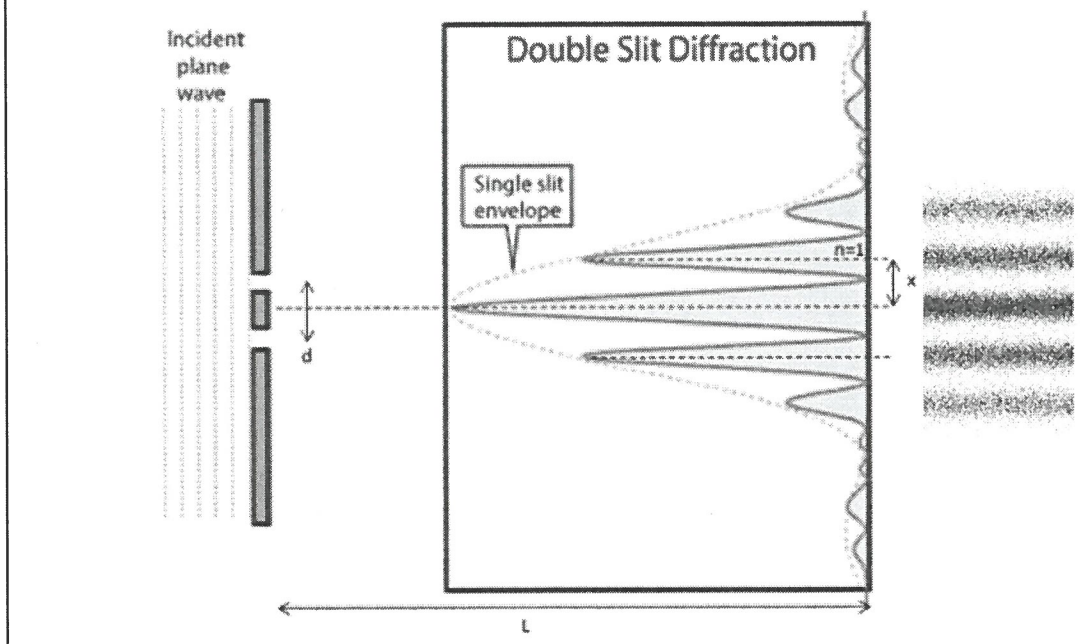
KEY

First Name:_____ Last Name:_____

L05 – FQ – Wave-Particle Duality

Use the following information to answer Q1 – Q5:

Double Slit Diffraction with an Electron Beam



Q1: An electron beam can create an interference pattern in a double-slit diffraction experiment because of which ***Physics Principle***?

*(Record your **one-digit** answer in the Numerical Response boxes below)*

9			

Wave-Particle Duality

Q2: If a proton is moving at a speed of 3.58×10^6 m/s, then its deBroglie wavelength is $a.b \times 10^{-cd}$, where ***a, b, c,*** and ***d*** are ___, ___, ___, and ___.

*(Record your **four-digit** answer in the Numerical Response boxes below)*

1	1	1	3

$p = mv \qquad p = \frac{h}{\lambda}$

$mv = \frac{h}{\lambda}$

$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{(1.67 \times 10^{-27})(3.58 \times 10^6)} = 1.1089... \times 10^{-13}\ m$

$\approx 1.1 \times 10^{-13}\ m$

KEY

Q3: Which formula best relates the angle of diffraction to the velocity of the incoming electron beam?

a. $\theta = Sin\left(\frac{nh}{mvd}\right)$

b. $\theta = Sin^{-1}\left(\frac{nh}{mvd}\right)$

c. $\theta = Sin\left(\frac{mvd}{nh}\right)$

d. $\theta = Sin^{-1}\left(\frac{mvd}{nh}\right)$

$p = mv$ and $p = \frac{h}{\lambda}$ so $mv = \frac{h}{\lambda}$ or $\lambda = \frac{h}{mv}$. Also $\lambda = \frac{d\sin\theta}{n}$ so $\frac{h}{mv} = \frac{d\sin\theta}{n}$

Taking $\frac{h}{mv} = \frac{d\sin\theta}{n}$ and solving for $\sin\theta = \frac{nh}{mvd}$ so $\theta = \sin^{-1}\left(\frac{nh}{mvd}\right)$.

Q4: If the diffraction angle, θ, between the central bright spot and the first antinode is 4.17×10^{-2} deg, and the slit separation distance is 5.0 µm, then the deBroglie wavelength of the incoming electron beam is ***a.bc*** $\times 10^{-d}$ m, where ***a, b, c,*** and ***d*** are ___, ___, ___, and ___.

*(Record your **four-digit** answer in the Numerical Response boxes below)*

3	6	4	9

$\lambda = \frac{d\sin\theta}{n} = \frac{(5.0\times10^{-6})\sin(4.17\times10^{-2})}{(1)}$

$\lambda = 3.639\times10^{-9}\ m$

$\approx 3.64\times10^{-9}\ m$

Q5: Given your answer from ***Q4***, the speed of the incoming electrons is ***a.bc*** $\times 10^{d}$ m/s, where ***a, b, c,*** and ***d*** are ___, ___, ___, and ___.

*(Record your **four-digit** answer in the Numerical Response boxes below)*

2	0	0	5

$p = mv$ and $p = \frac{h}{\lambda}$

so $mv = \frac{h}{\lambda}$

or $v = \frac{h}{m\lambda} = \frac{6.63\times10^{-34}}{(9.11\times10^{-31})(3.639\times10^{-9})}$

$v = 1.99992\times10^{5}\ m/s$

$\approx 2.00\times10^{5}\ m/s$

MARKING:

Beginning	0.0 – 2.0
Progressing	2.5 – 3.5
Competent	4.0 – 4.5
Exemplary	5.0