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 $= 180°$

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

5

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

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

$= 6.626\times10^{-34} \times 3\times108 \times \left(\frac{1}{10^{-11}} - \frac{1}{1.48\times10^{-11}}\right)$

$= 6.45\times10^{-15}$

$\therefore$ The ~~E~~ 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,

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

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

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

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

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

~~Diff~~

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

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

b) Heisenberg says that,

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

Equation,

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

2

Physical Significance :-

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

4)
a)

Interference	Diffraction
~~i) Interference occurs~~	
i) The fringes are perfectly ~~dark~~ dark	i) The fringes are not ~~perf~~ 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 ~~are~~ ~~not~~ width are varries.
iv) ~~The bright~~ ~~b~~ between It occurs, ~~when~~ two coherent wavelength	iv) It occurs between a large number of different coherent wavelength.

3

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]

2

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

5) or)

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

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

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

5

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

$= 6x+6y+6z$

$= 6(x+y+z)$

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

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