1. As 1 eV = 1.602 × 10^{-19} J, the kinetic energy = \( T = 100 \text{ eV} = 1.602 \times 10^{-17} \text{ J} \). Rearranging the equation for the kinetic energy in terms of the momentum gives and substituting in the value of the electron mass, \( m_e \), gives:

\[
p = \sqrt{2m_e \times T}
\]

\[
= \sqrt{2 \times (9.109 \times 10^{-31} \text{ kg}) \times (1.602 \times 10^{-17} \text{ J})} = 5.402 \times 10^{-24} \text{ kg m s}^{-1}
\]

As the momentum \( p = mv \), the electron velocity is:

\[
v = \frac{p}{m_e} = \frac{(5.402 \times 10^{-24} \text{ kg m s}^{-1})}{(9.109 \times 10^{-31} \text{ kg})} = 5.93 \times 10^{6} \text{ m s}^{-1}
\]

From de Broglie’s relationship, the wavelength associated with a particle of momentum \( p \) is:

\[
\lambda = \frac{h}{p} = \frac{(6.626 \times 10^{-34} \text{ J s})}{(5.402 \times 10^{-24} \text{ kg m s}^{-1})} = 1.23 \times 10^{-10} \text{ m} = 1.23 \text{ angstroms}
\]

2. The energy levels get closer and closer together as \( n \) increases so the biggest gap is between the \( n = 1 \) and \( n = 2 \) levels.

Helium has \( Z = 2 \). The energy of the \( n = 1 \) and \( n = 2 \) levels are:

\[
E_1 = \frac{-E_R (2)^2}{(1)^2} = -4E_R \quad \text{and} \quad E_2 = \frac{-E_R (2)^2}{(2)^2} = -E_R
\]

The energy separation is \( 3E_R = 3 \times (2.18 \times 10^{-18} \text{ J}) = 6.54 \times 10^{-18} \text{ J} \)

3. Radial part:

[Diagram of the radial part of the electron's orbit]
4. | Orbital | $n$ | $l$ | $m_l$ 
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>4$d$</td>
<td>4</td>
<td>2</td>
<td>-2, -1, 0, 1, 2</td>
</tr>
<tr>
<td>1$s$</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3$p$</td>
<td>3</td>
<td>1</td>
<td>-1, 0, 1</td>
</tr>
<tr>
<td>5$d$</td>
<td>5</td>
<td>2</td>
<td>-2, -1, 0, 1, 2</td>
</tr>
</tbody>
</table>

5. **2$p$:**

\[ \text{nodal plane} \]

**3$p$:**

\[ \text{nodal plane} \hspace{1cm} \text{spherical node} \]

6. (a) O \([\text{He}]2s^22p^4\) [He] ↑↓ ↑↑ ↑↑
(b) Ga \([\text{Ar}]4s^23d^{10}4p^1\) [Ar] ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ ↑
(c) Fr \([\text{Rn}]7s^1\) [Rn] ↑