# Grade 10 Science

Chemical Reactions

Class 1

## Overall Expectations

- Analyse a variety of safety and environmental issues associated with chemical reactions, including the ways in which chemical reactions can be applied to address environmental challenges
- Investigate, through inquiry, the characteristics of chemical reactions
- Demonstrate an understanding of the general principles of chemical reactions, and various ways to represent them

# Physical and Chemical Properties

- Physical Property – does not involve forming a new substance
  - Colour
  - Texture
  - Density
  - Smell
  - Melting Point
- Chemical Property – changes into one or more new substances
  - Flammability
  - Bleaching
  - Corrosion
  - Rusting

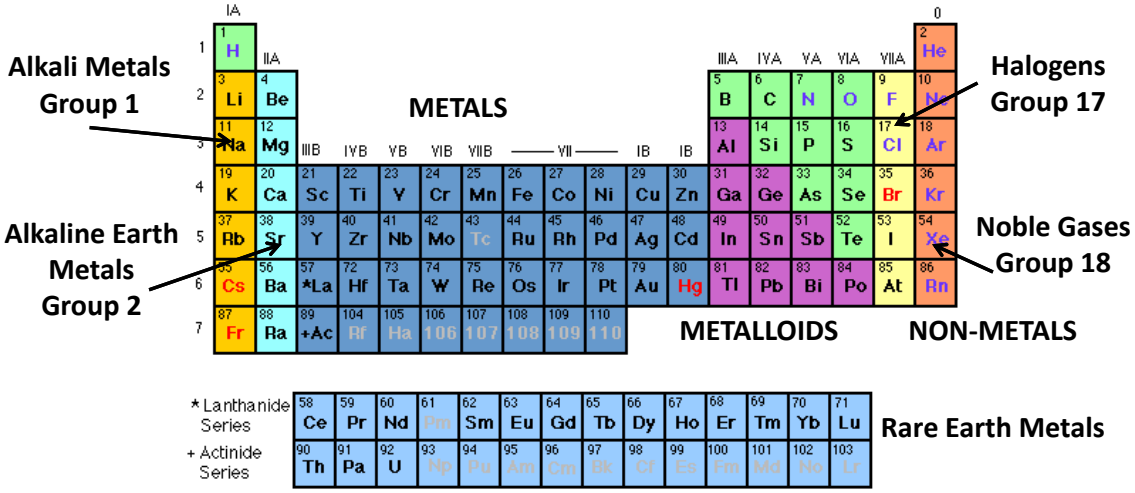

## Checkpoint


Classify the following as a physical or chemical property:

a) Liquid nitrogen boils at -196°C
b) Propane, leaking from a tank, ignites easily
c) Silver jewelry tarnishes in air
d) Spilled oil floats on the surface of water
e) Meat darkens when it is heated on a grill
f) Sulfur trioxide changes to sulfuric acid in the atmosphere

# Patterns in the Periodic Table

- **Group/Family** – column in the periodic table
- **Period** – row in the periodic table




# Atomic Structure

- An atom consists of:

| | Proton | Neutron | Electron |
|---|---|---|---|
| Electrical Charge | + | 0 | - |
| Relative Mass | 1 | 1 | 1/2000 |
| Symbol | $p^+$ | $n^0$ | $e^-$ |
| Location | Nucleus | Nucleus | Outside Nucleus |

# Mass Number/Atomic Number


- **Atomic number** = Protons OR Electrons (if neutral)
  - Ex: Helium has 2 protons and 2 electrons
- **Mass number** = Protons + Neutrons
  - Ex: Helium has 2 neutrons

# Terms to Know

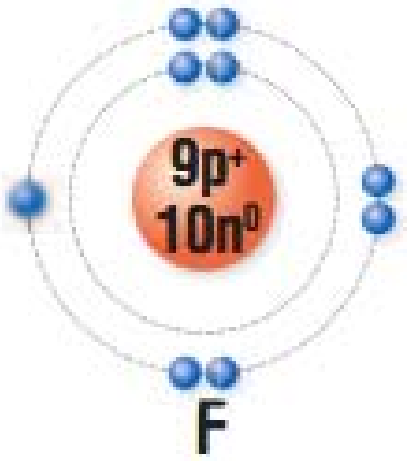
- **Isotope** – elements with the same number of protons but a different number of neutrons; different mass
  - Ex: Carbon-12 and Carbon-14
- **Ion** – elements with the same number of protons but a different number of electrons; different charge
  - Ex: Be and $Be^{2+}$
  - **Cations** = ions with a positive charge
  - **Anions** = ions with a negative charge
  - Note: Atoms become ions when there is a loss/gain of **electrons** NOT protons


# Checkpoint


List the number of $p^+$, $n^0$, and $e^-$ for:

a) Beryllium
b) Phosphorus
c) Neon
d) Fluorine ion ($F^-$)

# Bohr-Rutherford Diagrams




1. Draw the nucleus and write the number of protons and neutrons inside
2. Add the electrons to the outer shells
   - 1st = 2 electrons
   - 2nd = 8 electrons
   - 3rd = 8 electrons
   - 4th = 18 electrons


# Checkpoint


Draw the Bohr-Rutherford Diagrams for:

a) Lithium-6 isotope

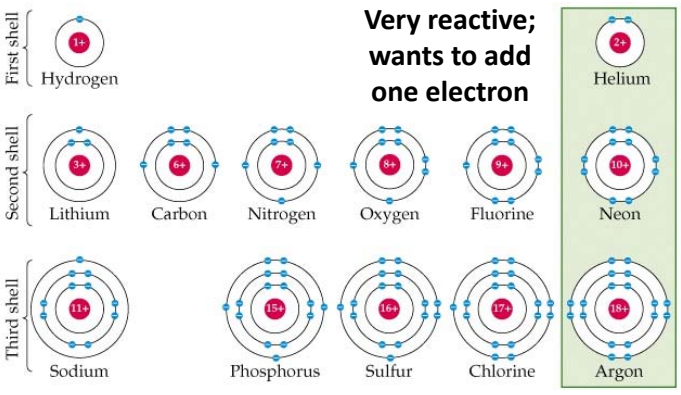
b) Potassium ion ($K^+$)

# Reactivity

- **Valence electrons** determine the reactivity of an element and how compounds are formed
- Elements lose or gain valence electrons to achieve stability

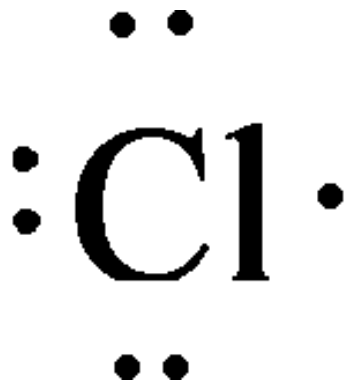
**HALOGENS**
**Very reactive; wants to add one electron**

**ALKALI METALS**
**Very reactive; wants to remove one electron**




**NOBLE GASES**
**Very stable due to complete valence shell**

# Lewis Dot Diagrams




1. Write the element symbol
2. Find the number of valence electrons by looking at the Roman Numeral above the element's group
3. Put dots representing the electrons on the four sides of the element singly before pairing up


## Checkpoint


Draw the Lewis Dot Diagram of:

a) Boron

b) Silicon

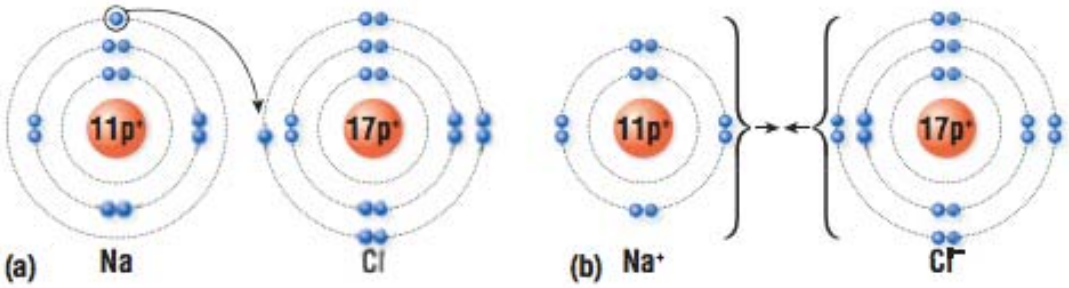
c) Argon

d) $Mg^{2+}$

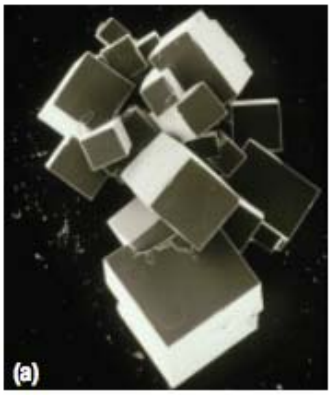
e) $O^{2-}$

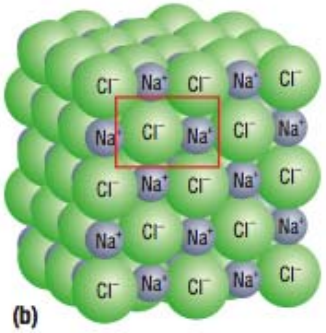
# Ionic Compounds

- Ionic compound – formed between a metal and a non-metal; a cation and an anion
  - Metal loses electron(s)
  - Non-metal gains electron(s)




- Properties of Ionic Compounds:
  - Form Crystal-Like Structures
  - Hard, Brittle
  - High Melting Points
  - Electrolytes (dissolve in water to conduct electricity)



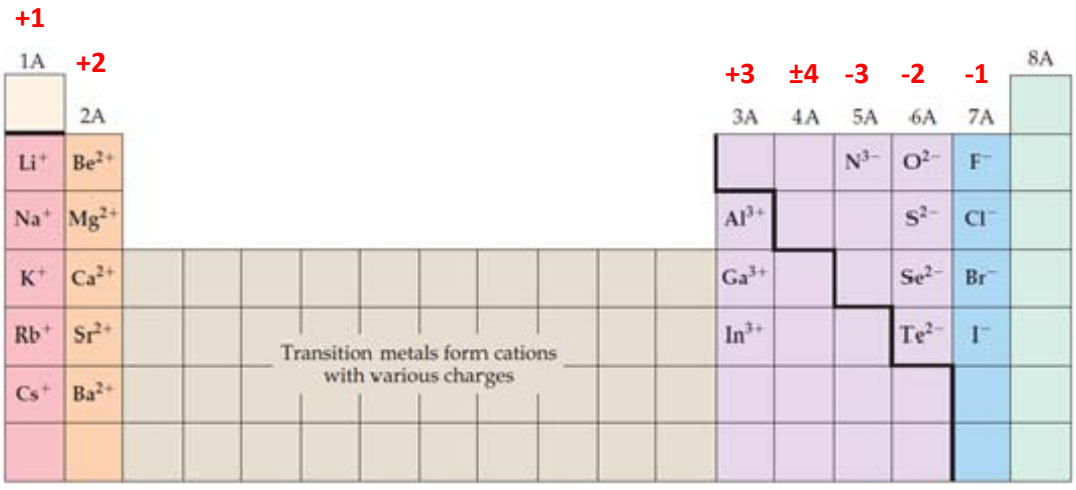



# Chemical Formulas

What is the chemical formula for sodium chloride?

1) Write the element symbol (metal+nonmetal)
2) Look at the periodic table and find their ionic charge
3) Criss-cross the ionic charge
4) If subscripts have a common factor, they should be simplified

## Common Ionic Charges




# Checkpoint


What is the formula for:

a) Calcium bromide

b) Boron nitride

c) Aluminum chloride

# Chemical Names

What is the chemical name of $CaBr_2$?

- In most cases:

  name of metal + name of nonmetal

  (change ending of nonmetal to –ide)

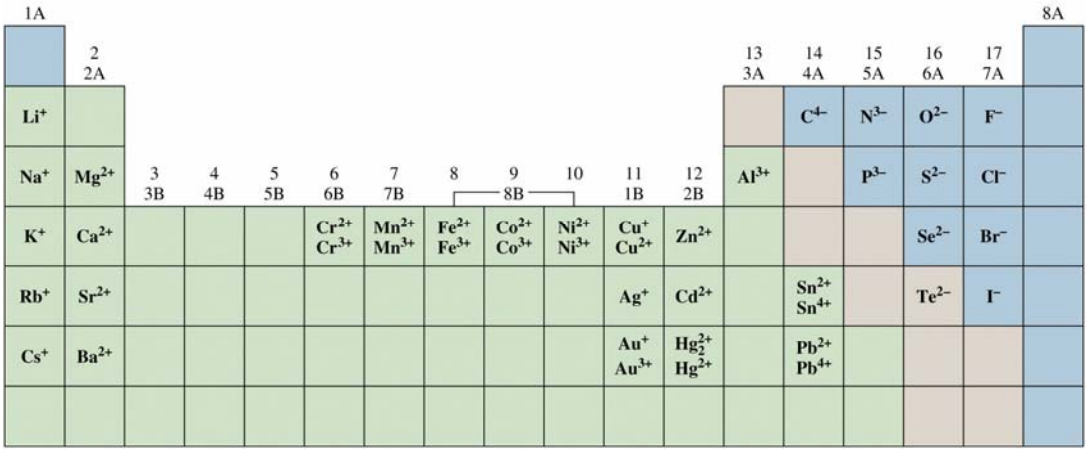
- $CaBr_2$ = calcium bromine

  calcium brom~~ine~~

  **calcium bromide**

# Multivalent Elements

- Some transition metals are multivalent (more than one ionic charge)
- Use Roman Numerals to distinguish between the two charges




| Element | Ionic Charge | Chemical Name |
|---|---|---|
| Chromium (Cr) | 2+<br>3+ | Chromium (II)<br>Chromium (III) |
| Manganese (Mn) | 2+<br>3+ | Manganese (II)<br>Manganese (III) |
| Iron (Fe) | 2+<br>3+ | Iron (II)<br>Iron (III) |
| Cobalt (Co) | 2+<br>3+ | Cobalt (II)<br>Cobalt (III) |
| Nickel (Ni) | 2+<br>3+ | Nickel (II)<br>Nickel (III) |
| Copper (Cu) | 1+<br>2+ | Copper (I)<br>Copper (II) |
| Tin (Sn) | 2+<br>4+ | Tin (II)<br>Tin (IV) |
| Lead (Pb) | 2+<br>4+ | Lead (II)<br>Lead (IV) |
| Gold (Au) | 1+<br>3+ | Gold (I)<br>Gold (III) |


# Checkpoint


What is the chemical formula for:

a) Copper (II) chloride
b) Iron (III) bromide
c) Nickel (II) oxide

What is the chemical name for:

d) $Fe_2O_3$
e) $Cu_2S$
f) FeN

# Polyatomic Ions

- Polyatomic Ion – an ion made of more than one atom but acts as a single particle
  - The charge is shared over the entire ion rather than each element
- Ex: $PO_4^{3-}$ = phosphate
  $OH^-$ = hydroxide
  $CO_3^{2-}$ = carbonate

TIP: It may be helpful to keep the elements in brackets and the charge outside the brackets. Ex: $(PO_4)^{3-}$ or $(OH)^-$

**Table 1** Formulas and Charges of Common Polyatomic Ions

| Name of polyatomic ion | Ion formula | Ionic charge |
|---|---|---|
| nitrate ion | $NO_3^-$ | –1 |
| nitrite ion | $NO_2^-$ | –1 |
| hydroxide ion | $OH^-$ | –1 |
| hydrogen carbonate ion (also called bicarbonate ion) | $HCO_3^-$ | –1 |
| chlorate ion | $ClO_3^-$ | –1 |
| carbonate ion | $CO_3^{2-}$ | –2 |
| sulfate ion | $SO_4^{2-}$ | –2 |
| phosphate ion | $PO_4^{3-}$ | –3 |
| ammonium | $NH_4^+$ | +1 |

# Naming Polyatomic Ions

Write the name of $Na_2CO_3$

1. Un-criss cross the charges
2. Write the name of the metal and check its ionic charge
3. Write the name of the polyatomic ion and check its ionic charge

**= sodium carbonate**

# Naming Polyatomic Ions

Write the chemical formula for iron(III) nitrate

1. Write the metal and its charge
2. Write the polyatomic ion and its charge
3. Criss-cross the charges
4. Simplify the subscripts


## Checkpoint


Name the following:

a) $KNO_3$
b) $(NH_4)_3PO_4$
c) $PbCO_3$

Write the chemical formula:

d) Calcium sulfate
e) Calcium chlorate
f) Iron(III) phosphate