VI. [Total 20pts]
A. Consider the photoelectric experiment apparatus shown at right. The electrodes are made of aluminum ($E_{0,Al} = 4.3$ eV). The light source is turned on and has a wavelength of 250 nm. The orientation of the ammeter shown in the circuit is such that the ammeter reading would be positive for a clockwise flow of conventional current.

1. [3pts] For the experiment described above, would the ammeter reading be:
   A. positive
   B. negative
   C. zero
   D. there is not enough information

   The energy of a photon ($E_{photon} = 1240 \text{ eV-nm} / 250 \text{ nm} = 5.0 \text{ eV}$) is greater than the work function ($\Phi_{Al} = 4.2$ eV), and thus electrons will be emitted. However, the direction of battery potential in the circuit opposes the flow of the emitted electrons. This stopping potential ($3 \text{ eV}$) is greater than the maximum kinetic energy of the emitted electrons ($5.0 - 4.2 = 0.8 \text{ eV}$). Therefore, none of the emitted electrons will reach cathode A and the ammeter reading will be zero (choice C).

2. [3pts] As shown at right, the batteries are removed from the circuit. Would the ammeter reading be:
   A. positive
   B. negative
   C. zero
   D. there is not enough information

   As discussed above, the photon energy ($5.0 \text{ eV}$) is greater than the work function ($\Phi_{Al} = 4.2$ eV), and thus electrons will be emitted and some of the emitted electrons will reach electrode A. The counter-clockwise flow of electrons and thus the clockwise flow of conventional current will show a positive reading on the ammeter (choice A).

3. [3pts] Suppose the wavelength of the light is doubled. Would the ammeter reading be:
   A. positive
   B. negative
   C. zero
   D. there is not enough information

   By doubling the photon wavelength to 500 nm, the photon energy will be reduced to half ($E_{photon} = 1240 \text{ eV-nm} / 500 \text{ nm} = 2.5 \text{ eV}$). The new photon energy is less than the work function ($\Phi_{Al} = 4.2$ eV), and thus no electron emission occurs and no current flows in the circuit (choice C).

B. Coherent red light is incident on a mask with three very narrow slits separated by distance $d$. Suppose that the screen is semicircular. The dashed and solid lines on the diagram below indicate angles corresponding to interference minima and maxima, respectively, due to light from the three slits.

1. [4 pts] What is the path length difference from two adjacent slits to point $X$ on the screen in terms of $\lambda$?
   A. $4\lambda/3$
   B. $2\lambda/3$
   C. $2\lambda$
   D. there is not enough information
For three-slit interference, the path length difference from two adjacent slits, $\Delta D_{\text{adj}}$, equal to $\frac{\lambda}{3}$, $2\left(\frac{\lambda}{3}\right)$, $4\left(\frac{\lambda}{3}\right)$, $5\left(\frac{\lambda}{3}\right)$, ... would result in minima. $X$ points to the second minimum for the three-slit interference. Therefore, $\Delta D_{\text{adj}}$ to this point is $2\left(\frac{\lambda}{3}\right)$ (choice B).

2. [4 pts] What is the path length difference from two adjacent slits to point $Y$ on the screen in terms of $\lambda$?
   
   A. $4\lambda/3$
   B. $2\lambda/3$
   C. $2\lambda$
   D. there is not enough information

   $Y$ points to the third minimum for the three-slit interference. Therefore, the path length difference from two adjacent slits to this point is $4\left(\frac{\lambda}{3}\right)$ (choice A).

3. [3 pts] What is the distance on the screen between points $X$ and $Y$ in terms of $\lambda$?
   
   A. $4\lambda/3$
   B. $2\lambda/3$
   C. $2\lambda$
   D. there is not enough information

   To determine the distance on the screen between points $X$ and $Y$, one needs to know the distance from the slits to the screen. Since this information is not provided, there is not enough information to answer this question (choice D).