Post Lab Questions:

1. Three students are discussing two photoelectric effect investigations where different metals were illuminated with different wavelength and intensity E-M waves. The E-M waves used in investigation A had a longer wavelength than those used in investigation B. Electrons were ejected from both metals, but more electrons were ejected from metal B than from metal A.

Amy: *"Since more electrons were ejected from metal B that means the intensity of the light used in that investigation was higher."*

Ben: *"I don't think we can say that, since the wavelength used in B was shorter those waves would have more energy so they could eject more electrons even at lower intensity."*

Corinne: *"No I think what we can conclude is that the work function for metal B is smaller and that is why more electrons were ejected from B."*

With which, if any, of these students do you agree?

__X__ **Amy** _____ **Ben** _____ **Corinne** _____ **None of them**

Explain your reasoning.

the number of electrons emitted depends on how many photons are being absorbed, not their energy.

2. What is the threshold frequency (minimum frequency to produce photoelectrons) of light for calcium?(7E14 Hz)

$\phi_{Ca} = 2.9\,eV$ $\quad \lambda = \frac{1240\,eV\,nm}{2.9\,eV} = 427.6\,nm$

$f = \frac{c}{\lambda} = \frac{3\cdot 10^8}{427.6\cdot 10^{-9}} = \boxed{7.02\cdot 10^{14}\,Hz}$

3. If light with a wavelength of 400 nm is directed to the surface of potassium, what is the maximum kinetic energy of the electrons ejected from the surface of the metal? (0.803 eV)

$E_\gamma = \frac{1240\,eV\,nm}{400\,nm} = 3.1\,eV$ $\quad \phi_K = 2.3\,eV$

$KE_e = E_\gamma - \phi$

$= 3.1 - 2.3 = \boxed{0.8\,eV}$

4. When blue light, with a wavelength of 420 nm is directed at the surface of a metal, the maximum kinetic energy of electrons ejected from the surface of a metal is 0.30 eV. What is the threshold wavelength for this metal? (468 nm)

$E_\gamma = \frac{1240}{420} = 2.95\,eV$ $\quad \lambda = \frac{1240}{\phi}$

$\phi = E_\gamma - KE$ $\quad = \boxed{467.5\,nm}$

$= 2.95 - .3 = 2.65\,eV$

5. A metal has a work function of 1.25 eV. If light with a frequency of 5.0 x 10^{14} Hz falls on the surface of the metal, what is the maximum kinetic energy of the ejected electrons? (0.818 eV)

$E_\gamma = hf = (4.14\cdot10^{-15}\ eVs)(5\cdot10^{14}\ Hz)$
$= 2.07\ eV$

$KE = E_\gamma - \phi = 2.07 - 1.25$
$= 0.82\ eV$

6. The work function for sodium, cesium, copper and iron are 2.3, 2.1, 4.7 and 4.5 eV. Which of these metals will not emit electrons when visible light (400 – 750 nm) shines on it?

Energy range: $\frac{1240}{750} - \frac{1240}{400}$
$= 1.653 \rightarrow 3.1$

max energy input is 3.1 eV which is not enough for copper and iron so only Na and Cs produce electrons

7. Barium has a work function of 2.48 eV. What is the kinetic energy of electrons if the metal is illuminated by UV light with λ = 365 nm? If the mass of an electron is 9.11*10^{-31} kg, what is the speed of the electron? (0.923 eV, 570,000 m/s)

$E_\gamma = \frac{1240}{365} = 3.4\ eV$

$KE = E_\gamma - \phi$
$= 3.4 - 2.48$

$KE = 0.92\ eV$

$KE = 0.92\cdot1.602\cdot10^{-19}$
$= 1.474\cdot10^{-19}\ J = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2KE}{m}}$
$= 569,000\ m/s$

8. In Einstein's photoelectric experiment, he measured the kinetic energy of the electrons by measuring how much voltage was needed to stop the electrons. The electric potential energy of a charged particle in an electric field is simply the product of the charge and voltage. If 200 nm light shines on an aluminum plate, a) what is the stopping voltage needed and b) what is the speed of the ejected electrons? (2.13 V, 865,000 m/s)

$E_\gamma = \frac{1240}{200} = 6.2\ eV$

$\phi_{Al} = 4.08\ eV$

$KE = E_\gamma - \phi$
$= 6.2 - 4.08$
$= 2.12\ eV$

If electrons stop, then $KE_{max} = \Delta U_E = q\Delta V$

$2.12\ eV\cdot e = e\Delta V$
$\Delta V = 2.12\ V$

$KE = 2.12\ eV\cdot(1.602\cdot10^{-19})$
$= 3.4\cdot10^{-19}\ J = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2KE}{m}}$
$= 863,000\ m/s$