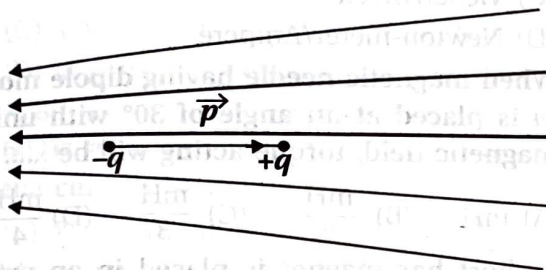Time : 1 Hour]   PART - A   [Total Marks : 50

❖ Select the following questions with proper alternative and answer it :

1) Figure shows electric field in which electric dipole $\vec{p}$ is placed. Which of the following statement is correct ? [March - 2023]

(A) The dipole will not experience any force

(B) The dipole will experience a net force towards right

(C) The dipole will experience a net force towards left

(D) The dipole will experience a net force upwards

2) The dimensional formula of electric flux is .... [March - 2023]

(A) $[M^{-1} L^3 T^{-3} A^{-1}]$ (B) $[M^1 L^3 T^{-3} A^{-1}]$

(C) $[M^1 L^{-3} T^{-3} A^{-1}]$ (D) $[M^1 L^3 T^3 A^{-1}]$

3) A plastic rod rubbed with wool is found to have a negative charge of 8×10^{-7} C. The no. of electrons transferred (from which to which ?) is .... [March - 2023]

(A) 5×10^{12}, from plastic rod to wool

(B) 5×10^{11}, from plastic rod to wool

(C) 5×10^{10}, from plastic rod to wool

(D) 5×10^{12}, from wool to plastic rod

4) How much charge should be placed on a spherical shell of radius 25 cm to have a surface charge density of $\frac{3}{\pi}$ C/m² ? [March - 2023]

(A) 0.25 C   (B) 0.75 C   (C) 0.57 C   (D) 0.5 C

5) The Coulombian repulsive force between to alpha particles kept at a distance of 3 cm in air is .... N. [March - 2023]

(A) 1.024×10^{-24} (B) 1.024×10^{-25}

(C) 1.024×10^{-27} (D) 1.024×10^{-23}

6) Figure shows the field lines of a positive and negative charge respectively. Give the sign of potential difference $V_Q - V_P$, $V_B - V_A$. [March - 2023]
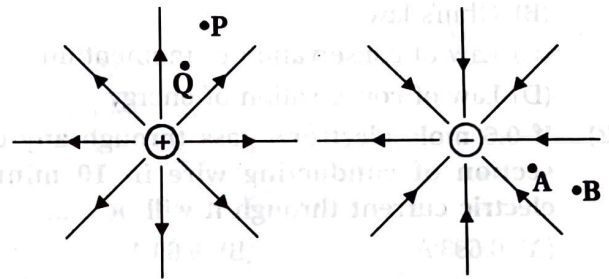
(A) +ve, +ve   (B) +ve, −ve

(C) −ve, +ve   (D) −ve, −ve

7) Energy of a charged capacitor is **U**. Now it is removed from a battery and then connected to two other identical uncharged capacitors in parallel. What will be the energy of each capacitor ? [March - 2023]

(A) U   (B) $\frac{3U}{2}$ (C) $\frac{U}{4}$ (D) $\frac{U}{9}$

8) The electric potential energy of 2μ C charge is 3×10^{-5} J at a point in a uniform electric field. The electric potential at that point is .... V. [March - 2023]

(A) 6   (B) 15   (C) 5   (D) Zero

9) Equipotential surfaces at a very large distance from the collection of charges whose total sum is not zero are approximately .... [March - 2023]

(A) spheres   (B) planes

(C) paraboloids   (D) ellipsoid

10) Two batteries of emf ε_1 & ε_2 ($\varepsilon_2 > \varepsilon_1$) and internal resistance r_1 & r_2 respectively are connected in parallel as shown. [March - 2023]

34
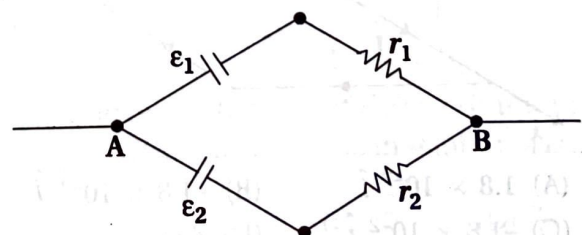
(A) The equivalent emf ε_{eq} & of the two cells is between ε_1 & ε_2 i.e. $\varepsilon_1 < \varepsilon_{eq.} < \varepsilon_2$

(B) The equivalent emf ε_{eq} is smaller than ε_1

(C) The equivalent emf is given by $\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2$

(D) $\varepsilon_{eq.}$ is independent of internal resistance r_1 & r_2

11) Loop rule of Kirchhoff's is a reflection of .... [March - 2023]

(A) Law of conservation of charge

(B) Ohm's law

(C) Law of conservation of momentum

(D) Law of conservation of energy

12) If 0.6 mole electrons pass through any cross section of conducting wire in 10 minutes, electric current through it will be ......

(A) 0.693 A   (B) 9.63 A

(C) 9.63 mA   (D) 96.3 A

13) A steady current flows in a metallic conductor of non uniform cross-section, which of following quantities is constant along the conductor ? [March - 2023]

(A) current   (B) current density

(C) electric field   (D) drift speed

14) If electron velocity is $(2\hat{i} + 3\hat{j})ms^{-1}$ and it is subjected to magnetic field of $4\hat{k}T$ then its .....

(A) path will change.   (B) speed will change.

(C) both path and speed will change.

(D) none of the above

15) A uniform magnetic field of 0.3 T is established along the +ve Z direction. A rectangular loop of sides 10 cm and 5 cm carries a current of 12 A is placed as shown in figure. The torque acting on the loop is .... Nm.

[March - 2023]
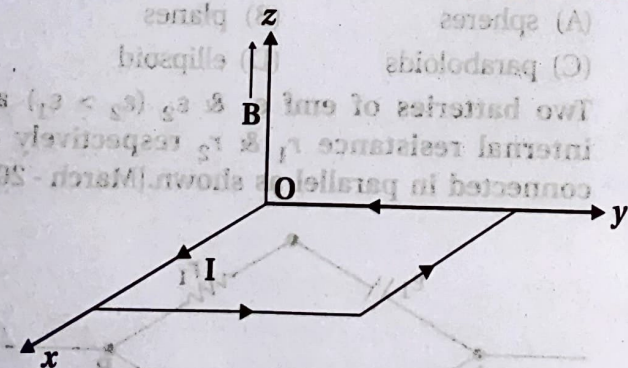
(A) $1.8 \times 10^{-2}\,\hat{i}$ (B) $-1.8 \times 10^{-2}\,\hat{j}$

(C) $-1.8 \times 10^{-2}\,\hat{i}$ (D) Zero

16) A galvanometer coil has a resistance of 10 Ω and the meter shows full scale deflection for 3 mA. The value of shunt to convert this meter into ammeter of range 0 to 10 A is .... Ω.

[March - 2023]

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

17) Which of the following is not a unit of magnetic induction ? [March - 2023]

(A) Tesla

(B) Newton/meter-Ampere

(C) Weber/meter^2

(D) Newton-meter/Ampere

18) When magnetic needle having dipole moment m is placed at an angle of 30° with uniform magnetic field, torque acting will be ......

(A) mH   (B) $\dfrac{mH}{2}$ (C) $\dfrac{mH}{3}$ (D) $\dfrac{mH}{4}$

19) A short bar magnet is placed in an external magnetic field of 600 G. When its axis makes an angle of 30° with the external field, it experiences a torque of 0.012 Nm. What is the magnetic moment of the magnet ?

(A) 0.2 Am^2 (B) 0.3 Am^2

(C) 0.4 Am^2 (D) 0.6 Am^2

20) A square of side L meter lies in the x-y plane in a region where the magnetic field is given by $\vec{B} = B_0(2\hat{i} + 4\hat{j} + 3\hat{k})$ T, where B_0 is constant. The magnitude of flux passing through the square is [March - 2023]

(A) $2B_0L^2$Wb   (B) $3B_0L^2$Wb

(C) $4B_0L^2$Wb   (D) $\sqrt{29}B_0L^2$Wb

21) When current I passes through an inductor having self inductance of 4 H. If the current is made double what will be the new self inductance of the inductor. [March - 2023]

(A) Zero   (B) 2 H   (C) 4 H   (D) 8 H

22) Inductive reactance .... [March - 2023]

(A) limits D.C. current

(B) limits D.C. voltage

(C) limits A.C. current

(D) stores the A.C. current

23) Magnetic flux linked with the coil is given by $\phi(t) = (2t^2 + 2t + 1)$ Wb and its resistance is 10 Ω. the current passing through the coil at $t = 2$ s is .... A. [March - 2023]

(A) 0.5   (B) 1   (C) 1.5   (D) 2

24) A power transmission line feeds input power at 2300 V to a stepdown transformer with its primary winding having 4000 turns. What should be the number of turns in the secondary in order to get output power at 230 V.

[March - 2023]

(A) 400   (B) 40   (C) 4000   (D) 2300

25) For circuits used for transporting electric power, a low power factor implies ...... [March - 2023]
(A) power increases in transmission
(B) remains constant in transmission
(C) small power loss in transmission
(D) large power loss in transmission

26) A 60 μF capacitor is connected to a 110 V, 60 Hz ac supply. Determine the rms value of the current in the circuit.

(A) 2.49 A (B) 24.9 A (C) 0.249 A (D) 249 A

27) If the rms current in a 50 Hz a.c. circuit is 5 A, at time $t = 0$ current I is 0. The value of current I at $t = \dfrac{1}{300}$ seconds is ...... A. [March - 2023]

(A) $5\sqrt{2}$ (B) $5\sqrt{\dfrac{3}{2}}$ (C) $\dfrac{5}{6}$ (D) $\dfrac{5}{\sqrt{2}}$

28) T.V. waves range from .... [March - 2023]
(A) 54 MHz - 890 MHz
(B) 88 MHz - 108 MHz
(C) 24.5 GHz - 229.5 GHz
(D) 400 GHz - 600 GHz

29) For a given electromagnetic waves the magnitude of electric field is 6.6 V/m at a point in space. The magnitude of magnetic field at this point is .... T. [March - 2023]
(A) 19.8×10^{-8} (B) 6.6×10^{-8}
(C) 2.1×10^{-8} (D) 2.2×10^{-8}

30) A small pin fixed on a table top is viewed from above from a distance of 100 cm. By what distance would the pin appear to be raised if it is viewed from the same point through a 9 cm thick glass slab held parallel to the table. Refractive index of glass = 1.5. [March - 2023]

(A) 3 cm   (B) 6 cm   (C) 9 cm   (D) 5 cm

31) A person doing shaving keeps his face 10 cm from concave mirror. What should be radius of curvature of mirror so he can see image of face clearly ?

(A) – 24 cm   (B) 24 cm
(C) 30 cm   (D) 60 cm

32) Power of plane mirror is .... [March - 2023]
(A) 0   (B) ∞   (C) +1   (D) –1

33) Time taken by the sunlight to pass through a slab of thickness 4 mm and refractive index 3 is .... sec.
(A) 4×10^{-11} s   (B) 2×10^{-11} s
(C) 2.5×10^{10} s   (D) 36×10^{5} s

34) Optical phenomenon taking place for mirror and lens respectively are .... & ....

[March - 2023]

(A) reflection, refraction
(B) interference, diffraction
(C) reflection, diffraction
(D) refraction, interference

35) A slit of size 'a' is illuminated by a parallel beam of light of wavelength λ. The angle at which this light is diffracted is approximately ....

[March - 2023]

(A) $\dfrac{\lambda}{a}$ (B) $\dfrac{\lambda}{a^2}$ (C) $\dfrac{a^2}{\lambda}$ (D) $\dfrac{a}{\lambda}$

36) The refractive index of a medium is $\dfrac{3}{2}$. The speed of light in this medium is .... m/s [Speed of light in vacuum is $c = 3 \times 10^8$ m/s]

[March - 2023]

(A) 3×10^8 (B) 2.5×10^8
(C) 2×10^8 (D) 3.5×10^8

37) In young's double experiment the distance between two slits is 0.2 mm and the distance between slit and screen is 1.5 m. The wavelength of light used is 600 nm. The distance between any two consecutive bright fringes is .... mm. [March - 2023]

(A) 0.5   (B) 4.5   (C) 0.8   (D) 2.0

38) The intensity of incident unpolarized light on a polaroid is I_1 and the intensity of emergent polarized light from this polaroid is I_2. The relation between I_1 & I_2 is ....[March - 2023]

(A) $I_1 = I_2$ (B) $I_1 > I_2$
(C) $I_1 < I_2$ (D) $I_1 = 2I_2$

39) For a given slit, ratio of diffraction angle of fringes of first maxima and first minima is ......

(A) $\dfrac{1}{2}$ (B) $\dfrac{2}{1}$ (C) $\dfrac{2}{3}$ (D) $\dfrac{3}{2}$

40) Variation of stopping potential V_0 with frequency (v) of incident radiation for a given photosensitive material is straight line. [frequency (v) of incident radiation is greater than threshold frequency (v)]
The slope of this line is .... [March - 2023]

(A) $\dfrac{\phi_0}{h}$ (B) $\dfrac{h}{v}$

(C) $\dfrac{h}{e}$ (D) $\dfrac{e}{V_0}$

41) On increasing the velocity of an electron, de-Broglie wavelength will ......
(A) increase
(B) decrease
(C) reamin unchanged
(D) be double

42) Monochromatic light of frequency 6×10^{14} Hz is produced by laser. The power emitted is 2×10^{-3} W. The energy of the photon in this light beam is .... eV.
[$h = 6.63 \times 10^{-34}$ Js, 1 eV = 1.6×10^{-19} J]
[March - 2023]

(A) 4.0   (B) 3.5

(C) 3.0   (D) 2.5

43) To explain his theory, Bohr used ......
(A) conservation of linear momentum
(B) conservation of angular momentum
(C) conservation of quantum frequency
(D) conservation of energy

44) What is the angular momentum of electron of Be^{+3} ion in $n = 5$ orbit ? [March - 2023]
(A) 5.3×10^{-34} Js   (B) 6.6×10^{-34} Js
(C) 3.3×10^{-34} Js   (D) 1.3×10^{-34} Js

45) What is the ratio of total energy of an electron in hydrogen atom in first excited state and third excited state ? [March - 2023]
(A) 1 : 1   (B) 3 : 1
(C) 4 : 1   (D) 1 : 4

46) According to mass energy equivalence relation, 9×10^{13} J of energy can be converted into .... maximum mass.
[Speed of light $c = 3 \times 10^8$ m/s] [March - 2023]
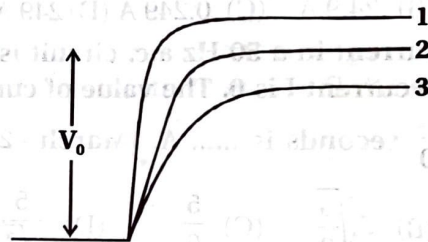(A) 3 g   (B) 9 g
(C) 91 g   (D) 1 g

47) One of the fusion reaction in Sun is given by $^2_1H + {}^1_1H \rightarrow {}^3_2He + \gamma + ...$ Fill in the blank with correct option. [March - 2023]
(A) 12.86 MeV   (B) 5.49 MeV
(C) 1.02 MeV   (D) 0.42 MeV

48) If the radius of nucleus is .... than the atomic radius is equal to the radius (6.4×10^3 km) of the earth.
(A) 32 m   (B) 6.4 m   (C) 64 m   (D) 64 km

49)

In figure, V_0 is the potential barrier across a p-n junction, when no battery is connected across the junction.
(A) 1 and 3 both correspond to forward bias of junction.
(B) 3 corresponds to forward bias of junction and 1 corresponds to reverse bias of junction.
(C) 1 corresponds to forward bias and 3 corresponds to reverse bias of junction.
(D) 3 and 1 both correspond to reverse bias of junction.

50) When a forward bias is applied to a p-n junction, it [March - 2023]
(A) raises the potential barrier
(B) reduces the majority carrier current to zero
(C) lowers the potential barrier
(D) none of the above

Time : 2 Hours]   **PART - B**   **[Total Marks : 50**

Section - A

❖ **Answer any 8 of the following given question 1 to 12 : (Each carries 2 marks)**   **[16]**

1) Derive an equation for an electric field due to infinitely long straight uniformly charged wire.
     [March - 2023]

2) At room temperature (27° C) the resistance of heating element is 100 Ω. What is the temperature of the element if the resistance is found to be 134 Ω, given that the temperature coefficient of material of the resistor is 1.7×10^{-4} °C^{-1} ?   **[March - 2023]**

3) State and explain Gauss's Law for magnetism.
     [March - 2023]

4) A permanent magnet in the shape of a thin cylinder of length 10 cm has M = 10^6 A/m. Calculate the magnetisation current I_M.

5) Define mutual inductance and mention the factors on which mutual inductance depends.
     [March - 2023]

6) Write the four Maxwell's equations in reference to electromagnetic waves.   **[March - 2023]**

7) If the magnetic field is parallel to the +ve X-axis and the charged particle is moving along +ve Y-axis. Which direction would the Lorentz force act (a) for an electron (b) for a proton ?
     [March - 2023]

8) Will the focal length of a lens for red light be more, same or less than that for blue light ?

9) How can fusion reactors provide unlimited power to humanity ?

10) Differentiate between P-type and N-type semiconductor (any four).   **[March - 2023]**

11) What is the focal length of a convex lens of focal length 30 cm in contact with a concave lens of focal length 20 cm ? Is the system a converging or a diverging lens ? Ignore thickness of the lenses.

12) Explain refraction of plane wave with a thin prism.

Section - B

❖ **Answer any 6 of the following given questions 13 to 21 : (Each carries 3 marks)**   **[18]**

13) Discuss some points about Gauss's law.

14) Why resistivity of metal decreases with increase in temperature or conductivity decrease with increase in temperature ?

15) A storage battery of emf 8.0 V and internal resistance 0.5 Ω is being charged by a 120 V dc supply using a series resistor of 15.5 Ω. What is the terminal voltage of the battery during charging ? What is the purpose of having a series resistor in the charging circuit ?

16) A long straight wire of circular cross-section (radius a) carrying steady current I. The current I is uniformly distributed across the cross-section. Calculate the magnetic field in the region $r < a$ and $r > a$.   **[March - 2023]**

17) State and explain Faraday's law of electromagnetic induction.

18) A beam of light consisting of two wavelengths 650 nm and 520 nm is used to obtain interference fringes in Young's double slit experiment. Distance between two slits is 0.25 mm and slit & screen is 1 m.

   (a) Find the distance of the third bright fringe on the screen from the central maximum for wavelength 650 nm ?

   (b) What is the least distance from the central maximum where the bright fringes due to both the wavelength coincide ?
     [March - 2023]

19) State and explain Huygen's Principle.
     [March - 2023]

20) Give outline of experimental study of photo-electric effect.

21) What is rectification ? Explain half wave rectifier with proper circuit and draw the wave forms of input and output voltage.   **[March - 2023]**

Section - C

❖ **Answer any 4 of the following given questions from 22 to 27 : (Each carries 4 marks)** [16]

22) Two charges 3×10^{-8} C and -2×10^{-8} C are located 15 cm apart. At what point on the line joining the two charges is the electric potential zero ? Take the potential at infinity to be zero.

23) Figure shows a series LCR circuit connected to a variable frequency 230 V a.c. source. L = 5 H, C = 80 μF, R = 40 Ω, **[March - 2023]**
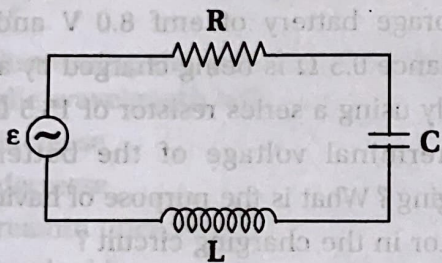
(a) Determine the source frequency which derives the circuit in resonance.

(b) Obtain the impedance of the circuit and amplitude of current at the resonating frequency.

(c) Determine the rms potential drops across the three elements of the circuit.

(d) Show that the potential drop across the LC combination is zero at the resonating frequency.

24) Discuss the power in AC circuit with only an inductor.

25) A compound microscope consists of an objective lens of focal length 2.0 cm and an eye piece of focal length 6.25 cm separated by a distance 15 cm. How far from the objective should an object be placed in order to obtain the final image at

(a) the least distance of distinct vision (25 cm) and

(b) at infinity ?

What is the magnifying power of microscope in each case ? **[March - 2023]**

26) State Bohr's postulates for atomic model. Derive the equations for orbital radius, orbital speed and total energy for an electron in n^{th} orbit in hydrogen atom. **[March - 2023]**

27) Explain atomic spectra. Write the equation for Lyman series, Paschen series, Brackett series & P fund series for hydrogen atom. **[March - 2023]**

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