## Chapter 25 Homework

**Due: 8:00am on Wednesday, February 10, 2010**

**Note:** To understand how points are awarded, read your instructor's Grading Policy.

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### The Visible Spectrum of Hydrogen: The Balmer Series

The visible spectrum of hydrogen can be described accurately with an empirical formula found by the Swiss teacher Johann Balmer in 1885. This formula, which gives the wavelength of a spectral line as a function of an integer quantity $n$, describes the spectrum known as the *Balmer series*. By varying $n$, you can calculate the wavelength of all spectral lines.

**Part A**

Find the minimum value of $n$ in the Balmer series for which the predicted wavelength is in the ultraviolet region of the spectrum.

**Hint A.1 Find a wavelength in the hydrogen spectrum**

From the Balmer series calculate the wavelength $\lambda$ of the spectral line corresponding to the integer value $n = 3$.

**Hint A.1.1 Balmer series equation**

*Hint not displayed*

**Express your answer in nanometers.**

**ANSWER:** $\lambda =$ **656** *Correct* nm

**Hint A.2 Find the range of the ultraviolet spectrum**

Lines in the ultraviolet correspond to light with a wavelength

**ANSWER:**

- greater than 700 nm.
- between 400 nm and 700 nm.
- (•) less than 400 nm.

*Correct*

Now find $n_0$ so that $\lambda$ is in the ultraviolet range.

**ANSWER:** $n =$ **7** *Correct*

### Problem 25.6

X rays diffract from a crystal in which the spacing between atomic planes is 0.173 nm. The second-order diffraction occurs at 52.0°.

**Part A**

What is the angle of the first-order diffraction?

**ANSWER:** **72.1** ° *Correct*

### Problem 25.7

X rays with a wavelength of 0.085 *nm* diffract from a crystal in which the spacing between atomic planes is 0.2550 nm.

**Part A**

How many diffraction orders are observed?

**ANSWER:** **6.00** *Correct*

### Problem 25.11

**Part A**

What is the energy of an x-ray photon that has a wavelength of 2.60 nm?

**ANSWER:** **7.65×10$^{-17}$** J *Correct*

### Conceptual Question 25.3

Photon 1 has wavelength $\lambda_1$ and photon 2 has wavelength $\lambda_2 = 2\lambda_1$.

**Part A**

What is the energy ratio $E_2/E_1$ of the two photons?

**ANSWER:** $E_2/E_1 =$ **0.500** *Correct*

## The Wavelength of an Electron

An electron has de Broglie wavelength $2.80\times10^{-10}\ \text{m}$.

**Part A**

Determine the magnitude of the electron's momentum $p_e$.

**Hint A.1** **The de Broglie wavelength**

*Hint not displayed*

**Express your answer in kilogram meters per second to three significant figures.**

**ANSWER:** $p_e = 2.37\times10^{-24}\ \text{kg}\cdot\text{m/s}$ *Correct*

**Part B**

Determine the kinetic energy $K_e$ of the electron.

**Hint B.1** **Find the kinetic energy as a function of momentum**

Given the momentum $p$ of a particle of mass $m$, what is the kinetic energy $K$ of the particle?

**Hint B.1.1** **The kinetic energy and momentum of a particle**

A particle of mass $m$ moving with speed $v$ has kinetic energy $K = \frac{1}{2}mv^2$ and momentum $p = mv$.

**ANSWER:**

- $\frac{1}{2}mp^2$
- $\frac{p}{m}$
- $\frac{mp}{2}$
- $\frac{p^2}{2m}$ (selected)

*Correct*

**Express your answer in joules to three significant figures.**

**ANSWER:** $K_e = 3.08\times10^{-18}\ \text{J}$ *Correct*

**Part C**

Determine the electron's kinetic energy in electron volts.

**Hint C.1** **The relation between electron volts and joules**

*Hint not displayed*

**Express your answer in electron volts to three significant figures.**

**ANSWER:** $K_e = 19.2\ \text{eV}$ *Correct*

## Problem 25.16

**Part A**

What is the length (in $\text{mm}$) of the smallest box in which you can confine an electron if you want to know for certain that the electron's speed is no faster than 10 $\text{m/s}$?

**Express your answer using two significant figures.**

**ANSWER:** $L = 3.6\times10^{-2}\ \text{mm}$ *Correct*

## Problem 25.23

A helium-neon laser emits a light beam with a wavelength of 633 $\text{nm}$. The power of the laser beam is 1.00 $\text{mW}$.

**Part A**

What is the energy of one photon of laser light?

**ANSWER:** $3.14\times10^{-19}\ \text{J}$ *Correct*

**Part B**

How many photons does the laser emit each second?

**ANSWER:** $3.18\times10^{15}$ *Correct*

**Score Summary:**

Your score on this assignment is 97.8%.
You received 44.03 out of a possible total of 45 points.