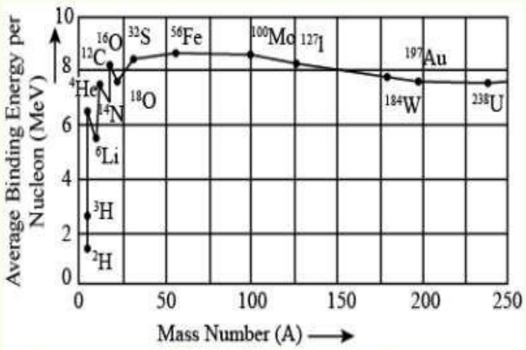
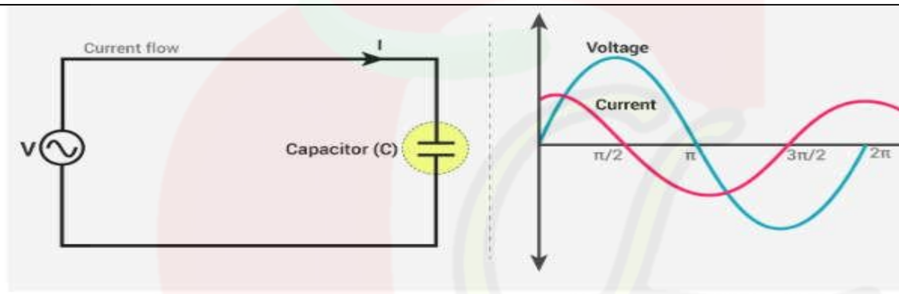
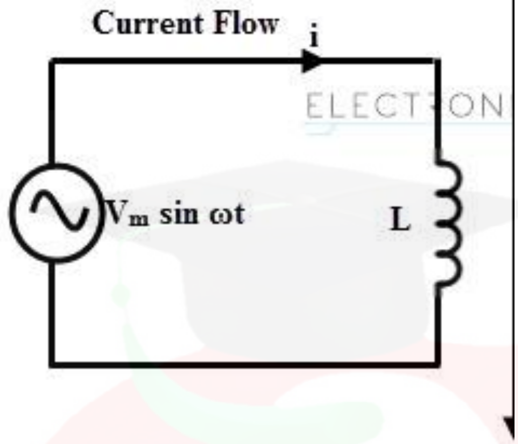
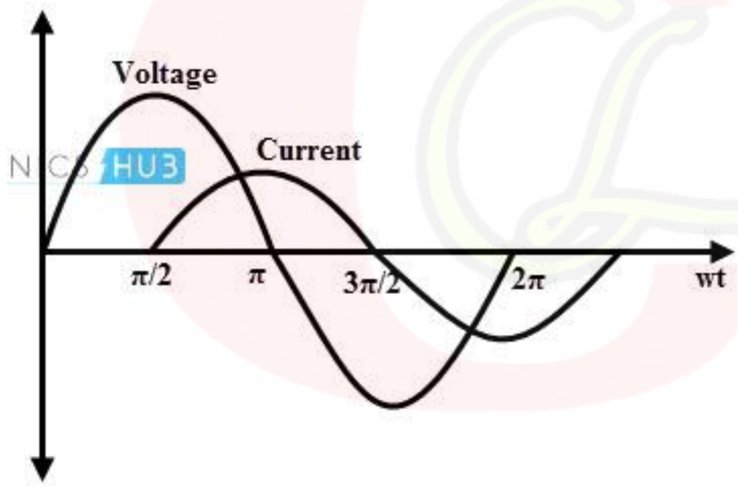
Class: XII
SESSION:2023-2024
MARKING SCHEME
HBSESAMPLEQUESTIONPAPER(THEORY)
SUBJECT:PHYSICS

Q.no		Marks
	SECTIONA	
1	(iv)ZERO	1
2	(iv)Potentialdifferenceappliedacrosstheconductor	1
3	(ii)materialAis germaniumandmaterialBiscopper	1
4	(ii)lowresistances	1
5	(i)decreases	1
6	(ii)increases	1
7	(iv)none	1
8	(iv)Both electric and magnetic field vectors are parallel to eachother.	1
9	(ii)betweenf and2f,betweenopticalcenterandf	1
10	(i)decreases	1
11	(iii)3000Å	1
12	(iv)$4.77X10^{-10}$m	1
13	(ii) Thenuclearforceismuchweakerthanthe Coulombforce.	1
14	(ii)convexlensoffocallength10metre	1
15	(d)Both A and R is incorrect	1
16	c)AistruebutR isfalse	1
17	a)Both AandR aretrueandRIsthecorrectexplanationofA	1
18	c)Ais true butRisfalse	1
	SECTIONB	
19	λ_1-Microwaveλ_2 ultraviolet	1 1
20	A diamagneticB-paramagnetic	1 1
21	The magnetic field at any point due to an element of a conductor carrying current is (1) directly proportional to (a) the strength of the current i (b) length of the element dl (c) sine of the angle θ between the element in the direction of current (2) inversely proportional to the square of the distance r of the point OR Ampere's circuital law states that "the line integral of the magneticfield surrounding closed-loop equals to the number of times thealgebraicsumofcurrentspassing throughtheloop."	2

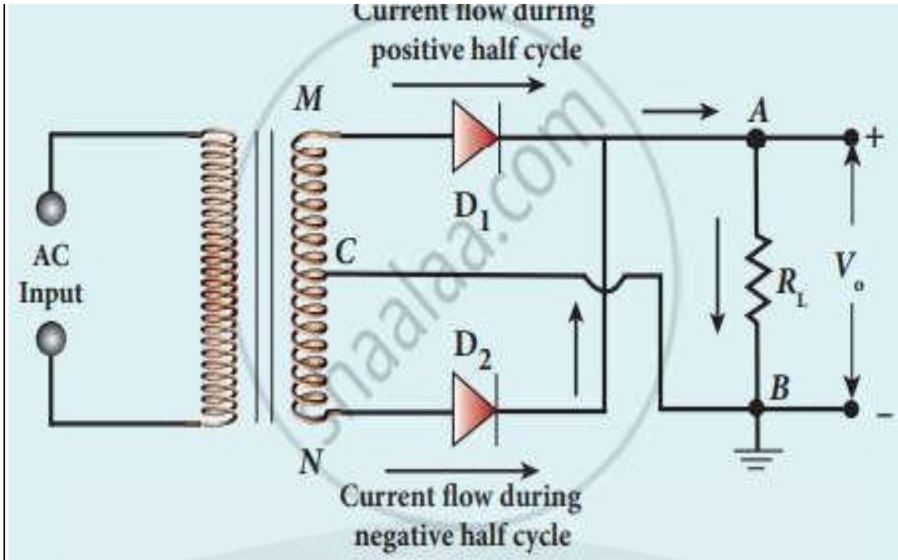
22	Moving coil galvanometers work on the principle that a current-carrying coil experiences torque when placed in a magnetic field. Asthe electric current is passed through the coil, a torque acts on it,which deflectsthe coil.	2
23	The masses are in the ratio $m_p : m_d : m_\alpha = 1 : 2 : 4$ As the momentum is same we get the velocity in the ratio $v_p : v_d : v_\alpha = 4 : 2 : 1$ For a charged particle in uniform magnetic field, we can write, $\frac{mv^2}{r} = Bqv$ If +e is the charge on proton, then charge on deutron is also +e and charge on alpha particle is +2e. Thus charges are in the ratio $q_p : q_d : q_\alpha = 1 : 1 : 2$ For a proton, a deutron and an alpha-particle are moving with same momentum in a uniform magnetic field $f_p : f_d : f_\alpha = eBv : eBv : 2eBv$ As B is same we get $f_p : f_d : f_\alpha = 2 : 1 : 1$	½ ½ ½ ½
24	Angularwidth2φ=2λ/dGiven λ=6000Å, d=2x10^{-2} =2x6000/2x10^{-2} =600000Å	1 1
25	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 ro (also known as contact distance). $r_0 = \frac{1}{4\pi\varepsilon_0}\frac{2Ze^2}{\frac{1}{2}mv_0^2} = \frac{1}{4\pi\varepsilon_0}\frac{2Ze^2}{E_k}$ OR 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.	1 1
	_ SECTIONC	

26	Surface charge density of plate A = +17.7 × 10^{-22} C/m^2 Surface charge density of plate B = -17.7 × 10^{-22} C/m^2 (a) In the outer region of plate I, electric field intensity E is zero. (b) Electric field intensity E in between the plates is given by relation $E = \frac{\sigma}{\epsilon_0}$ Where, ϵ_0 = Permittivity of free space = 8.85 x 10^{-12} N^{-1} C^2 m^{-2} $\therefore E = \frac{17.7\times10^{-22}}{8.85\times10^{-1}}$ Therefore, electric field between the plates is 2.0 x 10^{-10} N/C.	2 1
27	Lawsofphotoelectricemission:(anythree) (i) Thereisadefinitecutoffvalueoffrequencybelowwhichelectronscannotbeejectedbyanysubstance. (ii) Numberofemittedelectronsaredirectlyproportionalto theintensityoflightincident. (iii)Kineticenergyofemittedelectronsdependsonthe frequencyofincidentlightonsubstance. (iv)Thereisnotimeloggingbetweentheincidentoflightand emissionofelectrons.	1+1+1

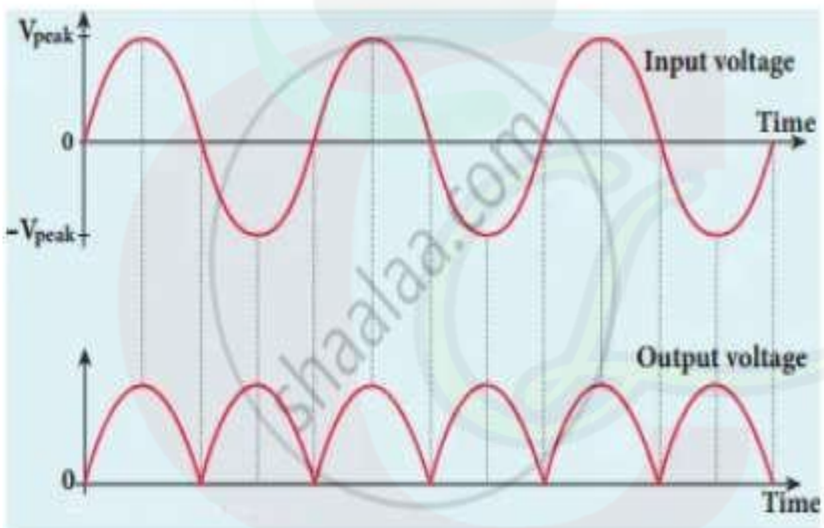
28	 When we move from the heavy nuclei region to the middle region of the plot, there is a gain in the overall binding energy and hence release of energy. This indicates that energy can be released when a heavy nucleus (A ≈ 240) breaks into two roughly equal fragments. This process is called nuclear 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.	1 1 1
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, $i = \frac{dq}{dt}$ $\Rightarrow i = \frac{d(v_m \ C sin \ \omega t)}{dt} = \omega C v_m \ cos \ \omega t$ $\Rightarrow i = i_m sin(\omega t + \frac{\pi}{2}) \ [Using \ the \ relation, \ cos \ \omega t = sin(\omega t + \frac{\pi}{2})]$ OR The instantaneous value of alternating voltage applied V=V0sinωt. ...(i) If i is the instantaneous current in the circuit and dt dt the rate of change of current in the circuit at that instant, then instantaneous induced emf ϵ=−Ldi/dt According to Kirchhoff's loop rule V+e=0⟹V−Ldi/dt=0 V=L di/dt	1 2 2

	Integrating with respect to time 't': di=Vosinwtdt/L =Vo/L ∫sinωtdt =Vowcoswt/L i=Vowsin(wt-π/2)/L This is required expression for Current i=iosin(wt-π/2) io is the peak value of alternating current Also comparing , we note that current lags behind the applied voltage by an angle π/2   	1

30	**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. **Second Postulate:** Electrons revolve around the nucleus only in orbits in which their angular momentum is an integral multiple of $h/2\pi$. **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, $v = \frac{E_i - E_f}{h}$	1 1 1
	SECTION- D	
31	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. 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 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. OR	2 1.5 1.5



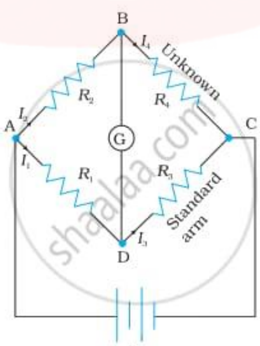
Full-wave rectifier circuit 2



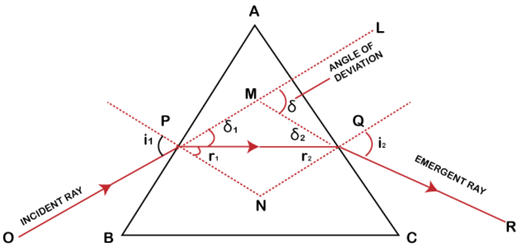
WorkingofFullWaveRectifier

During thepositive half cycle,diodeD_1isforwardbiasedasitis connected tothe topof thesecondarywinding whilediode$D_2$is reverse biased as it is connected to the bottom of the secondary winding. Due tothis,diodeD_1will conductactingasashortcircuitandD_2will notconduct actingasanopencircuit 3

During thenegative half cycle, thediodeD_1isreverse biasedand the diodeD_2isforward biasedbecause the tophalf of thesecondarycircuit becomes negative and the bottom half of the circuit becomes positive.Thus in a full wave rectifiers, DC voltage is obtained for both positive andnegativehalf cycle.

32(a)	Drift velocity : It is the average velocity acquired by the free electronssuperimposed over the random motion in the direction opposite toelectric field and along the length of the metallic conductor. Let n =number of free electrons per unit volume, vd = Drift velocity ofelectrons Total number of free electrons passing through a crosssection in unit time N/t = Anvd So, total charge passing through acrosssectioninunittimei.e.,current,I=Q/t=N/t=Anevd.	2
	Then, $V = \varepsilon_1 - I_1 r_1 \Rightarrow I_1 = \dfrac{\varepsilon_1 - V}{r_1}$	
32(b)	Similarly, for cell ε_2 $\quad I_2 = \dfrac{\varepsilon_2 - V}{r_2}$	½
	Putting these values in equation (*i*) $I = \dfrac{\varepsilon_1 - V}{r_1} + \dfrac{\varepsilon_2 - V}{r_2}$	½
	or $\quad I = \left(\dfrac{\varepsilon_1}{r_1} + \dfrac{\varepsilon_2}{r_2}\right) - V\left(\dfrac{1}{r_1} + \dfrac{1}{r_2}\right)$	1/2
	or $\quad V = \left(\dfrac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}\right) - I\left(\dfrac{r_1 r_2}{r_1 + r_2}\right) \quad ...(ii)$	
	Comparing the above equation with the equivalent circuit of emf 'ε_{eq}' and internal resistance 'r_{eq}' then,	1/2
	$V = \varepsilon_{eq} - I r_{eq} \quad ...(iii)$	1/2
	Then (*i*) $\varepsilon_{eq} = \dfrac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}$ $\quad$ (*ii*) $r_{eq} = \dfrac{r_1 r_2}{r_1 + r_2}$	
	(*iii*) The potential difference between *A* and *B* $V = \varepsilon_{eq} - I r_{eq}$	1/2
	OR	
	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	2
		1
	Derivation of balanced equation using kirchoff's law	2

33(a) A=Prism angle,
δ=Angle of deviation,
i1=Angle of incidence, 1
i2=Angle of emergent.



1

In the case of minimum deviation, ∠r1 = ∠r2 = ∠r
A = ∠r1 + ∠r2
SO, A = ∠r+ ∠r = ∠2r
∠r = A/2
Now, again
A + δ = i1 + i2 (∵ In the case of minimum deviation i1 = i2 = i and δ = δm)
So, A + δm = i + i = 2i
Now, i = A+δm/2
Now, from snell's rule, 1
μ= sin i/sin r
μ=sin((A + δm)/2)/ sin(A/2)

(b) The incident ray is normal to the face AB. 2

Thus we get $i_1 = 0°$ and $r_1 = 0°$

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

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

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

or

$\frac{2}{\sqrt{3}} = \frac{\sin e}{\sqrt{3}/2}$

Thus we get $e = 90°$

And angle of deviation is given as

$\delta = i_1 + e - A = 30^0$

OR

3

	(i) Given, angle of minimum deviation, $\delta_m = 30°$ Angle of prism, $A = 60°$ By prism formula, reflected index $\mu = \dfrac{\sin\dfrac{\delta_m + A}{2}}{\sin A/2} = \dfrac{\sin\dfrac{30° + 60°}{2}}{\sin 30°} = \dfrac{\sin 45°}{\sin 30°}$ $= \dfrac{1}{\sqrt{2}} \times 2 = \sqrt{2}$ Also, $\mu = \dfrac{\text{speed of light in vaccum (c)}}{\text{speed of light in prism (v)}}$ $\Rightarrow v = c/\mu = (3 \times 10^8/\sqrt{2})\, m/s$ Hence, speed of light through prism is $(3 \times 10^8/\sqrt{2})\, m/s$ (ii) Critical angle i_c is given as, $\sin i_c = \dfrac{1}{\sqrt{2}}$ $\quad [\because \sin i_c = \dfrac{1}{\mu}]$ $\Rightarrow \quad i_c = 45°$ $A = r + i_c = 60°$ $\Rightarrow \quad r = 60° - 45° = 15°$ $\dfrac{\sin i}{\sin r} = \sqrt{2}$ (using Snell's law) $\Rightarrow \quad \sin i = \sqrt{2}\, \sin r = \sqrt{2} \times \sin 15°$ $i = \sin^{-1}(\sqrt{2} \sin 15°)$	2

SECTIONE

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) $-1 \times 10^{-9}C = -1.6 \times 10^{-19}C \times N$ $N = \frac{10^{-9}}{1.6 \times 10^{-19}} = 6.25 \times 10^{9}$ electrons.	1
(b)	Scalar	1
(c)	Charge, Q = 3.2×10^{-7} C Charge on the electron, e = 1.6×10^{-19} C Therefore, Number of electron transferred is given by, $n = \frac{Q}{e} = \frac{3.2 \times 10^{-7}}{1.6 \times 10^{-19}} = 2 \times 10^{12}$. OR Defination of Charge.	2
35a	Self-inductance is the tendency of a coil toresist changes in current in itself	1
b)	Selfinductancedependson- 1-Sizeofcoil 2-Shapeofthecoil 3-Materialofthecoil 4-Medim	1
c)	$\because$ Induced emf, $e = -\frac{di}{dt}$ Given, L = 10 H, $\Delta i = 9 - 4 = 5A, dt = 0.2s$ emf, $e = 10 \times \frac{5}{0.2} = 250V$ OR Statement of Lenz's Law.	2