Halliday/Resnick/Walker
Fundamentals of Physics 8th edition

Classroom Response System Questions

Chapter 40: All about Atoms

Interactive Lecture Questions
40.2.1. Experiments show that each element in the periodic table has a unique set of spectral lines. What is the best explanation for this observation?

a) Each element has a unique nucleus.

b) The number of electrons within each atom is unique.

c) Each element has a unique set of interactions between its electrons and its protons.

d) The motion of the electrons within each atom is unique.

e) Each atom has a unique set of energy levels.
40.2.1. Experiments show that each element in the periodic table has a unique set of spectral lines. What is the best explanation for this observation?

a) Each element has a unique nucleus.

b) The number of electrons within each atom is unique.

c) Each element has a unique set of interactions between its electrons and its protons.

d) The motion of the electrons within each atom is unique.

e) Each atom has a unique set of energy levels.
40.2.2. Which one of the following statements best explains why a neon sign does not emit visible light after it is turned off?

a) All of the neon atoms have principle quantum number $n = 0$.

b) All of the neon atoms are ionized.

c) None of the neon atoms are in the $n = 2$ state.

d) Most of the neon atoms are in the ground state.

e) Only some of the neon atoms have returned to the $n = 1$ state.
40.2.2. Which one of the following statements best explains why a neon sign does not emit visible light after it is turned off?

a) All of the neon atoms have principle quantum number \( n = 0 \).

b) All of the neon atoms are ionized.

c) None of the neon atoms are in the \( n = 2 \) state.

d) Most of the neon atoms are in the ground state.

e) Only some of the neon atoms have returned to the \( n = 1 \) state.
40.2.3. The figure shows an energy level diagram for the hydrogen atom. Several transitions are shown and are labeled by letters. **Note:** *The diagram is not drawn to scale.* Which transition corresponds to the absorption of the photon with the longest wavelength?

- a) A
- b) B
- c) C
- d) D
- e) E
40.2.3. The figure shows an energy level diagram for the hydrogen atom. Several transitions are shown and are labeled by letters. **Note:** The diagram is not drawn to scale. Which transition corresponds to the absorption of the photon with the longest wavelength?

a) A  
b) B  
c) C  
d) D  
e) E
40.2.4. The figure shows an energy level diagram for the hydrogen atom. Several transitions are shown and are labeled by letters. **Note:** *The diagram is not drawn to scale.* Which transition involves the longest wavelength line in the visible portion of the hydrogen spectrum?

a) A  
b) B  
c) C  
d) D  
e) E
40.2.4. The figure shows an energy level diagram for the hydrogen atom. Several transitions are shown and are labeled by letters. **Note:** The diagram is not drawn to scale. Which transition involves the longest wavelength line in the visible portion of the hydrogen spectrum?

a) A  
b) B  
c) C  
d) D  
[e) E
40.3.1. A hydrogen atom is in a state for which the principle quantum number is \( n = 2 \). How many possible states are there for which the magnetic quantum number is equal to one?

a) zero

b) one

c) two

d) four

e) six
40.3.1. A hydrogen atom is in a state for which the principle quantum number is \( n = 2 \). How many possible states are there for which the magnetic quantum number is equal to one?

a) zero

b) one

c) two

d) four

e) six
40.3.2. A hydrogen atom is in a state for which the principle quantum number is six and the magnetic quantum number is three. What are the possible values for the orbital quantum number?

a) 0 or 3 only

b) 3 or 5 only

c) 4 or 6 only

d) 3, 4, or 5 only

e) 4, 5, or 6 only
40.3.2. A hydrogen atom is in a state for which the principle quantum number is six and the magnetic quantum number is three. What are the possible values for the orbital quantum number?

a) 0 or 3 only
b) 3 or 5 only
c) 4 or 6 only
d) 3, 4, or 5 only
e) 4, 5, or 6 only
40.3.3. Which one of the following sets of quantum numbers is not possible?

<table>
<thead>
<tr>
<th>( n )</th>
<th>( l )</th>
<th>( m_l )</th>
<th>( m_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 2</td>
<td>3</td>
<td>−2</td>
<td>+1/2</td>
</tr>
<tr>
<td>b) 4</td>
<td>3</td>
<td>+2</td>
<td>+1/2</td>
</tr>
<tr>
<td>c) 3</td>
<td>1</td>
<td>0</td>
<td>−1/2</td>
</tr>
<tr>
<td>d) 6</td>
<td>2</td>
<td>−1</td>
<td>+1/2</td>
</tr>
<tr>
<td>e) 5</td>
<td>4</td>
<td>−4</td>
<td>−1/2</td>
</tr>
</tbody>
</table>
40.3.3. Which one of the following sets of quantum numbers is not possible?

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>l</td>
<td>m&lt;sub&gt;l&lt;/sub&gt;</td>
<td>m&lt;sub&gt;s&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>2</td>
<td>3</td>
<td>−2</td>
<td>+1/2</td>
</tr>
<tr>
<td>b)</td>
<td>4</td>
<td>3</td>
<td>+2</td>
<td>+1/2</td>
</tr>
<tr>
<td>c)</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>−1/2</td>
</tr>
<tr>
<td>d)</td>
<td>6</td>
<td>2</td>
<td>−1</td>
<td>+1/2</td>
</tr>
<tr>
<td>e)</td>
<td>5</td>
<td>4</td>
<td>−4</td>
<td>−1/2</td>
</tr>
</tbody>
</table>
40.3.4. An electron in a hydrogen atom is described by the quantum numbers: \( n = 8 \) and \( m_\ell = 4 \).
What are the possible values for the orbital quantum number \( \ell \)?

a) only 0 or 4

b) only 4 or 7

c) only 5 or 8

d) only 5, 6, 7, or 8

e) only 4, 5, 6, or 7
40.3.4. An electron in a hydrogen atom is described by the quantum numbers: \( n = 8 \) and \( m_\ell = 4 \).

What are the possible values for the orbital quantum number \( \ell \)?

a) only 0 or 4

b) only 4 or 7

c) only 5 or 8

d) only 5, 6, 7, or 8

e) only 4, 5, 6, or 7
40.3.5. Which one of the following values of $m_\ell$ is not possible for $\ell = 2$?

a) zero
b) −1
c) +1
d) +2
e) +3
40.3.5. Which one of the following values of $m_\ell$ is not possible for $\ell = 2$?

a) zero
b) $-1$
c) $+1$
d) $+2$
e) $+3$
40.4.1. Which one of the following statements concerning the electron in the ground state in a hydrogen atom is true within the quantum mechanical model of the atom?

a) The ground state electron has zero ionization energy.

b) The ground state electron has zero orbital angular momentum.

c) The ground state electron has zero binding energy.

d) The ground state electron has zero spin angular momentum.

e) The ground state electron has zero kinetic energy.
40.4.1. Which one of the following statements concerning the electron in the ground state in a hydrogen atom is true within the quantum mechanical model of the atom?

a) The ground state electron has zero ionization energy.

b) The ground state electron has zero orbital angular momentum.

c) The ground state electron has zero binding energy.

d) The ground state electron has zero spin angular momentum.

e) The ground state electron has zero kinetic energy.
40.4.2. According to the quantum mechanical picture of the atom, which one of the following statements is true concerning the magnitude of the angular momentum $L$ of an electron in the $n = 3$ level of the hydrogen atom?

a) $L$ is 0.318$h$.

b) $L$ is 0.477$h$.

c) $L$ could be 0.159$h$ or 0.318$h$.

d) $L$ could be 0.225$h$ or 0.276$h$.

e) $L$ could be 0.225$h$ or 0.390$h$.
40.4.2. According to the quantum mechanical picture of the atom, which one of the following statements is true concerning the magnitude of the angular momentum $L$ of an electron in the $n = 3$ level of the hydrogen atom?

a) $L$ is $0.318\hbar$.

b) $L$ is $0.477\hbar$.

c) $L$ could be $0.159\hbar$ or $0.318\hbar$.

d) $L$ could be $0.225\hbar$ or $0.276\hbar$.

e) $L$ could be $0.225\hbar$ or $0.390\hbar$. 


40.4.3. The principle quantum number for the electron in a hydrogen atom is $n = 4$. According to the quantum mechanical picture of the atom, what is the maximum possible value for the magnitude of the $z$-component of the angular momentum of the electron?

a) $3.17 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s}$

b) $4.22 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s}$

c) $1.99 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s}$

d) $1.06 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s}$

e) $2.11 \times 10^{-33} \text{ kg} \cdot \text{m}^2/\text{s}$
40.4.3. The principle quantum number for the electron in a hydrogen atom is \( n = 4 \). According to the quantum mechanical picture of the atom, what is the maximum possible value for the magnitude of the \( z \)-component of the angular momentum of the electron?

a) \( 3.17 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s} \)

b) \( 4.22 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s} \)

c) \( 1.99 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s} \)

d) \( 1.06 \times 10^{-34} \text{ kg} \cdot \text{m}^2/\text{s} \)

e) \( 2.11 \times 10^{-33} \text{ kg} \cdot \text{m}^2/\text{s} \)
40.4.4. Two possible states for the hydrogen atom are labeled A and B. The maximum magnetic quantum number for state A is +3. For state B, the maximum value is +1. What is the ratio of the magnitudes of the orbital angular momenta, \( \frac{L_A}{L_B} \), of an electron in these two states?

a) 1.22
b) 1.73
c) 2.00
d) 2.45
e) 3.46
40.4.4. Two possible states for the hydrogen atom are labeled A and B. The maximum magnetic quantum number for state A is +3. For state B, the maximum value is +1. What is the ratio of the magnitudes of the orbital angular momenta, LA/LB, of an electron in these two states?

a) 1.22
b) 1.73
c) 2.00
d) 2.45
e) 3.46
40.8.1. Which of the following statements concerning electromagnetic waves emitted from atoms is true?

a) A collection of atoms emits electromagnetic radiation only at specific wavelengths.

b) Atoms only emit radiation in the visible part of the electromagnetic spectrum.

c) Free atoms have $3n$ unique lines in their atomic spectra, where $n$ is the number of electrons.

d) The wavelengths of electromagnetic radiation emitted by free atoms is specifically characteristic of the particular element.
40.8.1. Which of the following statements concerning electromagnetic waves emitted from atoms is true?

a) A collection of atoms emits electromagnetic radiation only at specific wavelengths.

b) Atoms only emit radiation in the visible part of the electromagnetic spectrum.

c) Free atoms have $3n$ unique lines in their atomic spectra, where $n$ is the number of electrons.

d) The wavelengths of electromagnetic radiation emitted by free atoms is specifically characteristic of the particular element.
40.9.1. Which one of the following subshells is not compatible with a principle quantum number of $n = 4$?

a) d

b) f

c) g

d) p

e) s
40.9.1. Which one of the following subshells is not compatible with a principle quantum number of $n = 4$?

a) d

b) f

c) g

d) p

e) s
40.9.2. A neutral atom has the following electronic configuration: 
\[1s^22s^22p^63s^23p^5\]. How many electrons are in the L shell of this atom?

a) 2
b) 4
c) 6
d) 7
e) 8
40.9.2. A neutral atom has the following electronic configuration: \(1s^22s^22p^63s^23p^5\). How many electrons are in the L shell of this atom?

a) 2  
b) 4  
c) 6  
d) 7  
e) 8
40.9.3. A neutral atom has the following electronic configuration: 
1s\(^2\)2s\(^2\)2p\(^5\). How many protons are in the nucleus of this atom?

a) 3
b) 5
c) 9
d) 16
e) There is no way to tell from an electron configuration.
40.9.3. A neutral atom has the following electronic configuration: \(1s^22s^22p^5\). How many protons are in the nucleus of this atom?

a) 3

b) 5

c) 9

d) 16

e) There is no way to tell from an electron configuration.
40.9.4. Determine the maximum number of electron states with principal quantum number \( n = 3 \)?

a) 2

b) 3

c) 6

d) 9

e) 18
40.9.4. Determine the maximum number of electron states with principal quantum number \( n = 3 \)?

a) 2  
b) 3  
c) 6  
d) 9  
e) 18
40.9.5. The ground state electronic configuration of a neon atom is $1s^2 2s^2 2p^6$. How many of these electrons have magnetic quantum number $m_l = 0$?

a) 2
b) 4
c) 6
d) 8
e) 10
40.9.5. The ground state electronic configuration of a neon atom is $1s^2 2s^2 2p^6$. How many of these electrons have magnetic quantum number $m_l = 0$?

a) 2

b) 4

c) 6

d) 8

e) 10
40.9.6. A neutral atom has the following electronic configuration: 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^5\). To which group of the periodic table does this element belong?

a) I

b) III

c) IV

d) V

e) VII
40.9.6. A neutral atom has the following electronic configuration: 1s² 2s² 2p⁶ 3s² 3p⁵. To which group of the periodic table does this element belong?

a) I  
b) III  
c) IV  
d) V  
e) VII
40.9.7. Consider the following list of electron configurations:

(1) \(1s^2\ 2s^2\ 3s^2\)
(2) \(1s^2\ 2s^2\ 2p^6\)
(3) \(1s^2\ 2s^2\ 2p^6\ 3s^1\)
(4) \(1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\)
(5) \(1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6\)

Which electronic configuration is characteristic of noble gases?

a) 1
b) 2
c) 3
d) 4
e) 5
40.9.7. Consider the following list of electron configurations:

(1) \(1s^2\ 2s^2\ 3s^2\)
(2) \(1s^2\ 2s^2\ 2p^6\)
(3) \(1s^2\ 2s^2\ 2p^6\ 3s^1\)
(4) \(1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\)
(5) \(1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6\)

Which electronic configuration is characteristic of noble gases?

a) 1
b) 2
c) 3
d) 4
e) 5
40.10.1. Which one of the following statements concerning the cutoff wavelength typically exhibited in X-ray spectra is true?

a) The cutoff wavelength depends on the instrument used to detect the X-rays.

b) The cutoff wavelength depends on the target material.

c) The cutoff wavelength occurs because an incident electron cannot give up all of its energy.

d) The cutoff wavelength occurs because of the mutual shielding effects of K-shell electrons.

e) The cutoff wavelength depends on the potential difference across the X-ray tube.
40.10.1. Which one of the following statements concerning the cutoff wavelength typically exhibited in X-ray spectra is true?

a) The cutoff wavelength depends on the instrument used to detect the X-rays.

b) The cutoff wavelength depends on the target material.

c) The cutoff wavelength occurs because an incident electron cannot give up all of its energy.

d) The cutoff wavelength occurs because of the mutual shielding effects of K-shell electrons.

e) The cutoff wavelength depends on the potential difference across the X-ray tube.
40.10.2. Consider the two graphs shown that are labeled A and B for X-ray intensity per unit wavelength versus wavelength. Which of the following statements is true?

a) The X-ray tubes are operating at different potential differences.

b) The X-ray tubes contain different elements.

c) The X-ray tubes are identical.

d) The tube represented by graph B is operating at a higher potential difference than the tube represented by graph A.

e) All of the above statements are true.
40.10.2. Consider the two graphs shown that are labeled A and B for X-ray intensity per unit wavelength versus wavelength. Which of the following statements is true?

a) The X-ray tubes are operating at different potential differences.

b) The X-ray tubes contain different elements.

c) The X-ray tubes are identical.

d) The tube represented by graph B is operating at a higher potential difference than the tube represented by graph A.

e) All of the above statements are true.
40.12.1. An electron makes a transition from a higher energy state to a lower one without any external provocation. As a result of the transition, a photon is emitted and moves in a random direction. What is the name of this emission process?

a) stationary emission
b) spontaneous emission
c) spectral emission
d) stimulated emission
e) specular emission
40.12.1. An electron makes a transition from a higher energy state to a lower one without any external provocation. As a result of the transition, a photon is emitted and moves in a random direction. What is the name of this emission process?

a) stationary emission

b) spontaneous emission

c) spectral emission

d) stimulated emission

e) specular emission