Welcome to Jeff's CHEM 4 lecture!

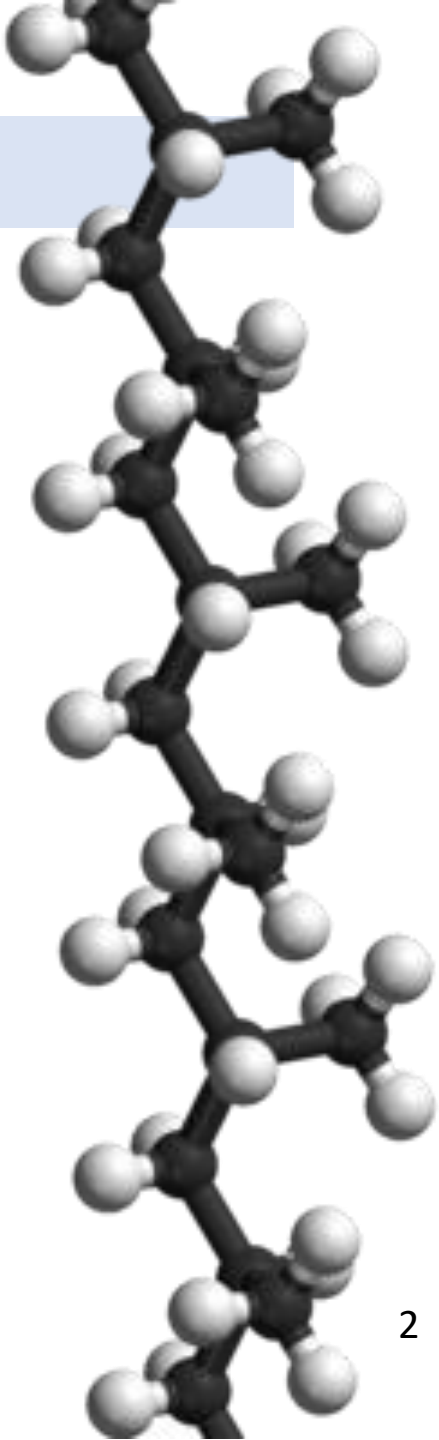
We'll be starting in just a bit…

While you are waiting:

1) Go to LearningCatalytics.com to prepare for today's clicker questions. Login with your MasteringChemistry login. **Session ID = _____**
2) *Let us know in the chat… what is your favorite childhood memory?* Mine is the huge summer picnics we'd have at my grandparent's house with tons of food and all my cousins.

Are up keeping up with CHEM 4?

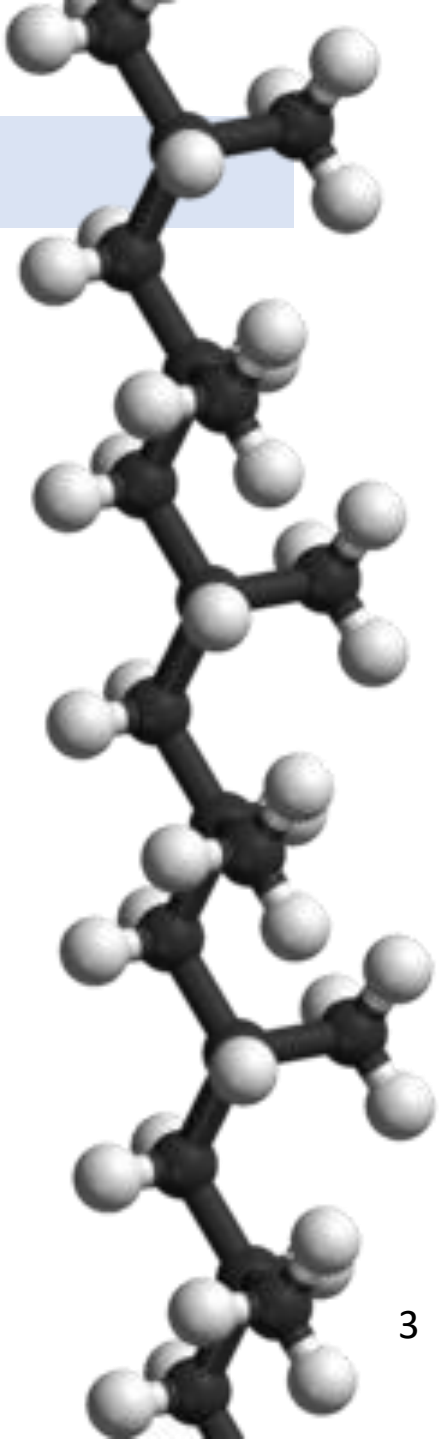
- ✓ **CHEM 4 Website: tinyurl.com/SacStateChem4**
  - ✓ Check **Aug/Sept calendar** for PowerPoint slides, readings, and homework.
- ✓ **Help:**
  - ✓ Jeff's office hours: MWF 9 – 9:30 am and 11 – 11:30 am; and by appointment
  - ✓ PAL office hours: link is on our CHEM 4 website
  - ✓ Can email me questions: Show question and email picture of work
- ✓ **Homework:**
  - ✓ Ideally, do it after every lecture so you are prepared for next class.
  - ✓ If you occasionally do your homework late, you will get credit for it.
- ✓ **Clickers:**
  - ✓ Automatic 2 pts for each time you vote (right or wrong).
  - ✓ ***Don't vote in a class you aren't registered in!!!!!***
  - ✓ If you are here, but unable to vote, message me in Zoom chat.
- ✓ **Optional:**
  - ✓ *Peer Assisted Learning (PAL)* – MW 12 noon is full.
  - ✓ *Commit to Study (C2S)* – Allows you to drop lowest exam.



Changes to CHEM 4

Security for Zoom lectures:

- ✓ Requires a password.
- ✓ All student microphones are muted (can't unmute yourself). We'll use chat for asking/answering questions.
- ✓ Your User ID should be your full name and should match my roster. I will remove other students from the session.
- ✓ To change your User ID, log into https://csus.zoom.us/
- ✓ Click "profile" and "edit"



Review clicker question (Coves material from last lecture)

Go to LearningCatalytics.com and login with your MasteringChemistry (Session ID =).

1) A 24.3 g sample of pure water is found to contain 21.6 g of oxygen. What mass of hydrogen can be isolated from a 95.0 g sample of pure water?

A) 2.7 g
B) 13.8 g
C) 84.4 g
D) 107 g
E) 855 g
F) 10.6 g

Answer:

	g of H	g of O	g total
Sample #1	2.7 g *	21.6 g	24.3 g
Sample #2	X		95.0 g

* g of H in Sample #1 = 24.3 g – 21.6 g = 2.7 g

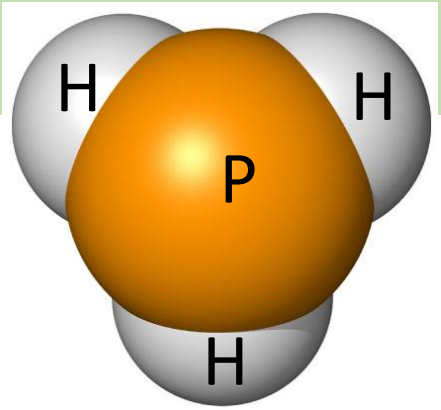
$$\frac{\text{g H in sample \#1}}{\text{g total in sample \#1}} = \frac{\text{g H in sample \#2}}{\text{g total in sample \#2}}$$

$$\frac{2.7 \text{ g H}}{24.3 \text{ g total}} = \frac{X \text{ g H}}{95.0 \text{ g total}}$$

X = 10.6 g H in sample #2

Chemistry in the News

*[**Note:** you won't be tested on this]*



Life on Venus? Astronomers See a Signal in Its Clouds

By Shannon Stirone, Kenneth Chang and Dennis Overbye
The New York Times, Published Sept. 14, 2020

- An international team of astronomers, led by Professor Jane Greaves of Cardiff University, announced the discovery of a rare molecule—phosphine—in the clouds of Venus.
- While phosphine had previously been detected in the atmospheres of Jupiter and Saturn, their immense heat and pressures can jam the phosphorus and hydrogen atoms together so life isn't necessary to form phosphine.
- On smaller, rocky planets like Earth and Venus there is not enough energy to produce copious amounts of phosphine in the same way. There is one thing, however, that appears to be very good at producing it: anaerobic life, or microbial organisms that don't require or use oxygen.

CHEM 4 lecture

Wednesday – September 16, 2020

Sec 5.4, 4.7, 5.5

Ionic Compounds

Reading clicker question (covers material from today's assigned reading)

Go to LearningCatalytics.com and login with your MasteringChemistry (Session ID =).

2) Which of the following statements is false?

A) Gaining electrons results in the formation of a positively charged ion.

B) Molecular compounds are formed from two or more non-metals.

C) Positively charged ions are called *cations*.

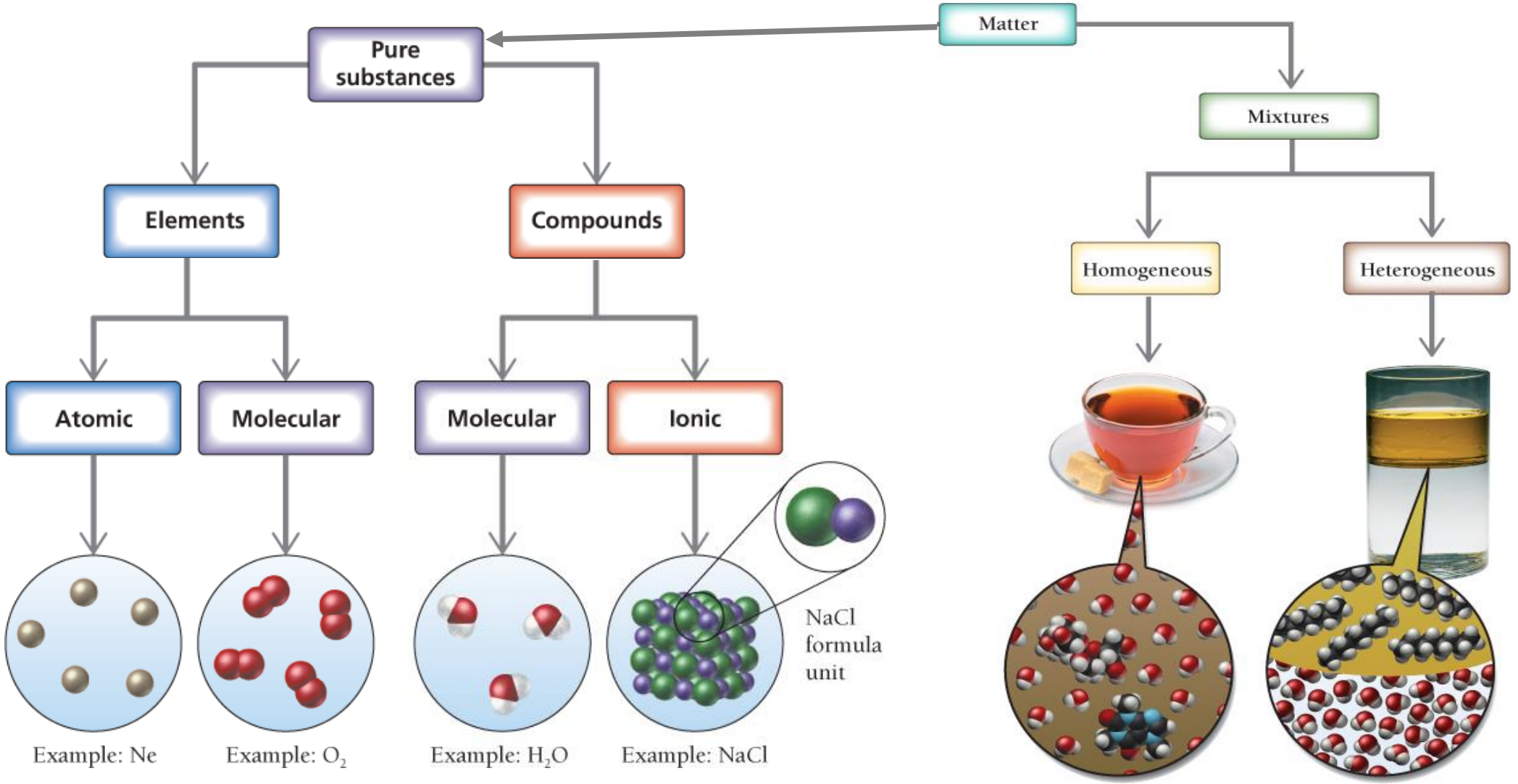
D) Ionic compounds typically contain both metals and non-metals.

E) Negatively charged ions are called *anions*.

F) Ionic compounds contain positive and negative ions in a ratio that cancels out their charges.

Background: Classifying matter

Elements and compounds can be further categorized…



Background: Compare/contrast ionic and molecular compounds

	Ionic compounds:	**Molecular compounds:**
A.K.A.	• *"salts"*	• *"covalent compounds"*
Composition:	• Contains both cations (typically metals) and anions (typically nonmetals) • NH_4^+ can take the place of a metal	• Contains only nonmetals • H and the metalloids are considered as nonmetals
Examples:	• NaCl, $CaBr_2$, $Fe(NO_3)_3$, $Al_2(SO_4)_3$ • NH_4OH	• CO_2, NH_3, H_2O • C_8H_{18} (octane), $C_6H_{12}O_6$ (glucose) • SiH_4
Typical properties:	• high melting/boiling points (usually solid) • conduct electricity when dissolved in water • hard; brittle	• lower melting/boiling points (can be solid, liquid, or gas) • Usually not soluble in water and usually don't conduct electricity if they do dissolve • flammable if contain C, H.

Progress clicker question (covers material we are learning now)

Go to LearningCatalytics.com and login with your MasteringChemistry (Session ID =).

3) Which of the following chlorine containing compounds are ionic? Feel free to look at your periodic table.

$CuCl_2$, $AlCl_3$, HCl, CCl_4, NH_4Cl, $CaCl_2$, PCl_5

A) $CuCl_2$, $AlCl_3$, PCl_5

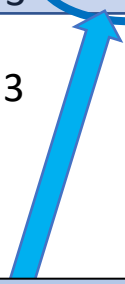
B) HCl, CCl_4, NH_4Cl, PCl_5

C) $CuCl_2$, $AlCl_3$, $CaCl_2$

D) $CuCl_2$, $AlCl_3$, HCl, $CaCl_2$

E) $CuCl_2$, $AlCl_3$, NH_4Cl $CaCl_2$

F) $CuCl_2$, $AlCl_3$



Remember: Even though NH_4Cl doesn't have any metal atoms, the presence of the NH_4^+ ion means it is categorized as an ionic compound.

Background: Compare/contrast ionic and molecular compounds

	Ionic compounds:	**Molecular compounds:**
Reason why they form:	• Atoms want same # of electrons as nearest noble gas	• Atoms want same # of electrons as nearest noble gas
Mechanism of formation:	• One or more electrons are transferred from the metal to the nonmetal • Results in cations (+ ions) and anions (– ions) held together by electrostatic attraction	• Shares electrons between the nonmetals • Results in neutral molecules

Background: Atoms prefer to have the same # of e^- as the nearest noble gas…

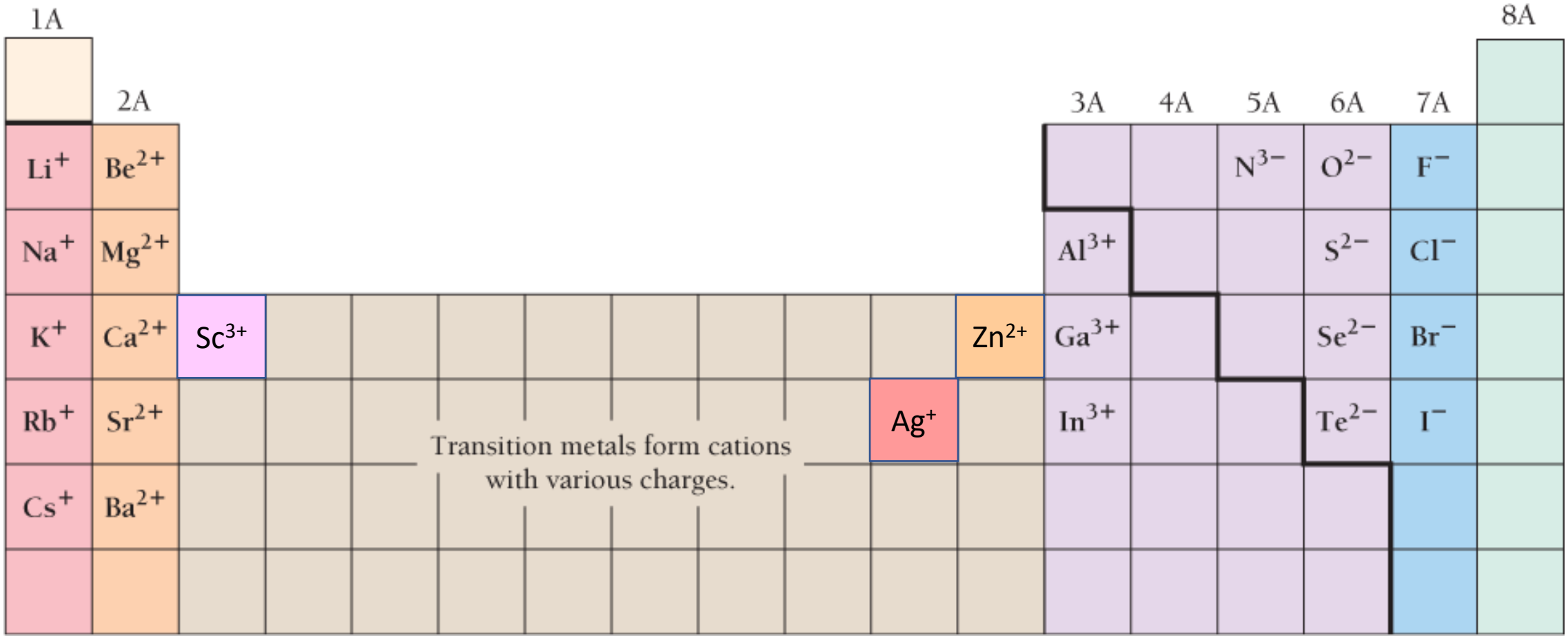
Note: Sometimes the nearest noble gas is found by going backwards on the periodic table to a lower atomic number.
For example: the nearest noble gas to Li is He, so Li wants to get 2 e- like He

The nearest noble gas to F is Ne, so F wants to get 10 e- like Ne

Noble gases

1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 97.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Nh (284)	114 Fl (289)	115 Mc (288)	116 Lv (292)	117 Ts (294)	118 Og (294)

Background: Typical charges when elements become ions



Background: Formation of ionic compounds

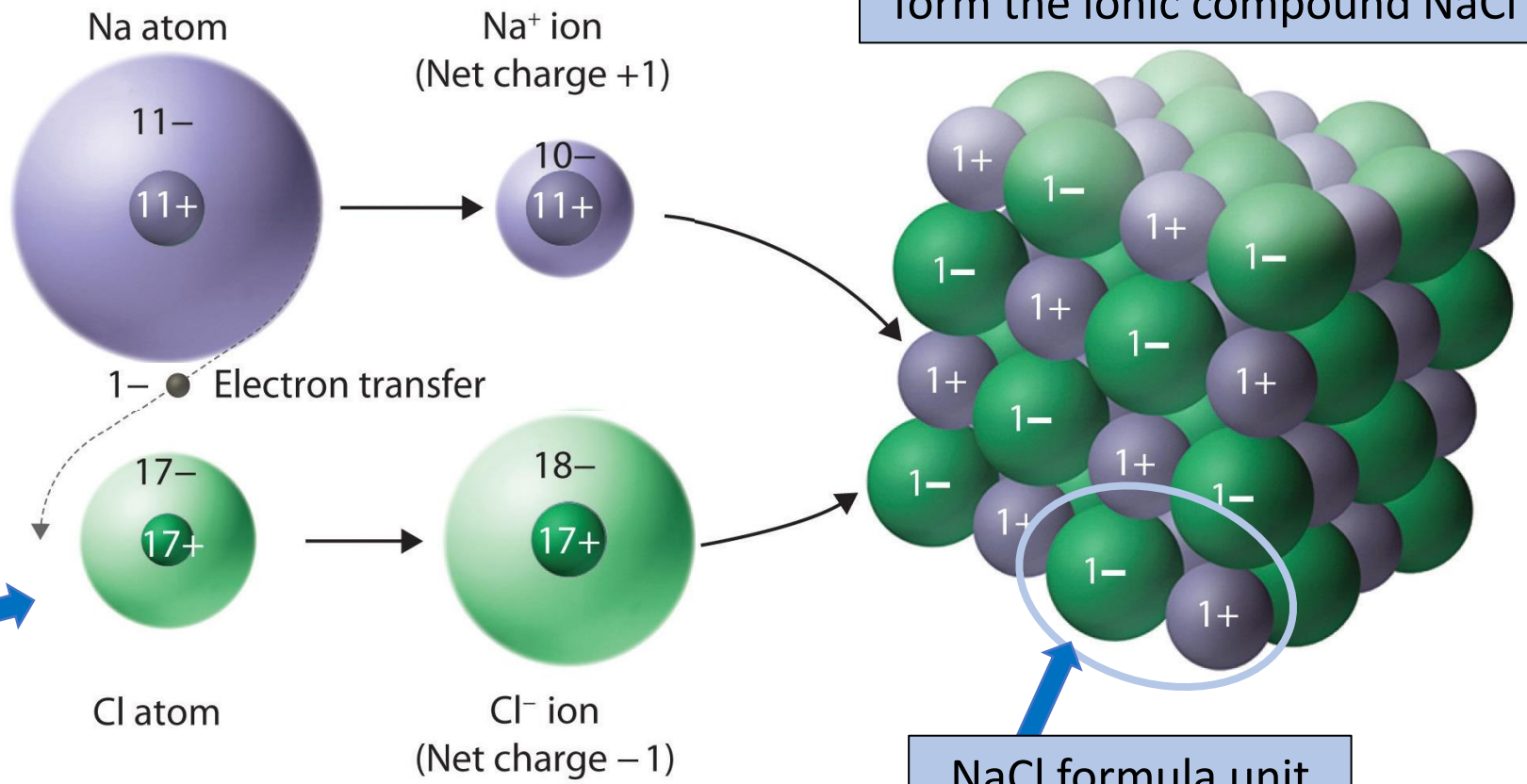
Metals typically lose e- to form cations

For example: Na loses 1e- to end up with 10e- (like its nearest noble gas, Ne)

Non-metals typically gain e- to form anions

For example: Cl gains 1e- to end up with 18e- (like its nearest noble gas, Ar)

Note: the # of p+ doesn't change



The "+" cations and "-" anions are attracted to each other and form the ionic compound NaCl

NaCl formula unit

Progress clicker question (covers material we are learning now)

Go to LearningCatalytics.com and login with your MasteringChemistry (Session ID =).

4) Which of the following statements is false? Feel free to use a periodic table.

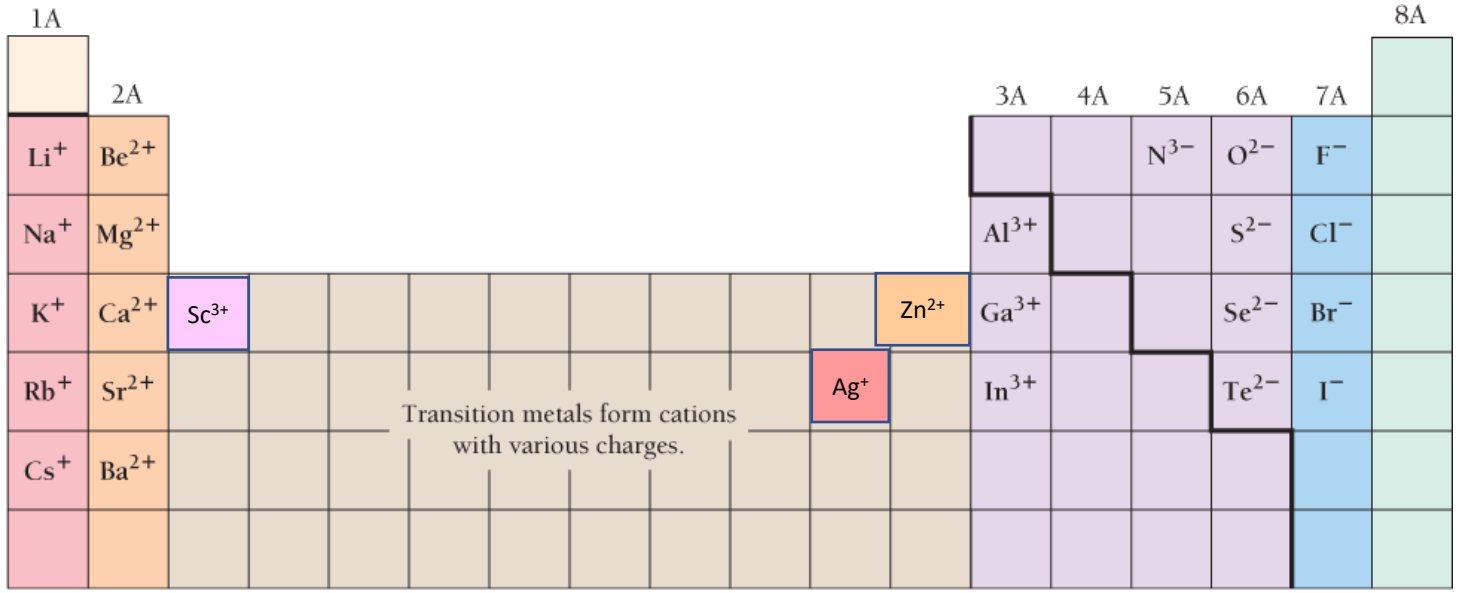
A) An atom of selenium typically gains 2 electrons when it becomes an ion.

B) The typical ion of magnesium contains 12 p^+ and 10 e^-.

C) The potassium ion has 1 more electron than a neutral atom of potassium.

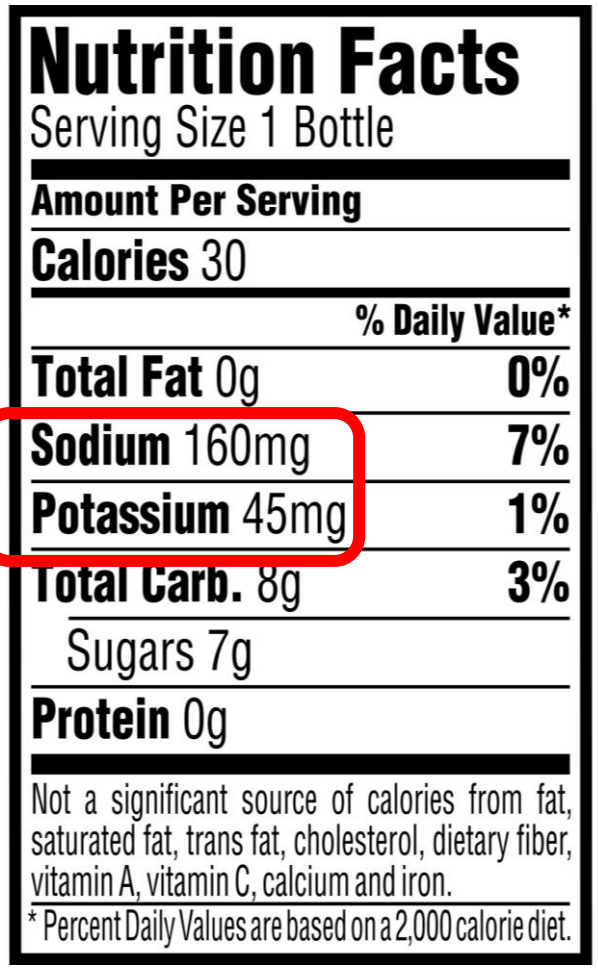
D) During chemical reactions, metals tend to lose e^- to form cations.

E) Aluminum's nearest noble gas is neon.



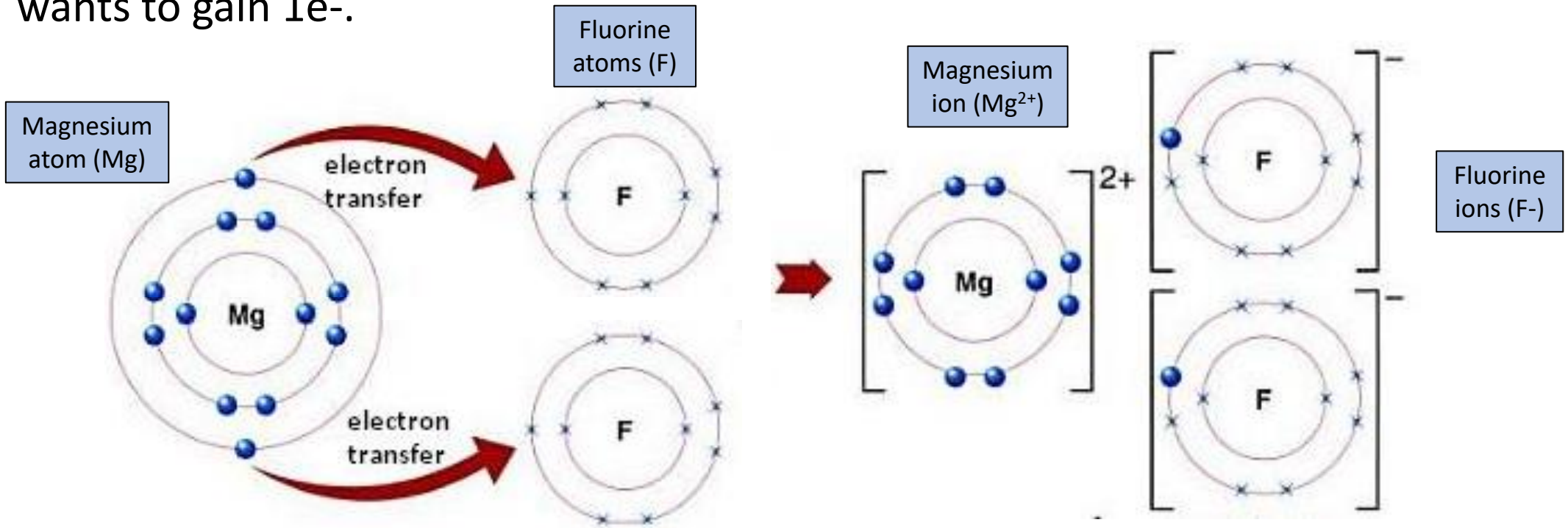
Application: Electrolytes

- **Electrolytes** are essential minerals that provide ions used in metabolic processes.
- Important electrolytes include: *[**Note:** you won't be tested on these]*
  - **Na^+** contributes to osmotic pressure; involved in generation of nerve impulses.
  - **K^+** helps establish resting membrane potential in neurons and muscle fibers.
  - **Cl^-** contributes to the osmotic pressure gradient and plays an important role in maintaining proper hydration.
  - **Ca^{2+}** necessary for muscle contraction, enzyme activity, and blood coagulation.
  - **HCO_3^-** (bicarbonate ion) acts as a buffer to regulate the body's pH.
  - **PO_4^{3-}** (phosphate ion) found in bones and teeth as well as in phospholipids, such as those that make up the cell membrane, and in ATP, nucleotides, and buffers.



Background: Formulas for ionic compounds

- Na and Cl are perfect pair for forming a compound: Na wants to lose 1e- and Cl wants to gain 1e-, so the transfer of 1e- results in 1+ and 1– ions.
- What about when Mg and F form a compound? Mg wants to lose 2e-, but F only wants to gain 1e-.



The Mg^{2+} and F^- ions combine in a 1:2 ratio, so MgF_2.

Background: Formulas for ionic compounds

- **Resulting pattern :**
  - Ions need to combine in a ratio that cancels their charges.
  - The same number of e- have to be gained as are lost
- What happens if Al and O react?
  - Al wants to lose 3e- to be Al^{3+}
  - O wants to gain 2e- to be O^{2-}
  - So, 2 x Al pairs up with 3 x O atoms.
  - This 2:3 ratio means the formula is Al_2O_3.
- Polyatomic ions (see class handout and next slide)
  - Sr^{2+} and OH^- → charges cancel in a 1:2 ratio → $Sr(OH)_2$
  - Sr^{2+} and PO_4^{3-} → charges cancel in a 3:2 ratio → $Sr_3(PO_4)_2$

Background: Important polyatomic ions

*[**Note:** you'll be able to use this handout on the exams]*

Element	Symbol
aluminum	Al
antimony	Sb
argon	Ar
arsenic	As
barium	Ba
beryllium	Be
bismuth	Bi
boron	B
bromine	Br
cadmium	Cd
calcium	Ca
carbon	C
cesium	Cs
chlorine	Cl
chromium	Cr
cobalt	Co
copper	Cu
fluorine	F
francium	Fr
gold	Au
helium	He
hydrogen	H
iodine	I
iron	Fe

Element	Symbol
krypton	Kr
lead	Pb
lithium	Li
magnesium	Mg
manganese	Mn
mercury	Hg
neon	Ne
nickel	Ni
nitrogen	N
oxygen	O
phosphorus	P
potassium	K
radium	Ra
rubidium	Rb
selenium	Se
silicon	Si
silver	Ag
sodium	Na
strontium	Sr
sulfur	S
tin	Sn
titanium	Ti
xenon	Xe
zinc	Zn

Monatomic ion	Symbol
bromide ion	Br^-
chloride ion	Cl^-
fluoride ion	F^-
iodide ion	I^-
nitride ion	N^{3-}
oxide ion	O^{2-}
sulfide ion	S^{2-}

Ions made by adding "H^+"	Symbol
hydrogen carbonate ion (bicarbonate)	HCO_3^-
hydrogen oxalate ion (bioxalate)	$HC_2O_4^-$
hydrogen phosphate ion	HPO_4^{2-}
dihydrogen phosphate ion	$H_2PO_4^-$
hydrogen sulfate ion (bisulfate)	HSO_4^-
hydrogen sulfide ion (bisulfide)	HS^-
hydrogen sulfite ion (bisulfite)	HSO_3^-

Polyatomic ion	Symbol
acetate ion	$C_2H_3O_2^-$
ammonium ion	NH_4^+
arsenate ion	AsO_4^{3-}
borate ion	BO_3^{3-}
bromate ion	BrO_3^-
bromite ion	BrO_2^-
carbonate ion	CO_3^{2-}
chlorate ion	ClO_3^-
chlorite ion	ClO_2^-
chromate ion	CrO_4^{2-}
cyanide ion	CN^-
dichromate ion	$Cr_2O_7^{2-}$
hydroxide ion	OH^-
hypobromite ion	BrO^-
hypochlorite ion	ClO^-

Polyatomic ion	Symbol
hypoiodite ion	IO^-
iodate ion	IO_3^-
iodite ion	IO_2^-
nitrate ion	NO_3^-
nitrite ion	NO_2^-
oxalate ion	$C_2O_4^{2-}$
perbromate ion	BrO_4^-
perchlorate ion	ClO_4^-
periodate ion	IO_4^-
permanganate ion	MnO_4^-
phosphate ion	PO_4^{3-}
phosphite ion	PO_3^{3-}
sulfate ion	SO_4^{2-}
sulfite ion	SO_3^{2-}
thiosulfate ion	$S_2O_3^{2-}$

Progress clicker question (covers material we are learning now)

Go to LearningCatalytics.com and login with your MasteringChemistry (Session ID =).

5) Which of the following is the likely formula for the compound that forms when strontium reacts with fluorine?

A) SrF_3

B) Sr_2F

C) SrF

D) SrF_2

E) Sr_3F

Answer:

- Based on their positions on the periodic table, we expect Sr to have a +2 charge and F to have a -1 charge.
- So, 2 of the F^- ions are needed to cancel out the Sr^{2+} charge.