Vidyamandir Classes
Gurukul for IITJEE & Medical Preparation

Sample Paper

Class XII (2017-18)

PHYSICS

Time allowed: 3 hrs. **Maximum Marks: 70**

GENERAL INSTRUCTIONS:

(i) There are a total of 26 questions and five sections in the question paper. All questions are compulsory.

(ii) Section A contains question number 1 to 5, **Very Short Answer type** questions of one mark each.

(iii) Section B contains question number 6 to 10, **Short Answer type I** questions of two marks each.

(iv) Section C contains question number 11 to 22, **Short Answer type II** questions of three marks each.

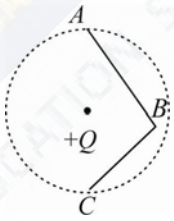
(v) Section D contains question number 23, **Value Based Question** of four marks.

(vi) Section E contains question number 24 to 26, **Long Answer type** questions of five marks each.

(vii) There is no overall choice in the question paper; however, an internal choice is provided in one question of two marks, one question of three marks and all three questions of five marks. An examinee is to attempt any one of the questions out of the two given in the question paper with the same question number.

[SECTION A]

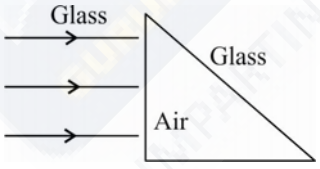
1. In the given figure, charge $+Q$ is placed at the centre of a dotted circle. Work done in taking another charge $+q$ from A to B is W_1 and from B to C is W_2. What is relation between W_1 and W_2 .



2. Plot a graph showing the variation of current 'I' versus resistance 'R', connected to a cell of emf E and internal resistance 'r'.

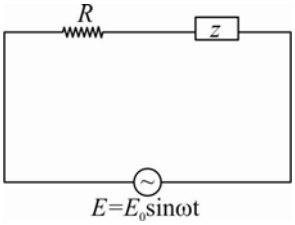
3. State the factors on which the refractive index of a material medium for a given wavelength depends.

4. Sketch the emergent wavefront.



5. In the wave picture of light, intensity of light is determined by square of the amplitude of wave. What determines the intensity of light in the photon picture of light?

[SECTION B]



6. An alternating voltage $E = E_0 \sin\omega t$ is applied to a circuit containing a resistor R connected in series with a black box. The current in the circuit is found to be $I = I_0 \sin(\omega t + \pi/4)$.

(i) State whether the element in the black box is a capacitor or an inductor.

(ii) Draw the corresponding phasor diagram and find the impedance in terms of R.

7. The magnetic field a plane electromagnetic wave is given by:

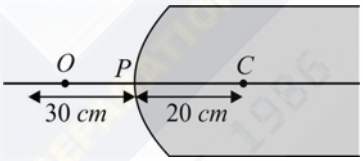
$$B_y = 12\times10^{-8}\sin\left(1.20\times10^{7}z + 3.60\times10^{15}t\right)T.$$

Calculate the

(i) Energy density associated with the electromagnetic wave.

(ii) Speed of the wave

8. A spherical convex surface of radius of curvature 20 *cm*, made of glass $(\mu = 1.5)$ is placed in air. Find the position of the image formed, if a point object is placed at 30 *cm* in front of the convex surface on the principal axis.



9. Name the optoelectronic device used for detecting optical signals and mention the biasing in which is operated. Draw its I-V characteristics.

10. Give reason, why high frequency carrier waves are needed for effective transmission of information signals.

OR

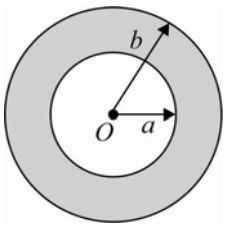
What is the range of frequencies used for *T.V.* transmission? State two factors by which the range of *TV* signals can be increased.

[SECTION C]

11. **(a)** How many electron must be added to one plate and removed from the other so as to store 25.0 *J* of energy in a 5.0 *nF* parallel plate capacitor?

(b) How would you modify this capacitor so that it can store 50.0 *J* of energy without changing the charge on its plates?

12. A point charge $+Q$ is placed at the centre O of an uncharged hollow spherical conductor of inner radius '*a*' and outer radius '*b*'. Find the following:



(a) The magnitude and sign of the charge induced on the inner and outer surface of the conducting shell.

(b) The magnitude of electric field vector at a distance

(i) $r = \frac{a}{2}$, and **(ii)** $r = 2b$, from the centre of the shell.

13. The following table gives the length of three copper wires, their diameters, and the applied potential difference across their ends. Arrange the wires in increasing order according to the following:

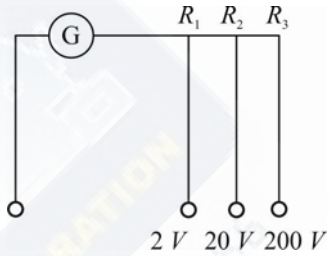
(a) The magnitude of the electric field within them,

(b) The drift speed of electrons through them, and

(c) The current density within them.

Wire Number	Length	Diameter	Potential difference
1	L	$3d$	V
2	$2L$	d	V
3	$3L$	$2d$	$2V$

14. A multi range voltmeter can be constructed by using a galvanometer circuit as shown in the figure. We want to construct a voltmeter that can measure $2V$, $20V$ and $200V$ using a galvanometer of resistance $10\,\Omega$ and that produces maximum deflection for current of 1 mA. Find the value of R_1 and R_3 that have to be used.

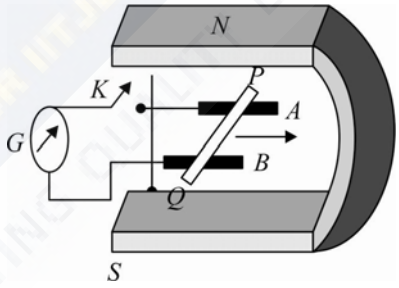


15. Figure shows a metal rod PQ of length l, resting on the smooth horizontal tails AB positioned between the poles of a permanent magnet. The rails, rod and the magnetic field $\vec{B}$ are in three mutually perpendicular direction. A galvanometer G connects the rails through a key 'K. Assume the magnetic field to be uniform. Given the resistance of the closed loop containing the rod is R.

(i) Suppose K is open and the rod is moved with a speed v in the directions shown. Find the polarity and the magnitude of induced emf.

(ii) With K open and the rod moving uniformly, there is no net force on the electrons in the rod PQ even though they do experience magnetic force due to the motion of the rod. Explain.

(iii) What is the induced emf in the moving rod if the magnetic field is parallel to the rails instead of being perpendicular?



16. With the help of a diagram, explain the principle of a device which changes a low voltage into a high voltage but does not violate the law of conservation of energy. Give any one reason why the device may not 100% efficient.

17. In a double slit experiment, the distance between the slits is 3 *mm* and the slits are 2 *m* away from the screen. Two interference patterns can be seen on the screen on due to light with wavelength 480 *nm*, and the other due to light with wavelength 600 *nm*. What is the separation on the screen between the fifth order bright fringes of the two interference patterns?

18. What do you understand by the statement 'Light from the sun is unpolarised'. Explain how does sunlight gets polarized by the process of scattering?

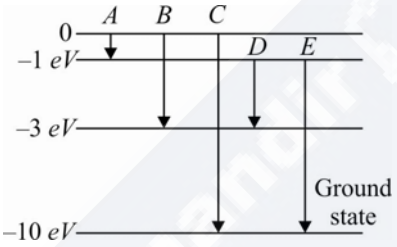
19. Explain how does (i) photoelectric current and (ii) kinetic energy of the photoelectrons emitted in a photocell vary if the frequency of incident radiation is doubled, but keeping the intensity same? Show the graphical variation in the above two cases.

OR

(i) Name the experiment which confirms the existence of wave nature of electrons. Derive the expression for de-Broglie wavelength of an electron moving under a potential difference of V volts.

(ii) An electron and a proton have the same kinetic energy. Which of these particles has the shorter de-Broglie wavelength?

20. The energy levels of an atom of element X are shown in the diagram. Which one of the level transitions will result in the emission of photons of wavelength 620 nm? Support your answer with mathematical calculations.



21. Draw a graph showing the variation of binding energy per nucleon versus the mass number A. Explain with the help of this graph, the release of energy in the process of nuclear fission and fusion.

22. A message signal of frequency 20 *KHz* and peak voltage of 20 volts is used to modulate a carrier signal of frequency 2 *MHz* and peak voltage of 40 volts. Determine (i) modulation index, (ii) the side bands produced. Draw the corresponding frequency spectrum of amplitude modulated signal.

[SECTION D]

23. When Deepak studied the electrical circuits and the current flowing through them, he became curious about the range of the currents we come across in daily life. He collected the data and presented in a tabular form as shown below. He then studied the instruments used to detect and measure current, however could not understand the difference between an ammeter and an ideal ammeter and thus went to his teacher for the explanation.

S. No.	Description	Magnitude of current
1.	Domestic Appliance	Few amperes
2.	Lightning	Ten thousand amperes
3.	Nervous system	Microamperes
4.	Galvanometer	Few milliamperes
5.	Semiconductors	Few milliamperes

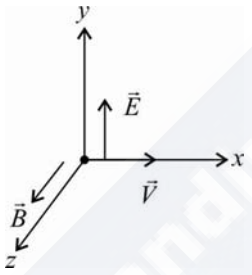
(i) What values did Deepak have?

(ii) As domestic appliances carry electric current of the order of few amperes, write one safety precaution we should take while working with them.

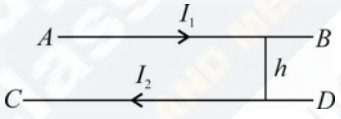
(iii) An ammeter of resistance R_A is connected in series with a resistor R and a battery of emf E and internal resistance r. The current flowing through this circuit is I_A. What will be the current flowing through the circuit if the given ammeter is replaced by an ideal ammeter and find the percentage error in measuring the current through an ammeter?

[SECTION E]

24. **(a)** A particle of charge q is moving with velocity v in the presence of crossed Electric field E and Magnetic field B as shown. Write three condition under which the particle will continue moving along x-axis. How would the trajectory of the particle be affected if the electric field is switched off?



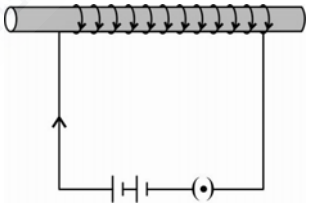
(b) A horizontal wire AB of length 'l' and mass 'm' carries a steady current I_1, free to move in vertical plane is in equilibrium at a height of 'h' over another parallel long wire CD carrying a steady current I_2, which is fixed in a horizontal plane as shown. Derive the expression for the force acting per unit length on the wire AB and write the condition for which wire AB is in equilibrium.



OR

(a) An electron in the ground state of Hydrogen atom is revolving in circular orbit of radius R. Obtain the expression for the orbital magnetic moment of the electron in terms of fundamental constants.

(b) Draw the magnetic field lines for a current carrying solenoid when a rod made of (i) copper, (ii) aluminium and (iii) iron are inserted within the solenoid as shown.



25. **(a)** Draw a ray diagram of compound microscope for the final image formed at least distance of distinct vision?

(b) An angular magnification of 30 is desired using an objective of focal length 1.25 cm and an eye piece of focal length 5 cm. How will you set up the compound microscope for the final image formed at least distance of distinct vision?

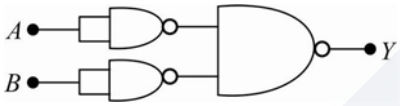
OR

(a) Draw a ray diagram of an astronomical telescope for the final image formed at least distance of distinct vision?

(b) An astronomical telescope has an angular magnification of magnitude 5 for distant objects. The separation between the objective and an eye piece is 36 cm and the final image is formed at infinity. Calculate the focal length of the objective and the focal length of the eye piece?

26. **(a)** With proper diagram, explain the movement of charge carriers through different parts of the transistor and hence show that $I_E = I_B + I_C$.

(b) Identify the logic operation carried out by the circuit shown below and write its truth table.



OR

(a) Draw a circuit diagram to study the input and output characteristics of an $n-p-n$ transistor in its common emitter configuration.

(b) Draw the typical input and output characteristics and explain how these graphs are used to calculate current amplification factor of the transistor.

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Answers to Sample Paper

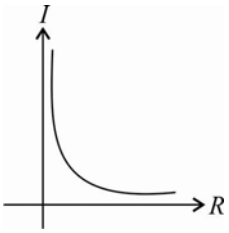
Class XII (2017-18)

PHYSICS

[SECTION A]

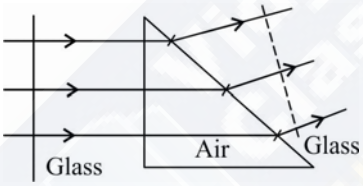
1. Since $V_A - V_B = V_B - V_C$ therefore, magnitude of work done is same i.e., $W_1 = W_2$

2. $I = \dfrac{E}{r+R}$



3. For a given wavelength, the refractive index of a material medium depends on the following factors:
(i) Magnetic permeability of the medium **(ii)** Electric permittivity of the medium

4. Diagram for the emergent wavefront is

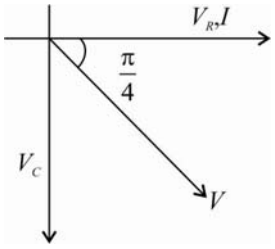


5. In photon picture, intensity is determined by the number of photons crossing per unit time.

[SECTION B]

6. **(i)** As the current leads the voltage by $\dfrac{\pi}{4}$, the element used in black box is a capacitor.

(ii) Phasor diagram



$\because$ The phase angle ϕ is given by $\tan = \dfrac{\pi}{4} = \dfrac{V_C}{V_R}$

$\therefore$ $V_C = V_R$ or $I_V X_C = I_V R$

$\therefore$ $X_C = R$

Impedance is given by, $Z = \sqrt{\left(X_C^2 + R^2\right)}$

$Z = R\sqrt{2}$

7. **(i)** The magnetic field in a plane electromagnetic wave is given by,
$B_y = 12 \times 10^{-8} \sin (1.20 \times 10^7 z + 3.60 \times 10^{15} t) T$
On comparing with general equation $B_y = B_0 \sin(kz + \omega t) T$

We get, $B_0 = 12\times10^{-8}T$

$\therefore$ Energy density $u = \dfrac{B_0^2}{\mu_0}$

$$u = \frac{\left(12\times10^{-8}\right)^2}{\left(4\pi\times10^{-7}\right)} = 11.5\times10^{-9}\,J/m^3$$

(ii) Speed of the wave $= \dfrac{\omega}{k} = \dfrac{3.60\times10^{15}}{1.20\times10^{7}} = 3\times10^{8}\,m/s$

8. Here; $R = 20cm,\ \mu_1 = 1.5,\ u = -30cm$

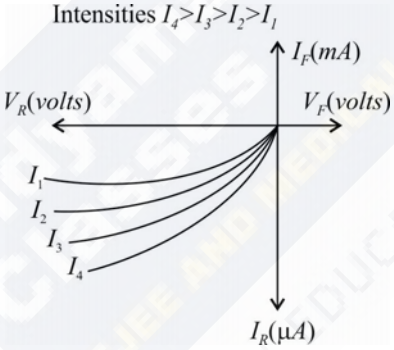
$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{(\mu_2 - \mu_1)}{R}$$

$$\frac{1.5}{v} - \frac{1}{-30} = \frac{(1.5-1.0)}{20} = \frac{1}{40};$$

$$\frac{1.5}{v} = \frac{1}{40} - \frac{1}{30}$$

$$v = -180cm$$

9. Photodiode is the optoelectronic device used for detecting optical signals. It is operated in reverse biasing. The I-V characteristics of a photodiode is shown as



10. High frequency carrier waves are used to increasing operating range, to reduce antenna length and convert the wide band signal into narrow band signal. Then the signal can be easily recovered and distinguished from other signals at the receiving station.

OR

The range of frequency used for *TV* transmission is 76-88 MHz and 420-890 *MHz*

The range of *TV* signals can be increased by increasing height of transmitting antenna and using repeater stations.

[SECTION C]

11. **(a)** $C = 5\times10^{\{9\}}F, U = 25J$

Energy stored in capacitor,

$$U = \frac{Q^2}{2C}$$

$$Q^2 = 2UC = 2\times25\times5\times10^{-9}$$

$$Q = 5\times10^{-4}C$$

$$Q = ne$$

$\therefore$ $n = \dfrac{Q}{e} = \dfrac{5\times10^{-4}}{1.6\times10^{-19}} = 3.125\times10^{15}$ electrons

(b) Without changing charge on the plates, we can make capacitance of capacitor C half.

$\because \quad C = \frac{\varepsilon_0 A}{d}, i.e.,$ By double the plate separation energy of the capacitor will be double.

12. **(a)** As the electrostatic field inside a conductor is zero, using Gausss's law, charge on the inner surface of the shell = $-Q$.

Charge on the outer surface of the shell = $+Q$

(b) By Gauss's law expression, the magnitude of electric field vector,

$$E = \frac{I}{4\pi\varepsilon_0}.\frac{Q}{r^2}$$

(i) The magnitude of electric field for radius, $r = \frac{a}{2}$,

$$E = \frac{1}{4\pi\varepsilon_0}.\frac{Q}{(a/2)^2} = \frac{1}{4\pi\varepsilon_0}\frac{4Q}{a^2}$$

(ii) The magnitude of electric field for radius $r = 2b$,

$$E = \frac{1}{4\pi\varepsilon_0}.\frac{Q}{(2b)^2} = \frac{Q}{16\pi\varepsilon_0 b^2}$$

13. **(a)** The magnitude of electric field,

$$E_1 = \frac{V}{L}, E_2 = \frac{V}{2L}, E_3 = \frac{2V}{3L} \qquad \therefore \qquad E_2 < E_3 < E_1$$

(b) The drift velocity of electrons is given by, $v_d = \mu E,$ where μ is the mobility of charge carrier. $v_d \propto E$

Or $\quad v_{d_2} < v_{d_3} < v_{d_1}$

(c) The electric current flowing through the conductor,

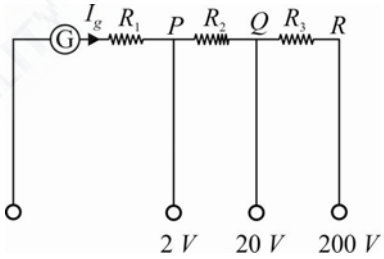
$$I = nAev_d$$

The magnitude of current density is given

$$J = \frac{1}{a} = n\ ev_d \qquad \therefore \qquad J_2 < J_3 > J_1$$

14. Here, $I_g = 1mA = 1\times10^{-3}A; G = 10\Omega$

$R_1 = ?,\ R_2 = ?,\ R_3 = ?$



Using $\quad R + G = \frac{V}{I_g}$

At point $P,\ R_1 + 10 = \frac{2}{10^{-3}} = 2000\Omega$

$R_1 = 2000 - 10 = 1990\Omega = 1.99k\Omega$

At point $Q,\ R_1 + R_2 + 10 = \frac{20}{10^{-3}} = 20000\Omega$

$R_2 + 2000 = 20000$

$\therefore \quad R_2 = 18000\,\Omega = 18\,k\Omega$

At point $R, R_1 + R_2 + R_3 + 10 = \frac{200}{10^{-3}} = 200000\Omega$

$\therefore \quad R_3 = 200000 - 1990 - 180000 - 10 = 180000\Omega = 180\,k\Omega$

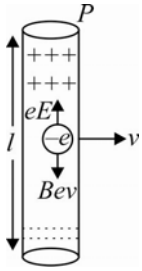
15. **(i)** Let switch K is open and the rod is moved with a speed v then the upper end (P) of the rod becomes positively charged and lower end (Q) becomes negatively charged. Magnetic flux linked with the loop due to motion of rod is given by $\phi_B = Blx$ (x= distance moved by rod)

Hence the induced emf, $\varepsilon = \frac{d\phi_B}{dt} = -Bl\frac{dx}{dt} = -Blv$. Magnitude of induced emf, $\varepsilon = Blv$

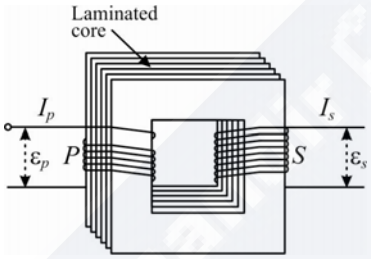
(ii) In the state when K is open very soon a state is reached when force due to electric field which is due to potential difference induced balance the magnetic force on electrons.

$eE = Bev$,

(iii) If B is parallel to rails, the induced/motional emf will be zero.



16. Step-up transformer is a device used for converting low alternating voltage at high current into high alternating voltage at low current and vice-versa. It works on the principle of mutual induction.



It consists of two coils primary and secondary wound on a laminated soft iron core. The input voltage is applied across the primary coil and output voltage is obtained across the secondary coil.

In an ideal transformer, there is no loss o energy or it is 100% efficient. But in actual transformers, wire has some resistance so small energy loses occur. Thus, it may not be 100% efficient.

17. For fringe which $\beta = \lambda D/d$ 5^{th} bright fringe $= 5\beta_1 = 5\lambda_1 D/d = \dfrac{5\times 480\times 10^{-9}\times 2}{3\times 10^{-3}} = 16\times 10^{-4} m$

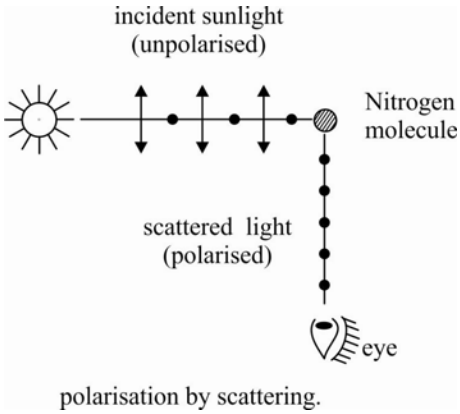
5^{th} bright fringe $= 5\beta_2 = 5\lambda_2 D/d = \dfrac{5\times 600\times 10^{-9}\times 2}{3\times 10^{-3}} = 20\times 10^{-4} m$

$\therefore$ Distance between two 5^{th} bright fringes $= (20-16)\times 10^{-4} = 4\times 10^{-4} m$

18. Light from the sun is unpolarised means that the electric field vector takes all possible directions in the transverse plane, rapidly and randomly during a measurement.

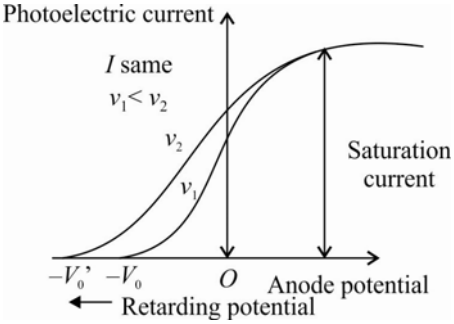
Let us look at the blue portion of the sky through a polaroid and rotate the polaroid, the transmitted light shows rise and fall of intensity. This shows that blue light received is a plane polarized.

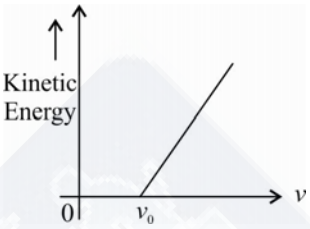
This is because sunlight gets scattered when it encounters the molecules of the earth's atmosphere. The scattered light seen in a direction perpendicular to the direction fi incidence is found to be plane polarized.



polarisation by scattering.

19. If radiations of same intensity I but different frequencies v_1 and v_2 are incident on photon cell then it is found that photoelectric current produced is same but the stopping potentials V_0 and V'_0 are different at different frequencies. So it follows that maximum kinetic energy with which photoelectrons are emitted depends only upon the frequency of incident light. "The number of photoelectrons emitted i.e., photoelectric current, is independent of the frequency of the incident light and depends only upon its intensity".





(i) Davisson and Germer experiment confirms the existence of wave nature of electrons.

The an electron of charge e, mass m accelerated through a potential difference of V volts, then kinetic energy K is to

$\therefore \quad K = eV$

$$K = \frac{p^2}{2m} \qquad \therefore p = \sqrt{(2mK)} = \sqrt{2meV}$$

The de Broglie wavelength λ of the electron is $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2meV}}$

(ii) For same kinetic energy $\lambda \propto \frac{1}{\sqrt{m}}$

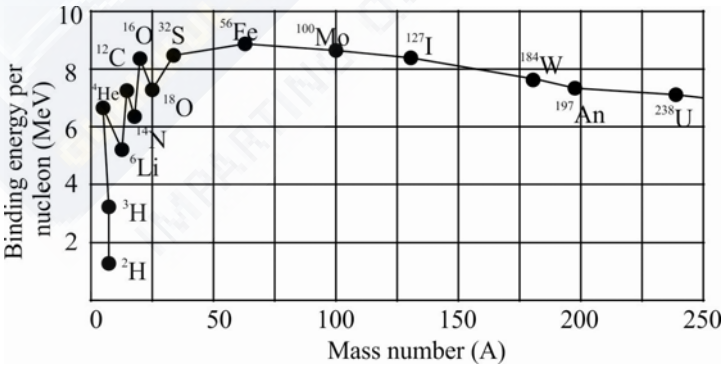
As mass of proton is greater than that of electron, So proton has the shorter de Broglie wavelength.

20. $E = \frac{hc}{\lambda} = \frac{6.65\times10^{-34}\times3\times10^{8}}{620\times10^{-9}} = 3.2\times10^{-19}\,J = \frac{3.0\times10^{-19}}{1.6\times10^{-19}} = 2eV$

The energy for the transition $D = -1-(-3) = 2eV$

$\therefore$ This corresponds to the transition 'D'

21. **(a)** Binding energy per nucleon versus mass number (A) curve



Conclusions

(i) Nuclear forces are strong and attractive in nature

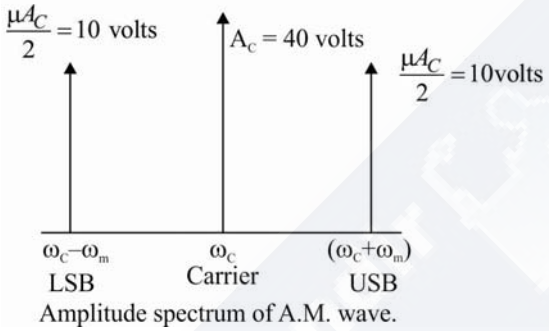
(ii) Nuclear force is a short ranged force.

Explanation of fusion: when two very light nuclei (A < 10) fuse to form a heavy nucleus, the BE/A of fused heavier nucleus is more than the binding energy per nucleon of lighter nuclei. This implies release of energy.

Energy released in nuclear fission: A very heavy nucleus, say A = 240, has lower binding energy per nucleon as compared to a nucleus with A = 120. Thus, if somehow a nucleus having A = 240 breaks into two nuclei, each having mass number A = 120. Then energy would be released in the process.

22. **(i)** Modulation index $\mu = \frac{A_m}{A_c} = \frac{20}{40} = 0.5$

(ii) The side band are $(\omega_C \pm \omega_m) = (2000 \pm 20)\,KHz = 2020 KHz$ and (1980) KHz



Amplitude spectrum of A.M. wave.

[SECTION D]

23. **(i)** Deepak have critical thinking and he is hard working.

(ii) One should not touch electrical appliances with wet hands while working with them.

(iii) $I_A = \frac{E}{r + R + R_A}$

For and ideal ammeter $R_A = 0$

$\therefore\ I = \frac{E}{r + R}$

Percentage error $= \left(\frac{I - I_A}{I}\right) \times 100 = \left(\frac{R_A}{R + r + R_A}\right) \times 100$

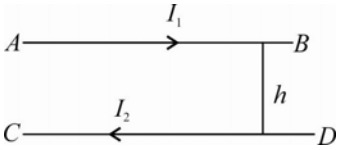
[SECTION E]

24. **(a)** The conduction for the particle in electric and magnetic field is $qE = q\ vB$

$$v = \frac{E}{B}$$

The trajectory becomes helical about the direction of magnetic field in the absence of electric field.

(b) When two parallel infinite straight wires carrying currents I_1 and I_2 are placed at distance h from each other, then current I_1 products magnetic field around it, which at any point on current I_2 carrying wire is



$B_1 = \frac{\mu_0 I_1}{2\pi h}$ directed inwards perpendicular to plane of wires.

So, current I_2 carrying wire then experiences force due to this magnetic field which on its length l is given by $F = I_2 l B_1 \sin 90° = l_2 l \times \frac{\mu_0 l_1}{2\pi h}$ Or $F = \frac{\mu_0 I_1 I_2}{2\pi h} l$

So, force per unit length that each wire exerts on the other is $f = \frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi h}$

At equilibrium magnetic force per unit length = mass per unit length $\therefore$ $\frac{\mu\ I_1 I_2}{2\pi h} = \frac{m}{l} g$

OR

(a) According to Bohr quantization condition

For H_2 atom $n = 1,\ \therefore v = \frac{h}{2\pi mr}$

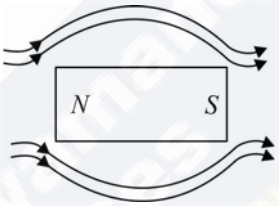
Time period $T = \frac{2\pi r}{v}$ $\therefore\ T = \frac{4\pi^2 mr^2}{h}, I = \frac{Q}{T} = \frac{eh}{2\pi mr}$

Orbital magnetic moment of the electron $M = IA$

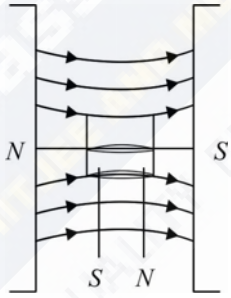
$$M = \left(\frac{eh}{4\pi^2 mr^2}\right)\left(\pi r^2\right) \ \therefore \ \ M = \frac{eh}{4\pi m}$$

(b) The magnetic field lines for a current carrying solenoid when rod made of

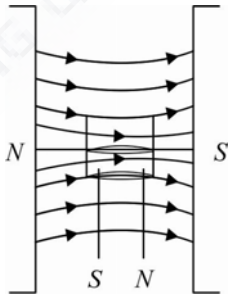
(i) Copper (Diamagnetic substance)



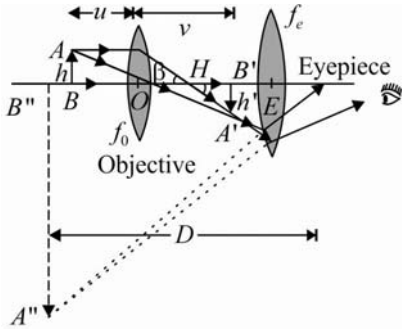
(ii) Aluminium (Paramagnetic substance)



(iii) Iron (Ferromagnetic substance)



25. **(a)**



(b) Magnifying power of eyepiece lens is $m_c = 1 + \frac{25}{5} = 6$

Magnifying power objective lens is $m_0 = \frac{30}{m_c} = \frac{30}{6} = 5$

$$m_0 = \frac{v_0}{-u_0} \quad \therefore v_0 = -5u_0$$

$$\frac{1}{f_0} = \frac{1}{v_0} - \frac{1}{u_0} \quad \therefore f_0 = -\left(\frac{5}{6}\right)u_0$$

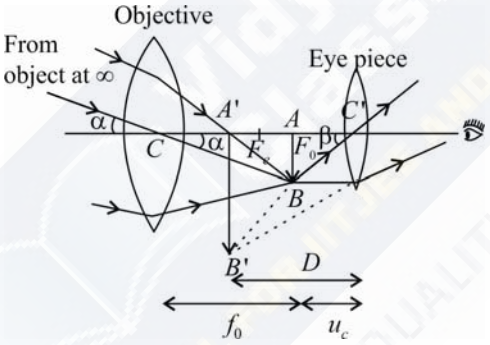
$$u_0 = -1.5cm,\ v_0 = -5 \times 1.5 = -7.5cm$$

$\because$ $\frac{1}{u_e} = \frac{1}{v_e} - \frac{1}{f_e} = \frac{1}{-25} - \frac{1}{5} = \frac{-6}{25}$ $\therefore$ $u_e = -4.17cm$

$\therefore$ Length of the tube $= \mu_e + v_0 = 11.67cm$

OR

(a)



(b) The angular magnification is given as

$$m = \frac{f_0}{f_e};\ f_0 = 5f_e$$

The separation between the objective and eyepiece,

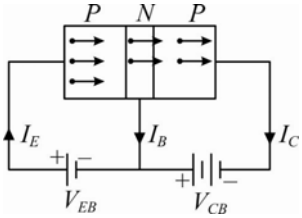
$$L = f_0 + f_e = 36$$

Focal length of eyepiece $f_e = \frac{36}{6} = 6cm$

Focal length of objective lens $\therefore$ $f_0 = 5 \times 6 = 30cm$

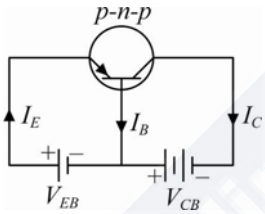
26. **(a)** Action of p –n-p transistor

The forward bias of the emitter-base circuit repels the holes of emitter towards the base. As the base is very thin and lightly doped, most of the holes $(\approx 95\%)$ entering it pass on to collector while a very few of them $(\approx 5\%)$ recombine with the electrons of the base region.



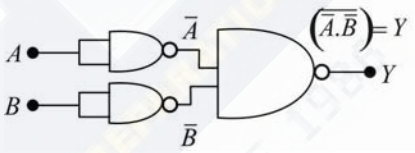
As soon as a hole combines with an electron, an electron from the negative terminal of the battery V_{EB} enters the base. This sets up a small base current I_B. Holes entering the collector region see the negative terminal of the battery V_{CB} and hence they easily reaches the collector terminal. This creates collector current I_C . Both the base current I_B and collector current I_C combine to from emitter current I_E.

$\therefore \quad I_E = I_B + I_C$



(b) By De-Morgna's theorem

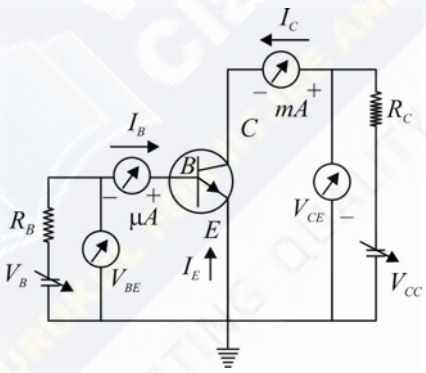
$$\left(\overline{A}\overline{B}\right) = \overline{\overline{A}} + \overline{\overline{B}} = A + B$$



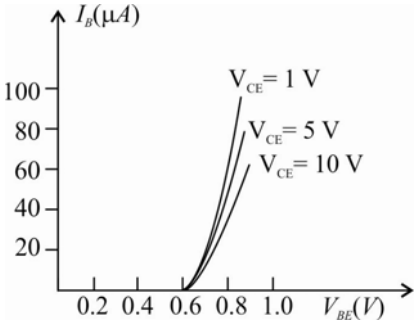
So, the given logic circuit acts as OR gate.

A	B	$\overline{A}$	$\overline{B}$	$\overline{A}.\overline{B}$	$\overline{\overline{A}.\overline{B}} = Y$
0	0	1	1	1	0
0	1	1	0	0	1
1	0	0	1	0	1
1	1	0	0	0	1

OR



(a) Input characteristics : Input characteristic means we have to plot the graphical representation between I_B and V_{BE}. V_{BE}. Is the emitter to base voltage or the forward bias voltage and I_B is the base current. In this forward biasing, *E* is at lower potential then *B*. We will be plotting I_B versus V_{BE} because base is at higher potential than emitter, so that will be reflected here. Now go on varying $V_{BE.}$ For silicon diode we have knee voltage, current will rise sharply. The input characteristic will be different if we go on increasing the V_{CE}. It will be shifting right, means for the same V_{BE} we will be getting lower input current I_B.



Input resistance (r_1): This is defined as the ratio of change in base-emitter voltage (ΔV_{BE}) to the resulting change in base current (Δl_B) at constant collector-emitter voltage (V_{CE}). This is dynamic (ac resistance) and as its value varies with the operating current in the transistor.

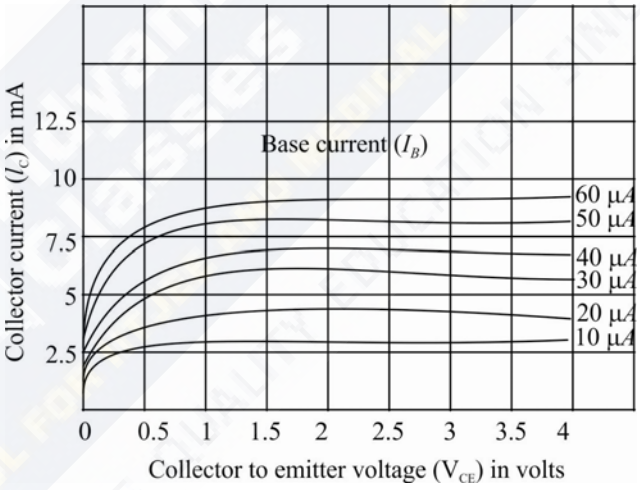
$$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$$

(b) Output characteristics: A graph showing the variation of collector current I_C with collector emitter voltage V_{CE} at constant base current I_B is called the output characteristic of the transistor.

A study of these curves reveals the following features:

(i) When the voltage V_{CE} increases from 0 to about 0.2 *V*, the collector current I_C increases rapidly.

(ii) Once the voltage V_{CE} exceeds the knee voltage the output current I_C varies very slowly but linearly with V_{CE} for a given base current I_B.



(iii) Output resistance (r_0): This is defined as the ratio of change in collector –emitter voltage (ΔV_{CE}) to the change in collector current (ΔI_C) at a constant base current I_B.

$$r_0 = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)_{I_B}$$

In the output characteristic current amplification factor is defined as the ratio of the change in collector current to the change in base current at a constant collector – emitter voltage (V_{CE}) when the transistor is in active state $\beta_{ac} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$

This is also known as small signal current gain and its value is very large.