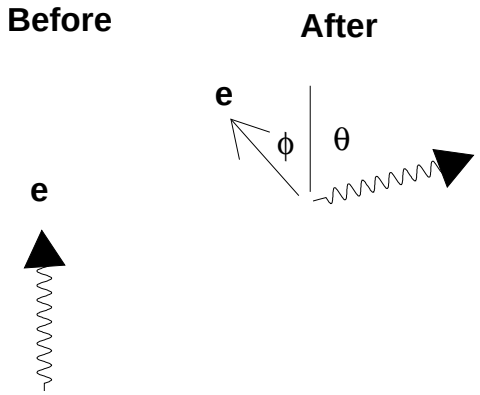
Quantity	**Symbol**	**Value**
Coulombs Constant	k_C	$8.98 \times 10^9\,\mathrm{Nm^2/C^2}$
Electron Mass	m_e	$9.1 \times 10^{-31}\,\mathrm{kg}$
Electron Charge	e	$-1.6 \times 10^{-19}\,\mathrm{C}$
Electron Volt	eV	$1.6 \times 10^{-19}\,\mathrm{J}$
Permitivity	ϵ_o	$8.85 \times 10^{-12}\,\frac{\mathrm{C^2}}{\mathrm{Nm^2}}$
Magnetic Permeability	μ_o	$4\pi \times 10^{-7}\,\mathrm{N \cdot A^2}$
Speed of Light	c	$3.0 \times 10^8\,\mathrm{m/s}$
Planck's Constant	h	$6.6 \times 10^{-34}\mathrm{m^2kg/s}$
Planck's Constant	hc	$1240\ \mathrm{eV\,nm}$
Planck's Constant	$\hbar c$	$197\ \mathrm{eV\,nm}$
Electron Mass	$m_e c^2$	$511\ \mathrm{keV}$
Coupling Constant	$\alpha = \frac{k_C e^2}{\hbar c}$	$1/137$
Bohr Radius	a_o	$0.5\,\mathring{A} = 0.05\,\mathrm{nm}$
Compton Length	$\frac{\hbar}{m_e c} = a_o \alpha$	0.00036 nm
Compton Length	$\frac{\hbar}{m_e c} = a_o \alpha$	0.0023 nm
1/2 of a Rydberg	$\frac{k_c e^2}{2a_o}$	13.6 eV

A rocket ship is sent with a speed $0.7\,c$ of towards a distance planet Foo which is a distance of $6.0 \times 10^8\,\mathrm{m}$ away from earth according to an earth observer. According to an earth observer, after traveling half of the total distance, the rocket sends out a forward scout which travels with a speed $0.95\,c$ (relative to earth).

- According to an earth observer how much time elapsed between take off and when the scout was sent out.
- According to an observer on the rocket ship what is the time between when take off and when the scout was sent out .
- What was the velocity of the scout as measured by someone on the space ship.
- According to earth observer how much much more time is needed for the scout to reach planet Foo.
- According to the observer on the ship what is the distance between himself and planet Foo when the scout is released.
- According to the rocket ship observer how much more time is needed for the scout to reach planet Foo.

work 1

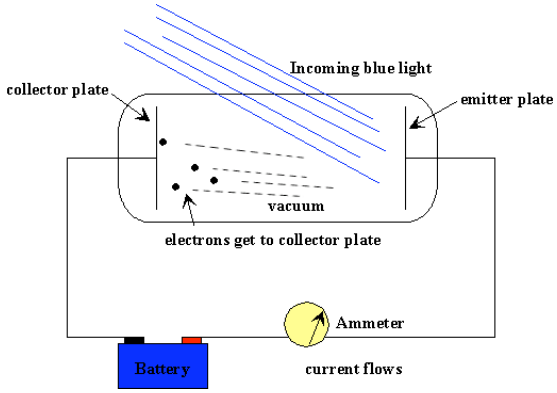
A high energy X-ray of energy $E = 400\,\text{keV}$ is scattered of an electron and is deflected an angle of $\theta = 80^o$ as shown below



- What is the energy and wavelength of the outgoing photon?
- What is the energy of the outgoing electron?
- What is the momentum of the outgoing electron?
- What is the scattering angle ϕ of the outgoing electron?

work 2

A mercury arc lamp is positioned a distance of 10 cm away from a $2 \times 2\,\mathrm{cm}^2$ square alkali metal foil in a photo-electric effect apparatus shown below. The arc lamp emits light with a total power of 1.1 mW uniformly in all directions. The wavelength of the light is 436 nm as is characteristic of mercury vapor. The work function of the metal foil is that of sodium 2.3 eV.



- What is the total number of photons which hit the metal foil per unit time?
- Assuming a that every photon produces a photo-electron what is the measured current?
- What is $\beta = v/c$ of the electron?
- What is the ratio between this velocity and the velocity of an electron in the ground (n=1) state of hydrogen?

work 3

You have an electron which moves around Z protons. In this problem start from the Bohr quantization condition $L = m_e v r = n\hbar$ and the coulomb law. If you are unable to do part one you can use formulas to do other parts

- Determine the velocity of the electron in the n-th orbital.
- Determine the orbital period of an electron in the n-th orbital.
- Evaluate this numerically for the third level of hydrogen ($Z = 1$).

work 4