

DO ALL THE PROBLEMS. THE WORTH OF EACH PROBLEM IS MARKED BESIDE THE SPACE FOR THE ANSWER. SHOW YOUR WORK FOR PARTIAL CREDIT.

- 1) A person has a surface area of 1.17 m^2 with a surface (skin) temperature of 95°F . What is the surface temperature in a) $^\circ\text{C}$? [1] 35°C b) in Kelvin? [1] 308 K .
- c) Assuming the person is a perfect blackbody ($\epsilon=1$), at what wavelength does the radiation from the person peak? [2] $9.42 \times 10^{-6} \text{ m}$. d) What is the total power radiated by the person? [2] 597 W .
- e) If the outside temperature is 41°F , what is the total power absorbed by the person? [2] 396 W . f) What is the net power lost by the person via radiation? [2] 201 W .

2) a) Describe one aspect of the **photoelectric effect** that contradicts what the wave theory of light predicts. [3]

b) Indicate in which way it (part a) contradicts what the wave theory predicts. A graph showing what the wave theory predicts and what the experiment gives would suffice. [3]

c) Indicate how the particle (photon) theory accounts for this aspect (part a): [4]

3) a) Given that the work function of a metal is 3.6 eV, what is the cut-off frequency for the photoelectric effect with this metal?

[3] $8.69 \times 10^{14} \text{ Hz}$. b) What wavelength is associated with this cut-off frequency?

[2] 345 nm. c) What is the stopping voltage required for ultraviolet light of wavelength 222 nm ?

[3] 2.0 volts. d) Will blue light of wavelength 500 nm be able to eject electrons from this metal?

[1] No. e) Will UV light of wavelength 300 nm be able to eject electrons from this metal?

[1] Yes.

4) a) List two experiments that indicate light behaves as a wave and not as a particle:

(1) [2]

(2) [2]

b) List two experiments that indicate light behaves as a particle and not as a wave:

(1) [2]

(2) [2]

5) a) What is the energy of a photon given off by a hydrogen atom in going from the $n=5$ state to the $n=4$ state?

[5] $.306 \text{ eV} = 4.90 \times 10^{-20} \text{ J}$. b) What is the wavelength of light from this transition?

[3] $4.06 \times 10^{-6} \text{ m}$. c) What type (or if visible, what color) is this photon?

[2] IR.

6) a) Briefly explain how the DeBroglie wavelength idea is used to explain why electrons can exist in state $n=1$ or state $n=2$ but not in a state with $n=1.66$. [5]

b) Describe one experiment that supports the idea that an electron shows wave properties and has a wavelength equal to the DeBroglie wavelength. [5]

7) a) How big is an atom (length in meters)? [2] 10^{-10} m .

b) How big is the nucleus? [2] 10^{-14} m .

c) How big is the electron? [2] $< 10^{-17} \text{ m}$.

d) How do we know the above value for part b (size of nucleus)? [4]

8) a) What is the speed of an electron accelerated through 44 volts?

[3] $3.93 \times 10^6 \text{ m/s}$.

b) What is the momentum of this electron (at the above speed)?

[3] $3.58 \times 10^{-24} \text{ kg}\cdot\text{m/s}$.

c) What is the wavelength of this electron (at the above momentum)?

[3] $1.85 \times 10^{-10} \text{ m}$.

d) What is the wavelength of a **photon** that has an energy of 44 eV ?

[3] $2.83 \times 10^{-8} \text{ m}$.

9) a) State the Heisenberg Uncertainty Principle. You can use an equation but be sure to define each symbol used: [4]

b) Design an experiment to locate an electron, and show how this principle applies when you try to locate the position of an electron: [4]

10) Explain the following terms as they are related to the operation of a laser:

a) spontaneous emission: [3]

b) stimulated emission: [3]

c) population inversion: [3]

d) light amplification: [3]