Problem 1: (50)

Question 1: c

Photons with an energy of 7.52 eV strike a material that has a work function of 4.22 eV. The maximum kinetic energy of the electron emitted from this material is

- a. 7.5 eV
- b. 12 eV
- c. 3.3 eV
- d. 0.98 eV
- e. No electrons are ejected by these photons.

Question 2: e

The curve shows the maximum kinetic energy of photoelectrons ejected from a clean metal surface as a function of the frequency of the incident light. The slope of this curve represents

- a. photoelectric current.
- b. the de Broglie wavelength.
- c. the work function.
- d. the energy of the incident photon.
- e. Planck’s constant.
Question 3:
e
The work function for tungsten is 4.58 eV. What is the kinetic energy of electrons emitted when light of wavelength 400 nm is incident on a tungsten surface? (Planck's constant $h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s} = 4.136 \times 10^{-15} \text{ eV} \cdot \text{s}$.)

- a. 0.74 eV
- b. 1.5 eV
- c. 7.7 eV
- d. 2.9 eV
- e. No electrons are emitted.

Question 4: b

An electron and a positron (an antielectron) each have an energy of 0.51 MeV. They destroy one another to produce two identical photons. The frequency of these photons is

- a. $4.1 \times 10^{11} \text{ Hz}$
- b. $1.2 \times 10^{10} \text{ Hz}$
- c. $3.7 \times 10^{10} \text{ Hz}$
- d. $1.6 \times 10^{9} \text{ Hz}$
- e. $2.2 \times 10^{20} \text{ Hz}$

Question 5: e

If the absolute temperature of a blackbody is doubled, the amount of energy radiated per second is multiplied by

- a. $\frac{1}{2}$
- b. 2
- c. 8
- d. 4
- e. 16

Question 6: e

The peak in the radiation spectrum emitted by a blackbody at $T = 1600 \text{ K}$ is at $\lambda = 1.90 \mu\text{m}$. What is the wavelength at the peak if $T = 3000 \text{ K}$?

- a. 3.6 $\mu\text{m}$
- b. 2.6 $\mu\text{m}$
- c. 1.9 $\mu\text{m}$
- d. 1.4 $\mu\text{m}$
- e. 1.0 $\mu\text{m}$
Question 7: d

The figure shows the wave functions for several stationary states of a particle in a one-dimensional box with the wall considered to be infinitely hard. The wave function that could not be representative of a particle in this one-dimensional box is

a. 1
b. 2
c. 3
d. 4
e. 5

Question 8:

For the electron wave function shown in **FIGURE Q40.3**, at what position or positions is the electron most likely to be found? Least likely to be found? Explain.

**FIGURE Q40.3**
The electron is most likely to be found at the point or points where $|\psi(x)|^2$ is a maximum. The graph given in the problem shows $\psi(x)$. The figure here shows $|\psi(x)|^2$. Notice that $|\psi(x = 0 \text{ nm})|^2 < |\psi(x = \pm 2 \text{ nm})|^2$, even though $\psi(x = 0 \text{ nm}) < 0$ in the original graph. So, the electron is most likely to be found at $x = 0 \text{ nm}$. The electron is least likely to be found where $|\psi(x)|^2$ is a minimum. From the figure, $|\psi(x)|^2 = 0$ at $x = \pm 1 \text{ nm}$. Thus, the electron is least likely to be found at $x = \pm 1 \text{ nm}.$

**Question 9**

**What is the value of the constant $a$ in Figure Q40.5?**

**Figure Q40.5**

40.5. The area under the probability density curve must be one. That is, $\int_{-\infty}^{\infty} P(x)dx = 1$. For that to be true for Figure Q40.4, $a$ must be $2 \text{ mm}^{-1}$, because the area of a triangle is half the base times the height.
Question 10

**FIGURE Q40.6** shows wave packets for particles 1, 2, and 3. Which particle can have its velocity known most precisely? Explain.

**FIGURE Q40.6**

Particle 1 because it has a less definite $\Delta x$ and therefore a more definite $\Delta p = \Delta mv$. 