Review for Quiz 2: Ionic and Covalent Compounds

1. Know and ***understand*** the definitions of: metal, non-metal, ionic compound, covalent (molecular) compound, binary compound and electrolyte.

- **ionic compounds** are pure substances that form when metal and non-metal atoms are chemically bonded together by an ionic bond (electrostatic attraction). Ionic compounds form a huge crystal lattice structure.
- **covalent compounds** are pure substances that form when two or more types of non-metal atoms are chemically bonded together by covalent bonds (sharing electrons). Covalent compounds form individual, separate molecules so they are also called molecular compounds.
- **binary compounds** contain only two **TYPES** of atoms chemically bonded together. Binary compounds can be ionic or covalent.
- **electrolytes** are substances that dissolve in distilled water to produce solutions that can conduct an electric current. Ionic compounds are electrolytes – they don't conduct electricity in their pure (solid) form, but they do conduct electricity in solution.

2. Be able to recognize ionic and covalent compounds from their chemical formulas.

- ionic compounds have a metal as their first element
- covalent compounds have a non-metal as their first element (consider hydrogen as a non-metal)

3. Be able to predict and ***compare*** the properties of metals, non-metals, ionic compounds and covalent compounds. (see the answers to later questions)

4. Complete the following statements:

a) Atoms lose, gain or share electrons to achieve a **stable octet** electron arrangement.
b) Metals are elements that are found on the **left** side of the staircase line on the Periodic table.
c) Metals tend to **lose** electrons to form ions with a **positive** charge, called **cations**.
d) Non-metal elements are found on the **right** side of the staircase line on the Periodic table.
e) Non-metals tend to **gain** electrons to form ions with a **negative** charge, called **anions**.
f) Positive and negative ions are held together by **ionic** bonds to form **ionic** compounds.
g) Two or more non-metal atoms can **share** valence electrons to complete a stable octet.
h) A compound that contains two ***TYPES*** of elements is called a **binary** compound. The names of these types of compound ends in the suffix: **ide**
i) The suffix "ate" indicates that a polyatomic ionic compound contains **oxygen**.

5. In the list of substances below, underline all ionic compounds:

$SC\ell_6$ Na_2SO_4 $C\ell O_2$ Li $Zn(OH)_2$ CrP Br_2 XeF_4 FeI_3 NH_3 SnO_2

6. In the list of substances above, circle all covalent compounds.

7. List six physical properties for each of the following substances:

cobalt (a metal)	cobalt (III) nitrate (an ionic compound)
• good conductor of electricity in its pure form • does not dissolve in water • high melting point • metallic solid at room temperature • shiny • malleable • silver-coloured	• does not conduct in its pure form • dissolves well in water • high melting point • crystalline solid at room temperature • probably does not have an odour • conducts electricity in solution

8. Write the chemical formulas for the following ionic compounds:

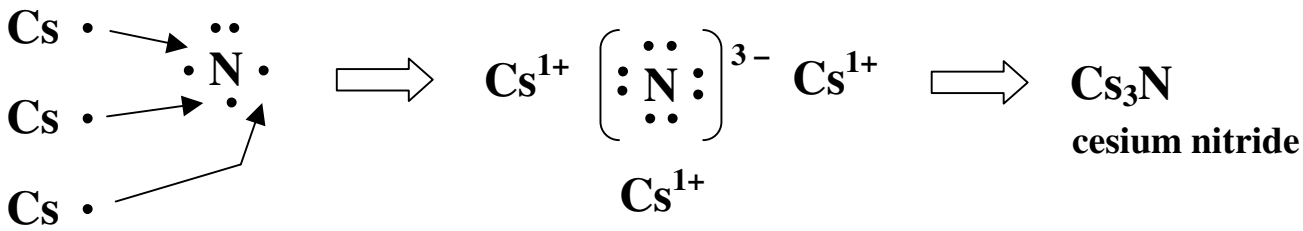
a)	iron (III) carbonate	$Fe_2(CO_3)_3$	f)	tin (IV) hydrogen phosphate	$Sn(HPO_4)_2$
b)	manganese (IV) chlorate	$Mn(C\ell O_3)_4$	g)	calcium hydroxide	$Ca(OH)_2$
c)	ammonium nitride	$(NH_4)_3N$	h)	mercury (I) nitrate	$HgNO_3$
d)	lead (II) sulfide	PbS	i)	cobalt (II) hydrogen sulfate	$Co(HSO_4)_2$
e)	zinc fluoride	ZnF_2	j)	chromium (III) oxide	Cr_2O_3

9. Name the following ionic compounds. Include Roman numerals where necessary:

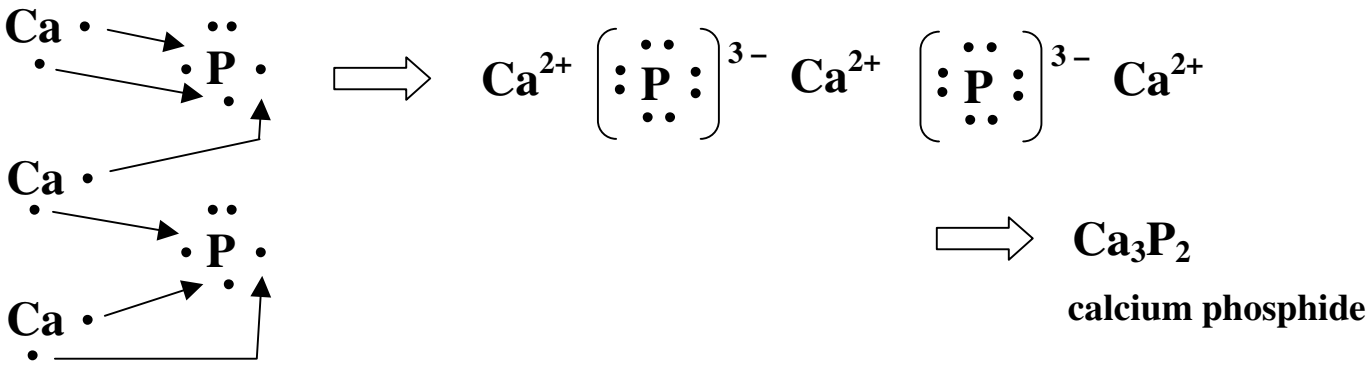
a)	NH_4OH	ammonium hydroxide	i)	$ScC\ell_3$	scandium chloride
b)	$CrSO_4$	chromium (II) sulfate	j)	$Mg(OH)_2$	magnesium hydroxide
c)	Sn_2C	tin (II) carbide	k)	Fe_2S_3	iron (III) sulfide
d)	Hg_3N	mercury (I) nitride	l)	Bi_2O_5	bismuth (V) oxide
e)	$MnCO_3$	manganese (II) carbonate	m)	Au_3P	gold (I) phosphide
f)	$AgNO_3$	silver nitrate	n)	$A\ell F_3$	aluminum fluoride
g)	$Co(HSO_4)_3$	cobalt (III) hydrogen sulfate			
h)	$CuHPO_4$	copper (II) hydrogen phosphate			

10. Use electron dot diagrams to show the formation of the ionic compounds between the following elements. Show three steps, write the chemical formula and name of each compound.

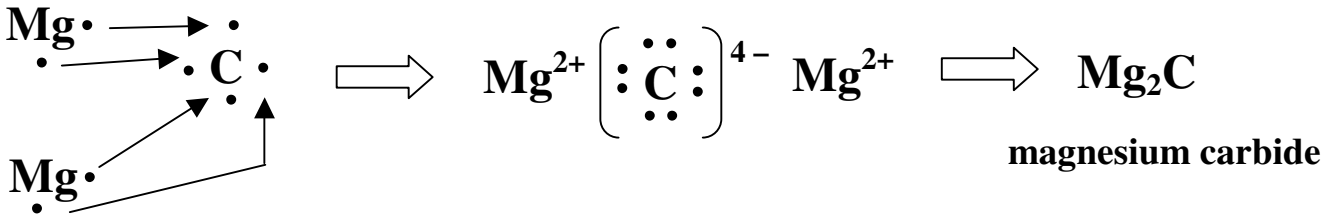
a) nitrogen and cesium



b) phosphorus and calcium



c) magnesium and carbon



11. Complete the following chart:

Compound	Formula	Ionic or Covalent	Number of each type of atom in one "unit"
calcium hydroxide	$Ca(OH)_2$	ionic	1 (Ca) + 2 (O) + 2 (H)
bismuth (V) chlorate	$Bi(C\ell O_3)_5$	ionic	1 (Bi) + 5 (Cℓ) + 15 (O)
iron (III) hydrogen carbonate	$Fe(HCO_3)_3$	ionic	1 (Fe) + 3 (H) + 3 (C) + 9 (O)
glycerol	$C_3H_8O_3$	covalent	3 (C) + 8 (H) + 3 (O)
cobalt (III) hydrogen phosphate	$Co_2(HPO_4)_3$	ionic	2 (Co) + 3 (H) + 3 (P) + 12 (O)
pyridine carbonate	$(N_2H_5)_2CO_3$	covalent	4 (N) + 10 (H) + 1 (C) + 3 (O)
creatine	$C_4(NH_3)_3O_2$	covalent	4 (C) + 3 (N) + 9 (H) + 2 (O)

12. Write the chemical formulas of the following covalent (molecular) compounds:

sulfur trichloride	$SC\ell_3$	dichlorine heptoxide	$C\ell_2O_7$
diphosphorus trioxide	P_2O_3	nitrogen monoxide	NO
carbon tetrabromide	CBr_4	oxygen difluoride	OF_2
tricarbon octahydride	C_3H_8	phosphorus pentabromide	PBr_5
xenon hexachloride	$XeC\ell_6$	nitrogen triiodide	NI_3

13. Are the compounds in question #12 binary compounds? Explain why or why not.

    Yes, these compounds are all binary compounds – they each contain only two TYPES of atoms.

14. Study the summary chart from Q10 on Lab #2, comparing the **properties** of ionic and covalent compounds.

* * identifying a compound as ionic or covalent, or stating the types of elements they are made from are NOT properties. Properties are characteristics of substances that can be observed.

Property	Ionic Compound	Covalent Compound
State at room temperature	always solid	can be solid, liquid or gas
Texture	usually hard, crystalline solids	solids are soft or waxy
Presence of an odour	usually odourless	often have odours
Melting point	usually high or very high	usually low or very low
Conductivity of pure substance	can not conduct in pure form	can not conduct in pure form
Solubility in water	usually soluble in water	sometimes soluble in water
Conductivity of solution	conduct in solution	do not conduct in solution

15. Predict five properties of CS_2. You can include any five of the following:
    - a distinctive odour
    - low melting point
    - may be solid, liquid or gas at room temp (it is a liquid)
    - soft or waxy in solid form
    - does not dissolve well in water
    - does not conduct electricity in pure form
    - does not conduct electricity in solution

16. Given the following substances in their pure form:

i) mercury	iv) solid silver chlorate
ii) liquid C_6H_6	v) solid P_2O_5
iii) bromine (Br_2)	vi) argon gas

a) Which substance will be the most soluble in water? **silver chlorate (it is ionic)**

b) Which substance(s) will conduct electricity in their pure form? **mercury (it is a metal)**

c) Which substance has the lowest melting point? **argon gas (it is gas at room conditions)**

d) Which substance(s) have shared valence electrons? **liquid C_6H_6, liquid Br_2 and solid P_2O_5 (covalents)**

e) Which substance(s) are held together by electrostatic attraction? **only silver chlorate (ionic)**

f) Which substance will be the best conductor in solution? **only silver chlorate (ionic)**

g) Which substance is chemically inert? **argon gas (it's a Noble gas so it is unreactive, or inert)**

h) Which substance(s) are binary? **C_6H_6 and P_2O_5 (because they contain 2 *types* of atoms)**

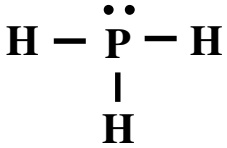
i) Silver chlorate and white sugar are both crystalline, white solids at room temperature. If you were given one of these solids, but you didn't know which one, what is **ONE** experiment you could do to determine whether it was silver chlorate or white sugar? Be specific.

- the best test to distinguish between ionic and covalent compounds is to see if they conduct electricity in a solution (all ionic compounds conduct in solution or are 'electrolytes')
- try to dissolve the substance in **DISTILLED** water, and then check the conductivity of the solution
- if the solution conducts, the solid is silver chlorate. If the solution does not conduct, the solid is sugar
- you could also check their melting points – but this is not always a reliable test (some ionic compounds can have low or medium melting points). Hold a small sample of each solid on a scoopula above the flame of a bunsen burner. Gradually lower the scoopula toward the tip of the blue cone and observe where it melts. Whichever compound melts higher in the flame (at a lower temperature) is white sugar.

17. **Name** the following covalent compounds using the prefix system. Use electron dot diagrams to **draw** the stick diagrams of each molecule. Remember to include all unshared (unbonded) pairs of electrons.

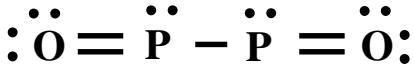
a) SiO_2 silicon dioxide

b) PH_3 phosphorus trihydride

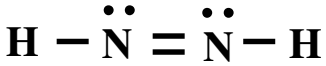


c) CS_2 carbon disulfide

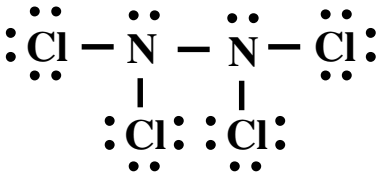
d) P_2O_2 diphosphorus dioxide



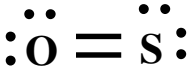
e) N_2H_2 dinitrogen dihydride



f) $N_2C\ell_4$ dinitrogen tetrachloride



h) SO sulfur monoxide



g) C_2H_4 dicarbon tetrahydride