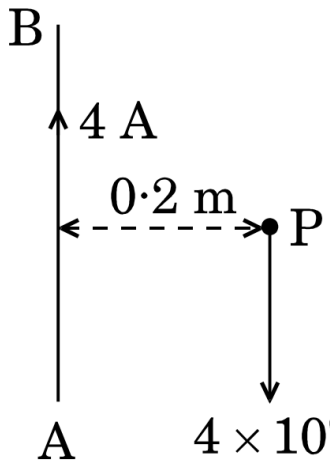
Q1. A long straight wire AB carries a current of 4A. A proton P travels at $4 \times 10^6 ms^{-1}$ parallel to the wire 0·2m from it and in a direction opposite to the current as shown in the figure. Calculate the force which the magnetic field due to the current carrying wire exerts on the proton. Also specify its direction. **2 Marks**



Q2. State Lenz's Law. **2 Marks**
A metallic rod held horizontally along east-west direction, is allowed to fall under gravity. Will there be an emf induced at its ends? Justify your answer.

Q3. Describe, with the help of a circuit diagram, the working of a photodiode. **2 Marks**

Q4. For a CE transistor amplifier, the audio signal voltage across the collector resistance of $2k\Omega$ is 2V. If the current amplification factor of the transistor is 100, calculate the input signal voltage and the base current, given the base resistance as $1k\Omega$. **2 Marks**

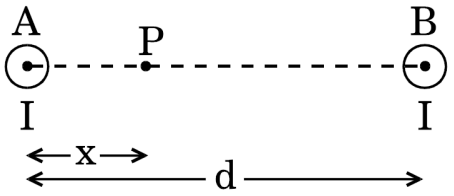
Q5. For paraxial rays, show that the focal length of a spherical mirror is one-half of its radius of curvature. **2 Marks**

Q6. A cell of emf E and internal resistance r is connected to two external resistances R_1 and R_2 and a perfect ammeter.The current in the circuit is measured in four different situations: **2 Marks**

1. Without any external resistance in the circuit.
2. With resistance R_1 only.
3. With R_1 and R_2 in series combination.
4. With R_1 and R_2 in parallel combination.

The currents measured in the four cases are 0.42 A, 1.05 A, 1.4 A and 4.2 A, but not necessarily in that order. Identify the currents corresponding to the four cases mentioned above.

Q7. Two long straight parallel wires A and B separated by a distance d, carry equal current I flowing in same direction as shown in the figure. **2 Marks**



1. Find the magnetic field at a point P situated between them at a distance x from one wire.
2. Show graphically the variation of the magnetic field with distance x for $0 < x < d$.

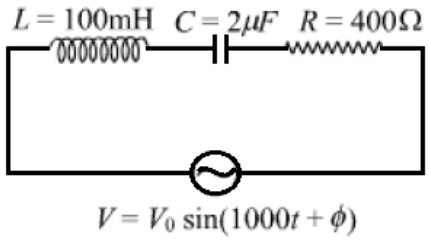
Q8. With the help of a circuit diagram, explain briefly how a p-n junction diode works as a half-wave rectifier. **2 Marks**

Q9. Draw typical output characteristics of an n-p-n transistor in CE configuration. Show how these characteristics can be used to determine output resistance. **2 Marks**

Q10. Show mathematically how Bohr's postulate of quantization of orbital angular momentum in hydrogen atom is explained by de-Broglie's hypothesis. **2 Marks**

Q11. **3 Marks**

1. 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?
2. Without making any other change, find the value of the additional capacitor C_1, to be connected in parallel with the capacitor C, in order to make the power factor of the circuit unity.

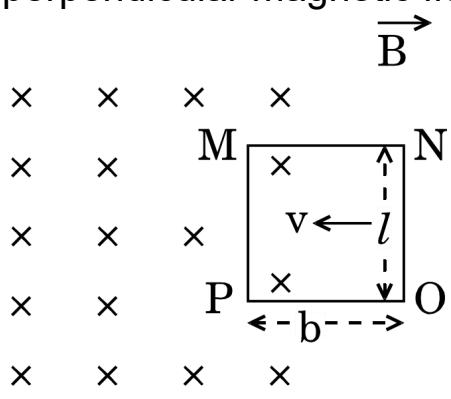


Q12. A beam of light converges to a point P. A lens is placed in the path of the convergent beam12 cm from P. At what point does the beam converge if the lens is. **3 Marks**

1. a convex lens of focal length 20 cm,
2. a concave lens of focal length 16 cm?

Do the required calculations.

Q13. The figure shows a rectangular conducting frame MNOP of resistance R placed partly in a perpendicular magnetic field $\overrightarrow{B}$ and moved with velocity $\overrightarrow{v}$ as shown in the figure. **3 Marks**



Obtain the expressions for the:

1. Force acting on the arm 'ON' and its direction, and
2. Power required to move the frame to get a steady emf induced between the arms MN and PO.

Q14. **3 Marks**

1. The electric field $\vec{E}$ of an electromagnetic wave propagating in north direction is oscillating in up and down direction. Describe the direction of magnetic field $\vec{B}$ of the wave.
2. Are the wave length of radio waves and microwaves longer or shorter than those detectable by human eyes?
3. Write main use of each of the following in human life:

1. Infrared waves
2. Gamma rays

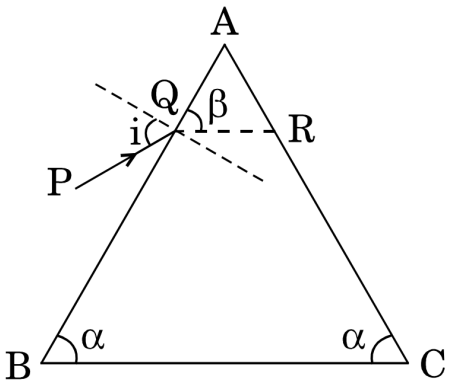
Q15. **3 Marks**

1. Show that the time period (T) of oscillations of a freely suspended magnetic dipole of magnetic moment (m) in a uniform magnetic field (B) is given by $\mathrm{T} = 2\pi\sqrt{\frac{\mathrm{I}}{\mathrm{mB}}}$, where I is a moment of inertia of the magnetic dipole.
2. Identify the following magnetic materials:

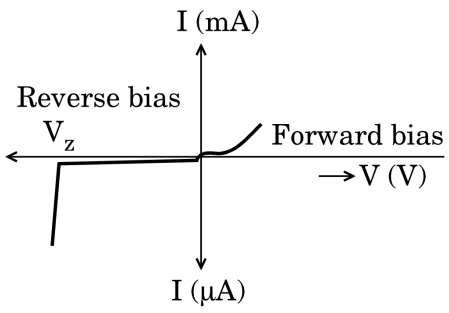
1. A material having susceptibility $(\chi_{\mathrm{m}}) = -0.00015$.
2. A material having susceptibility $(\chi_{\mathrm{m}}) = 10^{-5}$.

Q16. Draw the typical input and output characteristics of an n-p-n transistor in CE configuration. Show how these characteristics can be used to determine (a) the input resistance (r_i), and (b) current amplification factor (β). **3 Marks**

Q17. A ray of light incident on the face AB of an isosceles triangular prism makes an angle of incidence (i) and deviates by angle β as shown in the figure. Show that in the position of minimum deviation $\angle\beta = \angle\alpha$. Also find out the condition when the refracted ray QR suffers total internal reflection. **3 Marks**



Q18. The figure shows the V-I characteristic of a semiconductor diode designed to operate under reverse bias. **3 Marks**



1. Identify the semiconductor diode used.
2. Draw the circuit diagram to obtain the given characteristics of this device.
3. Briefly explain one use of this device.

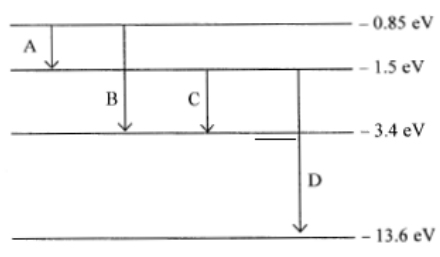
Q19. A cyclotron's oscillator frequency is 10MHz. What should be the operating magnetic field for accelerating protons? If the radius of its 'dees' is 60 cm, calculate the kinetic energy (in MeV) of the proton beam produced by the accelerator. **3 Marks**

Q20. **3 Marks**
1. A parallel plate capacitor is charged by an ac source. Show that the sum of conduction current (I_c) and the displacement current (I_d) has the same value at all points of the circuit.
2. In case (a) above, is Kirchhoff's first rule (junction rule) valid at each plate of the capacitor? Explain.

Q21. **3 Marks**
1. Calculate the frequency of a photon of energy 6.5×10^{-19}J.
2. Can this photon cause emission of an electron from the surface of Cs of work function 2.14 eV? If yes, what will be maximum kinetic energy of the photoelectron?

Q22. **3 Marks**
1. Show the variation of binding energy per nucleon with mass number. Write the significance of the binding energy curve.
2. Two nuclei with lower binding energy per nucleon form a nuclei with more binding energy per nucleon.
1. What type of nuclear reaction is it?
2. Whether the total mass of nuclei increases, decreases or remains unchanged?
3. Does the process require energy or produce energy?

Q23. The energy level diagram of an element is given below. Identify, by doing necessary calculations, which transition corresponds to the emission of a spectral line of wavelength 102.7 nm. **3 Marks**



Q24. **3 Marks**
1. Calculate the energy and momentum of a photon in a monochromatic beam of wavelength 331.5nm.
2. How fast should a hydrogen atom travel in order to have the same momentum as that of the photon in part(a)?

Q25. A 10 m long wire of uniform cross-section and 20 Ω resistance is used in a potentiometer. The wire is connected in series with a battery of 5V along with an external resistance of 480 Ω. If an unknown emf E is balanced at 6.0 m length of the wire, calculate: **3 Marks**

1. The potential gradient of the potentiometer wire.
2. The value of unknown emf E.

Q26. A charged particle is moving in a circular path with velocity $\vec{V}$ in a uniform magnetic field $\vec{B}$. It is made to pass through a sheet of lead and as a consequence, it looses one half of its kinetic energy without change in its direction. How will
the radius of its path
its time period of revolution change? **5 Marks**

Q27.
1. In Young's double slit experiment, derive the condition for (i) constructive interference and (ii) destructive interference at a point on the screen. **5 Marks**
2. A beam of light consisting of two wavelengths, 800 nm and 600 nm is used to obtain the interference fringes in a Young's double slit experiment on a screen placed 1.4 m away. If the two slits are separated by 0.28mm, calculate the least distance from the central bright maximum where the bright fringes of the two wavelengths coincide.

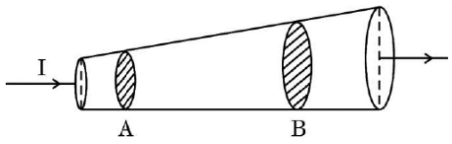
Q28.
1. Define the term 'resolving power of a telescople'. How will the resolving power be effected with the increase in: **5 Marks**
1. Wavelength of light used.
2. Diameter of the objective lens.

Justify your answers.
2. A screen is placed 80cm from an object. The image of the object on the screen is formed by a convex lens placed between them at two different locations separated by a distance 20cm. Determine the focal length of the lens.

Q29.
1. Write Ampere's circuital law in mathematical form and explain the terms used. **5 Marks**

As the current carrying solenoid is made longer, the magnetic field produced outside it approaches zero. Why?
A flexible loop of irregular shape carrying current when located in an external magnetic field, changes to a circular shape. Give reason.
2. A galvanometer of resistance G is converted into a voltmeter to measure up to V volts, by connecting a resistance R_1 in series with the coil. If R_1 is replaced by R_2, then it can only measure up to $\frac{V}{2}$ volt. Find the value of the resistance R_3 (in terms of R_1 and R_2) needed to convert it into a voltmeter that can read up to 2V..0

Q30.
1. Current I (=1A) is passing through a copper rod n= 8.5×10^{28} m^{-3}) of varying cross-sections as shown in the figure. The areas of cross-section at points A and B along its length are $1.0 \times 10^{-7} m^2$ and $2.0 \times 10^{-7} m^2$ respectively. Calculate: **5 Marks**



- the ratio of electric fields at points A and B.
- the drift velocity of free electrons at point B.

2. Two point charges $q_1(= 16\mu C)$ and $q_2(= 1\mu C)$ are placed at . points $\vec{r_1} = (3m)\hat{i}$ and $\vec{r_2} = (4m)\hat{j}$. Find the net electric field $\vec{E}$ at Point $\vec{r} = (3m)\hat{i} + (4m)\hat{j}$.

Q31.
1. Derive an expression for the electric field E due to a dipole of length '2a' at a point distant r from the centre of the dipole on the axial line. **5 Marks**
2. Draw a graph of E versus r for r >> a.
3. If this dipole were kept in a uniform external electric field E_0, diagrammatically represent the position of the dipole in stable and unstable equilibrium and write the expressions for the torque acting on the dipole in both the cases.

Q32.
1. Derive the expression for the torque acting on the rectangular current carrying coil of a galvanometer. Why is the magnetic field made radial? **5 Marks**
2. An $\alpha-$particle is accelerated through a potential difference of 10kV and moves along x-axis. It enters in a region of uniform magnetic field B = 2×10^{-3}T acting along y-axis. Find the radius of its path. (Take mass of $\alpha-$particle = 6.4×10^{-27}kg).