Grade 9 Science April 15-21

Thank you in advance for your patience and understanding as we determine how to navigate learning and teaching online. **Please ensure you read all of the information below before starting.**

Below you will find this week's science nine assignments. Each week will have a basic assignment, mandatory for all science nine students. The 'extending your learning' is offered for those who want to go beyond the minimal requirements.

If you need or want assistance on the assignment provided below, we are offering 'office hours' using the platform 'Zoom' twice per week with one of the four science teachers: Mr. Kyle Conne, Mr. Ricky Carr, Ms. Alanna Skene, and Mr. James Cutt. Please see the end of this document for this week's office hours. However, if you wish to speak directly with your science nine teacher, please do not hesitate to email them or ask a question on your classes Office 365 Team page at any time and they will respond in a timely manner.

Submitting completed work: Please submit your completed work by April 21, 2020 via **your Office 365 Class Teams account ideally or through email. Assignments and any relevant resources will be posted in your class' Teams Account.**

Learning Intentions:

1. To learn how to open and login to your Office.com account. To navigate the your class' Team and to understand the etiquette that is expected of both you and your teachers in this online learning environment.
2. Big idea: The electron arrangement of atoms impacts their chemical nature

   Todays content:

   - The periodic table groups elements according to their atomic number and properties (eg., atomic size, metals/non-metals/semi-metals, chemical families, diatomic elements)

Assignment Instructions:

Outline: This week's assignment will have you logging into your Office.com account, navigating to the Teams App and completing your assignment through this medium.

Required materials:

- Assignment # 2 and Class Notes
- BC Science nine textbook of chapter 3.2
- Chemistry Databook
- Naming Covalent and Type I Ionic Compounds Worksheet

Criteria / Rubric:

Assessment is based on a 4-point proficiency scale:

emerging	developing	proficient	extending
The student demonstrates an initial understanding of the concepts and competencies relevant to the expected learning.	The student demonstrates a partial understanding of the concepts and competencies relevant to the expected learning.	The student demonstrates a solid understanding of the concepts and competencies relevant to the expected learning.	The student demonstrates a sophisticated understanding of the concepts and competencies relevant to the expected learning.

Assignment Part 1:

Before you begin the main portion of the assignment this week, you will need to log into your Office 365 account and indicate that you have done so by writing which 2 components of the "Etiquette in Technology" sheet attached you think will be most important to you in Science 9 in the "Welcome" chat area of your Class Team. Once you have completed this, open the Assignments Tab at the top of the screen and continue with the assignment for this week.

Assignment Part 2:

Read the class notes below and watch the videos suggested at the end of each section to help with your understanding of the concepts discussed in the class notes. Then complete the "Covalent and Ionic Compounds Worksheet #1" in your Office 365 Teams Assignment page and submit it to your teacher once completed.

Class Notes:

Part A: Covalent/Molecular Compounds:

- **Covalent/Molecular Compounds:** compounds that are made of 2 or more non-metals that bond together by sharing electrons.
  - Always begins with a prefix (see "*Chemical Naming and Formulas Flow Chart*" at the end of your **Databook**)

- **Name → Chemical Formula:**
  - Covalent/molecular compound names contain "prefix" (words that appear before) to indicate the number of each type of element (see chart under "*Covalent*" sections on the last page of the **Databook**).
  - From the chemical name, find the symbols of the 2 non-metals. Write these symbols in the order they appear in the name.

    Example: Di**phosphorus** tetra**chloride**

    P Cl

  - Using the prefix, indicate the number of each type of element.

    Example: **Di**phosphorus **tetra**chloride

    P_2Cl_4

- **Chemical Formula → Name:**
  - Find the symbols on your Periodic Table.

- Write the name for the 1st element as it appears on the Periodic Table.
  - Add a prefix in front of the name ONLY if there is more than one atom of the 1st element to indicate the number of atoms of the 1st element
- Write the prefix to indicate the number of atoms of the second element, then write the name for the 2nd element, followed by its name and change the ending to -ide
  - **-ide** at the end of a name tells us that this is the end of the compound (like a period at the end of a sentence)

Examples: S_2C_5 (di=2, penta=5) (S = sulfur, C = carbide)

Disulfur pentacarbide

NO_3 (only 1 N, so no prefix, tri=3) (N = nitogen, O=oxide)

Nitrogen trioxide

To supplement your understanding, you could watch the following videos on how to write the names and formulas for covalent compounds:

https://www.youtube.com/watch?v=DejkvR4pvRw

Part B: Type I Ionic Compounds:

- **Ionic Compounds:** compounds that are made when a positive ion and a negative ion bond by transferring electrons
  - Typically this occurs between a metal ion (+) and a non-metal ion (-)
  - Always begins with a Metal or NH_4^+ (Ammonium) (see "*Chemical Naming and Formulas Flow Chart*" at the end of your **Databook**)

- **Type I Name → Formula:**
  - **Type I** = metals = ***alkali, alkali earth and Ag, Zn and Al***
  - Find the symbol and charge for the 1st element (above metals) on the Periodic Table.

    Example: **Calcium** chloride

    Ca^{2+}

  - Find the symbol and charge for the 2nd element (non-metal)

    Example: Calcium **chloride**

    Cl^{-}

  - Build a T-Chart to balance charges and determine the number of each type of atom.

    Example: Calcium chloride

Ca^{2+}	Cl^{-}
+2	-1
	-1
Total = +2	-2

This table shows that you require one Ca and 2Cl's to balance the charges of each ion. Therefore, the final formula is **$CaCl_2$**

Rubidium oxide

Rb^{+}	O^{2-}
+1	-2
+1	
Total = +2	-2

This table shows that you require two Rb's and one O to balance the charges of each ion. Therefore, the final formula is **Rb_2O**

Magnesium sulfide

Mg^{2+}	S^{2-}
+2	-2
Total = +2	-2

This table shows that you require one Mg and one S to balance the charges of each ion. Therefore, the final formula is MgS

- **<u>Type I Formula → Name:</u>**

  - Find the symbol for the 1st element (metals listed above) on the Periodic Table and write it as it appears.

Example: Na_2O

Sodium

  - Find the symbol for the 2nd element (non-metal) and write the name following the first elements name, but change the ending to <u>ide</u>

Na_2O

= Sodium Oxide

To supplement your understanding, you could watch the following videos on how to write the names and formulas for covalent compounds:

https://www.youtube.com/watch?v=URc75hoKGLY

Now that you have finished the notes, please work on the assignment called "Covalent and Ionic Compounds Worksheet #1" and submit it to your teacher in Office 365 Teams when you have completed it.

Extending Your Learning (Optional):

Please read the document titled “COVID-19 Backgrounder” and answer the questions on the worksheet titled “COVID-19 Worksheet for Students” in the Assignment area of your Office 365 Class Teams account.

Office Hours: April 15-21 (via ZOOM: https://zoom.us/join):

Time - 1:00pm to 2:00pm

Thursday, April 16: Mr. James Cutt

- Meeting ID: 468 236 083
- Password: smile

Monday, April 21: Mrs. Alanna Skene

- Meeting ID: 232 509 353
- Password: science

How to Log-in to Microsoft Office 365:

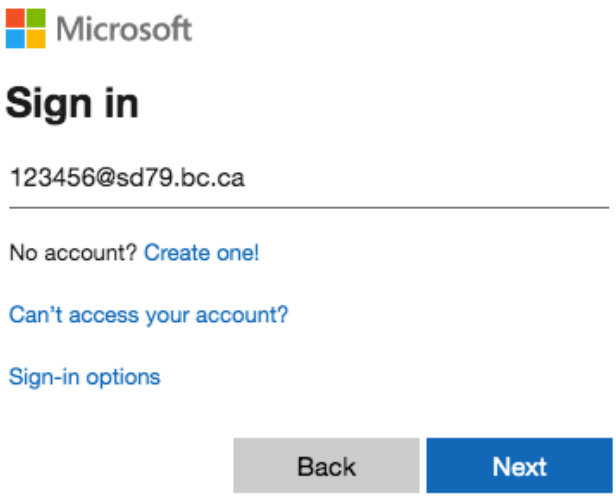
1. Type “office.com” in the Address Bar of your web browser

2. Click **Sign in**

3. Enter your username and password

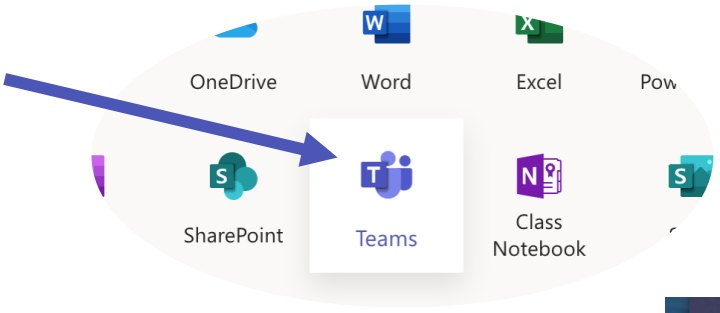
   Username: studentnumber@sd79.bc.ca

   Password: welcome



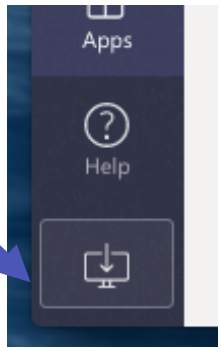
How to access your class Team:

1. Select the “Teams” application



2. Download the desktop version. **This is necessary for optimal functionality!** Press this button in the bottom left-hand corner

   2.1. If you are working on a tablet or mobile device, download the Teams App from the App Store or Google Play



3. Locate the class team you’re looking for!

4. Get comfortable! Practice switching between teams if you have multiple. Learn to navigate Chat, Posts, Files, and Assignments

5. Navigate to the “Welcome” bar and post your response to the first part of this weeks assignment about Technology Etiquette.

6. Navigate back the “General” bar and then to the “Assignments” tab at the top of the screen. Select the “April 15-21” folder to find your instructions for week #2

DIGITAL CLASSROOM ETIQUETTE

Guidelines for general Microsoft Teams online behavior:

- **Please be respectful** in all interactions with teachers and peers. The use of the chat function should be limited to school-related content ONLY
- The use of inappropriate language and/or the sharing of inappropriate content will not be tolerated.
- Your access to online lessons may be taken away if you cannot follow this expectation

Guidelines when participating in video conversations:

- Find a comfortable spot to learn in. Keep your device on a steady surface.
- Sit in a location in which there is a **blank wall behind you**
- Be mindful of your background lighting. If you are sitting in front of a window, you may be completely darkened by light coming through a window. Your overhead lighting might need to be turned off or dimmed as well.
- **Get organized** before the video chat. Gather any work and supplies you might need beforehand.
- Please ensure that all outside distractions are put away. It is expected that while you are in a video chat, the users have your undivided attention.
- Close all unnecessary applications on your device to keep the video function operating

- If you are having connection issues, try participating with just your microphone on. Turn off your video and see if that helps.
- You might want to use a headset for an external mic for best hearing and speaking capabilities
- If you are in a group video chat, **please mute when you are not speaking**. This helps to eliminate background noise if multiple people are participating. You can mute/unmute yourself by clicking on the microphone symbol in the chat.
- Please **put your hand up** if you have something to share with the class. This can be found in the participant's pop-up at the bottom of the screen. Remember to "lower" your hand once you've asked.
- Recording the video conversation or taking screen shots is not permitted.
- **Be patient**. This is a learning experience for everyone.

PERIODIC TABLE OF THE ELEMENTS

1 + **H** Hydrogen 1.0													METALS ← → NON-METALS				1 – **H** Hydrogen 1.0	18 2 0 **He** Helium 4.0
1	**2**											**13**	**14**	**15**	**16**	**17**	
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	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	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

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

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.

TABLE of IONS

ELEMENT NAME	SYMBOL	VALENCE
Actinium	Ac	3+
Aluminum	Al	3+
Antimony	Sb	3+ or 5+
Astatide	At	1-
Arsenide	As	3-
Barium	Ba	2+
Beryllium	Be	2+
Bismuth	Bi	3+ or 5+
Boride	B	3+
Bromide	Br	1-
Cadmium	Cd	2+
Calcium	Ca	2+
Carbide	C	4+ or 4-
Cerium	Ce	3+ or 4+
Cesium	Cs	1+
Chloride	Cl	1-
Chromium	Cr	3+ or 2+
Cobalt	Co	2+ or 3+
Copper	Cu	2+ or 1+
Europium	Eu	3+ or 2+
Fluoride	F	1-
Gallium	Ga	3+
Germanium	Ge	4+
Gold	Au	3+ or 1+
Hafnium	Hf	4+
Holmium	Ho	3+
Hydrogen	H	1+
Indium	In	3+
Iodide	I	1-
Iridium	Ir	3+ or 4+
Iron	Fe	3+ or 2+
Lanthanum	La	3+
Lead	Pb	2+ or 4+
Lithium	Li	1+
Magnesium	Mg	2+
Manganese	Mn	2+ or 3+ or 4+

ELEMENT NAME	SYMBOL	VALENCE
Mercury	Hg	2+ or 1+
Molybdenum	Mo	2+ or 3+
Nickel	Ni	2+ or 3+
Nitride	N	3-
Niobium	No	3+ or 5+
Osmium	Os	3+ or 4+
Oxide	O	2-
Phosphide	P	3-
Platinum	Pt	4+ or 2+
Polonium	Po	2+ or 4+
Potassium	K	1+
Radium	Ra	2+
Rhenium	Re	3+ or 4+
Rhodium	Rh	3+ or 4+
Rubidium	Rb	1+
Ruthenium	Ru	3+ or 4+
Scandium	Sc	3+
Selenide	Se	2-
Silicide	Si	4-
Silver	Ag	1+
Sodium	Na	1+
Strontium	Sr	2+
Sulfide	S	2-
Tantalum	Ta	5+
Telluride	Te	2-
Thallium	Tl	1+ or 3+
Thorium	Th	4+
Tin	Sn	4+ or 2+
Titanium	Ti	4+ or 3+
Tungsten	W	6+
Uranium	U	6+ or 4+ or 5+
Vanadium	V	5+ or 4+
Yttrium	Y	3+
Zinc	Zn	2+
Zirconium	Zr	4+

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
	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	HCI
Sulfuric acid	H_2SO_4
Nitric acid	NHO_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

only use prefixes for COVALENT compounds

Chemical Naming and Formulas Flow Chart

Chemical Names → Formula

Does it start with a **METAL** or **NH_4^+**?

- Yes → Ionic
  - Positive Ion 1st
    - Type I → -use 1st atom name to find symbol and charge (potassium = K^+)
    - Type II → -use 1st atoms name and Roman Numeral to write symbol and charge (iron (III) = Fe^{3+})
    - Ammonium (NH_4^+)
  - Write negative ion next
    - Monoatomic (usually ends in **-ide**) → -use 2nd name to find non-metal and charge (ox**ide** = O^{2-})
    - Polyatomic (usually ends in **-ate** or **-ite**) → -use 2nd name to find polyatomic and charge (carbon**ate**= CO_3^{2-})
- No → Covalent
  - -from the names find the symbols of the non-metals
  - -use **prefixes** to indicate the # of each type of atom (**no mono** for 1st element only)

Ex: **di**phosphorus **tetra**fluoride = P_2F_4

Sulfur **mono**bromide = SO

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

Build T-Chart to balance charges and determine # of each ion

Potassium oxide. K^+ O^{2-}
K^+ ·
K_2O

iron (III) carbonate. Fe^{3+} $(CO_3)^{2-}$
Fe^{3+} $(CO_3)^{2-}$
$(CO_3)^{2-}$
$Fe_2(CO_3)_3$

Ammonum chloride: $NH4^+$ Cl^- = NH_4Cl

Chemical Formulas → Names

Does it start with a **METAL** or **NH_4^+**?

- Yes → Ionic
  - Positive Ion 1st
    - Type I → -write the name of the 1st metal as is
      - -write name of **non-metal** but change ending to **-ide**
      - **OR**
      - -write name of **polyatomic** (do **NOT** change ending)
      - **Ex:** Na_2O = Sodium oxide
      - **OR**
      - **Ex:** K_2CO_3 = potassium carbonate
    - Type II → -write the name of the 1st metal with ( ) beside it
      - -write name of **non-metal** but change ending to **-ide**
      - **OR**
      - -write name of **polyatomic** (do **NOT** change ending)
      - -determine **Roman Numeral** using negative ion charge & T-Chart
    - Ammonium (NH_4^+) → -write ammonium as is
      - -write name of 2nd non-metal with **-ide** ending
      - **OR**
      - -write name of polyatomic as is
      - **Ex:** NH_4Br Ammonium bromide
- No → Covalent
  - -write the name of the 1st element as is (add **prefix** if more than one atom of it - **no mono** for 1st element only)
  - -Write **prefix** for 2nd element, followed by its name and change the ending of the name to **-ide**

Ex: S_2C_4 = **di**sulfur **tetra**carbide

NO_5 = nitrogen **penta**oxide

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

Ex: Fe_3P_2 = iron (?) phosph**ide**
$Fe^?$ P^{3-}
P^{3-}
+6 -6.

Iron needs to be **+2** in order to cancel out charges
→ Iron (II) phosphide

3.2 Names and Formulas of Ionic Compounds

Each ionic compound has a name that identifies the two types of ions it contains. An ionic compound also has a chemical formula that shows the ratio of the ions in the compound. In an ionic compound with only two elements, the first ion is always a positive metal ion and the second ion is always a negative non-metal ion. A metal that can form an ion in more than one way is described as multivalent. The name of a ion multivalent compound includes a Roman numeral to indicate the positive ion charge. Polyatomic ions contain the atoms of more than one element. There are both positive polyatomic ions and negative polyatomic ions.

Words to Know

chemical formula
chemical name
multivalent metal
Roman numeral

Table salt, road salt, rock salt, and sea salt are all different types of salt (Figure 3.10). Table salt and road salt are pure substances. Their chemical names are sodium chloride and calcium chloride. Rock salt and sea salt are mixtures of many different compounds. Names are important to us: we name ourselves, our pets, and the places where we live. What is important in naming a chemical?

(A) Table salt (B) Road salt (C) Rock salt (D) Sea salt

Figure 3.10 Salt comes in many forms and can be made of different compounds.

3-2A What's in a Name? Find Out ACTIVITY

A chemical name refers to only one compound and indicates the elements present. In this activity, you will work with a partner to discover what information can be collected from the names of ionic compounds.

What to Do

1. Working with your partner and the periodic table on page 54, review the ionic compounds listed below.
   lithium fluoride — zinc bromide
   calcium chloride — aluminum sulphide
   copper oxide
2. Look at where each element in the compound is located in the periodic table. What is one pattern that you can find in how these names are written?
3. Find one more pattern by examining the name of each ionic compound listed. The pattern has to apply to each chemical name.
4. Record any further patterns you or your partner observes.
5. Share your findings with the class.

What Did You Find Out?

1. What were two patterns you found in the chemical names of ionic compounds?
2. (a) What patterns and observations did you and your partner make that were similar to others in your class?
   (b) Which patterns and observations were different?
3. Explain how these patterns could be used as rules for identifying ionic compounds.

A Compound Has Both a Name and a Formula

All ionic compounds are composed of positive ions and negative ions. You can describe ionic compounds using a name or a formula. A **chemical name** indicates the elements present in the compound.

The chemical name

The International Union of Pure and Applied Chemistry (IUPAC) is a group that represents chemists around the world and is responsible for the rules for naming compounds. These rules are used in this textbook. The chemical name of an ionic compound always has two parts, one for each type of ion in it. The chemical name of table salt is sodium chloride.

- The first part of "sodium chloride" names the positive ion, sodium, which comes from the name of the sodium atom. The positive ion is *always* a metal in a compound containing two elements.
- The second part of "sodium chloride" names the negative ion, chloride. It is derived from a chlorine atom. The negative ion is *always* a non-metal in a compound containing two elements.
- The non-metal ion's name always ends with the suffix "-ide." In this example, "chlorine" changed to "chloride." The names and symbols for the non-metal ions are shown in Table 3.1.

Table 3.2 shows some examples of elements that can combine to form ionic compounds and the name of the resulting compound. Notice that the non-metal ion's name always ends in "-ide."

Table 3.1 Names and Symbols of Non-metal Ions

Name	Symbol
fluoride	F^-
chloride	Cl^-
bromide	Br^-
iodide	I^-
oxide	O^{2-}
sulphide	S^{2-}
selenide	Se^{2-}
nitride	N^{3-}
phosphide	P^{3-}

Table 3.2 Examples of Names of Ionic Compounds

Elements Forming the Ionic Compound	Name of the Ionic Compound
calcium and nitrogen	calcium nitride
potassium and oxygen	potassium oxide
lithium and chlorine	lithium chloride
magnesium and sulphur	magnesium sulphide
silver and fluorine	silver fluoride

Did You Know?

Antoine-Laurent Lavoisier (1743–1794) is considered the founder of modern chemistry. He published his ideas for a chemical naming system in 1787. The system of names we use today came from his ideas.

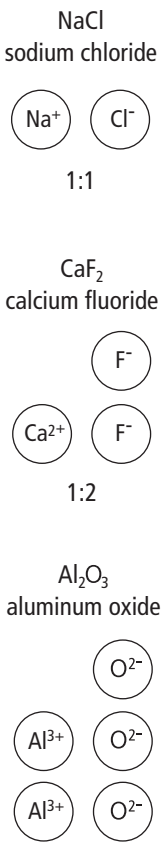


Figure 3.11 The formula and the diagram show the ratio of ions. Calcium fluoride has one Ca^{2+} ion for every two F^- ions. Aluminum oxide has two Al^{3+} and three O^{2-} ions.

The chemical formula

The **chemical formula** of an ionic compound contains symbols to identify each ion. It also shows the relative numbers of ions in the compound. These numbers are shown by a subscript set to the right of the element symbol. Figure 3.11 shows three examples.

- The metal ions in these examples are Na^+, Ca^{2+}, and Al^{3+}. Remember that these are ions, not atoms, when present in a compound. You can find their charges on the periodic table.
- The non-metal ions in these examples are Cl^-, F^-, and O^{2-}. You can also find their charges on the periodic table.

Rules for Writing the Names of Ionic Compounds

The rules for writing the name of an ionic compound from its formula are shown in Table 3.3, including two examples.

Table 3.3 Rules for Naming Ionic Compounds Containing Two Elements

Steps for Writing the Name	Examples	
	$MgBr_2$	Li_3N
1. Name the metal ion.	• The metal ion is Mg^{2+}. • The ion's name is given in the periodic table as magnesium.	• The metal ion is Li^+. • The ion's name is given in the periodic table as lithium.
2. Name the non-metal ion by ending the element name with the suffix "ide."	• The non-metal ion is Br^-. The element's name is bromine. • Changing the name to end with the suffix "-ide" gives bromide.	• The non-metal ion is N^{3-}. The element's name is nitrogen. • Changing the name to end with the suffix "-ide" gives nitride.
3. Write the name of the compound.	magnesium bromide	lithium nitride

Practice Problems

Write the names of the following compounds.

(a) AlI_3
(b) Na_2O
(c) Mg_3P_2
(d) AgI
(e) CaSe
(f) K_2S
(g) RbF
(h) Ag_3N
(i) KBr
(j) Sr_3P_2
(k) CdS
(l) Ag_2O
(m) Cs_2S
(n) CaI_2
(o) NaF

Answers provided on page 509

Rules for Writing the Formulas of Ionic Compounds

In an ionic compound, the positive charges balance the negative charges. You can use this balance to find the ratio of positive ions to negative ions. Then use the ratio to write subscripts in the formula. Table 3.4 gives the rules and two examples.

Notice that the final formula must represent the smallest whole number ratio. For example, Sn^{4+} combining with O^{2-} is written SnO_2 and not Sn_2O_4.

Table 3.4 Rules for Writing Formulas of Ionic Compounds Containing Two Elements

Steps for Writing the Formula	Examples	
	zinc nitride	aluminum chloride
1. Identify each ion and its charge.	zinc: Zn^{2+} nitride: N^{3-}	aluminum: Al^{3+} chloride: Cl^-
2. Determine the total charges needed to balance positive with negative.	Zn^2+: +2 +2 +2 = +6 N^{3-}: −3 −3 = −6	Al^{3+} : = +3 Cl^-: −1 −1 −1 = −3
3. Note the ratio of positive ions to negative ions.	3 Zn^{2+} ions for every 2 N^{3-} ions	1 Al^{3+} ion for every 3 Cl^- ions
4. Use subscripts to write the formula. A "1" is not shown in the subscripts.	Zn_3N_2	$AlCl_3$

Practice Problems

1. Write the formulas of the compounds containing the following ions.
   - (a) Li^+ with Cl^-
   - (b) Ca^{2+} with F^-
   - (c) Na^+ with S^{2-}
   - (d) Ca^{2+} with S^{2-}
   - (e) Al^{3+} with O^{2-}
   - (f) Al^{3+} with N^{3-}
2. Write the formulas of the following compounds.
   - (a) lithium fluoride
   - (b) silver sulphide
   - (c) magnesium chloride
   - (d) zinc oxide
   - (e) lithium oxide
   - (f) aluminum iodide
   - (g) barium phosphide
   - (h) aluminum phosphide
   - (i) rubidium selenide
   - (j) strontium nitride
   - (k) cesium sulphide
   - (l) sodium nitride
   - (m) zinc phosphide
   - (n) calcium oxide

Answers provided on page 509

Word Connect

The word "subscript" comes from the prefix "sub-," which means below, and "script," meaning to write. Subscripts are used in the formulas of ionic compounds to show the relative amounts of each ion.

Suggested Activity

Think About It 3-2B on page 93

Compounds Containing a Multivalent Metal

Many important metals are multivalent. The prefix "multi-" means many, and "valent" refers to the capacity to bond. **Multivalent metals** can form two or more different positive ions with different ion charges (Figure 3.12).

Figure 3.12 Ion charge can affect the colour of a metal ion. Solutions of vanadium ions are shown left to right: 5^+, 4^+, 3^+, and 2^+.

Table 3.5
Roman Numerals

Metal Ion Charge	Roman Numeral
1+	I
2+	II
3+	III
4+	IV
5+	V
6+	VI
7+	VII

Find iron on the periodic table. You will see that iron is multivalent. The table lists two ion charges: 3^+ and 2^+. This means that in some compounds, the iron ion is Fe^{3+}, and in other compounds the iron ion is Fe^{2+}. The table always lists the most common ion charge first. So for iron, Fe^{3+} is more common than Fe^{2+}.

To distinguish between two ions formed from multivalent metals, you need to name each ion. The name must contain the ion's charge. To do this, you need to know the Roman numerals from I to VII. (**Roman numerals** are numerals based on those used by the ancient Romans.) These correspond to ion charges from 1^+ to 7^+, as shown in Table 3.5. Here are some examples:

- Fe^{3+} or iron(III) is pronounced "iron three" and means the iron ion has an ion charge of 3+.
- Fe^{2+} or iron(II) is pronounced "iron two" and means the iron ion has an ion charge of 2+.
- Pb^{4+} or lead(IV) is pronounced "lead four" and means the lead ion has an ion charge of 4+.
- Cu^+ or copper(I) is pronounced "copper one" and means the copper ion has an ion charge of 1+.

What does a Roman numeral reveal about an ion? First, it tells you that this metal can form ions with different ion charges. Second, it tells you the charge on the metal ion. Table 3.6 gives examples of names and formulas for compounds containing a multivalent ion. Remember that the positive and negative charges on the ions must balance so that the overall charge on the compound is zero.

Table 3.6
Compounds with Multivalent Metal Ions

Name	Formula
chromium(II) fluoride	CrF_2
chromium(III) fluoride	CrF_3
lead(IV) sulphide	PbS_2
copper(I) phosphide	Cu_3P

Writing the Formula

Table 3.7 shows how to write the formula when you are given the name of a compound containing a multivalent metal.

Table 3.7 Rules for Writing Formulas of Compounds Containing a Multivalent Metal

Steps for Writing the Formula	Examples	
	iron(III) sulphide	lead(IV) oxide
1. Identify each ion and its charge.	iron(III): Fe^{3+} sulphide: S^{2-}	lead(IV): Pb^{4+} oxide: O^{2-}
2. Determine the total charges needed to balance positive with negative.	Fe^{3+}: $+3\ +3 \quad = +6$ S^{2-} : $-2\ -2\ -2 = -6$	Pb^{4+}: $\quad = +4$ O^{2-}: $-2\ -2 \ = -4$
3. Note the ratio of positive ions to negative ions.	2 Fe^{3+} ions for every 3 S^{2-} ions	1 Pb^{4+} ion for every 2 O^{2-} ions
4. Use subscripts to write the formula. A "1" is not shown in the subscripts.	Fe_2S_3	PbO_2

Practice Problems

1. Write the formulas of the following compounds.

(a) chromium(II) chloride
(b) chromium(III) chloride
(c) copper(I) sulphide
(d) copper(I) iodide
(e) iron(II) phosphide
(f) iron(III) phosphide
(g) manganese(II) oxide
(h) manganese(IV) oxide
(i) mercury(II) bromide
(j) tin(II) sulphide
(k) tin(II) nitride
(l) tin(IV) nitride
(m) copper(I) nitride
(n) lead(IV) chloride

Answers provided on page 509

Writing the Name

When you are writing the name of an ionic compound containing a multivalent metal, do you need a Roman numeral to indicate the ion charge. Table 3.8 shows how to determine the correct Roman numeral.

Table 3.8 Naming Ionic Compounds Containing a Multivalent Metal

Steps for Writing the Name	Examples	
	Cu_3P	MnO_2
1. Identify the metal.	copper (Cu)	manganese (Mn)
2. Verify that it can form more than one kind of ion by checking the periodic table.	Cu^{2+} and Cu^{+}	Mn^{2+}, Mn^{3+}, and Mn^{4+}
3. Determine the ratio of the ions in the formula.	Cu_3P means 3 copper ions for every 1 phosphide ion.	MnO_2 means 1 manganese ion for every 2 oxide ions.
4. Note the charge of the negative ion from the periodic table.	The charge on the phosphide P^{3-} is 3−.	The charge on the oxide O^{2-} is 2−.
5. The positive and negative charges must balance out. Determine what the charge needs to be on the metal ion to balance the negative ion.	Each of the 3 copper ions must have a charge of 1+ to balance the 1 phosphide ion with a charge of 3−. Therefore the name of the copper ion is copper(I).	The 1 manganese ion must have a charge of 4+ to balance the 2 oxide ions that each have a charge of 2−. Therefore, the name of the manganese ion is manganese(IV).
6. Write the name of the compound.	copper(I) phosphide	manganese(IV) oxide

Practice Problems

1. Each of these compounds contains a multivalent metal ion. That means that the name of the metal ion will contain a Roman numeral, which you will need to determine. Write the names of the following compounds.

(a) $CrBr_2$
(b) $CrBr_3$
(c) FeI_2
(d) FeI_3
(e) PbF_2
(f) PbF_4
(g) MnO
(h) PbS
(i) Fe_2O_3
(j) Hg_3P_2
(k) Hg_3N_2
(l) HgI_2
(m) MnS
(n) MnS_2
(o) Sn_3P_4

Answers provided on page 509.

Polyatomic Ions

You learned in section 3.1 that some molecules gain or lose one or more electrons and become polyatomic ions. Because a polyatomic ion carries an electric charge, it cannot exist on its own. It is always paired up with ions that carry an opposite charge. Table 3.9 shows you how to write the formulas for compounds with polyatomic ions.

Table 3.9 Steps for Writing the Formula of a Compound with Polyatomic Ions

Steps for Writing the Formula	Examples	
	iron(III) hydroxide	ammonium carbonate
1. Identify each ion and its charge.	iron(III): Fe^{3+} hydroxide: OH^-	ammonium: NH_4^+ carbonate: CO_3^{2-}
2. Determine the total charges needed to balance positive with negative.	Fe^{3+}: $= 3+$ OH^{-1}: $-1\ -1\ -1 = 3-$	NH_4^+: $+1\ +1 = 2+$ CO_3^{2-}: $= 2-$
3. Note the ratio of positive ions to negative ions.	1 Fe^{3+} ion for every 3 OH^- ions	2 NH_4^+ ions for every 1 CO_3^{2-} ion
4. Use subscripts and brackets to write the formula. Omit brackets if only one ion is needed.	$Fe(OH)_3$	$(NH_4)_2CO_3$

Practice Problems

Refer to Table 3.10 on page 92 as you do these problems.

1. Write the names of the following compounds.

(a) $NaCH_3COO$
(b) $Ca(CH_3COO)_2$
(c) $Cr(CH_3COO)_3$
(d) $Al(OH)_3$
(e) $Cr(OH)_3$
(f) $(NH_4)_3P$
(g) $(NH_4)_3PO_4$
(h) $CaSO_4$
(i) $Mg_3(PO_4)_2$
(j) $Ba_3(PO_3)_2$

2. Write the formulas of the following compounds.

(a) sodium chromate
(b) potassium permanganate
(c) lithium dichromate
(d) sodium hydroxide
(e) magnesium hydroxide
(f) ammonium nitrate
(g) tin(II) hydroxide
(h) lead(II) hydroxide
(i) aluminum nitrate
(j) manganese(IV) sulphate

Answers provided on page 509

Did You Know?

All medicines come with a list of ingredients like the one shown below. The list includes the chemical name of the medicine. The chemical name allows you to compare products that have different brand names but contain the same active (medicinal) ingredient. Non-medicinal ingredients may improve the taste, act as filler to make the dose large enough to handle, or increase shelf life.

Common Polyatomic Ions

There are many polyatomic ions. Table 3.10 lists some common ones. The names of these ions were assigned by the IUPAC. You do not have to memorize them. Simply refer to this table to find a name and formula.

Table 3.10 Common Polyatomic Ions

Name	Formula
acetate	CH_3COO^-
ammonium	NH_4^+
carbonate	CO_3^{2-}
chlorate	ClO_3^-
chlorite	ClO_2^-
chromate	CrO_4^{2-}
cyanide	CN^-
dichromate	$Cr_2O_7^{2-}$
hydrogen carbonate	HCO_3^-
hydrogen sulphate	HSO_4^-
hydrogen sulphide	HS^-
hydrogen sulphite	HSO_3^-
hydroxide	OH^-
hypochlorite	ClO^-
nitrate	NO_3^-
nitrite	NO_2^-
perchlorate	ClO_4^-
permanganate	MnO_4^-
phosphate	PO_4^{3-}
phosphite	PO_3^{3-}
sulphate	SO_4^{2-}
sulphite	SO_3^{2-}

Explore More

Ammonium (NH_4^+) and nitrate (NO_3^-) are present in fertilizers. They are both produced from ammonia (NH_3), which you may be familiar with as window cleaner. Find out about the Haber process for the production of ammonia. Begin your research at **www.bcscience9.ca**.

Reading Check

1. In Table 3.10, find the following:
   (a) the formula of an ion with a positive charge
   (b) the formulas of all four ions made of only two atoms
   (c) the name of the ion that contains nine atoms
   (d) the formula of the ion containing three elements and six atoms
   (e) the formula of the ion containing three elements and having a charge of 2−
   (f) the names and formulas of two ions containing nitrogen and oxygen
   (g) the charge on the ion containing four hydrogen atoms
2. Find all four ions in Table 3.10 that contain a chlorine atom, and write their formulas in descending order according to the number of oxygen atoms in each one.

3-2B Modelling an Ionic Compound

Think About It

In this activity, your teacher will guide you as you use different shapes to represent positive and negative ions. These shapes combine in a way that closely matches the way real ions combine. The patterns you discover here can help you write the names and formulas of ionic compounds.

Materials

- set of shapes in one colour representing various kinds of positive ions
- set of shapes in a different colour representing various kinds of negative ions
- scissors

What to Do

1. Work in pairs.
2. Your teacher will give you photocopies of sheets of shapes that you will cut out. You need to know the following points about each shape:
   - Each shape represents a single ion.
   - Positive ions look like a rectangle with a piece cut out. The cut-out part is called a hole.
   - Negative ions also look like a rectangle, but with an extra piece attached. The extra piece is called a peg.
3. An ionic compound has an orderly arrangement of alternating positive and negative ions. You will make models of several ionic compounds. For each compound, you will need one kind of positive ion and one kind of negative ion. You need to know the following points about each arrangement of your shapes.
   - Every hole must be filled with a peg, and every peg must be in a hole. Keep adding ions until this happens.
   - The positive and negative ions must alternate as much as possible throughout the compound.
4. In the beginning, your teacher will tell you which ions to use for each compound. For each compound, build the model, name the compound, and then write its formula using the following rules.

The Name

- Write the name of the positive ion, leave a blank space equal to one letter, and write the name of the negative ion.

The Formula

- Count the numbers of positive ions and negative ions in your model. Then find the smallest ratio of these two numbers (use whole numbers). For example, if your model has two positive ions and one negative ion, the ratio is 2:1. If it has six positive ions and nine negative ions, the ratio is 2:3.
- Write the symbol of the positive ion (without its charge) followed by the first number from the ratio as a subscript. Beside this, write the symbol for the negative ion (without its charge) followed by the second number in the ratio as a subscript. For example, if Al^{3+} is the symbol for the positive ion and S^{2-} is the symbol for the negative ion, the formula for this compound would be Al_2S_3.

What Did You Find Out?

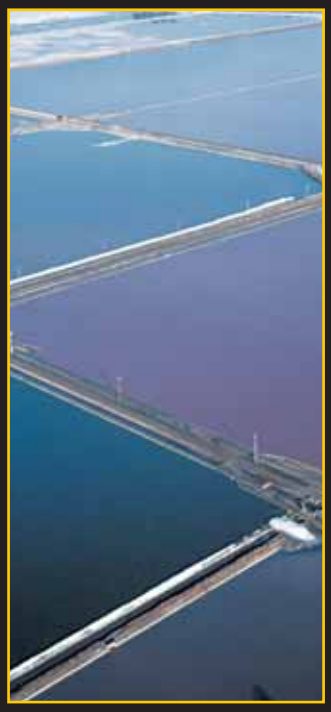
1. In what order are the ions named in an ionic compound: negative ion followed by positive ion or positive ion followed by negative ion?
2. Three possible formulas for silver sulphide are Ag_6S_3, Ag_2S, and $Ag_{12}S_6$. Only one of these formulas is correct.
   (a) Which one is correct?
   (b) Why?
3. Cadmium bromide is a poisonous compound used to engrave metal. Its formula is $CdBr_2$. How can the formula be used to find the charge on a cadmium ion if you already know that the bromide ion is Br^-?

NATIONAL GEOGRAPHIC

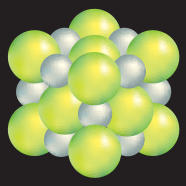
VISUALIZING SALT

The salt you use every day comes from both the land and the sea. Some salt can be mined from the ground in much the same way as coal, or salt can be obtained by the process of evaporation in crystallizing ponds.

▲ MINING SALT Underground salt deposits are found where there was once a sea. Salt mines can be located deep underground or near Earth's surface in salt domes. Salt domes form when pressure from Earth pushes buried salt deposits close to the surface, where they are easily mined.



◀ EVAPORATION PROCESS Workers fill evaporation ponds with salt water, or brine. They move the brine from pond to pond as it becomes saltier through evaporation. (Red-tinted ponds have a higher salt content.) The saltiest water is then pumped from evaporation ponds into crystallizing ponds, where the remaining water is drained off. In the five years it takes to produce a crop of salt, brine may move through as many as 23 different ponds.



Unit cell of sodium chloride (NaCl)

◀ TABLE SALT Raw sodium chloride is washed in chemicals and water to remove impurities before it appears on your dining-room table as salt. Iodine is added to table salt to ensure against iodine deficiency in the diet.

▼ SALT MOUNDS When the crystallizing ponds are drained, the result is huge piles of salt, like these on the Caribbean island of Bonaire.

Check Your Understanding

Checking Concepts

1. (a) How many parts are there in the name of an ionic compound?
   (b) What does each part describe?
2. Name each of the ions in the list below and indicate which of the following words describe it: positive ion, negative ion, multivalent metal, polyatomic ion.
   (a) Li^+
   (b) NO_3^-
   (c) Fe^{3+}
   (d) CH_3COO^-
   (e) Cr^{2+}
   (f) Cl^-
   (g) ClO_4^-
   (h) NH_4^+
3. For each polyatomic ion, list the name, the number of each kind of atom, the total number of atoms, and the electric charge on the ion.
   (a) CrO_4^{2-}
   (b) $Cr_2O_7^{2-}$
   (c) NH_4^+
   (d) CH_3COO^-
   (e) HSO_4^-
   (f) SO_4^{2-}
   (g) SO_3^{2-}
   (h) S^{2-}

Understanding Key Ideas

4. Write the name or formula of the following compounds.
   (a) sodium chloride
   (b) magnesium fluoride
   (c) aluminum bromide
   (d) potassium iodide
   (e) lithium sulphide
   (f) aluminum oxide
   (g) LiBr
   (h) NaI
   (i) K_2S
   (j) MgF_2
   (k) Al_2O_3
   (l) Ca_3N_2
5. Write the name or formula of the following compounds.
   (a) iron(III) bromide
   (b) iron(II) bromide
   (c) nickel(II) fluoride
   (d) nickel(II) sulphide
   (e) tin(IV) nitride
   (f) manganese(II) phosphide
   (g) CrF_2
   (h) CuI
   (i) MnS
   (j) PbO_2
   (k) SnS_2
   (l) Cr_3N_2
6. Write the name or formula of the following compounds.
   (a) $Mg(OH)_2$
   (b) K_2SO_4
   (c) $Al(HCO_3)_3$
   (d) Cu_2CO_3
   (e) $Fe(MnO_4)_2$
   (f) $(NH_4)_2SO_4$
   (g) sodium sulphate
   (h) calcium phosphate
   (i) aluminum nitrate
   (j) ammonium hydrogen sulphate
   (k) lead(IV) chlorate
   (l) iron(III) carbonate

Pause and Reflect

All ionic compounds have a chemical name and a chemical formula in accordance with rules of the IUPAC. It may be tempting to think that the formula is simply a shorter way of writing the chemical name. However, the two do not give exactly the same information about a compound. What information does the formula give about a compound that is not present in the name?

3.2 Names and Formulas of Ionic Compounds

Each ionic compound has a name that identifies the two types of ions it contains. An ionic compound also has a chemical formula that shows the ratio of the ions in the compound. In an ionic compound with only two elements, the first ion is always a positive metal ion and the second ion is always a negative non-metal ion. A metal that can form an ion in more than one way is described as multivalent. The name of a ion multivalent compound includes a Roman numeral to indicate the positive ion charge. Polyatomic ions contain the atoms of more than one element. There are both positive polyatomic ions and negative polyatomic ions.

Words to Know

chemical formula
chemical name
multivalent metal
Roman numeral

Table salt, road salt, rock salt, and sea salt are all different types of salt (Figure 3.10). Table salt and road salt are pure substances. Their chemical names are sodium chloride and calcium chloride. Rock salt and sea salt are mixtures of many different compounds. Names are important to us: we name ourselves, our pets, and the places where we live. What is important in naming a chemical?

(A) Table salt (B) Road salt (C) Rock salt (D) Sea salt

Figure 3.10 Salt comes in many forms and can be made of different compounds.

3-2A What's in a Name? Find Out ACTIVITY

A chemical name refers to only one compound and indicates the elements present. In this activity, you will work with a partner to discover what information can be collected from the names of ionic compounds.

What to Do

1. Working with your partner and the periodic table on page 54, review the ionic compounds listed below.
   lithium fluoride — zinc bromide
   calcium chloride — aluminum sulphide
   copper oxide
2. Look at where each element in the compound is located in the periodic table. What is one pattern that you can find in how these names are written?
3. Find one more pattern by examining the name of each ionic compound listed. The pattern has to apply to each chemical name.
4. Record any further patterns you or your partner observes.
5. Share your findings with the class.

What Did You Find Out?

1. What were two patterns you found in the chemical names of ionic compounds?
2. (a) What patterns and observations did you and your partner make that were similar to others in your class?
   (b) Which patterns and observations were different?
3. Explain how these patterns could be used as rules for identifying ionic compounds.

A Compound Has Both a Name and a Formula

All ionic compounds are composed of positive ions and negative ions. You can describe ionic compounds using a name or a formula. A **chemical name** indicates the elements present in the compound.

The chemical name

The International Union of Pure and Applied Chemistry (IUPAC) is a group that represents chemists around the world and is responsible for the rules for naming compounds. These rules are used in this textbook. The chemical name of an ionic compound always has two parts, one for each type of ion in it. The chemical name of table salt is sodium chloride.

- The first part of "sodium chloride" names the positive ion, sodium, which comes from the name of the sodium atom. The positive ion is *always* a metal in a compound containing two elements.
- The second part of "sodium chloride" names the negative ion, chloride. It is derived from a chlorine atom. The negative ion is *always* a non-metal in a compound containing two elements.
- The non-metal ion's name always ends with the suffix "-ide." In this example, "chlorine" changed to "chloride." The names and symbols for the non-metal ions are shown in Table 3.1.

Table 3.2 shows some examples of elements that can combine to form ionic compounds and the name of the resulting compound. Notice that the non-metal ion's name always ends in "-ide."

Table 3.1 Names and Symbols of Non-metal Ions

Name	Symbol
fluoride	F^-
chloride	Cl^-
bromide	Br^-
iodide	I^-
oxide	O^{2-}
sulphide	S^{2-}
selenide	Se^{2-}
nitride	N^{3-}
phosphide	P^{3-}

Table 3.2 Examples of Names of Ionic Compounds

Elements Forming the Ionic Compound	Name of the Ionic Compound
calcium and nitrogen	calcium nitride
potassium and oxygen	potassium oxide
lithium and chlorine	lithium chloride
magnesium and sulphur	magnesium sulphide
silver and fluorine	silver fluoride

Did You Know?

Antoine-Laurent Lavoisier (1743–1794) is considered the founder of modern chemistry. He published his ideas for a chemical naming system in 1787. The system of names we use today came from his ideas.

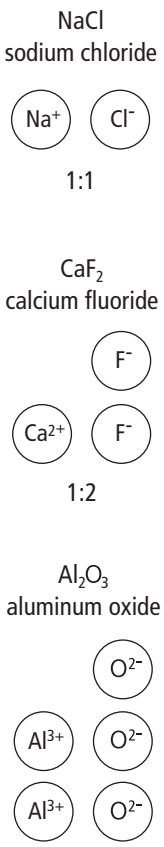


Figure 3.11 The formula and the diagram show the ratio of ions. Calcium fluoride has one Ca^{2+} ion for every two F^- ions. Aluminum oxide has two Al^{3+} and three O^{2-} ions.

The chemical formula

The **chemical formula** of an ionic compound contains symbols to identify each ion. It also shows the relative numbers of ions in the compound. These numbers are shown by a subscript set to the right of the element symbol. Figure 3.11 shows three examples.

- The metal ions in these examples are Na^+, Ca^{2+}, and Al^{3+}. Remember that these are ions, not atoms, when present in a compound. You can find their charges on the periodic table.
- The non-metal ions in these examples are Cl^-, F^-, and O^{2-}. You can also find their charges on the periodic table.

Rules for Writing the Names of Ionic Compounds

The rules for writing the name of an ionic compound from its formula are shown in Table 3.3, including two examples.

Table 3.3 Rules for Naming Ionic Compounds Containing Two Elements

Steps for Writing the Name	Examples	
	$MgBr_2$	Li_3N
1. Name the metal ion.	• The metal ion is Mg^{2+}. • The ion's name is given in the periodic table as magnesium.	• The metal ion is Li^+. • The ion's name is given in the periodic table as lithium.
2. Name the non-metal ion by ending the element name with the suffix "ide."	• The non-metal ion is Br^-. The element's name is bromine. • Changing the name to end with the suffix "-ide" gives bromide.	• The non-metal ion is N^{3-}. The element's name is nitrogen. • Changing the name to end with the suffix "-ide" gives nitride.
3. Write the name of the compound.	magnesium bromide	lithium nitride

Practice Problems

Write the names of the following compounds.

(a) AlI_3
(b) Na_2O
(c) Mg_3P_2
(d) AgI
(e) CaSe
(f) K_2S
(g) RbF
(h) Ag_3N
(i) KBr
(j) Sr_3P_2
(k) CdS
(l) Ag_2O
(m) Cs_2S
(n) CaI_2
(o) NaF

Answers provided on page 509

Rules for Writing the Formulas of Ionic Compounds

In an ionic compound, the positive charges balance the negative charges. You can use this balance to find the ratio of positive ions to negative ions. Then use the ratio to write subscripts in the formula. Table 3.4 gives the rules and two examples.

Notice that the final formula must represent the smallest whole number ratio. For example, Sn^{4+} combining with O^{2-} is written SnO_2 and not Sn_2O_4.

Table 3.4 Rules for Writing Formulas of Ionic Compounds Containing Two Elements

Steps for Writing the Formula	Examples	
	zinc nitride	aluminum chloride
1. Identify each ion and its charge.	zinc: Zn^{2+} nitride: N^{3-}	aluminum: Al^{3+} chloride: Cl^-
2. Determine the total charges needed to balance positive with negative.	Zn^2+: +2 +2 +2 = +6 N^{3-}: −3 −3 = −6	Al^{3+} : = +3 Cl^-: −1 −1 −1 = −3
3. Note the ratio of positive ions to negative ions.	3 Zn^{2+} ions for every 2 N^{3-} ions	1 Al^{3+} ion for every 3 Cl^- ions
4. Use subscripts to write the formula. A "1" is not shown in the subscripts.	Zn_3N_2	$AlCl_3$

Practice Problems

1. Write the formulas of the compounds containing the following ions.
   - (a) Li^+ with Cl^-
   - (b) Ca^{2+} with F^-
   - (c) Na^+ with S^{2-}
   - (d) Ca^{2+} with S^{2-}
   - (e) Al^{3+} with O^{2-}
   - (f) Al^{3+} with N^{3-}
2. Write the formulas of the following compounds.
   - (a) lithium fluoride
   - (b) silver sulphide
   - (c) magnesium chloride
   - (d) zinc oxide
   - (e) lithium oxide
   - (f) aluminum iodide
   - (g) barium phosphide
   - (h) aluminum phosphide
   - (i) rubidium selenide
   - (j) strontium nitride
   - (k) cesium sulphide
   - (l) sodium nitride
   - (m) zinc phosphide
   - (n) calcium oxide

Answers provided on page 509

Word Connect

The word "subscript" comes from the prefix "sub-," which means below, and "script," meaning to write. Subscripts are used in the formulas of ionic compounds to show the relative amounts of each ion.

Suggested Activity

Think About It 3-2B on page 93

Compounds Containing a Multivalent Metal

Many important metals are multivalent. The prefix "multi-" means many, and "valent" refers to the capacity to bond. **Multivalent metals** can form two or more different positive ions with different ion charges (Figure 3.12).

Figure 3.12 Ion charge can affect the colour of a metal ion. Solutions of vanadium ions are shown left to right: 5^+, 4^+, 3^+, and 2^+.

Table 3.5
Roman Numerals

Metal Ion Charge	Roman Numeral
1+	I
2+	II
3+	III
4+	IV
5+	V
6+	VI
7+	VII

Find iron on the periodic table. You will see that iron is multivalent. The table lists two ion charges: 3^+ and 2^+. This means that in some compounds, the iron ion is Fe^{3+}, and in other compounds the iron ion is Fe^{2+}. The table always lists the most common ion charge first. So for iron, Fe^{3+} is more common than Fe^{2+}.

To distinguish between two ions formed from multivalent metals, you need to name each ion. The name must contain the ion's charge. To do this, you need to know the Roman numerals from I to VII. (**Roman numerals** are numerals based on those used by the ancient Romans.) These correspond to ion charges from 1^+ to 7^+, as shown in Table 3.5. Here are some examples:

- Fe^{3+} or iron(III) is pronounced "iron three" and means the iron ion has an ion charge of 3+.
- Fe^{2+} or iron(II) is pronounced "iron two" and means the iron ion has an ion charge of 2+.
- Pb^{4+} or lead(IV) is pronounced "lead four" and means the lead ion has an ion charge of 4+.
- Cu^+ or copper(I) is pronounced "copper one" and means the copper ion has an ion charge of 1+.

What does a Roman numeral reveal about an ion? First, it tells you that this metal can form ions with different ion charges. Second, it tells you the charge on the metal ion. Table 3.6 gives examples of names and formulas for compounds containing a multivalent ion. Remember that the positive and negative charges on the ions must balance so that the overall charge on the compound is zero.

Table 3.6
Compounds with Multivalent Metal Ions

Name	Formula
chromium(II) fluoride	CrF_2
chromium(III) fluoride	CrF_3
lead(IV) sulphide	PbS_2
copper(I) phosphide	Cu_3P

Writing the Formula

Table 3.7 shows how to write the formula when you are given the name of a compound containing a multivalent metal.

Table 3.7 Rules for Writing Formulas of Compounds Containing a Multivalent Metal

Steps for Writing the Formula	Examples	
	iron(III) sulphide	lead(IV) oxide
1. Identify each ion and its charge.	iron(III): Fe^{3+} sulphide: S^{2-}	lead(IV): Pb^{4+} oxide: O^{2-}
2. Determine the total charges needed to balance positive with negative.	Fe^{3+}: $+3\ +3 \quad = +6$ S^{2-} : $-2\ -2\ -2 = -6$	Pb^{4+}: $\quad = +4$ O^{2-}: $-2\ -2 \ = -4$
3. Note the ratio of positive ions to negative ions.	2 Fe^{3+} ions for every 3 S^{2-} ions	1 Pb^{4+} ion for every 2 O^{2-} ions
4. Use subscripts to write the formula. A "1" is not shown in the subscripts.	Fe_2S_3	PbO_2

Practice Problems

1. Write the formulas of the following compounds.

(a) chromium(II) chloride
(b) chromium(III) chloride
(c) copper(I) sulphide
(d) copper(I) iodide
(e) iron(II) phosphide
(f) iron(III) phosphide
(g) manganese(II) oxide
(h) manganese(IV) oxide
(i) mercury(II) bromide
(j) tin(II) sulphide
(k) tin(II) nitride
(l) tin(IV) nitride
(m) copper(I) nitride
(n) lead(IV) chloride

Answers provided on page 509

Writing the Name

When you are writing the name of an ionic compound containing a multivalent metal, do you need a Roman numeral to indicate the ion charge. Table 3.8 shows how to determine the correct Roman numeral.

Table 3.8 Naming Ionic Compounds Containing a Multivalent Metal

Steps for Writing the Name	Examples	
	Cu_3P	MnO_2
1. Identify the metal.	copper (Cu)	manganese (Mn)
2. Verify that it can form more than one kind of ion by checking the periodic table.	Cu^{2+} and Cu^{+}	Mn^{2+}, Mn^{3+}, and Mn^{4+}
3. Determine the ratio of the ions in the formula.	Cu_3P means 3 copper ions for every 1 phosphide ion.	MnO_2 means 1 manganese ion for every 2 oxide ions.
4. Note the charge of the negative ion from the periodic table.	The charge on the phosphide P^{3-} is 3−.	The charge on the oxide O^{2-} is 2−.
5. The positive and negative charges must balance out. Determine what the charge needs to be on the metal ion to balance the negative ion.	Each of the 3 copper ions must have a charge of 1+ to balance the 1 phosphide ion with a charge of 3−. Therefore the name of the copper ion is copper(I).	The 1 manganese ion must have a charge of 4+ to balance the 2 oxide ions that each have a charge of 2−. Therefore, the name of the manganese ion is manganese(IV).
6. Write the name of the compound.	copper(I) phosphide	manganese(IV) oxide

Practice Problems

1. Each of these compounds contains a multivalent metal ion. That means that the name of the metal ion will contain a Roman numeral, which you will need to determine. Write the names of the following compounds.

(a) $CrBr_2$
(b) $CrBr_3$
(c) FeI_2
(d) FeI_3
(e) PbF_2
(f) PbF_4
(g) MnO
(h) PbS
(i) Fe_2O_3
(j) Hg_3P_2
(k) Hg_3N_2
(l) HgI_2
(m) MnS
(n) MnS_2
(o) Sn_3P_4

Answers provided on page 509.

Polyatomic Ions

You learned in section 3.1 that some molecules gain or lose one or more electrons and become polyatomic ions. Because a polyatomic ion carries an electric charge, it cannot exist on its own. It is always paired up with ions that carry an opposite charge. Table 3.9 shows you how to write the formulas for compounds with polyatomic ions.

Table 3.9 Steps for Writing the Formula of a Compound with Polyatomic Ions

Steps for Writing the Formula	Examples	
	iron(III) hydroxide	ammonium carbonate
1. Identify each ion and its charge.	iron(III): Fe^{3+} hydroxide: OH^-	ammonium: NH_4^+ carbonate: CO_3^{2-}
2. Determine the total charges needed to balance positive with negative.	Fe^{3+}: $= 3+$ OH^{-1}: $-1\ -1\ -1 = 3-$	NH_4^+: $+1\ +1 = 2+$ CO_3^{2-}: $= 2-$
3. Note the ratio of positive ions to negative ions.	1 Fe^{3+} ion for every 3 OH^- ions	2 NH_4^+ ions for every 1 CO_3^{2-} ion
4. Use subscripts and brackets to write the formula. Omit brackets if only one ion is needed.	$Fe(OH)_3$	$(NH_4)_2CO_3$

Practice Problems

Refer to Table 3.10 on page 92 as you do these problems.

1. Write the names of the following compounds.

(a) $NaCH_3COO$
(b) $Ca(CH_3COO)_2$
(c) $Cr(CH_3COO)_3$
(d) $Al(OH)_3$
(e) $Cr(OH)_3$
(f) $(NH_4)_3P$
(g) $(NH_4)_3PO_4$
(h) $CaSO_4$
(i) $Mg_3(PO_4)_2$
(j) $Ba_3(PO_3)_2$

2. Write the formulas of the following compounds.

(a) sodium chromate
(b) potassium permanganate
(c) lithium dichromate
(d) sodium hydroxide
(e) magnesium hydroxide
(f) ammonium nitrate
(g) tin(II) hydroxide
(h) lead(II) hydroxide
(i) aluminum nitrate
(j) manganese(IV) sulphate

Answers provided on page 509

Did You Know?

All medicines come with a list of ingredients like the one shown below. The list includes the chemical name of the medicine. The chemical name allows you to compare products that have different brand names but contain the same active (medicinal) ingredient. Non-medicinal ingredients may improve the taste, act as filler to make the dose large enough to handle, or increase shelf life.

Common Polyatomic Ions

There are many polyatomic ions. Table 3.10 lists some common ones. The names of these ions were assigned by the IUPAC. You do not have to memorize them. Simply refer to this table to find a name and formula.

Table 3.10 Common Polyatomic Ions

Name	Formula
acetate	CH_3COO^-
ammonium	NH_4^+
carbonate	CO_3^{2-}
chlorate	ClO_3^-
chlorite	ClO_2^-
chromate	CrO_4^{2-}
cyanide	CN^-
dichromate	$Cr_2O_7^{2-}$
hydrogen carbonate	HCO_3^-
hydrogen sulphate	HSO_4^-
hydrogen sulphide	HS^-
hydrogen sulphite	HSO_3^-
hydroxide	OH^-
hypochlorite	ClO^-
nitrate	NO_3^-
nitrite	NO_2^-
perchlorate	ClO_4^-
permanganate	MnO_4^-
phosphate	PO_4^{3-}
phosphite	PO_3^{3-}
sulphate	SO_4^{2-}
sulphite	SO_3^{2-}

Explore More

Ammonium (NH_4^+) and nitrate (NO_3^-) are present in fertilizers. They are both produced from ammonia (NH_3), which you may be familiar with as window cleaner. Find out about the Haber process for the production of ammonia. Begin your research at **www.bcscience9.ca**.

Reading Check

1. In Table 3.10, find the following:
   (a) the formula of an ion with a positive charge
   (b) the formulas of all four ions made of only two atoms
   (c) the name of the ion that contains nine atoms
   (d) the formula of the ion containing three elements and six atoms
   (e) the formula of the ion containing three elements and having a charge of 2−
   (f) the names and formulas of two ions containing nitrogen and oxygen
   (g) the charge on the ion containing four hydrogen atoms
2. Find all four ions in Table 3.10 that contain a chlorine atom, and write their formulas in descending order according to the number of oxygen atoms in each one.

3-2B Modelling an Ionic Compound

Think About It

In this activity, your teacher will guide you as you use different shapes to represent positive and negative ions. These shapes combine in a way that closely matches the way real ions combine. The patterns you discover here can help you write the names and formulas of ionic compounds.

Materials

- set of shapes in one colour representing various kinds of positive ions
- set of shapes in a different colour representing various kinds of negative ions
- scissors

What to Do

1. Work in pairs.
2. Your teacher will give you photocopies of sheets of shapes that you will cut out. You need to know the following points about each shape:
   - Each shape represents a single ion.
   - Positive ions look like a rectangle with a piece cut out. The cut-out part is called a hole.
   - Negative ions also look like a rectangle, but with an extra piece attached. The extra piece is called a peg.
3. An ionic compound has an orderly arrangement of alternating positive and negative ions. You will make models of several ionic compounds. For each compound, you will need one kind of positive ion and one kind of negative ion. You need to know the following points about each arrangement of your shapes.
   - Every hole must be filled with a peg, and every peg must be in a hole. Keep adding ions until this happens.
   - The positive and negative ions must alternate as much as possible throughout the compound.
4. In the beginning, your teacher will tell you which ions to use for each compound. For each compound, build the model, name the compound, and then write its formula using the following rules.

The Name

- Write the name of the positive ion, leave a blank space equal to one letter, and write the name of the negative ion.

The Formula

- Count the numbers of positive ions and negative ions in your model. Then find the smallest ratio of these two numbers (use whole numbers). For example, if your model has two positive ions and one negative ion, the ratio is 2:1. If it has six positive ions and nine negative ions, the ratio is 2:3.
- Write the symbol of the positive ion (without its charge) followed by the first number from the ratio as a subscript. Beside this, write the symbol for the negative ion (without its charge) followed by the second number in the ratio as a subscript. For example, if Al^{3+} is the symbol for the positive ion and S^{2-} is the symbol for the negative ion, the formula for this compound would be Al_2S_3.

What Did You Find Out?

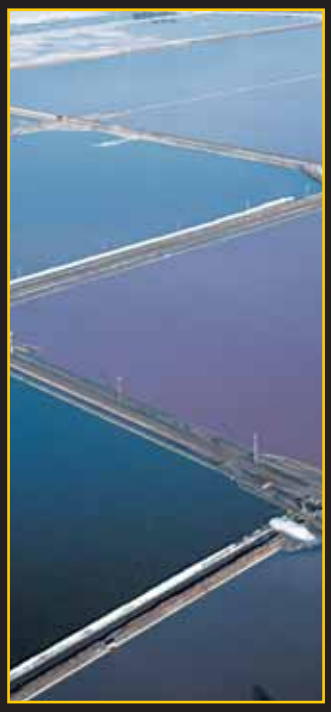
1. In what order are the ions named in an ionic compound: negative ion followed by positive ion or positive ion followed by negative ion?
2. Three possible formulas for silver sulphide are Ag_6S_3, Ag_2S, and $Ag_{12}S_6$. Only one of these formulas is correct.
   (a) Which one is correct?
   (b) Why?
3. Cadmium bromide is a poisonous compound used to engrave metal. Its formula is $CdBr_2$. How can the formula be used to find the charge on a cadmium ion if you already know that the bromide ion is Br^-?

NATIONAL GEOGRAPHIC

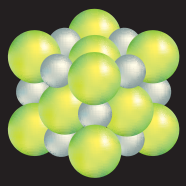
VISUALIZING SALT

The salt you use every day comes from both the land and the sea. Some salt can be mined from the ground in much the same way as coal, or salt can be obtained by the process of evaporation in crystallizing ponds.

▲ MINING SALT Underground salt deposits are found where there was once a sea. Salt mines can be located deep underground or near Earth's surface in salt domes. Salt domes form when pressure from Earth pushes buried salt deposits close to the surface, where they are easily mined.



◀ EVAPORATION PROCESS Workers fill evaporation ponds with salt water, or brine. They move the brine from pond to pond as it becomes saltier through evaporation. (Red-tinted ponds have a higher salt content.) The saltiest water is then pumped from evaporation ponds into crystallizing ponds, where the remaining water is drained off. In the five years it takes to produce a crop of salt, brine may move through as many as 23 different ponds.



Unit cell of sodium chloride (NaCl)

◀ TABLE SALT Raw sodium chloride is washed in chemicals and water to remove impurities before it appears on your dining-room table as salt. Iodine is added to table salt to ensure against iodine deficiency in the diet.

▼ SALT MOUNDS When the crystallizing ponds are drained, the result is huge piles of salt, like these on the Caribbean island of Bonaire.

Check Your Understanding

Checking Concepts

1. (a) How many parts are there in the name of an ionic compound?
   (b) What does each part describe?
2. Name each of the ions in the list below and indicate which of the following words describe it: positive ion, negative ion, multivalent metal, polyatomic ion.
   (a) Li^+
   (b) NO_3^-
   (c) Fe^{3+}
   (d) CH_3COO^-
   (e) Cr^{2+}
   (f) Cl^-
   (g) ClO_4^-
   (h) NH_4^+
3. For each polyatomic ion, list the name, the number of each kind of atom, the total number of atoms, and the electric charge on the ion.
   (a) CrO_4^{2-}
   (b) $Cr_2O_7^{2-}$
   (c) NH_4^+
   (d) CH_3COO^-
   (e) HSO_4^-
   (f) SO_4^{2-}
   (g) SO_3^{2-}
   (h) S^{2-}

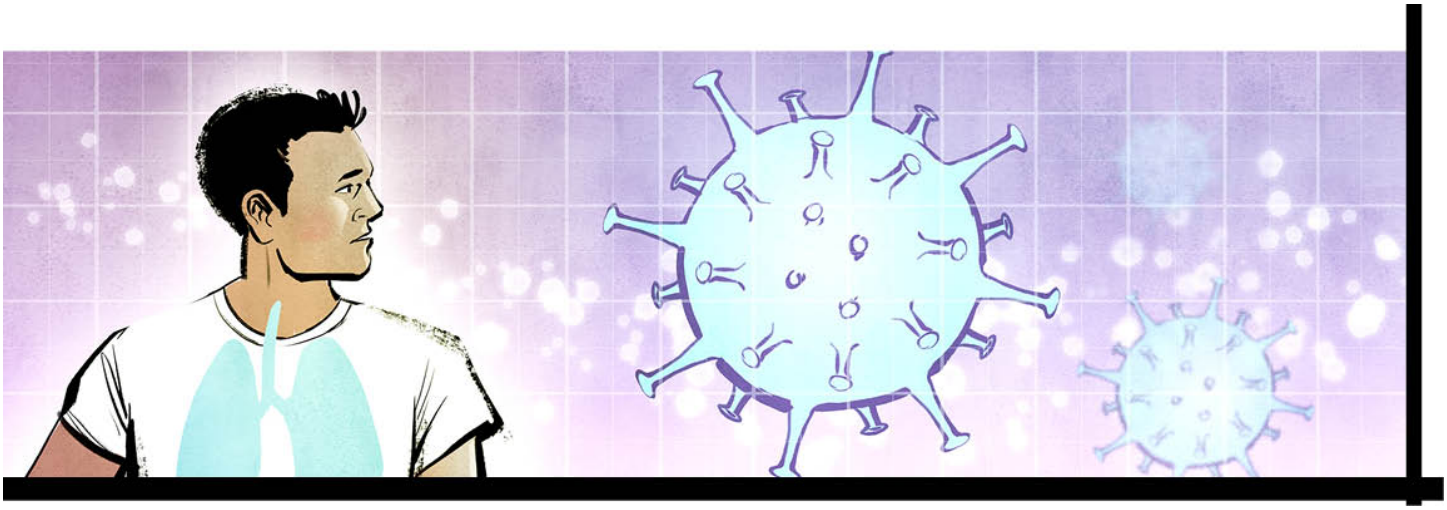
Understanding Key Ideas

4. Write the name or formula of the following compounds.
   (a) sodium chloride
   (b) magnesium fluoride
   (c) aluminum bromide
   (d) potassium iodide
   (e) lithium sulphide
   (f) aluminum oxide
   (g) LiBr
   (h) NaI
   (i) K_2S
   (j) MgF_2
   (k) Al_2O_3
   (l) Ca_3N_2
5. Write the name or formula of the following compounds.
   (a) iron(III) bromide
   (b) iron(II) bromide
   (c) nickel(II) fluoride
   (d) nickel(II) sulphide
   (e) tin(IV) nitride
   (f) manganese(II) phosphide
   (g) CrF_2
   (h) CuI
   (i) MnS
   (j) PbO_2
   (k) SnS_2
   (l) Cr_3N_2
6. Write the name or formula of the following compounds.
   (a) $Mg(OH)_2$
   (b) K_2SO_4
   (c) $Al(HCO_3)_3$
   (d) Cu_2CO_3
   (e) $Fe(MnO_4)_2$
   (f) $(NH_4)_2SO_4$
   (g) sodium sulphate
   (h) calcium phosphate
   (i) aluminum nitrate
   (j) ammonium hydrogen sulphate
   (k) lead(IV) chlorate
   (l) iron(III) carbonate

Pause and Reflect

All ionic compounds have a chemical name and a chemical formula in accordance with rules of the IUPAC. It may be tempting to think that the formula is simply a shorter way of writing the chemical name. However, the two do not give exactly the same information about a compound. What information does the formula give about a compound that is not present in the name?

Covid-19 Backgrounder



This hugely challenging pandemic has turned our lives upside down. It's easy to get caught up in the fear and anxiety, the rumours and 'noise.'

Instead, let's focus on the science. There are things **epidemiologists** and infectious disease experts still do not know about the **coronavirus** that causes COVID-19. We have only been aware of the virus for just over three months. But we're on a fast learning curve.

A Tiny Virus Goes Pandemic

A virus is a microscopic piece of genetic material (a strip of ribonucleic acid or RNA) surrounded by a capsule made of protein. If you've had a cold, the flu, or chicken pox, you've had experience with viruses. They can make you sick.

A virus cannot survive by itself. It needs to get inside a 'host.' Often the host is an animal, but sometimes the **pathogen** is transmitted to a human host.

Some viruses are highly contagious, while others spread less easily. COVID-19 is very infectious. It spreads through **respiratory** droplets coughed out by those infected with the virus. The virus may also linger on surfaces after sick people cough into their hands and then touch those surfaces.

Those exposed to the pathogen may not show symptoms for two to 14 days, with the average **incubation period** being five days. Yet even without symptoms, infected people can pass the virus on to others.

"I've Been Infected!"

Inside a host, COVID-19 – a spherical capsule covered with spikes – latches onto a healthy cell in the respiratory tract. It breaks into the cell and makes copies of itself, before breaking out of the cell again, killing it in the process.

Fortunately, the body's immune system is designed to fight off invaders like viruses. While the battle rages, the sick person will exhibit symptoms such as fever, a cough, and tiredness.

The good news is that about 80 percent of COVID-19 cases are relatively mild. With a strong immune system, the body will win. After a very unpleasant couple of weeks of self-isolation, rest, and drinking plenty of fluids, most patients recover.

More serious cases usually feature pneumonia. The virus is able to travel down to the lower respiratory system and attack the lungs. Patients may need to be hooked up to a **ventilator** to help them breathe and circulate oxygen through their bodies.

In Canada, seven percent of COVID-19 cases are serious enough to require hospitalization, with three percent requiring intensive care. One percent of Canadian COVID-19 cases are fatal. Usually these patients are older or have underlying medical conditions that have weakened their respiratory or immune systems.

Flattening The Curve

Without a COVID-19 vaccine, there is no way to stop the pandemic. So the strategy is to slow its spread. Although only a small fraction of the total infected population requires hospitalization, a small fraction of a very large number is a large number – certainly enough to overwhelm Canada's health system.

Were the virus to spread too quickly, as it did in Italy, for instance, the number of very sick people would skyrocket. But if the spread was slower, these seriously ill patients

would appear over a longer period of time. That would be more manageable for Canada's health care system.

Imagine a graph with a sharply rising line showing the increase in cases of COVID-19. By "flattening the curve" of this line, we would avoid overwhelming our hospitals. That's our country's urgent focus: to flatten the curve.

Prevention - We're All In This Together

The best way to avoid getting COVID-19 is to wash your hands with soap and water often. Don't touch your face with contaminated hands.

Health educators say a good hand wash takes at least 20 seconds, enough time to sing "Happy Birthday" twice. Scrub all parts of your hands – palms, backs, between the fingers, the finger tips, and the thumbs. Hand washing with soap is best, but alcohol-based hand sanitizer also works.

The other way to slow the spread of the virus? Get serious about social, or physical, distancing. Stay two metres away from everyone except members of your household. That's about two arm lengths, which is further than the droplets from someone's cough will travel.

Staying home as much as possible also helps contain the virus. The more citizens stay home, and don't go to work, school, or anywhere else, the less likely it is that the virus can spread within the community.

Meanwhile, anyone showing symptoms of COVID-19, or anyone who could have come into contact with an infectious person, or anyone returning to Canada from elsewhere, should self-isolate for two weeks at home and monitor themselves for symptoms.

No Time To Rest

Behind the scenes, scientist are busy on multiple fronts. They are testing to see if anti-viral drugs used to fight other kinds of viral attacks can be re-purposed for use on COVID-19. They are experimenting with injecting ill patients with blood plasma taken from recovered COVID-19 survivors to boost their immunity. Dozens of companies are racing to create a vaccine, although that is probably more than a year and a half away.

In the meantime, we must do all we can to stay healthy. Every time we stop one case of infection, we not only keep that person healthy, but we break the chain of transmission. We protect all the people that person might have infected, and the people who those people would have infected, and so on. It makes a big difference.

"If we act now, even if it seems like a big ask, things will be better tomorrow," says Prime Minister Justin Trudeau.

A History of Infectious Diseases

Throughout history, nothing has killed more human beings than infectious disease. It's only in the last century that the development of sanitation, along with medical advances like vaccines and antibiotics, has changed all that.

For example, the plague of Justinian struck in the 6th Century and killed as many as 50 million people, perhaps half the global population at the time. The Black Death of the 14th Century – likely caused by the same pathogen – may have killed up to 200 million people. Smallpox is thought to have killed as many as 300 million people in the 20th Century alone. When European colonists introduced smallpox and other infectious diseases to North America, Indigenous populations were **decimated**.

Some 50 to 100 million people died in the 1918 influenza pandemic – the so-called "Spanish flu." It infected one in every three people on the planet.

These viral epidemics were simply a terrible fact of life back then. But COVID-19 reminds us that infectious diseases haven't vanished. We had outbreaks of polio in the 1950s. Severe acute respiratory syndrome (SARS) in 2003. HIV (human immunodeficiency virus) is still **prevalent**; it has killed an estimated 32 million people and infected 75 million. And now COVID-19.

There are several reasons we are seeing these new infectious diseases. For one, over the past 50 years, we've more than doubled the number of people on the planet. This means more human beings to get infected and in turn to infect others, especially in densely-populated cities. We also have more livestock now, and some viruses can leap from those animals to

us. And we have an integrated global economy, which enables new infectious diseases to spread around the world as fast as a jet plane.

coronavirus: a family of viruses that can infect animals and humans, and that causes the common cold and COVID-19
decimate: to kill or destroy in very large numbers
epidemiologist: a medical scientist who studies the transmission and control of epidemic diseases
incubation period: the period between infection and the appearance of symptoms of a disease
pathogen: something such as bacteria or a virus that causes disease
prevalent: very common
respiratory: relating to the process of breathing air in and out
ventilator: a machine that pushes air in and out of someone's lungs when they cannot breathe on their own

COVID-19 Worksheet for Students:

On The Lines

Answer the following in complete sentences:

1. Explain what a **virus** is.

2. Explain how a virus usually spreads from person to person.

3. How infectious is COVID-19? How long is the average incubation period for this coronavirus?

4. How does a virus survive?

5. How does the COVID-19 coronavirus attack the human body? How does the body's immune system respond?

6. What happens to most people who come down with COVID-19?

7. How does COVID-19 affect the minority of infected people who develop serious complications? Explain.

8. Explain what '**flattening the curve**' means. What can happen if the disease curve is not flattened?

9. List the three strategies health authorities are asking people to do to help flatten the COVID-19 curve.

Between The Lines

An ***inference*** is a conclusion drawn from evidence. *A plausible inference is supported by evidence in the article and is consistent with known facts outside of the article.*

What inference(s) can you draw from the fact that even without symptoms, people infected with COVID-19 can pass the virus on to others?

Just Talk About It

1. What reasons can you suggest to explain why the world continues to experience new infectious diseases?

2. For what reasons is it important to try to slow the spread of COVID-19? Explain.

3. What can you do to prevent catching and spreading COVID-19? Explain.

On Line

Note: The links below are listed at **www.lesplan.com/en/links** for easy access.

1. Watch 'How soap kills coronavirus' at https://youtu.be/-LKVUarhtvE [3:44]. Then, check out the 'Wash Your Lyrics' app at https://washyourlyrics.com/

2. Learn more about 'flattening the curve' at https://www.washingtonpost.com/graphics/2020/world/corona-simulator/?itid=pm_pop

3. Explore common COVID-19 questions and answers at www.ctvnews.ca/health/coronavirus/should-you-wipe-down-your-groceries-answers-to-that-and-other-questions-1.4856659#anchor1

Quiz

A. Write the letter that corresponds to the best answer on the line beside each question:

_____ 1. **How long is the average incubation period for COVID-19?**

a) 2 days **b) 5 days**
c) 10 days **d) 14 days**
e) 30 days

_____ 2. **What percentage of COVID-19 cases are relatively mild ?**

a) 3 percent **b) 7 percent**
c) 25 percent **d) 50 percent**
e) 80 percent

_____ 3. **The overall strategy to slow down the COVID-19 outbreak is to 'flatten the _____'**

a) chart **b) disease**
c) pandemic **d) curve**
e) coronavirus

B. Mark the statements **T (True)** or **F (False).** If a statement is **True**, write one important fact to support it on the line below. If a statement is **False**, write the words that make it true on the line below.

_____ 4. **True** or **False?** Coronaviruses are primarily spread by infected people who cough and sneeze.

_____ 5. **True** or **False?** COVID-19 usually attacks a patients' kidneys and heart.

_____ 6. **True** or **False?** Everyone infected by COVID-19 shows flu-like symptoms.

C. Fill in the blanks to complete each sentence.

7. A virus needs a _____ to survive.

8. Patients with serious COVID-19 infections often develop _____ .

9. The best way not to develop a virus infection is to _____ your hands.

D. Respond to the following question in paragraph form. ***(Use a separate sheet of paper if necessary.)***

As you understand it, why is it important to 'flatten' the curve of COVID-19, and how can this be accomplished? Explain.