Practice Quiz #2 **PS303** **Modern Physics**

March 23, 2015

Show your work
(Closed Book, Closed Notes, No Calculator)
10 minutes

Answer Key
Name

2 points

1. The most intense radiation emitted from a hot sample of metal has a wavelength of 60 μm. When the temperature of the sample is doubled, what will be the wavelength of the most intense radiation?

(a) 30 μm (b) 120 μm (c) 960 μm (d) 15 μm (circle one)

$\lambda_{max} T = \text{constant}$

$\lambda_{max} = \frac{\text{constant}}{T}$

If you double the temperature, the peak wavelength will decrease by a factor of 2.

60 μm → 30 μm

2 points

2. Electrons are emitted when an ultraviolet light source of wavelength λ illuminates a certain metal surface. If you wanted to increase the number of electrons per unit time emitted from the surface, you should

↑ the flux

(a) increase the frequency of the light source → this increases the energy $E = hf$

(b) increase the wavelength of the light source → this lowers the energy $E = \frac{hc}{\lambda}$

(c) add a second light source identical to the first light source → this will increase the flux

2 points

3. A beam of electrons moving with speed *v* passes through a single slit and strikes a screen, where it forms a diffraction pattern with a bright central maximum and some less intense maxima on either side of center.

(a) If the speed of the electrons is increased to 2*v*, what happens to the width of the central maximum?

$a \sin\theta = n\lambda$ $\boxed{\sin\theta = \frac{n\lambda}{a}}$ a = slit width

(1) Increases (2) Decreases (3) Remains the same

$v \to 2v$ $\lambda = \frac{h}{mv}$ means $\lambda' = \frac{h}{2mv} = \frac{1}{2}\lambda$ or $\frac{1}{2}$ the original wavelength

$\theta \to$ smaller

(b) If the beam of electrons is replaced with a beam of protons moving with speed *v*, what happens to the width of the central maximum compared with that of electrons moving with the same speed?

(1) Increases (2) Decreases (3) Remains the same

$m_p \to 1836\, m_e$ $\lambda = \frac{h}{m_e v}$ means $\lambda' = \frac{h}{(1836 m_e)v} = \frac{1}{1836}\lambda$

λ' is much smaller than.

$\theta_p \to \frac{1}{1836}\lambda$ $\theta_e = \frac{1}{2}\lambda$ $\boxed{\theta_p \ll \theta_e}$

2 points

4. A particle in the first excited state of a one-dimensional infinite potential energy well (with $U = 0$ inside the well) has an energy of 6.0 eV. What is the energy of this particle in the ground state?

(a) 1.0 eV (b) 1.5 eV (c) 2.0 eV (d) 3.0 eV

$E_n = n^2 E_1$ in an infinitely deep potential well.

$E_2 = 6.0\text{ eV} = 2^2 E_1$

$E_1 = \frac{1}{4}(6.0\text{ eV}) = \underline{\underline{1.5\text{ eV}}}$