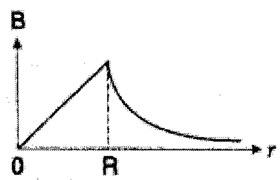
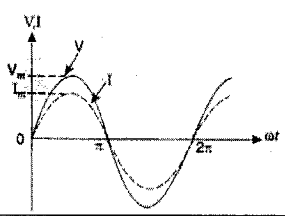
COMMON PRE-BOARD EXAMINATION: 2022-23

Class-XII Subject: PHYSICS (042)

Date: 15/01/2023

MARKING SCHEME

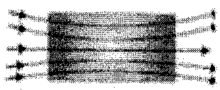
Maximum Marks: 70 Marks

Q.No.		Marks
	SECTION A	
1.	(iv) -1/4	1
2.	(ii) 10 V	1
3.	(i) free electron density in the conductor	1
4.	(ii) 	1
5.	(i) introducing a resistance of large value in series.	1
6.	(i) 1 A	1
7.	(ii) 	1
8.	(ii) anticlockwise	1
9.	(ii) law of conservation of energy	1
10.	(iv) 1 : 9	1
11.	(iii) 1.23 Å	1
12	(iv)$1/n^2$	1
13.	(ii) electrostatic force between protons are repulsive	1
14.	(i) 2A, 200V	1
15.	(iii) C_1/C_2	1
16.	a) Both A and R are true and R is the correct explanation of A	1
17.	b) Both A and R are true and R is NOT the correct explanation of A	1
18.	d) A is false and R is also false	1

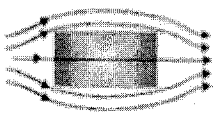
SECTION B

19. Gamma ray has the highest frequency in the electromagnetic waves. (½)
These rays are of the nuclear origin and are produced in the disintegration of radioactive atomic nuclei and in the decay of certain subatomic particles. (1)
They are used in the treatment of cancer and tumours. (½)
2

20.
2



(½)



(½)

Explanation (1)

A paramagnetic material tends to move from weaker to stronger region of the magnetic field passing through it. A diamagnetic material tends to move from stronger to weaker regions of the magnetic field and hence decreases the number of lines of magnetic field passing through it.

21. K.E of electron orbiting in the n=2 state of H-atom is,
2

$$E_k = \frac{13.6}{n^2}\text{eV} = \frac{13.6}{2^2}\text{eV} = 3.14 \times 1.6 \times 10^{-19}\,\text{J}$$ 1

De Broglie wavelength associated with the electron,

$$\lambda = \frac{h}{\sqrt{2mE_k}}$$ ½

$$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 3.4 \times 1.6 \times 10^{-19}}}\,\text{m} = 0.067 \times 10^{-9}\,\text{m} = \mathbf{0.067\ nm}$$ ½

OR

(a) Kinetic energy of the electron is equal to the negative of the total energy.

$\Rightarrow K = -E$

$= -(-3.4) = +3.4$ eV ½

(b) Potential energy (U) of the electron is equal to the negative of twice of its kinetic energy.

$\Rightarrow U = -2K$

$= -2 \times 3.4 = -6.8$ eV ½

(c) The potential energy of a system depends on the reference point taken. Here, the potential energy of the reference point is taken as zero. If the reference point is changed, then the value of the potential energy of the system also changes. Since total energy is the sum of kinetic and potential energies, total energy of the system will also change. 1

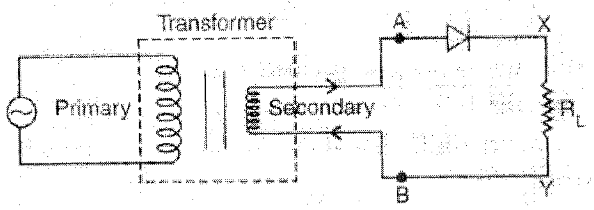
22. $A = 60°, \delta_m = 30°$ — **2**

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{60°+30°}{2}\right)}{\sin\left(\frac{60°}{2}\right)} = \frac{\sin 45°}{\sin 30°} = \sqrt{2}$$ 1

$$\mu = \frac{c}{v} \Rightarrow v = \frac{3\times10^8}{\sqrt{2}} \text{ m/s}$$

$$= 2.122\times10^8 \text{ m/s}$$ 1

23. — **2**

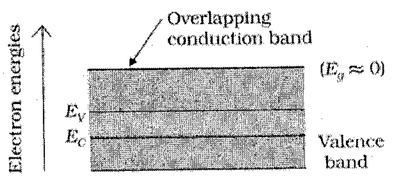


1

Working : During one half of the input a.c., the diode is forward biased and a current flows through R_L . During the other half of the input. a.c., the diode is reverse biased and no current flows through the load R_L. Hence, the given a.v. input is rectified. 1

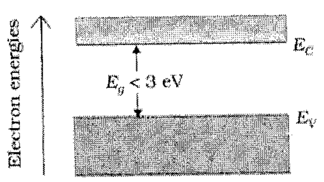
OR

<u>Metals</u>



1

<u>Semiconductors</u>



1

24. Any two conditions (½ + ½) — **2**

The conditions for sustained or permanent interference is as follows-

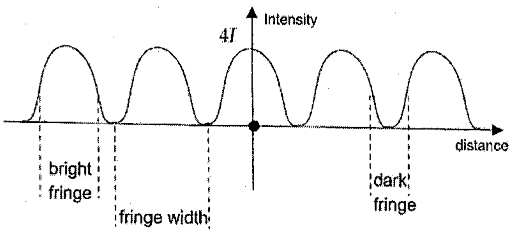
(i) The two sources of light must be coherent which means the two light waves emitted by them must have a constant phase difference or in the same phase.

(ii) The two sources must emit light of the same wavelength but the amplitudes between them should differ as little as possible. The emitted waves should be preferably of the same amplitude to get completely dark fringes.

(iii) The two sources should be very narrow. Otherwise with the increase of slit width, the coherence property will be lost. Hence, no interference pattern will be obtained.

(iv) The two sources must lie very close to each other. Otherwise overlapping of bright and dark points will hinder interference.

(v) At maxima, the path difference between two light waves is always an even multiple of $\lambda/2$ and at minima, it is an odd multiple of $\lambda/2$.



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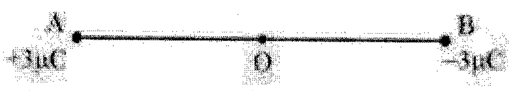
25. [finding directions of E_1 and E_2 – 1 mark
Net E -1] — **2**



Distance between the two charges, AB = 20 cm

∴ AO = OB = 10 cm

Net electric field at point O = E

Electric field at point O caused by +3μC charge,

$$E_1 = \frac{1}{4\pi\varepsilon_0}\cdot\frac{3\times10^{-6}}{(OA)^2} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{3\times10^{-6}}{(10\times10^{-2})^2}\ NC^{-1}\quad along\ OB$$

Magnitude of electric field at point O caused by −3μC charge,

$$E_2 = \left|\frac{1}{4\pi\varepsilon_0}\cdot\frac{-3\times10^{-6}}{(OB)^2}\right| = \frac{1}{4\pi\varepsilon_0}\cdot\frac{3\times10^{-6}}{(10\times10^{-2})^2}\ NC^{-1}\quad along\ OB$$

$$\therefore E = E_1 + E_2 = 2\times\frac{1}{4\pi\varepsilon_0}\cdot\frac{3\times10^{-6}}{(10\times10^{-2})^2}\ NC^{-1}\quad along\ OB$$

$$\therefore E = 2\times9\times10^9\times\frac{3\times10^{-6}}{(10\times10^{-2})^2}\ NC^{-1}$$

$= 5.4\times10^6\ NC^{-1}$ along OB

SECTION C

26. — **3**

a. The charge q describes a circular path; anticlockwise in XY plane. ½

b. The path will become helical. ½

c. Direction of Lorentz magnetic force is Y
Applied electric field should be in +Y direction. ½

27. — **3**

The induced emf,

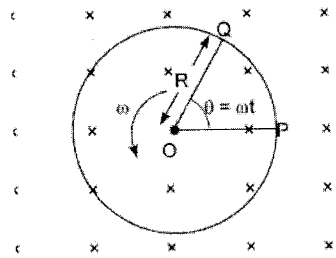
$$= \frac{d\phi_B}{dt}$$

$$\varepsilon = \frac{d}{dt}(BA) \qquad \therefore \phi_B = BA\cos\phi$$

$$= B\frac{dA}{dt} \qquad \because \phi = 0^\circ,\ \phi_B = BA$$

where dA/dt = Rate of change of area of loop formed by the sector OPQ.

Let q be the angle between the rod and the radius of the circle at P at time t.



The area of the sector $OPQ = \pi R^2 \times \frac{\theta}{2\pi} = \frac{1}{2}R^2\theta$

where R = Radius of the circle.

Hence $\varepsilon = B \times \frac{d}{dt}\left(\frac{1}{2}R^2\theta\right) = \frac{1}{2}BR^2\frac{d\theta}{dt} = \frac{B\omega R^2}{2}$

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28. (3)

i. X-resistor
Y-capacitor — ½ + ½

ii.

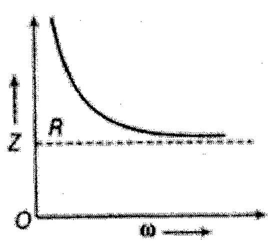
When X and Y are connected in series, net impedance of circuit,

$$Z = \sqrt{R^2 X_C^2} = \sqrt{\left(\frac{E_v}{\sqrt{2}}\right)^2 + \left(\frac{E_v}{\sqrt{2}}\right)^2} = E_v$$

$$\therefore I_v = \frac{E_v}{Z} = \frac{E_v}{E_v} = 1A$$

1

iii.



1

OR

$I_0 = V_0/R = 10/10 = 1$ A — ½
$\omega r = 1/\sqrt{LC} = 1/\sqrt{(1 \times 1 \times 10^{-6})} = 10^3$ rad/s — ½

$V_0 = I_0 X_L = I_0\, \omega r\, L$ — ½
$= 1 \times 10^3 \times 1 = 10^3$ V — ½

$Q = \omega r\, L/R$ — ½
$= (10^3 \times 1)/10 = 100$ — ½

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29. (3)

Three basic properties of photons :

(i) Photons are quanta or discrete carriers of energy.
(ii)The energy of a photon is proportional to the frequency of light.
(iii) The photon gives all its energy to the electron with which it interacts. (1+1+1)

OR

(i)

$$\lambda = \frac{C}{\nu}$$

As $(\nu_0)X < (\nu_0)Y \quad \therefore (\lambda_0)X > (\lambda_0)Y$

$\therefore$ **Metal 'X' has larger threshold wavelength** 1

(ii)

According to Einstein's photoelectric equation :

$$\frac{hC}{\lambda} = \frac{hC}{\lambda_0} + \text{K.E. of photoelectron}$$

For the same λ of incident radiation, L.H.S. is constant. So metal X with higher value of λ_0 will emit photoelectrons of larger K.E. 1

(iii) Kinetic energy will not change. On reducing the distance only intensity of light changes, frequency remains same. K.E. of emitted photoelectrons depends on frequency. 1

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30. 3

$R \propto A^{1/3}$

$$\frac{R_{Fe}}{R_{Al}} = \left(\frac{A_{Fe}}{A_{Al}}\right)^{1/3}$$

$$= \left(\frac{125}{27}\right)^{1/3}$$

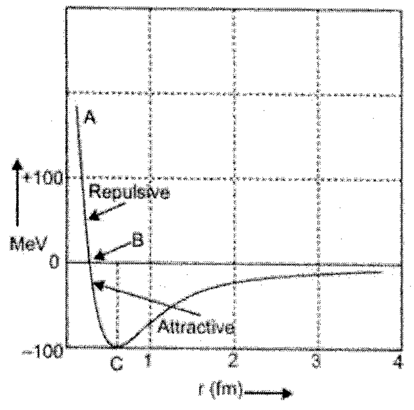
$$= \frac{5}{3}$$

$$= 1.67$$

$R_{Fe} = 1.67 \times R_{Al}$

$$= \frac{5}{3} \times 3.6 = 6 \text{ fermi.}$$

1

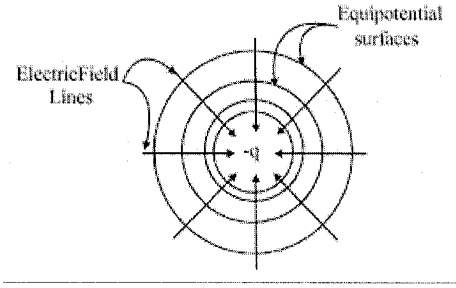


1

Conclusions:

(i) Nuclear forces are attractive and stronger, then electrostatic force.

(ii) Nuclear forces are charge-independent 1

	SECTION D	
31.	(a) Work done to bring q_1 from infinity to $r_1 = q_1 v(r_1)$ Work done to bring q_2 from infinity to $r_2 = q_2 v(r_2)$ Also, work done on q_2 to move it against the field due to $q_1 = \frac{kq_1q_2}{r_{12}}$ **$\therefore$ potential energy of the system = $q_1 v(r_1) + q_2 v(r_2) + \frac{kq_1q_2}{r_{12}}$** 2 (b)  1 (c) Work done= charge in potential energy $= [k\frac{q_1q_2}{r_{12}} + k\frac{q_1q_3}{r_{13}} + k\frac{q_2q_3}{r_{13}}]$ $= \frac{9\times10^{-3}}{0.1}(-1-2+2)$ $= -9\times10^{-2} J$ 2 **OR** (a) Diagram+ Explanation $E = \frac{V}{d} \Rightarrow V = Ed = \frac{\sigma}{\epsilon_0} d$ Since, $\sigma = \frac{q}{A}$ then $V = \frac{qd}{\epsilon_0 A}$ If c is the capacitance of the parallel plate capacitor, then $c = \frac{q}{V} = \frac{q}{\frac{qd}{\epsilon_0 A}}$ $= \frac{q \cdot \epsilon_0 A}{qd} = \frac{\epsilon_0 A}{d}$ $\therefore \boxed{C = \frac{\epsilon_0 A}{d}}$ 2 The capacitance increases when a dielectric medium is introduced. ½ $C = k\epsilon_0 A/d$.	5

	(b) $C_1 = \frac{\varepsilon_0 A}{d}$ $\frac{1}{C_2} = \frac{1}{K_1 \frac{\varepsilon_0 A}{d/2}} + \frac{1}{K_2 \frac{\varepsilon_0 A}{d/2}} = \frac{d}{2 \cdot K_1 \varepsilon_0 A} + \frac{d}{2 \cdot K_2 \varepsilon_0 A}$ $\frac{1}{C_2} = \frac{d}{2\varepsilon_0 A}\left[\frac{1}{K_1} + \frac{1}{K_2}\right] \Rightarrow C_2 = \frac{2 \cdot \varepsilon_0 A}{d}\left[\frac{K_1 K_2}{K_1 + K_2}\right]$ $C_2 = 2C_1\left[\frac{K_1 K_2}{K_1 + K_2}\right]$ $C_2 = C_1\left[\frac{2 K_1 K_2}{K_1 + K_2}\right]$ 2 ½	
32.	(a) Average velocity acquired by the electrons in the conductor in the presence of external electric field. 1 $v_d = \frac{-eE\tau}{m}$ where τ is the relaxation time.] **(ii)** $v_d = \frac{-eE\tau}{m}$ We have $E = \frac{V}{\ell}$, where V is potential across the length ℓ of the conductor $v_d = \frac{eV\tau}{m\ell}$ Current flowing $= neAv_d$ $I = neAv_d \frac{eV\tau}{m\ell} = \frac{ne^2AV\tau}{m\ell}$ $\frac{I}{V} = \frac{ne^2A\tau}{m\ell} = \frac{1}{R}$ ...(i) Also, $R = \rho\frac{\ell}{A}$ ...(ii) 3 Comparing (i) and (ii) Resistiviiy of the material of a conductor depends on the relaxation time, i.e., temperature and the number density of electron (b) Because constantan and manganin show very weak dependence of resistivity on temperature 1 **OR**	5

(a)

Junction Rule : At any Junction, the sum of currents, entering the junction, is equal to the sum of currents leaving the junction. ½

Loop Rule : The Algebraic sum of changes in potential, around any closed loop involving resistors and cells, in the loop is zero. ½

$$\Sigma(\Delta V) = 0$$

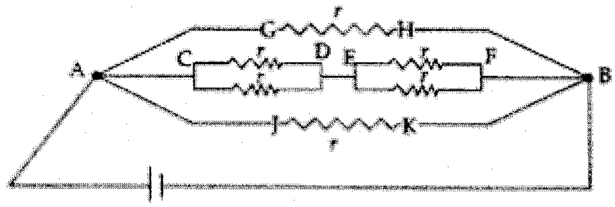
Justification :

The first law is in accordance with the law of conservation of charge. ½

The second law is in accordance with the law of conservation of energy. ½

(b) Given, EMF = E, internal resistance = r, resistance of each resistor = r

The equivalent circuit diagram is shown below



The two resistances of V each between points C and D are in parallel

$$\therefore \quad \frac{1}{r_{CD}} = \frac{1}{r} + \frac{1}{r} \Rightarrow r_{CD} = \frac{r}{2} \qquad \ldots(i)$$

Similarly two resistances between points E and F are in parallel,

$$\therefore \quad r_{EF} = \frac{r}{2} \qquad \ldots(ii)$$

Now these resistances rCD and rEF are in series,

$$r_{CF} = \frac{r}{2} + \frac{r}{2} = r \qquad \ldots(iii)$$

Now 3 resistances r_{GH}, r_{CF} and r_{JK} of 'r' each are in parallel

$$\therefore \quad r_{eq} = \frac{r}{3} \qquad \ldots(iv)$$

Total resistance $R = r_{eq} + r_i = \frac{r}{3} + r$

Hence current drawn from the cell

$$I = \frac{E}{\frac{r}{3} + r} = \frac{3E}{4r}$$

2

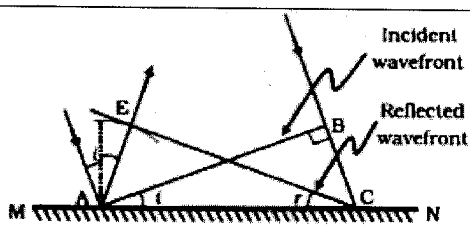
Power consumed,

$$P = I^2 \left(\frac{r}{3}\right) = \left(\frac{3E}{4r}\right)^2 \times \left(\frac{4r}{3}\right)$$

$$= \frac{9E^2}{16r^2} \times \frac{4r}{3} = \frac{3E^2}{4r}$$

1

33.	(a) Diagram Proof	1 1	5



Explanation

From the figure it is observed that AE = BC vt. the triangles EAC and BAC are congruent

∴ i = r.

This is the Law of reflection.

(b)

$$m = -20, m_e = 5, v_e = -20 \text{ cm}$$

For eyepiece , $m_e = \dfrac{v_e}{\mu_e}$

$\Rightarrow 5 = \dfrac{-20}{\mu_e} \Rightarrow = \dfrac{-20}{5}$ =-4 cm 1

Using lens formula,

$$\frac{1}{v_e} - \frac{1}{u_e} = \frac{1}{f_e}$$

$$-\frac{1}{20} + \frac{1}{4} = \frac{1}{f_e}$$

$\dfrac{-1+5}{20} = \dfrac{1}{f_e} \Rightarrow f_e = 5cm$ 1

Now , total magnification

$$m = m_e \times m_0$$

$$-20 = 5 \times m_0$$

$$m_0 = 1 - \frac{v_0}{f_0}$$

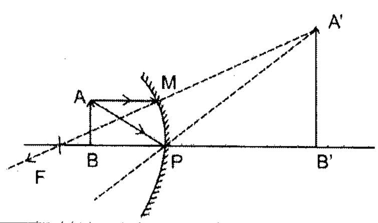
$$-4 = 1 - \frac{10}{f_0}$$

$-5 = \dfrac{10}{f_0} \Rightarrow f_0$ = 2cm

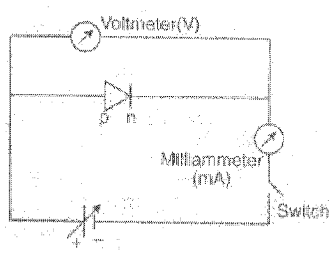
1

OR

(a) Diagram – 1 mark
Derivation- 2 marks



	From $\Delta A'B'F$ and MFP by similarity criteria. $\frac{A'B'}{MP} = \frac{B'F}{FP}$ Or $\frac{A'B'}{AB} = \frac{B'F}{FP}$ $(PM = BA)$ Similarly from $\Delta A'B'P$ and ABP $\frac{B'A}{BA} = \frac{B'P}{BP}$ $\frac{B'F}{FP} = \frac{B'P}{BP}$ $B'F = v + f$ $BP = u$ $\therefore \frac{v+f}{f} = \frac{v}{u}$ $1 + \frac{v}{f} = \frac{v}{u}$ Dividing throughout by v and applying sign convention $\frac{1}{v} - \frac{1}{f} = \frac{-1}{u}$ $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ (b) In the single slit diffraction experiment, the fringe width is given by $\beta = 2D\lambda/a$ When a is doubled, the **fringe size becomes half.** 1 When a is doubled, the amplitude of light gets doubled and so **intensity becomes four times.** 1	
	SECTION E	
34.	(i) focal length of converging lens is infinity i.e., glass lens behaves as a glass plate.	1
	(ii) As $\mu_2 > \mu_1$, the upper half of the lens will become diverging. ½ As $\mu_1 > \mu_3$, the lower half of the lens will become converging. ½	1
	(iii) As per lens maker's formula, $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ Focal length of a lens depends on the refractive index μ of the medium which in-turn depends upon the wavelength of light. **μ decreases with increasing wavelength.** 1 As μ decreases, **f increases.** 1 **OR**	2

	(iii) f = R_1 = R_2 = R (say) From lens maker's formula, $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\therefore \frac{1}{R} = (\mu - 1)\left[\frac{1}{R} - \left(-\frac{1}{R}\right)\right]$ Or, $\frac{1}{2} = \mu - 1$ $\therefore \mu = \frac{1}{2} + 1 = \frac{3}{2} = 1.5.$	
35.	(i) Width of depletion layer decreases in forward bias increases in reverse bias.	1
	(ii)  	1
	(iii) B_1 will glow 1 as the diode D_1 is forward based. 1 **OR** (iii) R should be increased 1 because the resistance of semiconductor S decreases on heating. 1	2