

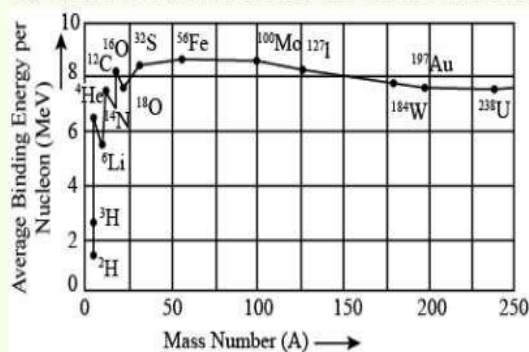
Class: XII
SESSION:2023-2024
MARKING SCHEME
HBSE SAMPLE QUESTION PAPER (THEORY)
SUBJECT: PHYSICS

Q.no		Marks
	SECTION A	
1	(iv) ZERO	1
2	(iv) Potential difference applied across the conductor	1
3	(ii) material A is germanium and material B is copper	1
4	(ii) low resistances	1
5	(i) decreases	1
6	(ii) increases	1
7	(iv) none	1
8	(iv) Both Electric and magnetic field vectors are parallel to each other.	1
9	(ii) between f and $2f$, between optical center and f	1
10	(i) decreases	1
11	(iii) 3000 \AA	1
12	(iv) $4.77 \times 10^{-10} \text{ m}$	1
13	(ii) The nuclear force is much weaker than the Coulomb force.	1
14	(ii) Convex lens of focal length 10 m	1
15	(d) Both A and R is incorrect	1
16	c) A is true but R is false	1
17	a) Both A and R are true and R is the correct explanation of A	1
18	c) A is true but R is false	1
	SECTION B	
19	λ_1 - Microwave λ_2 - ultraviolet	1 1
20	A diamagnetic B-paramagnetic	1 1
21	<p>THE MAGNETIC FIELD AT ANY POINT DUE TO AN ELEMENT OF A CONDUCTOR CARRYING CURRENT IS</p> <p>(1) DIRECTLY PROPORTIONAL TO (A) THE STRENGTH OF THE CURRENT I</p> <p>(b) LENGTH OF THE ELEMENT dL</p> <p>(c) sine of the angle θ BETWEEN THE ELEMENT IN THE DIRECTION OF CURRENT</p> <p>(2) INVERSELY PROPORTIONAL TO THE SQUARE OF THE DISTANCE r OF THE POINT</p> <p>OR</p> <p>Ampere's circuital law states that "THE LINE INTEGRAL OF THE MAGNETIC FIELD SURROUNDING CLOSED-LOOP EQUALS TO THE NUMBER OF TIMES THE ALGEBRAIC SUM OF CURRENTS PASSING THROUGH THE LOOP."</p>	2

22	Moving coil galvanometers work on the principle that a current-carrying coil experiences torque when placed in a magnetic field. As the electric current is passed through the coil, a torque acts on it, which deflects the coil.	2
23	<p>The masses are in the ratio $m_p : m_d : m_\alpha = 1 : 2 : 4$</p> <p>As the momentum is same we get the velocity in the ratio $v_p : v_d : v_\alpha = 4 : 2 : 1$</p> <p>For a charged particle in uniform magnetic field, we can write,</p> $\frac{mv^2}{r} = Bqv$ <p>If +e is the charge on proton, then charge on deuteron is also +e and charge on alpha particle is +2e.</p> <p>Thus charges are in the ratio $q_p : q_d : q_\alpha = 1 : 1 : 2$</p> <p>For a proton, a deuteron and an alpha-particle are moving with same momentum in a uniform magnetic field</p> $f_p : f_d : f_\alpha = eBv : eBv : 2eBv$ <p>As B is same we get</p> $f_p : f_d : f_\alpha = 2 : 1 : 1$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$
24	<p>Angular width $2\phi = 2\lambda/d$ Given</p> <p>$\lambda = 6000 \text{ \AA}$, $d = 2 \times 10^{-2}$</p> <p>$= 2 \times 6000 / 2 \times 10^{-2}$</p> <p>$= 600000 \text{ \AA}$</p>	1 1
25	<p>The minimum distance between the centre of the nucleus and the alpha particle just before it gets reflected back through 180° is defined as the distance of closest approach r_0 (also known as contact distance).</p> $r_0 = \frac{1}{4\pi\epsilon_0} \frac{2Ze^2}{\frac{1}{2}mv_0^2} = \frac{1}{4\pi\epsilon_0} \frac{2Ze^2}{E_k}$ <p>OR</p> <p>Rutherford's alpha(α) particles scattering experiment' resulted into the discovery of nucleus of an atom. That is, during his experiment, he found that, most space of an atom is empty, and he could find a small positively charged center in an atom which is called as the nucleus.</p>	1 1
SECTION C		

26	<p>Surface charge density of plate A = $+17.7 \times 10^{-22} \text{ C/m}^2$</p> <p>Surface charge density of plate B = $-17.7 \times 10^{-22} \text{ C/m}^2$</p> <p>(a) In the outer region of plate I, electric field intensity E is zero.</p> <p>(b) Electric field intensity E in between the plates is given by relation</p> $E = \frac{\sigma}{\epsilon_0}$ <p>Where, ϵ_0 = Permittivity of free space = $8.85 \times 10^{-12} \text{ N}^{-1} \text{ C}^2 \text{ m}^{-2}$</p> $\therefore E = \frac{17.7 \times 10^{-22}}{8.85 \times 10^{-12}}$ <p>Therefore, electric field between the plates is $2.0 \times 10^{-10} \text{ N/C}$.</p>	2 1
27	<p>Lawsofphotoelectricemission:(anythree)</p> <p>(i) Thereisadefinitecutoffvalueoffrequencybelowwhichelectrons cannotbeejectedbyanysubstance.</p> <p>(ii) Numberofemittedelectronsaredirectlyproportionalto theintensityoflightincident.</p> <p>(iii) Kineticenergyofemittedelectronsdependsonthe frequencyofincidentlightonsubstance.</p> <p>(iv) Thereisnotimeloggingbetweentheincidentoflightand emissionofelectrons.</p>	1+1+1

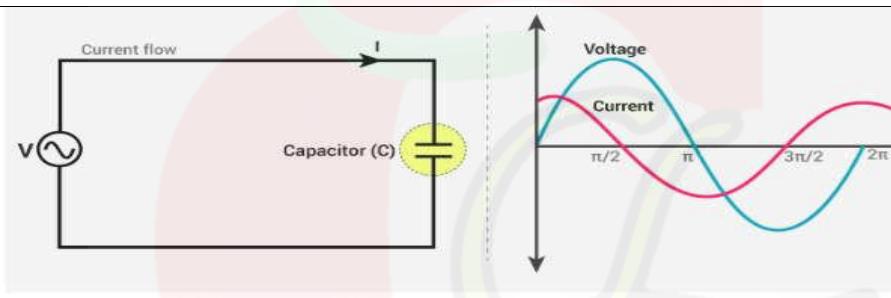
28



When we move from the heavy nuclei region to the middle region of the plot, there is a gain in the overall binding energy and hence release of energy. This indicates that energy can be released when a heavy nucleus ($A \approx 240$) breaks into two roughly equal fragments. This process is called nuclear fission.

Similarly, when we move from lighter nuclei to heavier nuclei, we again find that there is a gain in the overall binding energy and hence release of energy. This indicates that energy can be released when two or more lighter nuclei fuse together to form a heavy nucleus. This process is called nuclear fusion.

29



For the given capacitor we can write,

$$v = \frac{q}{C}$$

According to Kirchhoff's rule, we can write from the above circuit,

$$v_m \sin \omega t = \frac{q}{C}$$

The current through the circuit can be calculated using the relation,

$$i = \frac{dq}{dt}$$

$$\Rightarrow i = \frac{d(v_m C \sin \omega t)}{dt} = \omega C v_m \cos \omega t$$

$$\Rightarrow i = i_m \sin(\omega t + \frac{\pi}{2}) \quad [\text{Using the relation, } \cos \omega t = \sin(\omega t + \frac{\pi}{2})]$$

OR

The instantaneous value of alternating voltage applied $V = V_0 \sin \omega t$ (i)

If i is the instantaneous current in the circuit and $\frac{di}{dt}$

the rate of change of current in the circuit at that instant, then instantaneous induced emf

$$\epsilon = -L \frac{di}{dt}$$

According to Kirchhoff's loop rule

$$V + \epsilon = 0 \Rightarrow V - L \frac{di}{dt} = 0$$

$$V = L \frac{di}{dt}$$

Integrating with respect to time 't':

$$di = V \sin \omega t dt / L$$

$$= V_0 / L \int \sin \omega t dt$$

$$= V_0 \cos \omega t / L$$

$$i = V_0 \sin(\omega t - \pi/2) / L$$

This is required expression for Current

$$i = i_0 \sin(\omega t - \pi/2)$$

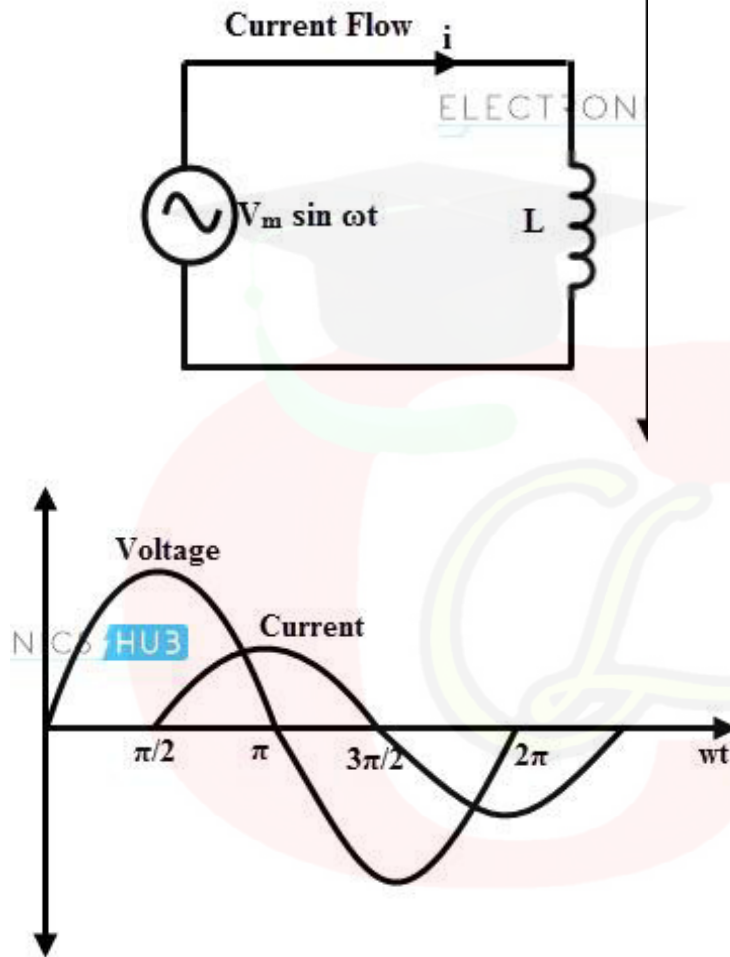
i_0 is the peak value of alternating current

Also

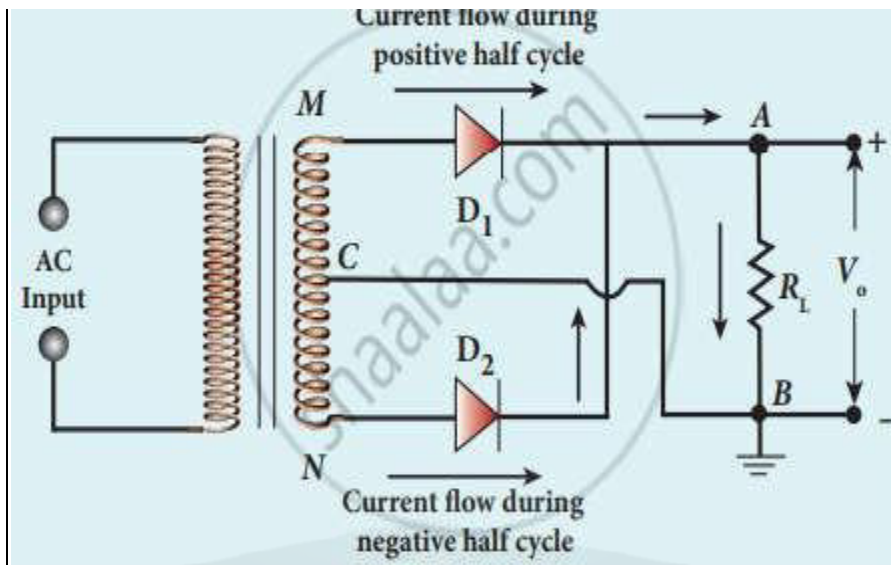
current lags

an angle $\pi/2$

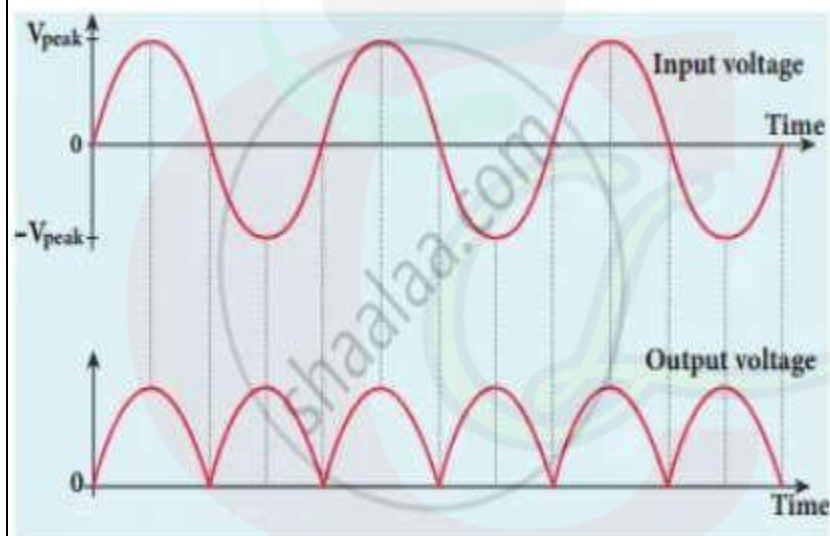
comparing , we note that
behind the applied voltage by



30	<p>First Postulate: Electron revolves round the nucleus in discrete circular orbits called stationary orbits without emission of radiant energy. These orbits are called stable orbits or non-radiating orbits.</p> <p>Second Postulate: Electrons revolve around the nucleus only in orbits in which their angular momentum is an integral multiple of $h/2\pi$.</p> <p>Third Postulate: When an electron makes a transition from one of its non-radiating orbits to another of lower energy, a photon is emitted having energy equal to the energy difference between the two states. The frequency of the emitted photon is then given by, $\nu = \frac{E_i - E_f}{h}$</p>	1 1 1
	SECTION- D	
31	<p>p–n junction diode allows electric charges to flow in one direction, but not in the opposite direction; negative charges (electrons) can easily flow through the junction from n to p but not from p to n, and the reverse is true for holes.</p> <p>The processes that follow after forming a P-N junction are of two types – diffusion and drift. There is a difference in the concentration of holes and electrons at the two sides of a junction. The holes from the p-side diffuse to the n-side, and the electrons from the n-side diffuse to the p-side</p> <p>Drift is the process of movement of charge carriers due to the net electric field. In a pn-junction with no external source, electric field is from n-side to p-side and hence electrons drift from p-side to n-side.</p> <p style="text-align: center;">OR</p>	2 1.5 1.5



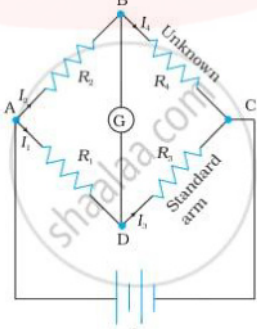
Full-wave rectifier circuit



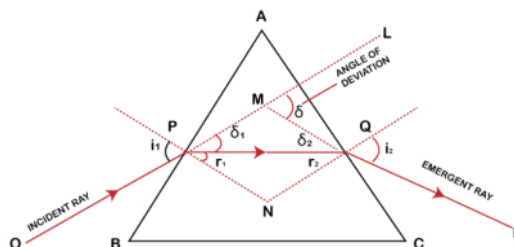
Working of Full Wave Rectifier

During the positive half cycle, diode D_1 is forward biased as it is connected to the top of the secondary winding while diode D_2 is reverse biased as it is connected to the bottom of the secondary winding. Due to this, diode D_1 will conduct as a short circuit and D_2 will not conduct as an open circuit.

During the negative half cycle, the diode D_1 is reverse biased and the diode D_2 is forward biased because the top half of the secondary circuit becomes negative and the bottom half of the circuit becomes positive. Thus in a full-wave rectifier, DC voltage is obtained for both positive and negative half cycles.

32(a)	<p>Drift velocity : IT IS THE AVERAGE VELOCITY ACQUIRED by THE FREE ELECTRONSSUPERIMPOSED OVER THE RANDOM MOTION IN THE DIRECTION OPPOSITE TO ELECTRIC FIELD AND ALONG THE LENGTH OF THE METALLIC CONDUCTOR. LET n = number of free electrons per unit volume, v_d = Drift velocity of electrons TOTAL number of free electrons passing through A cross section in unit time $N/t = nvd$ So, TOTAL CHARGE passing through A cross section in unit time i.e., current $= Q/t = nvdA$</p>	2
32(b)	<p>Then, $V = \varepsilon_1 - I_1 r_1 \Rightarrow I_1 = \frac{\varepsilon_1 - V}{r_1}$</p> <p>Similarly, for cell ε_2 $I_2 = \frac{\varepsilon_2 - V}{r_2}$</p> <p>Putting these values in equation (i)</p> $I = \frac{\varepsilon_1 - V}{r_1} + \frac{\varepsilon_2 - V}{r_2}$ <p>or $I = \left(\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} \right) - V \left(\frac{1}{r_1} + \frac{1}{r_2} \right)$</p> <p>or $V = \left(\frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2} \right) - I \left(\frac{r_1 r_2}{r_1 + r_2} \right) \dots (ii)$</p> <p>Comparing the above equation with the equivalent circuit of emf 'ε_{eq}' and internal resistance 'r_{eq}' then,</p> $V = \varepsilon_{eq} - I r_{eq} \dots (iii)$ <p>Then</p> <p>(i) $\varepsilon_{eq} = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}$ (ii) $r_{eq} = \frac{r_1 r_2}{r_1 + r_2}$</p> <p>(iii) The potential difference between A and B</p> $V = \varepsilon_{eq} - I r_{eq}$	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>
	<p>OR</p> <p>KIRCHHOFF'S FIRST RULE—THE JUNCTION RULE: THE sum of ALL CURRENTS ENTERING A junction must EQUAL THE sum of ALL CURRENTS LEAVING THE junction. KIRCHHOFF'S SECOND RULE—THE LOOP RULE: THE ALGEBRAIC sum of CHANGES IN POTENTIAL around ANY CLOSED CIRCUIT PATH (LOOP) must BE ZERO</p>	2
		<p>1</p> <p>2</p>
	<p>Derivation of balanced equation using kirchoff's law</p>	

33(a) A = Prism angle,
 δ = Angle of deviation,
 i_1 = Angle of incidence,
 i_2 = Angle of emergent.



In the case of minimum deviation, $\angle r_1 = \angle r_2 = \angle r$

$$A = \angle r_1 + \angle r_2$$

$$\text{SO, } A = \angle r + \angle r = 2\angle r$$

$$\angle r = A/2$$

Now, again

$$A + \delta = i_1 + i_2 \quad (\because \text{In the case of minimum deviation } i_1 = i_2 = i \text{ and } \delta = \delta_m)$$

$$\text{So, } A + \delta_m = i + i = 2i$$

$$\text{Now, } i = (A + \delta_m)/2$$

Now, from Snell's rule,

$$\mu = \sin i / \sin r$$

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

(b)

The incident ray is normal to the face AB.

Thus we get $i_1 = 0^\circ$ and $r_1 = 0^\circ$

Now this ray would refract at the face AC with the incident angle here as r_2 and the emergence angle as e .

We know that Angle of prism A is given as $r_1 + r_2$. Thus we get $r_2 = 60^\circ$

Now Refractive index of the prism is given as $\mu = \frac{\sin e}{\sin r_2}$

or

$$\frac{2}{\sqrt{3}} = \frac{\sin e}{\sin 60^\circ}$$

Thus we get $e = 90^\circ$

And angle of deviation is given as

$$\delta = i_1 + e - A = 30^\circ$$

OR

(i) Given, angle of minimum deviation, $\delta_m = 30^\circ$

Angle of prism, $A = 60^\circ$

By prism formula, refracted index

$$\mu = \frac{\sin \frac{\delta_m + A}{2}}{\sin \frac{A}{2}} = \frac{\sin \frac{30^\circ + 60^\circ}{2}}{\sin \frac{60^\circ}{2}} = \frac{\sin 45^\circ}{\sin 30^\circ}$$

$$= \frac{1}{\sqrt{2}} \times 2 = \sqrt{2}$$

Also, $\mu = \frac{\text{speed of light in vacuum (c)}}{\text{speed of light in prism (v)}}$

$$\Rightarrow v = c/\mu = (3 \times 10^8 / \sqrt{2}) \text{ m/s}$$

Hence, speed of light through prism is $(3 \times 10^8 / \sqrt{2}) \text{ m/s}$

(ii) Critical angle i_c is given as,

$$\sin i_c = \frac{1}{\sqrt{2}} \quad [\because \sin i_c = \frac{1}{\mu}]$$

$$\Rightarrow i_c = 45^\circ$$

$$A = r + i_c = 60^\circ$$

$$\Rightarrow r = 60^\circ - 45^\circ = 15^\circ$$

$$\frac{\sin i}{\sin r} = \sqrt{2} \quad (\text{using Snell's law})$$

$$\Rightarrow \sin i = \sqrt{2} \sin r = \sqrt{2} \times \sin 15^\circ$$

$$i = \sin^{-1} (\sqrt{2} \sin 15^\circ)$$

SECTION E

34 a)	$q = Ne$(1) where, N is number of electrons present on the body, e is the charge on an electron Step 2: Substitute the values From equation (1) $-1 \times 10^{-9} \text{C} = -1.6 \times 10^{-19} \text{C} \times N$ $N = \frac{10^{-9}}{1.6 \times 10^{-19}} = 6.25 \times 10^9 \text{ electrons.}$	1
(b)	Scalar Charge, $Q = 3.2 \times 10^{-7} \text{ C}$ Charge on the electron, $e = 1.6 \times 10^{-19} \text{ C}$ Therefore, Number of electron transferred is given by,	1
(c)	$n = \frac{Q}{e} = \frac{3.2 \times 10^{-7}}{1.6 \times 10^{-19}} = 2 \times 10^{12}.$ OR Definition of Charge.	2
35a	Self-Inductance is the tendency of a coil to resist changes in current in itself	1
b)	Self-inductance depends on- 1-Size of coil 2-Shape of the coil 3- Area Area of the coil 4- Medium Medium	1
c)	$\therefore \text{Induced emf, } e = - \frac{di}{dt}$ Given, $L = 10 \text{ H}$, $\Delta i = 9 - 4 = 5 \text{ A}$, $dt = 0.2 \text{ s}$ $\text{emf, } e = 10 \times \frac{5}{0.2} = 250 \text{ V}$ OR Statement of Lenz's Law.	2