Name ______Fuller______ Period ___35___ Date ________

B. Understanding Concepts

In the space to the left, write the letter of the answer to each question.

__a__ 1. Which color of light is most likely to eject electrons from a piece of metal?
a. violet b. green c. yellow d. red

__d__ 2. If the work function of a metal is greater than the energy of the incident light, ________ are ejected from the metal.
a. electrons b. protons c. neutrons d. no electrons

__b__ 3. If the exact position of an electron is known, its exact momentum
a. is known.
b. cannot be measured.
c. can be measured.

__d__ 4. When the maximum kinetic energy of ejected electrons is plotted against the frequency of the incident light minus the threshold frequency, the slope of the straight-line graph is
a. wavelength.
b. Compton's constant.
c. Heisenberg's principle.
d. Planck's constant.

__a__ 5. Which of the following loses energy in the Compton effect?
a. incident X rays
b. emergent X rays
c. incident electrons
d. ejected electrons

__d__ 6. Which of the following objects has the shortest de Broglie wavelength?
a. moving car
b. high-speed proton
c. high-speed electron
d. jet plane at 600 km/h

__a__ 7. Light having a frequency greater than the threshold frequency
a. increases the kinetic energy of the ejected electrons from the metal.
b. decreases the kinetic energy of the ejected electrons from the metal.
c. results in no electrons being ejected from the metal.

__c__ 8. The work function of a metal equals
a. KE_{max}. b. qV_o. c. hf_0. d. λf.

__b__ 9. The particle properties of photons are demonstrated in the
a. Millikan oil drop experiment.
b. Compton effect.
c. photoelectric effect.
d. mass spectrograph.

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Name ______________________ Period ________ Date ________

REVIEW — Chapter 28

1. When light falls on a photoelectric surface, the stopping potential that prevents electrons from flowing across a photocell is 3.5 V.

   a. What is the maximum kinetic energy given to the electrons by the incident light? Give the answer in J and eV.

   $E_k = eV_0$

   $E_k = (1.6 \times 10^{-19}\ C)(3.5 J/C)$

   $E_k = 5.6 \times 10^{-19}\ J$

   $E_k = 3.5 eV$

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   b. What is the speed of the electrons?

   $E_k = \frac{1}{2}mv^2$

   $2E_k = mv^2$

   $v^2 = \frac{2E_k}{m}$

   $v^2 = \frac{2(5.6 \times 10^{-19} J)}{9.11 \times 10^{-31} kg}$

   $v = 1.1 \times 10^6 m/s$

2. The maximum kinetic energy given to electrons by incident light is 4.5 eV. What is the stopping potential that prevents electrons from flowing across the photocell?

   $V_0 = 4.5V$

1

3. A certain metal has a threshold frequency of 1.5×10^{14} Hz.

   a. What is the work function of the metal in J and eV?

   $W = hf_0$

   $W = (6.63 \times 10^{-34} J{\cdot}s)(1.5 \times 10^{14}/s)$

   $W = 9.9 \times 10^{-20} J$

   $W = 0.62 eV$

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   b. The metal is irradiated by light of wavelength 3.0×10^{-7} m. What is the maximum kinetic energy of the photoelectrons in eV?

   $E_k = hf - W$

   $E_k = hc/\lambda - 0.62eV$

   $E_k = \frac{(6.63 \times 10^{-34} J{\cdot}s)(3.00 \times 10^8 m/s)}{3.0 \times 10^{-7} m} - 0.62eV$

   $E_k = 6.63 \times 10^{-19} J - 0.62eV$

   $E_k = 4.1 - 0.62$

   $E_k = 3.5 eV$

4. Light shines on the metal surface in a photocell that has a work function of 1.40 eV. The energy of the most energetic electrons emitted is 0.89 eV. What is the wavelength of the light? In what part of the electromagnetic spectrum is this wavelength?

   $E_k = hf - W$

   $0.89eV = hf - 1.40eV$

   $hf = 2.29eV$

   $hf = 3.66 \times 10^{-19} J$

   $f = 5.5 \times 10^{14} Hz$

   $\lambda = 5.4 \times 10^{-7} m$ ← green.

3

Name ______________________ Period ________ Date ________

2 **5.** Calculate the deBroglie wavelength of an automobile of mass 1570 kg traveling at a speed of 35 m/s. Could this wavelength be observed?

$p = \frac{h}{\lambda}$ $\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34} J \cdot s}{(1570 kg)(35 m/s)} = 1.2 \times 10^{-38} m$ not observable

2 **6.** A golf ball of mass 55 kg is moving with a speed of 7600 m/s. Find its deBroglie wavelength.

$\lambda = \frac{6.63 \times 10^{-34} J \cdot s}{(55 kg)(7600 m/s)} = 1.6 \times 10^{-39} m$

3 **7.** Compare the de Broglie wavelengths of an electron and proton moving at 6.0×10^4 m/s.

$\lambda_p = \frac{6.63 \times 10^{-34} J \cdot s}{(1.67 \times 10^{-27} kg)(6.0 \times 10^4 m/s)}$ $\lambda_e = \frac{6.63 \times 10^{-34} J \cdot s}{(9.11 \times 10^{-31} kg)(6.0 \times 10^4 m/s)}$

$\lambda_p = 6.6 \times 10^{-12} m$ $\lambda_e = 1.2 \times 10^{-8} m$ ← 1833 X greater

3 **8.** Find the de Broglie wavelength of an electron starting at rest and crossing a 20.0 kV potential difference in a television set.

$E_k = qV = \frac{1}{2}mv^2$

$v^2 = \frac{2qV}{m}$

$v^2 = \frac{2(1.6 \times 10^{-19} C)(20.0 \times 10^3 V)}{9.11 \times 10^{-31} kg}$

$v = 8.4 \times 10^7 m/s$

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

$\lambda = \frac{6.63 \times 10^{-34} J \cdot s}{(9.11 \times 10^{-31} kg)(8.4 \times 10^7 m/s)}$

$\lambda = 8.7 \times 10^{-12} m$

3 **9.** The electrons in an electron microscope are accelerated through a 5.0×10^4 V potential difference. Compare the wavelength of the electron to the wavelength of visible light.

$E_k = qV = \frac{1}{2}mv^2$

$v^2 = \frac{2qV}{m}$

$v^2 = \frac{2(1.6 \times 10^{-19} C)(5.0 \times 10^4 V)}{9.11 \times 10^{-31} kg}$

$v = 1.3 \times 10^8 m/s$

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

$\lambda = \frac{6.63 \times 10^{-34} J \cdot s}{(9.11 \times 10^{-31} kg)(1.3 \times 10^8 m/s)}$

$\lambda = 5.5 \times 10^{-12} m$ ← smaller than vis light. X 100000 (10^5)

3 **10.** Through what voltage must an electron be accelerated to obtain a deBroglie wavelength of 6.54×10^{-5} cm?

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

$6.54 \times 10^{-7} m = \frac{6.63 \times 10^{-34} J \cdot s}{(9.11 \times 10^{-31} kg)(v)}$

$v = 1.1 \times 10^3 m/s$

$E_k = qV = \frac{1}{2}mv^2$

$V = \frac{\frac{1}{2}mv^2}{q}$

$V = \frac{\frac{1}{2}(9.11 \times 10^{-31} kg)(1.1 \times 10^3 m/s)^2}{1.6 \times 10^{-19} C}$

$V = 3.5 \times 10^{-6} V$