

Atoms, Molecules & Ions – Supplementary Problems

- Write a brief definition of the following terms. Use complete sentences.

| | | | |
|-------------|-----------|------------------|----------------------|
| a) period | b) group | c) atomic number | d) mass number |
| e) isotopes | f) cation | g) anion | h) valence electrons |
- Copy and fill in the following table:

| Symbol | Atomic # | Mass # | # of Protons | # of Neutrons | # of Electrons |
|------------------|----------|--------|--------------|---------------|----------------|
| ^{57}Fe | | | | | 26 |
| | 16 | | | 14 | |
| | | 210 | 82 | | |
| ^{40}K | | | | | |
| | | | 11 | 12 | |
| | 13 | 27 | | | |

- Draw the **Bohr Diagram** for each isotope below. For each element, indicate the number of valence electrons.

| | | | |
|--------------|----------------|---------------|--------------|
| a) Sodium-23 | b) Fluorine-19 | c) Calcium-40 | d) Oxygen-15 |
|--------------|----------------|---------------|--------------|
- Draw **Energy Level Diagrams** for each element below. For each element, indicate the number of valence electrons.

| | | | |
|--------------|-----------|----------|--------------|
| a) Magnesium | b) Carbon | c) Argon | d) Potassium |
|--------------|-----------|----------|--------------|
- Boron has two naturally occurring isotopes – ^{10}B and ^{11}B . Boron-10 has an atomic mass of 10.0129 amu and an abundance of 19.91%. Boron-11 has an atomic mass of 11.0093 amu and an abundance of 80.09%. Calculate the **average atomic mass** of Boron.
- Magnesium has three naturally occurring isotopes – ^{24}Mg with a mass of 23.9850 amu, ^{25}Mg with a mass of 24.9858 amu, and ^{26}Mg with a mass of 25.9826 amu. If the abundances of the three isotopes are 78.99%, 10.00% and 11.01% respectively, calculate the **average atomic mass** of magnesium.
- Chlorine has two naturally occurring isotopes. Chlorine-35 has a mass of 34.96885 amu, while chlorine-37 has an atomic mass of 36.96590 amu. Use the average atomic mass of chlorine listed on your periodic table to calculate the **natural abundance** of each of the two isotopes.
- Identify the **chemical families** to which the following elements belong:

| | | | | | |
|--------------|---------|--------------|--------------|---------|-------------|
| a) Magnesium | b) Iron | c) Potassium | d) Plutonium | e) Neon | f) Fluorine |
|--------------|---------|--------------|--------------|---------|-------------|

9. For each element below, identify the **group** and **period** number.
- a) Nickel b) Barium c) Lanthanum d) Iodine
10. For each element below, identify the number of **valence electrons** and also the **charge on the ion** formed when the element gains/loses electrons.
- a) sodium b) bromine c) phosphorus d) sulfur e) calcium
11. Which element in group 13 would be least likely to conduct heat or electricity? Explain your choice.
12. What is a **semi-metal**? Give an example and describe its properties that illustrate that the element is a semi-metal (metalloid).
13. What two elements are liquids at room temperature?
14. Draw a **Bohr Diagram** for the following atoms and ions:
- a) Na b) K⁺ c) S²⁻ d) Al³⁺
15. In point form, describe as many contributions to atomic theory/chemistry as you can for each individual below.
- a) John Dalton c) J.J. Thomson f) Marie Curie
 b) Dmitri Mendeleev d) Ernest Rutherford g) Neils Bohr
 c) James Chadwick e) Henri Becquerel
16. Who is credited with the discovery of each element below?
- a) Oxygen b) Neon c) Nitrogen d) Hydrogen
17. What are the origins of the following element names?
- a) iodine c) curium e) promethium g) helium
 b) berkelium d) gallium f) hydrogen h) polonium
18. Copy and fill in the chart below in your notebook.

| Binary Ionic Compounds – Type I and II | | | |
|--|-------------------|--------------------------------|------------------|
| Chemical Formula | IUPAC Name | Chemical Formula | IUPAC Name |
| NaBr | | CaCl ₂ | |
| | zinc fluoride | | iron(II) nitride |
| MgO | | | barium fluoride |
| CuCl ₂ | | Al ₂ O ₃ | |
| | gold(III) sulfide | | tin(IV) bromide |
| Li ₂ S | | K ₃ N | |
| | nickel(III) oxide | | aluminum iodide |
| CoCl ₂ | | Fe ₃ P ₂ | |
| | calcium hydride | | silver selenide |
| | gallium arsenide | Ni ₃ N ₂ | |

19. What are the formulas for the complex ions below?

- a) ammonium c) nitrite e) permanganate g) hydroxide
 b) sulfate d) chlorate f) carbonate h) chromate

20. Copy and fill in the chart below in your notebook.

| Ionic Compounds with Complex Ions | | | |
|-----------------------------------|---------------------|---|----------------------|
| Chemical Formula | IUPAC Name | Chemical Formula | IUPAC Name |
| KOH | | (NH ₄) ₂ SO ₄ | |
| | copper(II) chlorate | | ferric nitrate |
| Al(NO ₂) ₃ | | | gold(III) sulfate |
| Ag ₂ CO ₃ | | Zn(OH) ₂ | |
| | ammonium acetate | | nickel(II) phosphate |
| Na ₂ HPO ₄ | | KClO | |
| | magnesium sulfite | | lithium bicarbonate |
| KMnO ₄ | | Ba(HSO ₄) ₂ | |
| | iron(III) chromate | | ammonium nitrate |
| | silver dichromate | NaCH ₃ COO | |

21. Write brief definitions of the following terms:

- a) covalent compound c) molecule e) complex ion
 b) ionic compound d) simple ion

22. Copy & fill in the following table.

| Covalent Compounds | | | |
|-------------------------------|------------------------|-------------------|--------------------------|
| Chemical Formula | IUPAC Name | Chemical Formula | IUPAC Name |
| SCl ₆ | | XeBr ₄ | |
| | carbon monoxide | | phosphorus pentachloride |
| N ₂ O ₅ | | | ammonia |
| SO ₂ | | IF ₆ | |
| | diphosphorus decaoxide | | dinitrogen tetraoxide |

23. List the properties of acids and of bases.

24. Write a set of instructions (or create a flow-chart) for **naming acids**.

25. Copy and fill in the table below.

| Acids | | | |
|--------------------------------|------------------|--------------------------------|--------------------|
| Chemical Formula | IUPAC Name | Chemical Formula | IUPAC Name |
| HF | | H ₂ CO ₃ | |
| | nitric acid | HCl | |
| | hydrobromic acid | | acetic acid |
| H ₃ PO ₄ | | HNO ₂ | |
| | sulfurous acid | | hydrosulfuric acid |
| H ₂ SO ₄ | | | chlorous acid |
| | perchloric acid | | hypochlorous acid |

More calculations with isotopes and average atomic mass:

26. Lithium exists in nature as Lithium-6 (6.015121 amu) and Lithium-7 (7.016003 amu). If the abundances of the two isotopes are 7.50% and 92.50% respectively, calculate the average atomic mass of lithium.
27. Gallium has two naturally occurring isotopes, ⁶⁹Ga and ⁷¹Ga, with masses of 68.9257 amu and 70.9249 amu, respectively. If the average atomic mass of gallium is 69.723 amu, calculate the natural abundances for these two isotopes.