Dr. B. C. Roy Engineering College, Durgapur
Basic Science and Humanities Department
1st Semester

Paper: Physics I **CODE: BS-PH 101** **AY: 2022-23**

Continuous Assessment-2 **FM: 25** **Date: 16-11-2022**

Q. No.	Question	Marks	COs	BL
1.	Write a Report on applications of Gradient, Divergence and Curl in Engineering.	12	CO1	P
2.	Write the assumptions of Planck's radiation law hence derive the Planck's radiation law.	13	CO4	R, A

1)

i) a) Plane

iii) a) Angle of Scattering

iv) c) $\frac{h}{p}$

v) c) 180°

vi) a) $\hat{n} = \frac{\vec{A}}{|\vec{A}|}$

ii) b) Never perfectly dark.

2) We know that,

$$\lambda' - \lambda = \frac{h}{m_0 c}(1 - \cos\phi)$$

or, $\lambda' = \lambda + \frac{h}{m_0 c}(1 - \cos\phi)$

If we want the maximum wave length of the scattered ray then, ϕ should be 180°

$\Rightarrow \lambda' = 10^{-11} + \frac{6.626 \times 10^{-34}}{9.11 \times 10^{-31} \times 3 \times 10^{8}}(1-(-1))$

$\Rightarrow \lambda' = 1.48 \times 10^{-11}$

λ = Incident wavelength $= 10^{-11} m$

λ' = Scattered rays wavelength = ?

h = Planck's constant $= 6.626 \times 10^{-34}$ J. sec

m_0 = mass of the electron $= 9.11 \times 10^{-31}$ kg

c = Speed of Light $= 3 \times 10^{8}$ m/s

ϕ = Angle of scattering $= 180^\circ$

$\therefore$ The maximum wavelength present in the scattered rays are $1.48 \times 10^{-11} m$

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$\therefore$ The Kinetic energy, $E = (h\nu - h\nu')$ | ν = frequency of that ray

$\Rightarrow E = h\left(\frac{c}{\lambda} - \frac{c}{\lambda'}\right) = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda'}\right)$

$= 6.626 \times 10^{-34} \times 3 \times 10^{8} \times \left(\frac{1}{10^{-11}} - \frac{1}{1.48 \times 10^{-11}}\right)$

$= 6.45 \times 10^{-15}$

$\therefore$ The maximum kinetic energy of the recoil electron is 6.45×10^{-15} Jule = 40312.5 eV = 40.3125 KeV

3) a) We know that,

Phase velocity, $V_p = \frac{\omega}{K}$

Group velocity, $V_g = \frac{d\omega}{dK}$

ω = Angular frequency

$K = \frac{2\pi}{\lambda}$ = Proportional constant.

λ = Wave length.

$\therefore V_p = \frac{\omega}{K}$

$\Rightarrow \omega = V_p K$

Differ. w.r.t K, we get,

$\Rightarrow \frac{d\omega}{dK} = V_p + K \cdot \frac{V_p}{dK}$

$\Rightarrow \frac{d\omega}{dK} = V_p + K \cdot \frac{V_p}{d\lambda} \cdot \frac{d\lambda}{dK}$

$\Rightarrow \frac{d\omega}{dK} = V_p + \frac{2\pi}{\lambda} \cdot \frac{V_p}{d\lambda} \cdot \left(-\frac{\lambda^2}{2\pi}\right)$

$\Rightarrow \boxed{\frac{d\omega}{dK} = V_p - \lambda \cdot \frac{V_p}{d\lambda}}$

$K = \frac{2\pi}{\lambda}$

$\Rightarrow dK = -\frac{2\pi}{\lambda^2} d\lambda$

$\Rightarrow \frac{d\lambda}{dK} = -\frac{\lambda^2}{2\pi}$

b) Heisenberg says that,

Product of the uncertain position (Δx) and momentum (ΔP) of a particle in simultaneously measurement is equal to or greater than to $\frac{h}{4\pi}$

Equation,

$$\Delta x \cdot \Delta P \geq \frac{h}{4\pi}$$

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Physical Significance :-

We can not find the both of position and momentum of a particle such as, electron, photon with perfect accuracy. When we nail the position of the particle, the less we know about the speed of the particle and vice versa.

4) a)

3

Interference	Diffraction
~~i) Interference occurs~~	
i) The fringes are perfectly dark	i) The fringes are not perfectly dark.
ii) The intensity of the maxima is bright	ii) The intensity of the maxima is not bright
iii) The fringes are of same width	iii) The fringes width are varries.
iv) ~~The bright~~ It occurs between two coherent wavelength	iv) It occurs between a large number of different coherent wavelength.

4) b)

We know that,

$\lambda = a \sin\theta$

When, θ is very small

$\sin\theta \simeq \theta$

λ = wave length of light = 6000Å
a = slit width = 0.1mm
θ = angular width = ?

$\therefore \lambda = a\theta$

$\Rightarrow \theta = \frac{\lambda}{a} = \frac{6000\times10^{-10}}{0.1\times10^{-3}}$

$\Rightarrow \theta = 6\times10^{-3}$

$\Rightarrow 2\theta = 12\times10^{-3}$ [As θ is one side angular width of central maxima]

$\therefore$ The angular width of the central maxima is 12×10^{-3} rad.

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5) or)

$\vec{F} = \vec{\nabla}(x^3+y^3+z^3-3xyz)$

$= \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)(x^3+y^3+z^3-3xyz)$

$= (3x^2-3yz)\hat{i} + (3y^2-3xz)\hat{j} + (3z^2-3xy)\hat{k}$

$\therefore \vec{\nabla}\cdot\vec{F} = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\cdot\left\{(3x^2-3yz)\hat{i} + (3y^2-3xz)\hat{j} + (3z^2-3xy)\hat{k}\right\}$

$= 6x+6y+6z$

$= 6(x+y+z)$

5

$\vec{\nabla}\times\vec{F} = \left(\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right)\times\left\{(3x^2-3yz)\hat{i} + (3y^2-3xz)\hat{j} + (3z^2-3xy)\hat{k}\right\}$

$= 0$ [As, $\hat{i}\times\hat{i}=0$, $\hat{j}\times\hat{j}=0$, $\hat{k}\times\hat{k}=0$]

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Paper: Physics-I   Paper Code: BS-PH 101

1st Semester   1st Internal Examination (SET 2)

Full Marks: 25   Session- 2022-23   Time: 50 mins.

Continuous Assessment – 3

Q. No.	Question	Marks	COs	BL
	GROUP –A (Multiple Choice Type Questions) **Choose the correct answer for any five of the following:**			
1. (i)	In Fraunhofer diffraction, the incident wave front is (a) Plane (b) Cylindrical (c) Spherical (d) None of these	1	CO2	**R**
(ii)	In Fraunhofer diffraction minima are (a) All perfectly dark (b) Never perfectly dark (c) Perfectly bright (d) None of these	1	CO2	**R**
(iii)	The Compton Shift depends on (a) Angle of scattering (b) Material of the target (c) Wavelength of the incident X-ray (d) None of these	1	CO4	**U**
(iv)	The de-Broglie wavelength of a particle with momentum p is (a) $\frac{h}{p^2}$ (b) $\frac{p^2}{h^2}$ (c) $\frac{h}{p}$ (d) $\frac{p}{h^2}$	1	CO4	**R**
(v)	The Compton shift is maximum when the scattering angle is (a) 45^0 (b) 90^0 (c) 180^0 (d) 60^0	1	CO4	**E**
(vi)	If $\hat{n}$ is the unit vector in the direction $\vec{A}$ then (a) $\hat{n} = \frac{\vec{A}}{\lvert\vec{A}\rvert}$ (b) $\hat{n} = \vec{A}\lvert\vec{A}\rvert$ (c) $\hat{n} = \frac{\lvert\vec{A}\rvert}{\vec{A}}$ (d) None of these	1	CO1	**P**
	GROUP – B (Short Answer Type Questions) **Answer all the questions from the following**			
2.	X-rays of wavelength 10^{-11}m are scattered by loosely bound electrons. Find the maximum wavelength present in the scattered rays and maximum kinetic energy of the recoil electron.	3 + 2	CO4	**E**
3.	(a) Find the relation between Phase velocity and Group velocity. (b) Write the Heisenberg's uncertainty principle and explain its physical significance.	2 + 3	CO4	**P** **R**
4.	(a) Differentiate Interference and Diffraction. (b) A light of 6000Å falls normally on a straight slit of 0.1mm width. Calculate the total angular width of the central maxima. **OR** Define the terms and find the expressions in connection with damped vibration (a) Decay Constant (b) Logarithmic decrement	3 + 2 2 + 3	CO2 CO1	**R** **E** **A**
5	What is Brewster's law in polarization of light? Show that sum of angle of polarization and angle of refraction is 90^0. **OR** Find $\vec{\nabla}.\vec{F}$ and $\vec{\nabla}\times\vec{F}$ where $\vec{F} = \vec{\nabla}(x^3 + y^3 + z^3 - 3xyz)$ **OR** Establish the differential equation of damped vibration and solve it.	1 + 4 1.5+ 1.5+2 2 + 3	CO2 CO1 CO1	**R** **E** **E** **A**