

As always, show all your work and circle your final answer. All numeric values are good to 3 significant figures.

$$h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}, \quad m_e = 9.11 \times 10^{-31} \text{ kg}, \quad 1\text{eV} = 1.60 \times 10^{-19} \text{ J}, \quad c = 3.00 \times 10^8 \text{ m/s}, \quad hc = 1240 \text{ eV}\cdot\text{nm}$$

$$K = \frac{1}{2}mv^2, \quad p = mv, \quad E = hf, \quad c = \lambda f, \quad K_{\text{max}} = hf - \phi_0, \quad p = \frac{h}{\lambda}, \quad \lambda = \frac{h}{p}$$

$$\Delta p_x \Delta x \geq \frac{h}{2\pi}, \quad \Delta E \Delta t \geq \frac{h}{2\pi}, \quad E_n = -(13.6\text{eV}) \frac{Z^2}{n^2}$$

1. [3 pts.] An electron is

A. a particle.	B. a wave.	C. both a particle and a wave.	D. just a figment of our imagination.	E. 42
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2. [3 pts.] Electrons are emitted from a metal surface when the metal is illuminated by light of frequency, f . How will the kinetic energy of each electron change if the frequency of the light is increased?

A. No change in each electron's kinetic energy.	B. Each electron will have a greater kinetic energy.	C. Each electron will have a lower kinetic energy.	D. No sure prediction can be made.	E. 42
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3. [3 pts.] What observation led Rutherford to propose that atoms have a small nucleus containing most of the atom's mass?

A. Alpha particles are readily absorbed by thin gold foil.	B. Alpha particles are all reflected and scattered equally in all directions when they contact gold foil.	C. Alpha particles all go through gold foil, being scattered equally in all directions.	D. Most alpha particles go through gold foil, but some are scattered backwards when they contact the foil.	E. The alpha particles whispered into Rutherford's ear what they discovered about atoms after they encountered gold foil.
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[5 pts.] Find the wavelength of the radiation emitted when a hydrogen atom makes a transition from the $n=4$ state to the $n=2$ state.

$$\Delta E = E_{\text{photon}}$$

$$E_n - E_2 = \frac{hc}{\lambda}$$

$$\frac{-13.6\text{eV}}{4^2} - \frac{-13.6\text{eV}}{2^2} = \frac{1240\text{eV}\cdot\text{nm}}{\lambda}$$

$$2.55\text{eV} = \frac{1240\text{eV}\cdot\text{nm}}{\lambda}$$

$$\lambda = \frac{1240\text{eV}\cdot\text{nm}}{2.55\text{eV}}$$

$$\lambda = \mathbf{486\text{nm}}$$

5. [6 pts.] Light of wavelength 280 nm is incident upon a metal that has a work function of 1.30 eV. What is the maximum speed of the emitted electrons?

$$K = \frac{hc}{\lambda} - \phi = \frac{1240\text{eV}\cdot\text{nm}}{280\text{nm}} - 1.30\text{eV} = \mathbf{3.13\text{eV}}$$

$$\frac{1}{2}m_e v^2 = 3.13\text{eV} \left(1.60 \times 10^{-19} \frac{\text{J}}{\text{eV}} \right) = 5.01 \times 10^{-19} \text{ J}$$

$$v = \sqrt{\frac{2(5.01 \times 10^{-19} \text{ J})}{9.11 \times 10^{-31} \text{ kg}}} = \mathbf{1.05 \times 10^6 \frac{\text{m}}{\text{s}}}$$