Name: Key

**Physics 2020 – Fall 2001**

**Quiz #4**

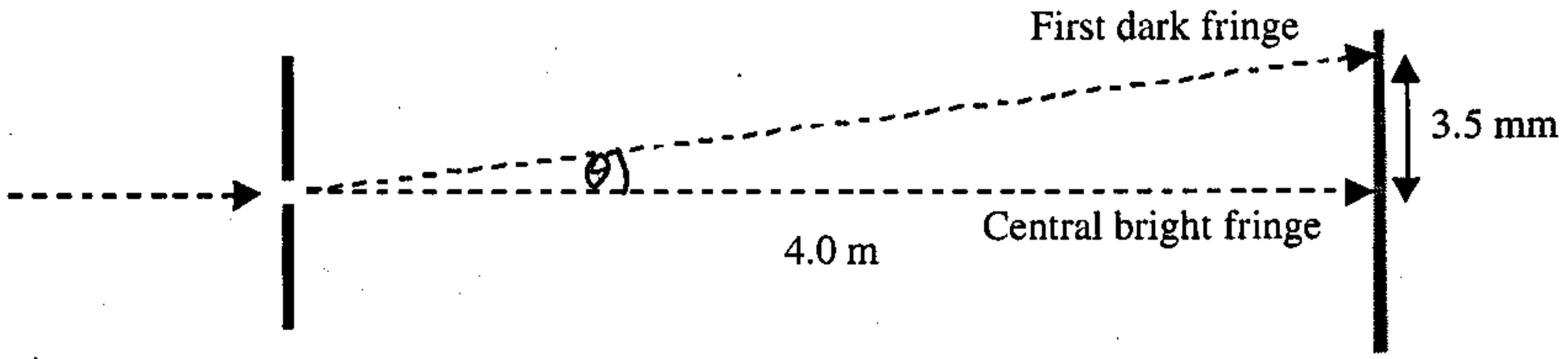
$c = 3.00 \times 10^{8}$ m/s  $h = 6.63 \times 10^{-34}$ Js  $m_e = 9.11 \times 10^{-31}$ kg  $1\ eV = 1.60 \times 10^{-19}$ J

*You must show your working and/or explain your answers to receive full credit.*

1. Your favorite radio station broadcasts from two transmitting antennas at two different locations. Explain **briefly** why the quality of your reception can vary considerably when you move just a few meters with your radio. (6 points)

The wavelength of radio waves is of the order of meters. Thus moving few meters could take you from a point where the two signals are interfering constructively to a point where they interfere destructively

2. Light shines through a single slit whose width is 5.6 x 10-4 m. A diffraction pattern is formed on a flat screen located 4.0 m away. The distance between the middle of the central bright fringe and the first dark fringe is 3.5 mm. What is the wavelength of the light? (6 points)




$\tan\theta = \frac{3.5\,mm}{4.0\,m} = \frac{0.0035\,m}{4.0\,m} \Rightarrow \theta = 0.050°$

$\sin\theta = \frac{m\lambda}{W}$  $m=1$, $W = 5.6 \times 10^{-4}$ m

$\Rightarrow \sin\theta = \frac{\lambda}{5.6\times10^{-4}\,m} \Rightarrow \lambda = 5.6\times10^{-4}\,m \times \sin 0.050°$

$= 4.89 \times 10^{-7}$ m

or 489 nm

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3. Ultraviolet light of a certain wavelength is shone on to an aluminum sheet and photoelectrons are ejected with a maximum speed of $5.0 \times 10^5$ m/s.

a) What is the maximum kinetic energy of the electrons? (2 points)

$$KE_{max} = \frac{1}{2} m v_{max}^2 = \frac{1}{2} \times 9.11 \times 10^{-31} kg \times (5.0 \times 10^5 m/s)^2$$

$$= 1.14 \times 10^{-19} J$$

$$(= 0.71 eV)$$

b) Given that the work function of aluminum is 4.08 eV, what is the energy of a single photon of the incoming light? Give your answer in eV and Joules. (3 points)

$W = 4.08 eV = 6.53 \times 10^{-19} J$ $\quad (1 eV = 1.60 \times 10^{-19} J)$

Energy of photon $= W + KE_{max}$

$= 4.08 eV + 0.71 eV \equiv 6.53 \times 10^{-19} J + 1.14 \times 10^{-19} J$

$= 4.79 eV \equiv 7.67 \times 10^{-19} J$

c) What is the frequency and wavelength of the incoming light? (3 points)

$$E = hf \Rightarrow f = \frac{E}{h} = \frac{7.67 \times 10^{-19} J}{6.63 \times 10^{-34} J s} = 1.16 \times 10^{15} Hz$$

$$c = f\lambda \Rightarrow \lambda = \frac{c}{f} = \frac{3.00 \times 10^8 m/s}{1.16 \times 10^{15} Hz} = 2.59 \times 10^{-7} m$$

$(or\ 259\ nm)$

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Useful equations:

Interference bright fringes: $\sin\theta = m\frac{\lambda}{d}$ Interference dark fringes: $\sin\theta = (m + \frac{1}{2})\frac{\lambda}{d}$

Diffraction dark fringes: $\sin\theta = m\frac{\lambda}{W}$ $c = f\lambda$ $E = hf$ $KE = \frac{1}{2}mv^2$ $p = mv$

Photoelectric effect: $hf = W + KE_{max}$ Uncertainty Principle: $\Delta p \Delta y \geq h/2\pi$