emission.

43. *(b)* When the monochromatic light in Young's double slit experiment is replaced by white light, a white central bright fringe is observed as all wavelengths of light have zero phase difference at centre while at all other points, it is different for different colours. So different colour fringes are observed on both sides.

44. *(d)* The radius in Bohr's atomic model is given by
$$r = 0.53 \frac{n^2}{Z}\text{Å}$$

For Be^{3+}, $Z_{Be} = 4, n_{Be} = ?$
For H, $Z_H = 1, n_H = 1$
As per question,

$$r_{Be} = r_H$$

$$\Rightarrow \qquad \frac{n_{Be}^2}{Z_{Be}} = \frac{n_H^2}{Z_H}$$

$$\Rightarrow \qquad n_{Be} = \sqrt{n_H^2\left(\frac{Z_{Be}}{Z_H}\right)} = \sqrt{1 \times \frac{4}{1}} = 2$$

45. *(b)* Packing fraction is the ratio of mass defect to the number of nucleons. Mass defect is the difference in the actual isotopic mass (M) and mass number (A).

$\therefore$ Packing fraction $= \frac{M - A}{A}$

where, A is mass number or number of nucleons.

46. (c) In radioactive decay, the decay rate is proportional to the amount of substance. So, for change of count rate from 240 per min to 30 per min, let N be the number of half-life passed in one hour. Then,

$$\frac{240}{2^N} = 30$$

$$\Rightarrow \qquad 2^N = 8$$

$$\Rightarrow \qquad N = 3$$

Half-life, $t_{1/2} = \dfrac{1h}{3} = \dfrac{60}{3}$ min $= 20$ min

47. (d) The rate of heat conduction is given by

$$H = \frac{d\theta}{dt} = \frac{kA}{l}\Delta T$$

Here, ΔT is same for both conductors, so ratio of heat conduction,

$$\frac{H_1}{H_2} = \frac{A_1}{l_1} \times \frac{l_2}{A_2}$$

$$= \frac{d_1^2}{l_1} \times \frac{l_2}{d_2^2} \qquad \left(\because A = \frac{\pi d^2}{4}\right)$$

$$= \left(\frac{d_1}{d_2}\right)^2 \cdot \frac{l_2}{l_1}$$

$$= \left(\frac{1}{2}\right)^2 \times \frac{1}{2} = \frac{1}{8}$$

48. (a) The air blown by mouth has same pressure as that of atmosphere, so it is an example of isobaric process.

49. (b) Longitudinal waves in air travels in the form as compression and rarefaction that changes its elastic properties. The air is a completely elastic medium, which does not have a modulus of rigidity. So, sound waves travel in it as a longitudinal wave.

50. (a) When an uncharged metal sphere is placed between two charged parallel plate capacitor, negative charge is induced on its upper side and on equal positive charge on its lower side. So, the lines of force enters the sphere normally as shown in figure of option (a).

51. (c) According to right hand rule, the thumb points in the direction of current, i.e. from East to West, then the curled fingers at a point above the conductor will point in the direction of magnetic field, i.e towards North.

52. (c) A bar magnet is equivalent to a solenoid carrying current as both produces similar magnetic field around them.

53. (c) The energy of nth state in hydrogen like atom,

$$E_n = -\frac{13.6Z^2}{n^2} \text{ eV}$$

The energy of first excitation,

$$E_2 - E_1 = \frac{-13.6 \times Z^2}{(2)^2} + \frac{13.6 \times Z^2}{(1)^2} = 40.8 \quad \text{(given)}$$

$$\Rightarrow \qquad Z^2 = \frac{40.8 \times 4}{13.6 \times 3} = 4$$

or $\qquad Z = 2$

$\therefore$ Energy needed to remove an electron from the ion in ground state, $E = -(E_1) = -\left[\dfrac{-13.6 \times (2)^2}{(1)^2}\right] = 54.4$ eV

54. (c) Given, $\mu_b = 1.67, \mu_y = 1.65, \mu_r = 1.63$

Dispersive power of material $= \dfrac{\mu_b - \mu_r}{\mu_y - 1}$

$$= \frac{1.67 - 1.63}{1.65 - 1} = \frac{0.04}{0.65} = 0.0615$$

55. (b) Given, $T_1 = 227°C = 227 + 273 = 500K$

$$T_2 = 127°C = 127 + 273 = 400K$$

Heat input, $H_i = 6 \times 10^4$ J

Efficiency of Carnot engine,

$$\eta = 1 - \frac{T_2}{T_1}$$

$$= 1 - \frac{400}{500} = \frac{1}{5}$$

Also, efficiency,

$$\eta = \frac{\text{Work output}}{\text{Heat input}} = \frac{W}{6 \times 10^4}$$

$$\Rightarrow \qquad W = \eta \times 6 \times 10^4 = \frac{1}{5} \times 6 \times 10^4$$

$$= 1.2 \times 10^4 \text{ J}$$

56. (d) For an ideal gas, $pV = nRT$

At constant temperature, $pV = $ constant.
So, pV does not vary with V and pV-V graph is a straight line parallel to V-axis as shown in option (d).

57. (d) The rainbow is formed in the sky after rain shower, due to tiny droplets of water which act as optical medium. When sunlight falls on them, it is totally internally reflected inside them and when comes out it got dispersed in its constituent colours. Thus, a rainbow is formed due to dispersion and total internal reflection.

58. (a) The focal length of the combination is given by

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

$f_1 = $ focal length of plano-convex lens $= f$
$f_2 = $ focal length of concave lens $= -f$

$$\therefore \quad \frac{1}{F} = \frac{1}{f} + \frac{1}{-f} = 0$$

$$\Rightarrow \quad F = \infty$$

Hence, focus shifts to infinity.

59. (d) Earth is a good conductor. So, when a body is earthed, electrons flow from earth to the body. It means, the body must be deficient of electrons i.e. it is positively charged.

60. (b) As it is a balanced Wheatstone bridge, so C and D are same potential and the capacitor $2\mu F$ is ineffective.
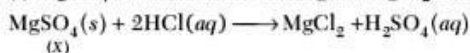
The $3\mu F$ and $6\mu F$ in upper portion are in series, so equivalent capacitance,
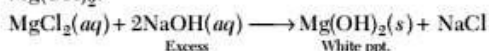
$$C_1 = \frac{3 \times 6}{3 + 6} = \frac{18}{9} = 2\mu F$$

Similarly, $C_2 = \frac{4 \times 8}{4 + 8} = \frac{32}{12} = \frac{8}{3}\mu F$

C_1 and C_2 are in parallel, so their equivalent capacitance

$$C = C_1 + C_2 = 2 + \frac{8}{3} = \frac{14}{3}\mu F$$

Chemistry

61. (c) $MgSO_4$ is soluble in HCl and gives $MgCl_2$ and H_2SO_4.

$$\underset{(x)}{MgSO_4}(s) + 2HCl(aq) \longrightarrow MgCl_2 + H_2SO_4(aq)$$

On adding NaOH to $MgCl_2$, it gives white ppt. of $Mg(OH)_2$.

$$\underset{Excess}{MgCl_2(aq) + 2NaOH(aq)} \longrightarrow \underset{White\ ppt.}{Mg(OH)_2(s)} + NaCl$$

62. (b) Mn is used to make alloy steel for armour plates, safes and helmets as Mn increases harden-ability by lowering transformation points and causing transformation to be sluggish.

63. (b) Iodoform test is given by compounds having,

$$\left(CH_3-\overset{\overset{O}{\|}}{C}- \right) \text{ or } \left(CH_3-\underset{\underset{OH}{|}}{CH}- \right) \text{ group.}$$
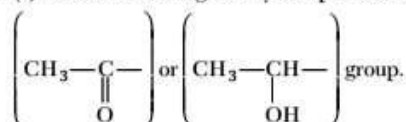
Thus, compound CH_3OH do not contain these groups. Hence, it do not give iodoform test.

64. (d) The gaseous carbon compound, methyl amine (CH_3NH_2) is soluble in dil. HCl and forms soluble hydrogen chloride salt solution.

This solution on treating with $NaNO_2$ gives nitrogen leaving behind a methanol solution with wood spirit smell.

65. (d) Benzyl chloride is more reactive than vinyl chloride as benzyl carbocation is stabilised by resonance. While, in vinyl chloride due to partial double bond character became of resonance, the C—Cl bond strength increases. Hence, reactivity of vinyl chloride decreases.

66. (a) As enthalpy of formation of HF is more negative, than that of HCl and HF is more stable than HCl. The bond strength of hydrogen with halogen decrease down the group due to increases in size.

67. (b) Equivalent of NaOH neutralised by HCl

$$= 100 \times 1 \times 10^{-3} = 0.1 \text{ mol}$$

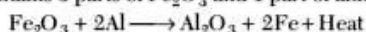$\therefore$ Heat released $= 57.3 \times 0.1 = 5.73$ kJ

68. (c) If $[A]$ double's then, $r_1 = 2r$

If $[B]$ increased 9 times then, $r_2 = 3r$

$\therefore$ Order w.r.t. A is 1 and order w.r.t B is $\frac{1}{2}$.

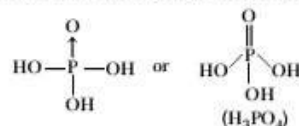$\therefore$ Order of reaction $= 1 + \frac{1}{2} = 1\frac{1}{2}$.

69. (c) In Goldschmidt aluminothermic process, thermite contains 3 parts of Fe_2O_3 and 1 part of aluminium (Al).

$$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe + Heat$$

70. (a) The structure of orthophosphoric acid is

$$HO-\overset{\overset{O}{\uparrow}}{\underset{\underset{OH}{|}}{P}}-OH \quad \text{or} \quad \underset{(H_3PO_4)}{HO-\overset{\overset{O}{\|}}{\underset{\underset{OH}{|}}{P}}-OH}$$

71. (d) At anode, oxidation occurs of H_2(gas), while at cathode reduction of AgCl take place.

$\therefore$ The cell notation is

$Pt \mid H_2(g), HCl(sol) \parallel AgCl(s) \mid Ag$
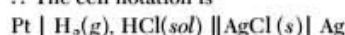
72. (c) If current is same then,

E_{wt} of Ag $= E_{wt}$ of H_2

$$\frac{1.08}{108} = \frac{x}{1}$$

$\therefore$ Mass of H_2, $x = 10^{-2}$ g

2g of H_2 at STP occupy 22400 cm^3

$\therefore$ 10^{-2} g of H_2 at STP occupy

$$= \frac{22400}{2} \times 10^{-2} \text{ cm}^3 = 112 \text{ cm}^3$$

73. (d) The flame colours of metal ions are due to metal excess defect. The free electrons can be exited to higher energy levels giving absorption spectra and as a consequence their compounds are coloured.

74. (a) The order of reaction of methyl halides increases from fluorine to iodine due to decrease in C—X bond strength.

$\therefore$ The order of reactivities of methyl halides in formation of Grignard reagent is

$$CH_3I > CH_3Br > CH_3Cl$$
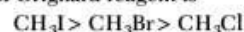
75. (d) Formaldehyde on reaction with ammonia gives urotropine which on nitration gives RDX.

$$Formaldehyde + NH_3 \longrightarrow Urotropine$$

$$\downarrow Nitration$$

Cyclo trimethylene-tri nitramine (RDX)
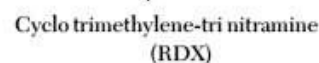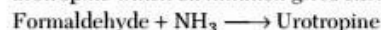
76. (d) Number of carbon atoms

$$= \frac{mass}{molar\ mass} \times 6.023 \times 10^{23}$$

$$= \frac{10^{-3}}{12} \times 6.023 \times 10^{23}$$

$$= 5.02 \times 10^{19} = 0.502 \times 10^{20}$$

77. (a) Distance travelled by gas is directly proportional to rate of diffusion

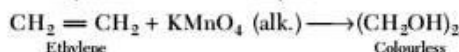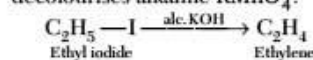$$\therefore \quad r_{NH_3}(l_1) \propto \frac{1}{\sqrt{M_{NH_3}}} \propto \frac{1}{\sqrt{17}}$$

$$r_{HCl}(l_2) \propto \frac{1}{\sqrt{M_{HCl}}} \propto \frac{1}{\sqrt{36.5}}$$

$$\because \quad r_{NH_3} > r_{HCl}$$

$\therefore$ Length travelled by NH_3 is greater than HCl.
Hence, white ring of NH_4Cl is formed nearer to HCl end.

78. (d) By the action of alc. KOH on ethyl iodide, ethylene gas is formed by elimination reaction. Ethylene decolourises alkaline $KMnO_4$.

$$\underset{\text{Ethyl iodide}}{C_2H_5-I} \xrightarrow{\text{alc. KOH}} \underset{\text{Ethylene}}{C_2H_4}$$

$$\underset{\text{Ethylene}}{CH_2 = CH_2} + KMnO_4 \text{ (alk.)} \longrightarrow \underset{\text{Colourless}}{(CH_2OH)_2}$$
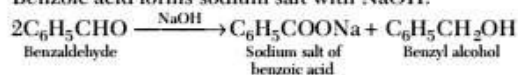
79. (c) Chemisorption is highly specific and will not form if there is no possibility of chemical bonding between adsorbent and adsorbate.

$\therefore$ Chemisorption doesn't form multimolecular layer and hence, option (c) is incorrect.

80. (d) The concentration of electrolyte required to coagulate a given amount of As_2S_3 sol is minimum in case of aluminium nitrate.

As_2S_3 is negatively charge sol. In aluminium nitrate, the charge on Al cation is + 3 which is maximum among given cations. Hence, its coagulating power is maximum.

81. (d) Benzaldehyde lacks α-H atom. On heating with strong NaOH solution, it undergoes Cannizzaro reaction to produce benzoic acid and benzyl alcohol. Benzoic acid forms sodium salt with NaOH.

$$\underset{\text{Benzaldehyde}}{2C_6H_5CHO} \xrightarrow{\text{NaOH}} \underset{\substack{\text{Sodium salt of} \\ \text{benzoic acid}}}{C_6H_5COONa} + \underset{\text{Benzyl alcohol}}{C_6H_5CH_2OH}$$

82. (a) The process by which synthesis of protein takes place based on the genetic information present in m-RNA is called translation.

83. (b) $\Delta H_{\text{Reaction}} = (\Delta H_f)_{\text{Product}} - (\Delta H_f)_{\text{Reactant}}$

$$= -1596 - (-1134) = -462 \text{ kJ}$$

84. (d) For the reaction

$$A + B \rightleftharpoons 2C + D + Q$$
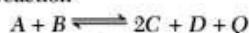
As the reaction is exothermic, low temperature favours formed direction according to Le-Chatelier's principle.
Also $\Delta n_{(g)} = (2+1) - (1+1) = 1$

$\because \quad \Delta n_g = +\text{ve}$
(low pressure favours forward direction)

$\therefore$ Low pressure and temperature favours formed direction for the reaction.

85. (a) For every 10°C rise in temperature, rate increase by 2 times i.e.,

$$r_1 = 2^n r$$

where, $n = \dfrac{\Delta t}{10} = \dfrac{100 - 30}{10} = 7$

$\therefore \quad r_1 = 2^7 r \implies r_1 = 128r$

86. (b) Moles of HCl $= \dfrac{1}{2} \times V \qquad \left\{ \dfrac{N}{2} \text{ HCl} \right\}$

For preparing $\dfrac{N}{10}$ solution,

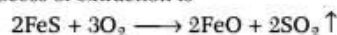$$\frac{1}{10} = \frac{\frac{1}{2} \times V}{500}$$

$$\therefore \quad V = \frac{1000}{10} = 100 \text{ cm}^3$$

87. (c) Equivalent weight $= \dfrac{\text{molecular weight}}{\text{valence factor}}$

$\therefore$ Molecular weight $= 20 \times 3 = 60$
It's oxide is M_2O_3 and molecular weight
$$= 2 \times 60 + 16 \times 3 = 120 + 48 = 168$$

88. (a) The reaction that doesn't take place during the smelting process of extraction is

$$2FeS + 3O_2 \longrightarrow 2FeO + 2SO_2 \uparrow$$

This reaction occurs during roasting, which comes before smelting.

89. (a) In $K_4[Fe(CN)_6]$, the central metal atom obeys EAN rule.
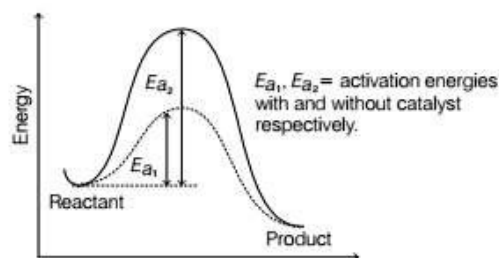EAN $= Z - X + Y = 26 - 2 + 12 = 36$
where,
$Z =$ atomic number
$X =$ number of electrons lost, while forming metal ion.
$Y =$ number of electron donated by ligands.

90. (c) In a reversible reaction, the catalyst decreases the activation energy of both, forward and backward reaction.

$E_{a_1}, E_{a_2} =$ activation energies with and without catalyst respectively.

91. (d) $K_{sp} = [A][B]$

$$10^{-8} = 10^{-3}[B]$$
$$[B] = 10^{-5} \text{ M}$$

$\therefore$ Salt will precipitate when $[B] > 10^{-5}$

92. (b) For reaction to be spontaneous, $E^\circ_{\text{cell}} > 0$

For option (b),
$$E^\circ_{\text{cell}} = (E^\circ_{\text{red}})_{\text{Cathode}} - (E^\circ_{\text{red}})_{\text{Anode}}$$
$$= 0.80 - (-0.76) = 1.56 \text{ V}$$

$\therefore$ It will be spontaneous reaction

$\because E^\circ_{\text{cell}} > 0$.

93. *(b)* When the radius ratio is between 0.732-1.000, the coordination number is 8 and arrangement is body centered cubic (bcc) packing.

94. *(a)* Dacron is obtained by the condensation polymerisation of ethylene glycol and terephthalic acid.
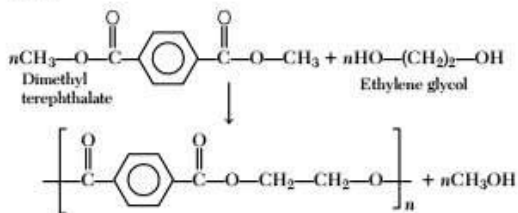
95. *(d)* 4-chloro-3, 5-dimethyl phenol is called dettol. It is a well known antiseptic. It's structure is
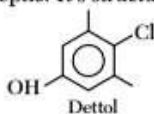

96. *(a)*

	Methane	Ethene	Ethyne
Hydrocarbon	CH_4	C_2H_4	C_2H_2
Hybridisation	sp^3	sp^2	sp
% s-character	25	33	50

97. *(d)* In the manufacture of sulphuric acid by contact process, Tyndall box is used to test the presence of dust particles.

98. *(d)* Aspirin is an acidic compound. It will not dissociate in acidic medium i.e., small intestine in order to react with base but will dissociate in basic medium.

99. *(d)* $^{232}_{90}Th \longrightarrow \, ^{208}_{82}Pb + n\alpha + m\beta$
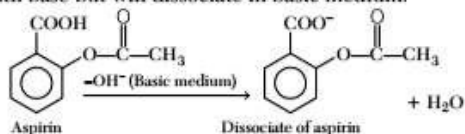
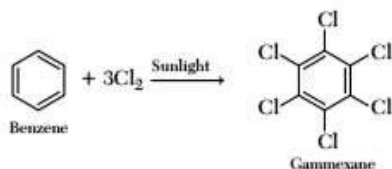Number of α-particles, $n = \dfrac{232-208}{4} = 6$
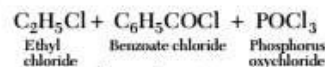
Now, for charge balanced

$90 = 82 + 2n - m$

$m = 4$

Number of β-particles, $m = 4$

100. *(c)* When chlorine is passed through warm benzene in presence of sunlight, the product obtained is gammexane.

101. *(b)* Ethyl benzoate reacts with PCl_5 to give C_2H_5Cl, C_6H_5COCl and $POCl_3$.

$$\underset{\text{Ethyl benzoate}}{C_6H_5COOCH_2CH_3} + PCl_5 \longrightarrow$$

$$\underset{\substack{\text{Ethyl}\\\text{chloride}}}{C_2H_5Cl} + \underset{\text{Benzoate chloride}}{C_6H_5COCl} + \underset{\substack{\text{Phosphorus}\\\text{oxychloride}}}{POCl_3}$$

102. *(a)* The statement that, sodium aluminium silicate is used in softening of hard water is not relevant with colloids.

It is a substitution reaction of calcium salts with zeolite.

103. *(c)*

$$\frac{dN}{dt} = \lambda N$$

$$\frac{dN}{dt} = \frac{1}{T} \frac{6.023 \times 10^{23}}{12} \qquad \left\{ \because \lambda = \frac{1}{T} \right\}$$

$$T = \frac{6.023 \times 10^{23}}{12 \times 1.18 \times 10^{13}} \quad \left\{ \frac{dN}{dt} = 1.18 \times 10^{13} \right\}$$

$$= 42530 \times 10^6 \text{ min}$$

$$= \frac{4253 \times 10^6}{60 \times 24 \times 365} \text{ years}$$

$$= 8092 \text{ years}$$

$$\approx 8100 \text{ years}$$

104. *(a)* $K_p = K_C(RT)^{\Delta n}$

If Δn is positive than $K_p > K_C$ also,

gaseous moles of product > moles of reactant.

$\therefore$ Forward reaction is favoured by low pressure, according to Le-Chatelier's principle.

105. *(d)* In a lime kiln, to get higher yield of CO_2, the measure that can be taken is to pump out CO_2. This will reduce the pressure of CO_2 and reaction will shift in forward direction.
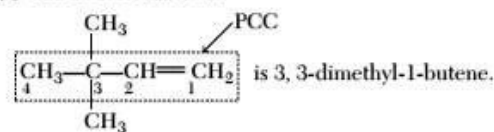
$$CaCO_3 \xrightarrow{\text{Heat}} CaO + CO_2$$

106. *(a)* 20 volume of H_2O_2 means that, 1 L of H_2O_2 on decomposition gives 20 L of oxygen.

$\therefore$ 5 L of oxygen will be obtained from

$$= \frac{5}{20} \times 1 = 0.250 \text{ L of } H_2O_2$$

or $= 250 \text{ cm}^3 \text{ of 20 volume } H_2O_2.$

107. *(d)* The IUPAC name of

is 3, 3-dimethyl-1-butene.

108. *(b)* The process of hardening of iron rods of railway wagon axles embedded in charcoal powder is known as case-hardening. In this process surface of iron rods get hardened by depositing a layer of steel on its surface.

109. (b) Thomas slag is tetracalcium phosphorus nonaoxide. It's molecular formula is $Ca_3(PO_4)_2$.

110. (d) Urea is preferred to ammonium sulphate as a nitrogenous fertiliser because it does not cause acidity in the soil.

111. (c) Pressure in the cylinder is directly proportional to the number of moles of gases.

$$44 \text{ g of } H_2 \text{ has} = \frac{44}{2} = 22 \text{ moles of } H_2$$

$$44 \text{ g of } CO_2 \text{ has} = \frac{44}{44} = 1 \text{ mole of } H_2$$

$$\therefore \text{ Pressure of } H_2 (p_{H_2}) = \frac{22}{1} \times 1 = 22 \text{ atm.}$$

112. (a) According to Bohr's model, angular momentum of nth orbit of hydrogen atom is mvr_n or $\frac{nh}{2\pi}$.

**113.** (a) Electronic configuration of atomic number 36

$$= 1s^2, 2s^2, 2p^6, 3s^2 3p^6 3d^{10} 4s^2 4p^6$$

As the last electrons is filled in p-orbital, so it belongs to p-block in periodic table.

114. (d) The function of $AlCl_3$ in Friedel-Craft's reaction is to produce electrophile.
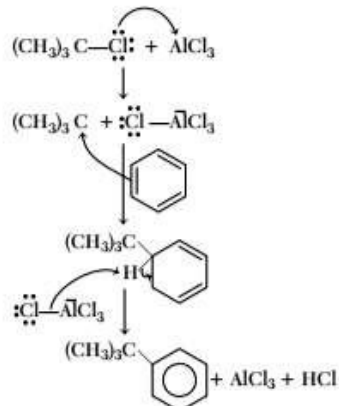
115. (a) An important reaction of acetone is auto-condensation in presence of concentrated sulphuric acid to give the aromatic compound mesitylene.
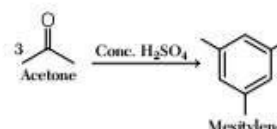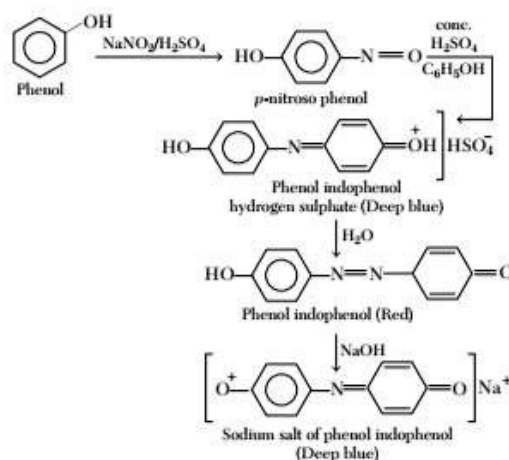

116. (a) Kinetic energy $= \frac{3}{2} RT$

$$= \frac{3}{2} \times 8.314 \times 300$$

$$= 3741.3 \text{ J} = 3.74 \text{ kJ}$$

117. (a) The tripeptide hormone present in most living cell is glutathione.

The three amino acids present are glutamic acid, cysteine and glycine.

118. (a) The given reaction is Liebermann's reaction. It is test for phenol.

119. (a) Energy is stored in our body in the form of ATP (Adeniotriphosphate). The stored energy is released by the breakdown of ATP. The released energy is used by muscles and other parts of body.

120. (d) Molisch's test is used to detect all kinds of carbohydrates. The Benedict test identifies reducing sugars (mono saccharides and some disaccharides) which have free ketone or aldehyde functional group.

Scliwanoff's test is used for detection of fructose or keto group in sugar solution. Therefore, give negative test for maltose.

Hence, organic compound is maltose.

Mathematics

121. (d)

p	q	$\sim p$	$\sim p \wedge q$	$p \to q$	$q \to p$	$\sim(p \to q)$	$\sim(q \to p)$
T	T	F	F	T	T	F	F
T	F	F	F	F	T	T	F
F	T	T	T	T	F	F	T
F	F	T	F	T	T	F	F

From table,
$$\sim p \wedge q \cong \sim(q \to p)$$

122. (b) Let p : A number is a prime.

q : A number is odd.

The given proposition is $p \to q$

Now, inverse of $(p \to q)$ is $\sim p \to \sim q$

Therefore, the inverse of the given proposition is 'If a number is not a prime, then it is not odd.'

123. (a) We have,
$$2X + \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} = \begin{bmatrix} 3 & 8 \\ 7 & 2 \end{bmatrix}$$
$$\Rightarrow \qquad 2X = \begin{bmatrix} 3 & 8 \\ 7 & 2 \end{bmatrix} - \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$
$$\Rightarrow \qquad 2X = \begin{bmatrix} 2 & 6 \\ 4 & -2 \end{bmatrix}$$
$$\Rightarrow \qquad X = \frac{1}{2}\begin{bmatrix} 2 & 6 \\ 4 & -2 \end{bmatrix} = \begin{bmatrix} 1 & 3 \\ 2 & -1 \end{bmatrix}$$

124. (c) We have, $\begin{vmatrix} 1 & 1 & 1 \\ bc & ca & ab \\ b+c & c+a & a+b \end{vmatrix}$

On applying $C_1 \to C_1 - C_2, C_2 \to C_2 - C_3$, we get
$$\begin{vmatrix} 0 & 0 & 1 \\ -c(a-b) & -a(b-c) & ab \\ -(a-b) & -(b-c) & a+b \end{vmatrix}$$

Taking common $(a-b), (b-c)$ from C_1, C_2 respectively, we get
$$(a-b)(b-c)\begin{vmatrix} 0 & 0 & 1 \\ -c & -a & ab \\ -1 & -1 & a+b \end{vmatrix}$$

On expanding along R_1, we get
$$(a-b)(b-c)\cdot 1\,(c-a)$$
$$= (a-b)(b-c)(c-a)$$

125. (b) We have,
$$\begin{vmatrix} 441 & 442 & 443 \\ 445 & 446 & 447 \\ 449 & 450 & 451 \end{vmatrix}$$

On applying, $C_1 \to C_1 - C_2, C_2 \to C_2 - C_3$, we get
$$\begin{vmatrix} -1 & -1 & 443 \\ -1 & -1 & 447 \\ -1 & -1 & 451 \end{vmatrix} = 0 \qquad [\because C_1 \text{ and } C_2 \text{ are identical}]$$

126. (a) Let $\mathbf{a} = x\hat{i} + y\hat{j} + z\hat{k}$, then
$$(\mathbf{a}\cdot\hat{i}) + (\mathbf{a}\cdot\hat{j})\hat{j} + (\mathbf{a}\cdot\hat{k})\hat{k}$$
$$= [(x\hat{i} + y\hat{j} + z\hat{k}\cdot\hat{i}]\cdot\hat{i} + [(x\hat{i} + y\hat{j} + z\hat{k})\cdot\hat{j}]\hat{j} +$$
$$[(x\hat{i} + y\hat{j} + z\hat{k})\cdot\hat{k}]\,\hat{k}$$
$$= (x)\hat{i} + (y)\hat{j} + (z)\hat{k} = x\hat{i} + y\hat{i} + \hat{k} = \mathbf{a}$$

127. (d) Let $A = \begin{bmatrix} \cos 2\theta & -\sin 2\theta \\ \sin 2\theta & \cos 2\theta \end{bmatrix}$

Now, $|A| = \begin{vmatrix} \cos 2\theta & -\sin 2\theta \\ \sin 2\theta & \cos 2\theta \end{vmatrix}$
$$= \cos^2 2\theta - (-\sin^2 2\theta)$$
$$= \cos^2 2\theta + \sin^2 2\theta = 1$$

Again, $A^{-1} = \frac{1}{|A|}\begin{vmatrix} \cos 2\theta & \sin 2\theta \\ -\sin 2\theta & \cos 2\theta \end{vmatrix}$

$$\left[\because \begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{ad - bc}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}\right]$$

$$= \begin{bmatrix} \cos 2\theta & \sin 2\theta \\ -\sin 2\theta & \cos 2\theta \end{bmatrix}$$

128. (b) Since, $(\mathbf{a} + \lambda\mathbf{b}) \perp (\mathbf{a} - \lambda\mathbf{b})$, then
$$(\mathbf{a} + \lambda\mathbf{b})\cdot(\mathbf{a} - \lambda\mathbf{b}) = 0$$
$$\Rightarrow \qquad |\mathbf{a}|^2 - \lambda^2|\mathbf{b}|^2 = 0 \quad \Rightarrow \quad |\mathbf{a}^2| = \lambda^2|\mathbf{b}|^2$$
$$\Rightarrow \qquad \lambda = \frac{|\mathbf{a}|}{|\mathbf{b}|} = \frac{3}{4}$$

129. (b) We have,
$$\mathbf{a} = 2\hat{i} + 3\hat{j} - 2\hat{k}, \ \mathbf{b} = \hat{i} + 2\hat{j} + 3\hat{k}$$

Now,
$$\mathbf{a}\cdot\mathbf{b} = (2\hat{i} + 3\hat{j} - 2\hat{k})\cdot(\hat{i} + 2\hat{j} + 3\hat{k})$$
$$= 2 + 6 - 6 = 2$$
and
$$|\mathbf{b}| = \sqrt{(1)^2 + (2)^2 + (3)^2}$$
$$= \sqrt{1 + 4 + 9} = \sqrt{14}$$

$\therefore$ Projection of $\mathbf{a}$ on $\mathbf{b} = \frac{\mathbf{a}\cdot\mathbf{b}}{|\mathbf{b}|} = \frac{2}{\sqrt{14}}$

130. (c) We have,
$$2 \times 4 = 1(\bmod 7)$$
Hence, $\qquad 2^{-1} = 4(\bmod 7)$
Now, $\qquad 2^{-1} \times 4 = 4 \times 4 = 16$
Now, $\qquad 16 = (2 \times 7) + 2$
$\therefore \qquad 16 = 2(\bmod 7)$
$\Rightarrow \qquad 2^{-1} \times 4 = 2(\bmod 7)$

131. (d) We know that,

$$a\sin x + b\cos x \le \sqrt{a^2 + b^2}$$

$$\therefore\ 3\cos x - 4\sin x \le \sqrt{(-4)^2 + (3)^2} = \sqrt{16 + 9} = 5$$

∴ Maximum value is 5.

132. (c) We have,

$$S = t^3 - 3t^2$$

$$\Rightarrow \frac{dS}{dt} = 3t^2 - 6t \text{ and } \frac{d^2S}{dt^2} = 6t - 6$$

Now, acceleration, $\dfrac{d^2S}{dt^2} = 0$

$$\Rightarrow\ 6t - 6 = 0$$

$$\Rightarrow\ t = 1$$

$$\therefore \text{Velocity} = \frac{dS}{dt}\Big|_{t=1}$$

$$= 3(1)^2 - 6(1) = 3 - 6 = -3 \text{ m/sec}$$

133. (b) We have,

$$y^n = a^{n-1}x$$

$$\Rightarrow\quad n\cdot y^{n-1}\frac{dy}{dx} = a^{n-1}$$

$$\Rightarrow\quad y^{n-1}\frac{dy}{dx} = \frac{1}{n}a^{n-1}$$

$$\Rightarrow\quad \frac{dy}{dx} = \frac{1}{n}a^{n-1}y^{1-n}$$

$$\therefore \text{ Length of the subnormal} = \left| y\frac{dy}{dx}\right|$$

$$= \left| y \times \frac{1}{n}a^{n-1}y^{1-n}\right|$$

$$= \left| \frac{1}{n}a^{n-1}y^{2-n}\right|$$

Since, length of subnormal is constant.

$$\therefore\quad 2 - n = 0$$

$$\Rightarrow\quad n = 2$$

134. (a) We have,

$$x = A\cos 4t + B\sin 4t$$

$$\Rightarrow \frac{dx}{dt} = A(-\sin 4t \cdot 4) + B(\cos 4t \cdot 4)$$

$$= -4A\sin 4t + 4B\cos 4t$$

Again,

$$\frac{d^2x}{dt^2} = -4A(\cos 4t \cdot 4) + 4B(-\sin 4t \cdot 4)$$

$$= -16A\cos 4t - 16B\sin 4t$$

$$= -16[A\cos 4t + B\sin 4t] = -16x$$

135. (c) We have,

$$x = at^2,\ y = 2at$$

Now,$$\quad \frac{dx}{dt} = 2at,\ \frac{dy}{dt} = 2a$$

$$\therefore\quad \frac{dy}{dx} = \frac{dy/dt}{dx/dt} = \frac{2a}{2at} = \frac{1}{t}$$

Since, tangent is perpendicular to X-axis, then

$$\frac{dy}{dx} = \frac{1}{0}$$

$$\Rightarrow\quad \frac{1}{t} = \frac{1}{0} \Rightarrow t = 0$$

$$\therefore\quad x = at^2 = 0 \text{ and } y = 2at = 0$$

So, required point is (0, 0).

136. (b) We have,

$$\frac{dy}{dx} + \frac{1 + \cos 2y}{1 - \cos 2x} = 0$$

$$\Rightarrow\quad \frac{dy}{dx} = -\left(\frac{1 + \cos 2y}{1 - \cos 2x}\right)$$

$$\Rightarrow\quad \frac{dy}{dx} = -\frac{2\cos^2 y}{2\sin^2 x}$$

$$\Rightarrow\quad \sec^2 y\, dy = -\csc^2 x\, dx$$

$$\Rightarrow\ \int \sec^2 y\, dy + \int \csc^2 x\, dx = 0$$
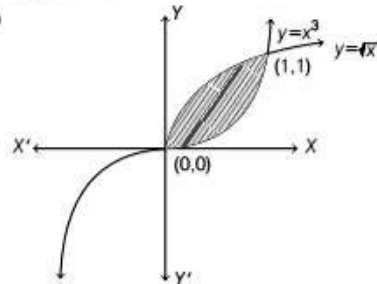
$$\Rightarrow\ \tan y - \cot x = c$$

137. (b) We have,

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

$$\Rightarrow\quad \left(1 + \left(\frac{dy}{dx}\right)^2\right)^9 = \left(\frac{d^2y}{dx^3}\right)^4$$

∴ Degree = 4

138. (c)

Required area $= \displaystyle\int_0^1 (\sqrt{x} - x^3)\, dx$

$$= \left[\frac{2x^{3/2}}{3} - \frac{x^4}{4}\right]_0^1$$

$$= \frac{2}{3} - \frac{1}{4} = \frac{5}{12}$$

139. (d) Let

$$I = \int_0^{\pi/8} \cos^3 4\theta\, d\theta = \int_0^{\pi/8} \frac{\cos 12\theta + 3\cos 4\theta}{4}\, d\theta$$

$$= \frac{1}{4}\left[\frac{\sin 12\theta}{12} + \frac{3\sin 4\theta}{4}\right]_0^{\pi/8} = \frac{1}{4}\left[\frac{1}{12}\sin\frac{3\pi}{2} + \frac{3}{4}\sin\frac{\pi}{2}\right]$$

$$= \frac{1}{4}\left[-\frac{1}{12} + \frac{3}{4}\right] = \frac{1}{4}\left(\frac{-1+9}{12}\right) = \frac{8}{4\times 12} = \frac{1}{6}$$

140. (a) Let $I = \int_0^{\pi/2} \dfrac{\cos x - \sin x}{1 + \cos x \sin x}\, dx$ ... (i)

$$= \int_0^{\pi/2} \dfrac{\cos\left(\dfrac{\pi}{2} - x\right) - \sin\left(\dfrac{\pi}{2} - x\right)}{1 + \cos\left(\dfrac{\pi}{2} - x\right) \sin\left(\dfrac{\pi}{2} - x\right)}\, dx$$

$$\left[\because \int_0^a f(x)\, dx = \int_0^a f(a - x)\, dx\right]$$

$$\therefore \quad I = \int_0^{\pi/2} \dfrac{\sin x - \cos x}{1 + \sin x \cos x}\, dx \quad \text{... (ii)}$$

On adding Eqs. (i) and (ii), we get
$$2I = 0 \implies I = 0$$

141. (b) $ax^2 - y^2 + 4x - y = 0$ represents a pair of straight line, if

$$\begin{vmatrix} a & 0 & 2 \\ 0 & -1 & -1/2 \\ 2 & -1/2 & 0 \end{vmatrix} = 0$$

$$\implies \quad a\left(0 - \dfrac{1}{4}\right) + 2(0 + 2) = 0$$

$$\implies \quad -\dfrac{a}{4} + 4 = 0$$

$$\implies \quad a = 16$$

142. (b) Let the required point be $P(x, y)$. Then,
$$4|y| = (\sqrt{(x - 0)^2 + (y - 0)^2})^2$$
$$\implies \quad 4|y| = x^2 + y^2$$
$$\implies x^2 + y^2 - 4|y| = 0$$

143. (c) Let the equation of line be
$$x + y = a \qquad [\because a = b]$$
Now, given line passes through $(2, 4)$, then
$$2 + 4 = a$$
$$\implies \quad a = 6$$
$\therefore$ Equation of line is $x + y - 6 = 0$

144. (c) We have,
$$\dfrac{1}{2}\begin{vmatrix} x & 0 & 1 \\ 1 & 1 & 1 \\ 0 & 2 & 1 \end{vmatrix} = \pm 4$$
$$\implies \quad x(1 - 2) + 1(2 - 0) = \pm 8$$
$$\implies \quad -x + 2 = \pm 8$$
$$\implies \quad x = 2 \pm 8 \implies x = 10, -6$$

145. (c) We have,
$$\lim_{\theta \to \frac{\pi}{2}} \dfrac{\dfrac{\pi}{2} - \theta}{\cot\theta} = \lim_{\theta \to \frac{\pi}{2}} \dfrac{-1}{-\csc^2\theta} \quad \text{[using L' Hospital Rule]}$$
$$\implies \quad \lim_{\theta \to \frac{\pi}{2}} \sin^2\theta = \sin^2\dfrac{\pi}{2} = 1$$

146. (a) The equation $x^2 + y^2 + 2gx + c = 0$ represents co-axial system of circle having centre at $(-g, 0)$ and radius $= \sqrt{g^2 - c}$.

As $c < 0$, radius is always greater than 0. So, it has imaginary limiting points which show that circles are intersecting.

147. (d) We have, diameters of circle are
$$x + y = 6 \text{ and } x + 2y = 4$$
On solving above equations, we get
$$x = 8 \text{ and } y = -2$$
$\therefore$ Centre of circle is $(8, -2)$.
Since, circle passes through $(6, 2)$.
$$\therefore \text{Radius} = \sqrt{(8 - 6)^2 + (-2 - 2)^2} = \sqrt{4 + 16} = \sqrt{20}$$

148. (a) The vertex and focus of the parabola are $(0, 6)$ and $(0, 3)$ respectively.
Clearly, axis is Y-axis.
$\therefore$ Latusrectum $= 4$ (Distance between vertex and focus)
$$= 4\sqrt{(0 - 0)^2 + (6 - 3)^2} = 12$$
Also, the vertex is on the right hand side of the focus, so the parabola opens downward.
Hence, equation of the parabola is
$$(x - 0)^2 = -12(y - 6)$$
$$\implies \quad x^2 = -12y + 72$$
$$\implies \quad x^2 + 12y = 72$$

149. (c) We have,
$$25x^2 + 9y^2 - 150x - 90y + 225 = 0$$
$$\implies 25(x^2 - 6x) + 9(y^2 - 10y) + 225 = 0$$
$$\implies 25[(x - 3)^2 - 9] + 9[(y - 5)^2 - 25] + 225 = 0$$
$$\implies 25(x - 3)^2 - 225 + 9(y - 5)^2 - 225 + 225 = 0$$
$$\implies \quad 25(x - 3)^2 + 9(y - 5)^2 = 225$$
$$\implies \quad \dfrac{(x - 3)^2}{9} + \dfrac{(y - 5)^2}{25} = 1$$
On comparing with $\dfrac{(x - h)^2}{a^2} + \dfrac{(y - k)^2}{b^2} = 1$, we have
$$a = 3, b = 5$$
$$\therefore \text{Eccentricity}, e = \sqrt{1 - \dfrac{a^2}{b^2}} = \sqrt{1 - \dfrac{9}{25}} = \dfrac{4}{5}$$

150. (b) The equation of the ellipse is $\dfrac{x^2}{16} + \dfrac{y^2}{b^2} = 1$ and equation of the hyperbola is $\dfrac{x^2}{144} - \dfrac{y^2}{81} = \dfrac{1}{25}$ or
$$\dfrac{x^2}{\left(\dfrac{12}{5}\right)^2} - \dfrac{y}{\left(\dfrac{9}{5}\right)^2} = 1$$
$\therefore$ Eccentricity of ellipse, $e = \sqrt{1 - \dfrac{b^2}{16}}$

and eccentricity of hyperbola,

$$e' = \sqrt{1 + \frac{\left(\frac{9}{5}\right)^2}{\left(\frac{12}{5}\right)^2}} = \sqrt{1 + \frac{81}{144}} = \frac{15}{12}$$

Since, foci of ellipse and hyperbola coincide.

$$\therefore \quad 4e = \frac{12}{5}e'$$

$$\Rightarrow \quad e = \frac{3}{5}e'$$

$$\Rightarrow \quad \sqrt{1 - \frac{b^2}{16}} = \frac{3}{5} \times \frac{15}{12}$$

$$\Rightarrow \quad 1 - \frac{b^2}{16} = \left(\frac{3}{4}\right)^2 \Rightarrow b^2 = 7$$

151. *(b)* We have,

$$f(x) = \log x$$

$$\therefore \quad f(\sin x) = \log \sin x$$

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

$$\frac{d}{dx} f(\sin x) = \frac{1}{\sin x} \cdot \cos x = \cot x$$

152. *(a)* We have,

$$f(x) = \begin{cases} \dfrac{1 - \cos x}{x}, & x \neq 0 \\ k, & x = 0 \end{cases}$$

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

$$\therefore \quad f(0) = \lim_{x \to 0} f(x)$$

$$\Rightarrow \quad k = \lim_{x \to 0} \frac{1 - \cos x}{x}$$

$$\Rightarrow \quad k = \lim_{x \to 0} \frac{2\sin^2(x/2)}{x}$$

$$\Rightarrow \quad k = \lim_{x \to 0} \frac{\sin(x/2)}{(x/2)} \times \sin(x/2)$$

$$\Rightarrow \quad k = 1 \times 0$$

$$\Rightarrow \quad k = 0$$

153. *(c)* We have,

$$(3 + \omega + 3\omega^2)^4$$

$$= (3 + 3\omega + 3\omega^2 - 2\omega)^4$$

$$= [3(1 + \omega + \omega^2) - 2\omega]^4$$

$$= (3 \times 0 - 2\omega)^4$$

$$\quad [\because 1 + \omega + \omega^2 = 0 \text{ or } \omega^3 = 1]$$

$$= (-2\omega)^4 = 16\,\omega^4$$

$$= 16\omega \qquad [\because \omega^4 = \omega^3 \cdot \omega = \omega]$$

154. *(d)* We have,

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

$$y = \tan^{-1}\left[\frac{1 - \sin x}{\cos x}\right]$$

$$= \tan^{-1}\left[\frac{1 - \cos\left(\frac{\pi}{2} - x\right)}{\sin\left(\frac{\pi}{2} - x\right)}\right]$$

$$= \tan^{-1}\left[\frac{2\sin^2\left(\frac{\pi}{4} - \frac{x}{2}\right)}{2\sin\left(\frac{\pi}{4} - \frac{x}{2}\right)\cos\left(\frac{\pi}{4} - \frac{x}{2}\right)}\right]$$

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

$$\therefore \quad \frac{dy}{dx} = -\frac{1}{2}$$

155. *(d)* We have,

$$x + \frac{1}{x} = 2\cos\alpha$$

$$\Rightarrow \quad x^2 + 1 = 2x\cos\alpha$$

$$\Rightarrow \quad x^2 - (2\cos\alpha)x + 1 = 0$$

$$\Rightarrow \quad x = \frac{2\cos\alpha \pm \sqrt{4\cos^2\alpha - 4}}{2}$$

$$= \frac{2\cos\alpha \pm \sqrt{-4\sin^2\alpha}}{2}$$

$$= \frac{2\cos\alpha \pm 2(\sin\alpha)i}{2} = \cos\alpha \pm (\sin\alpha)i$$

Now, $x^n = (\cos\alpha \pm (\sin\alpha)i)^n = \cos n\alpha \pm i\sin n\alpha$

and $\dfrac{1}{x^n} = (\cos\alpha \pm (\sin\alpha)i)^{-n} = \cos n\alpha \mp i\sin n\alpha$

$$\therefore x^n + \frac{1}{x^n} = (\cos n\alpha \pm i\sin n\alpha) + (\cos n\alpha \mp i\sin n\alpha)$$

$$= 2\cos n\alpha$$

156. *(c)* Let $I = \displaystyle\int_{-1}^{1} |1 - x|\, dx$

$$= \int_{-1}^{1}(1 - x)\, dx \qquad \left[\because |x| = \begin{cases} -x, & x < 0 \\ x, & x \geq 0 \end{cases}\right]$$

$$= \left[x - \frac{x^2}{2}\right]_{-1}^{1} = \left(1 - \frac{1}{2}\right) - \left(-1 - \frac{1}{2}\right) = \frac{1}{2} + \frac{3}{2} = 2$$

157. *(b)* Let $I = \displaystyle\int \frac{1}{x(x^7 + 1)}\, dx$

$$= \int \frac{x^6}{x^7(x^7 + 1)}\, dx$$

Put $x^7 = t \Rightarrow 7x^6\, dx = dt$

$$\therefore \quad I = \frac{1}{7}\int \frac{d}{t(t + 1)} = \frac{1}{7}\int\left(\frac{1}{t} - \frac{1}{t + 1}\right)dt$$

$$= \frac{1}{7}[\log t - \log(t + 1)] + c$$

$$= \frac{1}{7}\log\left(\frac{t}{t + 1}\right) + c = \frac{1}{7}\log\left(\frac{x^7}{x^7 + 1}\right) + c$$

158. (b) Let $I = \int \sqrt{x} \, e^{\sqrt{x}} \, dx$

Put $\sqrt{x} = t \Rightarrow x = t^2 \Rightarrow dx = 2t \, dt$

$\therefore I = 2\int \underset{I}{t^2} \underset{II}{e^t} \, dt$

$= 2[t^2 e^t - \int e^t \cdot 2t \, dt]$

$= 2[t^2 e^t - 2\int t e^t \, dt]$

$= 2[t^2 e^t - 2(\underset{I}{t} \underset{II}{e}^t - \int e^t \cdot 1 \, dt)]$

$= 2[t^2 e^t - 2t e^t + 2e^t] + c$

$= (2t^2 - 4t + 4)e^t + c$

$= (2x - 4\sqrt{x} + 4) \, e^{\sqrt{x}} + c$

159. (d) Let $I = \int \dfrac{dx}{x^2 + 2x + 2}$

$= \int \dfrac{dx}{(x+1)^2 + 1} = \tan^{-1}(x+1) + c$

160. (a) Let $P(x_1, y_1)$ be the required point. The given curve is

$$y = 6x - x^2$$

$\Rightarrow \qquad \dfrac{dy}{dx} = 6 - 2x$

$\Rightarrow \qquad \left(\dfrac{dy}{dx}\right)_{(x_1, y_1)} = 6 - 2x_1$

Since, the tangent at (x_1, y_1) is parallel to the line $4x - 2y - 1 = 0$.

$\therefore$ Slope of the tangent at (x_1, y_1) = Slope of the line $4x - 2y - 1 = 0$

$\Rightarrow \qquad \left(\dfrac{dy}{dx}\right)_{(x_1, y_1)} = 2$

$\Rightarrow \qquad 6 - 2x_1 = 2 \Rightarrow x_1 = 2$

$\therefore \qquad y_1 = 6x_1 - x_1^2 = 6 \times 2 - 2^2 = 8$

Thus, required point is $(2, 8)$.

161. (b) Let $x = 0.5737373....$

$\Rightarrow \qquad 10x = 5.737373....$

$\Rightarrow \qquad 1000x = 573.7373....$

$\Rightarrow 1000x - 10x = 573 - 5$

$\Rightarrow \qquad 990x = 568$

$\Rightarrow \qquad x = \dfrac{568}{990}$

$\Rightarrow \qquad x = \dfrac{284}{495}$

162. (a) We have,

$x^2 - 5|x| + 6 = 0$

$|x|^2 - 5|x| + 6 = 0 \qquad [\because x^2 = |x|^2]$

$(|x| - 3)(|x| - 2) = 0$

$\qquad |x| = 3, 2$

$\Rightarrow \qquad x = \pm 3, \pm 2$

$\therefore$ Number of solution is 4.

163. (c) Required number of 6-digits number

$= \dfrac{6!}{2! \, 2! \, 2!} = \dfrac{720}{8} = 90$

164. (c) We have,

$$7^1 = 7$$
$$7^2 = 49$$
$$7^3 = 343$$
$$7^4 = 2401$$

and so on.

Thus, the last digit repeat itself in multiple of 4.

Since, 300 is divisible by 4, the units digit of 7^{300} would be 1.

165. (b) Let

$$\dfrac{\log x}{a - b} = \dfrac{\log y}{b - c} = \dfrac{\log z}{c - a} = k$$

$\Rightarrow \qquad \log x = k(a - b),$

$\qquad \log y = k(b - c)$

and $\qquad \log z = k(c - a)$

Now, $\log x + \log y + \log z =$

$\qquad k(a - b + b - c + c - a)$

$\Rightarrow \qquad \log(xyz) = 0$

$\Rightarrow \qquad xyz = 1$

166. (b) We have,

$$(1 + i)^{2n} = (1 - i)^{2n}$$

$\Rightarrow \qquad \left(\dfrac{1 + i}{1 - i}\right)^{2n} = 1$

$\Rightarrow \qquad \left(\dfrac{1 + i}{1 - i} \times \dfrac{1 + i}{1 + i}\right)^{2n} = 1$

$\Rightarrow \qquad \left(\dfrac{1 + i^2 + 2i}{1 - i^2}\right)^{2n} = 1$

$\Rightarrow \qquad \left(\dfrac{1 - 1 + 2i}{1 + 1}\right)^{2n} = 1$

$\Rightarrow \qquad i^{2n} = 1$

$\Rightarrow \qquad 2n = 4 \qquad [\because i^4 = 1]$

$\Rightarrow \qquad n = 2$

167. (b) We have,

$= \cos^{-1} p + \cos^{-1} q + \cos^{-1} r = \pi$

$\Rightarrow \cos^{-1} p + \cos^{-1} q = \pi - \cos^{-1} r$

$\Rightarrow \cos^{-1}(pq - \sqrt{1 - p^2} \, \sqrt{1 - q^2}) = \pi - \cos^{-1} r$

$\Rightarrow pq - \sqrt{1 - p^2} \, \sqrt{1 - q^2} = \cos(\pi - \cos^{-1} r)$

$\Rightarrow pq - \sqrt{1 - p^2} \, \sqrt{1 - q^2} = -\cos(\cos^{-1} r)$

$\Rightarrow pq - \sqrt{1 - p^2} \, \sqrt{1 - q^2} = -r$

$\Rightarrow pq + r = \sqrt{1 - p^2} \, \sqrt{1 - q^2}$

$\Rightarrow (pq + r)^2 = (1 - p^2)(1 - q^2)$

$$\Rightarrow \quad p^2q^2 + r^2 + 2pqr = 1 - p^2 - q^2 + p^2q^2$$
$$\Rightarrow \quad p^2 + q^2 + r^2 + 2pqr = 1$$

168. (c) We have,
$$\sin^{-1}\frac{x}{5} + \operatorname{cosec}^{-1}\frac{5}{4} = \frac{\pi}{2}$$
$$\Rightarrow \quad \sin^{-1}\frac{x}{5} + \sin^{-1}\frac{4}{5} = \frac{\pi}{2}$$
$$\Rightarrow \quad \sin^{-1}\frac{x}{5} + \cos^{-1}\frac{3}{5} = \frac{\pi}{2}$$
$$\Rightarrow \quad \sin^{-1}\frac{x}{5} = \frac{\pi}{2} - \cos^{-1}\frac{3}{5}$$
$$\Rightarrow \quad \sin^{-1}\frac{x}{5} = \sin^{-1}\frac{3}{5}$$
$$\Rightarrow \quad \frac{x}{5} = \frac{3}{5}$$
$$\Rightarrow \quad x = 3$$

169. (a) We have,
$$81^{\sin^2 x} + 81^{\cos^2 x} = 30$$
$$\Rightarrow 81^{\sin^2 x} + 81^{\cos^2 x} = 3 + 27$$
$$= 81^{\sin^2 x} + 81^{\cos^2 x}$$
$$= (81)^{\frac{1}{4}} + (81)^{\frac{3}{4}}$$
$$\Rightarrow \sin^2 x = \frac{1}{4} \text{ and } \cos^2 x = \frac{3}{4}$$
$$\Rightarrow \sin x = \frac{\pm 1}{2} \text{ and } \cos x = \frac{\pm\sqrt{3}}{2}$$
Since, $\qquad 0 < x < \pi$
$$\Rightarrow \sin x = \frac{1}{2} \text{ and } \cos x = \frac{\sqrt{3}}{2}$$
$$\Rightarrow \qquad x = \frac{\pi}{6}$$

170. (d) Equation of director circle of hyperbola,
$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \text{ is } x^2 + y^2 = a^2 - b^2$$
Hence, director circle of $\frac{x^2}{16} - \frac{y^2}{4} = 1$ is
$$x^2 + y^2 = 16 - 4 \Rightarrow x^2 + y^2 = 12$$

171. (b) Let e be the identity element, then
$$a * e = a$$
$$\Rightarrow \quad a + e - ae = a$$
$$\Rightarrow \quad e(1 - a) = 0$$
$$\Rightarrow \quad e = 0 \qquad\qquad [a \neq 1]$$

172. (b) We have, $x^2 + y^2 - 8x + 4y + 4 = 0$
$$\Rightarrow (x^2 - 8x + 16) + (y^2 + 4y + 4) = 16$$
$$\Rightarrow \quad (x - 4)^2 + (y + 2)^2 = 4^2$$
$\therefore$ Centre is $(4, -2)$ and radius is 4.
Hence, given circle touches Y-axis.

173. (a) (a) Set of all fourth roots of unity is $a = \{1, -1, i, -i\}$
Now, $1 \times (-1) = -1 \in G$
$$1 \times i = i \in G$$
$$1 \times (-i) = -i \in G$$
$$(-1) \times i = -i \in G$$
$$(-1) \times (-i) = i \in G$$
$$i \times (-i) = -i^2 = 1 \in G$$
So, it is true.
(b) Set of all cube root of unit is
$$H = \{1, w, w^2\}$$
Now, $\quad 1 + w = -w^2 \notin H$
So, it is false.
(c) It is not true, as this is possible only, when a is an abelian group, i.e. $ab = ba$
(d) We have,
$$(ab)^2 = a^2 b^2$$
$$\Rightarrow \qquad (ab)(ab) = (aa)(bb)$$
$$\Rightarrow \qquad (b)(a) = (a)(b) \Rightarrow ba = ab$$
$\Rightarrow a$ is an abelian group.
So, it is false.

174. (d) Let H consist of the integral multiple of 5, i.e.
$$H = \{5x : x \in I\}$$
This H is the non-empty subset of I.
Now, let $a = 5r$ and $b = 5s$ any two elements of H, where r and s are some integers.
We have, $a + b = 5r + 5s = 5(r + s) \in H$.
$(r + s)$ comes out to be the some integer.
$\therefore a \in H, b \in H \Rightarrow (a + b) \in H$
Hence, H is a subgroup of set of all integers under addition.

175. (c) Given, circles can be written as
$$x^2 + y^2 + kx + 4y + 2 = 0$$
and $x^2 + y^2 - 2x - \frac{3}{2}y + \frac{k}{2} = 0$
Since, both circles are orthogonal, then
$$2g_1 g_2 + 2f_1 f_2 = c_1 + c_2$$
$$\Rightarrow \qquad -k - 3 = 2 + \frac{k}{2}$$
$$\frac{3k}{2} = -5$$
$$\Rightarrow \qquad k = -\frac{10}{3}$$

176. (b) $\lim_{x \to \infty}\left(1 - \frac{4}{x-1}\right)^{3x-1} \qquad [1^\infty \text{ form}]$
$$= e^{\lim_{x \to \infty}\left(\frac{-4}{x-1}\right)(3x-1)}$$
$$= e^{\lim_{x \to \infty} -\frac{12x+4}{x-1}} = e^{-12}$$

177. (b) We have,

$$A + B + C = \pi$$

$$\Rightarrow \quad A + B = \pi - C$$

$$\Rightarrow \quad \frac{A}{2} + \frac{B}{2} = \frac{\pi}{2} - \frac{C}{2}$$

$$\Rightarrow \quad \tan\left(\frac{A}{2} + \frac{B}{2}\right) = \tan\left(\frac{\pi}{2} - \frac{C}{2}\right)$$

$$\Rightarrow \quad \frac{\tan\frac{A}{2} + \tan\frac{B}{2}}{1 - \tan\frac{A}{2}\tan\frac{B}{2}} = \cot\frac{C}{2}$$

$$\Rightarrow \quad \frac{\tan\frac{A}{2} + \tan\frac{B}{2}}{1 - \tan\frac{A}{2}\tan\frac{B}{2}} = \frac{1}{\tan\frac{C}{2}}$$

$$\Rightarrow \quad \tan\frac{C}{2}\tan\frac{A}{2} + \tan\frac{B}{2}\tan\frac{C}{2}$$

$$= 1 - \tan\frac{A}{2}\tan\frac{B}{2}$$

$$\Rightarrow \quad \tan\frac{A}{2}\tan\frac{B}{2} + \tan\frac{B}{2}\tan\frac{C}{2} + \tan\frac{C}{2}\tan\frac{A}{2} = 1$$

$$\Rightarrow \quad \Sigma \tan\frac{A}{2}\tan\frac{B}{2} = 1$$

178. (c) We have,

$$\frac{b}{\sin B} = 2R$$

$$\Rightarrow \quad R = \frac{B}{2\sin B} = \frac{2}{2 \times \sin 30°} = 2$$

$\therefore$ Area of circumcircle $= \pi R^2$

$$= \pi(2)^2 = 4\pi$$

179. (a) We have,

$$\sin x + \sin^2 x = 1$$

$$\Rightarrow \quad \sin x = 1 - \sin^2 x$$

$$\Rightarrow \quad \sin x = \cos^2 x$$

Now, $\cos^{12} x + 3\cos^{10} x + 3\cos^8 x + \cos^6 x$

$$= \sin^6 x + 3\sin^5 x + 3\sin^4 x + \sin^3 x$$

$$= \sin^3 x[\sin^3 x + 3\sin^2 x + 3\sin x + 1]$$

$$= \sin^3 x(\sin x + 1)^3$$

$$= (\sin^2 x + \sin x)^3$$

$$= (1)^3 = 1$$

180. (d) We have,

$$f(x) = |x|$$

Now, $\quad f(1) = |1| = 1$

and $\quad f(-1) = |-1| = 1$

$\therefore \quad f(1) = f(-1)$ but $1 \neq -1$

So, $f(x)$ is not one-one.

Again, $|x| \geq 0, \ \forall \ x \in R$

So, range of $f(x) = [0, \infty]$

$\therefore$ Range $\neq$ Co-domain

So, $f(x)$ is not onto.