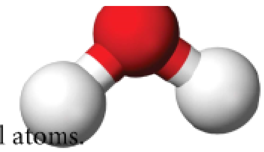
PART K: WHAT ARE COVALENT COMPOUNDS?



The atoms of many Non-metals **share electrons** with other non-metal atoms.

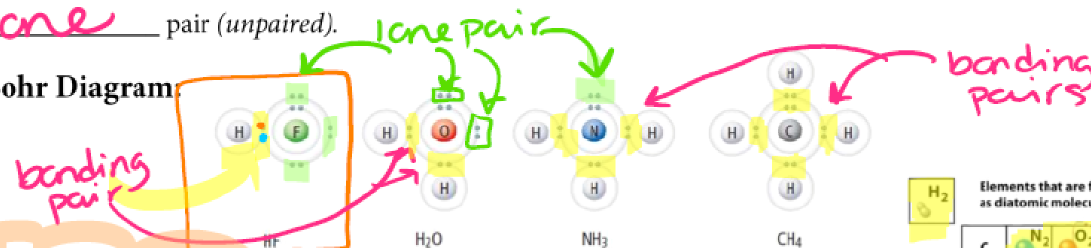
In covalent bonding, atoms overlap slightly, and one unpaired electron from each atom will pair together. (e⁻ pair = 2e⁻ = covalent bond)

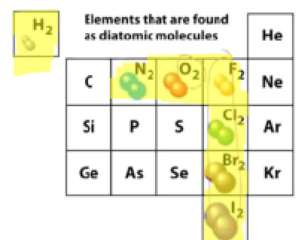
Both atoms are attracted to the same ***pair of electrons***, forming a covalent bond. A covalent compound is formed when non-metallic atoms ***share electrons*** to form covalent bonds.

A covalent molecule is a ***group of atoms*** in which the atoms are bound together by sharing one or more pairs of electrons.

The pair of electrons involved in a covalent bond are sometimes called the bonding pair. A pair of electrons in the valence shell that is ***not used in bonding*** is sometimes called a lone pair *(unpaired)*.

Bohr Diagram:

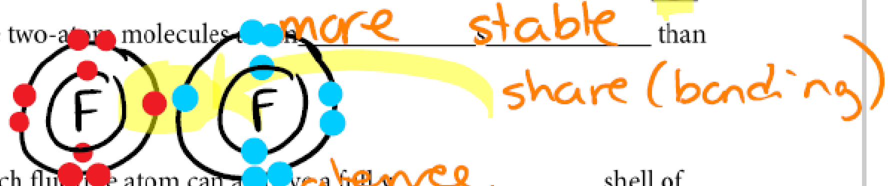




DIATOMIC MOLECULES

A diatomic molecule is a pair of atoms that are joined by covalent bonds.

Diatomic elements form this way because the two-atom molecules are more stable than the individual atoms.



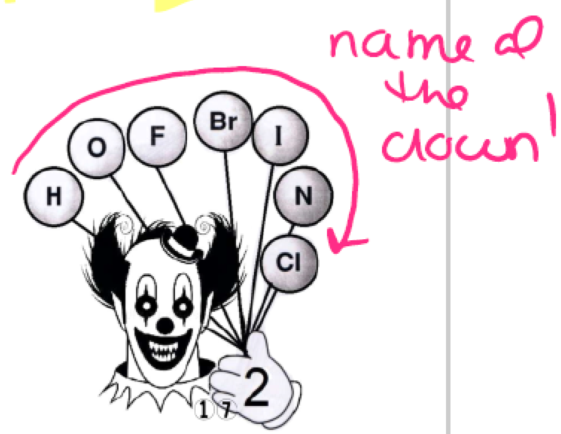
For example, fluorine gas is diatomic.

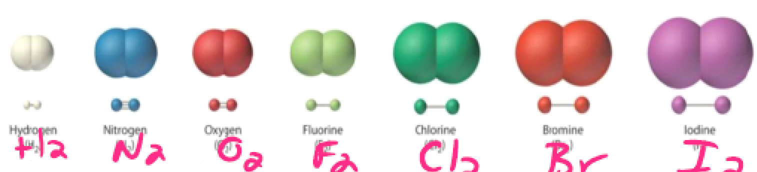
By joining together to form F_2 (2 fluorine atoms), each fluorine atom can achieve a full valence shell of 8 electrons

Other diatomic elements are hydrogen (H_2), nitrogen (N_2), oxygen (O_2), chlorine (Cl_2), bromine (Br_2), and iodine (I_2)..... F_2 fluorine

The HOFBrINCl Elements:

- There are 7 naturally occurring elements that , when found in nature, exist as diatomic molecules.
- The atoms will not exist alone, they **bond** to each other.
- This means they must ***always*** be written with a subscript of 2.





diatomic
↑ 2 ↑ atoms

PART L: PROPERTIES OF COVALENT COMPOUNDS

Covalent compounds have widely varying properties.

The plastic casing of a ballpoint pen, the components of gasoline, the strongly scented components in a banana, and the carbon dioxide that we exhale with every breath are all covalent compounds.

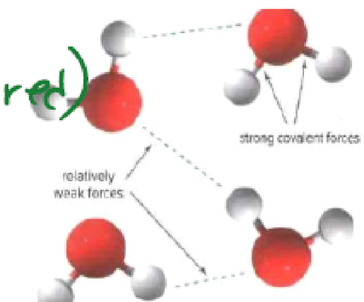
Here are some properties that covalent compounds do share:

1. **Covalent compounds have** low melting points

   Although the forces that hold atoms together in molecules are very strong, the bonds that attract one molecule to another in a covalent compound are relatively weak (e⁻ shared).

   Therefore, when you melt or vaporize a covalent compound there is less (less energy required) of a barrier to overcome so they will melt low(er) temperatures.

   ex. H_2O melts at 0°C



2. **Covalent compounds are relatively** soft (if the are solids)

   The weakness of the forces between molecules also explains the relative softness of covalent compounds.

3. **Covalent compounds are poor** conductors of electricity/heat

   Unlike ionic compounds, covalent compounds do not have free electrons ⊕/⊖ or ions. This covalent compounds poor conductors of both heat and electricity.

Properties of Ionic Compounds	Properties of Covalent Compounds
• metals + non-metal • ⊕ cations + ⊖ anions • strong bonds: - solid at room temp. - melting points are very high (°C) • dissolve in water to form ions ⊕ and ⊖ in solution • conduct electricity (in liquid or molten state)	• non-metal + non-metal • electrons are shared • weaker bonds: - many are liquid or gas at room temp. (not all) - lower melting points (°C) • most (not all) are insoluble (doesn't dissolve) • do NOT conduct electricity.

⑱

Lab: Comparing Properties of Ionic and Covalent Compounds

Introduction

Chemical compounds are combinations of atoms held together by chemical bonds. We have studied two basic types of compounds: ionic and covalent. Ionic compounds result when one or more electrons from one atom or group of atoms are transferred to another atom or group of atoms. In covalent compounds the electrons are shared by the bonded atoms.

The curls and waves of your hair are the result of many ionic, covalent and hydrogen bonds between the chains of atoms that make up each protein filament. Styling hair by wetting it or heating it with a curling iron is an attempt to change the hydrogen and ionic bonds. The solution in a “permanent” (or “perm”) on the other hand, breaks and reforms covalent bonds. A permanent wave does not wash out when you shampoo your hair.

The physical properties of a substance such as melting point and solubility tell us a lot about the type of bond in a compound. In this experiment, you will conduct tests on physical properties and compile data to enable you to classify compounds as ionic or covalent. You will also be given a unknown compound to test and predict whether it is an ionic or covalent compound.

Objective:

Materials

A - sodium chloride	aluminum plates x 5
B - sucrose ($C_{12}H_{22}O_{11}$)	hot plate
C - potassium chloride	5 test tubes
D - acetaminophen ($C_8H_9NO_2$)	tongs
E - unknown	sharpie
water	

Procedure

Part 1: Melting Point

1. Put on your safety glasses and keep them on until you have finished cleaning up your lab station.
2. Label your aluminum trays A, B, C, D, E.
3. Place a very **SMALL** sample of each substance A, B, C, D, E on the matching aluminum tray.
4. Plug in your hot plate and turn it on medium/high.
5. Place two of the aluminum trays on the hot plate. Observe the substances in each tray and make note of which substances melt.
6. If the substance does not melt right away continue to observe for 4 minutes.
7. Using the tongs, remove aluminum trays from the hot plate and continue the procedure with your next two samples.

Part 2: Solubility

1. Place one **SMALL** scoop of each substance A, B, C, D, E into a separate clean test tube.
2. Fill the test tube ⅓ full with water and gently agitate the test tube for 3 minutes.
3. Record your observations. Repeat this procedure for each of the test tubes.

Data

Substance	Colour	Melting Point: Does it melt?	Solubility: Does it dissolve?	Ionic or Covalent
A - sodium chloride **chemical formula:** ________				
B - sucrose ($C_{12}H_{22}O_{11}$)				
C - potassium chloride **chemical formula:** ________				
D - acetaminophen ($C_8H_9NO_2$)				
E - unknown				

Analysis

1. Look carefully at your results. Do you see any patterns? Summarize the results from your experimental data on the last page based on whether you were observing an ionic or covalent compound. If you don't see any patterns, state "no pattern". If you do see general patterns, state them.

	Ionic	**Covalent**
Melting Point		
Solubility		

2. Based on your experimental data and your analysis above, do you think the unknown compound was ionic or covalent? Why?

3. Can you think of another property we could test to determine if an unknown substance is an ionic compound or a covalent compound? Have a look at your notes for both types of compounds if you can't think of anything.

PERIODIC TABLE OF THE ELEMENTS

Atomic Number → 22
Symbol → Ti
Name → Titanium
Atomic Mass → 47.9
4+ 3+ ← Ion charge(s)

METALS ← | → NON-METALS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 + **H** Hydrogen 1.0																1 – **H** Hydrogen 1.0	2 0 **He** Helium 4.0
3 + **Li** Lithium 6.9	4 2+ **Be** Beryllium 9.0											5 **B** Boron 10.8	6 **C** Carbon 12.0	7 3– **N** Nitrogen 14.0	8 2– **O** Oxygen 16.0	9 – **F** Fluorine 19.0	10 0 **Ne** Neon 20.2
11 + **Na** Sodium 23.0	12 2+ **Mg** Magnesium 24.3											13 3+ **Al** Aluminium 27.0	14 **Si** Silicon 28.1	15 3– **P** Phosphorus 31.0	16 2– **S** Sulfur 32.1	17 – **Cl** Chlorine 35.5	18 0 **Ar** Argon 39.9
19 + **K** Potassium 39.1	20 2+ **Ca** Calcium 40.1	21 3+ **Sc** Scandium 45.0	22 4+ 3+ **Ti** Titanium 47.9	23 5+ 4+ **V** Vanadium 50.9	24 3+ 2+ **Cr** Chromium 52.0	25 2+ 3+ 4+ **Mn** Manganese 54.9	26 3+ 2+ **Fe** Iron 55.8	27 2+ 3+ **Co** Cobalt 58.9	28 2+ 3+ **Ni** Nickel 58.7	29 2+ 1+ **Cu** Copper 63.5	30 2+ **Zn** Zinc 65.4	31 3+ **Ga** Gallium 69.7	32 4+ **Ge** Germanium 72.6	33 3– **As** Arsenic 74.9	34 2– **Se** Selenium 79.0	35 – **Br** Bromine 79.9	36 0 **Kr** Krypton 83.8
37 + **Rb** Rubidium 85.5	38 2+ **Sr** Strontium 87.6	39 3+ **Y** Yttrium 88.9	40 4+ **Zr** Zirconium 91.2	41 3+ 5+ **Nb** Niobium 92.9	42 2+ 3+ **Mo** Molybdenum 95.9	43 7+ **Tc** Technetium (98)	44 3+ 4+ **Ru** Ruthenium 101.1	45 3+ 4+ **Rh** Rhodium 102.9	46 2+ 4+ **Pd** Palladium 106.4	47 + **Ag** Silver 107.9	48 2+ **Cd** Cadmium 112.4	49 3+ **In** Indium 114.8	50 4+ 2+ **Sn** Tin 118.7	51 3+ 5+ **Sb** Antimony 121.8	52 2– **Te** Tellurium 127.6	53 – **I** Iodine 126.9	54 0 **Xe** Xenon 131.3
55 + **Cs** Cesium 132.9	56 2+ **Ba** Barium 137.3	57 3+ **La** Lanthanum 138.9	72 4+ **Hf** Hafnium 178.5	73 5+ **Ta** Tantalum 180.9	74 6+ **W** Tungsten 183.8	75 4+ 7+ **Re** Rhenium 186.2	76 3+ 4+ **Os** Osmium 190.2	77 3+ 4+ **Ir** Iridium 192.2	78 4+ 2+ **Pt** Platinum 195.1	79 3+ 1+ **Au** Gold 197.0	80 2+ 1+ **Hg** Mercury 200.6	81 1+ 3+ **Tl** Thallium 204.4	82 2+ 4+ **Pb** Lead 207.2	83 3+ 5+ **Bi** Bismuth 209.0	84 2+ 4+ **Po** Polonium (209)	85 – **At** Astatine (210)	86 0 **Rn** Radon (222)
87 + **Fr** Francium (223)	88 2+ **Ra** Radium (226)	89 3+ **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)	110 **Ds** Darmstadtium (281)	111 **Rg** Roentgenium (272)	112 **Uub** Ununbium (285)	113 **Uut** Ununtrium (284)	114 **Uuq** Ununquadium (289)	115 **Uup** Ununpentium (288)	116 **Uuh** Ununhexium (292)	117 **Uus** Ununseptium (?)	118 **Uuo** Ununoctium (294)
Alkali Metals	Alkaline Earth Metals															Halogens	Noble Gases

58 3+ 4+ **Ce** Cerium 140.1	59 3+ 4+ **Pr** Praseodymium 140.9	60 3+ **Nd** Neodymium 144.2	61 3+ **Pm** Promethium (145)	62 3+ 4+ **Sm** Samarium 150.4	63 3+ 2+ **Eu** Europium 152.0	64 3+ **Gd** Gadolinium 157.3	65 3+ 4+ **Tb** Terbium 158.9	66 3+ **Dy** Dysprosium 162.5	67 3+ **Ho** Holmium 164.9	68 3+ **Er** Erbium 167.3	69 3+ 2+ **Tm** Thulium 168.9	70 3+ 2+ **Yb** Ytterbium 173.0	71 3+ **Lu** Lutetium 175.0
90 4+ **Th** Thorium 232.0	91 5+ 4+ **Pa** Protactinium 231.0	92 6+ 4+ 5+ **U** Uranium 238.0	93 5+ 3+ 4+ 6+ **Np** Neptunium (237)	94 4+ 6+ 3+ 5+ **Pu** Plutonium (244)	95 3+ 4+ 5+ 6+ **Am** Americium (243)	96 3+ **Cm** Curium (247)	97 3+ 4+ **Bk** Berkelium (247)	98 3+ **Cf** Californium (251)	99 3+ **Es** Einsteinium (252)	100 3+ **Fm** Fermium (257)	101 2+ 3+ **Md** Mendelevium (258)	102 2+ 3+ **No** Nobelium (259)	103 3+ **Lr** Lawrencium (262)

Based on mass of C-12 at 12.00.

Any value in parentheses is the mass of the most stable or best known isotope for elements which do not occur naturally.

NAMES, FORMULAE AND CHARGES OF SOME POLYATOMIC IONS

Positive Ions		Negative Ions	
NH_4^+	Ammonium	CH_3COO^-	Acetate
		CO_3^{2-}	Carbonate
		ClO_3^-	Chlorate
		ClO_2^-	Chlorite
		CrO_4^{2-}	Chromate
		CN^-	Cyanide
		$Cr_2O_7^{2-}$	Dichromate
		HCO_3^-	Hydrogen carbonate, bicarbonate
		HSO_4^-	Hydrogen sulfate, bisulfate
		HS^-	Hydrogen sulfide, bisulfide
		HSO_3^-	Hydrogen sulfite, bisulfite
		OH^-	Hydroxide
		ClO^-	Hypochlorite
		NO_3^-	Nitrate
		NO_2^-	Nitrite
		ClO_4^-	Perchlorate
		MnO_4^-	Permanganate
		PO_4^{3-}	Phosphate
		PO_3^{3-}	Phosphite
		SO_4^{2-}	Sulfate
		SO_3^{2-}	Sulfite

NAMES AND FORMULAE OF COMMON ACIDS

Hydrochloric acid	HCl
Sulfuric acid	H_2SO_4
Nitric acid	HNO_3
Acetic acid	HCH_3COO

PREFIXES

1	mono
2	di
3	tri
4	tetra
5	penta
6	hexa
7	hepta
8	octa
9	nona
10	deca