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Question 1

2 / 2 points

A photon of wavelength 200 nm is scattered by an electron that is initially at rest. Which one of the following statements concerning the wavelength of the scattered photon is true?

- a) The wavelength is zero nm.
- b) The wavelength is less than 200 nm, but greater than zero.
- c) The wavelength is 100 nm.
- d) The wavelength is 200 nm.
- e) The wavelength is greater than 200 nm.

Question 2

2 / 2 points

The work function for a particular metal is 4.0 eV. Which one of the following best describes the wavelength of electromagnetic radiation needed to eject electrons from this metal?

- a) 310 nm or smaller
- b) 620 nm or greater
- c) 800 nm or greater
- d) 620 nm or smaller
- e) 310 nm or greater

Question 3

2 / 2 points

Which one of the following statements concerning photons is false?

- a) The rest energy of all photons is zero.
- b) Photons have been brought to rest by applying a very strong magnetic field to them.
- c) Photons travel at the speed of light in a vacuum.
- d) The energy of a photon is proportional to its frequency.
- e) Photons have zero mass.

Question 4

2 / 2 points

Which one of the following phrases best describes the term *work function*?

- a) the minimum energy required to remove electrons from a metal surface
- b) the minimum energy required to vaporize a metal surface
- c) the work required to place a charged particle on a metal surface
- d) the work done by electromagnetic radiation when it hits a metal surface
- e) the minimum energy required to remove an atom from a metal surface

Question 5

2 / 2 points

Determine the energy of a single photon in a monochromatic beam of light of wavelength 625 nm.

- a) 2.32 eV
- b) 2.08 eV
- c) 1.99 eV
- d) 3.49 eV
- e) 4.77 eV

Question 6

2 / 2 points

What is the de Broglie wavelength of an electron ($m = 9.11 \times 10^{-31}$ kg) in a 2.5×10^3 -volt X-ray tube?

- a) 0.0072 nm
- b) 0.031 nm
- c) 0.017 nm
- d) 0.011 nm
- e) 0.025 nm

Question 7

2 / 2 points

The x component of the velocity of an electron ($m = 9.11 \times 10^{-31}$ kg) is known to be between 100 m/s and 300 m/s. Which one of the following is a true statement concerning the uncertainty in the x coordinate of the electron?

- a) The minimum uncertainty is about 3×10^{-7} m.
- b) The maximum uncertainty is about 6×10^{-9} m.
- c) The maximum uncertainty is about 6×10^{-7} m.
- d) The minimum uncertainty is about 3×10^{-9} m.
- e) The maximum uncertainty is about 10^6 m.

Question 8

2 / 2 points

A physicist wishes to produce electrons by shining light on a metal surface. The light source emits light with a wavelength of 450 nm. The table lists the only available metals and their work functions.

| <u>Metal</u> | <u>W_0 (eV)</u> |
|--------------|------------------------------|
| barium | 2.5 |
| lithium | 2.3 |
| tantalum | 4.2 |
| tungsten | 4.5 |

Reference: Ref 29-1

Which entry in the table below correctly identifies the metal that will produce the most energetic electrons and their energies?

| <i>Metal</i> | <i>Maximum electron energy observed</i> |
|--------------|---|
| a) tungsten | 2.8 eV |
| b) tungsten | 1.8 eV |
| c) lithium | 0.5 eV |
| d) lithium | 2.3 eV |
| e) tungsten | 4.5 eV |

Question 9

2 / 2 points

The position of a hydrogen atom ($m = 1.7 \times 10^{-27}$ kg) is known to within 2.0×10^{-6} m. What is the minimum uncertainty in the atom's velocity?

- a) zero m/s
- b) 0.0085 m/s
- c) 0.031 m/s
- d) 0.016 m/s
- e) 0.011 m/s

Question 10

2 / 2 points

For which one of the following problems did Max Planck make contributions that eventually led to the development of the "quantum" hypothesis?

- a) the motion of the earth in the ether
- b) uncertainty principle
- c) the invariance of the speed of light in a vacuum
- d) photoelectric effect
- e) blackbody radiation curves