	SOLUTIONS: PHYSICS(042)		
	Code: 55/2/3		
Q.No.	**VALUE POINTS/EXPECTED ANSWERS**	**Marks**	**Total Marks**
	SECTION A		
1.	(A) $qa(\hat{i}+\hat{j})$	1	1
2.	(D) 12V, 0.5 A	1	1
3.	(A) conservative and field lines do not form closed loops.	1	1
4.	(B) diamagnetic	1	1
5.	(B) anticlockwise current	1	1
6.	(C) $\dfrac{5.0}{\sqrt{2}}$ x $10^{-10}\hat{k}$ T	1	1
7.	(D) P and S	1	1
8.	(C)	1	1
9.	(D) $\dfrac{R}{2(n-1)}$	1	1
10.	(A) resistor / (C) capacitor	1	1
11.	(C) Lyman series	1	1
12.	(D) 5	1	1
13.	(B) If both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).	1	1
14.	(C) If Assertion (A) is true but Reason (R) is false.	1	1
15.	(A) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).	1	1
16.	(C) If Assertion (A) is true but Reason (R) is false.	1	1
	SECTION B		
17.	Finding the value of V. 2 $V - V_o = IR$ $V - 0.7 = (15 \times 10^{-3}) \times 1000$ $V = 15.7$ volt	½ 1 ½	 2

18.				
	Calculating the separation of the two slits. 2			

Angular width $(\theta) = \dfrac{\lambda}{d}$ ½

$$d = \frac{\lambda}{\theta}$$

$$= \frac{500 \times 10^{-9}}{0.2 \times \dfrac{\pi}{180}}$$ ½

$$d = \frac{45}{\pi} \times 10^{-5} \text{ m}$$

$$= 0.14 \text{ mm}$$ 1

     2

19.				
	Finding magnitude and direction of shift OO' 1½+½			

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$ ½

$$\frac{1}{v} = -\frac{1}{15} + \frac{1}{10}$$

On solving: -

$v = 30 \text{ cm}$ ½

Magnitude of OO' = 30-10 = 20 cm   ½

Direction is away from the lens.   ½

     2

20.				
	Calculating (i) the work function in eV 1 (ii) the maximum energy of the ejected photoelectrons in eV 1			

(i) $\phi = \dfrac{hc}{\lambda_o}$ ½

$$\phi = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{450 \times 10^{-9} \times 1.6 \times 10^{-19}}$$ ½

$\phi = 2.76$ eV

	(ii) $K_{max} = h\nu - \phi$		½	
	$h\nu = \dfrac{hc}{\lambda} = \dfrac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{250 \times 10^{-9} \times 1.6 \times 10^{-19}} = 4.97\,eV$			
	$K_{max} = 4.97 - 2.76$			
	$K_{max} = 2.21\,eV$		½	2
21.	(a)			

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Finding current   2

</div>

$R_1 = \dfrac{\rho l_1}{A}$; $R_2 = \dfrac{\rho l_2}{A}$ ½

$\dfrac{l_1}{l_2} = \dfrac{2}{3} \Rightarrow \dfrac{R_1}{R_2} = \dfrac{2}{3}$

$I \propto \dfrac{1}{R}$

$\Rightarrow \dfrac{I_1}{I_2} = \dfrac{3}{2}$ ½

$\Rightarrow I_1 = \dfrac{3}{5} \times 15 = 9A$ ½

$\Rightarrow I_2 = \dfrac{2}{5} \times 15 = 6A$ ½

<center>OR</center>

(b)

<div style="border:1px solid black; padding:4px;">

Finding the potential difference
(i) between P and Q   1
(ii) across capacitor C   1

</div>

In steady state,

$\quad 2V - V = i(2R + R)$

$\quad\quad i = \dfrac{V}{3R}$

(i) $V_P - V_Q = -V - iR$

$\quad\quad = -V - \dfrac{V}{3}$

$\quad V_P - V_Q = -\dfrac{4V}{3}$ 1

	(ii) $V_P - V_Q = -V + V_C$		
	$-\dfrac{4V}{3} = -V + V_C$	1	
	$V_C = -\dfrac{V}{3}$		2
	SECTION C		
22.	(a) Defining Electrical conductivity 1 Obtaining expression of electrical conductivity 1 (b) Explaining qualitative change in resistivity with temperature 1		
	(a) Electrical conductivity: - It is the reciprocal of the resistivity.	1	
	Alternatively: - $\sigma = 1/\rho$ $I_\Delta t = + neA\left|\vec{v}_d\right|_\Delta t$ Substituting $\left|\vec{v}_d\right| = \dfrac{e\left|\vec{E}\right|}{m}\tau$ $I_\Delta t = \dfrac{e^2 A}{m}\tau\, n\, _\Delta t\left|\vec{E}\right|$ $I = \left|\vec{j}\right| A$ $\Rightarrow \left|\vec{j}\right| = \dfrac{ne^2}{m}\tau\left|\vec{E}\right|$.........(1) $\vec{j} = \sigma\vec{E}$....................(2) Comparing eq. (1) & (2):- $\sigma = \dfrac{ne^2}{m}\tau$	½ ½	
	(b) On increasing the temperature, the value of τ decreases as a consequence conductivity decreases and hence resistivity increases.	1	3
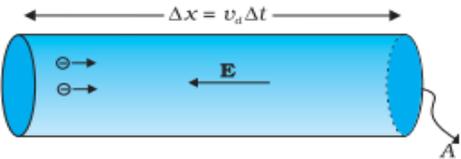
23.			
	(a) Showing variation of binding energy per nucleon with mass number 1 Significance of binding curve ½ (b) (i) Stating the type of reaction ½ (ii) To state whether total mass of nuclei increases, decreases or remains unchanged ½ (iii) Stating whether process requires energy or produces energy ½		

(a)

Building energy per nucleon (MeV) vs Mass number (A)
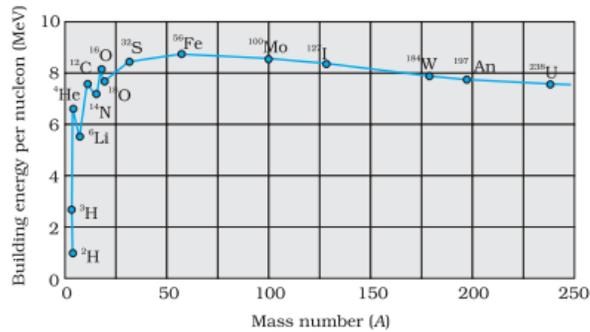
Note: - Full credit to be given even if the values are not shown.

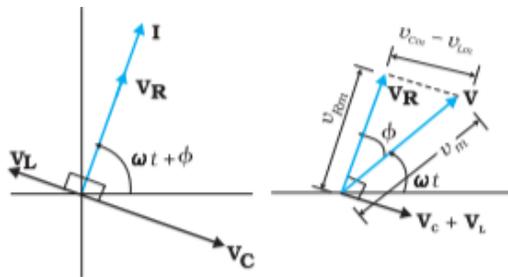Significance of the binding energy curve –
(Any one)
- Why lighter nuclei undergo fusion and heavier nuclei undergo fission.
- Nuclear forces are short ranged.
- Energy is released in both nuclear fission and nuclear fusion.

(b) (i) Nuclear fusion
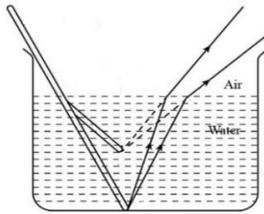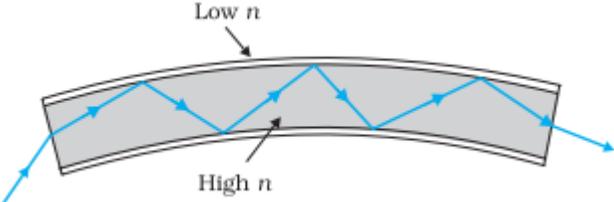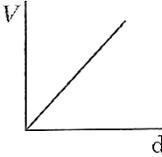   (ii) Decreases
     (iii) Energy is produced

col	val
(a)	1
significance	½
(b)(i)	½
(ii)	½
(iii)	½
	3

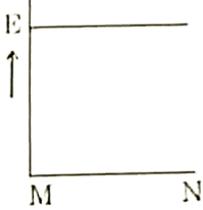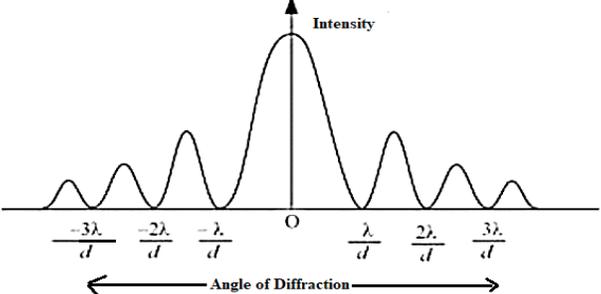| 24.		
	(a) Drawing the phasor diagram and obtaining the impedance 2 (b) Discussing 'resonance' and writing the expression for resonant frequency 1	

(a)

1

	$\vec{V}_L + \vec{V}_R + \vec{V}_C = \vec{V}$ $v_m^2 = v_{Rm}^2 + (v_{Cm} - v_{im})^2$ $= (i_m R)^2 + (i_m X_C - i_m X_L)^2$ $v_m^2 = i_m^2 \left[R^2 + (X_C - X_L)^2 \right]$ $i_m = \dfrac{v_m}{\sqrt{R^2 + (X_C - X_L)^2}}$ $\Rightarrow Z = \sqrt{R^2 + (X_C - X_L)^2}$ (b) When $X_L = X_C$, the impedance of the series LCR circuit is minimum and the current flowing through it is maximum. $\omega_o = \dfrac{1}{\sqrt{LC}}$	½ ½ ½ ½		3

25.	(a) Establishing relation between n and m 1
	 (b) Finding on which surface pressure is
	     (i) Maximum ½
	     (ii) Minimum ½
	        With justification ½+½
	
	 (a) Intensity (I) α (amplitude)
	       $\Rightarrow m = n^2$
	
	 (b) (i) White surface
	
	 As white surface will reflect maximum light falling on it, the change in momentum of light will be maximum and as a consequence the pressure exerted by the light will be maximum.
	
	 (ii) Black surface
	
	 As black surface absorbs maximum light falling on it, the change in momentum of light will be minimum and as a consequence the pressure exerted by the light will be minimum.
			1
			
			 ½
			
			 ½
			
			 ½
			
			 ½
				3

26.			
	(a) Defining majority and minority charge carries in an extrinsic semiconductor $\frac{1}{2}+\frac{1}{2}$ (b) Describing movement of the charge carriers when pn-junction diode is forward biased $\quad$ 1 (c) Estimating Dynamic resistance $\quad$ 1		
	(a) In an extrinsic semiconductor, the charge carriers whose number density is large are known as majority charge carriers. In an extrinsic semiconductor, the charge carriers whose number density is small are known as minority charge carriers.	$\frac{1}{2}+\frac{1}{2}$	
	(b) Due to the applied forward voltage, electrons from n-side cross the depletion region and reach p-side. Similarly, holes from p-side cross the junction and reach the n-side. Due to the movement of these charge carriers current is produced.	1	
	(c) At V = -0.6 volt, I = 0, so dynamic resistance is infinite.	1	
			3
27.	(a)		
	(i) Diagram showing direction of electric and magnetic fields $\quad$ 1 (ii) Naming forces acting on the charged particle $\quad$ 1 (iii) Finding the value of v_0 $\quad$ 1		
	(i)	1	
	(ii) Electric force Magnetic force **Alternatively**: - $F_E = eE$ $F_B = evB$	$\frac{1}{2}$ $\frac{1}{2}$	
	(iii) $ev_o B = eE$	$\frac{1}{2}$	

$$v_o \ \text{x} \ \left[\frac{\mu_o I}{2\pi d}\right] = E$$

$$v_o = \frac{(2\pi d)E}{\mu_o I}$$

½

OR

(b)

| Finding the magnitude and direction of the net magnetic field | 2+1 |

Magnetic field due to conductor carrying current I_1 $(\vec{B}_1) = \frac{\mu_0 I_1}{2\pi Y}(-\hat{k})$ ½

Magnetic field due to conductor Carrying current I_2 $(\vec{B}_2) = \frac{\mu_0 I_2}{2\pi X}(\hat{k})$ ½

$$\vec{B}_P = \vec{B}_1 + \vec{B}_2$$

$$\vec{B}_P = \frac{\mu_0}{2\pi}\left[\frac{I_2}{X} - \frac{I_1}{Y}\right]\hat{k}$$ 1

Direction will be along the Z-axis.   1

3

| 28. | (a) Effect on the width of the beam   1 (b) Ray diagram   1 (c) Diagram showing transmission   1 | |
| | (a) Width of the parallel beam of light increases in water. | 1 |

Alternatively: -
If a student explains using diagram, full credit to be given.

(b) Due to refraction of light, the image of the portion immersed in water appears to be raised.

(c)

	SECTION D		
29.	(i) (B) are parallel to each other.	1	
	(ii) (C) me	1	
	(iii) Full 1 mark to be awarded to all the students who have attempted this part of the question.	1	
	OR		
	(B) $\dfrac{1}{2}, \dfrac{1}{2}$		
	(iv) (D) 13.3 μm	1	
			4
30.	(i) (C) $\dfrac{E}{4}$	1	
	(ii) (D)	1	

(iii) (C)

(iv) (A) $(\vec{E}_1+\vec{E}_2).\vec{d}$

OR

(C) CK

SECTION E		

31. (a)

(i) Source of force	½
Obtaining expression for force	1½
Definition of 'ampere'	1
(ii) Finding work done by the magnetic force	1
(iii) Necessary conditions	1

<u>Reason –</u>

(i) The source of force is the interaction between the field produced by the current carrying conductor and the external field in which it is placed.
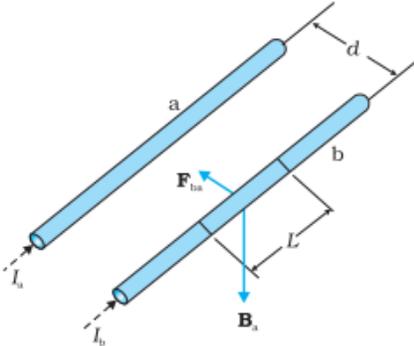
Two long parallel conductors a & b, separated by a distance d, carrying currents I_a and I_b, respectively.
The magnetic field due to a,

$$B_a = \frac{\mu_0 I_a}{2\pi d}$$

The force F_{ba}, is the force on a segment L of 'b' due to 'a'.

$$F_{ba} = I_b L B_a$$

$$= \frac{\mu_0 I_a I_b}{2\pi d} L$$

Definition –
The 'ampere' is that value of steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would produce on each of these conductors a force equal to 2×10^{-7} newton per metre of length. | 1

(ii) Work done by the magnetic force on the charge is zero as force is perpendicular to $\vec{v}$. | 1

(iii) The velocity ($\vec{v}$) is at an arbitrary angle θ w.r.t the magnetic field ($\vec{B}$). | 1

OR

(b)

(i) Explanation	1
(ii) Obtaining relation for $\vec{M}$, and direction of $\vec{M}$.	1+1
(iii) Net force on coil	1
Obtaining orientation	½
Showing flux is maximum	½

(i) The two faces of a current carrying loop behave like two poles of a magnet therefore can be considered as a magnetic dipole placed along its axis. | 1

(ii) Magnetic moment (M) α Current (I)
$\quad\quad\quad \alpha$ Area (A)
$\quad\quad \therefore \vec{M} = I\vec{A}$ | 1
Direction is same as the area vector. | 1

Alternatively: -

Magnetic moment is perpendicular to the plane of the coil.

(iii) Net force acting on the coil is zero. | 1
The potential energy (U_B) of a current carrying loop in an external magnetic field $= -\vec{M}.\vec{B}$

For the coil to be in stable equilibrium U_B should be minimum so $\theta = 0^\circ$. | ½

Therefore, magnetic flux (ϕ) due to the total field $= (B_{coil} + B_{ext})A$, which is its maximum value. | ½

	Alternatively: - Orientation of stable equilibrium is one where the area vector A of the loop is in the direction of external magnetic field. In this orientation, the magnetic field produced by the loop is in the same direction as external field, both normal to the plane of the loop, thus giving rise to maximum flux of the total field.			5

32. (a)

(i) Calculating magnification	2½
(ii) Showing emergent ray is normal	1½
Finding refractive index	1

(i) As the pencil lies between f and 2f such that one end of the pencil coincides with 2f.

Position of the other end $(u) = -\left(2f - \dfrac{f}{4}\right) = -\dfrac{7f}{4}$ .... ½

Magnification $(m) = \dfrac{f}{f-u}$ .... ½

$\qquad = \dfrac{-f}{-f-\left(-\dfrac{7f}{4}\right)}$ .... ½

$\qquad m = -\dfrac{4}{3}$ 1

Alternatively: -

As the pencil lies between f and 2f such that one end of the pencil coincides with 2f.

Position of the other end $(u) = -\left(2f - \dfrac{f}{4}\right) = -\dfrac{7f}{4}$ .... ½

$\dfrac{1}{v} + \dfrac{1}{u} = \dfrac{1}{f}$ .... ½

$\dfrac{1}{v} - \dfrac{4}{7f} = -\dfrac{1}{f}$

$$\frac{1}{v} = -\frac{1}{f} + \frac{4}{7f}$$

$$v = -\frac{7f}{3}$$

$$m = -\frac{v}{u} = -\frac{4}{3}$$

(ii) For prism;

$$i + e = A + \delta$$

$$45^o + e = 30^o + 15^o$$

$$\therefore e = 0^o$$

Hence, $r_2 = 0^o$

$\therefore$ Emergent ray is perpendicular to face AC.

Alternatively: - If the same is shown using diagram full credit to be given.

$r_1 + r_2 = A$

As $r_2 = 0$, hence $r_1 = 30^o$

$$\text{Refractive index(n)} = \frac{\sin i}{\sin r}$$

$$= \frac{\sin 45^o}{\sin 30^o}$$

$$n = \sqrt{2}$$

OR

(b)

(i) (1) Calculating distance of the third bright
fringe from central maximum   1
(2) Finding the least distance   1

(ii) (1) Diagram showing variation of intensity
with angle of diffraction   1
Writing expression for value of angle
corresponding to zero intensity   1
(2) Difference between diffraction of light and sound waves   1

(i)

(1) Distance of the nth bright fringe from the central maximum(x_n) = $\dfrac{n\lambda D}{d}$

For n = 3

$$x_3 = \frac{3 \times 600 \times 10^{-9} \times 1}{1 \times 10^{-9}}$$

$$= 1800\text{m}$$

(2)

$$n_1\lambda_1 = n_2\lambda_2$$

$$n_1 \times 600 = n_2 \times 480$$

$$\frac{n_1}{n_2} = \frac{480}{600}$$

$$\frac{n_1}{n_2} = \frac{4}{5}$$

Position of the 4th bright fringe of 600 nm = 4 x 600 = 2400 m

Alternatively: -
Position of the 5th bright fringe of 480 nm = 5 x 480 = 2400 m

Alternatively: -
$$(n-1)\lambda_1 = n\lambda_2$$
$$(n-1) \times 600 = n \times 450$$

on solving n = 4

Position of the 4th bright fringe of 600 nm = 4 x 600 = 2400 m
Position of the 5th bright fringe of 480 nm = 5 x 480 = 2400 m

(ii) (1)

Angle of diffraction for zero intensity, $\theta = \dfrac{n\lambda}{a}$; n = 0, 1, 2, ...

½

½

½

½

½

1

1

		(2) Diffraction of the light waves is not generally seen as compared to diffraction of sound waves as light waves have low wavelength.	1	
				5
33.	(a)			

		(i) Calculating final potential
		  - on sphere A 1
		  - on shell B 1
		(ii) Two characteristics of
		    of equipotential surface ½+½
		    Finding potential at (4m,3m) 2		

		(i) Potential on sphere A $= V = \dfrac{Q}{4\pi\varepsilon_o r}$ Charge on sphere A $= 4\pi\varepsilon_0 r\, V$	½	

		The charge is transferred to shell B.
		    Potential on shell B $= \dfrac{1}{4\pi\varepsilon_0} \times \dfrac{4\pi\varepsilon_0 r V}{R}$
		    Potential on shell B $= \dfrac{rV}{R}$
			½	

		Potential on sphere A = Potential on shell B	1	
		(ii) Characteristics of equipotential surfaces: - (Any two) - Potential at all points on the surface is same. - Equipotential surface is normal to the direction of the electric field. - The work done in moving a charge on an equipotential surface is zero.	½+½	
		$V_0 - V = E\, d = 50 \times 4$ $V_0 - V = 200\ V$ $V = 220\ V - 200\ V$ $V = 20\ V$	½ ½ ½ ½	
		OR		
	(b)			

		(i) Difference between an open surface and a closed surface ½
		    Diagram of elementary surface vector $\vec{ds}$ 1
		(ii) Definition of electric flux 1
		    Significance of Gaussian Surface ½
		    Reason ½
		(iii) Finding charge Q 1½		

(i) Open Surface – A surface which does not enclose a volume.
   Closed Surface – A surface which does enclose a volume.   ½

(ii) Electric flux is defined as the number of electric field lines crossing an area   1
normally.

Alternatively-

$\phi = \overrightarrow{E}.\overrightarrow{A}$

Alternatively-

$\phi = EA\cos\theta$

Significance of Gaussian Surface: -

It helps in finding the electric field in a simpler way.   ½

Reason: -

Because any electric field line from the charge which enters the surface at one   ½
point will exit at another, resulting in a net zero flux.

(iii) Total charge enclosed by S_1 = (-3-2+9) μC = 4 μC ½
Total charge enclosed by S_2= Q + 4 μC

$\phi_{s_2} = 4\phi_{s_1}$ ½

$\dfrac{Q + 4\mu C}{\varepsilon_O} = 4\left(\dfrac{4\mu C}{\varepsilon_O}\right)$

$Q = 12 \ \mu C$ ½

5