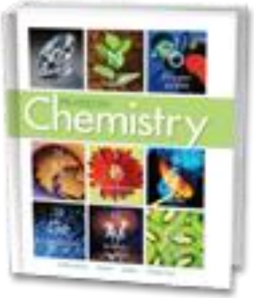


Chapter 7B

Ionic and Metallic Bonding

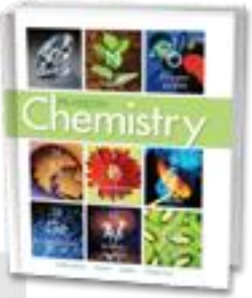
Ions

Ionic Bonds &

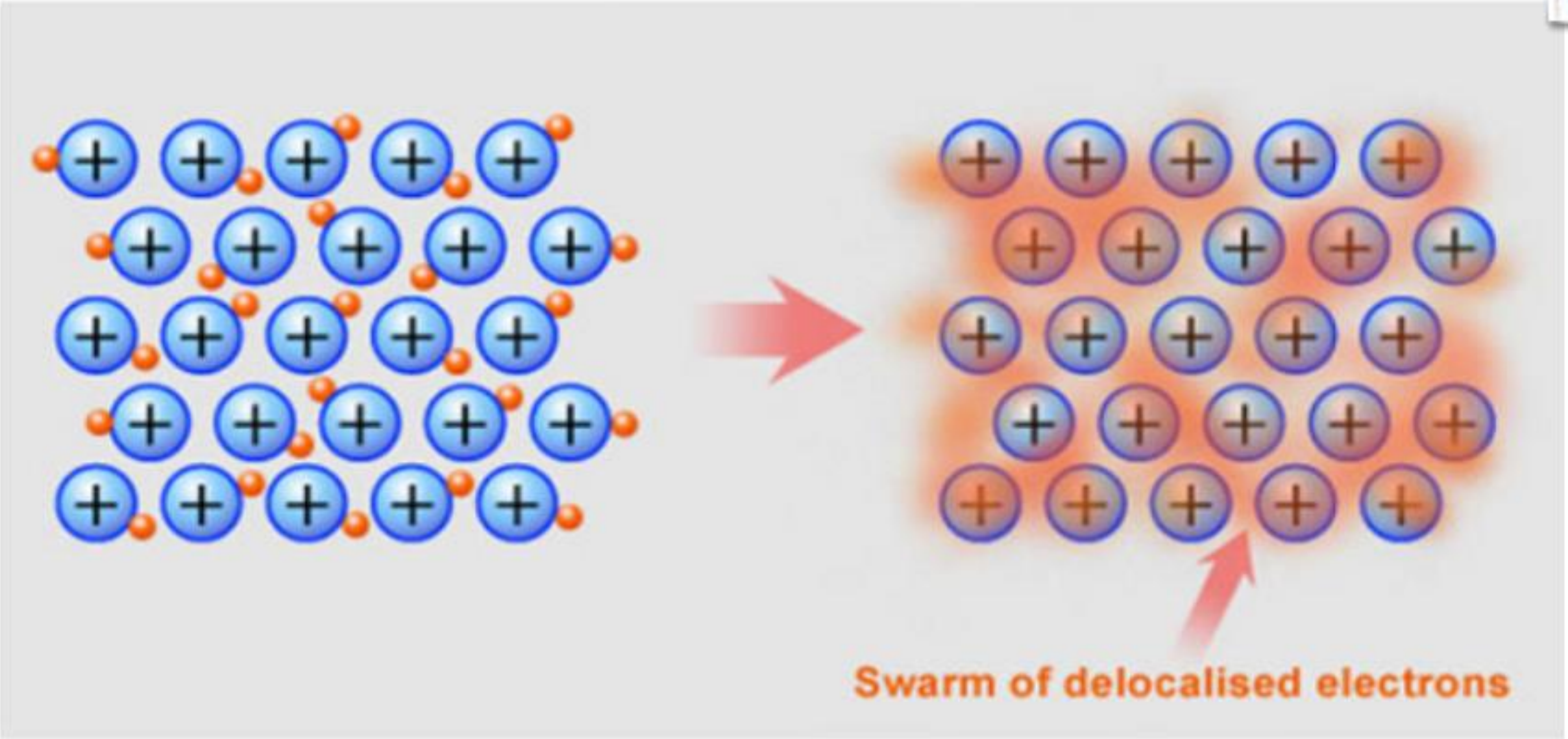
Forming Ionic Compounds

Properties of Ionic Compounds

Bonding in Metals



Metallic Bonding



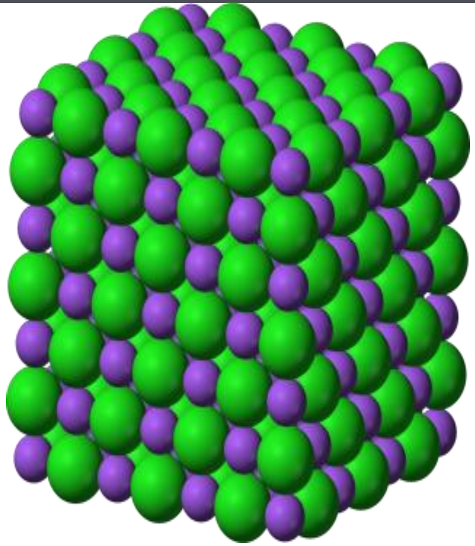
Topics:

1. Ionic and Metallic Bonding

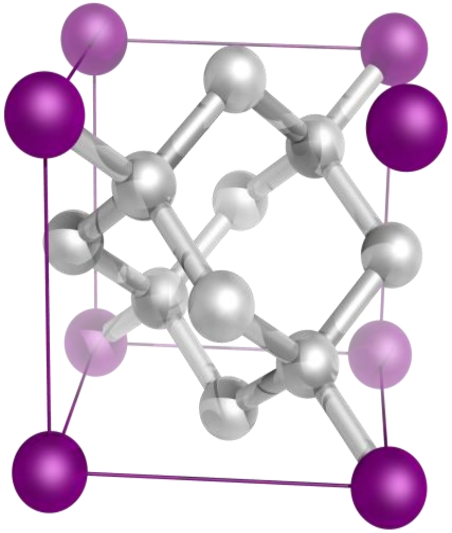
Objectives:

1. Learn the properties of ionic compounds.
2. Understand Metallic Bonds and properties.
3. Understand the conditions of stability for atoms related to bonding.
4. Explain and show how elements become ions (cations and anions).
5. Explain the ionic compounds in terms of formation, electrical charge, structure and Electronegativity Difference.

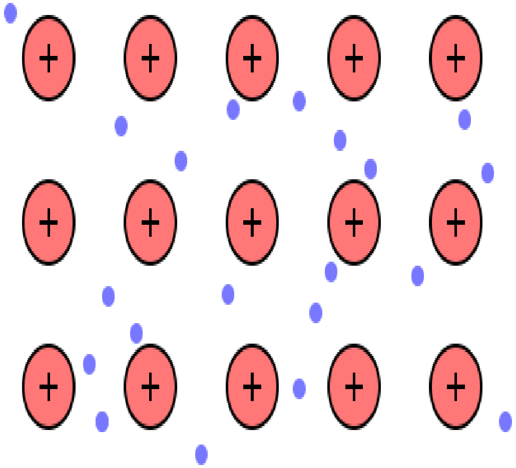
There are three main ways that elements can come together to form bonds.



Ionic



Covalent



Metallic

Give the Ion Symbol for each element and the charge of each cation & anion.

Some Common Cations		
Name	**Symbol**	**Charge**
Lithium		
Aluminum		
Calcium		
Sodium		
Magnesium		
Boron		
Potassium		
Beryllium		

Some Common Anions		
Name	**Symbol**	**Charge**
Fluoride		
Phosphide		
Sulfide		
Iodide		
Oxide		
Bromide		
Nitride		
Chloride		

Give the Ion Symbol for each element and the charge of each cation & anion.

Some Common Cations

Name	Symbol	Charge
Lithium	Li^+	1+
Aluminum	Al^{+3}	3+
Calcium	Ca^{+2}	2+
Sodium	Na^+	1+
Magnesium	Mg^{+2}	2+
Boron	B^{+3}	3+
Potassium	K^+	1+
Beryllium	Be^{+2}	2+

Some Common Anions

Name	Symbol	Charge
Fluoride	F^-	1–
Phosphide	P^{3-}	3–
Sulfide	S^{2-}	2–
Iodide	I^-	1–
Oxide	O^{2-}	2–
Bromide	Br^-	1–
Nitride	N^{3-}	3–
Chloride	Cl^-	1–

QUICK CHECK

> How Do Materials Become Charged? Review

Material A

+1 +1

+1 +1

+1 +1

Material B

+1 +1

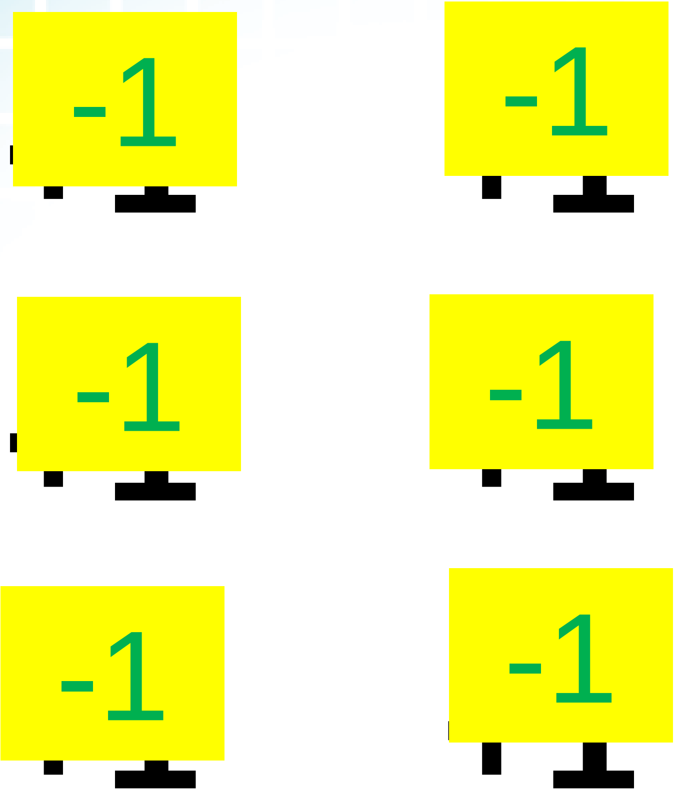
+1 +1

Material A has 6 e- & B has 4 e-. Show the net charge of the materials?

QUICK CHECK

How Do Materials Become Charged? Review

Material A

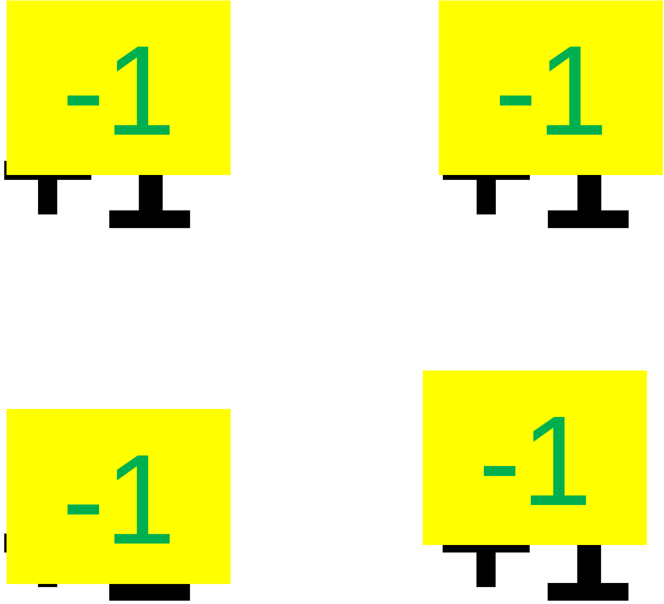


+6

<u>-6</u>

0

Material B



+4

<u>-4</u>

0

Material A has 6 e- & B has 4 e-. Show the net charge of the materials?

QUICK CHECK >

How Do Materials Become Charged? Review

Material A		**Material B**	
+1	**+1**	**+1**	**+1**
+1	**+1**	**+1**	**+1**
+1	**+1**		

Initially Material A has 6 e- & B has 4 e-. 2 e- transfer to Material B. Show the overall net charge of the materials after the transfer of e-.

QUICK CHECK >

How Do Materials Become Charged? Review

Material A

-1 -1

-1 -1

+1

+6
-4
+2

+1

→ 2e-

Material B

-1 -1

-1 -1

-1

+4
-6
-2

-1

Initially Material A has 6 e- & B has 4 e-. 2 e- transfer to Material B.
Show the overall net charge of the materials after the transfer of e-.

QUICK CHECK >

How Do Materials Become Charged? Review

Material A

+1 +1

+1 +1

+1 +1

Material B

+1 +1

+1 +1

Materials A & B are initially neutral.
How can Material A gain a net charge of +4?

QUICK CHECK

How Do Materials Become Charged? Review

Material A

-1 -1

+1 +1

+1 +1

+1 +6 +1

$\underline{-2}$

+4

→ 4e-

Material B

-1 -1

-1 -1

-1 -1

-1 +4 -1

$\underline{-8}$

-4

Materials A & B are initially neutral.
How can Material A gain a net charge of +4?

7.2 Properties of Ionic Compounds

Crystalline

Most **ionic compounds** are crystalline solids at room temperature.

The component ions in such crystals are arranged in repeating three-dimensional patterns called crystal lattices.

Each ion is attracted strongly to each of its neighbors, and repulsions are minimized.

Fluorite (CaF_2)

Grossularite ($Ca_3Al_2(SiO_4)_3$)

Wulfenite ($PbMoO_4$)

7.2 Properties of Ionic Compounds

Crystalline

The large attractive forces result in a **very stable structure**.

The beauty of crystalline solids comes from the orderly arrangement of their component ions.

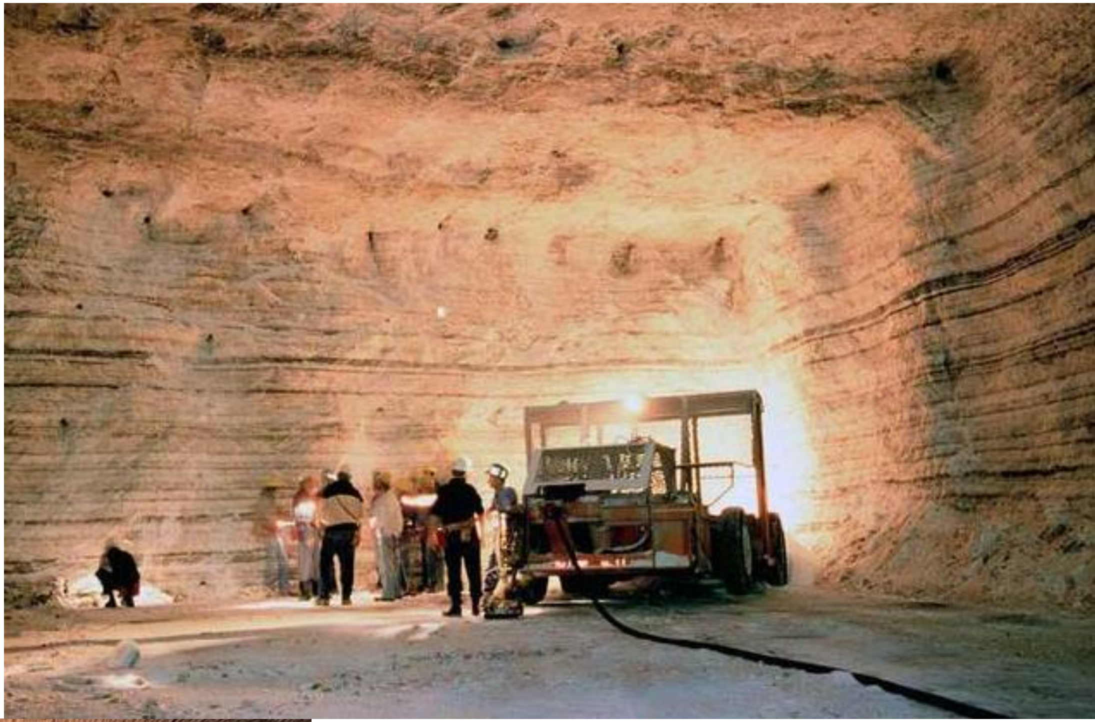
- **High melting points** due to strong **INTERmolecular** bonds - a lot of energy is needed to break them.

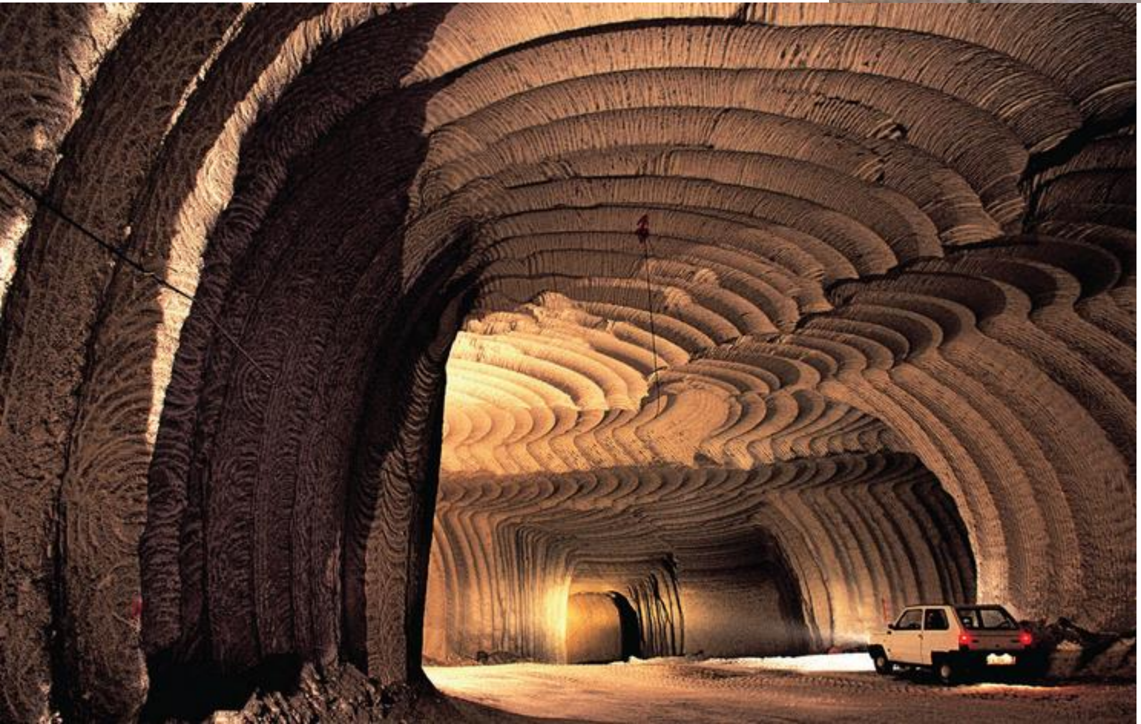
Beryl ($BeAl_2(SiO_3)_6$)

Hematite (Fe_2O_3)

Cinnabar (HgS)

Sodium chloride is found in underground rock deposits as a solid. Like most ionic compounds, sodium chloride has a high melting point (about 800 ºC).





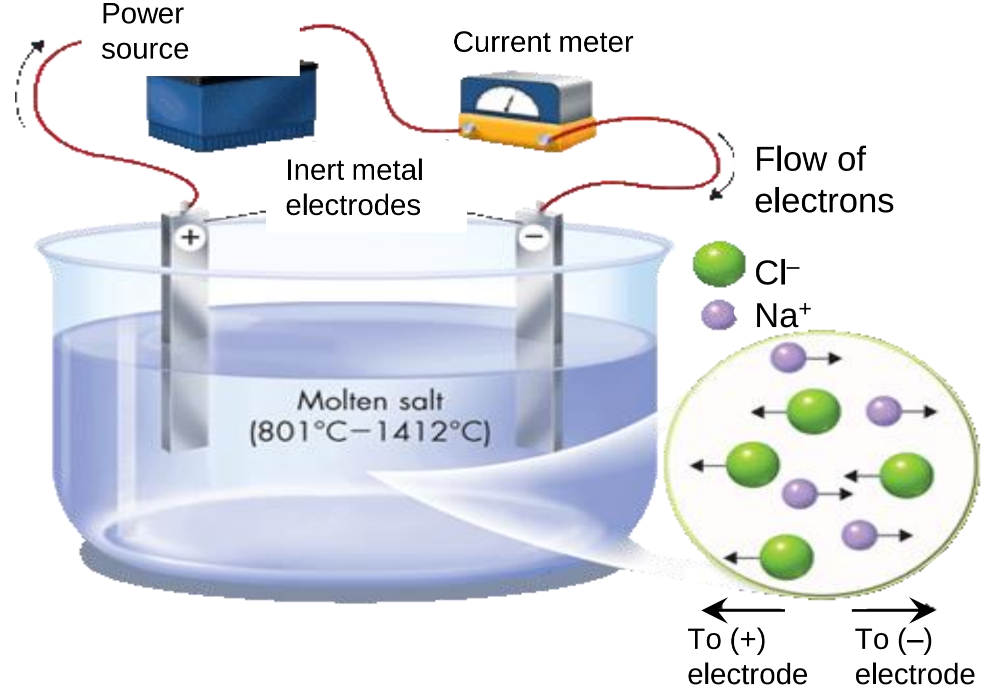
Subterranean deposits of rock salt under Lake Erie (above) and in Sicily (to the left)

Properties of Ionic Compounds

Solubility

Ionic **solids** **do NOT conduct** electricity due to **no free moving ions**.

They do conduct current when melted (**liquid** state), vaporized (gaseous state), or **dissolved** in water.



When sodium chloride is melted, the orderly crystal lattice structure breaks down and allows movement of the ions.

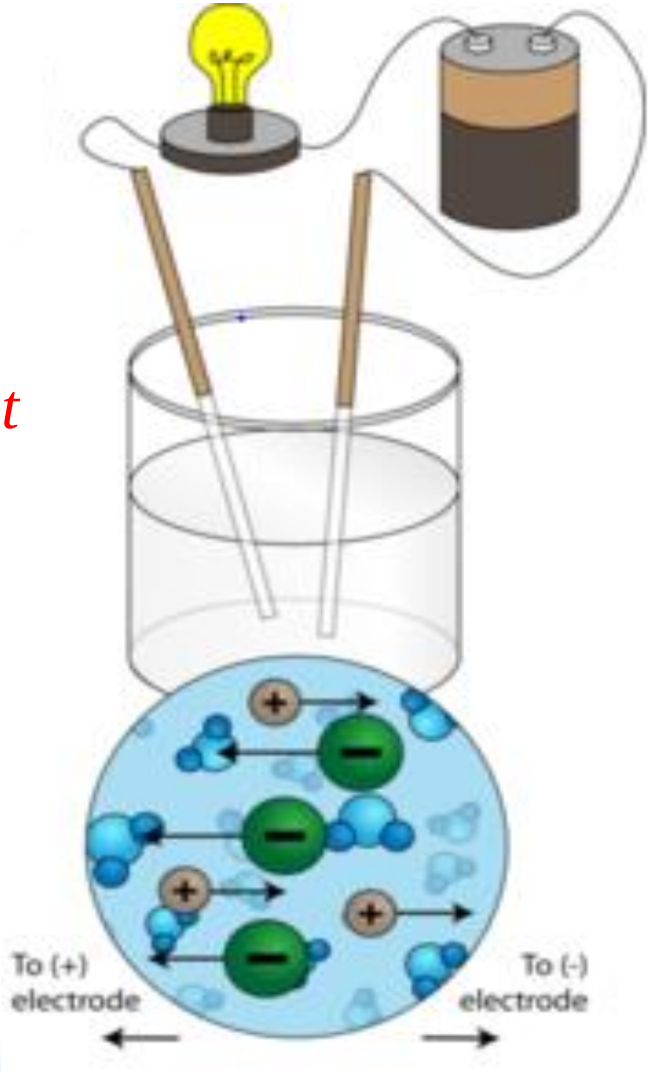
7.2 Properties of Ionic Compounds

Solubility

Ionic solids conduct electric current if they are **dissolved** in water.

Ionic compounds in the **liquid** state conduct electricity because of **free moving ions**.

When dissolved, the ions are free to move about in the solution.



Ionic Solids (1:13)

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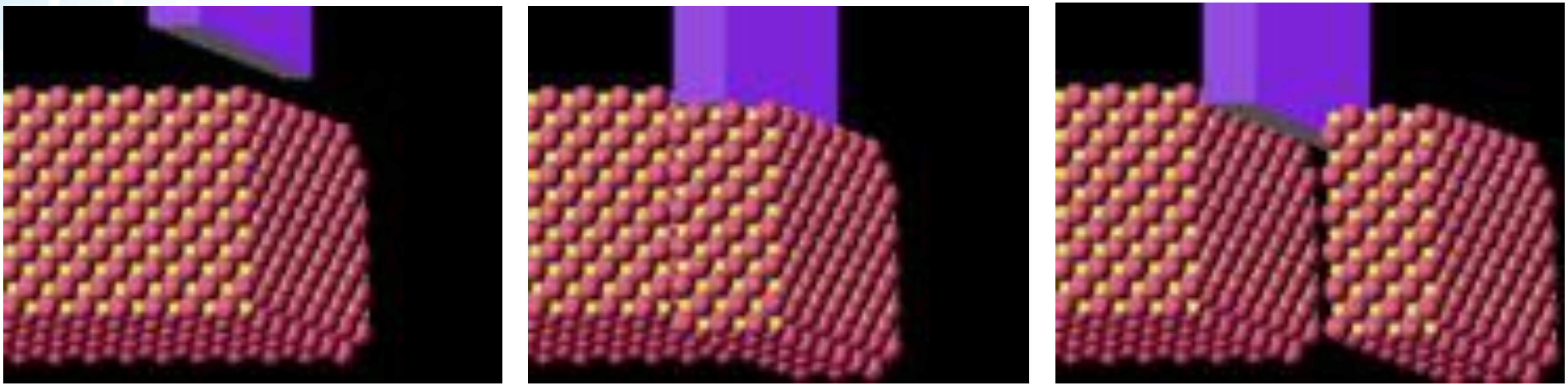
Solutions: (1:31)

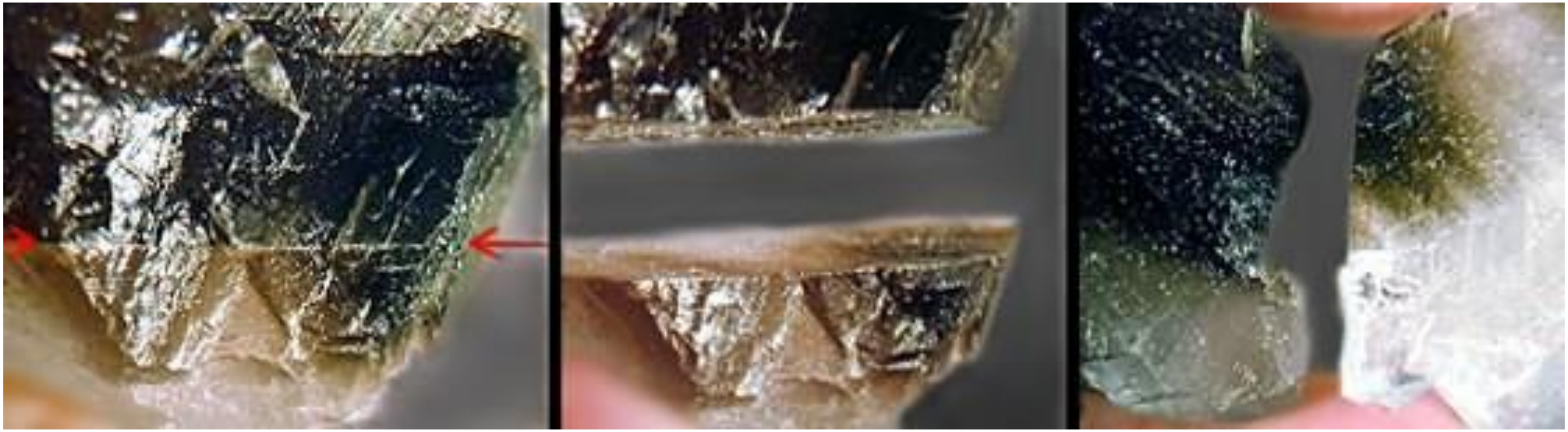
https://screencast-o-matic.com/watch/cF6eq8YIMI

7.2 Properties of Ionic Compounds

Cleavage

“**Cleavage**” is the ability to split the crystal lattice along a definite plane, thus, fragmenting the crystal lattice.





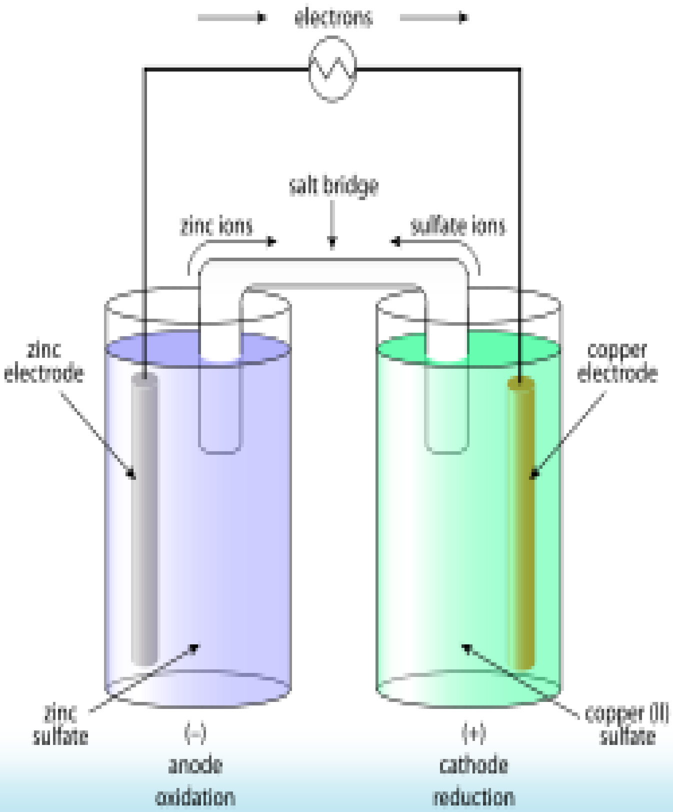
7.2 Properties of Ionic Compounds

Summary

Ionic compounds (especially solids) dissolve in water

Ionic compounds are often used for “salt bridges” in electrolysis.

Molten ionic compounds can conduct electricity.



QUICK CHECK

Indicate Properties of Ionic Compounds

Metals tend to have (low/high) ionization energies.

Nonmetals tend to have (low/high) electronegativities.

Metals tend to (lose/gain) electrons to complete their valence, forming (cations/anions).

Nonmetals tend to (lose/gain) electrons to complete their valence, forming (cations/anions).

An electronegativity difference of (less than/greater than) 1.7 determines ionic bonds.

Which of the following does not apply to ionic compounds?

[ ] cleavage along a definite plane

[ ] high melting points

[ ] conduct electricity all the time

[ ] electrons are transferred between atoms

QUICK CHECK

Indicate Properties of Ionic Compounds

Metals tend to have (**low**) ionization energies.

Nonmetals tend to have (**high**) electronegativities.

Metals tend to (**lose**) electrons to complete their valence, forming (**cations**).

Nonmetals tend to (**gain**) electrons to complete their valence, forming (**anions**).

An electronegativity difference of (**greater than**) 1.7 determines ionic bonds.

Which of the following does not apply to ionic compounds?

[ ] cleavage along a definite plane

[ ] high melting points

[X] conduct electricity all the time

[ ] electrons are transferred between atoms

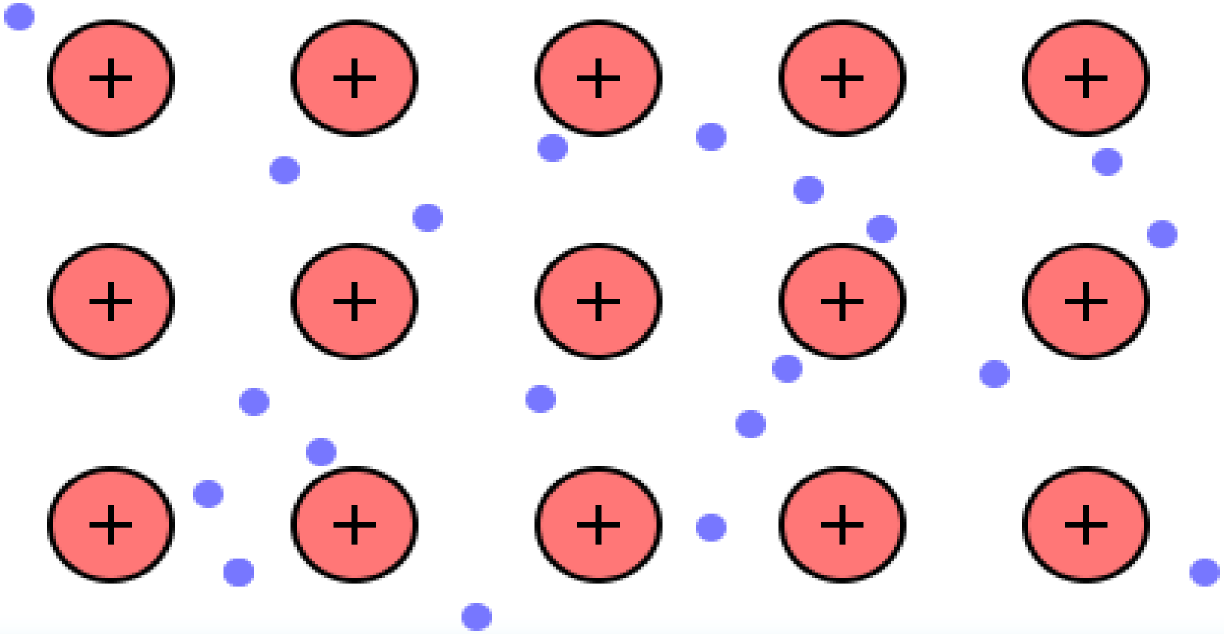
LESSON QUESTION

What are the properties of metals? How do metals form bonds with each other?

Metallic Bonds and Metallic Properties

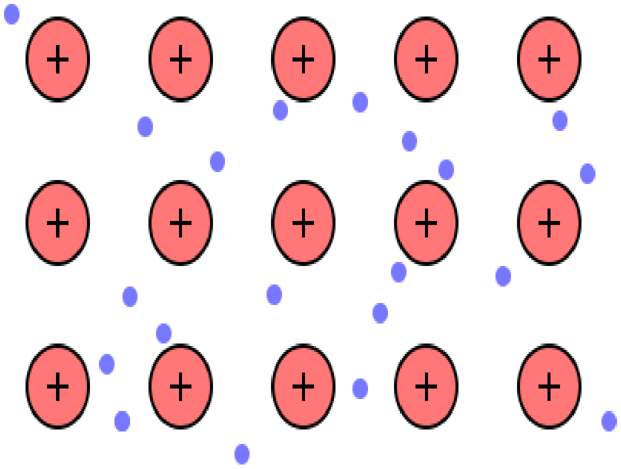
Metals consist of **closely packed cations** and **loosely held valence electrons** rather than “neutral” atoms.

The valence electrons of atoms in a pure metal can be modeled as a **sea of electrons**. The valence electrons are mobile and can drift freely from one part of the metal to another.



The Electron Sea Model

Metallic bonds are the forces of attraction between the free-floating valence electrons and the positively charged metal ions. These bonds hold metals together.



Metallic bonding results from the sharing of valence electrons among any of the metal atoms.

- "Delocalized" electrons act like glue.
- **Electron sea model:** electrons flow easily between atoms as in a "sea" of electrons in which nuclei "float"

Delocalized Electrons in Metals

Some properties of metals:

- Large atoms
- Relatively low electronegativities
- Low ionization energies

These properties allow:

- Electrons of the metals to “roam”
- Electrons are shared among all the metal nuclei
- Electrons are **“delocalized”**

Sodium (Na)

Tin (Sn)

Copper (Cu)

Silver (Ag)

Describe the Electron Sea Model

Check all the boxes that describe the electron sea model.

[ ] Metallic bonding results from the transfer of valence electrons.

[ ] Metallic bonding results from the sharing of valence electrons.

[ ] The electrons are delocalized.

[ ] The electrons are attracted to specific nuclei.

[ ] The delocalized electrons serve as the glue that keeps the metal atoms together.

[ ] The electrons that are attracted to specific nuclei serve as the glue that keeps the metal atoms together.

Describe the Electron Sea Model

Check all the boxes that describe the electron sea model.

[ ] Metallic bonding results from the transfer of valence electrons.
[X] Metallic bonding results from the sharing of valence electrons.

[X] The electrons are delocalized.
[ ] The electrons are attracted to specific nuclei.

[X] The delocalized electrons serve as the glue that keeps the metal atoms together.
[ ] The electrons that are attracted to specific nuclei serve as the glue that keeps the metal atoms together.

Metallic Bonds and Metallic Properties

Ductile — can be drawn into wires.

Malleable — hammered or pressed into shapes.

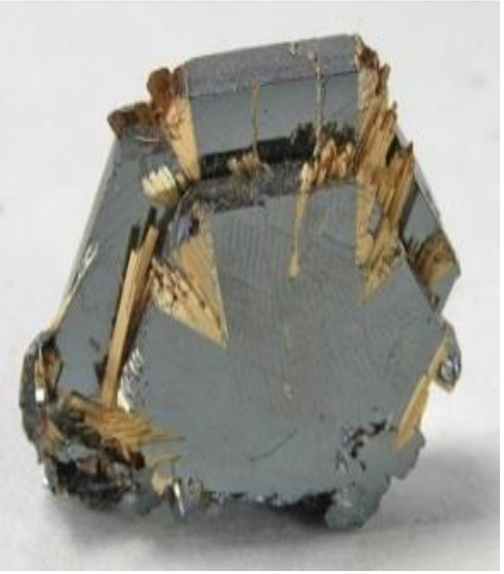
Good Conductors of heat and electricity.

When a metal is subjected to pressure, its cations easily slide past one another.

Malleability, Ductility, and Luster in Metals Explained

Metals are malleable, ductile, and exhibit luster.

- Delocalized electrons allows for metals to be easily shaped
- Easy electron movement produces “flexible” bonds
  - Metals are malleable and ductile instead of brittle
- metallic luster (shines) is due to “free” electrons easily lost



Conductivity of Metals Explained

Metals conduct heat and electricity well.

- Delocalized electrons allow for easy electron movement and the moving electrons carry current or thermal energy
- As electrons enter one end of a bar of metal, an equal number of electrons leave the other end.

THINK ABOUT IT

Describe the Consequences of Mobile Electrons

What properties of metals are explained by its mobile electrons?

[ ] strength

[ ] malleability

[ ] ductility

[ ] heat conduction

[ ] current conduction

[ ] luster

[ ] opacity

Describe the Consequences of Mobile Electrons

What properties of metals are explained by its mobile electrons?

[ ] strength

[X] malleability

[X] ductility

[X] heat conduction

[X] current conduction

[X] luster

[ ] opacity

Metallic Bonds

Metallic Properties & Metallic Bonds

(3:03)

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Alloys

Homogeneous mixture (solution) of two or more metals

- **Properties of an alloy are different from properties of the pure metals**
- Composition can vary from sample to sample

Alloy	Component Metals
Bronze	Copper and tin or aluminum
Brass	Copper and zinc
Rose gold	Gold and copper
Steel	Iron, chromium, and nickel

Alloys

Alloys are important because their **properties** are often **superior** to those of their component elements.

Sterling silver (92.5% silver and 7.5% copper) is harder and more durable than pure silver, yet it is still soft enough to be made into jewelry and tableware.

Cast Iron can be molded into intricate shapes.

Sterling Silver
92.5% Ag
7.5% Cu

Cast Iron
96% Fe
4% C

Alloys

The most important commercial alloys today are **steels**.

The principal elements in most steels, in addition to **iron** and **carbon**, are boron, chromium, manganese, molybdenum, nickel, tungsten, and vanadium.

Steels have a wide range of useful properties, such as corrosion resistance, ductility, hardness, and toughness.

Stainless Steel
80.6% Fe
18.0% Cr
0.4% C
1.0% Ni

Practice Test: Ionic & Metallic Bonding

Go to Chapter 7 Homework section and click on the link.

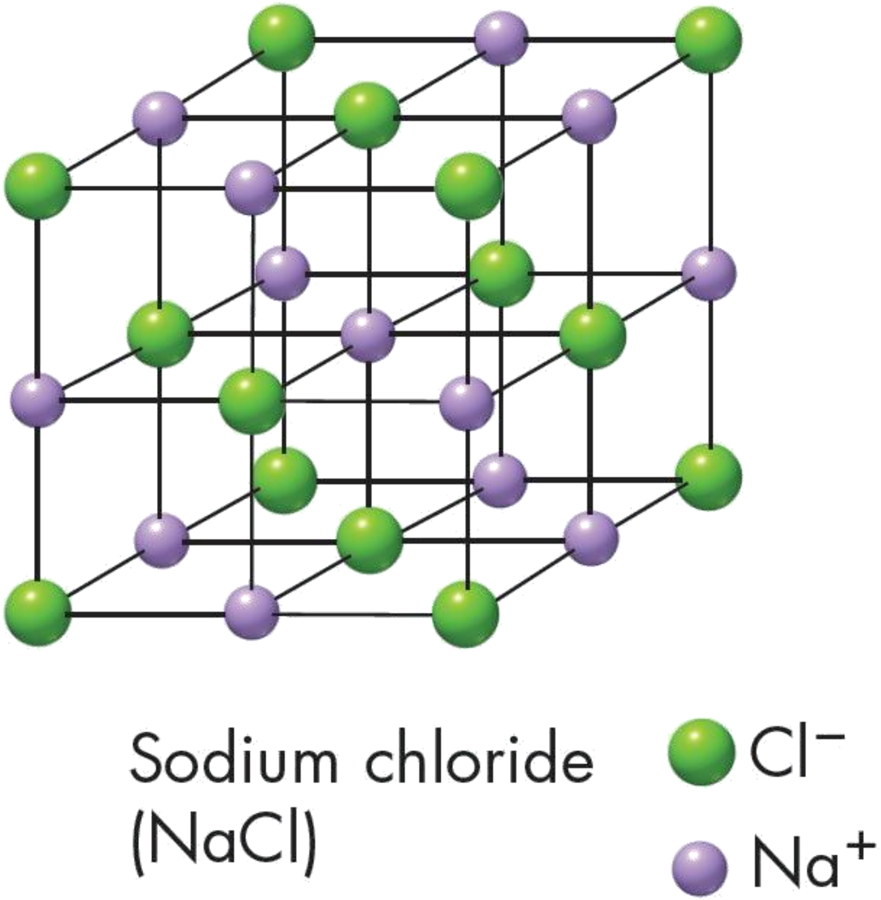
The Answer Key is provided after the test questions.

Properties of Ionic Compounds ENRICHMENT

The **coordination number** of an ion is the number of ions of opposite charge that surround the ion in a crystal.

In NaCl, each ion has a coordination number of 6 because each Na^+ ion is surrounded by six Cl^- ions.

The coordination number of Cl^- is also 6 because each Cl^- ion is surrounded by six Na^+ ions.

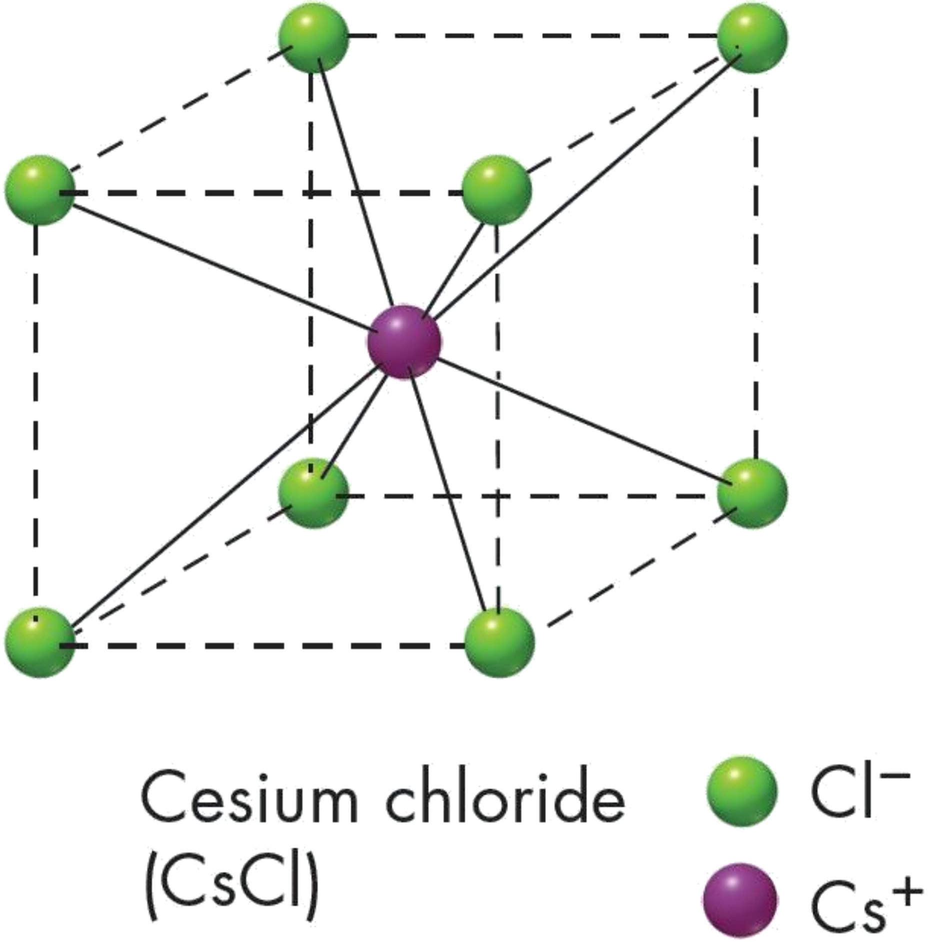


Sodium chloride (NaCl)

In CsCl, each ion has a coordination number of 8.

Each Cs^+ ion is surrounded by eight $Cl^–$ ions.

Each $Cl^–$ ion is surrounded by eight Cs^+ ions.



Properties of Ionic Compounds ENRICHMENT

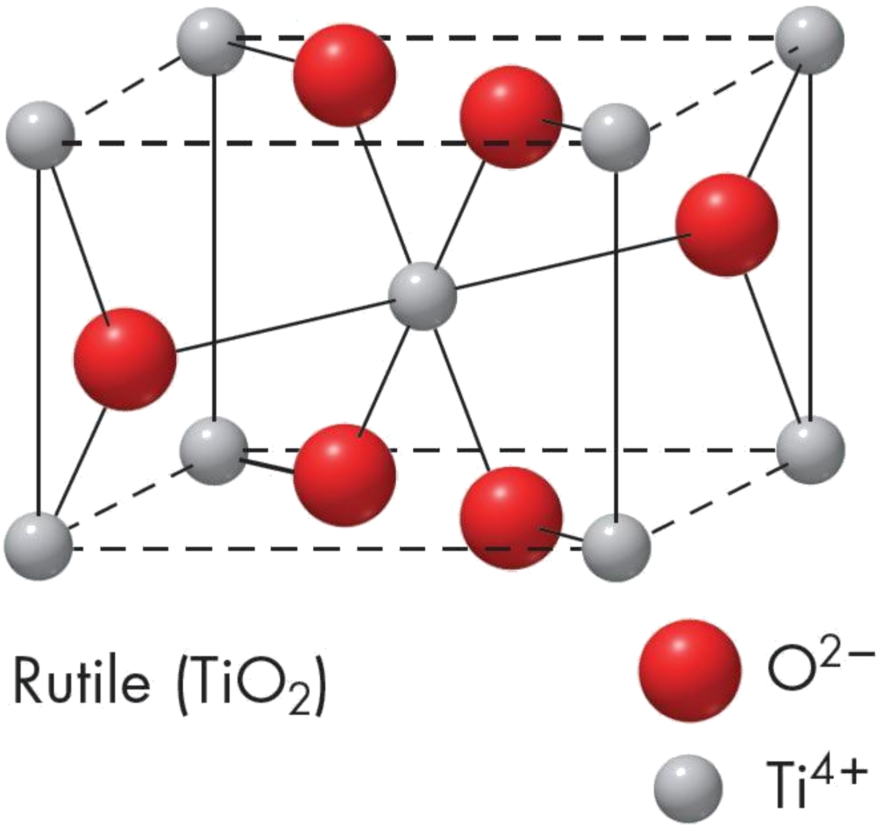
Titanium dioxide (TiO_2), or rutile, forms tetragonal crystals.

The coordination number for the cation (Ti^{4+}) is 6.

- Each Ti^{4+} ion is surrounded by six O^{2-} ions.

The coordination number of the anion (O^{2-}) is 3.

- Each O^{2-} ion is surrounded by three Ti^{4+} ions.



KEY

Atomic Mass → 12.0111

Selected Oxidation States → −4 +2 +4

Symbol → **C**

Atomic Number → 6

Electron Configuration → $1s^2 2s^2 2p^2$

Relative atomic masses are based on ^{12}C = 12.00000

s-block

GROUP

New Designation

Former Designation (prior to 1984 IUPAC decision)

d-block

Transition Elements

Period	*s*-block 1	2	3	4	5	6	7	8	9	10	
	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			
1	1.00794 +1 −1 **H** 1 $1s^1$										
2	6.941 +1 **Li** 3 $1s^2 2s^1$	9.01218 +2 **Be** 4 $1s^2 2s^2$									
3	22.98977 +1 **Na** 11 $[Ne]3s^1$	24.305 +2 **Mg** 12 $[Ne]3s^2$									
4	39.0983 +1 **K** 19 $[Ar]4s^1$	40.08 +2 **Ca** 20 $[Ar]4s^2$	44.9559 +3 **Sc** 21 $[Ar]3d^1 4s^2$	47.88 +2 +3 +4 **Ti** 22 $[Ar]3d^2 4s^2$	50.9415 +2 +3 +4 +5 **V** 23 $[Ar]3d^3 4s^2$	51.996 +2 +3 +6 **Cr** 24 $[Ar]3d^5 4s^1$	54.9380 +2 +3 +4 +7 **Mn** 25 $[Ar]3d^5 4s^2$	55.847 +2 +3 **Fe** 26 $[Ar]3d^6 4s^2$	58.9332 +2 +3 **Co** 27 $[Ar]3d^7 4s^2$	58.69 +2 +3 **Ni** 28 $[Ar]3d^8 4s^2$	63.54 29 [Ar]3d
5	85.4678 +1 **Rb** 37 $[Kr]5s^1$	87.62 +2 **Sr** 38 $[Kr]5s^2$	88.9059 +3 **Y** 39 $[Kr]4d^1 5s^2$	91.224 +4 **Zr** 40 $[Kr]4d^2 5s^2$	92.9064 +3 +5 **Nb** 41 $[Kr]4d^4 5s^1$	95.94 +3 +6 **Mo** 42 $[Kr]4d^5 5s^1$	(98) +4 +6 +7 **Tc** 43 $[Kr]4d^6 5s^1$	101.07 +3 **Ru** 44 $[Kr]4d^7 5s^1$	102.906 +3 **Rh** 45 $[Kr]4d^8 5s^1$	106.42 +2 +4 **Pd** 46 $[Kr]4d^{10} 5s^0$	107.86 47 [Kr]4d
6	132.905 +1 **Cs** 55 $[Xe]6s^1$	137.33 +2 **Ba** 56 $[Xe]6s^2$	**La-Lu** 57 71	178.49 +4 **Hf** 72 $[Xe]4f^{14}5d^2 6s^2$	180.948 +5 **Ta** 73 $[Xe]4f^{14}5d^3 6s^2$	183.85 +6 **W** 74 $[Xe]4f^{14}5d^4 6s^2$	186.207 +4 +6 +7 **Re** 75 $[Xe]4f^{14}5d^5 6s^2$	190.2 +3 +4 **Os** 76 $[Xe]4f^{14}5d^6 6s^2$	192.22 +3 +4 **Ir** 77 $[Xe]4f^{14}5d^7 6s^2$	195.08 +2 +4 **Pt** 78 $[Xe]4f^{14}5d^9 6s^1$	196.96 79 [Xe]4f
7	(223) +1 **Fr** 87 $[Rn]7s^1$	226.025 +2 **Ra** 88 $[Rn]7s^2$	**Ac-Lr** 89 103	(261) **Unq*** 104	(262) **Unp** 105	(263) **Unh** 106	(262) **Uns** 107	**Uno** 108	**Une** 109		

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s-block
18
O

p-block
GROUP

10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 O
								4.00260 0 **He** 2 $1s^2$
			10.81 +3 **B** 5 $1s^22s^22p^1$	12.0111 −4 +2 +4 **C** 6 $1s^22s^22p^2$	14.0067 −3 −2 −1 +1 +2 +3 +4 +5 **N** 7 $1s^22s^22p^3$	15.9994 −2 **O** 8 $1s^22s^22p^4$	18.998403 −1 **F** 9 $1s^22s^22p^5$	20.179 0 **Ne** 10 $1s^22s^22p^6$
			26.98154 +3 **Al** 13 $[Ne]3s^23p^1$	28.0855 −4 +2 +4 **Si** 14 $[Ne]3s^23p^2$	30.97376 −3 +3 +5 **P** 15 $[Ne]3s^23p^3$	32.06 −2 +4 +6 **S** 16 $[Ne]3s^23p^4$	35.453 −1 +1 +3 +5 +7 **Cl** 17 $[Ne]3s^23p^5$	39.948 0 **Ar** 18 $[Ne]3s^23p^6$
58.69 +2 +3 **Ni** 28 $[Ar]3d^84s^2$	63.546 +1 +2 **Cu** 29 $[Ar]3d^{10}4s^1$	65.39 +2 **Zn** 30 $[Ar]3d^{10}4s^2$	69.72 +3 **Ga** 31 $[Ar]3d^{10}4s^24p^1$	72.59 −4 +2 +4 **Ge** 32 $[Ar]3d^{10}4s^24p^2$	74.9216 −3 +3 +5 **As** 33 $[Ar]3d^{10}4s^24p^3$	78.96 −2 +4 +6 **Se** 34 $[Ar]3d^{10}4s^24p^4$	79.904 −1 +1 +5 **Br** 35 $[Ar]3d^{10}4s^24p^5$	83.80 0 +2 **Kr** 36 $[Ar]3d^{10}4s^24p^6$
106.42 +2 +4 **Pd** 46 $[Kr]4d^{10}5s^0$	107.868 +1 **Ag** 47 $[Kr]4d^{10}5s^1$	112.41 +2 **Cd** 48 $[Kr]4d^{10}5s^2$	114.82 +3 **In** 49 $[Kr]4d^{10}5s^25p^1$	118.71 +2 +4 **Sn** 50 $[Kr]4d^{10}5s^25p^2$	121.75 −3 +3 +5 **Sb** 51 $[Kr]4d^{10}5s^25p^3$	127.60 −2 +4 +6 **Te** 52 $[Kr]4d^{10}5s^25p^4$	126.905 −1 +1 +5 +7 **I** 53 $[Kr]4d^{10}5s^25p^5$	131.29 0 +2 +4 +6 **Xe** 54 $[Kr]4d^{10}5s^25p^6$
195.08 +2 +4 **Pt** 78 $[Xe]4f^{14}5d^96s^1$	196.967 +1 +3 **Au** 79 $[Xe]4f^{14}5d^{10}6s^1$	200.59 +1 +2 **Hg** 80 $[Xe]4f^{14}5d^{10}6s^2$	204.383 +1 +3 **Tl** 81 $[Xe]4f^{14}5d^{10}6s^26p^1$	207.2 +2 +4 **Pb** 82 $[Xe]4f^{14}5d^{10}6s^26p^2$	208.980 +3 +5 **Bi** 83 $[Xe]4f^{14}5d^{10}6s^26p^3$	(209) +2 +4 **Po** 84 $[Xe]4f^{14}5d^{10}6s^26p^4$	(210) **At** 85 $[Xe]4f^{14}5d^{10}6s^26p^5$	(222) 0 **Rn** 86 $[Xe]4f^{14}5d^{10}6s^26p^6$

IONIZATION ENERGIES AND ELECTRONEGATIVITIES

313 ← First Ionization Energy (kcal/mol of atoms)
H
2.2 ← Electronegativity*

1	2	13	14	15	16	17	18
313 H 2.2							567 He
125 Li 1.0	215 Be 1.5	191 B 2.0	260 C 2.6	336 N 3.1	314 O 3.5	402 F 4.0	497 Ne
119 Na 0.9	176 Mg 1.2	138 Al 1.5	188 Si 1.9	242 P 2.2	239 S 2.6	300 Cl 3.2	363 Ar
100 K 0.8	141 Ca 1.0	138 Ga 1.6	182 Ge 1.9	226 As 2.0	225 Se 2.5	273 Br 2.9	323 Kr
96 Rb 0.8	131 Sr 1.0	133 In 1.7	169 Sn 1.8	199 Sb 2.1	208 Te 2.3	241 I 2.7	280 Xe
90 Cs 0.7	120 Ba 0.9	141 Tl 1.8	171 Pb 1.8	168 Bi 1.9	194 Po 2.0	At 2.2	248 Rn
Fr 0.7	122 Ra 0.9						

* Arbitrary scale based on fluorine = 4.0

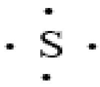
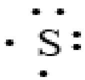
Polyatomic Ions

Name	Formula	Name	Formula
perPhosphate	$(PO_5)^{-3}$	perCarbonate	$(CO_4)^{-2}$
Phosphate	$(PO_4)^{-3}$	**Carbonate**	$(CO_3)^{-2}$
Phosphite	$(PO_3)^{-3}$	Carbonite	$(CO_2)^{-2}$
hypoPhosphite	$(PO_2)^{-3}$	hypocarbonite	$(CO)^{-2}$
perChlorate	$(ClO_4)^{-1}$	perNitrate	$(NO_4)^{-}$
Chlorate	$(ClO_3)^{-1}$	**Nitrate**	$(NO_3)^{-}$
Chlorite	$(ClO_2)^{-1}$	Nitrite	$(NO_2)^{-}$
hypoChlorite	$(ClO)^{-1}$	Hyponitrite	$(NO)^{-}$
perSulfate	$(SO_5)^{-2}$	perChromate	$(CrO_5)^{-2}$
Sulfate	$(SO_4)^{-2}$	**Chromate**	$(CrO_4)^{-2}$
Sulfite	$(SO_3)^{-2}$	Chromite	$(CrO_3)^{-2}$
hyposulfite	$(SO_2{}^{-2}$	Hypochromite	$(CrO_2)^{-2}$
Acetate	$(C_2H_3O_2)^{-1}$	**Cyanide**	$(CN)^{-1}$
Hydroxide	$(OH)^{-1}$	**Manganate**	$(MnO_4)^{-2}$

Ammonium
$(NH_4)^{+1}$

Practice Test: Ionic & Metallic Bonding

1. Which electron configuration would most likely represent an atom in the excited state?
a) $1s^2 2s^2 2p^5 3s^1$ b) $1s^2 2s^2 2p^6 3s^2 3p^1$ c) $1s^2 2s^2 2p^6 3s^2 3p^2$ d) $1s^2 2s^2 2p^6 3s^2$

2. Which is the correct electron dot representation of an atom of sulfur in the ground state?
a)  b)  c)  d) 

3. A crystal of NaCl is held together by what type of bonds?
a) covalent b) coordinate covalent c) hydrogen d) ionic

4. The element found in Group IIIA (13) and in Period 2 is:
a) Be b) Mg c) Al d) B

5. Element "M" has an electronegativity of less than 1.2 and reacts with bromine to form the compound, MBr_2. Element M could be:
a) Al b) Na c) Ca d) K

6. In an experiment, the gram atomic mass of magnesium was determined to be 24.7 compared to the accepted value of 24.3, the percent error for this determination was:
a) 0.400 b) 1.65 c) 24.7 d) 98.4

7. Which of the following compounds has the greatest ionic character?
a) NO b) KI c) HCl d) MgS

8. Elements in a group have similar chemical characteristics because of similar:
a) nuclear configurations
b) outer electron configurations
c) principal quantum numbers
d) mass numbers

9. When flourine reacts with a Group IA (1) metal, it becomes an ion with a charge of:
a) -1 b) -2 c) +1 d) +2

10. Which substance is an ionic solid?
a) Fe b) HCl c) Ne d) LiCl

11. The greatest degree of ionic character would be found in a bond between Sulfur and
a) oxygen b) chlorine c) bromine d) phosphorus

12. Which of the following elements has the lowest electronegativity?
a) oxygen b) flourine c) nitrogen d) carbon

13. The element with atomic number 10 has an electron configuration that is the same as
a) Cl- b) Cl c) Na+ d) Na

14. In what region of the Periodic Table are electrons first being added to the d sublevel as atomic number increases?
a) alkali metals b) transition elements c) non-metals d) actinide series

15. A neutral atom of an element has an electron configuration of 2-8-2. What is the total number of "p" electrons in this atom?
    a) 6 b) 2 c) 10 d) 12

16. What is the total number of electrons in a Mg+2 ion?
    a) 24 b) 12 c) 10 d) 2

17. Which atom has the strongest attraction for electrons?
    a) Cl b) F c) Br d) I

18. Which formula represent an ionic compound?
    a) H_2O (l) b) CCl_4 (l) c) NH_3 (g) d) NaCl (s)

19. Which substance exists as a metallic crystal at STP? a) Ar b) SiO_2 c) Au d) CO_2

20. Which of the following does NOT promote an electron being gained by an atom?
    a) ionization energy c) non-metallic character
    b) electronegativity d) electron affinity

21. Which one of the following statements is *incorrect*?
    a) In a group, the atom with the largest volume has the lowest ionization energy
    b) three half-filled p orbitals cause an increase in ionization energy
    c) Argon has a higher ionization energy than any other element in period 3
    d) unstable atoms tend to have high ionization energies

22. By one definition, the smallest particle of a substance capable of independent existence or independent motion is the: a) electron b) ion c) atom d) molecule

23. Calcium iodide is _____ stable than (as) calcium.
    a) more b) less c) equally d) horse

For each of questions 24-26, select the letter of the electron configuration chosen from the list below which best answers the question.

a. $1s^22s^22p^5$ b. $1s^22s^22p^6$ c. $1s^22s^22p^63s^1$ d. $1s^22s^22p^33p^3$

24. Which electron configuration shows the least reactive atom?

25. Which electron configuration shows an atom with the lowest ionization energy?

26. Which electron configuration shows an atom with the highest electronegativity?

Base your answers to questions 27-30 on the partial Periodic Table below

Groups in the Periodic Table							
IA (1)	IIA (2)	IIIA (13)	IVA (14)	VA (15)	VIA (16)	VIIA (17)	VIIIA (18)
A				E			
	J		D		M		R
		L				G	

27. Which two elements would be least likely to form a compound?
a) A & G b) D & G c) J & M d) L & R

28. Which two elements would form the most highly ionic compound
a) A & G b) D & M c) J & G d) L & M

29. What would be the probable formula for a compound formed from elements L & M?
a) LM b) LM_3 c) L_2M_3 d) L_3M_2

30. Which element has the lowest melting point?
a) G b) J c) R d) D