3-36. (a) \[ E = hf = \frac{hc}{\lambda} = \frac{1240 \text{ eV} \cdot \text{nm}}{0.0711 \text{ nm}} = \boxed{1.75 \times 10^4 \text{ eV}} = 17.5 \text{ keV} \]

(b) For \( \theta = 180^\circ \), \( \cos \theta = -1 \) so we get:

\[ \lambda_2 = \lambda_1 + \frac{h}{m} (1 - \cos \theta) \]

\[ = 0.0711 + [(1240 \text{ eV} \cdot \text{nm})/(5.11 \times 10^5 \text{ eV})] \]

\[ \lambda_2 = 0.0760 \text{ nm} \]

(c) The corresponding photon energy is:

\[ E_2 = \frac{hc}{\lambda_2} = \frac{1240 \text{ eV} \cdot \text{nm}}{0.0760 \text{ nm}} = \boxed{1.63 \times 10^4 \text{ eV}} = 16.3 \text{ keV} \]

(d) Total energy is conserved, so the electrons K.E. is:

\[ E = 1.75 \times 10^4 \text{ eV} - 1.63 \times 10^4 \text{ eV} \]

\[ E = 1130 \text{ eV} = 1.13 \text{ keV} \]

3-49. To get useful information from the data it's best to make a graph like Fig 3-13. The stopping potential is given by:

\[ qV_0 = hf - \phi \]

\[ = \frac{hc}{\lambda} - \phi \]

so \( V_0 \) is a linear function of \( f \) or of \( \lambda \). For each wavelength let's find the frequency using \( \lambda f = c \)

\[ \lambda = 253.5 \text{ nm} \quad f = 1.183 \times 10^{15} \text{ /s} \]

<table>
<thead>
<tr>
<th>( \lambda )</th>
<th>( f )</th>
</tr>
</thead>
<tbody>
<tr>
<td>312.5</td>
<td>0.960</td>
</tr>
<tr>
<td>365.0</td>
<td>0.822</td>
</tr>
<tr>
<td>404.7</td>
<td>0.741</td>
</tr>
<tr>
<td>433.9</td>
<td>0.691</td>
</tr>
</tbody>
</table>

(a) The graph is on the next page. To get the work function draw a line through the points and extrapolate to \( f = 0 \). At \( f = 0 \) we have \( qV_0 = -\phi \) \( \Rightarrow \) I get:

\[ \phi \approx 2.3 \text{ eV} \]
(b) We get Planck's constant from the slope. I get

\[ h = \frac{1.2 \text{eV}}{0.3 \times 10^{15} \text{s}} \Rightarrow h = 4.0 \times 10^{-15} \text{eV.s} \]

(c) The work function for lead is 4.14eV, which is (4.14-2.3)eV = 1.84eV greater than lithium \( \Rightarrow \) the electron energies would be smaller by 1.84eV. We get emission only for 253.5 nm.

---

The average energy is given by Eq. 8.84

\[ \langle E \rangle = \frac{hf}{e^{hf/kT} - 1} \]

\[ = KT \left[ \frac{hf/kT}{e^{hf/kT} - 1} \right] \]

(\( a \)) \( T = 10 \text{hf/k} \)

\[ \Rightarrow hf/kT = \frac{1}{10} \]

\[ \langle E \rangle = (KT) \frac{0.1}{e^{0.1} - 1} \]

\[ \langle E \rangle = 0.951KT \]

Which is close to the equipartition value.

(\( b \)) \( T = hf/k \Rightarrow hf/kT = 1 \)

\[ \langle E \rangle = KT \frac{1}{e^{1} - 1} = 0.582KT \]

(\( c \)) \( T = 0.1 \frac{hf}{k} \Rightarrow \frac{hf}{kT} = 10 \)

\[ \langle E \rangle = KT \frac{10}{e^{10} - 1} = 0.000454KT \]
From Eq. 8-86 we can find \( C_V \) at temperature \( T = T_E \).

\[
C_V = 3R \left( \frac{T_E}{T} \right)^2 \frac{e^{T_E/T}}{(e^{T_E/T} - 1)^2} = 3R (1)^2 \frac{e^1}{(e^1 - 1)^2}
\]

\[
= 3R (0.92)
\]

\[
= 3(1.987 \text{ cal/mole K})(0.92) = 5.49 \text{ cal/mole K}
\]

So \( T_E \) is roughly the temperature where \( C_V = 5.5 \text{ cal} \).

From the graph I get:

- \( T_E = 140 \text{ K} \) for gold
- \( 250 \text{ K} \) for Al
- \( 580 \text{ K} \) for Be
- \( > 1000 \text{ K} \) for diamond

The wavelengths are supposed to be given by the formula

\[
\lambda = \frac{1}{R \left( \frac{1}{m^2} - \frac{1}{n^2} \right)}
\]

\( n > m \)

where \( R = 1.096776 \times 10^7 \text{ /m} = 0.01096776 \text{ /nm} \).

Trying random values I get...
\[ \lambda = 7460 \quad m=5, \quad n=6 \]
\[ \lambda = 4654 \quad m=5, \quad n=7 \]
\[ \lambda = 3741 \quad m=5, \quad n=8 \]

There is no way to get 4103 nm.

4-14) From 4-19 \[ a_0 = \frac{k^2}{mke^2} \]. In the books notation \( k = \frac{1}{4\pi\epsilon_0} \) we have \( \alpha = \frac{ke^2}{mc^2} \) so we can write

\[ a_0 = \frac{k^2c^2}{mc^2ke^2} = \left( \frac{ke}{mc^2} \right) \left( \frac{ke}{c^2} \right) = \left( \frac{ke}{mc^2} \right) \frac{1}{\alpha} = \frac{h}{2\pi mc} \frac{1}{\alpha} \]

So

\[ a_0 = \frac{\lambda c}{2\pi \alpha} \]

\[ \lambda c = \frac{h}{mc} \]

From 4-20
\[ E_1 = -\frac{mk^2z^2e^4}{2h^2n^2} \]

So the magnitude \( E_1 \) for hydrogen \( (z=1) \) is

\[ |E_1| = \frac{1}{2} mc^2 \frac{k^2e^4}{h^2c^2} \left( \frac{1}{\alpha} \right) \Rightarrow E_1 = \frac{1}{2} \alpha^2 mc^2 \]

4-15) The wavelengths are given by \( \frac{1}{\lambda} = R \left[ \frac{1}{n^2} - \frac{1}{m^2} \right] \) where \( m > n \) (so \( m \) is the initial state and \( n \) is the final state). For the Lyman series \( n=1 \). I get the following results:

- \( m=2 \quad \lambda = 121.57 \)
- \( m=3 \quad \lambda = 102.57 \)
- \( m=4 \quad \lambda = 97.25 \)

The series limit (setting \( m \to \infty \)) is \( \lambda = 91.18 \text{ nm} \). These are all well outside the visible region.

4-41) From 4-14 we had \( a_0 = \frac{k}{mc} \frac{1}{\alpha} \) so in general \( \frac{\lambda}{n} = \frac{k}{mc} \frac{1}{\alpha} n^2 \).

But \( |E_1| = mre^2 = nh \Rightarrow \)

\[ v = \frac{nh}{mr} = \left( \frac{nh}{m} \right) \left( \frac{mc}{h} \right) \frac{1}{n^2} \Rightarrow v = \frac{\alpha c}{n} \]