Photoelectric effect problem

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The unknown is the work function. However, this equation also requires you to convert from wavelength in order to calculate the energy. Recall that the speed of light $c = \lambda\nu$. This means that $\nu = c/\lambda$.

$$h\nu = \frac{hc}{\lambda}$$

In this case we also need to understand that the “maximum” wavelength means the minimum energy needed to eject electrons. Therefore, the energy corresponding to 191 nm is equal to the work function.

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For the first part we calculate the work function as follows:

$$\Phi = \frac{\mathrm{hc}}{\lambda} = \frac{(6.626 \text{ x } 10^{-34}\, Js)(2.99 \text{ x } 10^{8}\text{ m/s})}{196\, x 10^{-9}\, m}$$

$$\Phi = 1.01 \text{ x } 10^{-18}\, J$$

Here we can convert to eV, which may be good to do as a check. For the remainder of the problem it is probably easier just to leave the energy in Joules.

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Let's check the energy in eV. Remember that to convert from Joules to eV
We will divide by the charge on an electron

$$\Phi(\mathrm{eV}) = \frac{\Phi(\mathrm{J})}{e} = \frac{1.01 \mathrm{~x~} 10^{-18}\, J}{1.602\, x\, 10^{-19}\, C} = 6.31\, eV$$

I looked it up on the internet and found 6.35 eV. Well, there may be slightly different sources for these numbers, but it seems at least reasonable.

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For the last part we solve for kinetic energy (and then velocity)

$$\frac{1}{2}\mathrm{m}v^2 = \frac{\mathrm{hc}}{\lambda} - \Phi$$

$$\frac{1}{2}\mathrm{m}v^2 = \frac{(6.626 \text{ x } 10^{-34}\ Js)(2.99 \text{ x } 10^{8}\ \mathrm{m/s})}{141\ x10^{-9}\ m} - 1.01 \text{ x } 10^{-18}\ J$$

$$\frac{1}{2}\mathrm{m}v^2 = 3.95 \text{ x } 10^{-19}\ J$$

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Now for the velocity

$$T = \frac{1}{2}\mathrm{m}v^2$$

$$v = \sqrt{\frac{2T}{m}} = \sqrt{\frac{2(3.95 \text{ x } 10^{-19}\, J\ )}{9.1 \text{ x } 10^{-31}\ kg}}$$

$$v = 9.31\ x\ 10^5\ m/s$$