SOLVED PAPER – 2017 (COMEDK)

Instructions

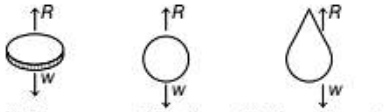
- There are 180 questions in all. The number of questions in each section is as given below.

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. When a body falls in air, the resistance of air depends to a great extent on the shape of the body. Three different shapes are given



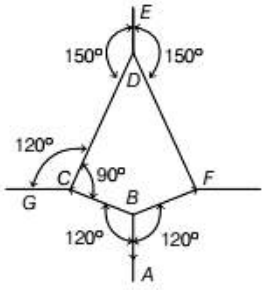
(I) Disc (II) Ball (III) Cigar shaped

Identify the combination of air resistances which truly represents the physical situation. (The cross-sectional areas are the same.)

a. I < II < III ***b.*** II < III < I

c. III < II < I ***d.*** III < I < II

2. The adjacent figure is the part of a horizontally stretched net. Section *AB* is stretched with a force of 10 N.



The tensions in the sections *BC* and *BF* are

a. 10N, 11 N

b. 10 N, 6 N

c. 10 N, 10 N

d. Can't calculate due to insufficient data

3. Out of the following four dimensional quantities, which one qualifies to be called a dimensional constant?

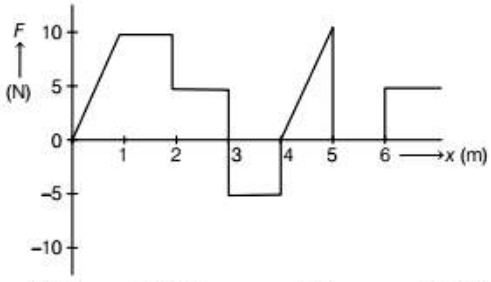
a. Acceleration due to gravity

b. Surface tension of water

c. Weight of a standard kilogram mass

d. Velocity of light in vacuum

4. The relationship between the force F and position x of a body is as shown in the figure. The work done in displacing the body from $x = 1$ m to $x = 5$ m will be



a. 30 J ***b.*** 15 J ***c.*** 25 J ***d.*** 20 J

5. From the top of a tower, two stones whose masses are in the ratio 1 : 2 are thrown - one straight up with an initial speed u and the second straight down with the same speed u. Then, neglecting air resistance

a. the heavier stone hits the ground with a higher speed

b. the lighter stone hits the ground with a higher speed

c. Both the stones will have the same speed when they hit the ground

d. the speed can't be determined with the given data

6. If M is the mass of the earth and R its radius, the ratio of the gravitational acceleration and the gravitational constant is

a. $\frac{R^2}{M}$ ***b.*** $\frac{M}{R^2}$ ***c.*** MR^2 ***d.*** $\frac{M}{R}$

7. A student unable to answer a question on Newton's laws of motion attempts to pull himself up by tugging on his hair. He will not succeed

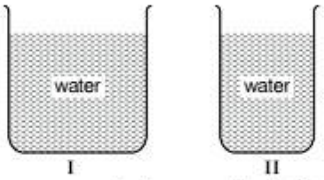
a. as the force exerted is small

b. the frictional force, while gripping is small

c. Newton's law of inertia is not applicable to living beings

d. as the force applied is internal to the system

8. From the adjacent figure, the correct observation is



a. the pressure on the bottom of tank (I) is greater than at the bottom of (II)

b. the pressure on the bottom of tank (I) is smaller than at the bottom of (II)

c. the pressure depend on the shape of the container

d. the pressure on the bottom of (I) and (II) is the same

9. Which one of the following is not a unit of Young's modulus?

a. Nm^{-1} ***b.*** Nm^{-2}

c. dyne cm^{-2} ***d.*** Mega pascal

10. A piece of blue glass heated to a high temperature and a piece of red glass at room temperature are taken inside a dimly lit room. Then

a. the blue piece will look blue and red will look as usual

b. red will look brighter red and blue will look ordinary blue

c. blue will shines like brighter red compared to the red piece

d. Both the pieces will look equally red

11. The wavelength of the radiation emitted by a body depends upon

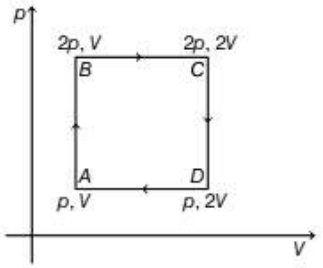
a. the nature of the surface

b. the area of the surface

c. the temperature of the surface

d. All of the above

12. An ideal monoatomic gas is taken around the cycle $ABCDA$ as shown in the p-V diagram. The work done during the cycle is given by



a. $\frac{1}{2}pV$ ***b.*** pV

c. $2pV$ ***d.*** $4pV$

13. Which mirror is to be used to obtain a parallel beam of light from a small lamp?

a. Plane mirror

b. Convex mirror

c. Concave mirror

d. Any one of the above

14. Which of the following is a wrong statement?

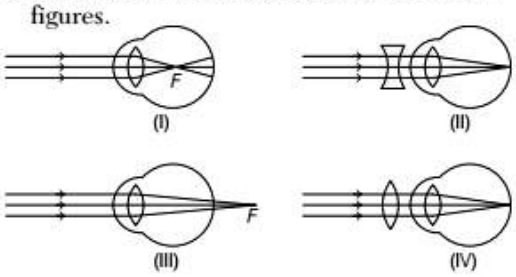
a. $D = \frac{1}{f}$, where f is the focal length and D is called the refractive power of a lens.

b. Power is called a dioptre when f is in metres.

c. Power is called a dioptre and does not depend on the system of unit used to measure f.

d. D is positive for convergent lens and negative for divergent lens.

15. Identify the wrong description of the below figures.



a. I represents far - sightedness
b. II correction for short-sightedness
c. III represents far - sightedness
d. IV correction for far - sightedness

16. Infrared radiation was discovered in 1800 by
a. William Wollaston *b.* William Herschel
c. Wilhelm Roentgen *d.* Thomas Young

17. A particle on the trough of a wave at any instant will come to the mean position after a time (T = time period)
a. $\frac{T}{2}$ *b.* $\frac{T}{4}$ *c.* T *d.* $2T$

18. The disc of a siren containing 60 holes rotates at a constant speed of 360 rpm. The emitted sound is in unison with a tuning-fork of frequency
a. 10 Hz *b.* 360 Hz
c. 216 kHz *d.* 6 Hz

19. The ratio of velocity of sound in hydrogen and oxygen at STP is
a. 16 : 1 *b.* 8 : 1
c. 4 : 1 *d.* 2 : 1

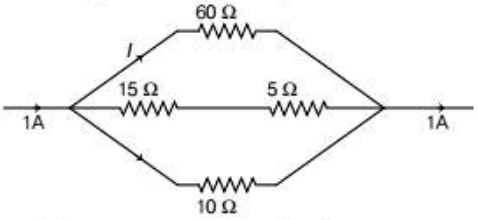
20. In an experiment with sonometer a tuning fork of frequency 256 Hz resonates with a length of 25 cm and another tuning fork resonates with a length of 16 cm. Tension of the string remaining constant the frequency of the second tuning fork is
a. 163.84 Hz *b.* 400 Hz
c. 320 Hz *d.* 204.8 Hz

21. The apparent frequency of a note is 200 Hz. When a listener is moving with a velocity of 40 ms^{-1} towards a stationary source. When he moves away from the same source with the same speed, the apparent frequency of the same note is 160 Hz. The velocity of sound in air (in m/s) is
a. 340 *b.* 330
c. 360 *d.* 320

22. The wave theory of light, in its original form, was first postulated by
a. Isaac Newton
b. Christian Huygens
c. Thomas Young
d. Augustin Jean Fresnel

23. If a liquid does not wet glass, its angle of contact is
a. zero *b.* acute
c. obtuse *d.* right angle

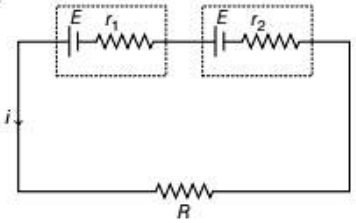
24. The magnitude of I in ampere unit is



a. 0.1 *b.* 0.3
c. 0.6 *d.* None of these

25. Electron of mass m and charge q is travelling with a speed v along a circular path of radius r at right angles to a uniform magnetic field of intensity B. If the speed of the electron is doubled and the magnetic field is halved, then the resulting path would have a radius
a. $2r$ *b.* $4r$ *c.* $\frac{r}{4}$ *d.* $\frac{r}{2}$

26. If the potential difference across the internal resistance r_1 is equal to the emf E of the battery, then



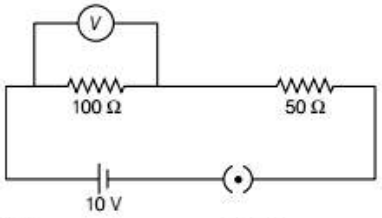
a. $R = r_1 + r_2$ *b.* $R = \frac{r_1}{r_2}$ *c.* $R = r_1 - r_2$ *d.* $R = \frac{r_2}{r_1}$

27. By using only two resistance coils-singly, in series, or in parallel-one should be able to obtain resistances of 3, 4, 12 and 16 ohms. The separate resistances of the coil are
a. 3 and 4 *b.* 4 and 12
c. 12 and 16 *d.* 16 and 3

28. The electrons in the beam of a television tube move horizontally from South to North. The vertical component of the earth's magnetic field points down. The electron is deflected towards
a. West *b.* no deflection
c. East *d.* North to South

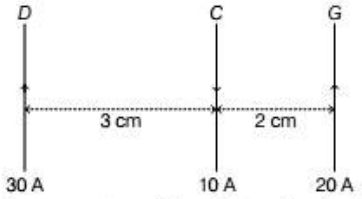
29. A tangent galvanometer has a reduction factor of 1 A and it is placed with the plane of its coil perpendicular to the magnetic meridian. The deflection produced when a current of 1 A is passed through it is
a. 60° *b.* 45°
c. 30° *d.* None of these

30. In the given circuit, the voltmeter records 5 V. The resistance of the voltmeter (in ohms) is



a. 200 ***b.*** 100
c. 10 ***d.*** 50

31. Three long, straight and parallel wires, carrying current, are arranged as shown in figure.

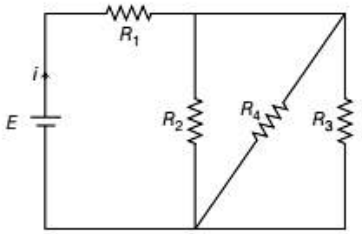


The force experienced by a 25 cm length of wire C is
a. 10^{-3} N ***b.*** 2.5×10^{-3} N
c. Zero ***d.*** 1.5×10^{-3} N

32. A 5.0 A current is setup in an external circuit by a 6.0 V storage battery for 6.0 min. The chemical energy of the battery is reduced by
a. 1.08×10^4 J ***b.*** 1.08×10^4 V
c. 1.8×10^4 J ***d.*** 1.8×10^4 V

33. The current in a simple series circuit is 5.0 A. When an additional resistance of 2.0 Ω is inserted, the current drops to 4.0 A. The original resistance of the circuit (in Ω) is
a. 1.25 ***b.*** 8 ***c.*** 10 ***d.*** 20

34. In the circuit given $E = 6.0$ V, $R_1 = 100\Omega$ $R_2 = R_3 = 50\Omega$ and $R_4 = 75\Omega$.
The equivalent resistance of the circuit (in Ω) is



a. 11.875
b. 26.31
c. 118.75
d. None of these

35. Two resistances are connected in two gaps of a meterbridge. The balance point is 20 cm from the zero end. A resistance of 15 Ω is connected in series with the smaller of the two. The null point shifts to 40 cm. The value of the smaller resistance (in Ω) is
a. 3 ***b.*** 6 ***c.*** 9 ***d.*** 12

36. An electric field of 1500 V/m and a magnetic field of 0.40 Wb/m^2 act on a moving electron. The minimum uniform speed along a straight line the electron could have is
a. 1.6×10^{15} m/s ***b.*** 6×10^{-16} m/s
c. 3.75×10^3 m/s ***d.*** 3.75×10^2 m/s

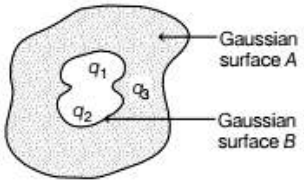
37. In an ammeter 10% of main current is passing through the galvanometer. If the resistance of the galvanometer is G, then the shunt resistance (in Ω) is
a. $9G$ ***b.*** $\frac{G}{9}$ ***c.*** $90\,G$ ***d.*** $\frac{G}{90}$

38. Among the following properties describing diamagnetism identify the property that is wrongly stated.
I. Diamagnetic material do not have permanent magnetic moment.
II. Diamagnetism is explained in terms of electromagnetic induction.
III. Diamagnetic materials have a small positive susceptibility.
IV. The magnetic moment of individual electrons neutralise each other.
a. I ***b.*** II ***c.*** III ***d.*** IV

39. The induction coil works on the principle of
a. self-induction ***b.*** mutual induction
c. Ampere's rule ***d.*** Fleming's right hand rule

40. The square root of the product of inductance and capacitance has the dimension of
a. length ***b.*** mass
c. time ***d.*** no dimension

41. The electric flux for Gaussian surface A that enclose the charged particles in free space is (Given, $q_1 = -14$ nC, $q_2 = 7.85$ nC, $q_3 = -56$ nC)



a. 10^3 N-m^{2}C^{-1} ***b.*** 10^3CN^{-1}m^{-2}
c. 6.32×10^3N-m^{2}C^{-1} ***d.*** 6.32×10^3CN^{-1}m^{-2}

42. Four metal conductors having different shapes a sphere, cylindrical, pear, lightning conductor are mounted on insulating stands and charged. The one which is best suited to retain the charges for a longer time is

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

43. The potential to which a conductor is raised, depends on

a. the amount of charge
b. geometry and size of the conductor
c. Both (a) and (b)
d. None of the above

44. The work done in carrying a charge q once round a circle of radius r with a charge Q at the centre is

a. $\frac{qQ}{4\pi\varepsilon_0 r}$ ***b.*** $\frac{qQ}{4\pi\varepsilon_0^2 r^2}$
c. $\frac{qQ}{4\pi\varepsilon_0 r^2}$ ***d.*** None of these

45. An air filled parallel plate condenser has a capacity of 2pF. The separation of the plates is doubled and the interspace between the plates is filled with wax. If the capacity is increased to 6pF, then the dielectric constant of wax is

a. 2 ***b.*** 3 ***c.*** 4 ***d.*** 6

46. Identify the wrong statement in the following. Coulomb's law correctly describes the electric force that

a. binds the electrons of an atom to its nucleus.
b. binds the protons and neutrons in the nucleus of an atom.
c. binds atoms together to form molecules.
d. binds atoms and molecules to form solids.

47. A single slit of width a is illuminated by violet light of wavelength 400 nm and the width of the diffraction pattern is measured as y. When half of the slit width is covered and illuminated by yellow light of wavelength 600 nm, the width of the diffraction pattern is

a. the pattern vanishes and the width is zero
b. $\frac{y}{3}$
c. $3y$
d. None of the above

48. At Kavalur in India, the astronomers using a telescope whose objective had a diameter of one metre started using a telescope of diameter 2.54 m. This resulted in

a. the increase in the resolving power by 2.54 times for the same λ
b. the increase in the limiting angle by 2.54 times for the same λ
c. decrease in the resolving power
d. no effect on the limiting angle

49. When unpolarised light beam is incident from air onto glass ($n = 1.5$) at the polarising angle

a. reflected beam is polarised 100 percent
b. reflected and refracted beams are partially polarised
c. the reason for (a) is that almost all the light is reflected
d. All of the above

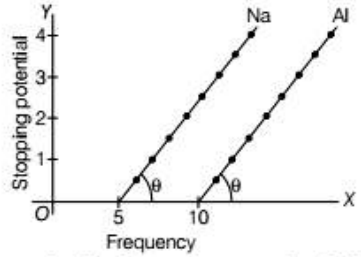
50. Select the correct statement from the following.

a. Christian Huygens, a contemporary of Newton established the wave theory of light by assuming that light waves were transverse.
b. Maxwell provided the compelling theoretical evidence that light is a transverse wave.
c. Thomas Young experimentally proved the wave behaviour of light and Huygens assumption.
d. All three statements given above, correctly answers the question 'what is light'?

51. Two coherent light beams of intensity I and $4I$ are superposed. The maximum and minimum possible intensities in the resulting beam are

a. $9I$ and I ***b.*** $9I$ and $3I$
c. $5I$ and I ***d.*** $5I$ and $3I$

52. From the figure describing photoelectric effect we may infer correctly that



a. Na and Al both have the same threshold frequency
b. Maximum kinetic energy for both the metals depend linearly on the frequency
c. The stopping potentials are different for Na and Al for the same change in frequency
d. Al is a better photo sensitive material than Na

53. The electron in a hydrogen atom makes a transition from $n = n_1$ to $n = n_2$ state. The time period of the electron in the initial state n_1 is eight times that in the final state n_2. The possible values of n_1 and n_2 are

a. $n_1 = 8, n_2 = 1$ ***b.*** $n_1 = 4, n_2 = 2$
c. $n_1 = 2, n_2 = 4$ ***d.*** $n_1 = 1, n_2 = 8$

54. If the forward voltage in a diode is increased, then the width of the depletion region
a. increases ***b.*** decreases
c. fluctuates ***d.*** no change

55. Two nucleons are at a separation of one Fermi. Protons have a charge of $+1.6 \times 10^{-19}$ C. The net nuclear force between them is F_1, if both are neutrons, F_2 if both are protons and F_3 if one is proton and the other is neutron. Then,
a. $F_1 = F_2 > F_3$
b. $F_1 = F_2 = F_3$
c. $F_1 < F_2 < F_3$
d. $F_1 > F_2 > F_3$

56. The energy that should be added to an electron to reduce its de-Broglie wavelength from 1 nm to 0.5 nm is
a. four times the initial energy
b. equal to the initial energy
c. twice the initial energy
d. thrice the initial energy

57. Mean life of a radioactive sample is 100 s. Then, its half-life (in min) is
a. 0.693 ***b.*** 1
c. 10^{-4} ***d.*** 1.155

58. Consider two nuclei of the same radioactive nuclide. One of the nuclei was created in a supernova explosion 5 billion years ago. The other was created in a nuclear reactor 5 min ago. The probability of decay during the next time is
a. different for each nuclei
b. nuclei created in explosion decays first
c. nuclei created in the reactor decays first
d. independent of the time of creation

59. Bohr's atom model assumes
a. the nucleus is of infinite mass and is at rest
b. electrons in a quantised orbit will not radiate energy
c. mass of the electron remains constant
d. All of the above

60. Identify the property which is not characteristic for a semi-conductor.
a. At a very low temperatures it behaves like an insulator.
b. At higher temperatures two types of charge carriers will cause conductivity.
c. The charge carriers are electrons and holes in the valance band at higher temperatures.
d. The semiconductor is electrically neutral.

CHEMISTRY

61. The correct order in which the first ionisation potential increases is
a. Na, K, Be ***b.*** K, Na, Be
c. K, Be, Na ***d.*** Be, Na, K

62. 10 cm^3 of 0.1 N monobasic acid requires 15 cm^3 of sodium hydroxide solution whose normality is
a. 1.5 N ***b.*** 0.15 N
c. 0.066 N ***d.*** 0.66 N

63. The IUPAC name for tertiary butyl iodide is
a. 4-iodobutane
b. 2-iodobutane
c. 1-iodo, 3-methyl propane
d. 2-iodo, 2-methyl propane

64. When sulphur dioxide is passed in an acidified $K_2Cr_2O_7$ solution, the oxidation state of sulphur is changed from
a. + 4 to 0 ***b.*** + 4 to + 2
c. + 4 to + 6 ***d.*** + 6 to + 4

65. Mass of 0.1 mole of methane is
a. 1g ***b.*** 16 g ***c.*** 1.6 g ***d.*** 0.1 g

66. Methoxy methane and ethanol are
a. position isomers
b. chain isomers
c. functional isomers
d. optical isomers

67. When the azimuthal quantum number has the value of 2, the number of orbitals possible are
a. 7 ***b.*** 5
c. 3 ***d.*** 0

68. For the reaction,
$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$, the volume of carbon monoxide required to reduce one mole of ferric oxide is
a. 22.4 dm^3 ***b.*** 44.8 dm^3
c. 67.2 dm^3 ***d.*** 11.2 dm^3

69. The monomers of buna-S rubber are
a. vinyl chloride and sulphur
b. butadiene
c. styrene and butadiene
d. isoprene and butadiene

70. An element with atomic number 21 is a
a. halogen
b. representative element
c. transition element
d. alkali metal

71. The maximum number of hydrogen bonds that a molecule of water can have is
a. 1 ***b.*** 2 ***c.*** 3 ***d.*** 4

72. A gas deviates from ideal behaviour at a high pressure because its molecules
a. attract one another
b. show the Tyndall effect
c. have kinetic energy
d. are bound by covalent bonds

73. The reagent used to convert an alkyne to alkene is
a. Zn/HCl ***b.*** Sn/HCl
c. Zn-Hg / HCl ***d.*** Pd/H_2

74. When, compared to $\Delta G°$ for the formation of Al_2O_3, the $\Delta G°$ for the formation of Cr_2O_3 is
a. higher ***b.*** lower
c. same ***d.*** unpredicted

75. In order to increase the volume of a gas by 10%, the pressure of the gas should be
a. increased by 10% ***b.*** increased by 1%
c. decreased by 10% ***d.*** decreased by 1%

76. Catalytic dehydrogenation of a primary alcohol gives a/an
a. secondary alcohol ***b.*** aldehyde
c. ketone ***d.*** ester

77. Excess of PCl_5 reacts with conc.H_2SO_4 giving
a. chlorosulphonic acid ***b.*** thionyl chloride
c. sulphuryl chloride ***d.*** sulphurous acid

78. If one mole of ammonia and one mole of hydrogen chloride are mixed in a closed container to form ammonium chloride gas, then
a. $\Delta H > \Delta U$
b. $\Delta H = \Delta U$
c. $\Delta H < \Delta U$
d. there is no relationship

79. The compound on dehydrogenation gives a ketone. The original compound is
a. primary alcohol ***b.*** secondary alcohol
c. tertiary alcohol ***d.*** carboxylic acid

80. Which is the most easily liquefiable rare gas?
a. Xe ***b.*** Kr ***c.*** Ar ***d.*** Ne

81. Mesomeric effect involves delocalisation of
a. π-electrons ***b.*** σ-electrons
c. protons ***d.*** None of these

82. Which of the following has the maximum number of unpaired *d*-electrons?
a. Zn^{2+} ***b.*** Fe^{2+} ***c.*** Ni^{3+} ***d.*** Cu^{+}

83. One mole of which of the following has the highest entropy?
a. Liquid nitrogen ***b.*** Hydrogen gas
c. Mercury ***d.*** Diamond

84. Which of the following species does not exert a resonance effect?
a. $C_6H_5NH_2$ ***b.*** $C_6H_5\overset{+}{N}H_3$
c. C_6H_5OH ***d.*** C_6H_5Cl

85. A complex compound in which the oxidation number of a metal is zero, is
a. $K_4[Fe(CN)_6]$ ***b.*** $K_3[Fe(CN)_6]$
c. $[Ni(CO)_4]$ ***d.*** $[Pt(NH_3)_4]Cl_2$

86. Three moles of PCl_5, three moles of PCl_3 and two moles of Cl_2 are taken in a closed vessel. If at equilibrium the vessel has 1.5 moles of PCl_5, the number of moles of PCl_3 present in it is
a. 5 ***b.*** 3 ***c.*** 6 ***d.*** 4.5

87. How many optically active stereomers are possible for butan-2, 3-diol?
a. 1 ***b.*** 2 ***c.*** 3 ***d.*** 4

88. An octahedral complex is formed when hybrid orbitals of the following type are involved
a. sp^3 ***b.*** $d\,sp^2$
c. d^2sp^3 ***d.*** sp^2d^2

89. For the reaction,
$2HI(g) \rightleftharpoons H_2(g) + I_2(g); -Q$ kJ, the equilibrium constant depends upon
a. temperature ***b.*** pressure
c. catalyst ***d.*** volume

90. The angle strain in cyclobutane is
a. 24°44′ ***b.*** 29°16′
c. 19°22′ ***d.*** 9°44′

91. The number of nodal planes present in σ^* *s*-antibonding orbital is
a. 1 ***b.*** 2 ***c.*** 0 ***d.*** 3

92. Which of the following electrolytic solution has the least specific conductance?
a. 0.02 N ***b.*** 0.2 N
c. 2 N ***d.*** 0.002 N

93. The overlapping of orbitals in benzene is of the type
a. *sp*-*sp* ***b.*** *p*-*p*
c. sp^2-sp^2 ***d.*** sp^3-sp^3

94. The calculated bond order of superoxide ion (O_2^-) is

a. 2.5 ***b.*** 2

c. 1.5 ***d.*** 1

95. Which of the following can be measured by the Ostwald-Walker dynamic method?

a. Relative lowering of vapour pressure

b. Lowering of vapour pressure

c. Vapour pressure of the solvent

d. All of the above

96. *n*-propyl bromide on treating with alcoholic KOH produces

a. propane ***b.*** propene

c. propyne ***d.*** propanol

97. Mercury is a liquid metal because

a. it has a completely filled *s*-orbital

b. it has a small atomic size

c. it has a completely filled *d*-orbital that prevents *d*-*d* overlapping of orbitals

d. it has a completely filled *d*-orbital that causes *d*-*d* overlapping

98. A compound is formed by elements *A* and *B*. This crystallises in the cubic structure, where the *A* atoms are at the corners of the cube and *B* atoms are at the body centres.

a. *AB* ***b.*** A_6B

c. A_8B_4 ***d.*** AB_6

99. Anisole can be prepared by the action of methyl iodide on sodium phenate. The reaction is called

a. Wurtz's reaction ***b.*** Williamson's reaction

c. Fittig's reaction ***d.*** Etard's reaction

100. Malleability and ductility of metals can be accounted due to

a. the presence of electrostatic force

b. the crystalline structure in metal

c. the capacity of layers of metal ions to slide over the other

d. the interaction of electrons with metal ions in the lattice

101. An ionic compound is expected to have tetrahedral structure if r_+ / r_- lies in the range of

a. 0.414 to 0.732 ***b.*** 0.225 to 0.414

c. 0.155 to 0.225 ***d.*** 0.732 to 1

102. Among the following, which is least acidic?

a. phenol ***b.*** *o*-cresol

c. *p*-nitrophenol ***d.*** *p*-chlorophenol

103. A ligand can also be regarded as

a. Lewis acid ***b.*** Bronsted base

c. Lewis base ***d.*** Bronsted acid

104. The colour of sky is due to

a. transmission of light

b. wavelength of scattered light

c. absorption of light by atmospheric gases

d. All of the above

105. Which of the following organic compounds answers to both iodoform test and Fehling's test?

a. Ethanol ***b.*** Methanol

c. Ethanal ***d.*** Propanone

106. Helium is used in balloons in place of hydrogen because it is

a. incombustible

b. lighter than hydrogen

c. radioactive

d. more abundant than hydrogen

107. The basic principle of Cottnell's precipitator is

a. Le-Chatelier's principle

b. peptisation

c. neutralisation of charge on colloidal particles

d. scattering of light

108. When carbon monoxide is passed over solid caustic soda heated to 200°C, it forms

a. Na_2CO_3 ***b.*** $NaHCO_3$

c. HCOONa ***d.*** CH_3COONa

109. $N_2 + 3H_2 \rightleftharpoons 2NH_3 + \text{Heat}$. What is the effect of the increase of temperature on the equilibrium of the reaction?

a. Equilibrium is shifted to the left

b. Equilibrium is shifted to the right

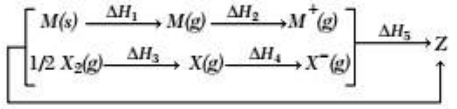
c. Equilibrium is unaltered

d. Reaction rate does not change

110. Hydrogen gas is not liberated when the following metal is added to dil. HCl

a. Ag ***b.*** Zn ***c.*** Mg ***d.*** Sn

111. Consider the Born-Haber cycle for the formation of an ionic compound, given below and identify the compound (Z) formed.



a. M^+X^- ***b.*** $M^-X^-(s)$ ***c.*** $M X$ ***d.*** $M^+X^-(g)$

112. In the brown ring test, the brown colour of the ring is due to

a. ferrous nitrate

b. ferric nitrate

c. a mixture of NO and NO_2

d. nitrosoferrous sulphate

113. Amines behave as
a. Lewis acids ***b.*** Lewis base
c. aprotic acid ***d.*** neutral compound

114. Dalda is prepared from oils by
a. oxidation ***b.*** reduction
c. hydrolysis ***d.*** distillation

115. The chemical name of anisole is
a. ethanoic acid ***b.*** methoxy benzene
c. propanone ***d.*** acetone

116. The number of disulphide linkages present in insulin are
a. 1 ***b.*** 2 ***c.*** 3 ***d.*** 4

117. 80 g of oxygen contains as many atoms as in
a. 80 g of hydrogen ***b.*** 1 g of hydrogen
c. 10 g of hydrogen ***d.*** 5 g of hydrogen

118. Which metal has a greater tendency to form metal oxide?
a. Cr ***b.*** Fe
c. Al ***d.*** Ca

119. Identify the reaction that does not take place in a blast furnace.
a. $CaCO_3 \longrightarrow CaO + CO_2$
b. $CaO + SiO_2 \longrightarrow CaSiO_3$
c. $2Fe_2O_3 + 3C \longrightarrow 4Fe + 3CO_2$
d. $CO_2 + C \longrightarrow 2CO$

120. Waxes are esters of
a. glycerol
b. long chain alcohols
c. glycerol and fatty acid
d. long chain alcohols and long chain fatty acids

MATHEMATICS

121. Which of the following is an even function?
a. $\sqrt{x}$ ***b.*** $x^2 + \sin^2 x$
c. $\sin^3 x$ ***d.*** None of these

122. If $A = \{x : x^2 - x + 2 > 0\}$ and $B = \{x : x^2 - 4x + 3 \le 0\}$, then $A \cap B$ is
a. $[1, 3]$ ***b.*** $(-\infty, \infty)$
c. $(1, 3)$ ***d.*** $(-\infty, 1) \cup (3, \infty)$

123. If $*$ be a binary operation on a set A and e be the identity element w.r.t. $*$, then $b \in A$ is said to be inverse of $a \in A$ w.r.t. $*$, if
a. $a * e = b * e$ ***b.*** $a = b$
c. $a * a = b * b$ ***d.*** $a * b = b * a = e$

124. If in a ΔABC, $\angle C = \frac{\pi}{2}$, then

$$\tan^{-1}\left(\frac{a}{b+c}\right) + \tan^{-1}\left(\frac{b}{c+a}\right) =$$

a. $\frac{\pi}{4}$ ***b.*** $\frac{\pi}{2}$
c. $\frac{\pi}{3}$ ***d.*** None of these

125. The sides a, b, c of a triangle are in AP. If $\cos\alpha = \frac{a}{b+c}$, $\cos\beta = \frac{b}{c+a}$, $\cos\gamma = \frac{c}{a+b}$

then $\tan^2\frac{\alpha}{2} + \tan^2\frac{\gamma}{2} =$

a. 1 ***b.*** $\frac{1}{2}$ ***c.*** $\frac{1}{3}$ ***d.*** $\frac{2}{3}$

126. The value of $\cos(35° + A)\cos(35° - B) + \sin(35° + A)\sin(35° - B)$ is equal to
a. $\sin(A + B)$ ***b.*** $\sin(A - B)$
c. $\cos(A + B)$ ***d.*** $\cos(A - B)$

127. The value of $2\,\text{cosec}\,2x + \text{cosec}\,x$ is equal to
a. $\tan x \cdot \sec(x/2)$ ***b.*** $\sec x \cdot \cot(x/2)$
c. $\sec x \cdot \tan(x/2)$ ***d.*** $\tan x \cdot \cot(x/2)$

128. The value of $\cot 2x \cot x - \cot 3x \cot 2x - \cot 3x \cot x$ is equal to
a. 3 ***b.*** 0 ***c.*** -1 ***d.*** 1

129. The value of $\cos\left(\frac{\pi}{4} - x\right)\cos\left(\frac{\pi}{4} - y\right) - \sin\left(\frac{\pi}{4} - x\right)\sin\left(\frac{\pi}{4} - y\right)$ is equal to
a. $\sin(x + y)$ ***b.*** $\sin(x - y)$
c. $\cos(x + y)$ ***d.*** $\cos(x - y)$

130. For all $n \in N$, $2 \cdot 4^{2n+1} + 3^{3n+1}$ is divisible by
a. 2 ***b.*** 9
c. 3 ***d.*** 11

131. The statement $P(n)$: '$1 \times 1! + 2 \times 2! + 3 \times 3! + \ldots + n \times n! = (n + 1)! - 1$' is
a. true for all $n > 1$ ***b.*** not true for any n
c. true for all $n \in N$ ***d.*** None of these

132. If $z = re^{i\theta}$, then $|e^{iz}| =$
a. 1 ***b.*** $e^{2r\sin\theta}$
c. $e^{r\sin\theta}$ ***d.*** $e^{-r\sin\theta}$

133. If $(\sqrt{5}+\sqrt{3}\,i)^{33}=2^{49}z$, then modulus of the complex number z is equal to

a. 1 ***b.*** $\sqrt{2}$

c. $2\sqrt{2}$ ***d.*** 4

134. The modulus of $[1-\cos\theta+i\sin\theta]^{-1}$ is

a. $\frac{1}{2}\operatorname{cosec}\frac{\theta}{2}$ ***b.*** $\operatorname{cosec}\frac{\theta}{2}$

c. $\frac{1}{2}\left|\operatorname{cosec}\frac{\theta}{2}\right|$ ***d.*** $\left|\operatorname{cosec}\frac{\theta}{2}\right|$

135. If a, b, c are real numbers and ω is a complex cube root of unity such that $a+b\omega+c\omega^2=0$, then

a. $b=-c$ ***b.*** $a=0, b=c$

c. $a=1, b=c$ ***d.*** $a=b=c$

136. If the cube roots of unity are $1, \omega, \omega^2$, then the roots of the equation $(x-1)^3+8=0$ are

a. $-1, -1, -1$

b. $-1, -1+2\omega, -1-2\omega^2$

c. $-1, 1+2\omega, 1+2\omega^2$

d. $-1, 1-2\omega, 1-2\omega^2$

137. Let α, β be the roots of the equation $ax^2+bx+c=0$. A root of the equation $a^3x^2+abcx+c^3=0$ is

a. $\alpha+\beta$ ***b.*** $\alpha^2+\beta$

c. $\alpha^2-\beta$ ***d.*** $\alpha^2\beta$

138. The sum of all 4-digit numbers that can be formed by using the digits 2, 4, 6,8 (repetition of digits is not allowed) is

a. 133320 ***b.*** 123330

c. 113230 ***d.*** 323430

139. In how many ways can 4 red, 3 yellow and 2 green discs be arranged in a row, if the discs of the same colour are indistinguishable?

a. 1200 ***b.*** 1220 ***c.*** 1240 ***d.*** 1260

140. Find the number of ways of choosing 4 face cards from a pack of 52 playing cards.

a. 495 ***b.*** 493

c. 490 ***d.*** 492

141. Given, the positive integers $r>1$, $n>2$ and the coefficients of $(3r)$th and $(r+2)$ th terms in the expansion of $(1+x)^{2n}$ are equal, then $n=$

a. $2r$ ***b.*** $2r-1$

c. $2r+1$ ***d.*** $3r$

142. Let the HM and GM of two positive numbers a and b be in the ratio 4 : 5, then $a:b$ is

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

c. 3 : 4 ***d.*** 1 : 4

143. If 2, 7, 9, 5 are subtracted respectively from four numbers forming a GP, the resulting numbers are in AP, then the smallest of the four numbers is

a. −24 ***b.*** 12 ***c.*** 6 ***d.*** 3

144. $\frac{1}{3!}+\frac{2}{5!}+\frac{3}{7!}+\ldots$ to ∞ is equal to

a. e ***b.*** $2e$ ***c.*** $\frac{1}{2e}$ ***d.*** $\frac{e}{2}$

145. Let PQR be a right angled isosceles triangle, right angled at $P(2, 1)$. If the equation of QR is $2x+y=3$,then the combined equation of the lines PQ and PR is

a. $3x^2-3y^2+8xy+20x+10y+25=0$

b. $3x^2-3y^2+8xy-20x-10y+25=0$

c. $3x^2-3y^2+8xy+10x+15y+20=0$

d. $3x^2-3y^2-8xy-10x-15y-20=0$

146. The sides of a triangle are $x=2$, $y+1=0$ and $x+2y=4$. Its circumcentre is

a. (4, 0) ***b.*** (2, −1)

c. (0, 4) ***d.*** (2, 3)

147. Find the coordinates of the foci and the length of the latusrectum of the hyperbola.

$$\frac{x^2}{9}-\frac{y^2}{16}=1$$

a. $(0, \pm 2), \frac{32}{3}$ ***b.*** $(0, \pm 5), \frac{32}{3}$

c. $(\pm 5, 0), \frac{32}{3}$ ***d.*** $(0, \pm 5), \frac{3}{32}$

148. The line $21x+5y=116$ is a tangent to the hyperbola $7x^2-5y^2=232$. Its point of contact is

a. (−6, −2) ***b.*** (6, 2)

c. (6, −2) ***d.*** (−6, 2)

149. Chords of the circle $x^2+y^2=r^2$ touch the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$. The locus of the mid-points of the chords is

a. $(x^2+y^2)^2=a^2x^2-b^2y^2$

b. $(x^2+y^2)^2=a^2x^2+b^2y^2$

c. $x^2+y^2=a^2x^2-b^2y^2$

d. $x^2+y^2=a^2x^2+b^2y^2$

150. If the latusrectum of a hyperbola subtends a right angle at the other focus, then its eccentricity is

a. $\sqrt{3}+1$ ***b.*** $\sqrt{2}+1$

c. $\sqrt{3}+\sqrt{2}$ ***d.*** 2

151. From the point (0, 1) two tangents are dawn to the hyperbola $2x^2 - y^2 = 1$. If θ is the angle between them, then $\tan\theta =$

a. $\frac{4}{3}$ ***b.*** $\frac{3}{4}$

c. $\frac{3}{2}$ ***d.*** $\frac{2}{3}$

152. Let (3, 4, – 1) and (–1, 2, 3) be the end points of a diameter of a sphere. Then, the radius of the sphere is equal to

a. 2 units ***b.*** 3 units ***c.*** 6 units ***d.*** 7 units

153. Differentiate $\cos^{-1}\left(\frac{1-x}{1+x}\right)$ w.r.t. x.

a. $\frac{1}{1+x}$ ***b.*** $\frac{1}{x(1+x)}$

c. $\frac{1}{(1+x)\sqrt{x}}$ ***d.*** $\frac{-1}{(1+x)\sqrt{x}}$

154. $f(x) = \left(\frac{5}{x} + 7\right)$, where $x \neq 0$ is decreasing for

a. $x \in R$ ***b.*** $x \in R - \{0\}$

c. $x \in R - \{1\}$ ***d.*** $x \in R - \{-1, 1\}$

155. Find the approximate value of $(15)^{\frac{1}{4}}$.

a. 1.9688 ***b.*** 0.9687 ***c.*** 2.0312 ***d.*** 0.1968

156. Find the point on the curve $y = x^2$, where the slope of the tangent is equal to the x coordinate of the point.

a. (1, 1) ***b.*** (–1, –1) ***c.*** (1, 2) ***d.*** (0, 0)

157. Find the equations of the tangent and the normal to the curve $y = \frac{x^3}{4-x}$ at (2, 4).

a. $8x + y - 12 = 0; x + 8y + 34 = 0$

b. $8x - y - 12 = 0; x - 8y - 34 = 0$

c. $8x + 4y + 12 = 0, x - 8y + 34 = 0$

d. $8x - y - 12 = 0, x + 8y - 34 = 0$

158. If $y = \log_a x + \log_x a + \log_x x + \log_a a$, then $\frac{dy}{dx}$ is equal to

a. $\frac{1}{x} + x\log a$ ***b.*** $\frac{\log a}{x} + \frac{x}{\log a}$

c. $\frac{1}{x\log a} + x\log a$ ***d.*** $\frac{1}{x\log a} - \frac{\log a}{x(\log x)^2}$

159. Evaluate $\int \frac{1}{\sin x + \sqrt{3}\cos x}\,dx$.

a. $\log\left|\tan\left(\frac{x}{2}\right)\right| + C$

b. $-\frac{1}{2}\log\left|\tan\left(\frac{x}{2} + \frac{\pi}{6}\right)\right| + C$

c. $\frac{1}{2}\log\left|\tan\left(\frac{x}{2} + \frac{\pi}{6}\right)\right| + C$

d. None of the above

160. The value of $\int e^{2x}(2\sin 3x + 3\cos 3x)\,dx$ is

a. $e^{2x}\sin 3x + C$ ***b.*** $e^x\operatorname{cosec} x + C$

c. $e^{2x} + C$ ***d.*** $e^{2x}(\sin 3x) + C$

161. Evaluate $\int_1^2 \frac{dx}{x^2}$.

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

162. Evaluate $\int_0^{\pi/2} \frac{\cos x}{\left(\cos\frac{x}{2} + \sin\frac{x}{2}\right)^3}\,dx$.

a. $2-\sqrt{2}$ ***b.*** $2+\sqrt{2}$

c. $3+\sqrt{3}$ ***d.*** $3-\sqrt{3}$

163. To area bounded by the lines

$|x| + |y| = 1$

a. 1 sq. unit ***b.*** 2 sq. units

c. $2\sqrt{2}$ sq. units ***d.*** 4 sq. units

164. The value of $\int \frac{dx}{\sqrt{x} + \sqrt[3]{x}}$ is

a. $3\sqrt{x} + 3(\sqrt[3]{x}) - 6\sqrt[6]{x} + \log(\sqrt[6]{x} + 1) + C$

b. $2\sqrt{x} + 6(\sqrt[6]{x}) - 6\log(\sqrt[6]{x} + 1) + C$

c. $2\sqrt{x} - 3(\sqrt[3]{x}) + 6\sqrt[6]{x} - 6\log(\sqrt[6]{x} + 1) + C$

d. None of the above

165. If $\int_a^b \frac{x^n}{x^n + (16-x)^n}\,dx = 6$, then

a. $a = 4, b = 12, n \in R$ ***b.*** $a = 2, b = 14, n \in R$

c. $a = -4, b = 20, n \in R$ ***d.*** $a = 2, b = 8, n \in R$

166. $\int_{-\pi/4}^{\pi/4} \frac{dx}{1 + \cos 2x}$ is equal to

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

167. The differential equation of $y = ae^{bx+c}$ is

a. $y_2 = y_1 + y$ ***b.*** $y_2^2 = yy_1$

c. $y_1^2 = yy_2$ ***d.*** $y^2 = y_1y_2$

168. If $\mathbf{a} = \hat{\mathbf{i}} + \hat{\mathbf{j}} + 2\hat{\mathbf{k}}$ and $\mathbf{b} = 3\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - \hat{\mathbf{k}}$, then find $(\mathbf{a} + 3\mathbf{b}) \cdot (2\mathbf{a} - \mathbf{b})$.

a. –15 ***b.*** 12

c. 13 ***d.*** – 10

169. The value of $[\mathbf{a}-\mathbf{b}\quad \mathbf{b}-\mathbf{c}\quad \mathbf{c}-\mathbf{a}]$, where $|\mathbf{a}|=1$, $|\mathbf{b}|=5|\mathbf{c}|=3$, is

a. 0 ***b.*** 1

c. 6 ***d.*** None of these

170. If $A=\begin{bmatrix}2 & -3\\ 5 & -7\end{bmatrix}$, then $A+A^{-1}=$

a. $\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$ ***b.*** $\begin{bmatrix}-5 & 0\\ 0 & -5\end{bmatrix}$

c. $\begin{bmatrix}5 & 0\\ 0 & 5\end{bmatrix}$ ***d.*** $\begin{bmatrix}4 & 0\\ 0 & -5\end{bmatrix}$

171. If $A=\begin{bmatrix}\cos\theta & -\sin\theta & 0\\ \sin\theta & \cos\theta & 0\\ 0 & 0 & 1\end{bmatrix}$, then minor and cofactor of a_{32} are

a. 1, −1 ***b.*** 0, 1

c. −1, 0 ***d.*** 0, 0

172. An anti-aircraft gun can take a maximum of 4 shots at an enemy plane moving away from it. The probabilities of hitting the plane at the first, second, third and fourth shot are 0.4, 0.3, 0.2, 0.1 respectively. The probability that the gun hits the plane is

a. 0.6972 ***b.*** 0.6875

c. 0.64 ***d.*** 0.6976

173. The negation of the statement "If I become a teacher, then I will open a school", is

a. Neither I will become a teacher nor I will open a school.

b. I will not become a teacher or I will open a school.

c. I will become a teacher and I will not open a school.

d. Either I will not become a teacher or I will not open a school.

174. Maximize $Z=7x_1-3x_2$ subject to,

$x_1+2x_2\le 2,\ 2x_1+4x_2\ge 8,\ x_1\ge 0,\ x_2\ge 0.$

a. Unique solution

b. Unbounded solution

c. Infeasible solution

d. Infinite number of solutions

175. Find the transformed equation of the straight line $xy-x-y+1=0$, when the origin is shifted to the point (1, 1) after translation of axes.

a. $xy=5$ ***b.*** $xy=2$

c. $xy=0$ ***d.*** $xy=8$

176. If $\log_6 a+\log_6 b+\log_6 c=6$, where a, b and c are positive integers that form an increasing GP and $b-a$ is a square of an integer, then $a+b+c=$

a. 95 ***b.*** 99 ***c.*** 105 ***d.*** 111

177. A random variable X has the following probability distribution :

X	0	1	2	3
$P(X=x)$	0.5	0.2	0.18	0.12

Find the c.d.f. of X

a.

$X=x$	0	1	2	3
$F(x)$	0.12	0.18	0.2	0.5

b.

$X=x$	0	1	2	3
$F(x)$	0.5	0.88	1	0.7

c.

$X=x$	0	1	2	3
$F(x)$	0.5	0.7	0.88	1

d.

$X=x$	0	1	2	3
$F(x)$	1	0.5	0.88	0.7

178. From a lot of 20 items containing 4 defective items, 2 items are drawn at random. If X denotes the number of defective items, then find the mean of the probability distribution of X.

a. $\frac{3}{8}$ ***b.*** $\frac{1}{95}$ ***c.*** $\frac{2}{5}$ ***d.*** $\frac{28}{57}$

179. The total number of subsets of a finite set A has 56 more elements than the total number of subsets of another finite set B. What is the number of elements in the set A?

a. 5 ***b.*** 6

c. 7 ***d.*** 8

180. If $\log_4 2+\log_4 4+\log_4 x+\log_4 16=6$, then the value of x is

a. 64 ***b.*** 4 ***c.*** 8 ***d.*** 32

ANSWERS

Physics

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

Chemistry

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

Mathematics

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

HINTS & SOLUTIONS

Physics

1. *(c)* The air resistance on an object depends on its area, normal to air flow.

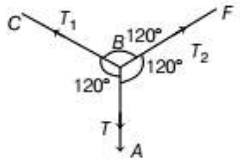
Since, area normal to air flow is maximum in case of disc.

So, air resistance on it is maximum. The air flow in case of cigar shaped is streamlined, so air resistance is minimum.

Hence, the correct order is

$$\text{III} < \text{II} < \text{I}$$

2. *(c)* Let tension in section BC is T and in section BF is T_2, then according to Lami's theorem,

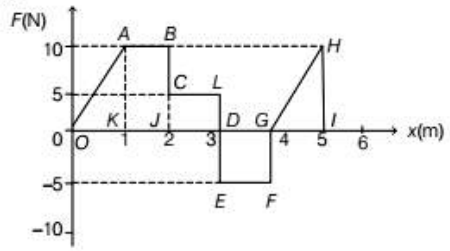


$$\frac{T_1}{\sin 120°} = \frac{T_2}{\sin 120°} = \frac{T}{\sin 120°}$$

$$\Rightarrow \quad T_1 = T_2 = T = 10 \text{ N}$$

3. *(d)* The velocity of light in vacuum is 3×10^8 m/s, which is a dimensional constant.

4. *(b)* The work done in a F-x graph is calculated by the area under the graph. The given graph can be shown as



$\therefore$ Work done in displacing the object from $x = 1$ m to $x = 5$ m will be

W = area under F-x graph

= area $ABJK$ + area $CLDJ$ + area $DGFE$ + area GHI

$$= (10 \times 1) + (5 \times 1) + (-5 \times 1) + \left(\frac{1}{2} \times 1 \times 10\right)$$

$$= 10 + 5 - 5 + 5 = 15 \text{ J}$$

5. *(c)* The first stone move up to some height and then its velocity becomes zero. Now, it move downward and at the level of top of tower, it acquires the same initial velocity u and gravitational acceleration g in downward direction.

The second stone is moving with the same speed u and with downward acceleration g. So, both will have same final velocity when they reach the bottom and hit the ground.

6. *(b)* The gravitational acceleration on earth is given by

$$g = \frac{F}{m} = \frac{GMm}{R^2 \times m} = \frac{GM}{R^2}$$

$$\therefore \quad \frac{g}{G} = \frac{M}{R^2}$$

7. *(d)* According to Newton's law, the state of an object can be changed by applying external force on it.

In given case the force applied is internal, so he will not succeed.

8. *(d)* The pressure applied at the bottom of a container by a liquid column of height h is given by

$$p = h\rho g$$

Here, in two cases, the liquid used is same (water), so ρ is same. Also, the height of liquid column is same on both. So, the pressure applied at the bottom is same for both.

9. *(a)* Young's modulus, $Y = \dfrac{\text{Stress}}{\text{Strain}}$

Here, strain is a dimensionless quantity and stress is measured in SI unit of Nm^{-2}, dyne cm^{-2} or pascal.

So, the Young's modulus has the same unit as stress.

$\therefore$ Nm^{-1} is not a unit of Young's modulus.

10. *(c)* When blue glass is heated to a high temperature, it absorbs all radiations of higher wavelength except red. So, when it is taken inside a dimly lit room, it emits all radiations and hence looks brighter red compared to the red piece. This happens according to Kirchhoff's law of radiation.

11. *(c)* According to Wien's law, the wavelength of radiation emitted by a body is

$$\lambda \propto \frac{1}{T}$$

i.e., it depends on the temperature of the surface.

12. *(b)* Work done in a cyclic process is equal to the area enclosed by the cycle in p-V diagram.

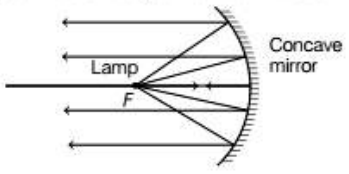
$$\therefore \quad W = \text{Area } ABCD$$

$$= AB \times AD$$

$$= (2p - p) \times (2V - V) = p \times V = pV$$

13. *(c)* A concave mirror is of converging type as the light parallel to principal axis converges at its focus.

So, when a lamp is placed at its focus, the ray of light falling on it becomes parallel beam as shown below.



14. *(c)* The power of a lens is given by the reciprocal of its focal length,

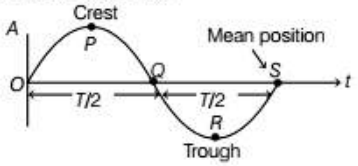
$$P = \frac{1}{f}$$

When f is in metre, then power P is in dioptre. Thus, power depends on the system of unit used to measure f.

15. *(a)* In first figure, the parallel rays are converging at a point before the retina. So, the person is suffering from near-sightedness.

16. *(b)* Infrared radiation was discovered in 1800 by William Herschel.

17. *(b)* As total time period of a wave is T. The wave motion can be shown as



From figure, it can be seen that time taken by the particle to move from trough to its mean position i.e., from R to S is

$$T' = \frac{T/2}{2} = \frac{T}{4}$$

18. *(b)* The number of waves produced by the disc is equal to number of notes

i.e., $n = 60$

Speed of rotation, $v = 360$ rpm

$$= \frac{360}{60} = 6 \text{ rps}$$

$\therefore$ Frequency $= n \times v = 60 \times 6 = 360$ Hz

19. *(c)* The velocity of sound in a gas is given by

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

At STP, both gases are at same temperature and as they are diatomic, so their specific heat ratio (γ) is also same.

$$\therefore \quad \frac{v_H}{v_O} = \sqrt{\frac{M_O}{M_H}} = \sqrt{\frac{32}{2}} = 4 \text{ or } 4:1$$

20. *(b)* The wavelength of the sound is proportional to the length of wire. Also, the velocity of sound is same in both cases, so

$$v_1 = v_2$$

$$\Rightarrow \quad f_1\lambda_1 = f_2\lambda_2$$

$$\Rightarrow \quad 256 \times 25 = f_2 \times 16$$

$$\Rightarrow \quad f_2 = \frac{256 \times 25}{16} = 400 \text{ Hz}$$

21. *(c)* Let f_s be the frequency of source.

The apparent frequency heard when listener moves towards source is

$$f' = f_s\left(\frac{v_s + v_o}{v_s}\right)$$

$$\Rightarrow \quad 200 = f_s\left(\frac{v_s + 40}{v_s}\right) \qquad \ldots(i)$$

The apparent frequency heard, when listener moves away from source is

$$f'' = f_s\left(\frac{v_s - v_o}{v_s}\right)$$

$$\Rightarrow \quad 160 = f_s\left(\frac{v_s - 40}{v_s}\right) \qquad \ldots(ii)$$

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

$$\frac{200}{160} = \frac{v_s + 40}{v_s - 40}$$

$$\Rightarrow \quad \frac{5}{4} = \frac{v_s + 40}{v_s - 40}$$

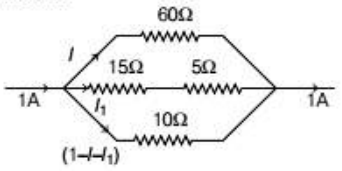
$$\Rightarrow \quad 5v_s - 200 = 4v_s + 160$$

$$\Rightarrow \quad v_s = 360 \text{ m/s}$$

22. *(b)* Christian Huygens believed that the light was made up of waves vibrating up and down perpendicular to the direction of propagation of wave. This is known as Huygens principle.

23. *(c)* If a liquid does not wet glass, it means that the liquid- liquid interaction (cohesion) is more than liquid - solid interaction (adhesion). So, the angle of contact is obtuse.

24. *(a)* Consider the diagram with current distribution as shown below.



As voltage is same in parallel combination, so

$$60I = (15 + 5)I_1$$

$$60I = 20I_1 \text{ or } I_1 = 3I \qquad \ldots(i)$$

Similarly, $(15 + 5)I_1 = 10(1 - I - I_1)$

$$\Rightarrow \quad 2I_1 = 1 - I - I_1$$

$$\Rightarrow \quad 3I_1 = 1 - I$$

$$\Rightarrow \quad 3(3I) = 1 - I \qquad \text{[Using Eq. (i)]}$$

$$\Rightarrow \quad 10I = 1$$

or $$I = \frac{1}{10} = 0.1\text{A}$$

25. *(b)* We know that, radius of charge particle of mass m having charge q moving with speed v in magnetic field perpendicular to it,

$$r = mv / Bq \qquad \ldots(i)$$

For second case,

$$r' = \frac{mv'}{qB'} = \frac{m(2v)}{q\left(\frac{B}{2}\right)} \left[\text{Since, } v' = 2v,\ B' = \frac{B}{2}\right]$$

$$= 4\frac{mv}{qB} = 4r \qquad \text{[using Eq. (i)]}$$

26. *(c)* Total emf of circuit, $E_T = E + E = 2E$

Total resistance of circuit, $R_T = r_1 + r_2 + R$

Current flowing through the circuit,

$$i = \frac{E_T}{R_T} = \frac{2E}{r_1 + r_2 + R} \quad ...(i)$$

As per question $E = ir_1$

$$\Rightarrow \quad i = \frac{E}{r_1} \quad ...(ii)$$

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

$$\frac{E}{r_1} = \frac{2E}{r_1 + r_2 + R}$$

$$\Rightarrow \quad r_1 + r_2 + R = 2r_1$$

$$\Rightarrow \quad R = r_1 - r_2$$

27. *(b)* The maximum and minimum resistances are 16Ω and 3Ω that are obtained by series and parallel combination of resistances. From given option only 4Ω and 12Ω resistors satisfies this condition.

28. *(a)* According to Fleming's right hand rule, for current in South-North direction, magnetic field in inward direction, the force on the electrons will be to the left or in West side.

29. *(b)* The deflection in a tangent galvanometer is given by

$$\tan\theta = \frac{I}{K}$$

where, K = reduction factor

Here, $K = 1\text{A}$, $I = 1\text{A}$

$$\therefore \quad \tan\theta = \frac{1}{1} = 1 \Rightarrow \theta = 45°$$

30. *(b)* If R be the resistance of voltmeter, then the equivalent resistance of circuit is

$$R_{eq} = \frac{R \times 100}{100 + R} + 50$$

$$= \frac{150R + 5000}{R + 100}$$

Total current in circuit,

$$i = \frac{V}{R_{eq}} = \frac{10}{\frac{150R + 5000}{(R + 100)}}$$

$$= \frac{10(R + 100)}{150R + 5000}$$

Voltage across 100Ω resistor,

$$V = i\left(\frac{R \times 100}{R + 100}\right)$$

Given, $V = 5\text{ V}$

$$\therefore \quad 5 = \frac{10(R + 100)}{150R + 5000} \times \frac{R \times 100}{R + 100}$$

$$= \frac{1000R}{150R + 5000}$$

$$\Rightarrow 750R + 25000 = 1000R$$

$$\Rightarrow \quad R = 100\Omega$$

31. *(c)* Force on 25 cm length of wire C due to wire D is

$$F_D = \frac{\mu_0}{4\pi}\frac{2I_1I_2}{r} \times l$$

$$= 10^{-7} \times \frac{30 \times 10 \times 2}{3 \times 10^{-2}} \times 25 \times 10^{-2}$$

$$= 5 \times 10^{-4}\text{ N, towards right}$$

Force of 25 cm length of wire C due to wire G is

$$F_G = 10^{-7} \times \frac{2 \times 20 \times 10}{2 \times 10^{-2}} \times 25 \times 10^{-2}$$

$$= 5 \times 10^{-4}\text{ N, towards left}$$

$\therefore$ Net force on wire $C = F_D - F_G = 0$

32. *(a)* Given, $I = 5\text{ A}$, $V = 6\text{ V}$, $t = 6\text{ min} = 6 \times 60 = 360\text{ s}$

Heat produced in a circuit = Chemical energy reduced in the battery

$$\Rightarrow \quad H = VIt$$

$$= 6 \times 5 \times 360$$

$$= 10800 = 1.08 \times 10^4\text{ J}$$

33. *(b)* Given, $I_1 = 5\text{ A}$, $R_2 = 2\Omega$, $I_2 = 4\text{A}$

Let initial resistance be R.

As voltage given is same in both cases, so

$$V_1 = V_2$$

$$\Rightarrow \quad I_1R = I_2R' = I_2(R + R_2)$$

$$\Rightarrow \quad 5 \times R = 4 \times (R + 2) \quad \Rightarrow R = 8\Omega$$

34. *(c)* Given, $R_1 = 100\Omega$, $R_2 = R_3 = 50\Omega$, $E = 6\text{ V}$, $R_4 = 75\Omega$

As R_2, R_3 and R_4 are in parallel combination, so their equivalent resistance be

$$\frac{1}{R'} = \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

$$= \frac{1}{50} + \frac{1}{50} + \frac{1}{75} = \frac{3 + 3 + 2}{150} = \frac{8}{150}$$

or $R' = \frac{150}{8}\Omega$

Now, R' is in series with R_1, so

$$R_{net} = R_1 + R' = 100 + \frac{150}{8} = \frac{950}{8} = 118.75\Omega$$

35. *(c)* In first case, at balance point,

$$\frac{P}{Q} = \frac{l}{100 - l} = \frac{20}{100 - 20} = \frac{1}{4} \quad \Rightarrow \quad Q = 4P \quad ...(i)$$

Let P be the smaller resistance, then in second case at balance point,

$$\frac{P + 15}{Q} = \frac{l'}{100 - l'} = \frac{40}{60} = \frac{2}{3}$$

$$\Rightarrow \frac{P + 15}{4P} = \frac{2}{3} \quad \text{[Using Eq. (i)]}$$

$$\Rightarrow 3P + 45 = 8P \quad \Rightarrow P = 9\Omega$$

36. *(c)* Given, electric field, $E = 1500\text{ V/m}$

Magnetic field, $B = 0.4\text{ Wb}/\text{m}^2$

Charge on electron, $q = e = 1.6 \times 10^{-19}\text{ C}$

For minimum uniform speed of electron along a straight line is a region, where electric field E and magnetic field B, both are present is given as

$$v = \frac{E}{B} \qquad \left[\because qE = Bqv \Rightarrow v = \frac{E}{B}\right]$$

$$= \frac{1500}{0.4}$$

$$= 3750 \text{ m/s}$$

$$= 3.75 \times 10^3 \text{ m/s}$$

37. *(b)* If I be the main current, then current passing through galvanometer,

$$I_g = 10\% \text{ of } I = \frac{I}{10}$$

Resistance of galvanometer, $R_g = G$

Shunt resistance, $R_S = \frac{I_g R_g}{I - I_g} = \frac{\frac{I}{10} \times G}{I - \frac{I}{10}} = \frac{G}{9}$

38. *(c)* Magnetic susceptibility of diamagnetic materials is small and negative.

Diamagnetic material do not have permanent magnetic moment because the magnetic moment of individual electrons neutralise each other due randomly oriented.

39. *(b)* The induction coil works on the principle of mutual induction. In the phenomena of mutual induction, an emf is induced across the secondary coil if the magnetic flux due to primary coil linked with the secondary coil changes.

40. *(c)* We know that, in L-C-R series resonant circuit, resonance frequency,

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$\Rightarrow \sqrt{LC} = \frac{1}{2\pi f}$$

$$\Rightarrow \sqrt{LC} = \frac{1}{\omega} \qquad [\omega = \text{angular frequency}]$$

$$\therefore \text{Dimension of } \sqrt{LC} = \frac{1}{\text{Dimension of } \omega}$$

$$\Rightarrow [\sqrt{LC}] = \frac{1}{[\omega]} = \frac{1}{[T^{-1}]} = [T]$$

Hence, square root of the product of inductance [L] and capacitance [C] has the dimension of time.

41. *(b)* Given, $q_1 = -14\text{nC} = -14 \times 10^{-9}$ C

$q_2 = 78.85\text{ nC} = 78.85 \times 10^{-9}$ C

$q_3 = -56\text{nC} = -56 \times 10^{-9}$ C

According to Gauss's law

Net electric flux passing through closed surface A,

$$\phi_A = \frac{1}{\varepsilon_0}(\text{total charged enclosed by closed surface } A)$$

$$= \frac{1}{\varepsilon_0}(q_1 + q_2 + q_3)$$

$$= \frac{-14 \times 10^{-9} + 78.85 \times 10^{-9} - 56 \times 10^{-9}}{8.85 \times 10^{-12}}$$

$$= \frac{8.85}{8.85} \times 10^{-9+12} = 10^3 \text{CN}^{-1}\text{m}^{-2}$$

42. *(a)* In case of spherical metal conductor, the charges quickly spread over its entire surface uniformly because of which charges can stay for longer time on spherical conductor.

While in case of non-spherical surfaces, charge concentration is different at different points due to which the charges do not stay on the surfaces for longer time.

43. *(c)* When we give charge to a conductor, then its potential increases.

$$\text{Potential, } V = \frac{\text{Charge}(Q)}{\text{Capacitance}(C)}$$

$$\Rightarrow V = \frac{Q}{\varepsilon_0 \frac{A}{d}} \qquad \left[\because C = \frac{\varepsilon_0 A}{d}\right]$$

$$\Rightarrow V = \frac{Qd}{\varepsilon_0 A}$$

Hence, V also depends on d and A. Thus, potential of conductor depends on the amount of charge, area or geometry and size of the conductor.

44. *(d)* According to given situation of charges, electrostatic force works which is conservative in nature i.e., work done depends on initial and final position only. Here, initial and final position coincide, hence work done will be zero.

45. *(d)* Given, capacitance of air filled parallel plate capacitor,

$$C_0 = 2\text{pF}$$

$$\Rightarrow = 2 \times 10^{-12} \text{ F}$$

$$\Rightarrow \frac{\varepsilon_0 A}{d} = 2 \times 10^{-12} \text{ F} \qquad \ldots(\text{i})$$

When the separation between the plates is doubled, i.e., $d' = 2d$

And wax of dielectric constant k is filled between the plates of capacitor, then,

$$C' = 6\text{ pF}$$

$$\frac{\varepsilon_0 k A}{d'} = 6 \times 10^{-12}\text{F}$$

$$\Rightarrow \frac{\varepsilon_0 k A}{2d} = 6 \times 10^{-12} \qquad [\because d' = 2d]$$

$$\Rightarrow \frac{\varepsilon_0 A}{d} \times \frac{k}{2} = 6 \times 10^{-12}$$

$$\Rightarrow 2 \times 10^{-12} \times \frac{k}{2} = 6 \times 10^{-12} \qquad [\text{from Eq. (i)}]$$

$$\Rightarrow k = 6$$

46. *(b)* According to Coulomb's law, electrostatic force acts only between two charge particles. Neutron is a neutral particle, therefore Coulomb's law is applicable only for protons.

47. *(c)* Given, In first case,

Wavelength of violet light,

$$\lambda_1 = 400 \text{ nm}$$

We know that, width of the diffraction pattern is given as

$$\beta = y = \frac{2D\lambda_1}{d}$$

$$\Rightarrow \quad y = \frac{2D\lambda_1}{d} = \frac{2D \times 400}{d}$$

$$y = \frac{800D}{d} \qquad \text{....(i)}$$

In the second case,

$$\lambda_2 = 600 \text{ nm}, \; d' = \frac{d}{2}$$

$$\therefore \quad y' = \frac{2D\lambda'}{d'} = \frac{2D \times 600}{\frac{d}{2}}$$

$$= 2400\frac{D}{d} = 3 \times \frac{800D}{d}$$

$$= 3y \qquad \text{[from Eq. (i)]}$$

48. *(a)* Diameter of objective,

$$D_1 = 1\text{m}, D_2 = 254 \text{ m}$$

Resolving power, $R_P = \frac{D}{1.22\lambda}$

Since, $R_P \propto D$ [For same value of λ]

$$\therefore \quad \frac{R_{P_1}}{R_{P_2}} = \frac{D_1}{D_2} = \frac{1}{2.54}$$

$$\Rightarrow \quad R_{P_2} = 2.54 \times R_{P_1}$$

49. *(a)* According to phenomena of polarisation by reflection, when unpolarised light beam is incident from air onto glass ($n = 1.5$) at the polarising angle (Brewster's angle), then reflected beam is polarised completely i.e. 100%.

50. *(b)* In Huygens principle, the wave theory was established by assuming that the waves were longitudinal. So, option (a) is not correct.

In Maxwell's theory of light, he stated that light is a transverse wave and conducted various experiments to prove so. Hence, option (b) is correct.

Thomas Young conducted his double slit experiment for determining fringe width and tried to prove the wave nature of light by providing that light undergoes interference which is a phenomenon showed by waves. He never proved the type of wave light is, i.e. transverse or longitudinal. Hence, option (c) is not correct.

These statements mostly highlight the wave nature of light.They do not comment on the particle nature of light or the dual nature of light established. Hence, they clearly do not answer the question "what is light" correctly. Hence, option (d) is not correct.

51. *(a)* Given, intensity of two coherent light beams,

$$I_1 = I \text{ and } I_2 = 4I$$

After superposition of two light beams,

$\therefore$ Maximum intensity,

$$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$$

$$= I_1 + I_2 + 2\sqrt{I_1 I_2}$$

$$= I + 4I + 2\sqrt{I \cdot 4I} = 9I$$

Minimum intensity,

$$I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2$$

$$= I_1 + I_2 - 2\sqrt{I_1 I_2}$$

$$= I + 4I - 2\sqrt{I \cdot 4I} = I$$

52. *(b)* According to given figure, the graph between stopping potential and frequency is a straight line, therefore stopping potential (V_0) and hence maximum kinetic energy ($K_{max} = eV_0$) of photoelectrons depends linearly on the frequency. Since, threshold frequency for Na is less than that of for Al, therefore work function for Na will be lesser than that of Al. Hence, Na is better photosensitive material than Al.

53. *(b)* Here, for hydrogen atom, Z = 1

We know that, time period of electron in nth orbit is given as

$$T_n \propto n^3$$

$$\therefore \quad \frac{T_{n_1}}{T_{n_2}} = \frac{n_1^3}{n_2^3}$$

Since, $T_{n_1} = 8T_{n_2}$

$$\therefore \quad \frac{8T_{n_2}}{T_{n_2}} = \frac{n_1^3}{n_2^3} \Rightarrow 2^3 = \left(\frac{n_1}{n_2}\right)^3$$

$$\Rightarrow \quad n_1 = 2n_2$$

Hence, this condition satisfies only in option (b).

i.e., $n_1 = 4$ and $n_2 = 2$

54. *(b)* When forward voltage in a diode is increased, then it opposes the potential barrier. Due to it, the potential barrier is considerably reduced and hence depletion region decreases.

55. *(b)* Since, nuclear force is independent of charge of the nucleons. Thus, nuclear force is same for any pair of two nucleons which are at same distance apart.

Therefore, $F_1 = F_2 = F_3$

56. *(d)* Given, initial value of de-Broglie wavelength,

$$\lambda_1 = 1 \text{ nm} = 1 \times 10^{-9} \text{ m}$$

Final value of de-Broglie wavelength,

$$\lambda_2 = 0.5 \text{ nm} = 0.5 \times 10^{-9} \text{m}$$

de-Broglie wavelength in terms of energy E is given as

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

$$\therefore \quad \lambda \propto \frac{1}{\sqrt{E}}$$

$$\Rightarrow \quad \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}}$$

where, E_1 and E_2 are initial and final energy,

$$\Rightarrow \quad \frac{1\times10^{-9}}{0.5\times10^{-9}} = \sqrt{\frac{E_2}{E_1}}$$

$$\Rightarrow \quad 2 = \sqrt{\frac{E_2}{E_1}}$$

$$\Rightarrow \quad E_2 = 4E_1$$

$\therefore$ Addition of energy $= E_2 - E_1 = 4E_1 - E_1 = 3E_1$

= thrice the initial energy

57. *(d)* Given, mean life of radioactive sample,

$$\tau = 100\text{ s} = \frac{100}{60}\text{ min} = \frac{5}{3}\text{ min}$$

We know that,

$$\tau = 1.44T_{1/2}$$

$$\Rightarrow \quad T_{1/2} = \frac{\tau}{1.44} = \frac{5/3}{1.44} = \frac{5}{3\times1.44} = 1.157\text{ min}$$

$$\simeq 1.155\text{ min}$$

58. *(d)* The decay's constant (λ) and half-life period of radioactive nuclei remains constant and independent of time of creation of radioactive nuclei.

Hence, the probability of decay during the next time is independent of the time of creation.

59. *(d)* Bohr assumed one of the postulates of Rutherford's atomic model. That is the mass of the nucleus is very large compared to that of the electrons and hence assumed to be infinite. Electrons in quantised orbit does not radiate energy. Mass of electron remains constant.

60. *(a)* A semiconductor acts like an insulator only at absolute temperature i.e. 0°K. It is because the free electrons in the valence band of semiconductor will not carry enough thermal energy to overcome the forbidden energy gap at absolute zero.

Hence, option (a) is not correct.

Chemistry

61. *(b)* The correct order in which first ionisation potential (IP) increases is K, Na, Be. On going down the group IP decreases while on going left to right IP increases.

62. *(c)* $V_1 = 10\text{ cm}^3$

$V_2 = 15\text{ cm}^3$

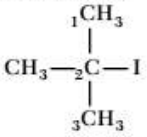
$N_1 = 0.1\text{ N}$

$N_2 = ?$

$N_1V_1 = N_2V_2$

$$N_2 = \frac{0.1\times10}{15} = 0.066\text{ N}$$

63. *(d)* Tertiary butyl iodide is



It's IUPAC name is 2-iodo-2-methyl propane.

64. *(c)* $3SO_2 + K_2Cr_2O_7 + H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$

O.N. of S in SO_2 is

$x + 2(-2) = 0$

$\Rightarrow \quad x = +4$

O.N. of S in K_2SO_4 is

$2(1) + x + 2(-4) = 0$

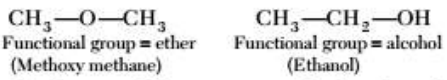
$x = +6$

$\therefore$ O.N. changes from + 4 to + 6.

65. *(c)* Mass of 0.1 mole of methane = molar mass × no. of moles

$= 16 \times 0.1 = 1.6\text{ g}$

66. *(c)* Methoxy methane and ethanol are functional group isomer as one is ether and other is alcohol group.

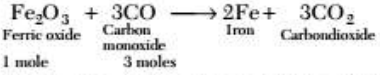


67. *(b)* The azimuthal quantum number has the value of 2 (i.e., $l = 2$) or (d-orbital).

$\therefore$ Magnetic quantum number (m) can be $= 2l + 1$

$= 2\times2 + 1 = 5$

68. *(c)* For the following reaction,

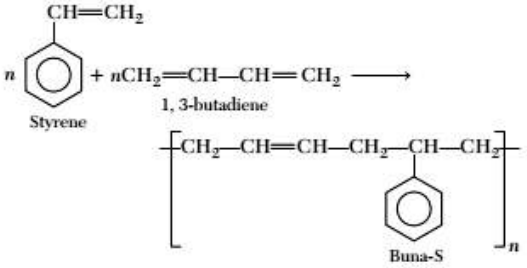


The volume of carbon monoxide require to reduce one mole of ferric oxide is

$= 3\times 22.4\text{ dm}^3 = 67.2\text{ dm}^3$

$\therefore$ Volume of CO required is 67.2 dm^3.

69. *(c)* The monomers of Buna-S rubber are styrene and butadiene.

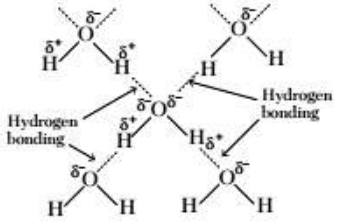


70. *(c)* Electronic configuration of element (21) is

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$

$\therefore$ It is a transition element as its last electron enters in d-orbital.

71. *(d)* The maximum number of hydrogen bonds that a molecule can have is 4.



72. *(a)* A gas deviates from ideal behaviour at high pressure because its molecules attract one another as their intermolecular distance decreases.

73. *(d)* The reagent used to convert alkyne to alkene is Pd/H_2.

$$\underset{\text{Ethyne}}{CH \equiv CH} \xrightarrow[\text{Lindlar's catalyst}]{H_2/Pd} \underset{\text{Ethene}}{CH_2 = CH_2}$$

74. *(b)* ΔG° for the formation of Al_2O_3 is higher than ΔG° for the formation of Cr_2O_3.

75. *(c)* According to ideal gas equation

$$pV = nRT$$

$$\therefore \quad V \propto \frac{1}{p}$$

$\therefore$ To increase the volume of gas by 10%, the pressure of gas should be decrease by 10%.

76. *(b)* Catalytic dehydration of a primary alcohol gives aldehyde i.e.,

$$\underset{\text{Primary alcohol}}{R{-}CH_2{-}OH} \xrightarrow[-H_2]{\text{Cu, 300°C}} \underset{\text{Aldehyde}}{R{-}CHO}$$

77. *(b)* Excess of PCl_5 reacts with conc.H_2SO_4 to gives thionyl chloride (SO_2Cl_2), phosphorus oxychloride ($POCl_3$) and HCl.

$$H_2SO_4 + 2PCl_5 \longrightarrow SO_2Cl_2 + 2POCl_3 + 2HCl$$

78. *(c)* $\underset{\text{Ammonical}}{NH_3(g)} + \underset{\text{Hydrogen chloride}}{HCl\,(g)} \longrightarrow \underset{\text{Ammonium chloride}}{NH_4Cl\,(g)}$

$$\Delta n_g = n_P - n_R = 1 - 2 = -1$$

Also, $\Delta H = \Delta U + \Delta n_g RT$

$\therefore \quad \Delta H - \Delta U = -\text{ve} \qquad [\because \Delta n_g = -\text{ve}]$

$\therefore \quad \Delta H < \Delta U$

79. *(b)* Secondary alcohols gives ketones on dehydrogenation e.g.,

$$\underset{\text{Secondary alcohol}}{CH_3{-}\underset{\displaystyle OH}{\underset{|}{CH}}{-}CH_3} \xrightarrow[-H_2]{\text{Cu/300°C}} \underset{\text{Ketone}}{CH_3{-}\overset{\displaystyle O}{\overset{\|}{C}}{-}CH_3}$$

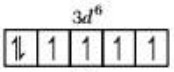
80. *(a)* Xenon has largest size and thus has high van der Waals' force of attraction. So, it is easily liquefiable rare gas.

81. *(a)* Mesomeric effect involves delocalisation of π-electrons. It can show + *M*-effect and $-M$-effect. The electron donating functional group shows + *M*-effect while electron withdrawing functional group shows $-M$-effect.

82. *(b)* The electronic configuration of

$Fe(26) = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$

$Fe^{2+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^0$



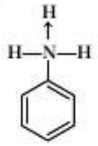
It has four unpaired electrons.

83. *(b)* The order of entropy is

$$S_{gas} > S_{liq} > S_{gas}$$

$\therefore$ One mole of hydrogen gas has the highest entropy.

84. *(b)* $C_6H_5\overset{+}{N}H_3$ does not exert a resonance effect because all the electron pairs of nitrogen are involved in bond formation.



Hence, no lone pair is present on nitrogen for resonance.

85. *(c)* The oxidation number of Ni metal is zero in complex $Ni(CO)_4$. As CO is a neutral ligand i.e., $\Rightarrow Ni(CO)_4$

$$x + 4(0) = 0$$

$$x = 0$$

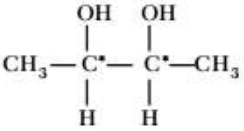
86. *(d)*

	PCl_3	+ Cl_2	$\rightleftharpoons$ PCl_5
Initially	3 moles	2 moles	3 moles
At equilibrium	(3 + 1.5) moles		1.5 moles

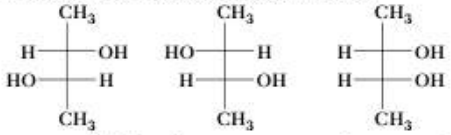
$\therefore$ At equilibrium 1.5 moles of PCl_5 is converted into 4.5 moles of PCl_3.

$\therefore$ Total moles of PCl_3 at equilibrium is 4.5.

87. *(b)* The structure of butane-2, 3-diol is



$\therefore$ It has three stereoisomers as follows:



$\therefore$ It has two optically active isomers.

88. *(c)* An octahedral complex is formed when hybrid orbital of sp^3d^2 (outer orbital) or d^2sp^3(inner orbital) types are involved.

89. *(a)* For the following reaction,

$2HI(g) \rightleftharpoons H_2(g) + I_2(g);\ -Q\text{kJ}$

$\Delta n = (n_P)_g - (n_R)_g = (1 + 1) - 2 = 0$

$\therefore$ Equilibrium constant (K_C) is independent of pressure and volume.

Heat is given in the reaction ($\Delta H = +ve$)

$\therefore$ According to Le-Chatelier's principle, on increasing temperature equilibrium shifts towards left hence, K_C decreases.

Catalyst only speeds up the reaction i.e., it help to achieves equilibrium faster without effecting the equilibrium point.

90. *(d)* The sp^3 hybridised carbon atom have bond angle of 109°28′ (tetrahedral angle). But in cyclobutane the bond angle is 90° due to square shape. Therefore,

$$\text{angle strain} = \frac{1}{2}(109°28' - 90°) = 9°44'$$

91. *(a)* The number of nodal planes in $\sigma^* s$-antibonding orbital is one. The σ^* orbital has nodal plane between nuclei and perpendicular to internuclear axis. As most of electron density is located away from the space between the nuclei, as a result of which there is a nodal plane between the nuclei.

92. *(d)* Specific conductance is least for 0.002 N electrolytic solution as it has least number of ions per unit volume of solution.

Specific conductance $\propto$ concentration of electrolyte.

93. *(c)* In benzene, the hybridisation of each carbon atom is sp^2.

$\therefore$ The overlapping in benzene is of sp^2-sp^2 type.

94. *(c)* The electronic configuration of O_2^- is

$$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 (\pi 2p_x^2 = \pi 2p_y^2) \quad (\pi^* 2p_x^2 = \pi^* 2p_y^1)$$

$$\therefore \text{ Bond order} = \frac{10 - 7}{2} = 1.5$$

95. *(a)* Ostwald-Walker's method is used to measure the relative lowering in vapour pressure of the solution.

96. *(b)* *n*-propyl bromide on treating with alcoholic KOH undergoes elimination reaction to produce propene i.e.,

$$\underset{n\text{-propyl bromide}}{CH_3—CH_2—CH_2—Br} \xrightarrow{\text{Alc. KOH}} \underset{\text{Propene}}{CH_3—CH=CH_2} + HBr$$

97. *(a)* Mercury is a liquid metal because it has completely filled 6*s*-orbital. The inner *f*-orbital poorly screens nuclear charge that stabilise 6*s*-orbital. Thus, it is not possible to form any bond with other elements.

98. *(a)* A occupies corner of unit cell.

$$\therefore \text{ Number of } A \text{ atoms} = 8 \times \frac{1}{8} = 1$$

B is at body centre.

$\therefore$ Number of *B* atoms = $1 \times 1 = 1$

The simplest formula of compound

$$A : B$$
$$1 : 1 = AB$$

99. *(b)* Anisole can be prepared by action of methyl iodide on sodium phenate. The reaction is called Williamson's reaction. It is used for preparation of simple or mixed ether.

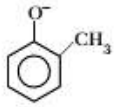
$$C_6H_5OH + NaOH \xrightarrow[-H_2O]{} \underset{\text{Sodium phenoxide}}{C_6H_5ONa} \xrightarrow{CH_3I} \underset{\substack{\text{Anisole}\\(\text{Ether})}}{C_6H_5—O—CH_3}$$

100. *(c)* Malleability and ductility of metals can be accounted due to capacity of layers of metal ions to slide over the other.

101. *(b)* For tetrahedral structure radius range is 0.225 to 0.414.

102. *(b)* Acidic character of organic compound increases with increase in strength of electron withdrawing group and decreases with electron releasing group.

In *o*-cresol, methyl group show + *I*-effect. It increase the density of electron on oxygen atom after the release of H^+ ion. Hence, it decrease the acidic strength.



Stability decreases

103. *(c)* A ligand is an atom or group of atom which donates lone pair of electron to central metal ions in coordination compound. Also, Lewis base is the substance that donates a pair of electron. Hence, ligand can also be regarded as Lewis base.

104. *(b)* The colour of sky is due to wavelength of scattered light. This scattering of light take place by particles of much small size.

105. *(c)* Iodoform test is given by compounds having $\left(CH_3—\underset{\underset{O}{\|}}{C}—\right)$ functional group.

Acetaldehyde $\left(H—\underset{\underset{O}{\|}}{C}—CH_3\right)$, also contains this group.

It also gives Fehling's test as all aldehydes (—CHO) give Fehling's test.

$\therefore$ Ethanal gives both the tests.

106. *(a)* Helium is used in balloons in place of hydrogen, because it is incombustible and inert in nature.

107. *(c)* The basic principle of Cottnell's precipitator is neutralisation of charge on colloidal particle by

attracting them towards the wall of oppositively charged precipitator.

Thus, lose their charge and coagulate colloidal particle.

108. *(c)* When, carbon mono-oxide is passed over solid caustic soda heated to 200°C, it forms sodium formate.

$$\underset{\text{Carbon monoxide}}{CO} + \underset{\text{Caustic soda}}{NaOH} \longrightarrow \underset{\text{Sodium formate}}{HCOONa}$$

109. *(a)* The given reaction, $N_2 + 3H_2 \rightleftharpoons 2NH_3 + \text{Heat}$, is an exothermic reaction.

$\therefore$ According to Le-Chatelier's principle, on increase in temperature equilibrium is shifted to the left.

110. *(a)* The order of reactivity of given elements is

$$Ag < H < Zn < Sn < Mg$$

As, Ag is less reactive than hydrogen, it cannot replace hydrogen from HCl and H_2 gas is not liberated.

111. *(a)* The ionic compound formed is $M^+X^-(s)$ as the gaseous ions $[M^+(g)$ and $Cl^-(g)]$ combines in the crystal lattice which is in solid state.

112. *(d)* The brown ring is due to the formation of a brown complex between nitric oxide and Fe^{2+} ions.

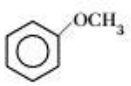
$$NO_3^- + 3Fe^{2+} + 4H^+ \longrightarrow 3Fe^{3+} + NO + 2H_2O$$

or $$2HNO_3 + 2H_2SO_4 + 6FeSO_4 \longrightarrow \underset{\substack{\text{Brown colour complex or} \\ \text{nitrosoferrous sulphate}}}{[Fe(H_2O)_5NO]SO_4} + H_2O$$

113. *(b)* Amines behaves as Lewis base as if donates it lone pairs in the chemical reaction.

114. *(b)* Oils reacts with hydrogen in presence of metal catalyst to give saturated glycerides. Thus, vegetable ghee (Dalda) is obtained by hydrogenation (reduction) of oils.

115. *(b)* Anisole is



Its chemical name is methoxy benzene.

116. *(c)* The number of disulphide linkages present in insulin are three. Two linkages are between two polypeptide chains containing 21 and 30 amino acid residues. In addition, the smaller polypeptide chain (21 amino acids) has also an internal disulphide linkage.

117. *(d)* Number of atoms $= \dfrac{\text{mass}}{\text{molecular mass}} \times N_A$

Number of atoms is oxygen = product of atoms in hydrogen

$$\frac{80}{16} \times N_A = \frac{W}{1} \times N_A$$

$$\therefore \quad W = \frac{80}{16} = 5 \text{ g of hydrogen}$$

118. *(d)* Greater the stability of oxide, greater is the chance of its formation. Generally, ionic oxide are more stable, than covalent oxides and among the given metals only Ca form ionic oxide. Hence, Ca has greater tendency to form oxide.

119. *(c)* The reaction, $2Fe_2O_3 + 3C \longrightarrow 4Fe + 3CO_2$, do not occur in blast furnance. This reaction occurs at the end of the process.

120. *(d)* Wax is an ester of fatty acid and an alcohol.

They are formed by combining one fatty acid with one fatty alcohol molecule.

$$\underset{\text{Fatty acid}}{RCOOH} + \underset{\text{Alcohol}}{R'OH} \longrightarrow \underset{\text{Wax (ester)}}{RCOOR'} + H_2O$$

Mathematics

121. *(b)* : Let $f(x) = x^2 + \sin^2 x$, then $f(-x) = f(x)$

Therefore, $f(x) = x^2 + \sin^2 x$ is an even functions.

122. *(a)* Here, $A = \{x : x^2 - x + 2 > 0\} = R$

$$\left(\because x^2 - x + 2 = x^2 - x + \frac{1}{4} + \frac{7}{4} \right.$$
$$\left. = \left(x - \frac{1}{2}\right)^2 + \frac{7}{4} \geq \frac{7}{4} \right)$$

and $B = \{x : x^2 - 4x + 3 \leq 0\}$

$= \{x : (x-1)(x-3) \leq 0) = [1, 3]$

Hence, $A \cap B = R \cap [1, 3] = [1, 3]$

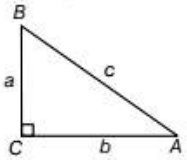
123. *(d)* : $b \in A$ is said to be an inverse of a w.r.t. operation * if $a * b = b * a = e$. [by definition]

124. *(a)* Given, $\angle C = \dfrac{\pi}{2} \Rightarrow c^2 = a^2 + b^2$ {by pythagoras}

Now, $\tan^{-1}\left(\dfrac{a}{b+c}\right) + \tan^{-1}\left(\dfrac{b}{c+a}\right)$

$$= \tan^{-1}\left[\frac{\frac{a}{b+c} + \frac{b}{c+a}}{1 - \left(\frac{a}{b+c}\right)\left(\frac{b}{c+a}\right)}\right]$$

$$= \tan^{-1}\left(\frac{ac + a^2 + b^2 + bc}{bc + ba + c^2 + ca - ab}\right)$$



$$= \tan^{-1}\left(\frac{ac + c^2 + bc}{bc + c^2 + ca}\right)$$

$$= \tan^{-1}(1) = \frac{\pi}{4}$$

125. *(d)* $\frac{\cos\alpha}{1}=\frac{a}{b+c}\Rightarrow\frac{1}{\cos\alpha}=\frac{b+c}{a}$

By componendo and dividendo,we have

$$\frac{1-\cos\alpha}{1+\cos\alpha}=\frac{b+c-a}{b+c+a}$$

$$\Rightarrow \tan^2\frac{\alpha}{2}=\frac{b+c-a}{3b}\quad\left\{\because a,b,c \text{ are in A.P.}\Rightarrow 2b=a+c\right\}$$

$$\Rightarrow \frac{1-\cos\gamma}{1+\cos\gamma}=\frac{a+b-c}{a+b-c}$$

$$\Rightarrow \tan^2\frac{\gamma}{2}=\frac{a+b-c}{3b}$$

$$\therefore \tan^2\frac{\alpha}{2}+\tan^2\frac{\gamma}{2}=\frac{2b}{3b}=\frac{2}{3}$$

126. *(c)* $\cos(35^\circ+A)\cos(35^\circ-B)+\sin(35^\circ+A)\sin(35^\circ-B)$

$=\cos[(35^\circ+A)-(35^\circ-B)]$

$=\cos(A+B)$

127. *(b)* $2\operatorname{cosec}2x+\operatorname{cosec}x$

$$=\frac{2}{\sin 2x}+\frac{1}{\sin x}=\frac{2}{2\sin x\cdot\cos x}+\frac{1}{\sin x}$$

$$=\frac{1}{\sin x}\left[\frac{1}{\cos x}+1\right]=\frac{1}{\sin x}.\frac{(1+\cos x)}{\cos x}$$

$$=\frac{1}{\cos x}.\frac{2\cos^2(x/2)}{2\cdot\sin(x/2)\cdot\cos(x/2)}$$

$$=\sec x.\frac{\cos(x/2)}{\sin(x/2)}\qquad\left[\because \cos 2x=2\cos^2x-1,\ \sin 2x=2\sin x\cos x\right]$$

$=\sec x\cdot\cot(x/2)$

128. *(d)* We have, $\cot 3x=\cot(2x+x)$

$$\Rightarrow \cot 3x=\frac{\cot 2x\cot x-1}{\cot 2x+\cot x}\qquad\left\{\cot(A+B)=\frac{\cot A\cot B-1}{\cot A+\cot B}\right\}$$

$\Rightarrow \cot 3x\cot 2x+\cot 3x\cot x=\cot 2x\cot x-1$

$\Rightarrow \cot 2x\cot x-\cot 3x\cot 2x-\cot 3x\cot x=1$

129. *(a)* We have $\cos A\cos B-\sin A\sin B$

$$=\cos(A+B)=\cos\left[\left(\frac{\pi}{4}-x\right)+\left(\frac{\pi}{4}-y\right)\right]$$

where, $A=\frac{\pi}{4}-x$ and $B=\frac{\pi}{4}-y$

$$=\cos\left[\frac{\pi}{2}-(x+y)\right]=\sin(x+y)$$

130. *(d)* Let $P(n)=2\cdot4^{2n+1}+3^{3n+1}$

$P(1)\equiv 128+81=209$, which is divisible by 11 only.

131. *(c)* $P(1)$: '$1\times1!=(1+1)!-1$' is true.

Let $P(k)$: ''$1\times1!+2\times2!+3\times3!+\ldots+k\times k!=(k+1)!-1$'' is true.

Now, $P(k+1):1\times1!+2\times2!+\ldots+k+k!+(k+1)\times(k+1)!$

$=(k+1)!-1+(k+1)(k+1)!$

$=(k+1)!+(k+1)\times(k+1)!-1$

$=(k+1)!(1+k+1)-1=(k+2)!-1$

i.e., $P(k)$ is true $\Rightarrow P(k+1)$ is true

132. *(d)* We have,

$z=re^{i\theta}=r(\cos\theta+i\sin\theta)$

$\therefore\ iz=ir(\cos\theta+i\sin\theta)$

$=ir\cos\theta+i^2r\sin\theta=-r\sin\theta+ir\cos\theta$

$|e^{iz}|=|e^{(-r\sin\theta+ir\cos\theta)}|$

$=|e^{-r\sin\theta}|.|ir\cos\theta|$

$=e^{-r\sin\theta}\left[\sqrt{\cos^2(r\cos\theta)+\sin^2(r\cos\theta)}\right]$

$=e^{-r\sin\theta}\times1=e^{-r\sin\theta}$

133. *(b)* We have, $(\sqrt{5}+\sqrt{3}i)^{33}=2^{49}z$

Taking modulus on both sides, we get

$2^{49}|z|=|\sqrt{5}+\sqrt{3}i)^{33}$

$\Rightarrow 2^{49}|z|=(\sqrt{5+3})^{33}=(\sqrt{8})^{33}=2^{33}2^{33/2}$

$$\Rightarrow\ |z|=\frac{2^{33}2^{33/2}}{2^{49}}=2^{\frac{33}{2}-16}=2^{1/2}=\sqrt{2}$$

134. *(c)* $\left|\frac{1}{1-\cos\theta+i\sin\theta}\right|=\frac{1}{|1-\cos\theta+i\sin\theta|}$

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

$$=\frac{1}{2|\sin(\theta/2)|}=\frac{1}{2}\left|\operatorname{cosec}\frac{\theta}{2}\right|$$

135. *(d)* We have, $a+b\omega+c\omega^2=0$

$$\Rightarrow\ a+b\left(-\frac{1}{2}+\frac{i\sqrt{3}}{2}\right)+c\left(-\frac{1}{2}-\frac{i\sqrt{3}}{2}\right)=0$$

$$\Rightarrow\ \left(a-\frac{b}{2}-\frac{c}{2}\right)+i\left(\frac{\sqrt{3}b}{2}-\frac{\sqrt{3}c}{2}\right)=0+0i$$

Real part $\Rightarrow a=\frac{b+c}{2}$.

Imaginary parts $\Rightarrow b=c$

$\therefore\qquad a=b=c$

136. *(d)* We have,

$(x-1)^3=-8=(-2)^3$

$\therefore\quad x-1=-2,-2\omega,-2\omega^2$

$\Rightarrow\qquad x=-1,1-2\omega,1-2\omega^2$

137. *(d)* We have, $a^3x^2+abcx+c^3=0$

$$\Rightarrow\ x^2+\frac{b}{a}.\frac{c}{a}x+\left(\frac{c}{a}\right)^3=0$$

$\Rightarrow\ x^2-(\alpha+\beta)\alpha\beta x+\alpha^3\beta^3=0$

$\Rightarrow\ x=\alpha^2\beta,\alpha\beta^2\Rightarrow\alpha^2\beta$ is one of the root.

138. *(a)* There are $4! = 24$ numbers. Each digit occurring $3! = 6$ times, in the unit's, ten's, hundred's and thousand's places. We note that $(2 + 4 + 6 + 8) = 120$. Thus in the over all sum there will be 120 units, 120 tens, 120 hundreds and 120 thousands.

The required sum

$$= 120(1 + 10 + 10^2 + 10^3)$$

$$= 120 \times 1111 = 133320$$

139. *(d)* Total number of discs are $4 + 3 + 2 = 9$.

Out of 9 discs, 4 are of the first kind (red) 3 are of the second kind (yellow) and 2 are of the third kind (green).

Therefore, the number of arrangements

$$= \frac{9!}{4!3!2!} = 1260$$

140. *(a)* There are 12 face cards and 4 are to be selected, out of these 12 cards. This can be done in ${}^{12}C_4$ ways.

Therefore, the required number of $= \frac{12!}{4!8!} = 495$

141. *(a)* $\binom{2n}{3r-1} = \binom{2n}{r+1}$

$$\left\{\because {}^nC_x = {}^nC_y \Rightarrow x + y = n \text{ or } n - x = y\right\}$$

$\Rightarrow \quad 2n = 3r - 1 + r + 1 \Rightarrow n = 2r$

142. *(d)* H.M. $= \frac{2ab}{a+b}$; G.M. $= \sqrt{ab}$,

Now, $\quad \frac{\text{H.M.}}{\text{G.M.}} = \frac{2\sqrt{ab}}{a+b} = \frac{4}{5}$

$\Rightarrow \quad 25ab = 4(a+b)^2$

$\Rightarrow \quad 4a^2 - 17ab + 4b^2 = 0$

$\Rightarrow \quad (4a - b)(a - 4b) = 0$

$\Rightarrow \quad 4a = b \Rightarrow a : b = 1 : 4$

143. *(a)* Let the numbers be a, ar, ar^2, ar^3.

$\Rightarrow \quad a - 2, ar - 7, ar^2 - 9$ are in A.P.

$\Rightarrow \quad a - 2 + ar^2 - 9 = 2(ar - 7)$

$\Rightarrow \quad a(r^2 + 1) - 11 = 2ar - 14$

$\Rightarrow \quad r^2 + 1 = 2r - \frac{3}{a} \qquad \ldots$ (i)

Further, $ar - 7 + ar^3 - 5 = 2(ar^2 - 9)$

$\Rightarrow \quad ar(r^2 + 1) - 12 = 2ar^2 - 18$

$\Rightarrow \quad r^2 + 1 = 2r - \frac{6}{ar} \qquad \ldots$ (ii)

Solving Eqs. (i) and (ii), we get $r = 2$, $a = -3$

The number are $-3, -6, -12, -24$

144. *(c)* n th term $= \frac{n}{(2n+1)!}$

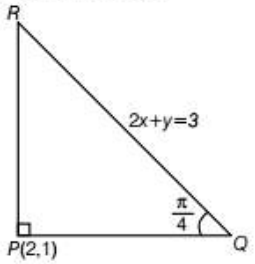
$$= \frac{1}{2}\left[\frac{(2n+1)-1}{(2n+1)!}\right] = \frac{1}{2}\left[\frac{1}{(2n)!} - \frac{1}{(2n+1)!}\right]$$

$\therefore$ Sum of the series

$$= \frac{1}{2}\left[\frac{1}{2!} - \frac{1}{3!} + \frac{1}{4!} - \frac{1}{5!} + \frac{1}{6!} - \frac{1}{7!} + \ldots\right]$$

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

145. *(b)* Let m be the slope of PQ.



Slope of QR is -2.

$$\left|\frac{m+2}{1-2m}\right| = \tan\frac{\pi}{4} = 1$$

$\Rightarrow \quad m + 2 = \pm(1 - 2m) \Rightarrow m = 3, -\frac{1}{3}$

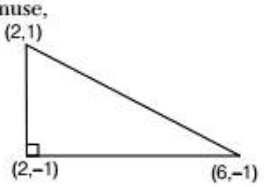
The lines PQ and PR are $\frac{y-1}{x-2} = 3, -\frac{1}{3}$

The combined equation is

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

or $\quad 3x^2 - 3y^2 + 8xy - 20x - 10y + 25 = 0$

146. *(a)* The vertices are $(2, -1), (6, -1), (2, 1)$ forming a right angled triangle. Circumcentre is the mid-point of the hypotenuse,



i.e., $\quad \left(\frac{6+2}{2}, \frac{1-1}{2}\right) = (4, 0)$

147. *(c)* We have, $a = 3$, $b = 4$ and

$$c = \sqrt{a^2 + b^2} = \sqrt{9 + 16} = 5$$

Therefore, the coordinates of the foci are $(\pm 5, 0)$.

Also, length of latusrectum $= \frac{2b^2}{a} = \frac{32}{3}$

148. *(c)* The line $21x + 5y = 116$ is a tangent to $7x^2 - 5y^2 = 232$. If $P(x_1, y_1)$ is the point of contact, then $S_1 = 0$.

$\Rightarrow 7x_1x - 5y_1y = 232$. It is same as $21x + 5y = 116$

$\therefore \quad \frac{7x_1}{21} = -\frac{5y_1}{5} = \frac{232}{116} = 2$

$\therefore \quad x_1 = 6, y_1 = -2$. So, P is $(6, -2)$.

149. *(a)* Let $P(x_1, y_1)$ be the mid-point of a chord of $x^2 + y^2 = r^2$.

Its equation is

$$S_1 = S_{11} \Rightarrow x_1x + y_1y = x_1^2 + y_1^2$$

or $$y = \left(-\frac{x_1}{y_1}\right)x + \frac{x_1^2 + y_1^2}{y_1}$$

The line $y = mx + c$ is a tangent to the hyperbola only if

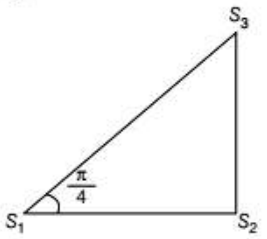
$$c^2 = a^2m^2 - b^2$$

$$\therefore \quad \frac{(x_1^2 + y_1^2)^2}{y_1^2} = \frac{a^2x_1^2}{y_1^2} - b^2$$

$\therefore$ The locus of P is

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

150. *(b)* $\tan\frac{\pi}{4} = \frac{LS}{S_1S}$



$$= \frac{a(e^2 - 1)}{2ae}$$

$$\Rightarrow \qquad 1 = \frac{e^2 - 1}{2e}$$

$$\Rightarrow \quad e^2 - 2e - 1 = 0$$

Solving, $\qquad e = \sqrt{2} + 1$

151. *(a)* Tangent with slope m is

$$y = mx \pm \sqrt{a^2m^2 - b^2}$$

It passes through (0, 1).

$$\therefore \qquad 1 = \sqrt{\frac{m^2}{2} - 1} \qquad \left[\text{Since, } a^2 = \frac{1}{2}, b^2 = 1\right]$$

$$\Rightarrow \qquad 1 = \frac{m^2}{2} - 1$$

$$\Rightarrow \qquad m = \pm 2$$

$$\Rightarrow \quad \tan\theta = \left|\frac{2 - (-2)}{1 - 4}\right| = \frac{4}{3}$$

152. *(b)* Let $P(3, 4, -1)$ and $Q(-1, 2, 3)$ be the end points of the diameter of a sphere.

$\therefore$ Length of diameter $= PQ$

$$= \sqrt{(-1 - 3)^2 + (2 - 4)^2 + (3 + 1)^2}$$

$$= \sqrt{16 + 4 + 16} = \sqrt{36} = 6 \text{ units}$$

$$\therefore \quad \text{Radius} = \frac{6}{2} = 3 \text{ units}$$

153. *(c)* Let $y = \cos^{-1}\left(\frac{1 - x}{1 + x}\right)$

Put $x = \tan^2\theta$

$$\Rightarrow \theta = \tan^{-1}\sqrt{x}$$

$$\therefore \quad y = \cos^{-1}\left(\frac{1 - \tan^2\theta}{1 + \tan^2\theta}\right)$$

$$= \cos^{-1}(\cos 2\theta) = 2\theta = 2\tan^{-1}\sqrt{x}$$

$$\therefore \quad \frac{dy}{dx} = 2\frac{d}{dx}(\tan^{-1}\sqrt{x})$$

$$= 2 \times \frac{1}{1 + x} \times \frac{1}{2\sqrt{x}} = \frac{1}{\sqrt{x}(1 + x)}$$

154. *(b)* $f(x) = \left(\frac{5}{x} + 7\right)$

$$\Rightarrow f'(x) = \frac{-5}{x^2} < 0 \text{ for all}$$

$x \in R$, where $x \neq 0$.

Hence, $f(x)$ is decreasing for $x \in R - \{0\}$.

155. *(a)* Let $f(x) = x^{1/4}$

$$\Rightarrow \qquad f'(x) = \frac{1}{4x^{3/4}}$$

Now, $a + h = 15 = 16 - 1$, where

$$a = 16, h = -1$$

We know, $f(a + h) = f(a) + hf'(a)$

$$\Rightarrow \quad f(15) = f(16) - 1f'(16)$$

$$\Rightarrow (15)^{1/4} = (16)^{1/4} - \frac{1}{4(16)^{3/4}} = 2 - \frac{1}{32}$$

$$\Rightarrow (15)^{1/4} = 2 - 0.03125 = 1.9688$$

156. *(d)* Let the required point be $P(x_1, y_1)$

The given curve is $y = x^2$ ... (i)

Differentiating Eq. (i) w.r.t. x, we get

$$\frac{dy}{dx} = 2x \Rightarrow \text{Slope of tangent at } P(x_1, y_1) = 2x$$

But the slope of tangent at

$P(x_1, y_1) = x$-coordinate of P

$$\Rightarrow \quad 2x_1 = x_1 \Rightarrow 2x_1 - x_1 = 0$$

$$\Rightarrow \quad x_1 = 0$$

As $P(x_1, y_1)$ lies on the curve, we get

$$y_1 = x_1^2 \Rightarrow y_1 = 0$$

Hence, the required point is (0, 0).

157. *(d)* Given curve, $y = \frac{x^3}{4 - x}$ ...(i)

is the given curve

Differentiating Eq. (i) w.r.t. x, we get

$$\frac{dy}{dx} = \frac{(4 - x)(3x^2) - x^3(-1)}{(4 - x)^2} = \frac{12x^2 - 2x^3}{(4 - x)^2}$$

$$\Rightarrow \left(\frac{dy}{dx}\right)_{x = 2} = \frac{12(2)^2 - 2(2)^3}{(4 - 2)^2} = \frac{32}{4} = 8$$

$\Rightarrow$ The slope of tangent at (2, 4) is 8.

$\therefore$ The equation of tangent is

$$y - 4 = 8(x - 2)$$

$$\Rightarrow \quad 8x - y - 12 = 0 \Rightarrow \text{slope} = \frac{-8}{-1} = 8$$

Now the slope of normal at $P(2, 4)$ is $\frac{-1}{8}$.

$\therefore$ The equation of normal is

$$y - 4 = \frac{-1}{8}(x - 2)$$

$$\Rightarrow \quad x + 8y - 34 = 0$$

158. *(d)* We have,

$$y = \log_a x + \frac{\log a}{\log x} + 1 + 1 \qquad [\because \log_x x = 1]$$

$$\Rightarrow \frac{dy}{dx} = \frac{1}{x}\log_a e - \log a\left(\frac{1}{\log x}\right)^2 \frac{1}{x} = \frac{1}{x \log a} - \frac{\log a}{x(\log x)^2}$$

159. *(c)* We have,

$$\int \frac{1}{\sin x + \sqrt{3}\cos x}\,dx = \frac{1}{2}\int \frac{dx}{\frac{1}{2}\sin x + \frac{\sqrt{3}}{2}\cos x}$$

$$= \frac{1}{2}\int \frac{1}{\sin\left(x + \frac{\pi}{3}\right)}dx$$

$$= \frac{1}{2}\int \text{cosec}\left(x + \frac{\pi}{3}\right)dx$$

$$= \frac{1}{2}\log\left|\tan\left(\frac{x}{2} + \frac{\pi}{6}\right)\right| + C$$

160. *(a)* $\int e^{2x}(2\sin 3x + 3\cos 3x)\,dx$

$$= 2\int e^{2x}\sin 3x\,dx + 3\int e^{2x}\cos 3x\,dx$$

$$= e^{2x}\sin 3x - 3\int e^{2x}\cos 3x\,dx + 3\int e^{2x}\cos 3x\,dx + C$$

$$= e^{2x}\sin 3x + C$$

161. *(a)* $\int_1^2 \frac{dx}{x^2} = \left[\left(\frac{-1}{x}\right)\right]_1^2 = \frac{1}{2}$

162. *(a)* We have,

$$I = \int_0^{\pi/2} \frac{\cos x}{\left(\cos\frac{x}{2} + \sin\frac{x}{2}\right)^3}dx = \int_0^{\pi/2} \frac{\cos^2\frac{x}{2} - \sin^2\frac{x}{2}}{\left(\cos\frac{x}{2} + \sin\frac{x}{2}\right)^3}dx$$

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

Put $\cos\frac{x}{2} + \sin\frac{x}{2} = t$

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

Also, when $x = 0 \Rightarrow t = 1$

When $x = \frac{\pi}{2} \Rightarrow t = \sqrt{2}$

$$\therefore \qquad I = \int_1^{\sqrt{2}} \frac{2dt}{t^2}$$

$$= 2\left[-\frac{1}{t}\right]_1^{\sqrt{2}} = 2\left[-\frac{1}{\sqrt{2}} + 1\right] = (2 - \sqrt{2})$$

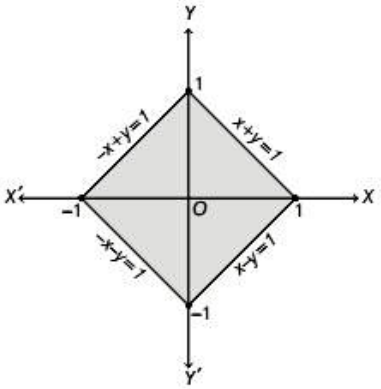
163. *(b)* We have,

$$x + y = 1 \;\forall\; x, y \geq 0 \qquad \ldots(i)$$

$$-x + y = 1 \;\forall\; x < 0, y \geq 0 \qquad \ldots(ii)$$

$$-x - y = 1 \;\forall\; x < 0, y < 0 \qquad \ldots(iii)$$

$$x - y = 1 \;\forall\; x \geq 0, y < 0 \qquad \ldots(iv)$$



Required area is the area of shaded region

$$= 4\int_0^1 (1 - x)\,dx$$

$$= 4\left[x - \frac{x^2}{2}\right]_0^1 = 4 \times \frac{1}{2} = 2 \text{ sq. units}$$

164. *(c)* Let $I = \int \frac{dx}{\sqrt{x} + \sqrt[3]{x}}$

Put $x = t^6 \Rightarrow dx = 6t^5\,dt$

$$\therefore \quad I = \int \frac{6t^5}{t^3 + t^2}\,dt = 6\int \frac{t^3}{t + 1}\,dt$$

$$= 6\int\left(t^2 - t + 1 - \frac{1}{t + 1}\right)dt$$

$$= 2t^3 - 3t^2 + 6t - 6\log(t + 1) + C$$

$$= 2\sqrt{x} - 3(\sqrt[3]{x}) + 6(\sqrt[6]{x}) - 6\log(\sqrt[6]{x} + 1) + C$$

165. *(b)* $\int_a^b \frac{x^n}{x^n + (16 - x)^n}\,dx = 6 \qquad \ldots(i)$

Let $a + b = 16$, then

$$\int_a^b \frac{(16-x)^n}{(16-x)^n + x^n}\,dx = 6 \quad \ldots(ii)$$

Adding Eqs. (i) and (ii), we get

$$\int_a^b 1 \cdot dx = 12 \Rightarrow b - a = 12$$

Solving $a + b = 16$ and $b - a = 12$, we get

$$a = 2,\ b = 14,\ n \in R$$

166. *(a)* $f(x) = 1 + \cos 2x$ and

$f(-x) = 1 + \cos(-2x) = 1 + \cos 2x = f(x)$

$\Rightarrow \quad f(x) = f(-x)$

Hence, $f(x)$ is even function.

$$\Rightarrow \quad I = 2\int_0^{\pi/4} \frac{dx}{1 + \cos 2x}$$

$$= 2\int_0^{\pi/4} \frac{dx}{2\cos^2 x}$$

$$= 2\int_0^{\pi/4} \frac{1}{2}\sec^2 x\,dx$$

$$= [\tan x]_0^{\pi/4} = \left(\tan\frac{\pi}{4} - \tan 0\right) = 1$$

167. *(c)* We have, $y = ae^{bx+c}$ ... (i)

Differentiating Eq. (i) w.r.t. x, we get

$$y_1 = a(e^{bx+c})b = b(ae^{bx+c}) = by \quad \ldots(ii)$$

Again differentiating Eq. (ii) w.r.t. x, we get

$$y_2 = by_1 \quad \ldots(ii)$$

From Eq. (ii) and Eq. (i), we have

$$\Rightarrow \quad y.y_2 = y_1^2$$

168. *(a)* Here, $\mathbf{a} + 3\mathbf{b} = \hat{\mathbf{i}} + \hat{\mathbf{j}} + 2\hat{\mathbf{k}} + 3(3\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - \hat{\mathbf{k}})$

$$= 10\hat{\mathbf{i}} + 7\hat{\mathbf{j}} - \hat{\mathbf{k}}$$

and $2\mathbf{a} - \mathbf{b} = 2(\hat{\mathbf{i}} + \hat{\mathbf{j}} + 2\hat{\mathbf{k}}) - (3\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - \hat{\mathbf{k}}) = -\hat{\mathbf{i}} + 5\hat{\mathbf{k}}$

$(\mathbf{a} + 3\mathbf{b}).(2\mathbf{a} - \mathbf{b}) = (10\hat{\mathbf{i}} + 7\hat{\mathbf{j}} - \hat{\mathbf{k}}).(-\hat{\mathbf{i}} + 5\hat{\mathbf{k}})$

$= 10 \times (-1) + 7 \times 0 + -1 \times 5 = -15$

169. *(a)* $[\mathbf{a} - \mathbf{b}\ \mathbf{b} - \mathbf{c}\ \ \mathbf{c} - \mathbf{a}] = (\mathbf{a} - \mathbf{b}) \cdot [(\mathbf{b} - \mathbf{c}) \times (\mathbf{c} - \mathbf{a})]$

$= (\mathbf{a} - \mathbf{b}) \cdot [\mathbf{b} \times \mathbf{c} - \mathbf{b} \times \mathbf{a} - \mathbf{c} \times \mathbf{c} + \mathbf{c} \times \mathbf{a})]$

$= (\mathbf{a} - \mathbf{b}).[\mathbf{b} \times \mathbf{c} - \mathbf{b} \times \mathbf{a} + \mathbf{c} \times \mathbf{a}]$

$= \mathbf{a} \cdot (\mathbf{b} \times \mathbf{c}) - \mathbf{a} \cdot (\mathbf{b} \times \mathbf{a}) + \mathbf{a} \cdot (\mathbf{c} \times \mathbf{a}) - \mathbf{b}(\mathbf{b} \times \mathbf{c})$

$+ \mathbf{b} \cdot (\mathbf{b} \times \mathbf{a}) - \mathbf{b}(\mathbf{c} \times \mathbf{a})$

$= [\mathbf{abc}] - [\mathbf{aba}] + [\mathbf{aca}] - [\mathbf{bbc}] + [\mathbf{bba}] - [\mathbf{bca}]$

$= [\mathbf{abc}] - [\mathbf{bca}] = 0 \qquad \{\because [\mathbf{abc}] = [\mathbf{bca}] = [\mathbf{cab}]\}$

170. *(b)* $A = \begin{bmatrix} 2 & -3 \\ 5 & -7 \end{bmatrix}$

$\therefore \quad |A| = -14 + 15 = 1 \neq 0$

So, A^{-1} exists.

$\therefore \quad \text{adj } A = \begin{bmatrix} -7 & 3 \\ -5 & 2 \end{bmatrix}$

$$\Rightarrow \quad A^{-1} = \frac{1}{|A|}(\text{adj } A) = \begin{bmatrix} -7 & 3 \\ -5 & 2 \end{bmatrix}$$

$$\Rightarrow \quad A + A^{-1} = \begin{bmatrix} 2 & -3 \\ 5 & -7 \end{bmatrix} + \begin{bmatrix} -7 & 3 \\ -5 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} -5 & 0 \\ 0 & -5 \end{bmatrix}$$

171. *(d)* We have,

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

$$\text{Minor of } a_{32} = \begin{vmatrix} \cos\theta & 0 \\ \sin\theta & 0 \end{vmatrix} = 0 - 0 = 0$$

and cofactor of a_{32} = − Minor of a_{32} = − 0 = 0

172. *(d)* The probability that the place does not hit is

$P(\text{FFFF}) = (1 - 0.4)(1 - 0.3)(1 - 0.2)(1 - 0.1)$

$= (0.6)(0.7)(0.8)(0.9) = 0.3024$

The probability of hitting is $1 - 0.3024 = 0.6976$

173. *(c)* The given statement is

"If I become a teacher, then I will open a school".

Negation of the given statements is

"I will become a teacher and I will not open a school".

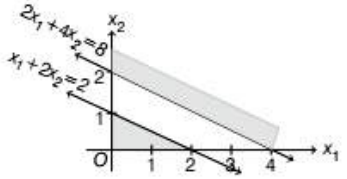
$(\because \sim(p \to q) = (p \wedge \sim q)$, where p is first statement and q is second statement.

174. *(c)* We have,

$$x_1 + 2x_2 = 2;\ 2x_1 + 4x_2 = 8$$

i.e., $\quad \frac{x_1}{2} + \frac{x_2}{1} = 1,\ \frac{x_1}{4} + \frac{x_2}{2} = 1$

The constraint are shown by the graph



From the graph, we conclude that there is no feasible region, i.e. there is no unique solutions satisfying all the constraints.

175. *(c)* Let the coordinates of a point P changes from (x, y) to (x', y') in new coordinates axes where origin has the coordinates $h = 1$,

$$k = 1$$

Then, $\quad x = x' + 1,\ y = y' + 1.$

Substituting these values in the given equation of straight line

$$(x' + 1)(y' + 1) - (x' + 1) - (y' + 1) + 1 = 0$$

$$\Rightarrow x'y' + x' + y' + 1 - x' - 1 - y' - 1 + 1 = 0$$

$$\Rightarrow x'y' = 0$$

Therefore, the equation of straight line in the new system is $xy = 0$

176. *(d)* We have, $\log_6 abc = 6 \Rightarrow abc = 6^6$ ...(i)

Let $b = ar,\ c = ar^2$

Eq. (i), $a^3r^3 = 6^6 \Rightarrow b = ar = 36$

$b - a = 36 - a$ is square for $a = 35, 32, 27, 20, 11$

$$c = \frac{b^2}{a} = \frac{36^2}{a} \text{ is an integer for } a = 27$$

$\therefore \quad a = 27,\ b = 36, c = 48$

$\Rightarrow \quad a + b + c = 111$

177. *(c)* $F(x) = P(X < x)$

$F(0) = P(X \le 0) = 0.5$

$F(1) = P(X \le 1) = 0.5 + 0.2 = 0.7$

$F(2) = P(X \le 2) = 0.5 + 0.2 + 0.18 = 0.88$

$F(3) = P(X \le 3) = 0.5 + 0.2 + 0.18 + 0.12 = 1$

$\therefore$ The c.d.f. of X is

$X = x$	0	1	2	3
$F(x)$	0.5	0.7	0.88	1

178. *(c)* X can take values 0, 1, 2.

The probability distribution of X.

Since there are 16 items are perfect and 4 are defective. Given that two items are drawn randomly.

$\therefore$ P(no defective items are drawn) $= \dfrac{^{16}C_2}{^{20}C_2}$

$X = x$	0	1	2
$P(X = x)$	$\dfrac{^{16}C_2}{^{20}C_2} = \dfrac{12}{19}$	$\dfrac{^4C_1 \times {}^{16}C_1}{^{20}C_2} = \dfrac{32}{95}$	$\dfrac{^4C_2}{^{20}C_2} = \dfrac{3}{95}$

179. *(b)* Let sets A and B have m and n elements, respectively.

Then, $2^m - 2^n = 56 \Rightarrow 2^n\,(2^{m-n} - 1) = 56$

$\Rightarrow \quad 2^n(2^{m-n} - 1) = 8 \times 7$

$\Rightarrow \quad 2^n(2^{m-n} - 1) = 2^3 \times 7$

One comparing both sides, we get

$2^n = 2^3$ and $2^{m-n} - 1 = 7$

$\Rightarrow \quad n = 3$ and $2^{m-n} = 8$

$\Rightarrow \quad 2^{m-n} = 2^3$

$\Rightarrow \quad m - n = 3$

$\Rightarrow \quad m - 3 = 3$

$\Rightarrow \quad m = 6$

Hence, number of the elements is set A is 6.

180. *(d)* $\because \log_4 2 + \log_4 4 + \log_4 x + \log_4 16 = 6$

$\Rightarrow \log_4(2 \times 4 \times x \times 16) = 6$

$\Rightarrow \quad 128x = 4^6$

$\therefore \quad x = \dfrac{4^3}{2} = 32$