Electron configuration for first 30 elements including exceptions Cu and Cr
Describe quantum number and atomic structure of atoms

Atomic Structure

- Electrons are not perfectly free to move about outside of an atom's nucleus. Electrons are restricted to certain regions of space within an atom called orbitals. An orbital can only house up to two electrons.
  - Electrons occupy energy levels (1, 2, 3...)
  - Within each energy level there are certain sublevels available (s, p, d and f)
  - Within an s sublevel there is one orbital that may contain up to two electrons max
  - Within a p sublevel there are three orbitals that may contain up to two electrons each (6 electrons max)

- We show the location of electrons through electron configurations.
Problems: Chapter 1 and 3

1) Write the electron configuration for oxygen.

2) What element resides in group 7 and period 2?

3) What element has the symbol Na?

4) What is the collective name for the elements in group 8A?

5) What is the atomic number of carbon?

6) Write the element symbol to represent carbon-12.

7) Circle the symbol that represents an isotope of nitrogen-14.
   A. $^{14}\text{C}$
   B. $^{15}\text{N}$
   C. $^{15}\text{Ni}$
   D. $^{14}\text{Ni}$

8) Classify the following as a chemical or physical change:
   A. Water boils
   B. Sodium metal and chlorine gas form sodium chloride
   C. Sodium metal is sliced into smaller pieces
   D. Milk sours
Chapter 3 and 4
The maximum number of electrons in any orbital is ________.
1 2 3 4 5

Which of the following subshells consists of three orbitals?
4s 4p 4d 4f none of the above

What is the electron configuration of S?
1s² 2s² 2p⁶ 3s² 3p⁶ 4s² 3d³
1s² 2s² 2p⁶ 3s² 3p⁴
1s² 2s² 2p⁶ 3s² 3p⁶
1s² 2s² 2p²
1s² 2s² 2p⁶ 3s² 3p²

What is the electron configuration of Mg?
1s² 2s² 2p⁶
1s² 2s² 2p⁶ 3s²
1s² 2s² 2p⁶ 3s² 3p⁶ 4s² 3d⁵
1s² 2s² 2p⁶ 3s² 3p³
none of the above

The element with the electron configuration 1s²2s²2p⁴ is ________.
S Be Si O C

The element with the electron configuration 1s²2s²2p⁶3s²3p³ is
carbon. potassium. fluorine. sulfur. chlorine.

The element with the electron configuration 1s²2s²2p⁶3s²3p⁶4s¹ is

The number of valence electrons in an element with electron configuration
1s²2s²2p⁶3s²3p³ is ________.
16 8 4 2 6

The number of valence electrons in a main group element is given by ________.
the element's group number the element's atomic number
the element's atomic weight none of the above

How many electrons are there in the valence shell of a nitrogen atom?
7 0 5 3 2

The element which has four valence electrons is ________.
Si S Na H Mg
Chapter 3 and 4

Naming Cations

Cations: When a metal loses it’s valence electron(s) it becomes a cation, which is an ion with a positive charge.

- Loss of electrons is known as oxidation.
- A metal will usually lose all valence electrons when oxidized. Since the number of valence electrons is equal to the group number, it is easy to predict the number of electrons that will be lost from an atom by looking at the group number.
- The cation is named by using the element name followed by the word “ion”.

Examples:

- Sodium is in group 1, and it will lose 1 electron to form the cation Na\(^+\), known as a sodium ion.
- Calcium is in group 2, and it will lose 2 electrons to form the cation Ca\(^{2+}\), known as a calcium ion.

NOTE: Metals in group 4A (Sn and Pb) can lose either 2 or 4 electrons. Transition elements can have more than one oxidation state as well, but we will not worry about transition metals in Chemistry 30A.
Chapter 3 and 4

Naming Anions

**Anions:** When a nonmetal gains a valence electron(s) it becomes an anion, which is an ion with a negative charge.
- Gain of electrons is known as reduction.
- A nonmetals will usually gain the number of electrons equal to their group number subtracted from 8 when reduced.
- The anion is named by using the stem of the element name with an –ide ending.

**Examples:**
- Fluorine is in group 7, and it will gain 1 electron to form F\(^-\), which is known as a fluoride ion.
- Oxygen is in group 6, and it will gain 2 electrons to form O\(^2-\), which is known as an oxide ion.
Chapter 3 and 4

Naming Ionic Compounds

Ionic compounds are formed when electrons are transferred between atoms in order to achieve a stable configuration; ions are formed, but the overall charge on the compound is neutral. Ionic compounds are held together by electrostatic forces of attraction, and are typically formed when metals react with nonmetals.

Binary Ionic Compounds: contain only one type of metal and one type of nonmetal.

Formula to name:
1. Write the name of the cation (use roman numeral if necessary)
2. Write the name of the anion (use the –ide ending)

Example:
Na₂S is named as sodium sulfide

Problems:
1. MgO
2. CaBr₂
Naming Ionic Compounds Continued

**Name to formula:**
- Determine the charge on the cation
- Determine the charge on the anion
- Determine the ratio of cations to anions needed to make the compound neutral
- Always express the ratio of cations to anions in the simplest whole number ratio

**Examples:**
- Lithium fluoride is composed of Li\(^+\) and F\(^-\); this forms the compound LiF
- Magnesium bromide is composed of Mg\(^{2+}\) and Br\(^{-}\); this forms the compound MgBr\(_2\)
- Aluminum chloride is composed of Al\(^{3+}\) and Cl\(^{-}\); this forms the compound AlCl\(_3\)

**Problems:**
- Magnesium oxide
- Potassium iodide
- Tin (II) oxide
Polyatomic Ions

Polyatomic Ions: are ions that contain two or more atoms (a group of atoms) with an overall charge. Polyatomic ions are held together by covalent bonds (to be discussed later), but they have an overall charge which makes them ions.

<table>
<thead>
<tr>
<th>NAME</th>
<th>FORMULA</th>
<th>NAME</th>
<th>FORMULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydronium ion</td>
<td>H₃O⁺</td>
<td>Nitrate ion</td>
<td>NO₃⁻</td>
</tr>
<tr>
<td>Ammonium ion</td>
<td>NH₄⁺</td>
<td>Nitrite ion</td>
<td>NO₂⁻</td>
</tr>
<tr>
<td>Acetate ion</td>
<td>CH₃CO₂⁻</td>
<td>Oxalate ion</td>
<td>C₂O₄²⁻</td>
</tr>
<tr>
<td>Carbonate ion</td>
<td>CO₃²⁻</td>
<td>Permanganate ion</td>
<td>MnO₄⁻</td>
</tr>
<tr>
<td>Hydrogen carbonate ion (bicarbonate ion)</td>
<td>HCO₃⁻</td>
<td>Phosphate ion</td>
<td>PO₄³⁻</td>
</tr>
<tr>
<td>Chromate ion</td>
<td>CrO₄²⁻</td>
<td>Hydrogen phosphate ion</td>
<td>H₂PO₄⁻</td>
</tr>
<tr>
<td>Dichromate ion</td>
<td>Cr₂O₇²⁻</td>
<td>Sulfate ion</td>
<td>SO₄²⁻</td>
</tr>
<tr>
<td>Cyanide ion</td>
<td>CN⁻</td>
<td>Hydrogen sulfite ion (bisulfate ion)</td>
<td>HSO₄⁻</td>
</tr>
<tr>
<td>Hydroxide ion</td>
<td>OH⁻</td>
<td>Sulfite ion</td>
<td>SO₃²⁻</td>
</tr>
</tbody>
</table>

TABLE 4.3 Some Common Polyatomic Ions

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Chapter 3 and 4

Naming Ionic Compounds with Polyatomic Ions

**Formula to Name:**
1. Write the name of the cation (use roman numeral if necessary)
2. Write the name of the anion (from the chart/memory)

**Examples:**
- \( \text{Ca}_3(\text{PO}_4)_2 \) is named as calcium phosphate
- \( \text{PbSO}_4 \) is named as lead (II) sulfate

**Name to Formula:**
1. Determine the charge on the cation
2. Determine the charge on the anion
3. Determine the ratio of cations to anions needed to make the compound neutral
4. Always express the ratio of cations to anions in the simplest whole number ratio
5. If there is more then one polyatomic ion use parenthesis and write the subscript outside the last parenthesis

**Examples:**
- Magnesium nitrate has the formula \( \text{Mg(NO}_3)_2 \)
- Iron (II) sulfate has the formula \( \text{FeSO}_4 \)
- Iron (III) sulfate has the formula \( \text{Fe}_2(\text{SO}_4)_3 \)
What is the formula for iron(III) oxide?

What is the formula for strontium chloride?

Sort the following chromium compounds by whether the cation is chromium(II) or chromium(III).

\[ \text{Cr}_3\text{P}_2 \quad \text{Crl}_3 \quad \text{CrN} \quad \text{Cr}_2\text{S}_3 \quad \text{CrO} \quad \text{CrBr}_2 \]

What is the name of the ionic compound \( \text{BaCO}_3 \)?

What is the molecular formula for ammonium nitrate?

Determine whether the following pairs of elements can form ionic compounds.

- oxygen and magnesium
- nitrogen and iodine
- lithium and calcium
- iron and chloride
- fluorine and sodium
- potassium and sulfur

What is the formula for an ionic compound that contains the elements calcium and fluorine?

\[ \text{CaF} \quad \text{Ca}_2\text{F} \quad \text{CaF}_2 \quad \text{Ca}_2\text{F}_2 \]

A positively charged particle formed by loss of one or more electrons from an atom is called a(an) ______.

- isotope.
- cation.
- proton.
- anion.
- nucleus.

A small negatively charged particle formed when an atom gains one or more electrons is called a(an) ______.

- isotope.
- anion.
- proton.
- nucleus.
- cation.

The property that describes the ease with which an atom gives up an electron to form a positive ion is ______.

- electronegativity.
- ionization energy.
- electron affinity.
- atomic number.
- none of the above

An element belonging to the halogen family would be expected to have a ______ ionization energy and a ______ electron affinity.

- large; large
- small; large
- large; small
- small; small
- none of the above

An element belonging to the alkaline earth family would be expected to have a ______ ionization energy and a ______ electron affinity.

- large; small
- small; small
- large; large
- small; large
- none of the above

The statement that best describes the formation of an ionic compound is:

Each atom achieves an octet using electrons provided from an external electrical supply.
Electrons are transferred from a non-metal to a metal, and the resulting charged particles form a crystalline network.
Electrons are transferred from a metal to a non-metal, and the resulting charged particles form a crystalline network.
Electrons move freely among a network of nuclei in fixed positions.
Electrons are shared between two atoms and discrete molecules are formed.
Which of the following electron configurations is most stable?

\[ 1s^22s^22p^2 \quad 1s^22s^22p^4 \quad 1s^22s^22p^3 \quad 1s^22s^22p^6 \quad 1s^22s^2 \]

Which of the following ions does not have the same electron configuration as the noble gas neon?

S\(^2\)  F\(^-\)  O\(^2-\)  Mg\(^{2+}\)  Al\(^{3+}\)

The charge on a sulfide ion is ________.

2\(^+\)  3\(^+\)  3\(^-\)  0  2\(^-\)

Which of the following elements is most likely to form an ion with a +2 charge?

K  Si  Mg  Br  S

The name of Cl\(^-\) is

clорide ion.  chlorate ion.  diatomic chlorine.  chlorite ion.  chlorine ion.

What is the formula of the ammonium ion?

\[ \text{NH}_4^+ \quad \text{Am} \quad \text{N}_2\text{H}^+ \quad \text{Am}^+ \quad \text{NH}_4^+ \]

What is the formula of the carbonate ion?

\[ \text{CO}_3^{2-} \quad \text{C}_2\text{H}_2\text{O}_2^- \quad \text{CO}_3^{2-} \quad \text{C}_2\text{O}_2^- \quad \text{C}_2\text{O}_4^- \]

What is the formula of the nitrate ion?

\[ \text{NO}_3^- \quad \text{NO}^- \quad \text{NO}_2^- \quad \text{NO}_3^- \quad \text{none of the above} \]

What is the formula of the sulfite ion?

S\(^2\)  HSO\(_4\)^{2-}  SO\(_3\)^{2-}  SO\(_4\)^{2-}  none of the above

The formula PO\(_4\)^{3-} means that this ion is composed of

one atom of phosphorus, four atoms of oxygen, and three extra electrons.

four atoms of phosphorus, four atoms or oxygen, and three extra electrons.

one atom of phosphorus, one atom of oxygen, and three extra electrons.

four atoms of phosphorus, four atoms of oxygen, and three electrons have been lost.

one atom of phosphorus, four atoms of oxygen, and three electrons have been lost.

The HCO\(_3\) \(^-\) ion is called ________.

carbonate  hydrogen carbonate  carbonate  hydrogen carbide  carbide

Which is the correct formula for the ionic compound containing iron(III) ions and oxide ions?

\[ \text{Fe}_2\text{O}_2 \quad \text{FeO}_2 \quad \text{FeO} \quad \text{Fe}_3\text{O}_2 \quad \text{Fe}_2\text{O}_3 \]

What is the formula for the ionic compound formed between lithium and bromide?

\[ \text{LiBr}_2 \quad \text{LiB} \quad \text{Li}^+\text{Br}^- \quad \text{LiBr} \quad \text{Li}_2\text{Br} \]

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What is the formula for the ionic compound formed between calcium and sulfur?
CaS  Ca₂S  CaSi₂  CaSi  CaS₂

A formula unit of the ionic compound copper(II) carbonate consists of ________ copper(II) ions and ________ carbonate ions.
two; one  two; two  one; one  one; two  some other combination of ions

A formula unit of ammonium sulfate consists of ________ ammonium ions and ________ sulfate ions.
two; one  two; three  three; two  one; two  four; four

The formula Ca(NO₃)₂ tells us that one formula unit of this compound is composed of ________ calcium atoms,
_______ nitrogen atoms, and ________ oxygen atoms.
one; two; five  one; one; five  one; two; six  one; one; six  two; two; six

What is the formula for calcium phosphate?
Ca₄(PO₄)₃  Ca₃(PO₄)₂  Ca₃PO₄  Ca₃PO₄

What is the name of Mg₃(PO₄)₂?
trimagnesium phosphate  magnesium phosphate  magnesium phosphorus oxide
magnesium diphosphate  trimagnesium diphosphate

What is the name of AlCl₃?
aluminum(III) chloride  aluminum carbide  aluminum chloride
aluminum tricarbide  aluminum trichloride

What is the name of SnCl₂?
strontium chloride  tin(II) chloride  tin dichloride
ditin chloride  tin chloride

Iron pyrite (fool's gold) is iron(II) sulfide. What is its formula?
FeSO₃  FeS  Fe₂(SO₃)₃  Fe₂S₃  FeSO₄

What is the name of K₂S?
potassium sulfide  potassium disulfide  dipotassium sulfide
potassium(II) sulfide  none of the above

The formula for ammonium hydroxide is ________.
NH₄NO₃  NH₄OH  Al(OH)₃  OHNH₄  NH₂O

Which of the following formulas represents a compound that is an acid?
H₃PO₄  CaSO₄  NH₄Cl  H₂O  Mg(OH)₂