Code Number: A

Aakash

Medical | IIT-JEE | Foundations

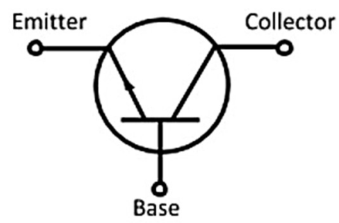
Corp. Office: Aakash Educational Services Limited, 3rd Floor, Incuspaze Campus- 2, Plot No. 13, Sector- 18, Udyog Vihar, Gurugram, Haryana - 122015

Time: 3 hrs. **Mock Test Paper for Class-XII** **Max. Marks: 60**

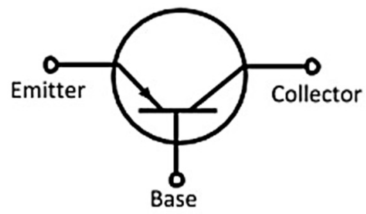
PHYSICS

Answers & Solutions

1. The Phenomenon of splitting of white light into its component colours is known as dispersion. The deviation is maximum for violet colour. Violet colour is relatively more dispersed.
2. A moving coil galvanometer can be converted into a voltmeter by connecting a high resistance in series to it.
3. The unit if magnetic moment (M) is ampere-meter2 (A-m2).
   The unit of magnetic induction (B) is tesla (T) ir N/ A-m
   The unit of magnetic field (H) is tesla (A-m)
4. The equatorial magnetic field is $B_E = \frac{\mu_0}{4\pi r^3} = M = \frac{B_E 4\pi r^3}{\mu_0}$
   We are given the B_E = 0.4 G = 4 x 10^{-5}T. For 'r' we take the radius of the earth as 6.4 x 10^6 m.
   Hence $M = \frac{4\times10^{-5}\times4\pi\times(6.4\times10^6)^3}{4\pi\times10^{-7}} = 4\times10^2\times262.14\times10^{18} \Rightarrow M = 1048.5\times10^{20}$
   $= 1.05\times10^{23}\,Am^2$
   This is close to the value 8 x 10^{22} Am^2 quoted in geomagnetic texts.
5. Transformers works on the phenomenon of mutual induction between two coils. When there is a change in current passing through a coil, am emf is induced in the neighboring coil. This phenomenon is called mutual induction
6. (a) (i) Infrared rays are used in earth Satellites
   (ii) To observe the growth of crops.
   (b) Pythons, snakes and boars can detect the infrared rays.
7. The minimum energy of incident photon required to eject an electron from a metal surface without imparting any kinetic energy to the electron is called 'work function'.
8. Accelerated potential, V = 100V; Plank's constant, h = 6.63 x 10-34 Js
   De-Broglie wavelength of electron, $\lambda = \frac{h}{p} = \frac{1.22}{\sqrt{v}}nm = \frac{1.22}{\sqrt{100}}nm = 0.123\,nm$

9. 

n-p-n transistor



p-n-p transistor

10. Basic blocks of a communication system are

(1) transmitter (2) medium or channel (3) receiver

11. **Focal length of concave mirror:** The distance between the focus (F) and pole (P) of a concave mirror is called focal length of concave mirror.

Relation between radius of curvature(R) and focal length (f) of a concave mirror: Let C be the center of curvature of the mirror. Consider a ray of light OM parallel to the principal axis incident on the mirror at M and reflected along MF. At Mm the angle of reflection (θ) is equal to the angle of incidence (θ).

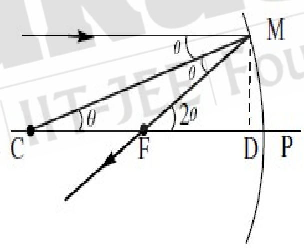
Since, the angle (θ) is very small, the arc PM may be regarded as a straight line MD perpendicular to principal axis.

In$\Delta CMD, tan\theta = \frac{MD}{CD}$ $and\ in\ \Delta FMD, tan2\theta = \frac{MD}{FD}$

Since 'θ' is very small, tanθ ≅ θ and tan2θ ≅ 2θ

$\therefore = \frac{MD}{CD}\ and\ 2\theta = \frac{MD}{FD} \Rightarrow \frac{MD}{FD} = 2\left(\frac{MD}{CD}\right) \Rightarrow CD = 2 \times FD$

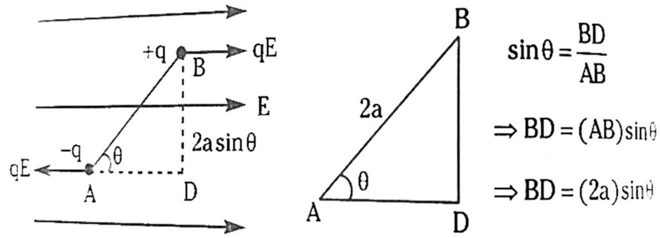
Radius of curvature, R = 2 x focal length



12. The resolving power of your eye can be estimated with a simple experiment. Make black stripes of equal width separated by white stripes as shown in figure. All the black stripes should be of equal width, while the width of the white stripes should increase as you go from the left to the right. Paste the pattern on a wall at a height of your eye.

Now watch the pattern with one eye. By moving away or close to the wall, find the position where you can see two black stripes as separate stripes. All the black stripes to the left of this stripe would merge into one stripe and would not be distinguishable. On the other hand, the black stripes to the right of this stripe would be more and more clearly visible. Note the width (d) of the white stripe and distance 'D' of the wall from your eye. Then value of d/D gives the resolution of your eye.

13. Consider an electric dipole which consists of two equal but opposite charges +q and -q separated by a distance 2a. This dipole is placed in a uniform field of intensity 'E'. Let 'θ. Be the sngle between dipole and direction of the electric field.



Magnitude of force acting on the charge +q at B = qE (along E)

Magnitude of force acting on charge -q at A = qE (opposite to direction of E).

From the diagram perpendicular distance between two forces = 2a sinθ

Magnitude of the torque or couple, C = one of the forces x perpendicular distance between two forces.

Couple, C = qE x 2a sinθ (Dipole moment, p – q x 2a)

In vector form $\vec{C} = \vec{p} \times \vec{E}$

14. a) Resultant capacitance in parallel combination, $C_P = C_1 + C_2 + C_3 = 2 + 3 + 4 = 9$ pF

b) Potential on each capacitor, $Q_1 = C_1V = 2 \times 10^{-12} \times 100 = 200 \times 10^{-12}$C,

$Q_2 = C_2V = 3 \times 10^{-12} \times 100 = 300 \times 10^{-12}$C,

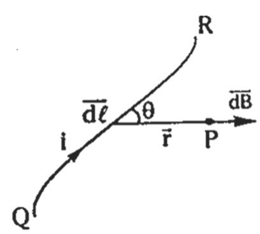
$Q_3 = C_3V = 4 \times 10^{-12} \times 100 = 400 \times 10^{-12}$C.

15. **Biot-Savart's law:** The magnetic field at a point due to a current carrying element is directly proportional to length of element. Strength of the current, sine of the angle between length of element and position vector of given point and inversely proportional to square of the distance between them.

Explanation: Consider a current carrying conductor QR carrying a current 'i'. Consider a small element of the conductor of length $\overrightarrow{dl}$. Let dB be the magnetic induction due to a small element dl at a point 'P' which is at a distance of 'r' from dl/ Let 'θ' be the angle between $\overrightarrow{dl}$ and position vector $\vec{r}$.

According to Biot savart law. $dB \alpha \frac{idl sin\theta}{r^2} \Rightarrow \frac{\mu_0}{4\pi}\frac{idl sin\theta}{r^2}$.

In vector notation. $\overrightarrow{dB} = \frac{\mu_0}{4\pi} i \frac{\overrightarrow{dl} \times \vec{r}}{r^3}$



16. Eddy currents are used in certain applications like

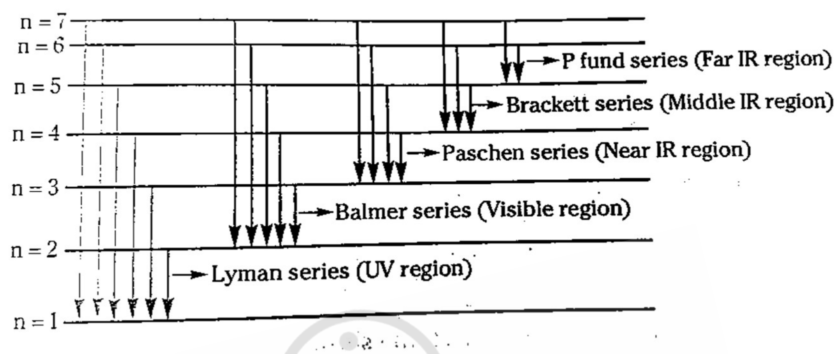
1. Magnetic brakes in trains: Strong electromagnets are situated above the rails in some electrically powered trains. When the electromagnets are activated, the eddy currents induced in the rails oppose the motion of the train. As there are no mechanical linkages, the breaking effect is smooth.
2. Electromagnetic damping: Certain galvanometers have a fixed core made of non magnetic metallic material. When the coil oscillated, the eddy currents generated in the core oppose the motion and bring the coil to rest quickly

3. Induction furnace: Induction furnace can be used to produce high temperatures and can be utilized to prepare alloys by melting the constituent metals. A high frequency alternating current is passed through a coil which surrounds the metals to be melted. The eddy currents generated in the metals produce high temperature which are sufficient to melt that metals

4. Electric power meter: The shiny metal disc in the electric power meter rotates due to the eddy currents. Electric currents are induced in the disc due to magnetic fields produced by sinusoidally varying currents in a coil.

5. Eddy currents are used in speedometers of automobiles.

17. Different types of spectral series observed in the Hydrogen spectrum are



1) **Lyman Series:** This series of spectral lines will from when electron jumps from higher energy levels. n_2 = 2, 3, 4 …..∞ to lower energy level n_1 = 1

This series of lines belongs to U, V region.

$\frac{1}{\lambda_1} = R\left(\frac{1}{1^2} - \frac{1}{n_2^2}\right)$, where n_2 = 2, 3, 4, ….. ∞.

2) **Balmer Series:** This series of spectral lines will from when electron jumps from higher energy levels, n_2 = 3, 4, 5 …..∞ to lower energy level n_1 = 2

This series of lines belongs to visible region. $\frac{1}{\lambda_{Ba}} = R\left(\frac{1}{2^2} - \frac{1}{n_2^2}\right)$, where n_2 = 3, 4, 5 ….. ∞.

3) **Paschen series:** This series of spectral lines will from when electro jumps from higher energy levels, n_2 = 4, 5, 6, …….∞, to lower energy level, n_1 = 3

This series of lines belongs to infrared region. $\frac{1}{\lambda_p} = R\left(\frac{1}{3^2} - \frac{1}{n_2^2}\right)$, where n_2 = 4, 5, 6 ….. ∞.

4) **Bracket series:** This series of spectral lines will form when electron jumps from higher energy levels, n_2 = 5, 6, 7…….∞, to lower energy level, n_1 = 4

This series of lines belongs to middle infrared region. $\frac{1}{\lambda_{Br}} = R\left(\frac{1}{4^2} - \frac{1}{n_2^2}\right)$, where n_2 = 5, 6, 7 ….. ∞.

5) **Pfund series:** This series of spectral lines will form when electron jumps from higher energy levels, n_2 = 6, 7, 8 …….∞, to lower energy level, n_1 = 5

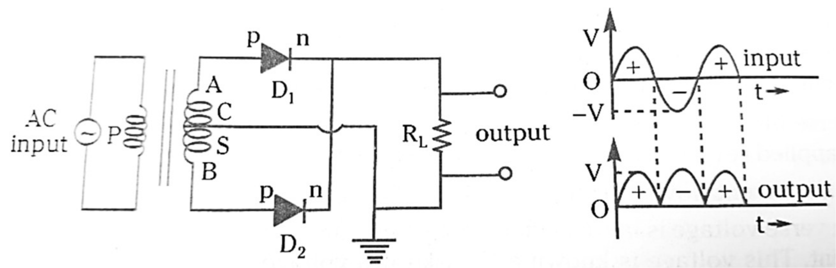
This series of lines belongs to middle infrared region. $\frac{1}{\lambda_{Pl}} = R\left(\frac{1}{5^2} - \frac{1}{n_2^2}\right)$, where n_2 = 6, 7, 8 ….. ∞.

18. Rectification: The process of converting alternating current into direct current is called rectification.

Working of full wave rectifier: A rectifier which rectifies both half cycles of the AC input is called full wave rectifier.

Circuit consists of two diodes D_1, D_2 and a center tap transformer shown in figure. During the positive cycles of

AC input, diode D_1 is forward biased and diode D_2 is reserve biased. So D_2 will not conduct current but current flows through the load resistance R_1, due to D_1. Similarly, during the negative half cycles of AC input, diode D_2 is forward biased and D_1. Similarly, during the negative half cycles of AC input, diode D_2 is forward biased and D_1 is reverse biased. So D_1 will not conduct current but current flows through the load resistance R_1, due to D_2. Hence, current flows through diodes due to both half cycles and in same direction. Thus, a full wave rectifier, gives continuous but pulsating output as shown in figure



Expression for efficiency of full wave rectifier is given by $\eta = \frac{P_{dc}}{P_{ac}} = \frac{0.812 \times R_L}{r_1 + R_L}$

Here, r_1 is diode forward resistance and R_L is load resistance.

19. Doppler Effect: The phenomenon of apparent change in the frequency of the sound wave due to relative motion between the observer and the source of sound is called Doppler effect.

Expression for the apparent frequency of sound heard when the source is in motion with respecte to an observer at rest: Consider a source 'S' moving with a velocity 'V_s' away from a stationary observer 'O'. Let 'v' be the velocity of the wave when medium is at rest.

At time t = 0, let source emits first wave and source is at point S_1.

Let 'L' be the distance between observer 'O' and point S_1.

Time taken by the first wave to reach the observer, $t_1 = \frac{L}{V}$.

At time t = T_0, let source emits second wave at point S_2.

Distance of point S_1 from S_2 is $v_s T_0$ and distance of observer O from S_2 is, L + $v_s T_0$.

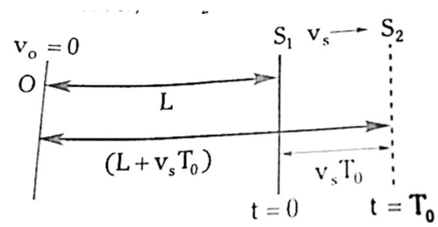
Time taken by the second wave to reach the observer, $t_2 = T_0 + \left(\frac{L + V_S T_0}{v}\right)$

Time interval between consecutive waves received by the observer, T = t_2 = t_1

$$\Rightarrow T = T_0 + \left(\frac{L + V_S T_0}{V}\right) - \frac{L}{V}$$

$$\Rightarrow T = T_0 + \frac{L}{V} + \frac{V_s T_0}{V} - \frac{L}{V} = T_0\left(1 + \frac{V_s}{V}\right)$$

$$\Rightarrow T = T_0\left(\frac{V + V_s}{V}\right)$$



Apparent frequency experienced by the observer, $n = \frac{1}{T} = \frac{1}{T_0}\left(\frac{V}{V + V_S}\right) \left(\because n = \frac{1}{T} and\ n_0 = \frac{1}{T_0}\right)$

When source is approaching the observer, we replace V_s by $-V_s$

Apparent frequency; $n^I = n_0\left(\frac{V}{V - V_0}\right)$.

20. **Working principle:** It works on the principle that the fall of potential across any portion of uniform wire is directly proportional to the length of that portion when constant current is flowing through it.

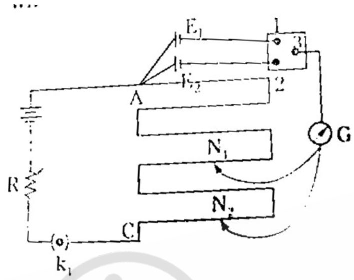
Let 'V' be the potential difference across the wire of length 'l', resistance 'R' and uniform area of cross section A. If 'i' be the current flowing through the wire then,

According to Ohm's law, V = iR

$\Rightarrow V = i.\rho\frac{l}{A} = \left(\frac{i\rho}{A}\right)l \Rightarrow V = \emptyset l, where\ \emptyset$ is potential drop per unit length of the wire.

Comparison of emf's of two cells: Circuit diagram of potentiometer is as shown in figure. The points marked 1, 2 and 3 from a two way key.

Consider the first position of the key where 1 and 3 points are connected, so that galvanometer is connected to a cell of emf 'E_1'. Jockey is moved along the wire till a balancing point N_1 is reached.



Now, balancing length l_1 is measured from point A.

Emf of the first cell, $E_1 = \emptyset l_1 \rightarrow (1)$

Consider the second position of key where 2 and 3 points are connected, so that galvanometer is connected to a cell of emf 'E_2'. Jockey is moved along the wire till a balancing point N_2 is reached.

Now, balancing length l_2 is measured from point A.

Emf of the second cell, $E_2 = \emptyset l_2 \rightarrow (2)$

On dividing eq (1) and (2), $\frac{E_1}{E_2} = \frac{\emptyset l_1}{\emptyset l_2} \Rightarrow \frac{E_1}{E_2} = \frac{l_1}{l_2}$

Using the above equation, we can compare emf's of given two cells.

Given E_1 = 1.25V, l_1 = 35.0 cm, l_2 = 63.0 cm

We know that $\frac{E_2}{E_1} = \frac{l_2}{l_1}$

$\therefore E_2 = \frac{l_2}{l_1} \times E_1 = \frac{63\times1.25}{35} = 2.25v$

21. Principle: Nuclear reactor works on the principle of controlled chain reaction for producing nuclear energy.

Parts of nuclear reactor: A nuclear reactor mainly consists of

1) Fuel 2) Moderator 3) Control rods 4) Radiation shielding 5) Coolant

1) **Fuel:** The fissionable material used for producing energy by fission is called nuclear fuel. Uranium-235 and Polutonium-239 are used as nuclear fuel. These are taken in the form of this long rods.
2) **Moderator:** To slow down the fast moving neutrons to thermal energies, they were allowed to pass through moderators. Heavy water and graphite are used as moderators.
3) **Control rods:** Control rods are used to absorb neutrons released in nuclear reactor. Cadmium Boron rods are used as control rods. By suitable movement of these rods into reactor core, the reactor can be started up or shut down

4) **Shielding:** Nuclear radiations like beta and gamma rays are emitted during fission reaction, in addition to neutrons. So suitable shielding such as steel, lead, concrete etc,. is provided around the reactor to absorb and to reduce the intensity to emitted radiation.

5) **Coolant:** Heat generated in fuel elements is removed by using a suitable coolant to flow around them. Substances used as coolants are water at high pressures, molten sodium etc.

Working: Uranium fuel rods are arranged in graphite blocks with equal separation. Graphite blocks acts as moderator. Control rods are placed in the holes of the graphite blocks. If one neutron initiates the fission with ^{235}U, fast neutrons are produced.

These fast neutrons pass through the moderator to become thermal neutrons. These thermal neutrons produce fission with further Uranium nuclei and proceeds the chain reaction in controlled conditions. The heat generated here is used for heating suitable coolants which in turn heat water and produce steam. This steam is used to rotate turbines to produce electricity.