THE RANKERS ACADEMY

Sure shots Science Questions (Most Probable)

12th (CBSE) session 2024-25

Sure shots (1 Mark) Questions

1. Which of the following is not the property of an equipotential surface?
(A) They do not cross each other.
(B) The work done in carrying a charge from one point to another on an equipotential surface is zero.
(C) For a uniform electric field, they are concentric spheres.
(D) They can be imaginary spheres.

2. An electric dipole placed in an electric field of intensity 2×10^5 N/C at an angle of 30° experiences a torque equal to 4 Nm. The charge on the dipole of dipole length 2 cm is
(A) 7 μC (B) 8 μC
(C) 2 μC (D) 5 μC

3. A metallic plate exposed to white light emits electrons. For which of the following colours of light, the stopping potential will be maximum?
(A) Blue (B) Yellow
(C) Red (D) Violet

4. When alpha particles are sent through a thin gold foil, most of them go straight through the foil, because
(A) alpha particles are positively charged
(B) the mass of an alpha particle is more than the mass of an electron
(C) most of the part of an atom is empty space
(D) alpha particles move with high velocity

5. An electron is moving along positive x-axis in a magnetic field which is parallel to the positive y-axis. In what direction will the magnetic force be acting on the electron?
(A) Along –x axis (B) Along –z axis
(C) Along +z axis (D) Along –y axis

6. The relative magnetic permeability of a substance X is slightly less than unity and that of substance Y is slightly more than unity, then
(A) X is paramagnetic and Y is ferromagnetic
(B) X is diamagnetic and Y is ferromagnetic
(C) X and Y both are paramagnetic
(D) X is diamagnetic and Y is paramagnetic

7. An ammeter of resistance 0.81 ohm reads up to 1 A. The value of the required shunt to increase the range to 10 A is
(A) 0.9 ohm (B) 0.09 ohm
(C) 0.03 ohm (D) 0.3 ohm

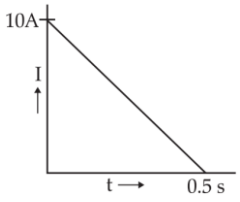
8. An electron with angular momentum L moving around the nucleus has a magnetic moment given by
(A) e L/2m (B) e L/3m
(C) e L/4m (D) e L/m

9. The large scale transmission of electrical energy over long distances is done with the use of transformers. The voltage output of the generator is stepped-up because of
(A) reduction of current
(B) reduction of current and voltage both
(C) power loss is cut down
(D) (A) and (C) both

10. The diagram below shows the electric field ($\vec{E}$) and magnetic field ($\vec{B}$) components of an electromagnetic wave at a certain time and location.

The direction of the propagation of the electromagnetic wave is
(A) perpendicular to $\vec{E}$ and $\vec{B}$ and out of plane of the paper
(B) perpendicular to $\vec{E}$ and $\vec{B}$ and into the plane of the paper
(C) parallel and in the same direction as $\vec{E}$
(D) parallel and in the same direction as $\vec{B}$

11. In a coil of resistance 100Ω a current is induced by changing the magnetic flux through it. The variation of current with time is as shown in the figure. The magnitude of change in flux through coil is



(A) 200 Wb (B) 275 Wb
(C) 225 Wb (D) 250 Wb

12. The energy of an electron in nth orbit of hydrogen atom is $E_n = -13.6/n^2$eV. The negative sign of energy indicates that
(A) electron is free to move.
(B) electron is bound to the nucleus.
(C) kinetic energy of electron is equal to potential energy of electron.
(D) atom is radiating energy.

13. The capacitance of a capacitor is C_0. It is connected to a battery of voltage V which charges the capacitor. With the capacitor still connected to the battery, a slab of dielectric material is introduced between the plates of the capacitor. Which of the following explains the effect of the dielectric slab in the above situation?
(A) The electric field between the plates of the capacitor rises.
(B) The potential difference between the plates falls.
(C) The total charge on the capacitor increases.
(D) The ability of the capacitor to store charge decreases.

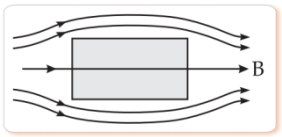
14. In a given region, electric potential varies with position as $V(x) = 3 + 2x^2$.
Identify which of the following statements is correct.
(A) Potential difference between the two points x = 2 and x = –2 is 2 V.
(B) A charge of 1 C placed at x = 2 experiences a force of 6 N.
(C) The force experienced by the above charge is along +x-axis.
(D) The electric field in the given region is non-uniform along x-axis.

15. Photoelectrons emitted from a metal have
(A) different speeds starting from 0 to certain maximum.
(B) same kinetic energy.
(C) same frequency. (D) Both (b) & (c).

16. A deuteron and an alpha particle move with the same kinetic energy under the effect of identical magnetic fields. What will be the ratio of the radii of their paths followed?
(A) 1 (B) $\sqrt{2}$
(C) 1/2 (D) 2

17. The strength of the magnetic field at distance r from a long straight current carrying wire is B. The field at a distance r/2 will be
(A) B (B) 2B
(C) B/2 (D) B/4

18. Two blocks of different materials are placed in a uniform magnetic field B. The magnetic field lines passing through the two blocks are represented as follows.



I

II

Identify the suitable values of relative permeability μ_r and magnetic susceptibility χ for the materials I and II.
(A) For I : $\mu_r > 1$, $c < 0$, For II : $\mu_r < 1$, $c > 0$
(B) For I : $\mu_r < 1$, $c = 0$, For II : $\mu_r > 1$, $c = 0$
(C) For I : $\mu_r = 0$, $c = 1$, For II : $\mu_r = 1$, $c = 0$
(D) For I : $\mu_r < 1$, $c < 0$, For II : $\mu_r > 1$, $c > 0$

19. A galvanometer can be converted into a voltmeter by connecting a
(A) high resistance in series.
(B) high resistance in parallel.
(C) low resistance in parallel.
(D) low resistance in series.

20. Each of the statements below are based on the properties of electron orbits in a hydrogen atom. Identify a statement that correctly satisfies the Bohr's model of an atom.
(A) The angular momentum of the orbiting electron is $3h/\pi$.
(B) The potential energy of the electron in any stable orbit is positive.
(C) The radius of the second electron orbit is $2a_0$, where a_0 is Bohr's radius.
(D) An amount of energy = –3.4 eV given to an electron in its second orbit will let it escape the atom.

21. When an alternating voltage $E = E_0 \sin \omega t$ is applied to a circuit, a current $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$ flows through it. The average power dissipated in the circuit is
(A) $E_{rms} - I_{rms}$ (B) $E_0 I_0$
(C) $\frac{E_0 I_0}{\sqrt{2}}$ (D) Zero

22. Which of the following relation indicates the speed of electromagnetic wave in free space?
(A) E_0/B_0 (B) B_0/E_0
(C) $\frac{1}{\sqrt{(\mu_0\varepsilon_0)}}$ (D) Both (A) and (C)

23. There is a pair of concentric and coplanar conducting loops of radii R_1 and R_2 such that $R_2 = 0.01\ R_1$. To which of the following is the mutual inductance M for this pair directly proportional?
(A) $1/R_{12}$ (B) R_{12}
(C) $1/R_1$ (D) R_1

24. Total energy of an electron in an energy level is –1.51eV. The quantum number is
(A) 1 (B) 2
(C) 3 (D) 4

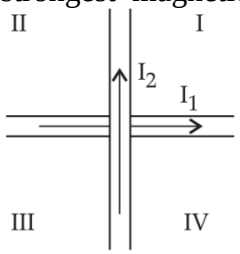
25. A variable capacitor is connected to a 200 V battery. If its capacitance is changed from 2 μF to X μF, the decrease in energy of the capacitor is 2×10^{-2} J. The value of X is
(A) 1 μF (B) 2 μF
(C) 3 μF (D) 4 μF

26. The electric potential on the axis of an electric dipole at a distance r from it's centre is V. Then the potential at a point at the same distance on its equatorial line will be
(A) 2V (B) –V
(C) V 2 (D) Zero

27. The work function for a metal surface is 4.14 eV. The threshold wavelength for this metal surface is
(A) 4125 Å (B) 2062.5 Å
(C) 3000 Å (D) 6000 Å

28. Which of the following statements about nuclear forces is not true?
(A) The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few metres.
(B) The nuclear force is much weaker than the Coulomb force.
(C) The force is attractive for distances larger than 0.8 fm and repulsive if they are separated by distances less than 0.8 fm.
(D) The nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same.

29. Two wires carrying currents I_1 and I_2 lie, one slightly above the other, in a horizontal plane as shown in figure. The region of vertically upward strongest magnetic field is



(A) I (B) II
(C) III (D) IV

30. Two parallel conductors carrying current of 4.0 A and 10.0 A are placed 2.5 cm apart in vacuum. The force per unit length between them is
(A) 6.4×10^{-5} N/m (B) 6.4×10^{-2} N/m
(C) 4.6×10^{-4} N/m (D) 3.2×10^{-4} N/m

31. The magnetic field at the centre of a current carrying circular loop of radius R, is B_1. The magnetic field at a point on its axis at a distance R from the center of the loop is B_2. Then the ratio (B_1/B_2) is
(A) $2\sqrt{2}$ (B) $\frac{1}{\sqrt{2}}$
(C) $\sqrt{2}$ (D) 2

32. A current carrying wire kept in a uniform magnetic field, will experience a maximum force when it is
(A) perpendicular to the magnetic field
(B) parallel to the magnetic field
(C) at an angle of 45° to the magnetic field
(D) at an angle of 60° to the magnetic field

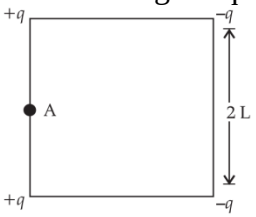
33. The rms current in a circuit connected to 50 Hz ac source is 15 A. The value of the current in the circuit $\left(\frac{1}{600}\right)$ s after the instant the current is zero, is
(A) $\frac{15}{\sqrt{2}}$ A (B) $15\sqrt{2}$ A
(C) $\frac{\sqrt{2}}{15}$ A (D) 8 A

34. If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of the electromagnetic wave, the direction of propagation of electromagnetic wave is along
(A) $\vec{E}.\vec{B}$ (B) $\vec{B} \perp \vec{E}$
(C) $\vec{B} \times \vec{E}$ (D) $\vec{E} \times \vec{B}$

35. The self-inductance of a solenoid of 600 turns is 108 mH. The self-inductance of a coil having 500 turns with the same length, the same radius and the same medium will be
(A) 95 mH (B) 90 mH
(C) 85 mH (D) 75 mH

36. O_2 molecule consists of two oxygen atoms. In the molecule, nuclear force between the nuclei of the two atoms
(A) is not important because nuclear forces are short-ranged.
(B) is as important as electrostatic force for binding the two atoms.
(C) cancels the repulsive electrostatic force between the nuclei.
(D) is not important because oxygen nucleus have equal number of neutrons and protons.

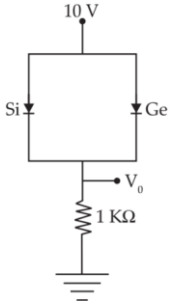
37. Four charges –q, –q, +q and +q are placed at the corners of a square of side 2 L is shown in figure. The electric potential at point A midway between the two charges +q and +q is



(A) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$ (B) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$
(C) $\frac{1}{4\pi\varepsilon_0}\frac{q}{2L}\left(1-\frac{1}{\sqrt{5}}\right)$ (D) zero

38. The work done to move a charge along an equipotential surface from A to B
(A) cannot be defined (B) is a negative quantity
(C) is zero (D) is a positive quantity

39. In an ON state, the individual Silicon and Germanium diodes, allow a voltage drop of 0.7 V and 0.3 V respectively across them. In the circuit shown, the Si and the Ge diode, are connected in a parallel combination to a voltage source of 10V. What is the voltage V_0 for the circuit network?



(A) 0 volt (B) 9.3 volt
(C) 9.7 volt (D) 10 volt

40. Taking the Bohr radius as r_0 = 53 pm, the radius of Li^{++} ion in its ground state, on the basis of Bohr's model, will be about
(A) 53 pm. (B) 27 pm.
(C) 18 pm. (D) 13 pm.

41. Two concentric and coplanar circular loops P and Q have their radii in the ratio 2:3. Loop Q carries a current 9 A in the anti-clockwise direction. For the magnetic field to be zero at the common centre, loop P must carry
(A) 3 A in clockwise direction
(B) 9 A in clockwise direction
(C) 6 A in anti-clockwise direction
(D) 6 A in the clockwise direction.

42. A bar magnet has magnetic dipole moment $\vec{M}$. Its initial position is parallel to the direction of uniform magnetic field $\vec{B}$. In this position, the magnitudes of torque and force acting on it respectively are
(A) 0 and MB (B) MB and MB
(C) 0 and 0 (D) $|\vec{M}\times\vec{B}|$ and 0

43. The deflecting torque acting on the coil of a galvanometer is
(A) Inversely proportional to number of turns.
(B) Inversely proportional to current flowing.
(C) Inversely proportional to area of the coil.
(D) directly proportional to the magnetic field strength.

44. Time period of oscillation of a magnetic needle is
(A) $T=\sqrt{\frac{I}{MB}}$ (B) $T=2\pi\sqrt{\frac{I}{MB}}$
(C) $T=2\pi\sqrt{\frac{MB}{I}}$ (D) $T=\pi\sqrt{\frac{MB}{I}}$

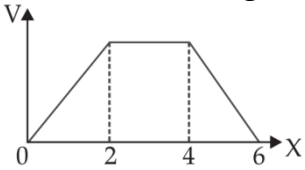
45. A circuit is connected to an ac source of variable frequency. As the frequency of the source is increased, the current first increases and then decreases. Which of the following combinations of elements is likely to comprise the circuit?
(A) L, C and R (B) L and C
(C) L and R (D) R and C

46. From Maxwell's hypothesis, a changing electric field gives rise to
(A) an electric field (B) an induced emf
(C) a magnetic field (D) a magnetic torque

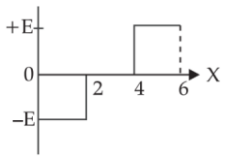
47. A square of side L metres lies in the x-y plane in a region where the magnetic field is given by $B = B_0(2\hat{\imath} + 3\hat{\jmath} + 4\hat{k})$ Tesla, where, B_0 is constant. The magnitude of flux passing through the square is
(A) $2B_0L^2$ Wb (B) $3B_0L^2$ Wb
(C) $4B_0L^2$ Wb (D) B_0L^2 Wb

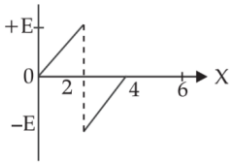
48. The binding energy of an H-atom, considering an electron moving around a fixed nuclei (proton), is $B = -\frac{me^4}{8\pi^2\varepsilon_0^2h^2}$ (m = electron mass). If one decides to work in a frame of reference where the electron is at rest, the proton would be moving around it. By similar arguments, the binding energy would be $B = -\frac{Me^4}{8\pi^2\varepsilon_0^2h^2}$ (M = proton mass). This last expression is not correct because
(A) n would be integral.
(B) Bohr-quantisation applies only to electron.
(C) the frame in which the electron is at rest is not inertial.
(D) the motion of the proton would not be in circular orbits, even approximately.

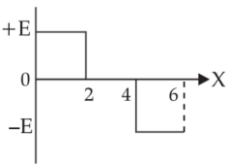
49. The electric potential V as a function of distance x is shown in the figure.

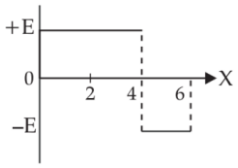


The graph of the magnitude of electric field intensity E as a function of x is

(A)


(B)


(C)


(D)


50. Equipotentials at a large distance from a collection of charges whose total sum is not zero are
(A) spheres (B) planes
(C) ellipsoids (D) paraboloids

51. The wavelength of a photon needed to remove a proton from a nucleus which is bound to the nucleus with 1 MeV energy is nearly
(A) 1.2 nm (B) 1.2×10^{-3} nm
(C) 1.2×10^{-6} nm (D) 1.2×10 nm

52. A set of atoms in an excited state decays
(A) in general, to any of the states with lower energy.
(B) into a lower state only when excited by an external electric field.
(C) all together simultaneously into a lower state.
(D) to emit photons only when they collide.

53. A straight conducting rod of length *l* and mass m is suspended in a horizontal plane by a pair of flexible strings in a magnetic field of magnitude B. To remove the tension in the supporting strings, the magnitude of the current in the wire is
(A) $\frac{mgB}{l}$ (B) $\frac{mgl}{B}$
(C) $\frac{mg}{lB}$ (D) $\frac{lB}{mg}$

54. If the magnetising field on a ferromagnetic material is increased, its permeability
(A) decreases
(B) increases
(C) remains unchanged
(D) first decreases and then increases

55. If an ammeter is to be used in place of a voltmeter, then we must connect with the ammeter a
(A) low resistance in parallel
(B) low resistance in series
(C) high resistance in parallel
(D) high resistance in series

56. A constant current is flowing through a solenoid. An iron rod is inserted in the solenoid along its axis. Which of the following quantities will not increase?
(A) The magnetic field at the centre
(B) The magnetic flux linked with the solenoid
(C) The rate of heating
(D) The self-inductance of the solenoid

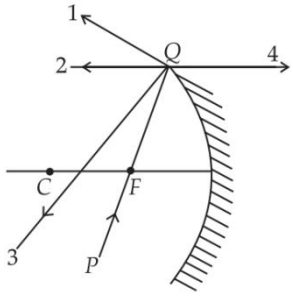
57. The voltage across a resistor, an inductor, and a capacitor connected in series to an ac source are 20 V, 15 V and 30 V respectively. The resultant voltage in the circuit is
(A) 5 V (B) 20 V
(C) 25 V (D) 65 V

58. In electromagnetic waves, the phase difference between magnetic and electric field vectors is
(A) zero (B) π
(C) $\pi/2$ (D) $\pi/4$

59. The current in the primary coil of a pair of coils changes from 70 A to 30 A in 0.4 s. The mutual inductance between the two coils is 0.5 H. The induced emf in the secondary coil is
(A) 50 V (B) 75 V
(C) 100 V (D) 220 V

60. Two H atoms in the ground state collide inelastically. The maximum amount by which their combined kinetic energy is reduced, is
(A) 10.20 eV (B) 20.40 eV
(C) 13.6 eV (D) 27.2 eV

61. The direction of ray of light incident on a concave mirror is shown by PQ while directions in which the ray would travel after reflection is shown by four rays marked 1, 2, 3 and 4 (Figure).Which of the four rays correctly shows the direction of reflected ray?



(A) 1 (B) 2
(C) 3 (D) 4

62. When an object is placed between f and 2f of a concave mirror, the image formed is
(A) Real, diminished (B) Real, magnified
(C) Virtual, diminished (D) Virtual, magnified

63. In an n-type silicon, which of the following statement is true?
(A) Electrons are majority carriers and trivalent atoms are the dopants.
(B) Electrons are minority carriers and pentavalent atoms are the dopants.
(C) Holes are minority carriers and pentavalent atoms are the dopants.
(D) Holes are majority carriers and trivalent atoms are the dopants.

64. The air bubble inside water behaves like
(A) Convex lens (B) Concave lens
(C) Convex mirror (D) Concave mirror

65. A long straight wire of circular cross section of radius a carries a steady current I. The current is uniformly distributed across its cross section. The ratio of the magnitudes of magnetic field at a point at a distance a 2 above the surface of wire to that at a point at a distance $\frac{a}{2}$ below its surface is
(A) 4 : 1 (B) 1 : 1
(C) 4 : 3 (D) 3 : 4

66. A magnetic needle is kept in a non-uniform magnetic field experiences
(A) a force as well as a torque
(B) a torque but not a force
(C) a force and a torque
(D) a force but not a torque

67. Magnetic field due to a straight solenoid at any point inside it is $B = \mu_0 ni$. Magnetic field at the end of the solenoid is
(A) B (B) B/2
(C) 2B (D) B/4

68. A negatively charged object X is repelled by another charged object Y. However an object Z is attracted to object Y. Which of the following is the most possibility for the charge of object Z?
(A) positively charged only
(B) negatively charged only
(C) neutral or positively charged
(D) neutral or negatively charged

69. A 5 ohm resistor, a 5 mH inductor and a 5 μF capacitor, joined in series resonate with an ac source of frequency ω_0. If only the resistance is changed to 10 ohm, the circuit resonates at a frequency ω_1. If only the inductor is changed to 20 mH, the circuit resonates at a frequency ω_2. Find the ratio ω_1/ω_2.
(A) 0.5 (B) 1
(C) 2 (D) 4

70. The phenomenon which shows quantum nature of electromagnetic radiation is
(A) Piezoelectric effect (B) Photoelectric effect
(C) Hall effect (D) Tyndall effect

71. The magnetic flux linked with a coil is given by an equation $\phi = 5t^2 + 2t + 3$. The induced e.m.f. in the coil at the third second will be
(A) 32 units (B) 54 units
(C) 40 units (D) 65 units

72. Rays of light coming from the Sun makes an angle θ radian at the pole of a concave mirror. Diameter of the Sun is D. The diameter of the image is
(A) Dθ (B) 2Dθ
(C) fθ (D) 2fθ

73. 64 water droplets of same radius and having same amount of charge form a large single drop. Ratio of potentials of large and small drop is
(A) 64 : 1 (B) 1 : 64
(C) 16 : 1 (D) 1 : 16

74. Electric potential inside a conducting sphere
(A) is zero
(B) remains constant.
(C) decreases from centre to surface
(D) increases from centre to surface.

75. Kinetic energy of electrons emitted in photoelectric effect is
(A) Directly proportional to the intensity of incident light.
(B) Inversely proportional to the intensity of incident light.
(C) Independent of the intensity of incident light.
(D) Independent of the frequency of light.

76. The simple Bohr model cannot be directly applied to calculate the energy levels of an atom with many electrons. This is because
(A) Of the electrons not being subject to a central force.
(B) OF the electrons colliding with each other.
(C) Of screening effects.
(D) The force between the nucleus and an electron will no longer be given by Coulomb's law.

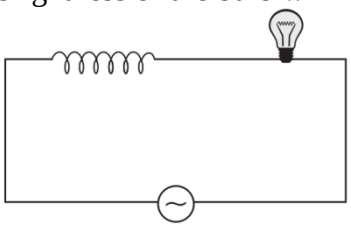
77. A circular current loop of magnetic moment M is in an arbitrary orientation in an external magnetic field B. The work done to rotate the loop by 30° about an axis perpendicular to its plane is
(A) MB (B) $\frac{\sqrt{3}MB}{2}$
(C) $\frac{MB}{2}$ (D) Zero

78. A 15 Ω resistor, an 80 mH inductor and a capacitor of capacitance C are connected in series with a 50 Hz ac source. If the source voltage and current in the circuit are in phase, then the value of capacitance is
(A) 100 μF (B) 127 μF
(C) 142 μF (D) 160 μF

79. The core of a transformer is laminated to reduce the effect of
(A) Flux leakage (B) Copper loss
(C) Hysteresis loss (D) Eddy current

80. The electromagnetic radiations used for water purification and eye surgery is
(A) Infrared (B) Microwave
(C) X-rays (D) Ultraviolet

81. An iron cored coil is connected in series with an electric bulb with an AC source as shown in figure. When iron piece is taken out of the coil, the brightness of the bulb will

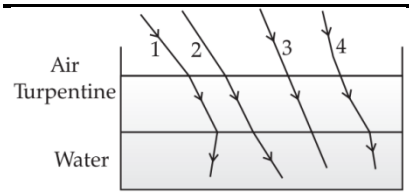


(A) Decrease (B) Increase
(C) Remain unaffected (D) Fluctuate

82. Electromagnetic wave having frequency 5×10^{11} Hz is
(A) Ultraviolet wave (B) Radio wave
(C) Microwave (D) X-rays

83. A coil of area 100 cm^2 is kept at an angle of 30° with a magnetic field of 10^{-1} T. The magnetic field is reduced to zero in 10^{-4} s. The induced emf in the coil is
(A) $5\sqrt{3}$V (B) $50\sqrt{3}$ V
(C) 5.0 V (D) 50.0 V

84. The optical density of turpentine is higher than that of water while its mass density is lower. Figure shows a layer of turpentine floating over water in a container. For which one of the four rays incident on turpentine in Figure, the path shown is correct?



(A) 1 (B) 2
(C) 3 (D) 4

85. Capacitance of a parallel plate capacitor can be increased by
(A) Increasing the distance between the plates.
(B) Decreasing the distance between the plates.
(C) Decreasing the area of plates.
(D) Increasing the thickness of the plates.

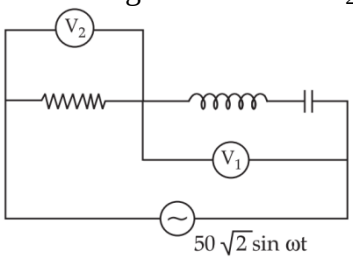
86. A parallel plate capacitor is charged by connecting it to a battery. Which of the following will remain constant if the distance between the plates of the capacitor is increased in this situation?
(A) Energy stored
(B) Electric field
(C) Potential difference
(D) Capacitance

87. Threshold wavelength of a photoelectric emission from a material is 600 nm. Which of the following illuminating source will emit photoelectrons?
(A) 400 W, infrared lamp
(B) 10 W, ultraviolet lamp
(C) 100 W, ultraviolet lamp
(D) Both (B) & (C)

88. For the ground state, the electron in the H-atom has an angular momentum = h, according to the simple Bohr model. Angular momentum is a vector and hence there will be infinitely many orbits with the vector pointing in all possible directions. In actuality, this is not true
(A) Because Bohr model gives incorrect values of angular momentum.
(B) Because only one of these would have a minimum energy.
(C) Angular momentum must be in the direction of spin of electron.
(D) Because electrons go around only in horizontal orbits.

89. A ferromagnetic substance is heated above its Curie temperature. Which of the following statements is correct?
(A) Ferromagnetic domains get perfectly arranged.
(B) Ferromagnetic domains get randomly arranged.
(C) Ferromagnetic domains are not at all influenced.
(D) Ferromagnetic material transforms into diamagnetic substance.

90. If the reading of the voltmeter V_1 is 40 V, then the reading of voltmeter V_2 is



(A) 30 V (B) 58 V
(C) 29 V (D) 15 V

91. In a circuit the phase difference between the alternating current and the source voltage is $\frac{\pi}{2}$. Which of the following cannot be the element(s) of the circuit?
(A) Only C (B) Only L
(C) L and R (D) L or C

92. Proper arrangement of Gamma rays, Microwave, IR wave and UV rays in ascending order of frequency is
(A) Gamma rays > UV rays > IR rays > Microwave
(B) Microwave > IR rays > UV rays > Gamma rays
(C) UV rays > Gamma rays > Microwave > IR rays
(D) IR rays > UV rays > Microwave > Gamma rays

93. Relation between r.m.s. voltage and instantaneous voltage of an AC
(A) $V_0 = V_{rms}/\sqrt{2}$ (B) $V_{rms} = V_0/\sqrt{2}$
(C) $V_{rms} = 0.707\ V_0$ (D) Both (B) and (C)

94. In vacuum, the physical property which remains same for microwave of wavelength 1 mm and UV radiation of wavelength 1600 Å is
(A) Wavelength (B) Frequency
(C) Speed (D) None of these

95. A rectangular, a square, a circular and an elliptical loop, all in the (x – y) plane, are moving out of a uniform magnetic field with a constant velocity $\vec{v} = v\hat{i}$. The magnetic field is directed along the negative z-axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for
(A) Any of the four loops
(B) The circular and elliptical loops

(C) The rectangular, circular and elliptical loops
(D) Only the elliptical loops

96. A short pulse of white light is incident from air to a glass slab at normal incidence. After travelling through the slab, the first color to emerge is
(A) Blue (B) Green
(C) Violet (D) Red

97. The capacitance of a parallel plate capacitor is 10 μF. When a dielectric plate is introduced in between the plates, its potential becomes 1/4th of its original value. What is the value of the dielectric constant of the plate introduced?
(A) 4 (B) 40
(C) 2.5 (D) None of these

98. An object has a charge of 2 C and gains 10.0×10^{18} electrons. The net charge on the object becomes….
(A) 0.40 C (B) +0.80 C
(C) +1.40 C (D) +0.20 C

99. At stopping potential, the kinetic energy of emitted photoelectron is
(A) Minimum
(B) Maximum
(C) Zero
(D) Cannot be predicted

100. Two H atoms in the ground state collide inelastically. The maximum amount by which their combined kinetic energy is reduced, is
(A) 10.20 eV (B) 20.40 eV
(C) 13.6 eV (D) 27.3 eV

101. When a charge of 2C moving with velocity of 1 m/s normal to a magnetic field experiences of force 1 N, then the magnitude of the magnetic field is
(A) 2 Gauss (B) 0.5 Tesla
(C) 1 Oersted (D) None of these

102. The impedance of a series LCR circuit is
(A) $R + X_L + X_C$ (B) $\sqrt{\frac{1}{X_C^2} + \frac{1}{X_L^2} + R^2}$
(C) $\sqrt{X_L^3 - X_C^2 + R^2}$ (D) $\sqrt{R^2 + (X_L + X_C)^2}$

103. In which of the following circuit power dissipation is maximum?
(A) Pure capacitive circuit
(B) Pure inductive circuit
(C) Pure resistive circuit (D) LR or CR circuit

104. In vacuum, the wavelength of the electromagnetic wave of frequency 5×10^{19} Hz is
(A) 6×10^{-12} m (B) 3×10^{-8} m
(C) 1.6×10^{11} m (D) 15×10^{27} m

105. With increase in frequency of an A.C. supply, the impedance of a series L-C-R circuit
(A) Remains constant
(B) Increases
(C) Decreases
(D) Decreases at first, becomes minimum and then increases.

106. The frequency of an electromagnetic wave whose wavelength is given by 5×10^{-5} m in free space is equal to
(A) 5×10^{12} Hz (B) 6×10^{12} Hz
(C) 5×10^{11} Hz (D) 6×10^{11} Hz

107. Lenz's law is a consequence of the law of conservation of
(A) Charge (B) Mass
(C) Energy (D) Momentum

108. Radius of curvature of human eye is 0.78 cm. For an object at infinity, image is formed at 3 cm behind the refracting surface. The refractive index of eye is
(A) 1.35 (B) 3
(C) 6.2 (D) 1

109. When a square loop with a surface area of 20 cm^2 is placed in a homogeneous electric field with an intensity of 20 N/C and the angle between the surface and the electric field is 30°, the electric flux associated with the loop is
(A) 1.250 Vm (B) 125 Vm
(C) 0.125 Vm (D) 0.0346 Vm

110. On moving a charge of 10 C by 1 cm, 1 J of work is done. Then, the potential difference between the points is
(A) 0.1V (B) 8 V
(C) 2 V (D) 0.5 V

111. A particle is dropped from a height H. The de-Broglie wavelength of the particle as a function of height is proportional to
(A) H (B) $H^{1/2}$
(C) H_0 (D) $H^{-1/2}$

112. In a nuclear fission reaction, 200 MeV energy evolves from each fission. If fission of 10^{20} atoms takes place per second then evolved power
(A) 2×10^{22} W (B) 32×10^{8} W
(C) 16×10^{8} W (D) 5×10^{11} W

113. The strength of the magnetic field at distance r from a long straight current carrying wire is B. The field at a distance r/2 will be
(A) B (B) 2B
(C) B/2 (D) B/4

114. Parameter that remains unchanged in a transformer is
(A) Voltage (B) Current
(C) Frequency (D) None of these

115. The efficiency of transformer is very high because
(A) There is no moving part
(B) It uses AC only
(C) It uses the copper wire for the coils
(D) None of these

116. Electromagnetic wave does not carry
(A) Energy (B) Charge
(C) Information (D) Momentum

117. The power factor of series LCR circuit at resonance is
(A) 0.707 (B) 1
(C) 0.5 (D) 0

118. The speed of an electromagnetic wave travelling in free space is related to the permeability (μ_0) and permittivity (ε_0) of the free space as
(A) $c = \mu_0\varepsilon_0$ (B) $c = \frac{1}{\mu_0\varepsilon_0}$
(C) $c = \sqrt{\mu_0\varepsilon_0}$ (D) $c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$

119. The polarity of induced emf is defined by
(A) Ampere's circuital law.
(B) Biot-Savart's law.
(C) Lenz's law.
(D) Fleming's right hand rule.

120. Magnifying power of a microscope depends on
(A) Colour of light only.
(B) Focal length of objective only.
(C) Focal length of eyepiece only.
(D) Focal length of eyepiece and objective both.

Assertion Reasoning Based Questions

For Questions 121 to 160, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.
(A) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) If Assertion is true but Reason is false.
(D) If both Assertion and Reason are false.

121. **Assertion (A):** For the radiation of a frequency greater than the threshold frequency, photoelectric current is proportional to the intensity of the radiation.
Reason (R): Greater the number of energy quanta available, greater is the number of electrons absorbing the energy quanta and greater is number of electrons coming out of the metal.

122. **Assertion (A):** Putting p type semiconductor slab directly in physical contact with n type semiconductor slab cannot form the pn junction.
Reason (R): The roughness at contact will be much more than inter atomic crystal spacing and continuous flow of charge carriers is not possible.

123. **Assertion (A):** An electron has a higher potential energy when it is at a location associated with a negative value of potential and has a lower potential energy when at a location associated with a positive potential.
Reason (R): Electrons move from a region of higher potential to a region of lower potential.

124. **Assertion (A):** Propagation of light through an optical fibre is due to total internal reflection taking place at the core-cladding interface.
Reason (R): Refractive index of the material of the cladding of the optical fibre is greater than that of the core.

125. **Assertion (A):** The photoelectrons produced by a monochromatic light beam incident on a metal surface have a spread in their kinetic energies.
Reason (R): The energy of electrons emitted from inside the metal surface, is lost in collision with the other atoms in the metal.

126. **Assertion (A):** The electrical conductivity of a semiconductor increases on doping.
Reason (R): Doping always increases the number of electrons in the semiconductor.

127. **Assertion (A):** The same amount of current flows through the filament and line wire. But more heat is produced in filament.
Reason (R): Filament is made of material having high resistance and high melting point.

128. **Assertion (A):** A convex mirror cannot form real images.
Reason (R): Convex mirror converges the parallel rays that are incident on it.

129. **Assertion (A):** Bohr postulated that the electrons in stationary orbits around the nucleus do not radiate.
Reason (R): According to classical Physics, all moving electrons radiate.

130. **Assertion (A):** The resistivity of a semiconductor decreases with temperature.
Reason (R): As temperature increases, the electrons gain sufficient energy and jump from valence band to conduction band.

131. **Assertion (A):** A negative charge in an electric field moves opposite direction of the electric field.
Reason (R): On a negative charge a force acts in the opposite direction of the electric field.

132. **Assertion (A):** The focal length of a concave mirror is f and an object is placed at a distance x from the focus. The magnification produced by the mirror is f/x.
Reason (R): Magnification = size of image/size of object.

133. **Assertion (A):** In the α-particle scattering experiment, most of the α-particles pass undeviated.
Reason (R): Most of the space in the atom is empty.

134. **Assertion (A):** When diode is used as a rectifier, its specified reverse breakdown voltage should not be exceeded.
Reason (R): When p-n junction diode crosses the reverse break down voltage, it get destroyed.

135. **Assertion (A):** In a non-uniform electric field, a dipole will have translatory as well as rotatory motion.
Reason (R): In a non-uniform electric field, a dipole experiences a force as well as torque.

136. **Assertion (A):** Air bubbles shine in water.
Reason (R): Air bubbles shine in water due to refraction of light.

137. **Assertion (A):** According to Rutherford Atomic Model, the path of an electron is parabolic.
Reason (R): Rutherford could explain the stability of the atom.

138. **Assertion (A):** The resistance of superconductor is zero.
Reason (R): Super conductors are used for electrical power transmission.

139. **Assertion (A):** Electric field is always normal to equipotential surfaces and along the direction of decreasing order of potential.
Reason (R): Negative gradient of electric potential is electric field.

140. **Assertion (A):** The mirror formula $1/v + 1/u = 1/f$ is valid for mirrors of small aperture.
Reason (R): Laws of reflection of light is valid for only plane surface and not for large spherical surface.

141. **Assertion (A):** Bohr model is not applicable for multi-electron model.
Reason (R): Bohr model cannot account for sublevel (s, p, d, f) orbitals and electron spin.

142. **Assertion (A):** When a p-n junction diode is reverse biased, a feeble reverse current flows known as reverse saturation current.
Reason (R): In reverse bias condition, the minority carries can cross the junction.

143. **Assertion (A):** When radius of a current carrying loop is doubled, its magnetic moment becomes four times.
Reason (R): The magnetic moment of a current carrying loop is directly proportional to the area of the loop.

144. **Assertion (A):** Convex mirror is used as rear-view mirror in automobiles.

Reason (R): Field of view of convex mirror is narrow.

145. **Assertion (A):** A double convex air bubble is formed within a glass slab. The air bubble behaves like a converging lens.
Reason (R): Refractive index of glass is less that the refractive index of air.

146. **Assertion (A):** When a diode is used in a half wave rectifier, the break down voltage should be greater than the amplitude of the input ac supply which is to be rectified.
Reason (R): In reverse bias a feeble current flows through a diode.

147. **Assertion (A):** Electric lines of force cannot cross each other.
Reason (R): Electric lines of force are imaginary lines.

148. **Assertion (A):** If the objective lens and the eyepiece lens of a microscope are interchanged, it works as a telescope.
Reason (R): Objective lens of telescope require small focal length and eyepiece lens require large focal length.

149. **Assertion (A):** In a simple microscope, the image formed is virtual, erect and magnified.
Reason (R): Object placed between the focus and optical centre of a convex lens the image formed is virtual, erect and magnified.

150. **Assertion (A):** The resistivity of a semiconductor decreases with temperature.
Reason (R): The atoms of a semiconductor vibrate with larger amplitude at higher temperature thereby increasing it's resistivity.

151. **Assertion (A):** If two spherical conductors of different radii have the same surface charge densities, then their electric field intensities will be equal.
Reason (R): Surface charge density = $\frac{\text{Total charge}}{\text{area}}$

152. **Assertion (A):** According to Huygen's theory no backward wavefront is possible.
Reason (R): Amplitude of secondary wavelets is proportional to $(1 + \cos\theta)$, where θ is the angle between the ray at the point of consideration and direction of secondary wavelet.

153. **Assertion (A):** Wavefront emitted by a point source of light in an isotropic medium is spherical.
Reason (R): Isotropic medium has same refractive index in all directions.

154. **Assertion (A):** When an electron jumps from valance band to conduction band, a hole is created in the conduction band.
Reason (R): In p-type semiconductor, minority carriers are holes.

155. **Assertion (A):** In a cavity of a conductor, the electric field is zero.
Reason (R): Charges in a conductor reside only at its surface.

156. **Assertion (A):** When a light wave travels from rarer to denser medium, its speed decreases. Due to this reduction of speed the energy carried by the light wave reduces.
Reason (R): Energy of wave is inversely proportional to the frequency.

157. **Assertion (A):** No interference pattern is detected when two coherent sources are too close to each other.
Reason (R): The fringe width is inversely proportional to the distance between the two slits.

158. **Assertion (A):** When diode is used as a rectifier, its specified reverse breakdown voltage should not be exceeded.
Reason (R): When p-n junction diode crosses the reverse breakdown voltage, it get destroyed.

159. **Assertion (A):** Gauss' law follows inverse square law.
Reason (R): The conservation of charges leads to Gauss' law.

160. **Assertion (A):** Diffraction takes place with all types of waves.
Reason (R): Diffraction is perceptible when the wavelength of the wave is comparable to the dimension of the diffracting device.

Sure shots (2 Marks) Questions

1. (a) Name the device which utilizes unilateral action of a pn diode to convert ac into dc.
(b) Draw the circuit diagram of full wave rectifier.

2. The wavelength λ of a photon and the de Broglie wavelength of an electron of mass m have the same value. Show that the energy of the photon is 2λmc/h times the kinetic energy of the electron, where c and h have their usual meanings.

3. A ray of monochromatic light passes through an equilateral glass prism in such a way that the angle of incidence is equal to the angle of emergence and each of these angles is $\frac{3}{4}$ times the angle of the prism. Determine the angle of deviation and the refractive index of the glass prism.

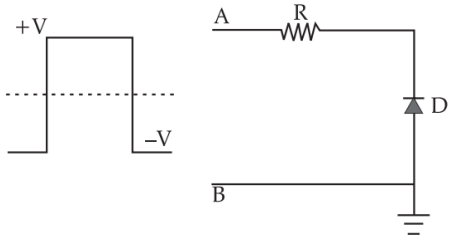
4. A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds to a steady value of 2.8 A. What is the steady temperature of the heating element if the room temperature is 27.0 °C and the temperature coefficient of resistance of nichrome is 1.70×10^{-4} °C^{-1}?

5. Show that the least possible distance between an object and its real image in a convex lens is 4f, where f is the focal length of the lens.

OR

In an astronomical telescope in normal adjustment a straight black line of length L is drawn on the objective lens. The eyepiece forms a real image of this line whose length is *l*. What is the angular magnification of the telescope?

6. In the circuit containing an ideal p-n junction diode D and a resistor R is given an input square wave as shown.



(i) What is the shape of the output waveform across diode D?
(ii) Give an explanation for your answer in (i).

7. Why it is the frequency and not the intensity of light source that determines whether emission of photoelectrons will occur or not? Explain.

8. The critical angle for the total internal reflection of diamond in air is 24°. State whether the two statements given here are correct or incorrect. Give a reason for your answer.
(i) The critical angle for total internal reflection of diamond is more than 24° when surrounded by water.
(ii) The sparkle of the diamond increases remarkably when placed in water?

9. Use Kirchhoff's rules to obtain conditions for the balance condition in a Wheatstone bridge.

10. A biconvex lens made of a transparent material of refractive index 1.25 is immersed in water of refractive index 1.33. Will the lens behave as a converging or a diverging lens? Justify your answer.

OR

Draw a labelled ray diagram to show image formation by a compound microscope?

11. (i) What type of impurity is added to pure semiconductor to form n-type and p-type semiconductor? What are known as donors and acceptors?
(ii) What do you mean by forward bias, reverse bias and zero bias of a p-n junction diode?

12. (i) An electron of mass m and a photon carry the same energy E. What is the ratio of de Broglie wavelength associated with the electron to the wavelength of the photon?
(ii) Why do macroscopic objects in our daily life not show wave-like properties whereas in the sub-atomic domain the wave-like character is significant?

13. Use the mirror equation to show that an object placed between f and 2f of a concave mirror forms an image beyond 2f.

14. A wire of length L_0 has a resistance R_0. It is gradually stretched till its length becomes $2L_0$.
(a) Plot a graph showing variation of its resistance R with its length L during stretching.
(b) What will be its resistance when its length becomes 2 L_0?

15. A concave or convex mirror is held under water. Will its focal length change?

OR

Define the magnifying power of a compound microscope when the final image is formed at infinity. Why must both the objective and the eyepiece of a compound microscope have short focal lengths? Explain.

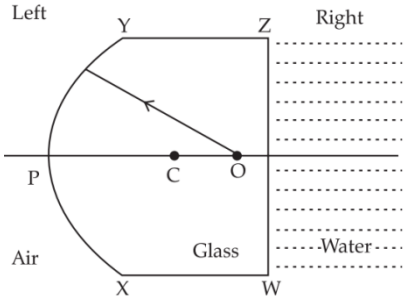
16. (i) Define barrier potential across a p-n junction. What is the impact on the barrier potential when the p-n junction is connected in forward bias?
(ii) How does the current change as the voltage applied across the p-n junction varies from small to very high in reverse bias condition?

17. The table below lists the different transitions of an electron in a hydrogen atom:

a	$n_i = 4$ to $n_f = 2$
b	$n_i = 3$ to $n_f = 1$
c	$n_i = 2$ to $n_f = 3$
d	$n_i = 4$ to $n_f = 3$

Among these, identify:
(i) The transition that gives absorption spectra.
(ii) The transition that gives Lyman spectral line, Balmer spectral line, and Paschen spectral line.

18. (i) A given glass slab WXYZ has a curved side on the left and a plane side on the right. On the left of the curved side, XPY is air and on the right side of the plane side, WZ is water. An object is present inside the glass slab at O beyond its center of curvature C.



Copy the diagram and complete the ray diagram to represent an image I as viewed from the left side. Also state whether this image is real or virtual.
(ii) In a refracting type of telescope, what is the impact on its magnifying power if the objective and eyepiece lens are interchanged? Explain your answer.

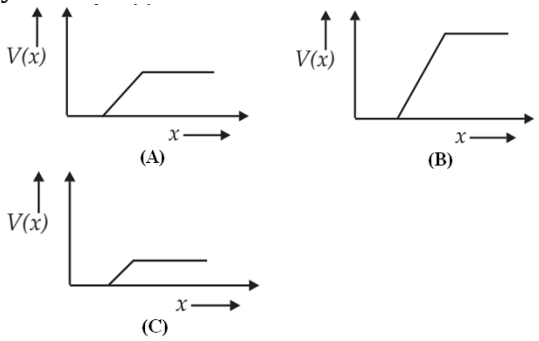
19. Two electric bulbs P and Q have their resistances in the ratio of 1 : 2. They are connected in series across a battery. Find the ratio of the power dissipation in these bulbs.

20. Under what conditions does the phenomenon of total internal reflection take place? Draw a ray diagram showing how a ray of light deviates by 90° after passing through a right-angled isosceles prism.

OR

Draw the ray diagram of an astronomical telescope showing image formation in the normal adjustment position. Write the expression for its magnifying power.

21. The graph of potential barrier versus width of depletion region for an unbiased diode is shown in graph A. In comparison to A, graphs B and C are obtained after biasing the diode in different ways. Identify the type of biasing in B and C and justify your answer.



22. What results do you expect if α-particle scattering experiment is repeated using a thin sheet of hydrogen in place of a gold foil? Explain. (Hydrogen is a solid at temperature below 14 K)

23. Write two characteristics of image formed when an object is placed between the optical centre and focus of a thin convex lens. Draw the graph showing variation of image distance v with object distance u and obtain 2f from the graph.

24. State the two Kirchhoff's rules. Explain briefly how these rules are justified.

25. State two positions in which a concave mirror produces a magnified image of a given object. List two differences between the two images.

OR

Calculate the radius of curvature of an equi-concave lens of refractive index 1.5, when it is kept in a medium of refractive index 1.4, to have a power of –5 D?

26. With the help of a circuit diagram, explain briefly how a p-n junction diode works as a half-wave rectifier.

27. Will photoelectric emission take place if radiation of wavelength 600 nm is incident on Cesium? (Work function of Cesium is 2.27eV).

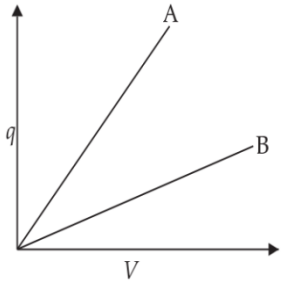
28. A beam of light converges at a point P. Draw ray diagrams to show where the beam will converge if (i) a convex lens, and (ii) a concave lens is kept in the path of the beam.

29. Two metallic wires P_1 and P_2 of the same material and same length but different cross-sectional areas A_1 and A_2 are joined together and then connected to a source of emf. Find the ratio of the drift velocities of free electrons in the wires P_1 and P_2, if the wires are connected (i) in series, and (ii) in parallel.

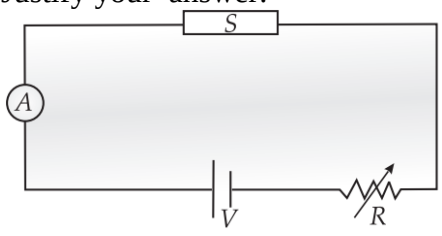
30. 0.8C amount of charge is divided into two charges Q_1 and Q_2. The distance between the charges is 30 cm. Find the values of Q_1 and Q_2 so the force acting between then becomes maximum.

OR

The given graph shows variation of charge q versus potential difference V for two capacitors C_1 and C_2. Both the capacitors have same plate separation but plate area of C_2 is greater than that of C_1. Which line (A or B) corresponds to C_1 and why?



31. The figure shows a piece of pure semiconductor S in series with a variable resistor R and a source of constant voltage V. Should the value of R be increased or decreased to keep the reading of the ammeter constant, when semiconductor S is heated? Justify your answer.

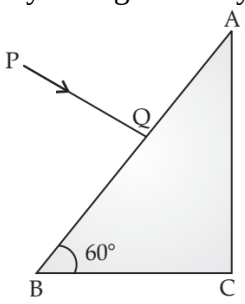


32. Light of same wavelength is incident on three photo-sensitive surfaces A, B and C. The following observations are recorded.
(a) From surface A, photoelectrons are not emitted.
(b) From surface B, photoelectrons are just emitted.
(c) From surface C, photoelectrons with some kinetic energy are emitted. Compare the threshold frequencies of the three surfaces and justify your answer.

33. Why should the objective of a telescope have large focal length? Justify your answer.

34. Distance between two towns is 150km. Electricity is transmitted from one town to another through copper wire. Average resistance of the wire per km is 0.5Ω and voltage drop per km is 8V. Find the waste of power during transmission.

35. A ray PQ incident normally on the refracting face BA is refracted in the prism BAC made of material of refractive index 1.5. Complete the path of ray through the prism. From which face will the ray emerge? Justify your answer.



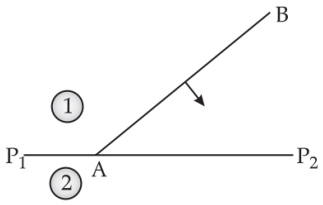
OR

In a single slit diffraction experiment, width of the slit is increased. How will the: (i) size and (ii) intensity of central bright band be affected? Justify your answer.

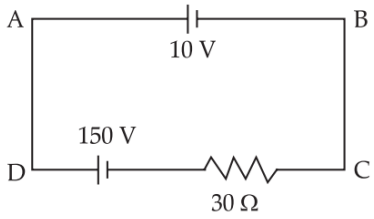
36. Two crystals C_1 and C_2, made of pure silicon, are doped with arsenic and aluminium respectively.
(i) Identify the extrinsic semiconductors so formed.
(ii) Why is doping of intrinsic semiconductors necessary?

37. If the frequency of light incident on the cathode of a photocell is increased, how will the following be affected? Justify your answer.
(i) Energy of the photo-electrons
(ii) Photo current

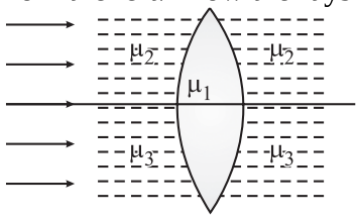
38. Define the term 'wavefront of light'. A plane wave front AB propagating from denser medium (1) into a rarer medium (2) is incident on the surface P_1 P_2 separating the two media as shown in fig. Using Huygens' principle, draw the secondary wavelets and obtain the refracted wavefront in the diagram.



39. A 10 V cell of negligible internal resistance is connected in parallel across a battery of emf 150 V and internal resistance 30Ω as shown in the figure. Find the value of current in the circuit.



40. (i) A double convex lens, made of a material of refractive index μ_1, is placed inside two liquids of refractive indices μ_2 and μ_3, as shown. $\mu_2 > \mu_1 > \mu_3$. A wide, parallel beam of light is incident on the lens from the left. How the rays will be refracted?

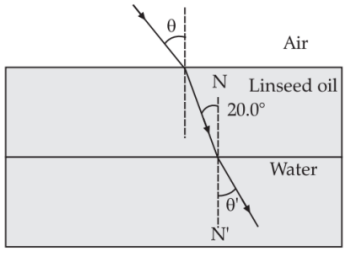


(ii) A biconvex lens of focal length f is cut into two identical plano convex lenses. What will be the focal length of each part?

OR

(i) Define the power of a lens. Write its S.I. unit.

(ii) The light beam shown in the figure makes an angle of 20.0° with the normal NN' in the linseed oil. Determine the angles θ and θ'. (The index of refraction of linseed oil is 1.48)



41. What is meant by doping of an intrinsic semiconductor? Name the two types of atoms used for doping of Ge/Si.

42. It light of wavelength 412.5 nm is incident on each of the metals given below, which ones will show photoelectric emission and why?

Metal	Work function (eV)
Na	1.92
K	2.15
Ca	3.20
Mo	4.17

43. Based on Huygens' construction, draw the shape of a plane wavefront as it gets refracted on passing through a convex lens.

44. A cell of emf 4 V and internal resistance 1Ω is connected to a d.c. source of 10 V through a resistor of 5Ω. Calculate the terminal voltage across the cell during charging.

45. An equilateral glass prism has a refractive index 1.6 in air. Calculate the angle of the minimum deviation of the prism, when kept in a medium of refractive index $\frac{4\sqrt{2}}{5}$.

OR

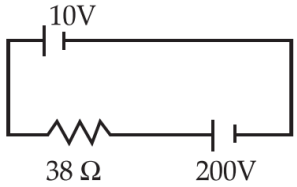
A 4.5 cm needle is placed 12 cm away from a convex mirror of focal length 15 an. Find the location and size of the image and the magnification.

46. Why Silicon diodes are more preferable than Germanium diodes?

47. Find the frequency of light which ejects electrons from a metal surface, fully stopped by a retarding potential of 3.3 V. If photoelectric emission begins in this metal at a frequency of 8×10^{14} Hz, calculate the work function (in eV) for this metal.

48. What is a wavefront? How does it propagate? Using Huygens' principle, explain reflection of a plane wavefront from a surface and verify the laws of reflection.

49. (i) A 10 V battery of negligible internal resistance is connected across a 200 V battery and a resistance of 38Ω as shown in the figure. Find the value of the current in the circuit.



(ii) What is the amount of current flowing through the galvanometer of a balanced Wheatstone bridge?

50. A narrow slit is illuminated by a parallel beam of monochromatic light of wavelength λ equals to 6000 Å and the angular width of the central maxima in the resulting diffraction pattern is measured. When the slit is next illuminated by light of wavelength λ', the angular width decreases by 30%. Calculate the value of the wavelength λ'.

OR

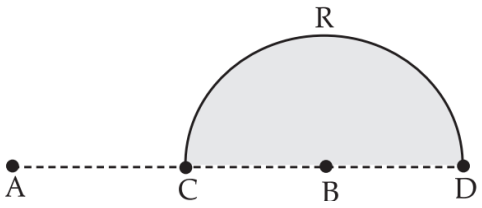
(i) What is the type of wavefront generated from (a) Line source (b) Point source?

(ii) In a Young's double-slit experiment, the source is white light. One of the holes is covered by a red filter and another by a blue filter. What will be the change in interference fringes?

Sure shots (3 Marks) Questions

1. A given coin has a mass of 3.0g. Calculate the nuclear energy that would be required to separate all the neutrons and protons from each other. For simplicity assume that the coin is entirely made of $_{29}^{63}Cu$ atoms (of mass 62.92960 u). Given m_p = 1.007825u and m_n = 1.008665u.

2. Charges (+q) and (–q) are placed at the points A and B respectively which are a distance 2L apart. C is the midpoint between A and B. What is the work done in moving a charge +Q along the semicircle CRD.



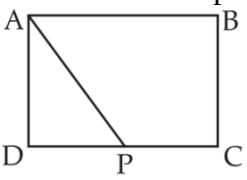
3. The total energy of an electron in the first excited state of the hydrogen atom is about –3.4 eV.

(a) What is the kinetic energy of the electron in this state?

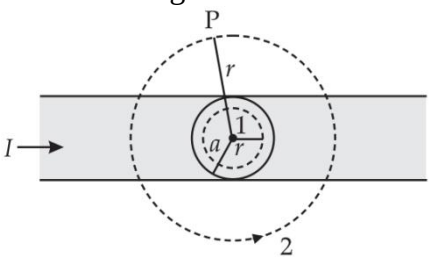
(b) What is the potential energy of the electron in this state?

(c) Which of the answers above would change if the choice of the zero of potential energy is changed?

4. A wire of uniform cross-section and resistance 4 ohm is bent in the shape of square ABCD. Point A is connected to a point P on DC by a wire AP of resistance 1 ohm. When a potential difference is applied between A and C, the points B and P are seen to be at the same potential. What is the resistance of the part DP?



5. The given figure shows a long straight wire of a circular cross-section (radius a) carrying steady current I. The current 1 is uniformly distributed across this cross-section. Calculate the magnetic field in the region r < a and r > a.



6. Identify the part of the electromagnetic spectrum which:

(a) produces heating effect,

(b) is absorbed by the ozone layer in the atmosphere,

(c) is used for studying crystal structure.

Write any one method of the production of each of the above radiations.

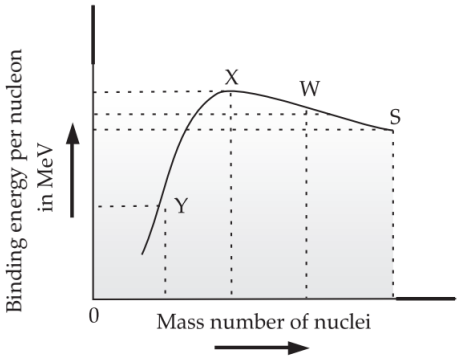
7. (a) Define mutual inductance and write its SI unit.

(b) Two circular loops, one of small radius r and other of larger radius R, such that R > > r, are placed coaxially with centres coinciding. Obtain the mutual inductance of the arrangement.

OR

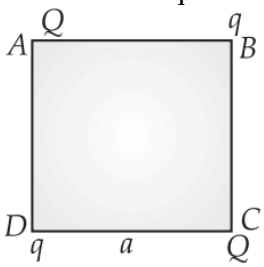
Two long straight parallel current carrying conductors are kept 'a' distant apart in air. The direction of current in both the conductors is same. Find the magnitude of force per unit length and direction of the force between them. Hence define one ampere.

8. Binding energy per nucleon versus mass number curve is as shown.
$_{Z}{}^{A}S$, $_{Z1}{}^{A1}W$, $_{Z2}{}^{A2}X$ and $_{Z3}{}^{A3}Y$ are four nuclei indicated on the curve.



Based on the graph:
(i) Arrange X, W and S in the increasing order of stability.
(ii) Write the relation between the relevant A and Z values for the following nuclear reaction.
$S \rightarrow X + W$
(iii) Explain why binding energy for heavy nuclei is low.

9. Four point charges Q, q, Q and q are placed at the corners of a square of side 'a' as shown in the figure.



Find the:
(i) Resultant electric force on a charge Q, and
(ii) Potential energy of this system.

10. Use Bohr's postulate to prove that the radius of n^{th} orbit in a hydrogen atom is proportional to n^2.

11. (i) Differentiate between electrical resistance and resistivity of a conductor.
(ii) Two metallic rods, each of length L, area of cross-section A_1 and A_2, having resistivity ρ_1 and ρ_2 are connected in parallel across a dc battery. Obtain the expression for the effective resistivity of this combination.

12. (a) How much force will be experienced by a charge at rest in a uniform magnetic field?
(b) 10A current flows through a coil of 100 turns. Radius of the coil is 25 cm. Find the magnetic field at the centre of the coil.

13. (i) Arrange the following electromagnetic radiation in the ascending order of their frequencies: X-rays, microwaves, gamma rays, radio waves.
(ii) Write two uses of any two of these radiation.

14. (i) A coil of certain radius has 100 turns and a self-inductance of 15 mH. What will be the change in self inductance if number of turns in increased to 500?
(ii) A rectangular frame of wire is placed in a uniform magnetic field directed outwards, normal to the paper. AB is connected to a spring which is stretched to A'B' and then released at time t = 0. Explain qualitatively how induced e.m.f. in the coil would vary with time. (Neglect damping of oscillations of spring)

OR

A coil of wire enclosing an area 100 cm^2 is placed with its plane making an angle 60° with the magnetic field of strength 10^{-1} T. What is the flux through the coil? If magnetic field is reduced to zero in 10^{-3} s, then find the induced emf.

15. (i) Given are two nuclei: $_{1}{}^{3}H$ and $_{2}{}^{3}He$. Justify that these two nuclei have the same radii.
(ii) A scientist hypothesizes the existence of a neutral particle of mass 2.0272 u which consist of two neutrons only. Take mass of neutron = 1.0086 u.
(a) What is the mass defect of this particle?
(b) Can such a particle exist? Give a reason for your answer.

16. (a) Two point charges q_1 and q_2 are kept at a distance of r_{12} in air. Deduce the expression for the electrostatic potential energy of the system.
(b) If an external electric field (E) is applied on the system, write the expression for total energy of this system.

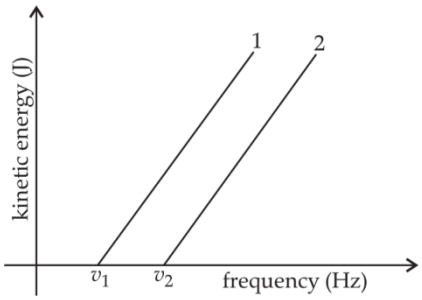
17. (i) What is the ratio of minimum to maximum energy of the radiations emitted by transition of an electron to the ground state of a hydrogen atom?
(ii) As per de Broglie's explanation of Bohr's quantization condition of an orbiting electron, represent a schematic diagram of particle waves associated with the electron of the hydrogen atom in the two states, n = 2 and n = 3.

(iii) Express the de Broglie's wavelength of an electron in the second orbit of Bohr's hydrogen atom in terms of the radius of the orbit.

18. A storage battery is of emf 8 V and internal resistance 0.5 ohm is being charged by supply of 120 V using a resistor of 15.5 ohm.
(a) Draw the circuit diagram.
(b) Calculate the potential difference across the battery.
(c) What is the purpose of having series resistance in this circuit?

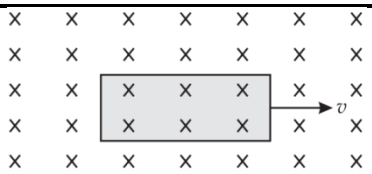
19. A bar magnet of dipole moment 3 Am^2 rests with its centre on a frictionless pivot. A force F is applied at right angles to the axis of the magnet, 10 cm from the pivot. It is observed that an external magnetic field of 0.25 T is required to hold the magnet in equilibrium at an angle of 30° with the field. Calculate the value of F. How will the equilibrium be effected if F is withdrawn?

20. Radiations of different frequencies fall on two different metal surfaces. The graph below represents the kinetic energy of the emitted photoelectrons as a function of frequencies of incident radiations.



(i) If the two metals along with their work functions are:
Potassium (2.3 eV) and Aluminium (4.3 eV), identify which line represents each metal. Give a reason for your answer.
(ii) Write the photoelectric equation that represents each of the above graphs. Find the slope of the graph.
(iii) State one condition with respect to incident radiation for which the photoelectric current produced by it is proportional to its intensity.

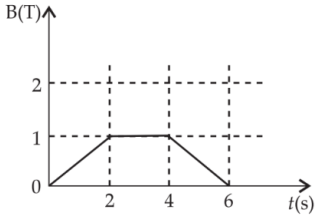
21. A rectangular loop which was initially inside the region of uniform and time-independent magnetic field, is pulled out with constant velocity v as shown in the figure.



(a) Sketch the variation of magnetic flux, the induced current, and power dissipated as Joule heat as function of time.
(b) If instead of rectangular loop, circular loop is pulled out do you expect the same value of induced current? Justify your answer. Sketch the variation of flux in this case with time.

OR

The magnetic field through a circular loop of wire of 12 cm radius and 8.5Ω resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Calculate the induced current in the loop and plot it as a function of time.



22. (i) What do you mean by binding energy per nucleon?
(ii) How the mass density of a nucleus varies with mass number?
(iii) The binding energies per nucleon for deutron and an alpha-particle are x_1 and x_2 respectively. Find the amount of energy released in the following reactions.
$_1{}^2H + _1{}^2H \rightarrow _2{}^4He + Q$

23. A hollow conducting sphere of inner radius r_1 and outer radius r_2 has a charge Q on its surface. A point charge –q is also placed at the centre of the sphere.
(i) What is the surface charge density on the (a) inner and (b) outer surface of the sphere?
(ii) Use Gauss' law of electrostatics to obtain the expression for the electric field at a point lying outside the sphere.

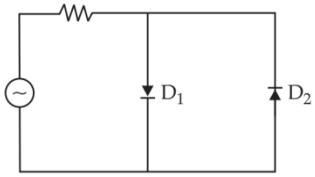
24. The ground state energy of hydrogen atom is –13.6 eV. The photon emitted during the transition of electron from n = 3 to n = 1 state, is incident on a photosensitive material of unknown work function. The photoelectrons are emitted from the material with the maximum kinetic energy of 9 eV.

Calculate the threshold wavelength of the material used.

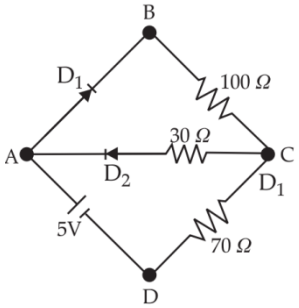
25. (i) Define the term 'conductivity' of a metallic wire. Write its SI unit.
(ii) Using the concept of free electrons in a conductor, derive the expression for the conductivity of a wire in terms of current density and relaxation time. Hence obtain the relation between current density and the applied electric field E.

26. Derive the expression for the torque t acting on a rectangular current loop of area A placed in a uniform magnetic field B. Show that $\vec{\tau} = \vec{M} \times \vec{B}$ where $\vec{M}$ is the magnetic moment of the current loop given by $\vec{M} = I\vec{A}$.

27. (i) In the circuit given, identify the nature of biasing (forward or reverse) across each of the diodes.



(ii) Consider a network ABCD containing two identical diodes D_1 and D_2. The two diodes offer a resistance of 30Ω when in forward bias and infinite resistance when in reverse bias.

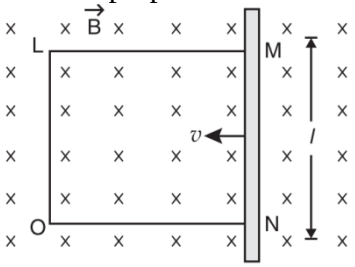


If the maximum current that can flow in either of the diodes is 30 mA beyond which they burn out, determine which of the diodes are safe in the above circuit?

28. (a) Differentiate between self-inductance and mutual inductance.
(b) The mutual inductance of two coaxial coils is 2 H. The current in one coil is changed uniformly from zero to 0.5 A in 100 ms. Find the:
(i) change in magnetic flux through the other coil.
(ii) emf induced in the other coil during the change.

OR

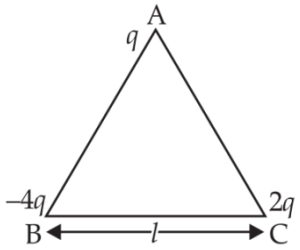
A rectangular conductor LMNO is placed in a uniform magnetic field of 0.5 T. The field is directed perpendicular to the plane of the conductor.



When the arm MN of length of 20 cm is moved towards left with a velocity of 10 ms–1, calculate the emf induced in the arm. Given the resistance of the arm to be 5Ω (assuming that other arms are of negligible resistance), find the value of the current in the arm.

29. (i) State two distinguishing features of nuclear force.
(ii) Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation. Mark the regions on the graph where the force is (a) attractive, and (b) repulsive.

30. Three point charges q, –4q and 2q are placed at the vertices of an equilateral triangle ABC of side '*l*' as shown in the figure.



(i) Obtain the expression for the magnitude of the resultant electric force acting on the charge q.
(ii) Find out the amount of the work done to separate the charges at infinite distance.

31. (i) The energy of hydrogen atom in an orbit is –1.51 eV. What are kinetic and potential energies of the electron in this orbit?
(ii) The electron in a hydrogen atom is typically found at a distance of about 5.3×10^{-11} m from the nucleus which has a diameter of about 1.0×10^{-15} m. Assuming the hydrogen atom to be a sphere of radius 5.3×10^{-11} m, what fraction of its volume is occupied by the nucleus?

32. (i) Define internal resistance of a cell.
(ii) A cell of emf E and internal resistance r is connected across a variable resistor R. Plot the

shape of graphs showing variation of terminal voltage V with (a) R and (b) circuit current I.

33. (i) Write an expression for the force $\vec{F}$ acting on a particle of mass m and charge q moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. Under what conditions will it move in (a) a circular path and (b) a helical path?
(ii) Show that kinetic energy of the particle moving in magnetic field remains constant.

34. (i) James Chadwick, in 1932 studied the emission of neutral radiations when Beryllium nuclei were bombarded with alpha particles. He concluded that emitted radiations were neutrons and not photons. Explain.
(ii) Two nuclei may have the same radius, even though they contain different number of protons and neutrons. Explain.

35. State Lenz's law. Explain, by giving examples that Lenz's law is a consequence of conservation of energy.

OR

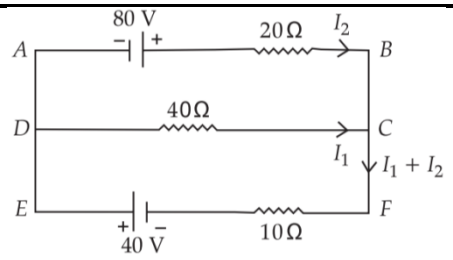
Draw the labelled diagram of an AC generator. Briefly explain its working and obtain the expression for the emf produced in the coil.

36. (i) What do you mean by mass defect of a nucleus?
(ii) What is the nuclear radius of ^{125}Fe ,if that of ^{27}Al is 3.6 fermi?

37. An infinitely long thin straight wire has a uniform linear charge density λ.
(i) Obtain the expression for the electric field (E) at a point lying at a distance x from the wire, using Gauss' law.
(ii) Show graphically the variation of this electric field E as a function of distance x from the wire.

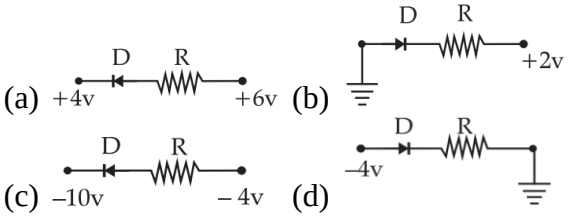
38. An object is placed in front of a concave mirror of focal length of 12 cm. There are two possible positions of the object for which the image formed is three times the size of the object.
(i) Draw the ray diagram for the each case, and
(ii) Find the distance between the two positions of the object.

39. Using Kirchhoff's rules, calculate the current through the 40Ω and 20Ω resistors in the following circuit:

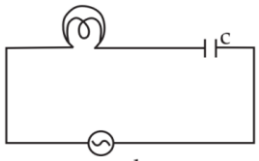


40. Write three points of differences between para, dia and ferromagnetic materials, giving one example for each.

41. (i) Why a pure semiconductor behaves like an insulator at 0 K?
(ii) Categorize each of the following junction diodes as either forward biased or reverse biased. Give reason for each answer.

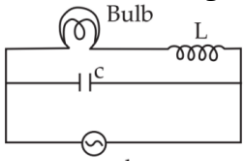


42. A bulb is connected through a capacitor in an ac circuit as in the circuit (a). The bulb in the circuit glows when the frequency of the input ac voltage is ω.



Circuit (a)

A circuit (b) is constructed by including an inductor L as shown, keeping all other components the same as in circuit (a). The bulb continues to glow when the frequency of the input ac voltage is ω. Now the frequency ω of the ac supply is changed in both the circuits while keeping the voltage amplitude constant and same in both the circuits. Explain the effect on the brightness of the bulb in each circuit if

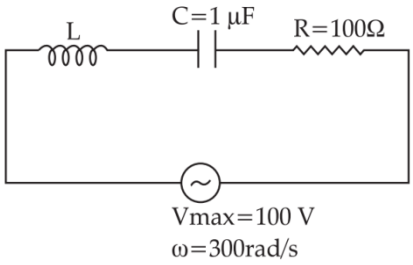


Circuit (b)

(i) the frequency of input ac voltage is lowered
(ii) the frequency of input ac voltage is increased
(iii) the frequency of input ac voltage approaches zero.

OR

A series LCR circuit as shown in the diagram is connected to an input ac voltage. The voltage across the capacitor lags the applied input voltage by 45°.



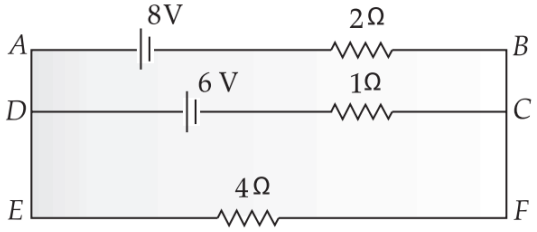
(i) Represent the phase relationship for the voltages across the three elements L, C and R using a phasor diagram.
(ii) Determine the phase angle j in the given circuit.
(iii) Determine the value of inductor L.

43. In a fission event of $_{92}^{238}U$ by fast moving neutrons, no neutrons are emitted and final products, after the beta decay of the primary fragments, are $_{58}^{140}Ce$ and $_{44}^{99}Ru$. Calculate Q for this process. Neglect the masses of electrons/ positrons emitted during the intermediate steps.
Mass of m($_{92}^{238}U$) = 238.05079u
Mass of ($_{58}^{140}Ce$) = 139.90543u
Mass of ($_{44}^{99}Ru$) = 98.90594u
Mass ($_{0}^{1}n$) = 1.008665u

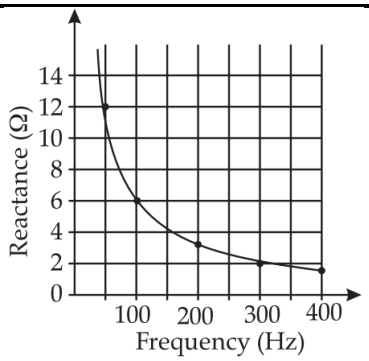
44. A charge is distributed uniformly over a ring of radius 'a'. Obtain an expression for the electric intensity E at a point on the axis of the ring. Hence show that for points at large distances from the ring, it behaves like a point charge.

45. Define the term 'focal length of a mirror' with the help of any diagram. Obtain the relation between focal length and radius of curvature.

46. Calculate the potential difference across the 4 Ω resistor in the given electrical circuit, using Kirchhoff's rules.



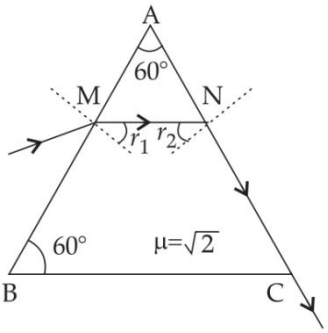
47. The figure shows the graphical variation of the reactance of a capacitor with frequency of ac source.



(i) Find the capacitance of the capacitor.
(ii) An ideal inductor has the same reactance at 100 Hz frequency as the capacitor has at the same frequency. Find the value of inductance of the inductor.
(iii) Draw the graph showing the variation of the reactance of this inductor with frequency.

48. Radiation of frequency 10^{15} Hz is incident on three photosensitive surfaces A, B and C. Following observations are recorded:
Surface A: no photoemission occurs
Surface B: photoemission occurs but the photoelectrons have zero kinetic energy.
Surface C: photo emission occurs and photoelectrons have some kinetic energy.
Using Einstein's photo-electric equation, explain the three observations.

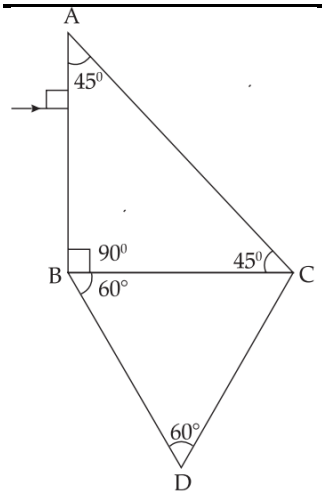
49. A ray of light passes through a prism of refractive index $\sqrt{2}$ as shown in the figure.



Find:
(i) The angle of incidence ($\angle r_2$) at face AC.
(ii) The angle of minimum deviation for this prism.

OR

(i) Write two necessary conditions for total internal reflection.
(ii) Two prisms ABC and DBC are arranged as shown in figure.



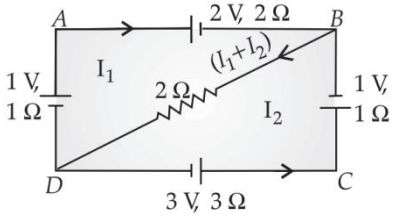
The critical angles for the two prisms with respect to air are 41.1° and 45° respectively. Trace the path of the ray through the combination.

50. Explain the processes of nuclear fission and nuclear fusion by using the plot of binding energy per nucleon (BE/A) versus the mass number A.

51. (i) Obtain the expression for the torque $\vec{\tau}$ experienced by an electric dipole of dipole moment $\vec{p}$ in a uniform electric field $\vec{E}$.
(ii) What will happen if the field were not uniform?

52. Show that the spherical mirror formula holds equally to a plane mirror.

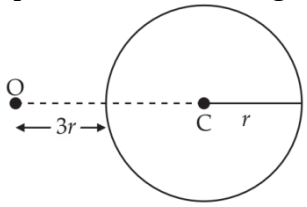
53. Using Kirchhoff's rules, calculate the potential difference between B and D in the circuit diagram as shown in the figure.



54. (i) In a series LCR circuit, obtain the conditions under which
(a) impedance of the circuit is minimum.
(b) wattless current flows in the circuit.
(ii) When the selectivity of a series LCR circuit will be large?

55. (i) Calculate the energy and momentum of a photon in a monochromatic beam of wavelength 331.5 nm.
(ii) How fast should a hydrogen atom travel in order to have the same momentum as that of the photon in part (i)?

56. (i) An object is placed in front of a converging lens. Write the conditions under which the magnification produced by the lens is (a) negative and (b) positive.
(ii) A point object is placed at O in front of a glass sphere as shown in figure.



Show the formation of image by the sphere.

OR

(i) Define prism angle.
(ii) A plano-convex lens is made of glass of refractive index 1.5. The radius of curvature of the convex surface is 25 cm. (a) Calculate the focal length of the lens. (b) If an object is placed 50 cm in front of the lens, find the nature and position of the image formed.

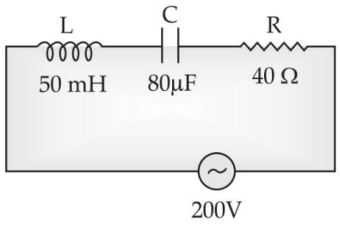
57. Draw a plot of α-particle scattering by a thin foil of gold to show the variation of the number of the scattered particles with scattering angle. Describe briefly how the large angle scattering explains the existence of the nucleus inside the atom. Explain with the help of impact parameter picture, how Rutherford scattering serves a powerful way to determine an upper limit on the size of the nucleus.

58. Surface charge density of a positively charged plate is σCm^{-2}. A ball of mass M and charge +q is connected with the plate by a thread. What will be the angle made by the thread with the plate at equilibrium?

59. With the help of a ray diagram explain the working of a reflecting telescope. Mention two advantages of a reflecting telescope over a refracting telescope.

60. (i) Define the term 'conductivity' of a metallic wire. Write its SI unit.
(ii) Using the concept of free electrons in a conductor, derive the expression for the conductivity of a wire in terms of current density and relaxation time. Hence obtain the relation between current density and the electric field E.

61. (i) The figure shows a series LCR circuit connected to a variable frequency 200 V ac source.



Find (a) the source frequency which drives the circuit to resonance.
(b) the quality factor (Q) of the circuit.
(ii) What is the power factor of a series LCR circuit at resonance?

62. An alpha particle is accelerated through a potential difference of 100 V. Calculate:
(i) The speed acquired by the alpha particle, and
(ii) The de-Broglie wavelength associated with it. (Take mass of alpha particle = 6.4×10^{-27} kg).

63. (i) Draw a labelled ray diagram of an astronomical telescope in the near point adjustment position.
(ii) A giant refraction telescope at an observatory has an objective lens of focal length 15 m and an eyepiece of focal length 1.0 cm. If this telescope is used to view the moon, find the diameter of the image of the moon formed by the objective lens. The diameter of the moon is 3.48×10^6 m and the radius of lunar orbit is 3.8×10^8 m.

OR

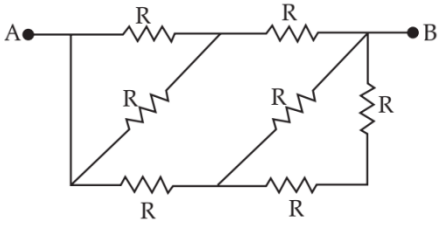
(i) State two conditions for two light sources to be coherent.
(ii) Light of wavelength 6×10^{-5} cm passing through two slits separated by 1 mm produces an interference pattern on a screen placed at a distance 1m. Find the distance between two consecutive bright bands of the pattern.

64. (i) Mention two limitations of Bohr's atomic model.
(ii) In decay of free neutron, name the elementary particle emitted along with proton and electron in nuclear reaction.

65. (i) Write an expression for the work done on an electric dipole with a dipole moment of p in a uniform electric field E to move it from a stable to an unstable equilibrium state.
(ii) Draw the equipotential surfaces for an electric dipole.

66. Define the term, "refractive index" of a medium. Verify Snell's law of refraction when a plane wavefront is propagating from a denser to a rarer medium.

67. (i) Find the equivalent resistance between points A and B of the following circuit:



(ii) Very high and very low resistance cannot be measured correctly by using Wheatstone bridge. Why?

68. State Lenz's law. Explain, by giving examples that Lenz's law is a consequence of conservation of energy.

69. The work function of a metal is 2.31 eV. Photoelectric emission occurs when light of frequency 6.4×10^{14} Hz is incident on the metal surface. Calculate (i) the energy of the incident radiation, (ii) the maximum kinetic energy of the emitted electron and (iii) the stopping potential of the surface.

70. In a diffraction pattern due to a single slit, how will the angular width of central maximum change, if (i)orange light is used in place of green light, (ii) the screen is moved closer to the slit, (iii) the slit width is decreased? Justify your answer in each case.

OR

(i) Compare Maxwell's electromagnetic theory with Huygens' wave theory of light.
(ii) Define incident angle of a light wave.

Sure shots (5 Marks) Questions

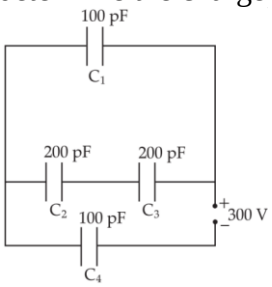
1. (i) Draw a ray diagram for the formation of image of a point object by a thin double convex lens having radii of curvature R_1 and R_2. Hence derive lens maker's formula.
(ii) A converging lens has a focal length of 10 cm in air. It is made of a material of refractive index 1.6. If it is immersed in a liquid of refractive index 1.3, find its new focal length.

OR

(i) Define a wavefront. How is it different from a ray?

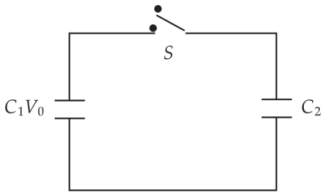
(ii) Using Huygens's construction of secondary wavelets draw a diagram showing the passage of a plane wavefront from a denser to a rarer medium. Using it verify Snell's law.
(iii) In a double slit experiment using light of wavelength 600nm and the angular width of the fringe formed on a distant screen is 0.1°. Find the spacing between the two slits.
(iv) Write two differences between interference pattern and diffraction pattern.

2. (i) Derive an expression for the capacitance of a parallel plate capacitor with air present between the two plates.
(ii) Obtain the equivalent capacitance of the network shown in figure. For a 300V supply, determine the charge on each capacitor.



OR

(i) A dielectric slab of thickness 't' is kept between the plates of a parallel plate capacitor with plate separation 'd' (t < d). Derive the expression for the capacitance of the capacitor.
(ii) A capacitor of capacity C_1 is charged to the potential of V_0. On disconnecting with the battery, it is connected with an uncharged capacitor of capacity C_2 as shown in the adjoining figure. Find the ratio of energies before and after the connection of switch S.

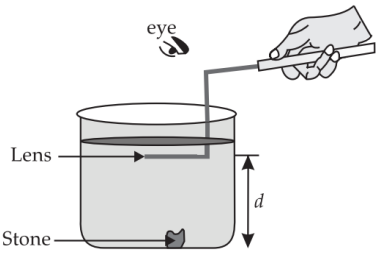


3. (a) Draw graphs showing the variations of inductive reactance and capacitive reactance with frequency of applied ac source.
(b) Draw the phasor diagram for a series LRC circuit connected to an AC source.
(c) When an alternating voltage of 220V is applied across a device X, a current of 0.25A flows which lags behind the applied voltage in phase by π/2 radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage.
(i) Name the devices X and Y.
(ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y.

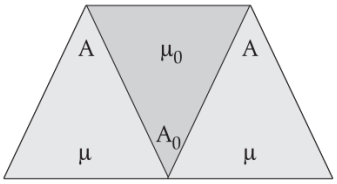
OR

(a) A series LCR circuit is connected to an ac source. Using the phasor diagram, derive the expression for the impedance of the circuit.
(b) Plot a graph to show the variation of current with frequency of the ac source, explaining the nature of its variation for two different resistances R_1 and R_2 ($R_1 < R_2$) at resonance.

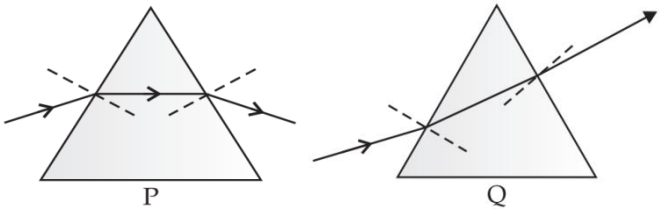
4. (i) In reference to the picture given here, a convex lens of focal length fair (in air), is immersed in the water to view a small black stone that is placed at the bottom of the container is at a depth d from the lens.



Will it form a magnified virtual image of the stone if $d > f_{air}$?
(ii) In the given combination of three triangular prisms, a ray of light enters the first prism on the left and exits from prism on the right after refraction. Consider the angles of the prisms to be small and the ratio $A_0/A = 2$.



Prove that for a net deviation produced in the light ray to be zero, $\mu = \mu_0$ in the given combination.
(iii) A glass prism of absolute refractive index of 1.52 is surrounded by a medium. The emergent rays are bent either upwards or downwards.



Select the suitable surrounding mediums from the given table of refractive indices here for each of the

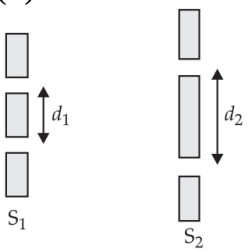
above refractions through the prisms P and Q. Give reason for the choice of the mediums.

Medium	Refractive Index
Benzene	1.50
Carbon disulphide	1.63
Ethyl alcohol	1.54
Aqueous sodium chloride	1.54

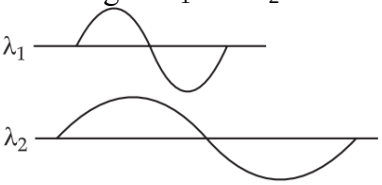
OR

(i) The interference pattern due to light shows bright and dark regions that appear similar to the antinodes and nodes of a standing-wave pattern on a string. While both the patterns are based on the superposition principle, give one major point of difference between the standing waves pattern and the interference pattern.

(ii) Given two sets of slits S_1 and S_2.



Also given are two possible incident light wavelengths λ_1 and λ_2.



State with reason for what combination of the slits and wavelengths will the interference pattern be

(a) most spread out

(b) least spread out?

(iii) Find ratio of the maximum and minimum intensities produced due to superposition of two coherent light waves of intensity I and 4I.

5. (i) Draw equipotential surfaces for

(a) an electric dipole and

(b) two identical positive charges placed near each other.

(ii) In a parallel plate capacitor with air between the plates, each plate has an area of 6×10^{-3} m^2 and the separation between the plates is 3 mm.

(a) Calculate the capacitance of the capacitor.

(b) If the capacitor is connected to 100 V supply, what would be the charge on each plate?

(c) How would charge on the plate be affected if a 3 mm thick mica sheet of k = 6 is inserted between the plates while the voltage supply remains connected?

OR

A capacitor of capacitance C_1 is charged to a potential V_1 while another capacitor of capacitance C_2 is charged to a potential difference V_2. The capacitors are now disconnected from their respective charging batteries and connected in parallel to each other.

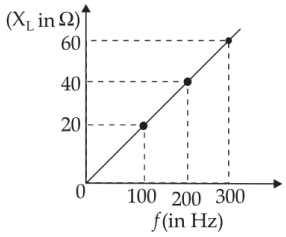
(i) Find the total energy stored in the two capacitors before they are connected.

(ii) Find the total energy stored in the parallel combination of the two capacitors.

(iii) Explain the reason for the difference of energy in parallel combination in comparison to the total energy before they are connected.

6. (i) Show that an ideal inductor does not dissipate power in an a.c. circuit.

(ii) The variation of inductive reactance (X_L) of an inductor with the frequency (f) of the a.c. source of 100 V and variable frequency is shown in the figure.

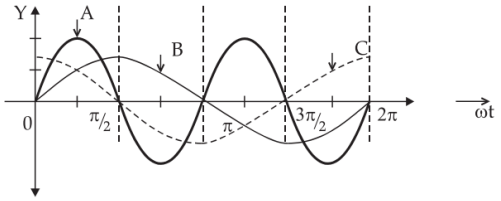


(a) Calculate the self-inductance of the inductor.

(b) When this inductor is used in series with a capacitor of unknown value and a resistor of 10Ω at 300 s^{-1}, maximum power dissipation occurs in the circuit. Calculate the capacitance of the capacitor.

OR

A device 'X' is connected to an ac source $V = V_0 \sin \omega t$. The variation of voltage, current and power is shown in the following graph:



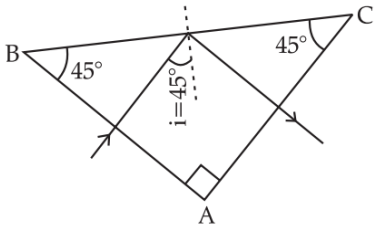
(i) Identify the device 'X'.

(ii) Which of the curves A, B and C represent the voltage, current and the power consumed in the circuit? Justify your answer.

(iii) How does its impedance vary with frequency of the ac source? Show graphically.

(iv) Obtain an expression for the current in the circuit and its phase relation with ac voltage.

7. (i) A ray of light of wavelength λ falls normally on a right-angled isosceles prism ABC of refractive index n.



Find the minimum value of refractive index n of the prism required for the total internal reflection of the light to occur on the face BC of the prism.

(ii) For any given thin prism of small angle A, the refractive index n, and an incident blue light, answer the following questions.

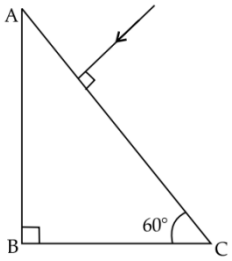
(a) Write the formula for refractive index in terms of angle of minimum deviation for a thin prism. If the whole arrangement is immersed in water how will the angle of minimum deviation change?

(b) For some angle of incidence on the second face of the prism, the incident blue light undergoes total internal reflection. However, a red incident light for the same angle of incidence on the second face of the prism does not undergo total internal reflection. Give reason.

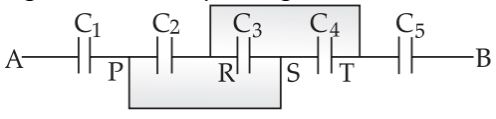
(iii) An equilateral prism has a refractive index of 1.6 in air. Calculate the angle of the minimum deviation of the prism, when kept in a medium of refractive index $4\frac{\sqrt{2}}{5}$.

OR

Calculate the angle of emergence (e) of the ray of light incident normally on the face AC of a glass prism ABC of refractive index $\sqrt{3}$. How will the angle of emergence change, if the ray of light emerges from the prism into a liquid of refractive index 1.3 instead of air?

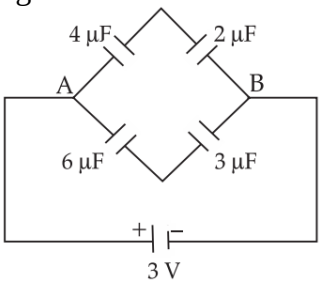


8. (i) Find the equivalent capacitance between A and B in the combination given above. Each capacitor is of 2μF capacitance.



(ii) If a DC source of 7 V is connected across AB, how much charge is drawn from the source and what is the energy stored in the network?

(iii) Find the total charge stored in the network of capacitors connected between A and B as shown in figure:



OR

(i) A 12 pF capacitor is connected to a 50 V battery. How much electrostatic energy is stored in the capacitor? If another capacitor of 6 pF is connected in series with it with the same battery connected across the combination, find the charge stored and potential difference across each capacitor.

(ii) A capacitor of unknown capacitance is connected across a battery of V volt. A charge of 360 μC is stored in it. When the potential across the capacitor is reduced by 120 V, the charge stored in the capacitor becomes 120 μC. Calculate V and the unknown capacitance. What would have been the charge on the capacitor if the voltage were increased by 120 V?

9. (i) Derive the expression for the current flowing in an ideal capacitor and its reactance when connected to an ac source of voltage $V = V_0 \sin \omega t$.

(ii) Draw its phasor diagram.

(iii) If resistance is added in series to capacitor what changes will occur in the current flowing in the circuit and phase angle between voltage and current.

OR

A device X is connected across an ac source of voltage $V = V_0 \sin \omega t$. The current through X is given as $I = I_0 \sin \left(\omega t + \frac{\pi}{2}\right)$.

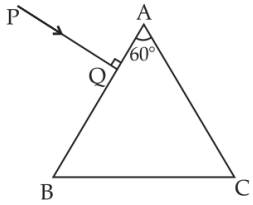
(i) Identify the device X and write the expression for its reactance.

(ii) Draw graphs showing variation of voltage and current with time over one cycle of ac, for X.

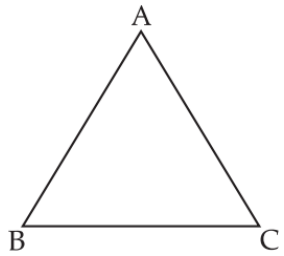
(iii) How does the reactance of the device X vary with frequency of the ac? Show this variation graphically.

(iv) Draw the phasor diagram for the device X.

10. (a) A ray PQ is incident normally on the face AB of a triangular prism of refracting angle 60° as shown in figure. The prism is made of a transparent material of refractive index $\frac{2}{\sqrt{3}}$. Trace the path of the ray as it passes through the prism. Calculate the angle of emergence and the angle of deviation.



(b) (i) A ray of light incident on face AB of an equilateral glass prism, shows minimum deviation of 30°. Calculate the speed of light through the prism.



(ii) Find the angle of incidence at face AB so that the emergent ray grazes along the face AC.

OR

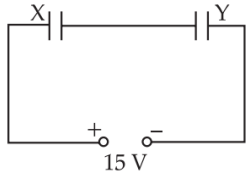
(i) A slit of width 0.6 mm is illuminated by a beam of light consisting of two wavelengths 600 nm and 480 nm. The diffraction pattern is observed on a screen 1.0 m from the slit. Find:

(a) The distance of the second bright fringe from the central maximum pertaining to light of 600 nm.

(b) The least distance from the central maximum at which bright fringes due to both the wavelengths coincide.

(ii) Draw the graph showing intensity distribution of fringes with phase angle due to diffraction through single slit.

11. (i) Two parallel plate capacitors X and Y have the same area of plates and same separation between them. X has air between the plates while Y contains a dielectric medium of $\varepsilon_r = 4$.



(a) Calculate capacitance of each capacitor if equivalent capacitance of the combination is 4 μF.

(b) Calculate the potential difference between the plates of X and Y.

(c) Estimate the ratio of electrostatic energy stored in X and Y.

(ii) Two identical capacitors of 12 pF each are connected in series across a battery of 50 V. How much electrostatic energy is stored in the combination? If these were connected in parallel across the same battery, how much energy will be stored in the combination now?

Also, find the charge drawn from the battery in each case.

OR

(i) Three charges –q, Q and –q are placed at equal distances on a straight line. If the potential energy of the system of these charges is zero, then what is the ratio Q : q?

(ii) (a) Obtain the expression for the electric field intensity due to a uniformly charged spherical shell of radius R at a point distant r from the centre of the shell outside it.

(b) Draw a graph showing the variation of electric field intensity E with r, for r > R and r < R.

12. (i) A capacitor (C) and resistor (R) are connected in series with an ac source of voltage of frequency 50 Hz. The potential difference across C and R are respectively 120 V and 90 V, and the current in the circuit is 3 A. Calculate (i) the impedance of the circuit (ii) the value of the inductance, which when connected in series with C and R will make the power factor of the circuit unity.

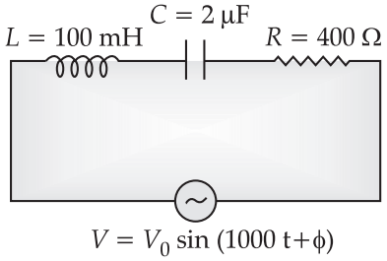
(ii) (a) Explain the term 'sharpness of resonance' in ac circuit.

(b)In a series LCR circuit, $V_L = V_C \neq V_R$. What is the value of power factor for this circuit?

OR

(i) Find the value of the phase difference between the current and the voltage in the series LCR circuit shown below. Which one leads in phase: current or voltage?

(ii) Without making any other change, find the value of the additional capacitor C1, to be connected in parallel with the capacitor C, in order to make the power factor of the circuit unity.



(iii) A resistor R and an inductor L are connected in series to a source of voltage $V = V_0 \sin \omega t$. The voltage is found to lead current in phase by $\frac{\pi}{4}$. If the inductor is replaced by a capacitor C, the voltage lags behind current in phase by $\frac{\pi}{4}$. When L, C and R are connected in series with the same source, Find the:
(a) average power dissipated and
(b) instantaneous current in the circuit

13. (i) State two main considerations taken into account while choosing the objective of astronomical telescope.
(ii) Draw a ray diagram of reflecting type telescope.
(iii) State the advantages of reflecting type telescope over the refracting type?

OR

(i) How can you differentiate whether a pattern is produced by a single slit or double slits? Derive the expression for the angular position of (a) bright and (b) dark fringes produced in a single slit diffraction.
(ii) A narrow slit is illuminated by a parallel beam of monochromatic light of wavelength λ equal to 6000 Å and the angular width of the central maximum in the resulting diffraction pattern is measured. When the slit is next illuminated by light of wavelength λ′, the angular width decreases by 30%. Calculate the value of the wavelength λ′.

14. (i) Define the capacitance of a capacitor. Write the expression for the capacitance of an air filled parallel plate capacitor in terms of plate area A and separation d between the plates.
(ii) A slab of material of dielectric constant κ has the same area as the plates of a parallel plate capacitor but has a thickness $\frac{3d}{4}$. Find the ratio of the capacitance with dielectric inside it to its capacitance without the dielectric.

OR

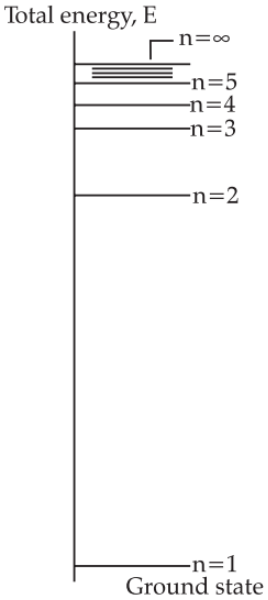
(i) You are given three capacitors of 2μF, 3μF and 4μF, respectively.
(a) Form a combination of all these capacitors of equivalent capacitance of 13/3μF.
(b) What is the maximum and minimum value of the equivalent capacitance that can be obtained by connecting these capacitors?
(ii) A 200μF parallel plate capacitor having plate separation of 5 mm is charged by a 100 V dc source. It remains connected to the source. Using an insulated handle, the distance between the plates is doubled and a dielectric slab of thickness 5 mm and dielectric constant 10 is introduced between the plates. Explain with reason, how the (a) capacitance, (b) electric field between the plates, (c) energy density of the capacitor will change?

15. (i) Draw a labelled diagram of a step-down transformer. State the principle of its working.
(ii) Express the turn ratio in terms of voltages.
(iii) Find the ratio of primary and secondary currents in terms of turn ratio of an ideal transformer.
(iv) How much current is drawn by the primary of a transformer connected to 220 V supply when it delivers power to a 110 V – 550 W refrigerator?

OR

(i) Describe, the working principle of a step-up transformer with the help of a suitable diagram. Obtain the relation between input and output voltages in terms of the number of turns of primary and secondary windings and the currents in the input and output circuits.
(ii) Given the input current 15 A and the input voltage of 100 V for a step-up transformer having 90% efficiency, find the output power and the voltage in the secondary if the output current is 3A.

16. (i) By what factor does kinetic and potential energy of an electron in a hydrogen atom change as it moves from n = 1 to n = 3?
(ii) A glass container contains hydrogen atoms with all its atoms in their ground states. The container is irradiated with electromagnetic waves containing 3 wavelengths corresponding to Lyman, Balmer and Paschen series. The electromagnetic waves exiting the glass container are found to have certain strong absorption spectral lines. Identify one or more series to which these absorption spectral lines would correspond to. Explain. Assume that once an electron absorbs a photon and jumps to a higher level, it does not absorb more photons to jump to even higher levels.
(iii) An electron in its orbit undergoes transitions across the energy levels either by absorbing or emitting the photons. A given hydrogen atom is in third excited state. Determine the final quantum number and the energy of the photon,



(a) When a photon with shortest wavelength is emitted

(b) When a photon with longest wavelength is absorbed.

OR

(i) In Rutherford scattering experiment, draw the trajectory traced by α-particles in the coulomb field of target nucleus and explain how this led to estimate the size of the nucleus.

(ii) What is thermal neutron?

(iii) Estimate the ratio of de-Broglie wavelengths associated with deuterons and α-particles when they are accelerated from rest through the same accelerating potential V.

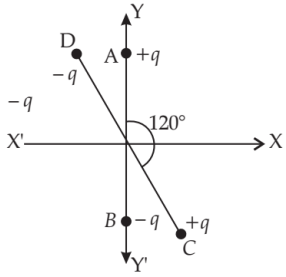
17. (i) Derive an expression for the electric field at any point on the equatorial line of an electric dipole.

(ii) Two identical point charges, q each, are kept 2 m apart in the air. A third point charge Q of unknown magnitude and sign is placed on the line joining the charges such that the system remains in equilibrium. Find the position and nature of Q.

OR

(i) Derive the expression for the torque acting on an electric dipole, when it is held in a uniform electric field. Identify the orientation of the dipole in the electric field, in which it attains a stable equilibrium.

(ii) Two small identical electric dipoles AB and CD, each of dipole moment $\vec{p}$ are kept at an angle of 120° to each other in an external electric field $\vec{E}$ pointing along the x-axis as shown in the figure. Find the (a) dipole moment of the arrangement, and (b) magnitude and direction of the net torque acting on it.



18. (i) Instantaneous emf of an ac source is
e = 200 sin 314t.
Find the rms voltage and the frequency of the source.

(ii) An a.c. source generating a voltage $\varepsilon = \varepsilon_0 \sin \omega t$ is connected to a capacitor of capacitance C. Find the expression for the current I flowing through it. Plot a graph of ε and I versus ωt to show that the current is ahead of the voltage by $\frac{\pi}{2}$.

OR

(i) The current through a resistor is 2 A when connected to a 220 V, 50 Hz line. Find the value of capacitor which is to be connected to reduce the current to 1A.

(ii) An ac voltage $V = V_0$ is applied across a pure inductor of inductance L. Find an expression for the current i, flowing in the circuit and show mathematically that the current flowing through it lags behind the applied voltage by a phase angle of $\frac{\pi}{2}$. Also draw graphs of V and i versus ωt for the circuit.

19. (i) State the postulates of Bohr's model of hydrogen atom and derive the expression for Bohr radius.

(ii) Find the ratio of the longest and the shortest wavelengths amongst the spectral lines of Balmer series in the spectrum of hydrogen atom.

OR

(i) Using Bohr's postulates, derive the expression for the total energy of the electron in the stationary states of the hydrogen atom.

(ii) Using Rydberg formula, calculate the wavelengths of the spectral lines of the first member of the Lyman series and of the Balmer series.

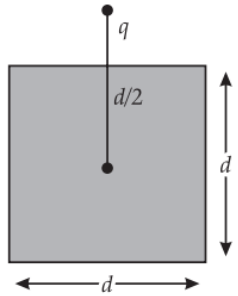
20. (i) Use Gauss' law to show that due to a uniformly charged spherical shell of radius R, the electric field at any point situated outside the shell at a distance r from its centre is equal to the electric field at the same point, when the entire charge on the shell were concentrated at its centre. Also plot

the graph showing the variation of electric field with r, for r ≤ R and r ≥ R.

(ii) Two point charges of +1μC and +4μC are kept 30 cm apart. How far from the + 1 μC charge on the line joining the two charges, will the net electric field be zero?

OR

(i) Define electric flux. Is it a scalar or a vector quantity? A point charge q is at a distance of $\frac{d}{2}$ directly above the centre of a square of side d, as shown in the figure. Use Gauss' law to obtain the expression for the electric flux through the square.



(ii) If the point charge is now moved to a distance 'd' from the centre of the square and the side of the square is doubled, explain how the electric flux will be affected.

21. (i) A small compass needle of magnetic moment 'm' is free to turn about an axis perpendicular to the direction of uniform magnetic field 'B'. The moment of inertia of the needle about the axis is 'I'. The needle is slightly disturbed from its stable position and then released. Prove that it executes simple harmonic motion. Hence, deduce the expression for its time period.

(ii) Prove that the potential energy of a magnet in a uniform magnetic field is U = $-\vec{M}.\vec{B}$.

OR

Define the term magnetic dipole moment.

Derive an expression for magnetic field intensity due to magnetic dipole:

(i) At a point on its axis and

(ii) At a point on its equator.

22. (i) (a) Explain briefly how Rutherford scattering of a-particle by a target nucleus can provide information on the size of nucleus.

(b) Show that density of nucleus is independent of its mass number A.

(ii) Write the shortcomings of Rutherford atomic model. Explain how these were overcome by the postulates of Bohr's atomic model.

OR

(i) Find the ratio between the wavelengths of the 'most energetic' spectral lines in the Balmer and Paschen series of the hydrogen spectrum.

(ii) State Bohr's quantization condition of angular momentum. Calculate the shortest wavelength of the Brackett series and state to which part of the electromagnetic spectrum does it belong.

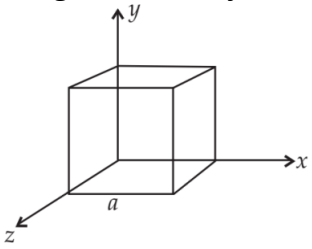
23. (i) Use Gauss' theorem to find the electric field due to a uniformly charged infinitely large plane thin sheet with surface charge density σ.

(ii) An infinitely large thin plane sheet has a uniform surface charge density +σ. Obtain the expression for the amount of work done in bringing a point charge q from infinity to a point, distant r, in front of the charged plane sheet.

OR

(i) A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q. (a) A charge q is placed at the centre of the shell. Find out the surface charge density on the inner and outer surfaces of the shell. (b) Is the electric field inside a cavity (with no charge) does not depend on the fact whether the shell is spherical or not? Explain.

(ii) Given the electric field in the region $\vec{E}$ = 2ax$\hat{\imath}$, find the net electric flux through the cube and the charge enclosed by it.



24. (i) Show that a current carrying solenoid behaves like a small bar magnet. Obtain the expression for the magnetic field at an external point lying on its axis.

(ii) A steady current of 2 A flows through a circular coil having 5 turns of radius 7 cm. The coil lies in X-Y plane with its centre at the origin. Find the magnitude and direction of the magnetic dipole moment of the coil.

OR

Draw a detail figure of a moving coil galvanometer. Describe briefly its principle and working. Answer the following:

(a) What is it necessary introduce a cylindrical soft iron core inside the coil of a galvanometer?

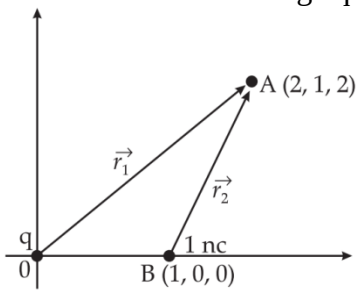
(b) Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Explain, giving reason.

25. (i) State the postulates of Bohr's model of hydrogen atom and derive the expression for Bohr radius.
(ii) Find the ratio of the longest and the shortest wavelengths of Balmer series.

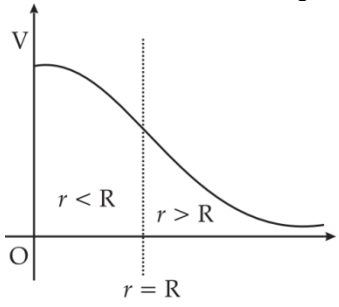
OR

(i) (a) A hydrogen atom in the ground state is excited by an electron beam of 12.5 eV energy. Find out the maximum number of lines emitted by the atom from its excited state.
(b) Write two important limitations of Rutherford's nuclear model of the atom.
(ii) What will be the ionisation potential if the first excitation potential of a given atom is 10.2 V?

26. (i) An unknown charge q is placed at the origin and another charge of 1 nanocoloumb is placed at position B(1, 0, 0). The x-component of the electric field due to these two charges at position A(2, 1, 2) is zero. Determine charge q.



(ii) A given solid sphere of radius R made of an insulating material carries a charge q distributed uniformly throughout its volume. The potential due to this charge distribution as a function of distance r from the center of the sphere is given as:

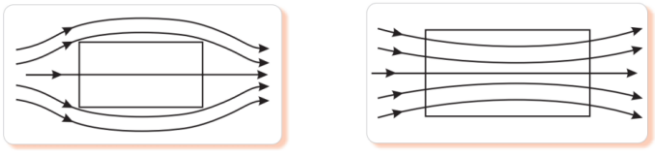


(a) At which location with respect to the sphere, is the potential V maximum in this case?
(b) In case the above sphere is made up of a conducting material instead of an insulating material, what would be your answer for part (a)? How is the charge q distributed across a charged conducting sphere?

OR

A parallel plate capacitor of capacitance C is charged to a potential V by a battery. Q is the charge stored on the capacitor. Without disconnecting the battery, the plates of the capacitor are pulled apart to a larger distance of separation.
What changes will occur in each of the following quantities? Will they increase, decrease or remain the same? Give an explanation in each case.
(a) Capacitance
(b) Charge
(c) Potential difference
(d) Electric field
(e) Energy stored in the capacitor

27. A uniform magnetic field gets modified as shown in figure when two specimens A and B are placed in it.



Specimen A Specimen B

(i) Identify the specimen A and B.
(ii) How is the magnetic susceptibility of specimen A different from that of specimen B?
(iii) Write the four important properties of the magnetic field lines due to a bar magnet.
(iv) A thin rectangular magnet suspended freely has a period of oscillation equal to T. Now, it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T', the ratio T'/T is?

OR

(i) A long bar magnet is cut into three pieces. These parts are then combined with their like poles together. Find the ratio of the time period of oscillation of the original magnet and the combination magnet in the same external magnetic field.
(ii) The susceptibility of a magnetic material is 0.9853. Identify the type of magnetic material. Draw the modification of the field pattern on keeping a piece of this material in a uniform magnetic field.
(iii) Which orientation of the magnetic dipole in a uniform magnetic field will correspond to its stable equilibrium?

28. (i) The ground state energy of hydrogen atom is –13.6 eV. If an electron makes a transition from an energy level –1.51 eV to –3.4 eV, calculate the wavelength of the spectral line emitted and the series of hydrogen spectrum to which it belongs.
(ii) A heavy nucleus P of mass number 240 and binding energy 7.6 MeV per nucleon splits in to two nuclei Q and R of mass numbers 110 and 130 and binding energy per nucleon 8.5 MeV and 8.4 MeV, respectively. Calculate the energy released in the fission.
(iii) What do you mean by mass defect of a nucleus?

OR

(i) Distinguish between isotopes and isobars.
(ii) Two nuclei have different mass numbers A_1 and A_2. Are these nuclei necessarily the isotopes of the same element? Explain.
(iii) In the following nuclear reaction, identify unknown labelled X.
${}_{11}{}^{22}Na + X \rightarrow {}_{10}{}^{22}Ne + v_e$

29. (i) An electric flux of -3×10^{-14} Nm^2/C passes through a spherical Gaussian surface is caused by a point charge. Compute the magnitude of the point charge.
(ii) Find the flux of a uniform electric field $\vec{E} = 5 \times 10^3 \hat{\imath}$ N/C held through a square of 10 cm on a side with a plane parallel to the YZ-plane. What would be the flux across the same square if the plane intersected the X-axis at a 30° angle?
(iii) How does the electric flux due to a point charge enclosed by a spherical Gaussian surface get affected when its radius is increased?

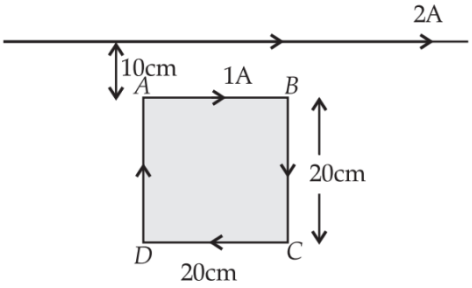
OR

(i) A particle whose mass 5×10^{-6} g is held over a huge horizontal charged sheet with a charge density of 4×10^{-6} C/m^2. What charge should be applied to this particle such that it does not fall when released?
(ii) Why can't you compute the field of a cube using Gauss' law?
(iii) On which factors does the electric flux through a closed Gaussian surface depend upon?

30. (i) Derive the expression for the torque acting on a current carrying loop placed in a magnetic field.
(ii) Explain the significance of a radial magnetic field when a current carrying coil is kept in it.
(iii) A moving coil galvanometer of resistance 100Ω is used as an ammeter using a resistance of 0.1 Ω. The maximum deflection current in the galvanometer is 100 μA. Find the current in the circuit so that the ammeter shows full scale deflection.
(iv) If a galvanometer acts as a voltmeter what type of resistance is to be connected with it and how?

OR

(i) Two infinitely long straight wires A_1 and A_2 carrying currents I and 2I flowing in the same direction are kept 'd' distance apart. Where should a third straight wire A_3 carrying current 1.5 I be placed between A_1 and A_2 so that it experiences no net force due to A_1 and A_2? Does the net force acting on A_3 depend on the current flowing through it?
(ii) A square loop of side 20 cm carrying current of 1 A is kept near an infinite long straight wire carrying a current of 2 A in the same plane as shown in the figure.



Calculate the magnitude and direction of the net force exerted on the loop due to the current carrying conductor.