Teacher Workbooks
Science and Nature Series

Chemistry

$E=mc^2$

Biology

Atomic Structure, Electron Configuration, Classifying Matter and Nuclear Chemistry, Vol. 1

Teachotechnology Publishing Company
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Atomic Structure

An atom is composed of protons, neutrons, and electrons. The protons and neutrons are found in the nucleus of the atom. The electrons are found in the electron cloud, which is an area that surrounds the nucleus.

A standard periodic table of elements can provide you with a great deal of insight into the composition of an atom. The atomic number is equal to the number of protons. The mass number is equal to the number of protons and neutrons. In a neutral atom, the number of protons and electrons are equal. When an atom is in a charged state (ion), the charge indicates the imbalance between protons and electrons. Too many electrons produces a negative charge, too few electrons results in a positive charge.

Example:

\[ \text{O}^{-2} \]

Mass Number = 16  
Atomic Number = 8  
8 protons, 8 neutrons (16-8), 10 electrons (8+2)

Explanation:

- Protons = Atomic Number
- Neutrons = Mass Number – Atomic Number
- Electrons = Charge (+/-) Proton Number.

Complete the following chart.

<table>
<thead>
<tr>
<th>Element or Ion</th>
<th>Atomic Number</th>
<th>Mass Number</th>
<th># of Protons</th>
<th># of Neutrons</th>
<th># of Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ba(^{+2})</td>
<td>137</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al(^{+3})</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F(^{-})</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Br</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ru(^{+3})</td>
<td>101</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cr(^{+2})</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S(^{-2})</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P(^{-3})</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Atomic Structure Practice Sheet 1

1. How many protons and neutrons are present in an atom of calcium (Mass # = 40)?
   Protons = ________
   Neutrons = ________

2. How many protons and neutrons are present in an atom of krypton (Mass # = 84)?
   Protons = ________
   Neutrons = ________

3. How many protons and neutrons are present in an atom of tin (Mass # = 119)?
   Protons = ________
   Neutrons = ________

4. How many protons and neutrons are present in an atom of tungsten (Mass # = 184)?
   Protons = ________
   Neutrons = ________

5. How many protons and neutrons are present in an atom of titanium (Mass # = 48)?
   Protons = ________
   Neutrons = ________

6. What is the name, symbol, and charge of an ion that contains 12 protons and 10 electrons?
   Name = _________________
   Symbol = ________
   Charge = ________

7. What is the name, symbol, and charge of an ion that contains 15 protons and 18 electrons?
   Name = _________________
   Symbol = ________
   Charge = ________

8. What is the mass number, symbol, and charge of an ion that contains 35 protons, 45 neutrons and 36 electrons?
   Mass Number = _________________
   Symbol = ________
   Charge = ________

9. What is the mass number, symbol, and charge of an atom that contains 19 protons, 20 neutrons and 19 electrons?
   Mass Number = _________________
   Symbol = ________
   Charge = ________

10. What is the mass number, symbol, and charge of an ion that contains 87 protons, 136 neutrons and 86 electrons?
    Mass Number = _________________
    Symbol = ________
    Charge = ________
Atomic Structure Practice Sheet 2

1. Write the complete chemical symbol for the ion with 37 protons and 36 electrons.

___________________

6. Write the complete chemical symbol for the ion with 82 protons and 80 electrons.

___________________

2. How many protons, neutrons, and electrons are present in the $^{93}\text{Nb}^{+3}$ ion?

Protons = _____
Neutrons = _____
Electrons = _____

7. What is the atomic mass of an element that has 37 protons, 43 neutrons, and 36 electrons?

___________________

3. How many protons, neutrons, and electrons are present in the $^{141}\text{Ce}^{+4}$ ion?

Protons = _____
Neutrons = _____
Electrons = _____

8. Write the complete chemical symbol for the ion with 73 protons, 108 neutrons, and 68 electrons.

___________________

4. How many protons, neutrons, and electrons are present in the $^{128}\text{Te}^{-2}$ ion?

Protons = _____
Neutrons = _____
Electrons = _____

9. Write the complete chemical symbol for the ion with 75 protons, 111 neutrons, and 71 electrons.

___________________

5. How many protons, neutrons, and electrons are present in the $^{73}\text{Ge}^{-4}$ ion?

Protons = _____
Neutrons = _____
Electrons = _____

10. Write the complete chemical symbol for the ion with 26 protons, 29 neutrons, and 24 electrons.

___________________
# Atomic Structure Quiz

## Version A

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Symbol</th>
<th>Atomic #</th>
<th>Mass #</th>
<th># Protons</th>
<th># Neutrons</th>
<th># Electrons</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>19</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>-1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

## Version B

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Symbol</th>
<th>Atomic #</th>
<th>Mass #</th>
<th># Protons</th>
<th># Neutrons</th>
<th># Electrons</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barium</td>
<td></td>
<td></td>
<td></td>
<td>81</td>
<td>54</td>
<td></td>
<td>-2</td>
</tr>
<tr>
<td>O</td>
<td>15</td>
<td>17</td>
<td>18</td>
<td>18</td>
<td>-2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

## Version C

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Symbol</th>
<th>Atomic #</th>
<th>Mass #</th>
<th># Protons</th>
<th># Neutrons</th>
<th># Electrons</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si</td>
<td>28</td>
<td>13</td>
<td>14</td>
<td>13</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Electron Configuration

Electrons are found in the electron cloud that surrounds the nucleus of an atom. The electron cloud is separated into principal energy level (1, 2, 3,…), sublevels (s, p, d, f). In an electron configuration, the electrons of an atom are described by identifying the energy level of each electron and its sublevel.

The complete electron configuration of an atom is shown by writing symbols for all of the occupied sublevels in sequence, starting from the lowest energy level.

Example: Electron Configuration for Magnesium

\[
\text{Mg} = 1s^2 \, 2s^2 \, 2p^6 \, 3s^2
\]

Write the complete electron configuration for each of the following elements.

1. Lithium
2. Oxygen
3. Neon
4. Carbon
5. Chlorine
6. Calcium
7. Aluminum
8. Phosphorus
9. Sulfur
10. Hydrogen
## Electron Configuration Practice Sheet 1

Identify the element that corresponds to each of the following electron configurations:

<table>
<thead>
<tr>
<th>Electron Configuration</th>
<th>Element Name</th>
<th>Element Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 1s(^2) 2s(^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. 1s(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. 1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^6) 4s(^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. 1s(^2) 2s(^2) 2p(^5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. 1s(^2) 2s(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. 1s(^2) 2s(^2) 2p(^3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. 1s(^2) 2s(^2) 2p(^6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. 1s(^2) 2s(^2) 2p(^6) 3s(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. 1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^6) 4s(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. 1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. 1s(^2) 2s(^2) 2p(^6) 3s(^2) 3p(^4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Electron Orbital Diagrams

Electrons are distributed in the electron cloud into principal energy levels (1, 2, 3, 4, 5, ...), sub levels (s, p, d, f), orbital (s has 1, p has 3, d has 5, and f has 7), and spin (2 electrons per orbital).

Example: Draw an orbital diagram for Mg

Step 1. Draw the electron configuration:

\[1s^2 \ 2s^2 \ 2p^6 \ 3s^2\]

Step 2. Draw orbital based on sublevels:

\[\uparrow \uparrow \ \uparrow \uparrow \ \uparrow \uparrow \ \uparrow \uparrow \ \uparrow \uparrow\]

Draw orbital diagrams for the following atoms:

1. F

2. K

3. B

4. S

5. Cl

6. Al

7. P

8. Ne
# Electron Configuration Review Sheet

**Directions:** For each atom complete the information requested.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(Mass # = 19)</td>
<td>(Mass # = 9)</td>
<td>(Mass # = 14)</td>
<td>(Mass # = 24)</td>
<td>(Mass # = 23)</td>
</tr>
<tr>
<td>Number of protons</td>
<td>=</td>
<td>Number of protons</td>
<td>=</td>
<td>Number of protons</td>
</tr>
<tr>
<td>Number of electrons</td>
<td>=</td>
<td>Number of electrons</td>
<td>=</td>
<td>Number of electrons</td>
</tr>
<tr>
<td>Number of neutrons</td>
<td>=</td>
<td>Number of neutrons</td>
<td>=</td>
<td>Number of neutrons</td>
</tr>
<tr>
<td>Orbital Diagram:</td>
<td></td>
<td>Orbital Diagram:</td>
<td></td>
<td>Orbital Diagram:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Valence Electrons

The electrons found in the outermost energy level of an atom are collectively referred to as **valence electrons**.

**Example:** Oxygen

Electron configuration = \(1s^2 2s^2 2p^4\)

Therefore, Oxygen has 6 valence electrons.

Determine the number of valence electrons in the following atoms:

1. Phosphorus
2. Carbon
3. Neon
4. Silicon
5. Chlorine
6. Nitrogen
7. Helium
8. Potassium
9. Sulfur
10. Helium
11. Hydrogen
12. Boron
13. Lithium
14. Magnesium
15. Aluminum
16. Argon
17. Calcium
18. Beryllium
Lewis Dot Diagrams

Lewis Dot Diagrams are used to indicate the number of valence electrons for an atom.

Example: Nitrogen

Electron configuration = 1s^2 2s^2 2p^3

Therefore, Nitrogen has 5 valence electrons.

Draw Lewis dot diagrams for the following atoms.

1. Oxygen
2. Phosphorus
3. Helium
4. Carbon
5. Magnesium
6. Potassium
7. Beryllium
8. Hydrogen
9. Aluminum
10. Boron
Electron Configuration Review

Directions For 1-7: Given the element Sulfur (Atomic Number 16, Mass Number 32), please provide all the following information for this element.

1. Number of Protons ________________________
2. Number of Neutrons ________________________
3. Number of Electrons ________________________
4. Write the electron configuration __________________________
5. Draw the orbital diagram:

[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
6. Number of valence electrons ______
7. Draw the Lewis dot diagram:

S

Directions For 8-14: Given the element Magnesium (Atomic Number 12, Mass Number 24), please provide all the following information for this element.

8. Number of Protons ________________________
9. Number of Neutrons ________________________
10. Number of Electrons ________________________
11. Write the electron configuration __________________________
12. Draw the orbital diagram:

[ ] [ ] [ ] [ ] [ ]
13. Number of valence electrons ______
14. Draw the Lewis dot diagram:

Mg
Electron Configuration Quiz: Form A

Directions: For identified element identify the ground state electron configuration, orbital diagram, Lewis dot diagram, and number of valence.

1. F- Fluorine

Ground State Electron Configuration: ____________________________________________

Orbital Diagram:

Lewis Dot:

F

# of Valence Electrons: ______

Electron Configuration Quiz: Form B

Directions: For identified element identify the ground state electron configuration, orbital diagram, Lewis dot diagram, and number of valence.

1. Na- Sodium

Ground State Electron Configuration: ____________________________________________

Orbital Diagram:

Lewis Dot:

Na

# of Valence Electrons: ______
### Identifying Compounds, Elements, Mixtures through Common Names

**Elements** are substances that cannot be broken into simpler substances by chemical means. **Compounds** are composed of two or more elements that are chemically combined in definite proportions by mass. **Mixtures** are combinations of two or more substances that can be separated by physical means.

**Directions:** Place a check in the correct box to indicate the classification of each form of matter.

<table>
<thead>
<tr>
<th></th>
<th>Element</th>
<th>Compound</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antimony</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Table Salt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salt and Pepper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Krypton</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cola</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gallium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yttrium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil and Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zirconium</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Identifying Compounds, Elements, Mixtures through Chemical Symbols

Elements are substances that cannot be broken into simpler substances by chemical means. **Compounds** are composed of two or more elements that are chemically combined in definite proportions by mass. **Mixtures** are combinations of two or more substances that can be separated by physical means.

**Directions:** Place a check in the correct box to indicate the classification of each form of matter.

<table>
<thead>
<tr>
<th></th>
<th>Element</th>
<th>Compound</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₂O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C₆H₁₂O₆</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NH₃ + H₂O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO + CO₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
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<td></td>
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<tr>
<td>Oxygen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table Salt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salt and Pepper</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Nuclear Chemistry: Identifying Forms of Radiation

Nuclear reactions are quite different than chemical reactions in that they involve a change inside the nucleus rather than an exchange or sharing of electrons. An unstable nucleus decays into products that are more stable. When an unstable nucleus decays, it releases radiation in the form of alpha particles, beta particles, and/or positrons.

| Alpha Decay: 239\(^{\text{Pu}}\) → 235\(^{\text{U}}\) + 4\(^{\text{He}}\) |
| Beta Decay: 60\(^{\text{Co}}\) → 60\(^{\text{Ni}}\) + 0\(^{-\text{β}}\) |
| Positron Emission: 37\(^{\text{Ca}}\) → 37\(^{\text{K}}\) + 0\(^{+1\text{β}}\) |

Directions: Place a check to identify the form of radiation demonstrated by each reaction below.

| 1. \(234\)\(^{\text{Pa}}\) → 234\(^{\text{U}}\) + 0\(^{-1\text{β}}\) | Alpha | Beta | Positron |
| 2. \(222\)\(^{\text{Rn}}\) → 218\(^{\text{Po}}\) + 4\(^{\text{He}}\) | | | |
| 3. \(37\)\(^{\text{K}}\) → 37\(^{\text{Ar}}\) + 0\(^{+1\text{β}}\) | | | |
| 4. \(99\)\(^{\text{Tc}}\) → 99\(^{\text{Ru}}\) + 0\(^{-1\text{β}}\) | | | |
| 5. \(19\)\(^{\text{Ne}}\) → 19\(^{\text{F}}\) + 0\(^{+1\text{β}}\) | | | |
| 6. \(32\)\(^{\text{P}}\) → 32\(^{\text{S}}\) + 0\(^{-1\text{β}}\) | | | |
| 7. \(238\)\(^{\text{U}}\) → 234\(^{\text{Th}}\) + 4\(^{\text{He}}\) | | | |
| 8. \(53\)\(^{\text{Fe}}\) → 53\(^{\text{Mn}}\) + 0\(^{+1\text{β}}\) | | | |
| 9. \(220\)\(^{\text{Fr}}\) → 216\(^{\text{At}}\) + 4\(^{\text{He}}\) | | | |

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Nuclear Chemistry: Predicting Nuclear Decay Part 1

Directions: Predict the products of the following nuclear reactions.

1. \(^{235}\text{U} \rightarrow ^{231}\text{Th} + \) __________

2. \(\frac{6}{3}\text{Li} + \frac{1}{0}\text{n} \rightarrow ^{4}\text{He} + \) __________

3. \(\frac{14}{6}\text{C} \rightarrow ^{14}\text{N} + \) __________

4. \(^{226}\text{Ra} \rightarrow ^{222}\text{Rn} + \) __________

5. \(^{32}\text{P} + \frac{0}{-1}\text{e} \rightarrow \) __________

6. \(^{220}\text{Fr} + ^{4}\text{He} \rightarrow \) __________

7. \(^{198}\text{Au} \rightarrow ^{198}\text{Hg} + \) __________

8. \(\frac{14}{7}\text{N} + ^{4}\text{He} \rightarrow ^{1}\text{H} + \) __________
Nuclear Chemistry: Predicting Nuclear Decay Part 2

 Directions: Predict the reactants of the following nuclear reactions.

1. \[ \text{__________} \rightarrow ^{231}\text{Th} + ^{4}_{2}\text{He} \]

2. \[ \text{__________} \rightarrow ^{0}_{-1}\text{e} + ^{131}_{54}\text{Xe} \]

3. \[ \text{__________} + ^{4}_{2}\text{He} \rightarrow ^{241}\text{Pu} + ^{1}_{0}\text{n} \]

4. \[ \text{__________} \rightarrow ^{0}_{-1}\text{e} + ^{10}_{5}\text{B} \]

5. \[ ^{7}\text{Li} + \text{__________} \rightarrow ^{8}_{4}\text{Be} \]

6. \[ ^{235}\text{U} + \text{__________} \rightarrow ^{72}_{30}\text{Zn} + ^{1}_{0}\text{n} + ^{160}_{62}\text{Sm} \]

7. \[ \text{__________} \rightarrow ^{0}_{-1}\text{e} + ^{3}_{1}\text{He} \]

8. \[ \text{__________} \rightarrow ^{216}_{85}\text{At} + ^{4}_{2}\text{He} \]
Radioactive substances decay at a constant rate. There are a number of unstable nuclei that decay in a given time. The time that it takes for half of the atoms in a given sample of an element to decay is termed the half-life.

To determine half-life:

\[
\text{Half-life} = \frac{\text{total time elapsed}}{\text{half-life}}
\]

To determine how much of an unstable remains after a given time:

\[
\text{Fraction remaining} = \left(\frac{1}{2}\right)^{\text{Half-life}}
\]

Data Table 1: Known Half-life of selected elements:

<table>
<thead>
<tr>
<th>Element</th>
<th>Half-life</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{198}$Au</td>
<td>2.69 days</td>
</tr>
<tr>
<td>$^{131}$I</td>
<td>8.07 days</td>
</tr>
<tr>
<td>$^{42}$K</td>
<td>12.4 hours</td>
</tr>
<tr>
<td>$^{32}$P</td>
<td>14.3 days</td>
</tr>
<tr>
<td>$^{90}$Sr</td>
<td>28.1 years</td>
</tr>
<tr>
<td>$^{53}$Fe</td>
<td>8.51 minutes</td>
</tr>
</tbody>
</table>

1. Predict the mass of a 75.00 g sample of $^{198}$Au after 16.14 years.

2. How many days are required for $^{32}$P to undergo 6 half-lives?

3. Predict the mass of a 125.00 g sample of $^{42}$K after 62.0 years.

4. Of all of the elements listed above, which element decays the fastest? Predict the mass of a 107g sample of this element after 34.04 minutes.

5. If a 120 g sample of a radioactive element decays to 15 g in 40 minutes, what is the element’s half-life?
Nuclear Chemistry Review Quiz: Form A

Directions (Questions 1 and 2): For questions 1 and 2 predict the missing reactant or product and identify the form of radiation demonstrated in each problem.

1. $^{198}\text{Au} \rightarrow ^{198}\text{Hg} + \text{__________}

   Form of radiation: __________________

2. $^{238}\text{U} + \text{__________} \rightarrow ^{241}\text{Pu} + ^{0}\text{n}

   Form of radiation: __________________

3. Predict the mass of a 135 gram sample $^{85}\text{Kr}$ after 32.28 years.

   $^{85}\text{Kr} \quad \text{Half-life} = 10.76\text{ years}$

---

Nuclear Chemistry Review Quiz: Form B

Directions (Questions 1 and 2): For questions 1 and 2 predict the missing reactant or product and identify the form of radiation demonstrated in each problem.

1. $^{14}\text{C} \rightarrow ^{14}\text{N} + \text{__________}

   Form of radiation: __________________

2. $\text{__________} \rightarrow ^{0}\text{e} -^{1}\text{e} + ^{3}\text{He}

   Form of radiation: __________________

3. Predict the mass of a 155 gram sample $^{32}\text{P}$ after 28.6 days.

   $^{32}\text{P} \quad \text{Half-life} = 14.3\text{ days}$
Part A.

1. For an atom of the element Argon indicate the following information:
   A. Chemical Symbol _________  B. Atomic Number _________
   C. Mass Number 40  D. Number of protons _________
   E. Number of neutrons _________  F. Number of electrons _________

2. For an ion of Magnesium (charge = +2) indicate the following information:
   A. Chemical Symbol _________  B. Atomic Number _________
   C. Mass Number 24  D. Number of protons _________
   E. Number of neutrons _________  F. Number of electrons _________

3. For an ion of Sulfur (charge = -2) indicate the following information:
   A. Chemical Symbol _________  B. Atomic Number _________
   C. Mass Number 32  D. Number of protons _________
   E. Number of neutrons _________  F. Number of electrons _________

4. Identify the element that corresponds to each of the following ground state electron configurations.
   A. 1s² 2s² 2p⁶ 3s¹ _________________________
   B. 1s² 2s² 2p⁴ _________________________
   C. 1s² 2s² 2p⁶ 3s² 3p⁶ 4s¹ _________________________
   D. 1s² 2s² 2p⁶ 3s² 3p³ _________________________

Scoring Part A: _____ correct out of _______  Total Score: ______
Part B.

5. For an atom of each element below write the electron configuration, orbital diagram, total number of valence electrons, and Lewis dot structure.

A. Silicon

Electron configuration: ________________________________

Orbital Diagram:

Total number of valence electrons: _____

Lewis dot structure:

\( \text{Si} \)

B. Oxygen

Electron configuration: ________________________________

Orbital Diagram:

Total number of valence electrons: _____

Lewis dot structure:

\( \text{O} \)

Scoring Part B: _____ correct out of _______  Total Score: _____
Part C.

6. Indicate if the item presented is an element, compound, or mixture.
   A. Water ____________________
   B. Air ____________________
   C. Gold ____________________
   D. Soil ____________________
   E. Neon ____________________

7. Predict the reactants or products of each of the following nuclear reactions.

   A. \( ^{27}_{13}\text{Li} + ^{4}_{2}\text{He} \rightarrow ^{1}_{0}\text{n} + \text{______________} \)

   B. \( \text{______________} \rightarrow ^{0}_{-1}\text{e} + ^{42}_{20}\text{K} \)

   C. \( ^{234}_{90}\text{Th} \rightarrow ^{234}_{90}\text{Pa} + \text{______________} \)

   D. \( \text{______________} \rightarrow ^{0}_{+1}\text{e} + ^{20}_{9}\text{Ne} \)

   E. \( ^{9}_{4}\text{Be} + \text{______________} \rightarrow ^{12}_{6}\text{C} + ^{1}_{0}\text{n} \)

Scoring Part C: _____ correct out of _______                                   Total Score: ______
Part D.

8. Half-life

A. $^3\text{H}$ has a half-life of 12.26 years. A sample was allowed to decay for 49.04 years. What fraction of the original sample will remain?

B. A 75 gram sample of a radioisotope decayed to 9.375 grams in 66 years. What is the half-life?

C. A radioisotope has a half-life of 30 days. 1 gram remains after 90 days. What was the initial mass of the radioisotope?
Unit Test: Form B

Part A.

1. For an atom of the element Calcium indicate the following information:
   A. Chemical Symbol _________    B. Atomic Number _________
   C. Mass Number  40  D. Number of protons _________
   E. Number of neutrons _________        F. Number of electrons _________

2. For an ion of Sodium (charge = +1) indicate the following information:
   A. Chemical Symbol _________    B. Atomic Number _________
   C. Mass Number 23  D. Number of protons _________
   E. Number of neutrons _________        F. Number of electrons _________

3. For an ion of Fluorine (charge = -1) indicate the following information:
   A. Chemical Symbol _________    B. Atomic Number _________
   C. Mass Number  19  D. Number of protons _________
   E. Number of neutrons _________        F. Number of electrons _________

4. Identify the element that corresponds to each of the following electron configurations.
   A. 1s\(^2\) 2s\(^2\) 2p\(^6\)        ________________
   
   B. 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^2\)        ________________
   
   C. 1s\(^2\) 2s\(^1\)        ________________
   
   D. 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^6\) 4s\(^1\)        ________________

Final Score: _____
Part B.

A. Phosphorus

Electron configuration: ________________________________

Orbital Diagram:

Total number of valence electrons: _____

Lewis dot structure:

P

B. Magnesium

Electron configuration: ________________________________

Orbital Diagram:

Total number of valence electrons: _____

Lewis dot structure:

Mg

Scoring Part B: _____ correct out of _______  Total Score: ______
Part C.

6. Indicate if the item presented is an element, compound, or mixture.
   A. Tungsten
   B. Table Salt
   C. Soil
   D. Phosphorus
   E. Oil and Water

7. Predict the reactants or products of each of the following nuclear reactions.
   A. $^{220}\text{Fr} \rightarrow ^{216}\text{At} + \square$
   B. $\square \rightarrow ^{0}\text{e}_{-1} + ^{99}\text{Ru}_{44}$
   C. $^{222}\text{Rn} \rightarrow ^{218}\text{Po} + \square$
   D. $\square \rightarrow ^{0}\text{e}_{+1} + ^{37}\text{K}_{19}$
   E. $^{27}_{13}\text{Li} + ^{4}_{2}\text{He} \rightarrow ^{1}\text{n}_{0} + \square$

Scoring Part C: _____ correct out of _______  Total Score: ______
Part D.

8. Half-life

A. $^{53}\text{Fe}$ has a half-life of 8.51 minutes. A sample was allowed to decay for 42.55 minutes. What fraction of the original sample will remain?

B. A 120 gram sample of a radioisotope decayed to 7.5 grams in 60 years. What is the half-life?

C. A radioisotope has a half-life of 13 days. 3 grams remain after 52 days. What was the initial mass of the radioisotope?
# Answers

## Page 1.

<table>
<thead>
<tr>
<th>Element or Ion</th>
<th>Atomic Number</th>
<th>Mass Number</th>
<th># of Protons</th>
<th># of Neutrons</th>
<th># of Electrons</th>
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<tbody>
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<td>7</td>
<td>3</td>
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<td>3</td>
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<td>137</td>
<td>56</td>
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<td>13</td>
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<td>10</td>
</tr>
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<td>F$^{-}$</td>
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<td>19</td>
<td>9</td>
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<td>10</td>
</tr>
<tr>
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<td>31</td>
<td>15</td>
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<td>18</td>
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## Page 2.

1. Protons = 20, Neutrons = 20
2. Protons = 36, Neutrons = 48
3. Protons = 50, Neutrons = 69
4. Protons = 74, Neutrons = 110
5. Protons = 22, Neutrons = 26
6. Name = Magnesium, Symbol = Mg or Mg$^{+2}$, Charge = +2
7. Name = Phosphorus, Symbol = P or P$^{-3}$, Charge = -3
8. Mass Number = 80, Symbol = Br or Br$^{-1}$, Charge = -1
9. Mass Number = 39, Symbol = K or K$^0$, Charge = 0
10. Mass Number = 223, Symbol = Fr or Fr$^{+1}$, Charge = +1

## Page 3.

1. $^{37}$Rb$^{+1}$
2. Protons = 41, Neutrons = 52, Electrons = 38
3. Protons = 58, Neutrons = 83, Electrons = 54
4. Protons = 52, Neutrons = 76, Electrons = 50
5. Protons = 32, Neutrons = 41, Electrons = 36
6. $^{82}$Pb$^{+2}$
7. $^{80}$Rb$^{+1}$
8. $^{181}$Ta$^{+5}$
9. $^{186}$Re$^{+4}$
10. $^{55}$Fe$^{+2}$
Page 4.

Version A

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<th>Element Name</th>
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<th>Atomic #</th>
<th>Mass #</th>
<th># Protons</th>
<th># Neutrons</th>
<th># Electrons</th>
<th>Charge</th>
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<td>19</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>-1</td>
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<td>Carbon</td>
<td>C</td>
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</table>

Version B

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<th>Element Name</th>
<th>Symbol</th>
<th>Atomic #</th>
<th>Mass #</th>
<th># Protons</th>
<th># Neutrons</th>
<th># Electrons</th>
<th>Charge</th>
</tr>
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<td>Barium</td>
<td>Ba</td>
<td>56</td>
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<td>56</td>
<td>81</td>
<td>54</td>
<td>+2</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O</td>
<td>8</td>
<td>15</td>
<td>8</td>
<td>7</td>
<td>10</td>
<td>-2</td>
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<td>Chlorine</td>
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<td>17</td>
<td>35</td>
<td>17</td>
<td>18</td>
<td>18</td>
<td>-1</td>
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</table>

Version C

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<th>Element Name</th>
<th>Symbol</th>
<th>Atomic #</th>
<th>Mass #</th>
<th># Protons</th>
<th># Neutrons</th>
<th># Electrons</th>
<th>Charge</th>
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<tr>
<td>Sodium</td>
<td>Na</td>
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<td>Aluminum</td>
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<td>27</td>
<td>13</td>
<td>14</td>
<td>13</td>
<td>0</td>
</tr>
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</table>

Page 5.

1. $1s^2 2s^1$
2. $1s^2 2s^2 2p^4$
3. $1s^2 2s^2 2p^6$
4. $1s^2 2s^2 2p^2$
5. $1s^2 2s^2 2p^6 3s^2 3p^5$
6. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
7. $1s^2 2s^2 2p^6 3s^2 3p^1$
8. $1s^2 2s^2 2p^6 3s^2 3p^3$
9. $1s^2 2s^2 2p^6 3s^2 3p^4$
10. $1s^1$
Page 6.
1. Phosphorus, P
2. Lithium, Li
3. Argon, Ar
4. Helium, He
5. Potassium, K
6. Fluorine, F
7. Beryllium, Be
8. Nitrogen, N
9. Neon, Ne
10. Magnesium, Mg
11. Calcium, Ca
12. Aluminum, Al
13. Sulfur, S

Page 7.
1. \(1s^2 2s^2 2p^5\)
   \[\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \uparrow\]
2. \(1s^2 2s^2 2p^6 3s^2 3p^6 4s^1\)
   \[\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \uparrow \uparrow \uparrow \]
3. \(1s^2 2s^2 2p^1\)
   \[\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \]
4. \(1s^2 2s^2 2p^6 3s^2 3p^4\)
   \[\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \uparrow \uparrow \uparrow \]
5. \(1s^2 2s^2 2p^6 3s^2 3p^5\)
   \[\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \uparrow \uparrow \uparrow \]
6. \(1s^2 2s^2 2p^6 3s^2 3p^1\)
   \[\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \]
7. \(1s^2 2s^2 2p^6 3s^2 3p^3\)
   \[\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \uparrow \uparrow \uparrow \]
8. \(1s^2 2s^2 2p^6\)
   \[\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \uparrow \uparrow \uparrow \]

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Page 8.

1. \( P = 9, E = 9, N = 10 \), Elec. Config. = \( 1s^2 2s^2 2p^5 \)
   Orbital Diagram: \[ \begin{array}{c}
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \\
\end{array} \]

2. \( P = 4, E = 4, N = 9 \), Elec. Config. = \( 1s^2 2s^2 \)
   Orbital Diagram: \[ \begin{array}{c}
   \uparrow \downarrow \\
   \uparrow \downarrow \\
\end{array} \]

3. \( P = 7, E = 7, N = 7 \), Elec. Config. = \( 1s^2 2s^2 2p^3 \)
   Orbital Diagram: \[ \begin{array}{c}
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
\end{array} \]

4. \( P = 12, E = 12, N = 12 \), Elec. Config. = \( 1s^2 2s^2 2p^6 3s^2 \)
   Orbital Diagram: \[ \begin{array}{c}
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
\end{array} \]

5. \( P = 11, E = 11, N = 12 \), Elec. Config. = \( 1s^2 2s^2 2p^6 3s^1 \)
   Orbital Diagram: \[ \begin{array}{c}
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
\end{array} \]

6. \( P = 8, E = 8, N = 8 \), Elec. Config. = \( 1s^2 2s^2 2p^4 \)
   Orbital Diagram: \[ \begin{array}{c}
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
   \uparrow \downarrow \\
\end{array} \]

Page 9.

1. 5 10. 2
2. 4 11. 1
3. 8 12. 3
4. 4 13. 1
5. 7 14. 2
6. 5 15. 3
7. 2 16. 8
8. 1 17. 2
9. 6 18. 2
Page 11.

1. \( \cdot O \cdot \)
2. \( \cdot P \cdot \)
3. \( \cdot He \cdot \)
4. \( \cdot C \cdot \)
5. \( \cdot Mg \cdot \)
6. \( \cdot K \cdot \)
7. \( \cdot Be \cdot \)
8. \( \cdot H \cdot \)
9. \( \cdot Al \cdot \)
10. \( \cdot B \cdot \)

Page 12.

1. 16
2. 16
3. 16
4. \( 1s^2 \ 2s^2 \ 2p^6 \ 3s^2 \ 3p^4 \)
5. \( \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \)
6. 6
7. .. S :
8. 12
9. 12
10. 12
11. \( 1s^2 \ 2s^2 \ 2p^6 \ 3s^2 \)
5. \( \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \downarrow \uparrow \)
6. 2
7. .. Mg
Page 13.

Form A

1. $1s^2 \ 2s^2 \ 2p^5$
2. $\uparrow \downarrow \ \uparrow \downarrow \ \uparrow \downarrow \ \uparrow$
3. $\ .. \ F : \ ..$
4. 7

Form B

1. $1s^2 \ 2s^2 \ 2p^6 \ 3s^1$
2. $\uparrow \downarrow \ \uparrow \downarrow \ \uparrow \downarrow \ \uparrow \ \uparrow$
3. $\ .. \ \text{Na} \ ..$
4. 1

Page 13.

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Page 14.

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<td>NH$_3$ + H$_2$O</td>
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<tr>
<td>Salt and Pepper</td>
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Page 15.

1. Beta
2. Alpha
3. Positron
4. Beta
5. Positron
6. Beta
7. Alpha
8. Positron
9. Alpha

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1. $^4_2\text{He}$
2. $^3_1\text{H}$
3. $^0_{-1}\text{e}$
4. $^4_2\text{He}$

5. $^{32}_{14}\text{Si}$
6. $^{224}_{89}\text{Ac}$
7. $^0_{-1}\text{e}$
8. $^{17}_8\text{O}$

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1. $^{235}_{92}\text{U}$
2. $^{131}_{53}\text{I}$
3. $^{238}_{92}\text{U}$
4. $^4_{4}\text{Be}$

5. $^1_1\text{H}$
6. $^1_0\text{n}$
7. $^3_1\text{H}$
8. $^{220}_{87}\text{Fr}$
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1. 4.689 g
2. 85.8 days; Proper sig. Figs. = 90 days
3. 3.91 g
4. 6.688 g
5. 13.3 minutes

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Form A

1. $^0_1 e$; Beta
2. $^4_2 He$; Alpha
3. 16.88 g

Form B

1. $^0_{−1} e$; Beta
2. $^3_1 H$; Beta
3. 38.75 g

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1. A = Ar   B = 18   D = 18   E = 22   F = 18
2. A = Mg   B = 12   D = 12   E = 12   F = 10
3. A = S    B = 16   D = 16   E = 16   F = 18
4. A. Na
   B. O
   C. K
   D. P
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5.

A. $1s^2 2s^2 2p^6 3s^2 3p^2$


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6. A. Compound  B. Mixture  C. Element  D. Mixture  E. Element

7. A. $^{30}\text{P}$  B. $^{42}\text{K}$  C. $^0\text{e}$  D. $^{20}\text{Ne}$  E. $^4\text{He}$

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8. A. 1/16  B. 22 years  C. 8 g

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1. A = Ca  B = 20  D = 20  E = 20  F = 20
2. A = Na  B = 11  D = 11  E = 12  F = 10
3. A = F  B = 9  D = 9  E = 10  F = 10
4. A. Ne  
   B. Si  
   C. Li  
   D. K
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5.

A. $1s^2 2s^2 2p^6 3s^2 3p^3$

B. $1s^2 2s^2 2p^6 3s^2$

P.

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6. A. Element  B. Compound  C. Mixture  D. Element  E. Mixture

7. A. $^4_2$He  B. $^{99}_{43}$Tc  C. $^4_2$He  D. $^{37}_{20}$Ca  E. $^{30}_{15}$P

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8. A. 1/32  B. 15 years  C. 48 g