

(The figures in the margin indicate full marks for the questions)

Section A [Each question carries 1 mark]

- The total electric flux through the faces of the cube with side of length 'a' if a charge q is placed at the centre of the cube is
 (a) $q/8\epsilon_0$ (b) q/ϵ_0 (c) $q/6\epsilon_0$ (d) $q/4\epsilon_0$
- If n cells each of emf ϵ and internal resistance r are connected in parallel, then the total emf and internal resistance will be
 (a) $\epsilon, r/n$ (b) ϵ, nr (c) $n\epsilon, r/n$ (d) $n\epsilon, nr$
- The maximum current that can be measured by a galvanometer of resistance $40\ \Omega$ is $10\ \text{mA}$. It is converted into voltmeter that can read upto $50\ \text{V}$. The resistance to be connected in the series with the galvanometer is
 (a) $2010\ \Omega$ (b) $4050\ \Omega$ (c) $5040\ \Omega$ (d) $4960\ \Omega$
- A transformer is employed to
 (a) Obtain a suitable dc voltage (b) Convert dc into ac
 (c) Obtain a suitable ac voltage (d) Convert ac into dc
- cutting a bar magnet into half is like cutting a solenoid. We get two smaller solenoids
 (a) with stronger magnetic properties.
 (b) with weaker magnetic properties.
 (c) with semi magnetic properties. (d) none of these.
- A transformer is used to light a $100\ \text{W}$ and $110\ \text{V}$ lamp from a $220\ \text{V}$ mains. If the main current is $0.5\ \text{A}$, the efficiency of the transformer is approximately
 (a) 30% (b) 50% (c) 90% (d) 10%
- $1\ \text{eV}$ is energy acquired by an electron when it is accelerated through potential difference of –
 (a) $1\ \text{V}$ (b) $10\ \text{V}$ (c) $0.1\ \text{V}$ (d) none of these
- In a coil of self-induction $5\ \text{H}$, the rate of change of current is $2\ \text{A/s}$. Then emf induced in the coil is
 (a) $10\ \text{V}$ (b) $5\ \text{V}$ (c) $-5\ \text{V}$ (d) $-10\ \text{V}$
- 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) $H^{-1/2}$
- By what factor must the mass number change for the nuclear radius to become twice?
 (a) 3^3 (b) 4^3 (c) 2^3 (d) 5^3
- In the circuit diagram shown, $R = 10\ \Omega$, $L = 5\ \text{mH}$, $E = 10\ \text{V}$ and $i = 1\ \text{A}$. The current is decreasing at the rate of $10^3\ \text{A/s}$. Then $(V_A - V_B)$ at this instant is
 (a) $10\ \text{V}$ (b) $15\ \text{V}$ (c) $20\ \text{V}$ (d) $25\ \text{V}$



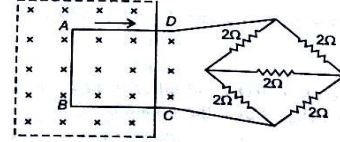
- The spacing between field lines indicates its _____
 (a) charge (b) position (c) strength (d) none of above
- For Q. 13 to Q. 16 :Two statements are given-one Assertion (A) and the other Reason .Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**
- If both Assertion and Reason are true and Reason is correct explanation Of Assertion.
 - If both Assertion and Reason are true but Reason is not the correct explanation Of Assertion.
 - If Assertion is true but Reason is false.
 - If both Assertion and Reason are false.

- Assertion (A): A spherical equipotential surface is not possible for a point charge.
 Reason (R): A spherical equipotential surface is not possible inside a parallel plate capacitor.
- Assertion (A): To observe diffraction of light, the size of the obstacle/aperture should be Of the order of $10^{-7}\ \text{m}$.
 Reason (R): $10^{-7}\ \text{m}$ is the order of the wavelength of visible light.
- Assertion (A): de Broglie equation is significant for microscopic particles.
 Reason (R): de Broglie wavelength is inversely proportional to the mass of a particle when velocity is kept constant.
- Assertion (A): When an electron falls from a higher energy to a lower energy' level, the difference in the energies appears in the form of electromagnetic radiation. It can't emit as other forms of energy.

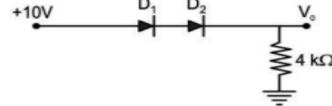
Reason (R): Electrons interact electromagnetically only.

SECTION - B [Each question carries 2 marks]

- A plane electromagnetic wave travels in vacuum along z-direction. What can you say about the directions of its electric and magnetic field vectors? If the frequency of the wave is $30\ \text{MHz}$, what is its wavelength?
- A metallic square loop ABCD of size $15\ \text{cm}$ and resistance $1.0\ \Omega$ is moved at a uniform velocity of $v\ \text{m/s}$, in a uniform magnetic field of $2\ \text{T}$, the field lines being normal to the plane of the paper. The loop is connected to an electrical network of resistors, each of $2\ \Omega$. Find the speed of the loop, for which $2\ \text{mA}$ current flows in the loop.



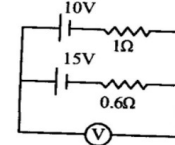
- The threshold voltage for diodes D_1 and D_2 are $0.3\ \text{V}$ and $0.7\ \text{V}$ respectively. Determine current in the circuit. Find V_0



Or

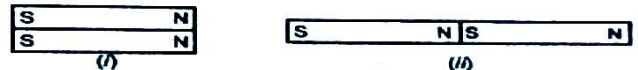
Calculate the orbital period of the electron in the first excited state of hydrogen atom.

- Violet light is incident on a converging lens of focal length f. State with reason, how the focal length of the lens will change, if the violet light is replaced by red light.
- A $10\ \text{V}$ battery with internal resistance $1\ \Omega$ and a $15\ \text{V}$ battery with internal resistance $0.6\ \Omega$ are connected in parallel to a voltmeter as shown in the figure. The reading in the voltmeter will be close to



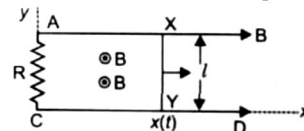
SECTION - C [Each question carries 3 mark]

- (a) Calculate the force per unit length acting between two parallel wires of infinite extent separated by a distance $2\ \text{cm}$ each carrying current of $4\ \text{A}$.
 (b) Two identical bar magnets of magnetic dipole moment M each are arranged as shown in the figure (i) and figure (ii).



What will be the dipole moment in each case?

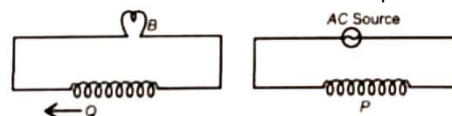
- A conducting wire XY of mass m and negligible resistance slides smoothly on two parallel conducting wires as shown in figure. The circuit has a resistance R due to AC. AB and CD are perfect conductors. There is a magnetic field $B = B(t) \hat{k}$



- Write down equation for emf induced in the wire XY.
 - Find the current flowing through R.
- The primary coil of an ideal step-up transformer has 100 turns and the transformation ratio is also 100. The input voltage and power are $220\ \text{V}$ and $1100\ \text{W}$ respectively. Calculate
 (a) number of turns in the secondary coil
 (b) the current in the primary coil and secondary coil
 (c) voltage across the secondary coil
 (d) power in the secondary coil

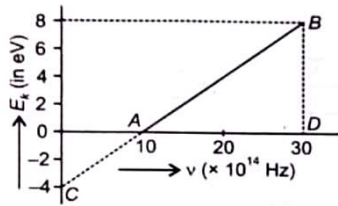
Or

A coil Q is connected to low voltage bulb B and placed near another coil P as shown below . Give reasons to explain the following observations:



- The bulb B lights
- Bulb gets dimmer if the coil Q is moved towards left.

25. (a) Draw the intensity pattern for single slit diffraction and double slit interference.
 (b) State two differences between interference and diffraction patterns.
26. (a) Given below is the graph between frequency (ν) of the incident light and maximum kinetic energy (E_k) of emitted photoelectrons. Find the values of (i) threshold frequency and (ii) work function from the graph.



- (b) In photoelectric effect, why should the photoelectric current increase as the intensity of monochromatic radiation incident on a photosensitive surface is increased? Explain.
27. (a) Using postulates of Bohr's theory of hydrogen atom, show that
 (i) the radii of orbits increase as n^2 , and
 (ii) the total energy of the electron increases as $1/n^2$, where n is the principal quantum number of the atom.
 (b) Calculate the wavelength of H_α line in Balmer series of hydrogen atom, given Rydberg's constant $R = 1.0947 \times 10^7 \text{ m}^{-1}$.

28. Answer the following.

- (a) Why do Ge and Si behave as semiconductors?
 (b) Draw IV characteristics of PN junction diode.
 (c) What is meant by doping in semiconductor?

SECTION - D [Each question carries 4 marks]

Case Study Based Questions

29. Read the following paragraph & answer the questions that follow

Refraction of light is change in the direction of propagation of light when it enters into the Other medium. is refractive index of second medium with respect to medium I. The refracted ray deviate towards the normal or away from normal depending on the density of medium also known optical density. Optical density should not be confused with mass density. Refraction is responsible for many interesting phenomena in atmosphere.

- (i) When a ray of light enters from one medium to another, then which of the following remains unchanged?
 (a) wavelength (b) speed (c) amplitude (d) frequency
- (ii) Refractive index of a transparent medium is greater than one because
 (a) speed of light in vacuum is always less than speed in a transparent medium.
 (b) speed of light in vacuum is always greater than the speed in a transparent medium.
 (c) frequency of wave changes when it crosses medium.
 (d) none of these.
- (iii) A setting sun appears to at an altitude higher than it really is. This is because of
 (a) absorption of light. (b) reflection of light.
 (c) refraction of light. (d) dispersion of light.
- (iv) The time taken by the light to cross a glass of thickness 4 mm and refractive index ($\mu = 3$). will be
 (a) $4 \times 10^{-11} \text{ s}$ (c) $40 \times 10^{-11} \text{ s}$ (b) $0.4 \times 10^{-11} \text{ s}$ (d) $0.04 \times 10^{-11} \text{ s}$
- Or
- (iv) A ray of light is incident on the surface of separation of a medium with the velocity of light at an angle 45° and is refracted in the medium at an angle 30° . What will velocity of light in the medium?
 (a) $1.96 \times 10^8 \text{ m/s}$ (b) $3.18 \times 10^8 \text{ m/s}$ (c) $2.12 \times 10^8 \text{ m/s}$ (d) $3.33 \times 10^8 \text{ m/s}$

30. Read the following paragraph and answer the questions that follow

The bands namely valence band and conduction band which are generated by the interaction of atoms. The conduction band at temperature is always empty and valence band is 'filled'. There exists a band gap between the two bands. The band gap $> 3 \text{ eV}$ is insulator. E_g between 0.2 eV and 3 eV is semiconductor but for metal $E_g = 0$ i.e., no gap between bands is seen and that's why they are called good conductors. By doping we can change the characteristic of the elements

- (i) An intrinsic semiconductor is converted into n-type extrinsic semiconductor by doping it with

- (a) germanium (b) phosphorus (c) aluminium (d) silver
- (ii) In an n-type semiconductor, which of following statements is true?
 (a) Electrons are majority carriers and trivalent atoms are dopants.
 (b) Electrons are minority carriers and pentavalent atoms are dopants.
 (c) Holes are minority carriers and pentavalent atoms are dopants.
 (d) Holes are majority carriers and trivalent atoms are dopants.
- (iii) For a p-type semiconductor, which of following statements is true?
 (a) Holes are the majority carriers and trivalent atoms are dopants.
 (b) Holes are the majority carriers and pentavalent atoms are dopants.
 (c) Electrons are the majority carriers and pentavalent atoms are dopants.
 (d) Electrons are the majority carriers and trivalent atoms are dopants.
- (iv) In semiconductors at a room temperature
 (a) the valence band is partially empty and the conduction band is partially filled.
 (b) the valence band is completely filled and conduction band is partially filled.
 (c) the valence band is completely filled.
 (d) the conduction band is completely empty.
- Or
- (iv) At zero. Ge acts as
 (a) non-metal (b) metal (c) insulator (d) semiconductor

SECTION - E [Each question carries 5 marks]

31. (a) Define the term 'electrostatic potential'.

Find an expression for the electrostatic potential due to an electric dipole at a point.

- (b) Explain why electrostatic potential inside a charged hollow sphere is zero.

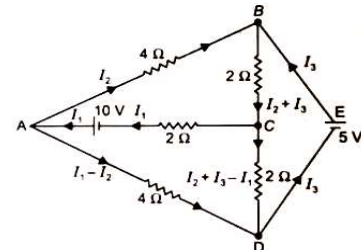
Or

Define the capacitance of a capacitor. Obtain the expression for the capacitance of a parallel plate capacitor in vacuum in terms of plate area A and separation d between the plates d .

What will be the expression for the capacitance of the parallel plate capacitor if a dielectric slab of thickness t ($t < d$) is introduced between the plates of capacitor.

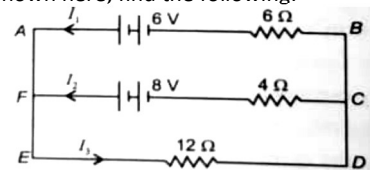
32. (a) State Kirchoff's rules for electrical circuits with diagrams.

- (b) Determine the current in each branch of the network shown below



Or

In the network shown here, find the following:



- (a) Currents I_1 , I_2 and I_3
 (b) Terminal potential difference of each battery.
 Consider 6Ω to be the internal resistance of 6 V battery and 4Ω to be internal resistance of 8 V battery.

33. (a) Draw a ray diagram of compound microscope. Write the expression for its magnifying power.
 (b) A compound microscope consists of an objective lens of focal length 2.0 cm and an eyepiece of focal length 6.25 cm separated by a distance of 18 cm . How far from the objective lens should an object be placed in order to obtain the final image at the least distance of distinct vision (25 cm)? Find the magnifying power of the microscope.

Or

- (a) Obtain the condition for getting dark and bright fringes in Young's experiment. Hence write the expression for the fringe width.
 (b) What are the criteria for obtaining interference fringes on a screen?
 (c) Is the phenomenon of interference of light in accordance with the law of conservation of energy? Justify.