CBSE Board
Class XII Physics

Time: Three Hours **Maximum Marks: 70**

General Instructions

(a) All questions are compulsory.

(b) There are 29 questions in total. Questions 1 to 8 carry one mark each, questions 9 to 16 carry two marks each, questions 17 to 25 carry three marks each and questions 27 to 29 carry five marks each.

(c) Question 26 is a value based question carrying four marks.

(d) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks each. You have to attempt only one of the given choices in such questions.

(e) Use of calculator is not permitted.

(f) You may use the following physical constants wherever necessary.

$$e = 1.6\times10^{-19}\ \text{C}$$
$$c = 3\times10^{8}\ \text{m s}^{-1}$$
$$h = 6.6\times10^{-34}\ \text{J s}$$
$$\mu_o = 4\pi\times10^{-7}\ \text{T ma}^{-1}$$
$$K_B = 1.38\times10^{23}\ \text{J K}^{-1}$$
$$N_A = 6.023\times10^{23}\ \text{/mole}$$
$$m_n = 1.6\times10^{-27}\ \text{kg}$$

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1. A 500 μ C charge is at the centre of a square of side 10 cm. Find the work done in moving a charge of 10 C between two diagonally opposite points on the square. (1)

2. What effect will be on current sensitivity of a moving coil galvanometer by increasing the number of turns in galvanometer coil? (1)

3. Which two main considerations are kept in mind while designing the objective of an astronomical telescope? (1)

4. How are eddy current in the transformer minimized? (1)

5. A double convex lens, made from a material of refractive index n_1, is immersed in a liquid of refractive index n_2 where $n_2 > n_1$. What change, if any, would occur in the nature of the lens? (1)

6. Which among x-rays, sound waves and radio waves can be polarised? (1)

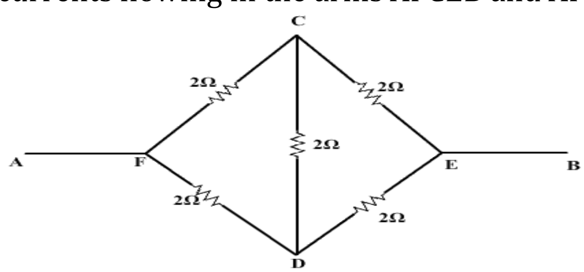
7. Why is the conductivity of an n-type semiconductor greater than that of the p-type semiconductor, even when both of them have same level of doping? (1)

8. A capacitor of a capacitance C is charged to a potential V. what is the electric flux through a closed surface around the capacitor? (1)

9. Why is the mass of a nucleus always less than the sum of the mass of its neutrons and protons? (2)

10. A potential difference of 2 V is applied between the points A and B shown in the network drawn in the figure

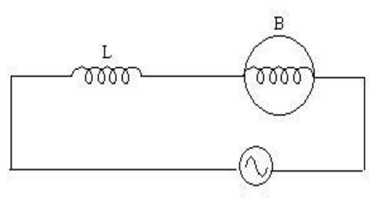
Calculate (i) equivalent resistance of the network across the points A and B, and (ii) the magnitude of currents flowing in the arms AFCEB and AFDEB.



(2)

11. Using the Ampere's circuital law, derive an expression for the magnetic field along the axis of a toroidal solenoid. (2)

12. An inductor 'L' of reactance X_L, is connected in series with a bulb 'B' to an a. c. source as shown in figure.



Briefly explain how the brightness of the bulb changes, when

(i) number of turns of the inductor is reduced and

(ii) A capacitor of reactance $X_c = X_L$ is included in series in the same circuit. (2)

13. Define electric flux. Write its S.I unit. A spherical rubber balloon carrying a charge increases in size, how does the total electric flux coming out of the surface change? Give reason. (2)

14. Keeping the voltage of the charging source constant, what would be the percentage change in the energy stored in the parallel plate capacitor if the separation between its plates were to be decreased by 10 %? (2)

15. An armature coil consists of 20 turns of wire, each of area A = 0.10 m^2 and total resistance 15.0 Ω . It rotates in a magnetic field of 0.5 T at a constant frequency of $\frac{150}{\pi} Hz$. Calculate the value of (i) maximum (ii) average induced emf produced in the coil. (2)

OR

Two circular coils one of radius *a* and the other of radius *b* are placed coaxially with their centres coinciding. For b>>a, obtain an expression for the mutual inductance for the arrangement. (2)

16. A transmitting antenna at the top of a tower has a height of 36 m and the height of receiving antenna is 49 m. What is the maximum distance between them, for satisfactory communication in the LOS mode? (Radius of earth = 6400 Km). (2)

17. A convex lens made up of glass of refractive index 1.5 is dipped, in turn in:

(i) Medium A of refractive index 1.65

(ii) Medium B of refractive index 1.33

Explain, giving reasons, whether it will behave as a converging lens or a diverging lens in each of these two media. (3)

18.

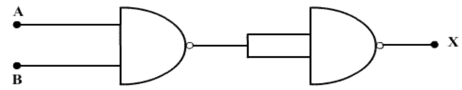
(a) Using gauss's law, derive an expression for the electric field intensity at any point outside a uniformly charged thin spherical shell of radius R and charge density σ C/m^2.

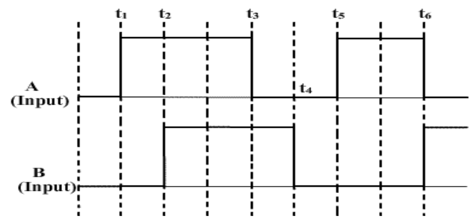
(b) A uniformly charged conducting sphere of 2.5 m in diameter has surface charge density of $100 \mu C/m^2$. Calculate the

(i) Charge on the sphere

(ii) Total electric flux passing through the sphere. (3)

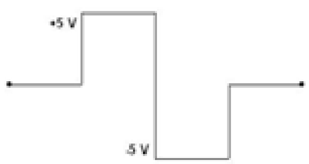
19. Draw the output waveform at X, using the given inputs A, B for the logic circuit shown below. Also identify the gate. (3)

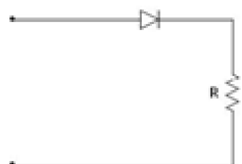




OR

Draw and explain the output waveform across the load resistor R, if the input waveform is as shown in the given figure.





(3)

20. Define the term 'resolving power' of an astronomical telescope. How does it get affected by

(i) Increasing the aperture of the objective lens?

(ii) Increasing the wavelength of the light used?

Justify your answer in each case. (3)

21. A potential difference of V volts is applied to a conductor of length L and diameter D. How are the electric field and resistance of the conductor affected when in turn

(i) V is doubled

(ii) L is halved

(iii) D is halved (3)

22. Define the term (i) work function (ii) threshold frequency (iii) stopping potential with reference to photoelectric effect.

Calculate the maximum kinetic energy of electron emitted from a photosensitive surface of work function 3.2 eV, for the incident radiation of wavelength 300 nm. (3)

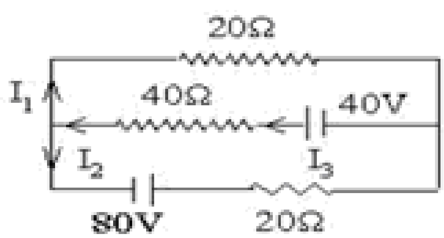
23. Draw a plot of the variation of amplitude versus ω for an amplitude modulated wave. Define modulation index. State its importance for effective amplitude modulation. (3)

24. Distinguish between an intrinsic semiconductor and p-type semiconductor. Give reason, why a p-type semiconductor crystal is electrically neutral, although $n_h >> n_e$?
Where n_e = number of free electron
n_h = number of free holes
n_i = Intrinsic carrier concentration (3)

25. State the principle of working of p - n diode as a rectifier. Explain with the help of a circuit diagram the use of p - n diode as a full wave rectifier. Draw a sketch of the input output waveforms. (3)

26. A person looking at a person wearing a shirt with a pattern comprising vertical and horizontal lines is able to see vertical lines more distinctly than the horizontal ones. He shares his problem with his friend who suggests him to go to a doctor immediately.
(i) Name the value displayed by his friend.
(ii) What is this defect due to?
(iii) How is such a defect of eye corrected? (4)

27. State Kirchhoff's rules of current distribution in an electrical network.
Using these rules determine the value of the current I_1 in the electric circuit given below. (5)



OR

Define the term potential gradient of potentiometer.
In a potentiometer arrangement, a cell of 1.20 Volt gives a balance point at 30 cm length of the wire. This cell is now replaced by another cell of unknown emf. If the ratio of emf's of the two cells is 1.5, calculate the difference in the balancing length of the potentiometer wire in the two cases. (5)

28. A bar magnet M is falling under gravity through an air cored coil C. Plot a graph showing variation of induced emf (E) with time t. What does the area enclosed by the E-t curve depict?

An armature coil consists of 20 turns of wire, each of area A = 0.10 m^2 and total resistance 15.0 Ω . It rotates in amagnetic field of 0.5 T at a constant frequency of $\frac{150}{\pi} Hz$. Calculate the value of (i) maximum (ii) average induced emf produced in the coil. (5)

OR

Write the relation for the force $\vec{F}$ acting on a charge carrier q moving with a velocity $\vec{v}$ through a magnetic field $\vec{B}$ in vector notation. Using this relation, deduce the conditions under which this force will be (i) maximum (ii) minimum

An electron travelling west to east enters a chamber having a uniform electrostatic field in a north to south direction. Specify the direction in which a uniform magnetic field should be set up to prevent the electron from deflecting from its straight line path. (5)

29. Prove that $\frac{-\mu_1}{u} + \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R}$ when refraction occurs from rarer to denser media at a convex refracting spherical surface.

OR

Draw a labelled diagram of a compound microscope when the image is formed at infinity. Deduce the expression for its magnifying power. How can the magnifying power be increased? (5)

CBSE Board
Class XII – Physics
Solution

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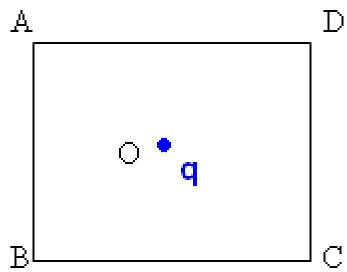
1. Given: ABCD is a square.
$q = 500\,\mu$ C and Q = 10C.



Work done: $W = q\,(V_c - V_A)$

$$W = \frac{qQ}{4\pi\varepsilon_o}\left[\frac{1}{OA} - \frac{1}{OC}\right]$$

As, OA = OC, so W=0

2. The current sensitivity of moving coil galvanometer will get enhanced on increasing the number of turns in the coil of galvanometer.

3. Main considerations which are kept in mind while designing the objective of an astronomical telescope are:

(i) Large focal length
(ii) Large aperture

4. Eddy currents are reduced in cores of transformers by making it laminated. This increases the resistance to the flow of these currents. Eddy currents can also be reduced by cutting slots in the metal plate. This increases the resistance as current needs to flow over a greater path length.

5. If focal length is negative, the lens is diverging.
And, if the focal length is positive, the lens is converging.

Now, apply the lens maker's formula: $\frac{1}{f} = \left(\frac{n_1}{n_2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

As $n_2 > n_1$, therefore f will be negative and so the lens behaves as diverging lens.

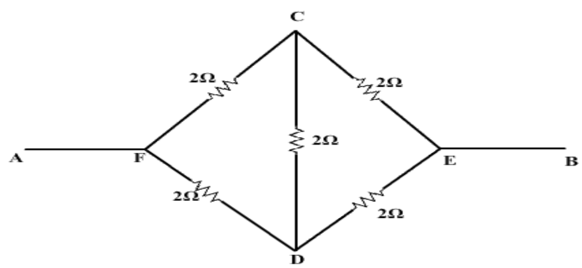
6. We know that only transverse waves can be polarised. So, the x-rays and radio waves can be polarised but sound waves are longitudinal, and hence they cannot be polarised.

7. Conductivity of n-type semiconductor is greater because mobility of electrons is more than that of holes.

8. Zero, because net charge enclosed is zero. It is on an account of the fact that two plates of a capacitor have equal and opposite charges on them.

9. The mass of a nucleus is always slightly less than the sum of the masses of its constituent protons and neutrons on account of the fact that some energy is to be supplied to bind constituent protons and neutrons together within the small volume of nucleus.
As there is no other source of energy, an extremely small amount of mass is converted into energy in accordance with Einstein's mass energy relation. As a result, the mass of nucleus is slightly less.

10.



The circuit corresponds to a balanced Wheatstone bridge, and therefore no current flows in the arm CD.

(i) Resistance of the arm FCE = 2 + 2 = 4Ω
Resistance of the arm FDE = 2 + 2 = 4 Ω
Therefore total resistance between points A and B = $\frac{4\times4}{4+4}=2\Omega$

(ii) Current in arm AFCEB =
$\frac{V}{R}=\frac{2V}{4\Omega}=0.5\,A$
and current in arm AFDEB $=\frac{2V}{4\Omega}=0.5\ A$

11. Consider a toroidal solenoid consisting of ring of mean radius R, over which a large number of turns (say N) of an insulated metallic wire is wound. When a current I is passed through the toroid, the magnetic field produced will be same at all the point on the central axis of the ring.

Hence,

$$\oint \vec{B}.d\vec{l} = \mu_o NI$$

$$\therefore B.2\pi R = \mu_o NI$$

$$B = \frac{\mu_o NI}{2\pi R} = \mu_o nI$$

Where, $n = \frac{N}{2\pi R}$ = Number of turns per unit length of toroid

12.

(i) When the number of turns of the inductor is reduced, its reactance decreases, so current in the circuit increases and brightness of the bulb increases.

(ii) When $X_L = X_c$, impedance $Z = \sqrt{R^2 + (X_L - X_C)^2}$ = R becomes minimum. Current in the circuit is maximum. Bulb glows with maximum brightness.

13. The electric flux through a given surface area is the total number of electric lines of force passing normally through that area. It is given by $\phi_E = \vec{E}.\Delta\vec{S}$ and its SI unit is Nm^2C^{-1}.

As the balloon is blown up, the total charge on the balloon's surface remains unchanged, so the total electric flux coming out of its surface remains unchanged.

14. Capacitance of a parallel plate capacitor $C = \frac{\varepsilon_o A}{d}$

d=Separation between the plates.
A=Area of each plate.

If the separation between the plates is decreased by 10%, then the new separation d' = 0.9 d and new capacitance will be

$$C' = \frac{\varepsilon_o A}{d'} = \frac{\varepsilon_o A}{0.9d}$$

$$\Rightarrow C' = 1.11\frac{\varepsilon_o A}{d} = 1.11C$$

Energy stored in a capacitor U = ½ CV^2. For a constant value of voltage, the energy is proportional to the capacitance.

Percentage change in energy can be written as

$$\frac{U' - U}{U} \times 100\,\% = \left(\frac{U'}{U} - 1\right) \times 100\%$$

Here $U' =$ New energy of parallel plate capacitor.

$$\text{Hence, percentage change in energy} = \left(\frac{C'}{C} - 1\right) \times 100\% = (1.11 - 1) \times 100\% = 11\%$$

15.

(i) The induced emf is

$\varepsilon = NBA\omega \sin \omega t$

$\omega = 2\pi f$

Maximum value of emf is NBAω

$N = 20, A = 0.10 m^2, B = 0.5 T, f = \dfrac{150}{\pi} Hz$

$\varepsilon_0 = \mathrm{NBA}\omega = \mathrm{NBA}(2\pi f)$ (1/2 mark)

$= 20 \times 0.5 \times 0.10 \times 2 \times \pi \times \dfrac{150}{\pi}$

=300 V (1 mark)

(ii) Since this emf is varying sinusoidally, its average value is zero.

OR

Let current I_b flows through bigger coil of radius *b*.

Magnetic field inside this coil and also through the smaller coil of radius *a* placed inside it will be $B_a = \dfrac{\mu_0 I_b}{2b}$.

The flux through the smaller coil of radius *a* is

$$\phi_a = \pi a^2 B_a = (\pi a^2)\frac{\mu_0 I_b}{2b} = M_{ab} I_b$$

For current I_b flowing through outer coil of radius *b*.

So,

$$M = \frac{\phi_a}{I_b} = \frac{\pi a^2 \mu_0}{2b}$$

If a current is assumed through inner coil and then mutual inductance found, the same value will be obtained.

16. It is given that height of transmitting antenna h_t = 36 m = 0.036 km and height of receiving antenna h_R = 49 m = 0.049 km.

Moreover distance between transmitting and receiving antenna for satisfactory communication in LOS mode is given

$$d_M = d_t + d_R = \sqrt{2Rh_t} + \sqrt{2Rh_R}$$
$$= \sqrt{2\times6400\times0.036} + \sqrt{2\times6400\times0.049}$$
$$= (21.47 + 25.04)\text{km} = 46.5\,\text{km}$$

17.

(i) Convex lens dipped in medium A of refractive index 1.65.

Focal length f_A in medium A of refractive index 1.65 is given by

$$\frac{1}{f_A} = \left({}^{m_1}\mu_g - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \left(\frac{1.5}{1.65} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$
$$= -\frac{0.15}{1.65}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

(Since, R_1 is positive and R_2 is negative for a convex lens)

Hence, $1/f_A = -\frac{0.15}{1.65}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ = - ve

As f_A is negative, the lens is diverging.

(ii) Convex lens dipped in medium B of refractive index 1.33.

Focal length f_B in medium B of refractive index 1.33 is given by

$$\frac{1}{f_B} = \left({}^{m_2}\mu_g - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \left(\frac{1.5}{1.33} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$
$$= \left(\frac{0.17}{1.33}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Since, R_1 is positive and R_2 is negative for a convex lens.

Hence, $1/f_B = \left(\frac{0.17}{1.33}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ = + ve

As f_B is positive, the lens is converging.

18.

(a) Consider a uniformly charged thin spherical shell 'S' of radius R having charge Q. According to Gauss theorem,

Electric flux- $\phi_E = \dfrac{Q}{\varepsilon_0}$

Total electric flux through the Gaussian surface of radius 'r' = $\phi_E = E.4\pi r^2$

Comparing above equations we get

$$E.4\pi r^2 = \frac{Q}{\varepsilon_o} \quad \text{or } E = \frac{Q}{4\pi\varepsilon_o r^2}$$

(b) Total charge on sphere is

(i)

Given

$d = 2.5\text{m};\ \sigma = 100\,\mu\text{C/m}^2;$

To find Q

$Q = 4\pi r^2.\sigma$

$\Rightarrow 4 \times 3.14 \times \left(\dfrac{2.5}{2}\right)^2 \times 100\,\mu\text{C}$

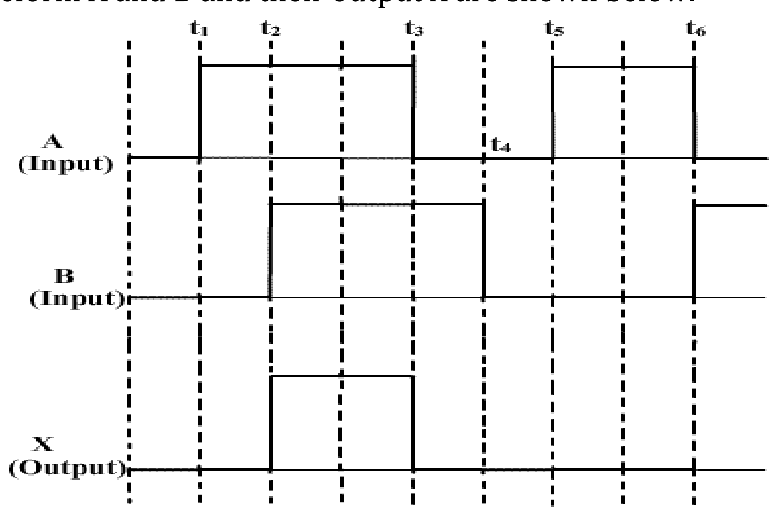
$\Rightarrow 1.96 \times 10^{-3}\,\text{C}$

(ii) The total electric flux passing through the surface is

$$\phi_E = \frac{Q}{\varepsilon_o} = \frac{1.96 \times 10^{-3}\,\text{C}}{8.85 \times 10^{-12}\,\text{C}^2\text{N}^{-1}\text{m}^{-2}} = 2.21 \times\ 10^8\ \text{Nm}^2\ \text{C}^{-1}$$

19. As the circuit consists of two AND gates joined together, hence the logic circuit shown in the figure behaves as an AND gate.

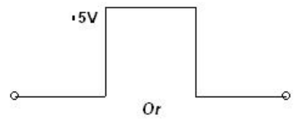
The input waveform A and B and their output X are shown below.



OR

Given circuit diagram consist of p-n junction diode with load resistance R. As we know that, p-n junction primarily allows current in one direction (forward bias) because of low resistance.

So, when the input voltage is + 5 V, the diode gets forward biased; the output across R is + 5V, as shown in the figure.



When the input voltage is – 5V, the diode gets reverse biased. Thus, no output is obtained across R.

20. The resolving power of an astronomical telescope is defined as its ability to resolve the images of two point objects lying close and is given as: the reciprocal of the smallest angular separation between two point objects whose images can just be resolved by the telescope.

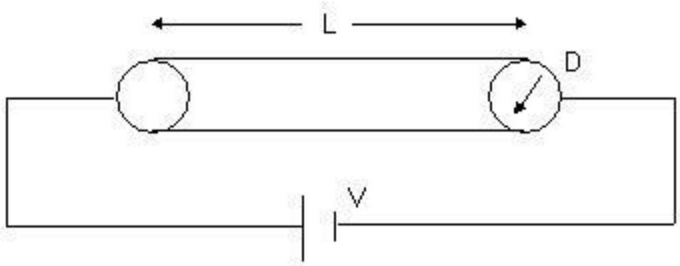
Resolving power of astronomical telescope- $\frac{1}{d\theta} = \frac{D}{1.22\lambda}$

(i) When the aperture of the objective lens is increased, the resolving power increases, because $R.P. \propto D$.

(ii) When the wavelength of the light is increased, the resolving power decreases, because $R.P. \propto 1/\lambda$.

21. Effect on electric field

(*i*) $E = \frac{V}{L}$



When V is doubled:

$$E' = \frac{2V}{L} = 2E$$

Electric field gets doubled.

(ii) When L is halved:

$$E' = \frac{2V}{L} = 2E$$

Electric field gets doubled.

(iii) When D is halved. No effect on electric field.

Effect on resistance:

(i) When potential is doubled, current also gets increased in the same proportion. Thus, resistance does not change.

$$i.\,e.,\ \frac{V}{I} = R = \text{constant}$$

(ii) $\because R = \frac{\rho l}{A}$

As length is halved, resistance also gets halved.

(iii) When D is halved, area reduces to one fourth. Thus, resistance becomes four times.

22. **Work function**: The minimum amount of energy required to just eject an electron from a given metal surface is called the work function for that metal surface.

Threshold frequency: The minimum frequency of incident radiation, which can eject electrons from a metal, is called threshold frequency.

Stopping potential: The minimum negative potential given to the anode of a photocell for which the photoelectric current becomes zero is called stopping potential.

Here, λ = 300 nm = 3 x 10 $^{-7}$ m

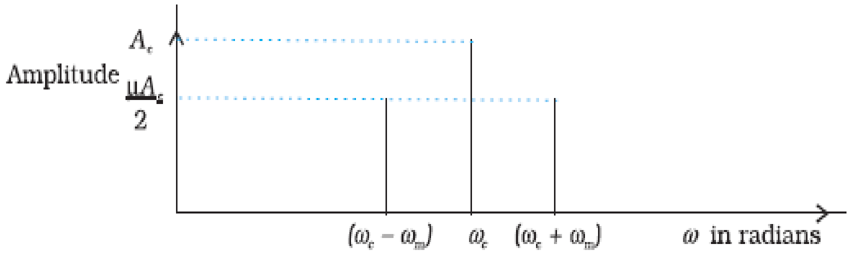
Therefore Energy of photon E =

$$\frac{hc}{\lambda}\,J = \frac{hc}{e\lambda}\,eV = \frac{6.63\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}\times3\times10^{-7}} = 4.14\,ev$$

As work function of photosensitive surface $\phi = 3.2\,eV$

$\therefore$ Maximum kinetic energy of electron $K_{max} = E - \phi_o = 4.14 - 3.2 = 0.94\,eV$

23. For amplitude modulated wave, the plot of the variation of amplitude versus ω is shown in the following figure.



Here, A_c is the amplitude of carrier wave of frequency ω_C and ω_m is the frequency of modulating signal wave. μ is the modulation index.

Modulation index for amplitude modulated wave is defined as the ratio of the amplitude of modulating signal to the amplitude of carrier. Thus,

Modulation Index $\mu = \frac{A_m}{A_C}$

The modulation index is very important for effective amplitude modulation. It is observed that, greater the value of modulation index μ, greater is the useful power transmitted by AM wave.

However, if $\mu \geq 1$, then it causes distortion in output. Therefore, for effective distortion free AM Wave transmission, we prefer modulation index in the range 0.5 to 0.75.

24.

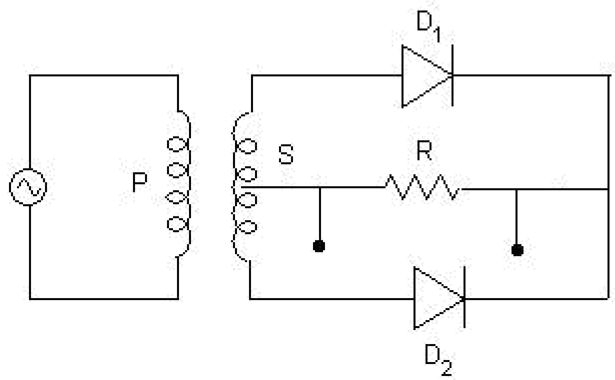
Intrinsic semiconductors	**P-Type semiconductor**
1) Pure semi- conducting material and no impurity of any sort is added to them. 2) $n_e = n_h = n_i$	1) Prepared by doping a small quantity of impurity of trivalent material to the pure semiconductor material. 2) $n_h >> n_e$.

A p-type semiconductor crystal is electrically neutral because the charge of additional charge carriers (holes) is just equal and opposite to that of the ionised cores in the crystal lattice.

25. Device which converts alternative current (a. c.) into direct current (d. c.) is known as rectifier.

Principle– Junction diode conducts only when forward biased and it does not conduct when reverse biased. This makes the junction diode work as a rectifier.

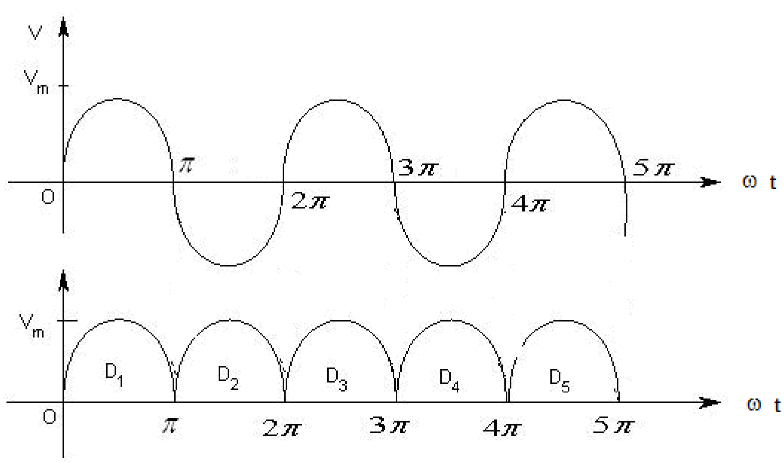
Full wave rectifier:



In the figure, P is the primary coil and S is the secondary coil of the transformer. D_1 and D_2 are the diodes which are connected to the secondary coil of the transformer. The load R, across which output voltage is obtained, is connected to a mid point on secondary coil.

Working: When the half cycle of input ac signal flows through the primary coil, induced emf is set up in the secondary winding coil due to mutual induction. Now the diode D_1 becomes forward biased and diode D_2 becomes reverse biased. Thus, output is there due to diode D_1.

During the negative half cycle of the ac input signal, diode D_2 becomes forward and conducts while diode D_1 becomes reverse biased and does not conduct. Thus, in this case, the output is due to diode D_2.



26.

(i) Empathy and care for his friend. He also did not show any over smartness by suggesting his friend some sort of remedy.

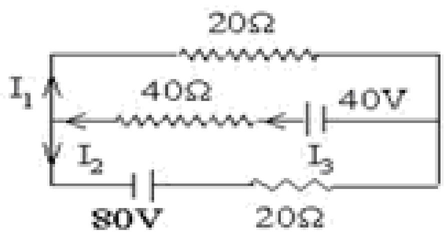
(ii) This defect is called Astigmatism. It arises when cornea has different curvature in different directions.

(iii) This defect can be corrected by using a cylindrical lens.

27. Kirchhoff's rules for electrical network are as follows:

(i) Junction rule: At any junction, the sum of the currents entering the junction is equal to the sum of currents leaving the junction.

(ii) Loop rule: The algebraic sum of the changes in potential around any closed loop involving resistors and cells in the loop is zero.



By Kirchhoff's rule, $I_1 + I_2 = I_3$

Applying loop rule to both the lower and upper loops, we get,

For upper loop:

$$40\ I_3 + 20\ I_1 = 40$$

For lower loop:

$$40\ I_3 + 20\ I_2 = 80 + 40 = 120$$

Adding the two equations, we get

$$80\ I_3 + 20\ (I_1 + I_2) = 160$$

Or $$80\ I_3 + 20\ I_3 = 160$$

$$I_3 = 160/100 = 1.6\ A$$

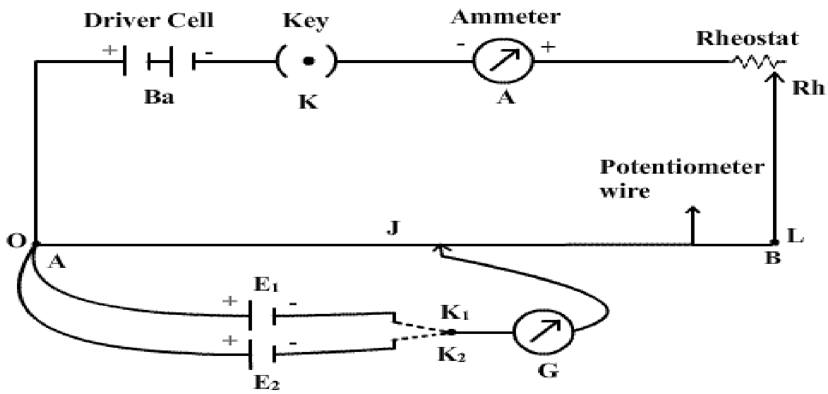
Again $$40 \times 1.6 + 20\ I_1 = 40$$

Or $$20\ I_1 = 40 - 64 = -24$$

$$I_1 = -24/20 = -1.2\ A$$

OR

Potential gradient of a potentiometer is defined as the fall in the potential per unit length along the given potentiometer wire. If V be the potential difference across a length l of the potentiometer wire, then potential gradient = V/l.
Comparison of emfs of two cells:



Therefore, $\frac{E_1}{E_2} = \frac{l_1}{l_2}$

It is given that $\frac{\varepsilon_1}{\varepsilon_2} = 1.5$

$\varepsilon_1 = kl_1$

$1.20 = k \times 30\,\text{cm}$

$\varepsilon_2 = kl_2$, but also, $\varepsilon_2 = \frac{\varepsilon_1}{1.5}$

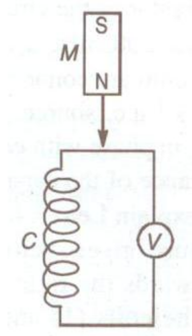
Hence, $kl_2 = \frac{kl_1}{1.5} \quad \because (l_1 = 30\,\text{cm})$

$\therefore l_2 = \frac{30}{1.5} = 20\,\text{cm}$

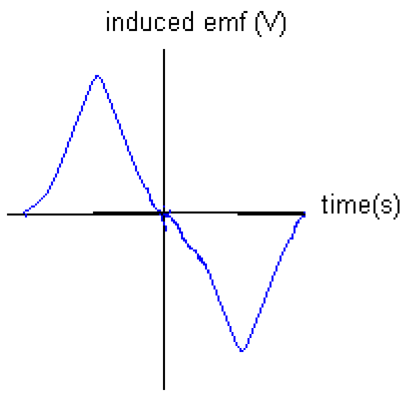
So, the difference in the balancing length of the potentiometer wire in the two cases will be:

$l_1 - l_2 = (30 - 20) = 10$ cm

28.



As the bar magnet moves towards the coil, the magnetic flux increases but this increases non-uniformly because the falling magnet is accelerating.
It increases till the magnet enters the coil. Once it is completely inside the coil, the induced emf is zero. When the magnet emerges from the other end of the coil, the induced emf is in the opposite direction.



The area under the graph denotes the energy consumed by the system.

(i) The induced emf is

$\varepsilon = NBA\omega \sin \omega t$

$\omega = 2\pi f$

Maximum value of emf is NBAω

$N = 20, A = 0.10m^2, B = 0.5T, f = \dfrac{150}{\pi} Hz$

$\varepsilon_0 = \mathrm{NBA}\omega = \mathrm{NBA}(2\pi f)$

$= 20 \times 0.5 \times 0.10 \times 2 \times \pi \times \dfrac{150}{\pi}$

=300 V

(ii) Since this emf is varying sinusoidally, its average value is zero.

OR

The force acting on a charge carrier q is given by

$$\vec{F}=q\left(\vec{v}\times\vec{B}\right)$$

(i) Magnitude of force F will be maximum when $\left|\vec{v}\times\vec{B}\right|$ is maximum and it possible only when $\vec{v}$ and $\vec{B}$ are mutually perpendicular to each other.

As we know that, $\left|\vec{v}\times\vec{B}\right|$ = v B sin 90° = Vb

Hence, F_{max} = qvB

(ii) F will be minimum when $\left|\vec{v}\times\vec{B}\right|$ is minimum having a zero value which is possible when angle between $\vec{v}$ and $\vec{B}$ is 0° or 180°. Means charge carrier is moving along (or opposite) the direction of magnetic field.

An electron travelling west to east on entering a chamber having uniform electrostatic field in north to south direction will be deflect towards north.

To prevent the electron from deflection from its straight line path, the direction of deflection due to magnetic field must be opposite to that of electrostatic field. Thus, magnetic field, B should be in vertically downward direction so that in accordance with Fleming's left hand rule the deflection of electron due to B is in horizontal plane from north to south and may nullify the deflection due to electrostatic field.

29. Let μ_1 be refracting index of rarer medium and μ_2 be the refracting index of spherical convex refracting surface XY of small aperture.

From A draw AM such that $AM \perp OI$

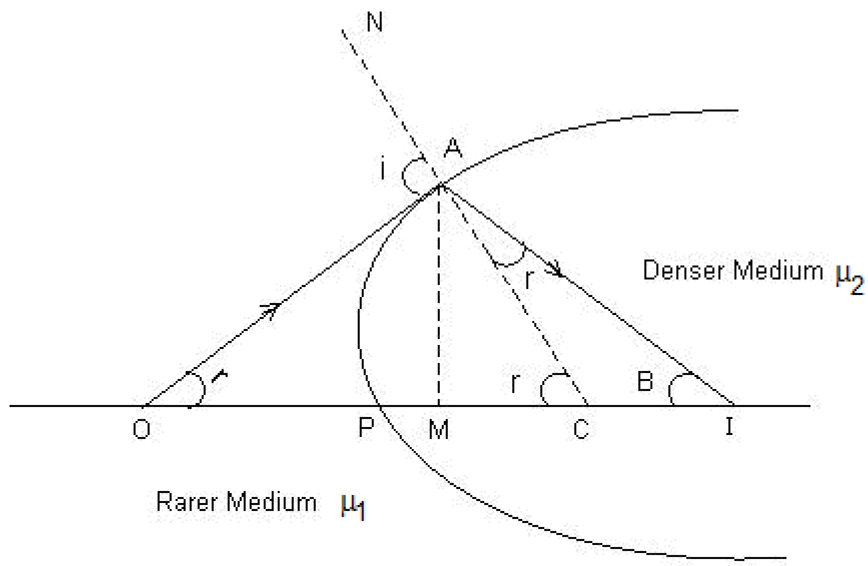
In ΔIAC

$$\mathrm{r} + B = \gamma\left(\text{Ext. angle property}\right)$$

$$\therefore \quad r = \gamma - \beta$$

Similarly in $\Delta\ OAC$

$$i = \alpha + \gamma$$



According to Snell's law

$$\frac{\mu_2}{\mu_1} = \frac{\sin i}{\sin r} \approx \frac{i}{r} \Rightarrow \mu_2 r = \mu_1 i$$

So, $\mu_1(\alpha+\gamma) = \mu_2(\gamma-\beta)$ (i)

Let

$$\alpha \approx \tan\,\alpha = \frac{AM}{OM} = \frac{AM}{PO}$$

$$\beta = \tan\beta = \frac{AM}{MI} = \frac{AM}{PC}$$

As spherical surface has small aperture, so we have

$$y = \tan\beta = \frac{AM}{MC} = \frac{AM}{PC}$$

Substituting the value in eq. (i), we get

$$\frac{\mu_1}{PO} + \frac{\mu_2}{PI} = \frac{\mu_2-\mu_1}{PC}$$

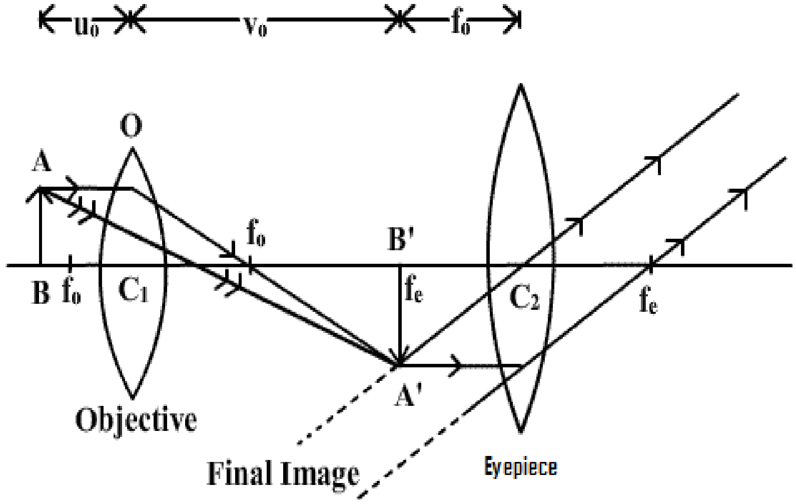
By sign convention put $PO = -u,\ PI = +v,\ PC = +R$

We get

$$\frac{\mu_1}{-u} + \frac{\mu_2}{v} = \frac{\mu_2-\mu_1}{R}$$

OR

A labelled diagram of a compound microscope, when the final image is formed at infinity:



If m_o and m_e be the magnification produced by the objective lens and eye lens respectively, then the total magnifying power of microscope is $m = m_o \times m_e$.

If u_o be the distance of the object AB from objective lens and v_o be the distance of image A′B′ formed by objective, then magnifying power of objective is

$$m_o = \frac{v_o}{u_o}$$

The magnifying power of eyepiece when the final image is formed at infinity is

$$m_e = \frac{D}{f_e}$$

Here, object distance, $u_e = f_e$

D = Least distance of distinct vision

Now, the magnifying power of microscope is

$$m = \frac{v_o}{u_o} \cdot \frac{D}{f_e}$$

As a first approximation $u_o \approx f_o$ and $v_o = L$ (distance between objective and eyepiece), then after substituting the values from above equation, we get

$$m = \left(\frac{L}{f_o}\right) \cdot \left(\frac{D}{f_e}\right)$$