CBSE Sample Paper 6

Class XII Exam 2022-23

Physics

Time: 3 Hours **Max. Marks: 70**

General Instructions:

1. There are 35 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
3. Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
4. There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

SECTION - A

18 Marks

1. A charge is to be placed between two charges of 9e and 16e respectively, placed 70cm apart. The position of the third charge placed between the two charges will be:

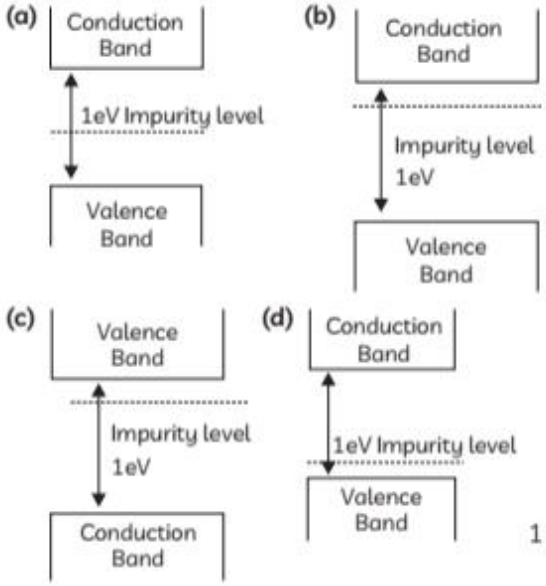
(a) 30 cm from 9e

(b) 30 cm from 16e

(c) 40 cm from 9e

(d) 35 cm from either charge 1

2. Determine the *n*-type semiconductor from the given figures.



1

3. Considering the V-I characteristics of a p-n junction, we see that current under reverse bias is :

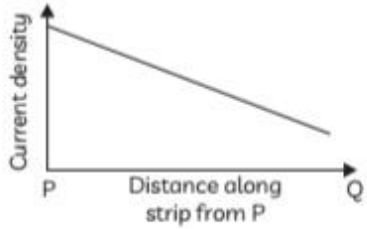
(a) almost independent of the applied potential upto a critical voltage.

(b) directly depends on applied voltage.

(c) independent of applied potential and critical voltage.

(d) None of the above. 1

4. Variation between current density and distance of an insulated strip PQ of a metallic conductor, through which current is flowing, is shown below. Which one of the following statements could explain this variation?



(a) The strip gets narrower from Q to P.

(b) The strip gets narrower from P to Q.

(c) The potential gradient along the strip is uniform.

(d) The strip has equal width along its length. 1

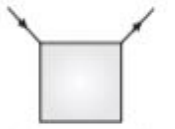
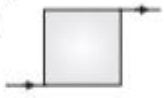
5. Two small nuclei forms a bigger nuclei, when the binding energy per nucleon in two smaller nuclei:
   (a) increases with mass number at high mass number.
   (b) decreases with mass number at high mass number.
   (c) increases with mass number at low mass number.
   (d) decreases with mass number at low mass number. 1

6. To detect the planet Venus, the order of magnitude of the minimum frequency of EM waves should be:
   (a) 10Hz (b) 30Hz
   (c) 50Hz (d) 100Hz 1

7. Megnetic field produced by a current circular coil is always:
   (a) uniform (b) non-uniform
   (c) Both (a) and (b) (d) None of these 1

8. How will the motion of an electron projected in the direction of magnetic field will be affected by the action of magnetic field?
   (a) It can increases
   (b) It can decreases
   (c) It can not be affected
   (d) All of these 1

9. For obtaining a real image of an object with the convex mirror the object should be placed:
   (a) at F (b) at R
   (c) behind the mirror (d) None of these 1

10. As represented in the given figures, current flows through uniform, square frames. In which condition is the magnetic field at the frame's centre not zero?
   (a) 
   (b) 
   (c) 
   (d) 
   1

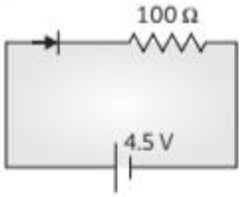
11. Potential barrier developed in a junction diode opposes the flow of:
   (a) minority carrier in both regions only
   (b) majority carriers only
   (c) electrons in p-region
   (d) holes in p-region 1

12. In a half wave rectifier circuit, operating from 50 Hz mains frequency, the fundamental frequency in the ripple would be:
   (a) 25 Hz (b) 50 Hz
   (c) 75 Hz (d) 100 Hz 1

13. The diameter of moon is 3.5×10^3 km and distance from earth is 3.8×10^5 km is being seen by a telescope whose objective lens has focal length of 4 m and eyepiece have focal length 1 m. The angular diameter of the image of the moon is:
   (a) 10° (b) 20°
   (c) 15° (d) 30° 1

14. A far sighted person has a near point of 60 cm. What power lens should be used for eye glasses such that the person can read this book at a distance of 25 cm.
   (a) + 2.33 D (b) + 4.33 D
   (c) – 2.33 D (d) – 4.33 D 1

15. Figure shows a diode connected to an external resistance and an e.m.f. If the barrier potential developed in diode is 0.5 V, Calculate the value of current in the circuit in milliampere.



   (a) 20 mA (b) 50 mA
   (c) 40 mA (d) 60 mA 1

Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   (a) Both A and R are true and R is the correct explanation of A.
   (b) Both A and R are true and R is NOT the correct explanation of A.
   (c) A is true but R is false.
   (d) A is false and R is also false.

16. Assertion (A): At absolute zero kelvin temperature, semiconductor behaves as an insulator.
   Reason (R): At absolute zero kelvin temperature, covalent bonds are very weak. 1

17. Assertion (A): Fusion is the main source of energy in sun.
   Reason (R): It takes four hydrogen atoms to fuse into each helium atom. This is called nuclear fusion. 1

18. Assertion (A): The atomic mass of an element is the weighted average of the atomic masses of different isotopes.

Reason: (R): If we consider masses of individual isotopes, they are not strictly integer multiples of the mass of a hydrogen atom. 1

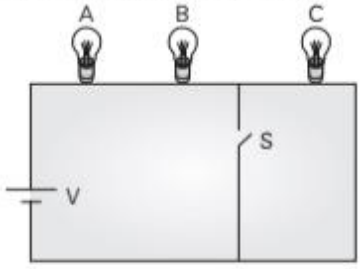
SECTION - B

14 Marks

19. An electric dipole is placed in a uniform electric field, making angle $\frac{\theta}{2}$ with electric field, experiences a torque τ. What will be the minimum work done in changing the orientation to 4θ?

OR

Consider the given figure and Conclude the observation if switch S is closed.



2

20. A galvanometer having 30 divisions has current sensitivity of 20 μA/division. It has a resistance of 100Ω. How will you convert it into an ammeter measuring currents upto 1 ampere? 2

21. A particle of mass m and positive charge q is released from point A. Its speed is found to be v, when it passes through a point B. Which of the two points is at higher potential? What is the potential difference between the points? 2

22. Sound waves are deflected more easily than the light waves. Explain the given statement. 2

23. AC generator consists of a coil of 50 turns and area 2.5m^2 rotating at an angular speed of 60rad s^{-1} in a uniform magnetic field 0.30T between two fixed pole pieces. The resistance of the circuit including that of coil is 50Ω.

(A) What is the maximum current drawn from the generator?

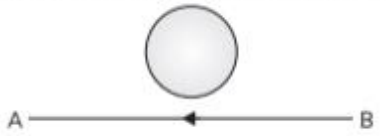
(B) What is the flux through the coil, when the current is zero and maximum? 2

24. Plot graph showing the variation of stopping potential with the frequency of incident radiation of two different photosensitive materials having work function W_1 and W_2, ($W_1 > W_2$). On what factors does the slope and intercept of lines depend ?

OR

When the monochromatic radiation of wavelength 2000Å force upon a nickel plate, the latter acquires a positive charge. The wavelength is increased and at 3000Å however intense the incident radiation may be, the effect is found to cease. Explain. 2

25. The electric current in a wire in the direction from B to A is increasing. What is the direction of induced current in the metallic kept above the wire as shown in figure?



2

SECTION - C

15 Marks

26. Mutual inductance between two coils, when a current of 6.0A changes to 10.0A in 0.5s and induces emf of 100mV in the secondary coil.

OR

A wheel with 10 metallic spokes each 0.5m long is rotated with the speed of 120 rotations per minute in a plane normal to the Earth's magnetic field at a place. If the magnitude of the field is 0.40G, what is the induced emf between the axle and the rim of the wheel? 3

27. Explain why, for the photoelectric effect, the existence of a threshold frequency and a very short emission time provide evidence for particulate nature of electromagnetic radiation, as opposed to a wave theory. 3

28. Explain the two distinct part of *x*-ray spectrum

OR

State the limitations of Bohr's atomic model. 3

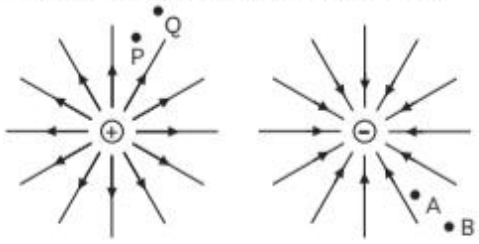
29. The refracting angle of a Prism is A and the refractive index of the material is $\cot\left(\frac{A}{2}\right)$. For a Ray of light incident on the prism, find the angle of minimum deviation in terms of A. 3

30. Explain the prismatic action of a convex lens. 3

SECTION - D

15 Marks

31. Given figure show the field lines of a positive and negative point charge respectively.



(A) Give the signs of the potential difference $V_P - V_Q$; $V_B - V_A$.

(B) Give the sign of the potential energy difference if a small negative charge is moved from points Q to P; from point A to B.

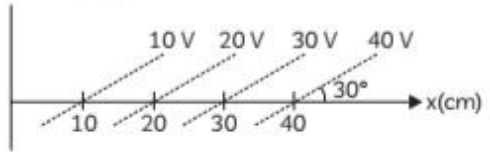
(C) Give the sign of the work done by the field in moving a small positive charge from Q to P.

(D) Give the sign of the work done by the external agency in moving a small negative charge from B to A.

(E) Does the kinetic energy of a small negative charge increase or decrease in going from B to A?

OR

Some equipotential surfaces are shown in the figure below. What can you say about the magnitude and the direction of the electric field?



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32. Calculate the resistance or inductance required to operate a lamp (60V, 10W) from a source of (100 V, 50 Hz).

OR

Explain the working of a transformer. 5

33. Using the Huygens' construction, explain how a parallel beam of light on reflection from a concave mirror gets converged.

OR

There are n identical sources and each of them is emitting light intensity I_o. Find the resultant intensity of light on interference, when the sources of light are coherent and incoherent. 5

SECTION - E

8 Marks

34. *A camera consists of a light-proof box provided with a lens system. A light sensitive photographic film is placed at the back of the lens. A focussing device is used to adjust the distance between the lens and the film. By this adjustment, a real and inverted image of an object located at any distance can be cast sharply on the film. Another device, called aperture or stop varies the area of the lens exposed to the film. By varying the size of this aperture, the amount of light reaching the film can be controlled. A shutter is placed between the lens and the film. The shutter opens and closes quickly exposing the film to the light for a short time. A timing device with a spring-catch fixes the time for which the film is exposed to the light coming from the object. For obtaining a good photograph of an object, an adequate amount of light should fall on the film, when the shutter is open.*

(A) Draw the graph between *u* and *v*, if object is placed at distance *u* from lens and measuring the distance *v* of the image pin. 1

(B) Why an astronomical telescope has a large aperture? 1

(C) A convex lens is dipped in a liquid, whose refractive index is equal to the refractive index of the lens. Then, find the focal length.

OR

The focal length of a convex lens for red and violet colour are 44.6cm and 42.5cm. Calculate the focal length for the mean colour and dispersive power of the lens. 2

35. *A solar cell is basically a silicon p-n junction photodiode with a very large light-sensitive area. The junction diode is made from extremely thin silicon slices or wafers. The wafers are usually doped lightly with a p-type impurity, on which a surface diffusion of n-type doping materials is performed on the front side of the wafer. This forms a p-njunction a few hundred nanometres below the surface. To increase the light gathering power of the cell, a coating of titanium dioxide is applied. However, silicon nitride has proved to be more useful than titanium dioxide as the antireflection coating. It prevents charge carriers from recombining at the surface of the solar cell. In some solar cells, its front surface is textured to further increase the light gathering power of the cell. As such, the solar cell consists of three layers. The top junction layer (made of n-type semiconductor) and the bottom junction layer (made of p-type semiconductor) are necessary for the energy conversion in a solar cell. The middle layer in the cell is the core of the device and is the absorber layer (the p-n junction). The silicon wafer is then provided a grid-like metal contact on the front surface by using silver paste and a full area metal contact on its back surface using aluminium paste.*

(A) Give an application of a forward bias to a p-n junction. 1

(B) Which metal will be more efficient for manufacturing solar cells? 1

(C) Which metal is used in manufacturing of solar cell?

OR

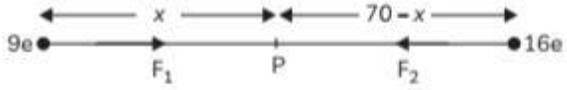
What is the purpose of using bypass diode in series connected solar panels? 2

SOLUTION

SECTION - A

1. *(a) 30 cm from 9e*

Explanation: Let the charge q be placed at point P between them



Here, $F_{net} = 0$

$$F_1 = F_2$$

$$\frac{k(9e)(q)}{x^2} = \frac{k(16e)(q)}{(70-x)^2}$$

$$\frac{9}{x^2} = \frac{16}{(70-x)^2}$$

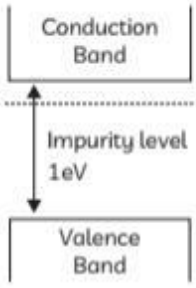
taking square root on both sides,

$$\Rightarrow \quad \frac{3}{x} = \frac{4}{70-x}$$

$$x = 30 \text{ cm}$$

x = 30cm from 9e or 40cm from 16e.

2. *(b)*



Explanation: In *n*-type semiconductor impurity energy level lies just below the conduction band.

3. *(a) almost independent of applied potential upto a critical voltage.*

Explanation: When the diode is reverse biased, very small current flows due to drift of minority charge carriers whose changed density remains constant, so the current under reverse bias is almost independent of the applied potential upto a critical voltage.

4. *(a) The strip gets narrower from Q to P.*

Explanation: The current density at P is higher than at Q. For the same current flowing through the metallic conductor PQ, the cross-sectional area at P is narrower than at Q.

Related Theory

The resistance per unit length r is given by,

$$r = \frac{\rho}{A}$$

where, ρ is the resistivity and A is the cross-sectional area of the conductor PQ. Thus, r is inversely proportional to the cross-sectional area A of the conductor.

5. *(b) decreases with mass number at high mass number.*

Explanation: We know that the more the binding energy, the more stable the nucleus is. Energy is released when fission occurs by going from less stable to more stable configuration.

6. *(b) 30Hz*

Explanation: The planet Venus is about 10^7 m in diameter. The frequency of the EM waves is given by,

$$\nu = \frac{c}{\lambda} = \frac{3\times10^8}{10^7} = 30\text{Hz}$$

7. *(b) non-uniform*

Explanation: Magnetic field produced due to a current carrying coil is not uniform. However, it may be considered as uniform at the centre of the circular coil.

8. *(c) It cannot be affected*

Explanation: No force acts on the electron due to the magnetic field, when it is projected in the direction of magnetic field. Hence, its motion will not be affected.

9. *(d) None of these*

Explanation: A convex mirror produces real image of a virtual object. Therefore, if a beam of light from a virtual object converges to a point behind the convex mirror, then its real image will be formed in front of the mirror. Convex mirror always forms virtual image.

10. *(c)*

Explanation: Current dispersion is less along the longer path, the magnetic field related to rectangular shape will be zero in all cases. However, the combined effect of the magnetic field in the centre will be the same.

Related Theory

Because the current line in options (A) and (B) crosses through the centre, its perpendicular distance is zero, and the magnetic field in both options (A) and (B) is zero related to incoming and outgoing current.

In the case of (D), the magnetic field caused by the incoming and exiting currents will be equal and opposing. As a result, the net effect is zero.

However, in the case of (C), the magnetic field will be in the same direction and of equal magnitude due to the incoming and exiting current, thus the net impact will not be zero.

11. *(b) majority carriers only*

Explanation: A depletion layer is produced across the junction of a semiconductor diode when it is manufactured. This depletion layer, which has a negative charge in a p-type crystal and a positive charge in an n-type crystal, functions as a potential barrier for charge carriers.

Related Theory

In the p- region, holes are majority carriers (electrons are minority carriers), whereas electrons are majority carriers in the n- region (Holes are minority carriers). When an electron (majority carrier) from the n-region tries to enter the junction, the negative charge of the barriers (in the p-region) resists the electron (while assisting the holes), and electrons are stopped by the negative plate of this barrier. The same thing happens when there is a hole in the p-region. As a result, the potential barriers provide a challenge to majority carriers in both areas.

12. *(d) 100 Hz*

Explanation: As we know that,

The fundamental frequency in the ripple would be = 2 × (the input frequency)

Hence, = 2 × 50 Hz

= 100 Hz

13. *(b) 20°*

Explanation: Magnification Power, $m = -\frac{f_0}{f_e}$

$$= -\frac{400}{100} = -4$$

Angle subtended by the moon at the objective lens

$$\alpha = \frac{3.5\times10^{3}}{3.8\times10^{5}} = \frac{3.5}{3.8}\times10^{-2}$$

$$= 0.09 \text{ radian}$$

Thus, angular diameter of the image = Magnification power × visual angle

$$= 4 \times 0.09 = 0.36 \text{ radian} \approx 20°$$

14. *(a) + 2.33 D*

Explanation: It is given that his far sight is good beyond 60 cm. His near sight is bad. If he desires to read book at $u = -25$cm, then for good vision image distance should be at a distance of 60 cm or more. For minimum power lens,

$$v = -60 \text{ cm}, u = -25 \text{ cm}$$

Therefore, the focal length of the lens used should be such that:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = -\frac{1}{60} + \frac{1}{25}$$

$$f = \frac{300}{7} \text{ cm}$$

$$\text{Power, } P = \frac{1}{f(\text{in meter})} = \frac{1}{\frac{3}{7}} = +2.33\text{D}$$

15. *(c) 40 mA*

Explanation: Applied voltage E = 4.5 V, R = 100Ω

Voltage drop across *p-n* junction = 0.5 V

Effective voltage = 4.5 – 0.5

$$= 4.0 \text{ V}$$

Current in the circuit

$$I = \frac{V}{R} = \frac{4}{100} = 0.04\text{A}$$

$$= 0.04 \times 1000\text{mA} = 40\text{mA}$$

16. *(c) A is true but R is false.*

Explanation: At absolute zero kelvin temperature, covalent bonds are very strong and there are no free electrons and semiconductor behaves as perfect insulator. With increase in temperature some covalent bonds are broken and few valence electrons jump to conduction band and hence it behaves as a poor conductor.

17. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: When two light nuclei fuse or combine to form a comparatively heavy nucleus then the reaction is called nuclear fusion reaction. To bring the light nuclei within the separation of about a femtometre (fm) (10^{-15} m) so, that they can fuse together is possible only at high temperature and pressure.

18. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: The mass of a photon is not the same as that of a neutron. The atomic mass also includes mass of electrons and an atom of mass number A has Z electrons. The mass of nucleus is slightly less than the mass of the constituent nucleons.

SECTION - B

19.

$$\tau = pE\sin\theta$$

$$pE = \frac{\tau}{\sin\theta}$$

$$W = \Delta U = -pE\cos\theta_2 - pE\cos\theta_1$$

$$W = pE\left[\cos\frac{\theta}{2} - pE\cos 4\theta\right]$$

$$W = \frac{\tau}{\sin\theta}\left[\cos\frac{\theta}{2} - pE\cos 4\theta\right]$$

OR

When switch S is closed, current does not pass through bulb C. Hence total resistance decreases and current passing through bulbs A and B increases. Brightness of bulbs A and B also increases.

20. The current required for full scale deflection $I_g = 20\mu\text{A} \times 30 = 600\mu\text{A} = 6 \times 10^{-4}$ A

To convert it into ammeter, a shunt is required in parallel with it.

Shunt resistance,

$$R_S = \frac{I_g R_g}{I - I_g} = \left(\frac{6\times10^{-4}}{1-6\times10^{-4}}\right) 100 = 0.06\Omega$$

21. The point A is at higher potential than B as the particle has gained kinetic energy while moving from A to B.

The kinetic energy acquired by the particle is equal to loss in potential energy. *i.e.*,

$$\Delta K = q(V_A - V_B)$$

$$\frac{1}{2}mv^2 = q(V_A - V_B)$$

$$V_A - V_B = \frac{1}{2}\frac{mv^2}{q}$$

22. For diffraction to take place, the size of the obstacle should be of order of the wavelength of the waves. Change in the wavelength of light is very small as compared to the size of the obstacle around us, light cannot be deflected readily. On the other hand, wavelength of sound is not of order of such object. Therefore, sound waves get diffracted easily.

23. (A) Maximum emf produced,

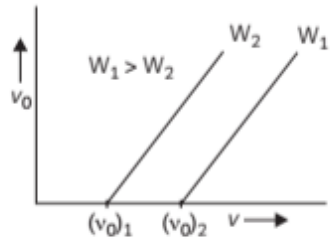
$$e_o = nBA\omega = 50 \times 0.30 \times 2.5 \times 60$$
$$= 2{,}250V$$

Therefore, maximum current drawn from the generator,

$$I_o = \frac{e_o}{R} = \frac{2250}{50} = 45A$$

(B) The current is zero, when the coil is vertical. In this position, flux through the coil is maximum. On the other hand, when the coil is horizontal, the current is maximum and the flux through the coil is minimum.

24. The graph showing the variation of stopping potential with the frequency of incident radiation for two different materials having work functions W_1 and W_2,



Einstein's Photoelectric equation, we have,

$$h\nu = h\nu_0 + m\frac{1}{2}mv_{max}^2$$
$$= h\nu_0 + eV_0$$
$$V_0 = \frac{h\nu}{e} - \frac{h\nu_0}{e}$$

Since frequency is plotted along x-axis and stopping potential across y-axis, it represents a straight line.

The slope of stopping potential versus frequency is independent of nature of metal surface.

The intercept of lines depends on the work function of the metal.

OR

When radiation of 2000 Å falls on a nickel plate, it acquires positive charge due to emission of photoelectrons. It implies that the wavelength of the incident radiation is below the threshold wavelength of Nickel.

When the incident radiation has wavelength equal to or greater than the threshold, no photo electrons are emitted, howsoever intense the radiation may be. The wavelength has been gradually increasing to 3400 Å, when the effect is found to cease, 3400 Å corresponds to the wavelength equal to or greater than the threshold wavelength of the Nickel surface.

25. When the increasing current flows through the wire in the direction from point B to A, the increasing magnetic field is produced, which is directed perpendicular to the plane of the loop and in inward direction. Due to this, induced emf is produced in the loop which opposes the magnetic field produced due to the current following the wire i.e., induced current in the loop should flow in a direction so that it produces magnetic field perpendicular to the plane of the loop find in outward direction. Maxwell corkscrew rule is that induced current in the loop will flow in anticlockwise direction.

SECTION - C

26. Here, induced emf produced,

$$e = 100mV = 100 \times 10^{-3}\ V$$

Change in current in the primary coil.

$$dI = 10.0 - 6.0 = 4.0A$$

Time in which change in the current takes place, $dt = 0.5s$.

If M is the mutual inductance between two coils, then

$$e = -M\frac{dI}{dT}$$

$$\Rightarrow \quad M = \frac{e}{\frac{dI}{dT}}$$

$$M = \frac{100\times10^{-3}}{4.0/0.5} = 1.25 \times 10^{-2}\ H$$

OR

Due to rotation of the wheel inside the magnetic field, induced emf will be produced across the two ends of each spoke. As all the

ten spokes are connected with their one end of the rim, the net emf produced with the same as that produced across a single spoke.

Induced emf produced across two ends of the spoke is given by

$$e = -B \times \pi l^2 \times v$$

$$e = -40 \times 10^{-4} \times \pi \times (0.5)^2 \times 2$$

$$e = -6.283 \times 10^{-5}\ V$$

27. On Wave picture of radiation, when the radiation falls on a metal surface, the radiation energy spread evenly all over the surface. As such, a single atom in the metal surface receives only an extremely small part of the incident energy, which is insufficient to cause photoelectric emission. The energy keeps on accumulating over the electron in the atom of the metal surface during its exposure to the radiation. When the required amount of energy becomes available, the electron is ejected out of the metal surface. Thus, according to Wave theory, radiation of any wavelength can cause photoelectric emission from a metal surface and the emission of electron will take a good enough time, therefore, admission will not be instantaneous.

The particle nature ascribes a specific value of energy to a Photon, which depends on its frequency. The photoelectric emission takes place from a metal surface, if the energy of the photon is greater than a threshold value of the energy of the metal, called its work function. Owing to its particle nature, a photon cannot be shared by all the atoms in the metal surface. It can get incident on one particular electron in the atom and in case it's energy e is greater than the work function of the metal, the emission of electron will take place as soon as radiation falls over the metal surface.

28. (A) Continuous X-ray spectrum: It contains all possible wavelength from a certain minimum value to a maximum value. The lower limit of wavelength is independent of the material of the target and depends only on the potential difference through which the electrons falling on the target are accelerated. The intensity curve of X-Ray produced starts at the lower limit of the wavelength, rises rapidly to the maximum value and then drops gradually. The wavelength at which the intensity is maximum depends on the accelerating potential, being shorter of higher potential difference.

(B) Characteristic X-ray spectrum: This part consists of distinct spectral lines in the form of small groups superimposed on the container spectrum. As the name suggests, this part of the spectrum is characteristic of the target. In the most cases K series consists of two spectral lines.

OR

It explains the spectra of only hydrogen like and atoms, atoms having only one electron. It fails to explain the spectra of multi electron atoms.

When a spectral line is observed under a powerful microscope, it is found to consist a number of closely spaced lines. Bohr's atomic model does not explain the fine structure of a spectral line.

It does not explain the splitting of the spectral line into a number of spectral lines under the effect of magnetic field called Zeeman effect and electric field called Stark effect.

It does not tell about the relative intensities of spectral lines

It considers an electron only as a particle, but electrons exhibit wave nature also.

The researchers show that the charge distribution due to electrons in different orbits is altogether different from the one assumed in Bohr's model of atom.

29. The refractive index of the material of the prism is given by,

$$\mu = \frac{\sin(A+\delta_m)/2}{\sin A/2}$$

$$\therefore \quad \frac{\sin(A+\delta_m)/2}{\sin A/2} = \cot\frac{A}{2}$$

$$\text{or} \quad \frac{\sin(A+\delta_m)/2}{\sin A/2} = \frac{\cos A/2}{\sin A/2}$$

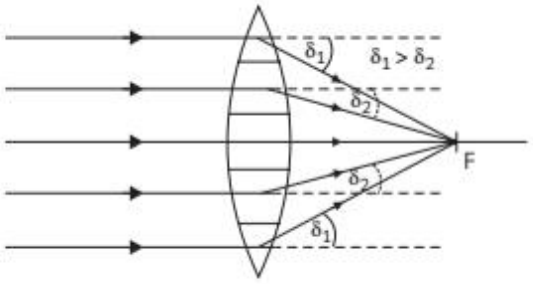
$$\text{or} \quad \sin\frac{A+\delta_m}{2} = \cot\frac{A}{2}$$

$$\text{or} \quad \sin\frac{A+\delta_m}{2} = \sin\left(90° - \frac{A}{2}\right)$$

$$\text{or} \quad \frac{A+\delta_m}{2} = 90° - \frac{A}{2}$$

$$\text{or} \quad \delta_m = 180° - 2A$$

30. A convex lens may be considered to be made of number of prisms; the prisms being placed one above another. The basis of all the prisms is towards the centre of the lens.



As the two surfaces of the lens are curved, the angles of all these prisms are not the same. The portion of the lens near the edge behaves as the prism having the maximum value of the angle of prism, while the portion at the middle behaves as a prism of zero angle. Since the angle of deviation produced by a prism depends upon the angle of the prism, the prismatic part of the lens near its edge deviates the light maximum, while that at the centre does not produce any deviation in the path of the light. The result is that all the rays after refraction from the lens meet at one point, called the focus of the lens. Thus, a convex lens converges light due to the prismatic action of the lens. In addition to produce deviation in the path of light, a thick lens disperses white light in the same manner as the prism does.

SECTION - D

31. (A) As $V \propto \frac{1}{r}$, $V_P > V_Q$. Thus, $(V_P - V_Q)$ is positive.

Also V_B is less negative than V_A. Thus $V_B > V_A$ or $(V_B - V_A)$ is positive.

(B) A small negative charge will be attracted towards positive charge. The negative charge moves from higher potential energy to lower potential energy. Therefore, the sign of potential energy difference from Q to P is negative.

Similarly, $(PE)_A > (PE)_B$, and hence sign of potential energy differences is negative.

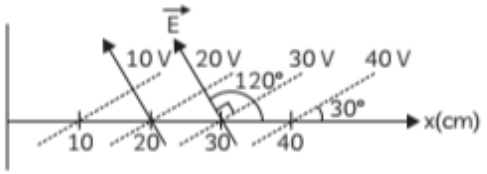
(C) In moving, a small positive charge from Q to P, work has to be done by an external agency against the electric field. Therefore, work done by the field is negative.

(D) In moving a small negative charge from B to A work has to be done by the external agency. It is positive.

(E) Due to force of repulsion on the negative charge, velocity decreases and hence the kinetic energy decreases in going from B to A.

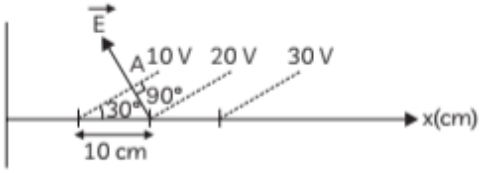
OR

First we will find the direction of the $\vec{E}$, noting that the $\vec{E}$ lines are always perpendicular to the local equipotential surfaces and points in that direction in which the potential is decreasing. So, it will be as shown below:



$\vec{E}$ lines are drawn perpendicular to all equipotential surfaces and it is pointing in that direction in which the potential is decreasing. So, the total angle $\vec{E}$ is making with the positive *x*-axis is 120°.

Now, to calculate the magnitude of the electric field, we need to jump from one equipotential surface to another through shortest (perpendicular) distance.



$$E = \frac{\text{Change in potential}}{\text{Distance travelled}}$$

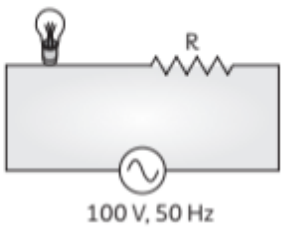
Jumping from 20 V line to 10 V line from B to A, the potential difference between the two lines is (20 V – 10 V) = 10 volt. Now, calculate the length

$$AB = 10 \sin 30° \text{ cm} = 5 \text{ cm} = 5 \times 10^{-2} \text{ m}$$

$$E = \frac{10}{5 \times 10^{-2}} = 200 \frac{V}{m}$$

Hence, $\vec{E}$ has the value 200 V/m and makes 120° with positive *x*-axis.

32. Maximum voltage across lamp = 60V



$$V_{lamp} - V_R = 100$$

$$V_R = 40V$$

Now current through Lamp is,

$$\frac{\text{Wattage}}{\text{Voltage}} = \frac{10}{60} = \frac{1}{6} \text{ A}$$

But, $V_R = IR$

$$40 = \frac{1}{6}(R)$$

$$R = 240$$

For inductance,

$$V^2_{lamp} + V_L^2 = V^2$$

$$60^2 + V_L^2 = 100^2$$

$$V_L = 80V$$

$$V_L = IX_L = \frac{1}{6} X_L$$

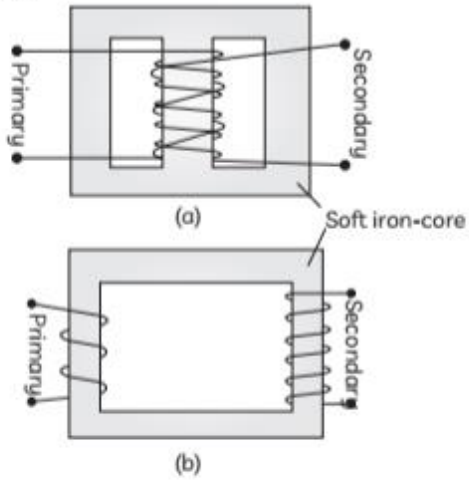
$$X_L = 80 \times 6 = 480\Omega = L(2\pi f)$$

$$L = 1.5H$$

OR

Transformer are based upon mutual inductance which transform and alternating voltage from one to another of greater for smaller value and vice versa.

Transformer consists of two coils wound on a soft iron core, world primary and secondary points



Induced EMF across the primary coil is given by,

$$E_p = -N_p \frac{d\phi}{dt}$$

Induced EMF across secondary coil is given by,

$$E_s = -N_s \frac{d\phi}{dt}$$

From these equations,

$$\frac{\text{AC voltage obtained across secondary coil}}{\text{AC voltage applied across primary coil}}$$

$$= \frac{V_s}{V_p} = \frac{E_s}{E_p} = \frac{N_s}{N_p}$$

Two arrangements for winding of primary and secondary coil in a transformer (a) two coils on top of each other, (b) two coils on separate limbs of the core

Thus, $$\frac{I_p}{I_s} = \frac{V_s}{V_p} = \frac{N_s}{N_p}$$

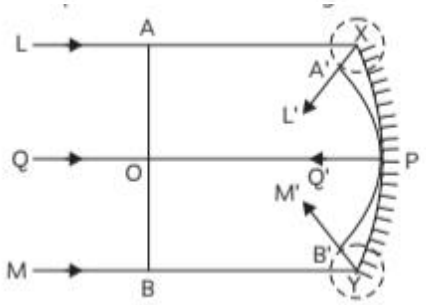
In a transformer some energy losses occur due to following reasons,

Flux leakage

Resistance of windings

Hysteresis

33. Consider that a plane wavefront AB is incident on a concave spherical mirror. The lines LA, QO and MB represent the incident rays.



Since the distance AX or BY is smaller than the distance OP, the disturbance will reach the points X and Y on the mirror earlier than it reaches the point P. Therefore, the instant, when the disturbance reaches the point P, the secondary wavelets from the points X and Y will grow into spheres of radii (OP - AX) and (OP-BY) respectively. At this instant, the point P on the mirror has just become the source of secondary wavelet and therefore, the secondary wavelet originating from the point P will be of zero radius at that instant.

To find the reflected wavefront (new position of the wavefront after reflection from the concave mirror); with the points X and Y as centres, draw spheres of radii XA' = (OP- AX) and YB'= (OP-BY) respectively. Then, the sphere A PB', the common envelope of the secondary wavelets issuing out from the points X, P and Y gives the reflected wavefront and the normal AL', PQ' and BM' to the reflected wavefront represent the reflected rays. It follows that a plane wavefront incident on a concave

spherical mirror is reflected as a converging spherical wavefront.

It, thus, explains why a parallel beam of light on reflection from a concave mirror gets converged.

OR

Lets first consider two sources of light emitting of intensity I_1 and I_2 having phase difference Φ.

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi \quad ...(i)$$

(i) In case, the sources of light are coherent, they must emit light in same phase *i.e.*, $\phi = 0$.

$$\therefore \quad I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos 0$$

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

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

Extending the above result for n sources, the resultant light intensity will be given by

$$I = (\sqrt{I_1} + \sqrt{I_2} + \sqrt{I_3} + \ldots\ldots\ldots + \sqrt{I_n})^2$$

Finally, if all the sources emit light of intensity I_0, then

$$I = (\sqrt{I_0} + \sqrt{I_0} + \sqrt{I_0} + \ldots\ldots\ldots + \sqrt{I_0})^2$$

$$= (n\sqrt{I_0})^2$$

$$= n^2 I_0$$

(ii) In case, the sources of light are incoherent, the phase difference ϕ between them will very in random manner. Therefore, average value of $\cos\phi$ will be zero.

Therefore, for incoherent sources, the equation (i) will become

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2} \times 0 = I_1 + I_2$$

Extending the above result for n sources, the resultant light intensity will be given by

$$I = I_1 + I_2 + I_3 + \ldots\ldots\ldots + I_n$$

Finally, if all the sources emit light of intensity I_0, the

$$I = I_0 + I_0 + I_0 + \ldots\ldots\ldots + I_0$$

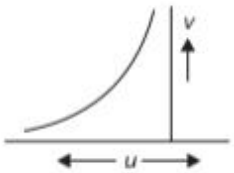
$$= n I_0$$

SECTION - E

34. (A) The relation between u and v is given by the lens equation,

$$-\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

It is the equation of hyperbola. Since the object distance *u* is negative, the *u*-*v* graph will be,



(B) The resolving power of the telescope is given by,

$$\text{Resolving Power} = \frac{D}{1.22\lambda}$$

Therefore, resolving power of the telescope will be high if the objective is of large aperture.

(C) When the lens is dipped in a liquid, its focal length is given by,

Lens maker's formula

$$\frac{1}{f_{liquid}} = ({}^{l}\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right),$$

where, $${}^{l}\mu_g = \frac{{}^{a}\mu_g}{{}^{a}\mu_l}$$

Now, $${}^{a}\mu_g = {}^{l}\mu_l$$

$$\therefore \quad {}^{l}\mu_g = \frac{{}^{a}\mu_g}{{}^{a}\mu_l} = 1$$

Hence, $$\frac{1}{f_{liquid}} = (1 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = 0$$

OR

We know that

Mean focal length,

$$f = \sqrt{f_v f_r}$$

$$= \sqrt{44.6 \times 42.5} = 43.53 \text{ cm}$$

Dispersive power,

$$\frac{f_r - f_v}{f} = \frac{44.6 - 42.5}{43.33} = 0.048$$

35. (A) When *p*-*n* junction is forward biased, the electrons from the negative pole of the battery enter the n-section. The electron is formed by the positive pole of the battery leaving behind the hole in *p*-section.

(B) Silicon cells are made of silicon atoms connected to one another in form of crystal lattice providing an organised structure that makes the conversion of solar to electric energy more effcient.

(C) Silica is obtained from silicon by melting in furnace. Silicon is most widely used material for solar cells due to abundance in the earth's crust.

OR

Bypass diodes are connected in Reverse bias between solar cells, positive and negative output terminals and have more effect on its output. Bypass diodes function is to eliminate the hotspot phenomena which can damage the PV cells.