AP Chemistry 2018-19
Summer Assignment

Welcome to AP Chemistry!

If you have chosen this course you should have a very strong background in chemistry from Honors Chemistry I. Advanced Placement Chemistry is a college level course covering topics including electrochemistry, equilibrium, kinetics and thermochemistry. Rather than memorizing how to do a particular type of problem, you must really understand the chemistry and be able to apply it to different situations. Because of the amount of material we must cover before the AP exams in May students must complete much of the work outside of class. Homework will include practice problems, sample AP questions and reading assignments from the textbook. But with hard work you will not only be successful in the AP Chemistry exam and course but also be prepared for college level coursework.

Like most AP classes, AP Chemistry comes with a summer assignment. You will need time to complete the different parts of this assignment, memorize some items and review content before school starts. So it is important to schedule your work during the summer.

To sign up for AP Chemistry Remind text:

Website for course and summer work videos/answers:

http://chrylpierce.wordpress.com/

The summer assignment document, answers, practice exam and videos explaining some of the content will be available under the AP Chemistry tab.

Contact Ms. Pierce

Email me at cheryl.pierce@polk-fl.net if you have questions about the assignment during the summer.

Summer Assignment Schedule

End of June Complete sections I-IV and check answers on AP Chem website

End of July Complete sections V-VII and check answers on AP Chem website

August Work through Practice AP Multiple Choice & Free Response Questions

August 10 Bring for first day of class

1. Completed summer packet
2. Completed Practice AP Multiple Choice & Free Response Questions
3. Polyatomic Ion Flashcards

Materials

1-½ inch 3-ring binder
Divider tabs
scientific calculator
lab manual (provided)

AP Course Content

Prepare your binder before the first day of class with tabs for each of the following AP topics:

- Atomic Theory/Structure
- Chemical Bonding
- Intermolecular Attractions
- Reaction Types
- Stoichiometry
- Equilibrium (Kc/Kp)
- Thermodynamics
- Electrochemistry
- Equilibrium (Ka/Kb)
- Kinetics
- Lab Manual

2018 Summer Assignment Checklist

Check off each part of the assignment as you complete it and be sure to bring the appropriate items for collection the first day of school. Do not just complete the material in the summer assignment-***make sure that you know and understand the material for the first class***.

- ☐ Review the information and summer work timeline on pages 1-2.
- ☐ Set up your notebook for AP Chemistry as described on page 2.

I. Chemical Bonding-Cations & Anions

- ☐ Pages 5-7 — Play the video "Learning Polyatomics" under the "AP Chemistry" tab at http://chrylpierce.wordpress.com/

  Use the "Quizlet-Polyatomic Ions" link on the AP website to practice the names and formulas of the ions.

II. Review of Chemical Bonding-Compound Formulas & Names

- ☐ Page 8 — Go over the examples of ionic and covalent compound nomenclature.
- ☐ Pages 9-10 — Complete the exercise.

III. Chemical Bonding-Rules for Naming Acids

- ☐ Page 11 — Read through the examples of acid naming rules.
- ☐ Page 12 — Complete the exercise.

IV. Solubility Rules

- ☐ Page 13 — Read through the solubility rules and answer the questions.

V. Applying Solubility Rules

- ☐ Pages 14-15 — Use the examples provided to complete the exercise on page 17.

  Play the video "Applying Solubility Rules" on the website.

VI. Review of Reactions-Chemical Equations

- ☐ Page 16 — Review the types of equations in the examples provided.
  Play the video "Review of Reaction Types" on the website.
- ☐ Pages 17-18 — Complete the exercise. Be sure to balance each equation.

VII. Review of Electron Configuration

- ☐ Pages 19-20 — Review the examples of electron configuration and complete the exercises.
  Watch the video "Review of Electron Configuration" on the website.

VIII. Electromagnetic Radiation

- ☐ Page 22 — Watch the video on "Electromagnetic Radiation" on the website.
- ☐ Review the variables and equations.
- ☐ Page 23 — Complete the exercises

Practice Multiple Choice & Free Response Questions

- ☐ Complete the AP Multiple Choice and Free Response practice questions.

Bring these items with you to class the first day of school:

1. Completed summer packet sections I-VII to turn in.
2. Completed practice multiple choice & free response questions.

Quiz-First day of school on selected summer assignment topics.

Test-First week of school on summer assignment topics.

I. Chemical Bonding-Cations & Anions

Common Ions with One Oxidation State (charge)

Name	Formula	Name	Formula
lithium	Li^{+1}	sodium	Na^{+1}
potassium	K^{+1}	magnesium	Mg^{+2}
calcium	Ca^{+2}	strontium	Sr^{+2}
barium	Ba^{+2}	silver	Ag^{+1}
zinc	Zn^{+2}	aluminum	Al^{+3}
hydrogen	H^{+1} or H^{-1}	nitride	N^{-3}
oxide	O^{-2}	sulfide	S^{-2}
fluoride	F^{-1}	chloride	Cl^{-1}
bromide	Br^{-1}	iodide	I^{-1}

Exercise: Locate the elements listed above on your periodic table and observe the trend. Remove the periodic table from the plastic protector and label the top of each column involved with the appropriate ion charge.

Common Ions with More Than One Oxidation State

Name	Formula	Name	Formula
copper (I)	Cu^{+1}	mercury (I)	Hg_2^{+1}
copper (II)	Cu^{+2}	mercury (II)	Hg^{+2}
iron (II)	Fe^{+2}	chromium (I)	Cr^{+1}
iron (III)	Fe^{+3}	chromium (III)	Cr^{+3}
manganese (II)	Mn^{+2}	cobalt (II)	Co^{+2}
manganese (III)	Mn^{+3}	cobalt (III)	Co^{+3}
tin (II)	Sn^{+2}	lead (II)	Pb^{+2}
tin (IV)	Sn^{+4}	lead (IV)	Pb^{+4}

Questions: Locate the elements listed above on your periodic table.
Is there a trend based on the oxidation states for each of the transition elements?
What does the Roman number indicate about the ion?
Why is it not necessary to give a Roman number when writing the name for silver and zinc ions?

Exercise: Write the charges above in the box on your periodic table for each of the transition elements listed on page 5.

Polyatomic Ions = a charged particle which has two or more atoms held together by covalent bonds.

Polyatomic Ions = charged particle with two or more atoms held together by covalent bonds

Name	Formula	Name	Formula
ammonium	NH_4^{+1}	acetate	$C_2H_3O_2^{-1}$
oxalate	$C_2O_4^{-2}$	peroxide	O_2^{-2}
hydroxide	OH^{-1}	permanganate	MnO_4^{-1}
selenate	SeO_4^{-2}	bromate	BrO_3^{-1}
iodate	IO_3^{-1}	silicate	SiO_3^{-2}
nitrate	NO_3^{-1}	cyanide	CN^{-1}
nitrite	NO_2^{-1}	thiocyanate	SCN^{-1}
phosphate	PO_4^{-3}	chromate	CrO_4^{-2}
phosphite	PO_3^{-3}	dichromate	$Cr_2O_7^{-2}$
carbonate	CO_3^{-2}	perchlorate	ClO_4^{-1}
bicarbonate	HCO_3^{-1}	chlorate	ClO_3^{-1}
		chlorite	ClO_2^{-1}
sulfate	SO_4^{-2}	hypochlorite	ClO^{-1}
bisulfate	HSO_4^{-1}		
sulfite	SO_3^{-2}		
bisulfite	HSO_3^{-1}		

Questions: What do the prefixes hypo-, per-, bi- and thio- mean in terms of polyatomic ion?

What is the significance of the suffixes –ate and –ite in terms of the formula of the ions?

Assignment: Students taking the AP Chemistry exam are given several reference sheets to use during the test. Monoatomic and polyatomic ions are **not** included on those reference sheets so students are required to memorize them. Use the Quizlet on the AP website to learn common polyatomic names and formulas. You may wish to make flashcards of the ions from the lists above-write the ion formula with charge on one side of the flashcard and the name of the ion on the other side of the card.

First day of class-have the ion names and formulas memorized (there will be a quiz). B

II. Review of Chemical Bonding-Compound Formulas & Names

Use the examples below to complete the chart on the following page.

Ionic Compounds

metal + nonmetal
or containing a polyatomic ion

total ions charges must equal 0

roman # = transition metal ion charge

potassium oxide
ions = K^{+1} O^{-2}
formula = K_2O

calcium nitrate
ions = Ca^{+2} NO_3^{-1}
formula = $Ca(NO_3)_2$

iron III hydroxide
ions = Fe^{+3} OH^{-1}
formula = $Fe(OH)_3$

$BaBr_2$
barium bromide

$(NH_4)_2CO_3$
ammonium carbonate

Cu_2O
copper (I) oxide

Covalent Compounds

nonmetal + nonmetal
or acid (HX)

prefixes in name indicate number of each element

sulfur trioxide
SO_3

phosphorus pentachloride
PCl_5

dinitrogen tetraoxide
N_2O_4

BCl_3
boron trichloride

SCl_6
sulfur hexachloride

OCl_2
oxygen dichloride

Exercise: Complete this section by giving the correct formula or name for each compound.

Write the formulas for the following:		**Name each of the following:**	
a.	barium sulfate	a.	$CuSO_4$
b.	ammonium chloride	b.	PCl_3
c.	chlorine monoxide	c.	Li_3N
d.	silicon tetrachloride	d.	$BaSO_3$
e.	magnesium fluoride	e.	N_2F_4
f.	sodium oxide	f.	$KClO_4$
g.	sodium peroxide	g.	NaH
h.	copper (I) oxide	h.	$(NH_4)_2Cr_2O_7$
i.	zinc sulfide	i.	$Ba(NO_2)_2$
j.	potassium carbonate	j.	Sr_3P_2
k.	manganese (II) phosphate	k.	$Mg(OH)_2$

Write the formulas for the following:		**Name each of the following:**	
l.	silicon tetrabromide	l.	Al_2S_3
m.	lead (II) acetate	m.	AgBr
n.	sodium permanganate	n.	P_4O_{10}
o.	lithium oxalate	o.	$Pb(C_2H_3O_2)_4$
p.	potassium cyanide	p.	CaI_2
q.	iron (III) hydroxide	q.	MnO_2
r.	silicon dioxide	r.	Li_2O
s.	nitrogen trifluoride	s.	FeI_3
t.	chromium (III) oxide	t.	Cu_3PO_4
u.	calcium chlorate	u.	PCl_5
v.	sodium thiocyanate	v.	NaCN
w.	aluminum nitride	w.	IF_3

III. Chemical Bonding-Rules for Naming Acids

Acids are covalent compounds that ionize or form ions in water:

$HCl + H_2O \rightarrow H_3O^{+1} + \mathbf{Cl^{-1}}$ (chlor**ide**)

Acid names are linked to the anion formed when the acid reacts with water.

1. When the name of the anion (negative ion) ends in **–ide**, the acid name begins with the prefix hydro- and the stem of the anion has the suffix –ic. The is followed by the word acid.

Pattern: hydro _____ ic acid

Examples: HCl = hydrochloric acid [Cl^{-1} = chloride]

HCN = hydrocyanic acid [CN^{-1} = cyanide]

2. When the name of the anion ends it **–ite**, the acid name is the stem of the anion with the suffix –ous. This is followed by the word acid.

Pattern: _____ous acid

Examples: HNO_2 = nitrous acid [NO_2^{-1} = nitrite]

H_2SO_3 = sulfurous acid [SO_3^{-2} = sulfite]

3. When the name of the anion ends in **–ate**, the acid name is the stem of the anion with the suffix –ic. This is followed by the word acid.

Pattern: _____ ic acid

Examples: HNO_3 = nitric acid [NO_3^{-1} = nitrate]

H_2SO_4 = sulfuric acid [SO_4^{-2} = sulfate]

Acids Names & Formulas

Exercise: Complete the page using the rules on the previous page.

1. Name the following acids:

a. HBr

b. H_3PO_4

c. $HClO_4$

d. $HC_2H_3O_2$

e. HI

f. HIO_3

g. HClO

h. $H_2C_2O_4$

2. Give the formula for the following acids:

a. hydrofluoric acid

b. bromic acid

c. chloric acid

d. carbonic acid

e. chlorous acid

f. phosphorous acid

g. selenic acid

IV. Solubility Rules (for aqueous solutions)

Ion	Solubility
NO_3^{-1} $C_2H_3O_2^{-1}$ ClO_4^{-1} ClO_3^{-1}	always soluble
alkali metals (Li^{+1}, Na^{+1}, K^{+1}, etc) NH_4^{+1}	always soluble
Cl^{-1} Br^{-1} I^{-1}	soluble except with Ag^{+1}, Pb^{+2}, Hg_2^{+2}
SO_4^{-2}	soluble except with Pb^{+2}, Hg_2^{+2}, Sr^{+2}, Ca^{+2}, Ba^{+2}
OH^{-1}	insoluble except with Ca^{+2}, Sr^{+2}, Ba^{+2}
PO_4^{-3} S^{-2} CO_3^{-2} SO_3^{-2}	insoluble except with alkali metals or NH_4^{+1}
Acids	soluble acids = HCl, HBr, HI, HNO_3, $HClO_4$, H_2SO_4 insoluble acids = all other acids

Questions: What is meant by the term solution?

What does it mean when we say a compound is soluble or insoluble?

What does the term "aqueous" mean?

Are the solubility rules different for compounds mixed with alcohol or other liquids?

What elements are included in the alkali metal group mentioned in solubility rules?

V. Applying Solubility Rules

Exercise: Use the examples below to complete the chart on the following page.

Compound	Soluble or Insoluble?	Ions present in solution?
KCl potassium chloride	Soluble	K^{+1} and Cl^{-1}
Solubility Rule alkali metal K^{+1} is always soluble **or** Cl^{-1} (chloride ion) is soluble except with Ag^{+1}, Pb^{+2}, Hg_2^{+2}		

Compound	Soluble or Insoluble?	Ions present in solution?
$Cu(NO_3)_2$ copper II nitrate	Soluble	Cu^{+2} and NO_3^{-1}
Solubility Rule nitrate is always soluble (with any positive ion)		

Compound	Soluble or Insoluble?	Ions present in solution?
AgCl silver chloride	Insoluble	None Ag^{+1} and Cl^{-1} ions remain bonded together in a ionic crystal
Solubility Rule chloride ion is soluble except with Ag^{+1}, Pb^{+2} and Hg_2^{+2}		

Compound	Soluble or Insoluble?	Ions present in solution?
$Zn(OH)_2$ zinc hydroxide	Insoluble	None Zn^{+2} and OH^{-1} ions remain bonded together in an ionic crystal
Solubility Rule hydroxide ion is insoluble except with Ca^{+2}, Sr^{+2}, Ba^{+2}		

Exercise: For each compound below determine whether the compound is soluble or insoluble in water. Indicate which ions, if any, would be present in an aqueous solution.

Compound	Soluble or Insoluble?	Ions present in solution?
NaCN		
NH_4NO_3		
$CuSO_4$		
sulfurous acid		
FeI_3		
$KC_2H_3O_2$		
HNO_3		
copper (I) chlorate		
Al_2S_3		
lead (II) bromide		
$(NH_4)_2Cr_2O_7$		
Na_3N		
zinc sulfide		
$BaSO_3$		
potassium chlorate		
NaH		
$Mg(OH)_2$		
calcium iodide		
$Cu_3(PO_4)_2$		
K_2CO_3		
$ZnSiO_3$		

VI. Review of Reactions-Chemical Equations

Diatomic Molecules: H_2 O_2 N_2 F_2 Cl_2 Br_2 I_2

Examples of five types of reactions (equations are unbalanced)-

1. Composition/Synthesis/Combination
example: lithium burns in oxygen gas

element + element ➔ compound — check to see if the elements involved are diatomic then use charges of the ions to determine the formula of the compound
$Li + O_2 \rightarrow Li_2O$

2. Decomposition
example: calcium oxide is heated

compound ➔ element + element — heat applied to the compound triggers the decomposition of the compound
$CaO \rightarrow Ca + O_2$

3. Single Replacement/Displacement
example: lithium reacts with sodium nitrate

element + compound ➔ compound + element — the three ions in the reactants switch partners to form a new compound ($LiNO_3$) and a different free element (Na)
$Li + NaNO_3 \rightarrow LiNO_3 + Na$

4. Double Replacement/Displacement
example: calcium oxide reacts with barium sulfate

compound + compound ➔ compound + compound — the four ions in the reactants switch partners to form two new compounds as products
$CaO + BaSO_4 \rightarrow CaSO_4 + BaO$

5. Combustion
example: hydrocarbon react with oxygen

hydrocarbon + oxygen ➔ carbon dioxide + water — a hydrocarbon contains C, H and may contain O also
$CH_4 + O_2 \rightarrow CO_2 + H_2O$

Exercise:

For each reaction below:

- identify the type of reaction
- predict and write the products
- balance the reaction.

Hint: when writing these reactions, ignore all of the information about heat, bubbling, or mixing details. These are excess words used to make complete sentences. Simply locate the chemical formulas or names in the description to find the reactants for the reaction.

Example: Solutions of silver nitrate and magnesium iodide are combined.

$$2AgNO_3 + MgI_2 \rightarrow 2AgI + Mg(NO_3)_2$$

1. Ammonium sulfate reacts with barium nitrate.

2. Zinc metal is added to a solution of copper (II) chloride.

3. Propane gas (C_3H_8) is burned in excess oxygen.

4. Magnesium and nitrogen gas are heated together.

5. Chlorine gas is bubbled through a solution of sodium bromide.

6. Solutions of lead (II) nitrate and calcium iodide are mixed.

7. Sulfuric acid is combined with sodium hydroxide.

8. Isopropyl alcohol (C_3H_7OH) is burned in oxygen.

9. Iron metal shavings are added to hydrochloric acid.

10. Ammonium hydroxide solution is added to potassium sulfite.

Be sure all equations are balanced.

VII. Review of Electron Configuration

What is meant by the terms shell, subshell and orbital?

What is meant by the ground state of an electron?

1	1s			**He**
2	2s		2p	**Ne**
3	3s		3p	**Ar**
4	4s	3d	4p	**Kr**
5	5s	4d	5p	**Xe**
6	6s	5d	6p	**Rn**
7	7s	6d	7p	**?**

4f
5f

Electron configuration examples:

Na = [Ne]3s^1 **Cl = [Ne]3s^{2}3p^5** **Fe = [Ar]4s^{2}3d^6**

Elements with electrons in the f sublevel:

Tl = [Xe]6s^{2}5d^{1}4f^{14}5d^{9}6p^1 or combine d electrons to give **[Xe]6s^{2}5d^{10}6p^1**

Exceptions: **Cr = [Ar]4s^{1}3d^5** **Cu = [Ar]4s^{1}3d^{10}**

What do elements in the columns with Cr and Cu not have a filled s sublevel?

Exercise:
1. Give the electron configuration for the following atoms:

a. Mg b. Rb

c. I d. Mo

e. As f. Ba

g. Ag h. Sr

i. Pb j. U

k. Tc l. Kr

Electron configuration of ions:

Cations (+) = lose high energy level e^- **Anions (-) = gain e^-**

Na = $[Ne]3s^1$ **Cl = $[Ne]3s^23p^5$**

Na^{+1} = [Ne] **Cl^{-1} = [Ar]**

Transition metals (+) = lose s electrons first

Fe = $[Ar]4s^23d^6$ **Fe^{+2} = $[Ar]3d^6$**

2. Give the electron configuration for the following ions:

a. Mg^{+2} b. Rb^{+1}

c. I^{-1} d. Sr^{+2}

e. Ag^{+1} f. Pb^{+2}

Electron dot diagram and orbital notation-show the highest energy level e^- only

Na **Cl** **Fe**

3. Draw the orbital notation for the following elements:

a. I b. Ca

c. Ag d. As

e. Cu f. Fr

4. Draw the electron dot diagram for:

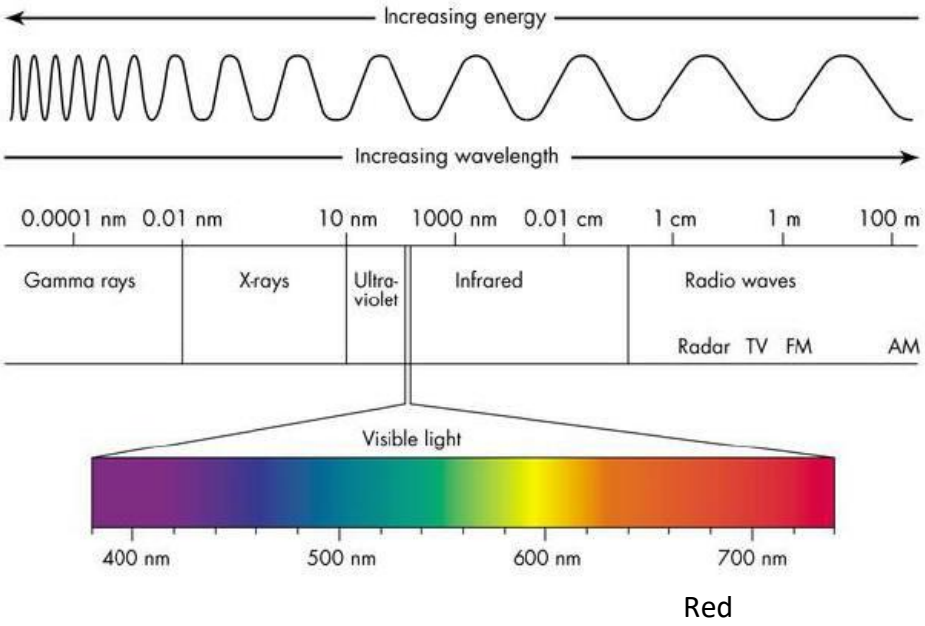
a. Mg b. Se d. Sr e. Co

5. Identify the element that has the following electron configurations:

a. $[Ne]3s^1$ b. $[Kr]5s^14d^{10}$ c. $[Xe]6s^24f^{14}5d^{10}6p^5$

d. [Xe] (+2 ion) e. [Ar] (-3 ion)

VIII. Electromagnetic Radiation



The electromagnetic spectrum is made up of packets of energy called photons that travel in waves. The more compact the wave the higher the energy (more energy would be transmitted every second so higher energy). Gamma rays have more compact waves so they are higher energy than TV/radio waves.

Use the Atomic Structure section of the AP Chemistry Equations and Constants sheets (Appendix B) to fill in the blanks below:

Variables

λ = _____unit = m, nm, angstroms
(distance from the top of one wave to the top of the next wave)

E = _____ of the photon unit = KJ or J

ν = _____unit = waves/second or /s or s^{-1}
(how many times the wave passes a point per second)

Constants

c = _____ speed of light
(distance light or the other forms of energy travel per second)

h = _____ Planck's constant

Equations

$c = \lambda\nu$ **$E = h\nu$**

Conversions (for wavelength)

$1\ m = 1x10^{6}\ nm$ $1\ m = 1x10^{9}\ nm$ $1\ m = 1x10^{10}$ Å

Example: Calculate the frequency of energy with a wavelength of $2.2x10^{-7}$ m.

Exercise:

1. A laser used to weld detached retinas produces radiation with a frequency of $4.69x10^{14}\ s^{-1}$. What is the wavelength of this radiation? $\lambda = c/\nu$

2. The yellow light given off by a sodium vapor lamp used for public lighting has a wavelength of 589 nm. What is the frequency of this radiation? (convert wavelength from nm to m)

3. Using the frequency calculated in #2, calculate the smallest increment of energy (E) that an object can absorb from yellow light whose wavelength is 589 nm.

4. What is the energy, in Joules, of radiation that has a frequency of $9.00x10^{11}s^{-1}$?

5. Yellow light has a wavelength of 0.583 nm. Calculate the energy, in Joules, of this radiation.

6. What is the wavelength of radiation, in Angstroms, whose frequency is $8.34x10^{14}\ s^{-1}$.

Practice Multiple Choice & Free Response Questions

I. Multiple Choice-

Directions-Eliminate choices as you work each question and use your Honors Chemistry notebook if needed for background information.

$1s^2\ 2s^2 2p^6\ 3s^2 3p^3$

1. Atoms of an element, X, have the electronic configuration shown above. The compound most likely formed with magnesium, Mg, is:

(A) MgX (B) Mg_2X (C) MgX_2 (D) MgX_3 (E) Mg_3X_2

2. Which of the following represents the ground state electron configuration for the Mn^{3+} ion?

(A) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^4$ (B) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^5\ 4s^2$
(C) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^2\ 4s^2$ (D) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^8\ 4s^2$
(E) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^3\ 4s^1$

Use the following answers for questions 3-5.
(A) F (B) S (C) Mg (D) Ar (E) Mn

3. Forms monatomic ions with 2^- charge in solutions

4. Forms a compound having the formula KXO_4

5. Forms oxides that are common air pollutants and that yield acidic solution in water.

Use these answers for questions 6-9.
(A) $1s^2\ 2s^2 2p^5\ 3s^2 3p^5$ (B) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6$ (C) $1s^2\ 2s^2 2p^6 2d^{10}\ 3s^2 3p^6$
(D) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^5$ (E) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^3\ 4s^2$

6. An impossible electronic configuration

7. The ground-state configuration for the atoms of a transition element

8. The ground-state configuration of a negative ion of a halogen

9. The ground-state configuration of a common ion of an alkaline earth element

10. . . . $C_{10}H_{12}O_4S(s)$ + . . $O_2(g)$ ---> . . . $CO_2(g)$ + . . . $SO_2(g)$ + . . . $H_2O(g)$

When the equation above is balanced and all coefficients are reduced to their lowest whole-number terms, the coefficient for $O_2(g)$ is?

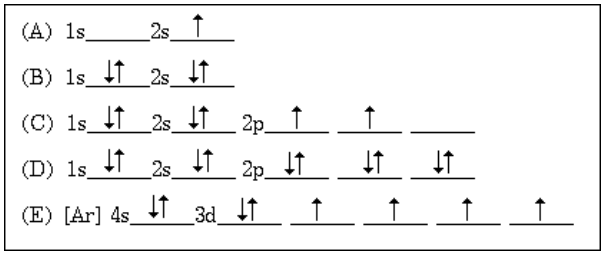
(A) 6 (B) 7 (C) 12 (D) 14 (E) 28

11. . . . $Li_3N(s)$ + . . . $H_2O(l)$ ---> . . . $Li^+(aq)$ + . . . $OH^-(aq)$ + . . . $NH_3(g)$

When the equation above is balanced and all coefficients reduced to lowest whole number terms, the coefficient for $OH^-(aq)$ is:

(A) 1 (B) 2 (C) 3 (D) 4 (E) 6

Questions 12-14 refer to atoms for which the occupied atomic orbitals shown below:



12. Represents an atom that is chemically unreactive

13. Represents an atom that has four valence electrons.

14. Represents an atom of a transition metal.

15. Which is the most likely electron configuration for a sodium ion?

(A) $1s^2 2s^2 2p^5$ (B) $1s^2 2s^2 2p^6$ (C) $1s^2 2s^2 2p^6 3s^1$
(D) $1s^2 2s^2 2p^6 3s^2$ (E) $1s^2 2s^2 2p^5 3s^1$

16. Which of the following pairs of ions are isoelectric (have the same number of electrons)?

(A) Kr^{-1}, Br^{+1} (B) F^{-1}, Na^{+1} (C) Sc, Ti^{-1}
(D) Be^{+2}, Ne (E) Cs, Ba^{+2}

17. Which of the following has the same number of electrons as I^{-1}?

(A) Sr^{+2} (B) Rb^{+1} (C) Cs^{-1} (D) Ba^{+2} (E) Br^{-1}

II. Free Response Questions-

Directions-Answer the free response questions below. If asked to explain your reasoning in no more than 1-2 sentences and use specific details in your answer.

1.

	# of Valence e^-
Element A	4
Element B	1
Element C	7
Element D	8

The table above shows the number of valence electrons for atoms of four elements from the third period (row) of the periodic table. The elements are represented with letters A-D.

Use the information in the table to answer the following questions.

(a) Which element is most metallic in character? Explain your reasoning.

(b) Identify element C. Explain your reasoning.

(c) Write the complete electron configuration for an atom of element C.

(d) What is the expected oxidation state (charge) for the most common ion of element B?

(e) What is the chemical symbol for element B?

(f) A neutral atom of which of the four elements is most unreactive? Explain your reasoning.

2. Suppose a stable element with atomic number 119, symbol Q, has been discovered.

(a) Write the ground-state electron configuration for Q.

(b) Would Q be a metal or a nonmetal? Explain in terms of electron configuration.

(c) On the basis of the periodic trends, would Q have the largest atomic radius in its group or would it have the smallest? Explain in terms of electron structure.

(d) What would be the most common oxidation number for element Q.

3. For each reaction described below:

(i) write the complete, balanced equation in the box.
(ii) answer the question related to the equation from part (i).

(a) Magnesium metal is burned in nitrogen gas.

(ii) What type of bond is present in the product?

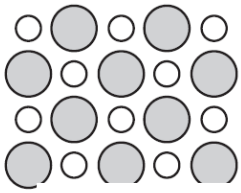
(b) Magnesium metal is immersed in silver nitrate solution.

(ii) What is the oxidation number (charge) of the magnesium before the reaction? What is the oxidation number of the magnesium after the reaction?

(c) A solution of sodium sulfate is added to a solution of barium nitrate.

(ii) Identify the precipitate (the insoluble product) that forms in the reaction.

H_2O molecule



LiCl crystal

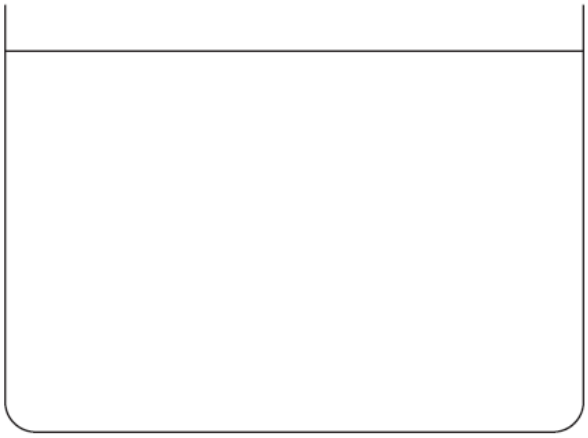
4. The structures of a water molecule and a crystal of $LiCl_{(s)}$ are represented above.
A student prepares a 1.0 M solution by dissolving 4.2 g of $LiCl_{(s)}$ in enough water to make 100 ml of solution.

In the space provided below, show the interactions of the components of $LiCl_{(aq)}$ by making a drawing the represents the different particles present in the solution.
Base the particles in your drawing on the particles shown in the representations above.

Include only one formula unit of LiCl and no more than ten molecules of water.

Your drawing must include the following details:

- Identity of ions (symbol and charge)
- the arrangement and proper orientation of the particles in the solution



$LiCl_{(aq)}$

DO NOT DETACH FROM BOOK.

PERIODIC TABLE OF THE ELEMENTS

1																	18
1 **H** 1.008	2											13	14	15	16	17	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											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** 24.30	3	4	5	6	7	8	9	10	11	12	13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	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** 65.38	31 **Ga** 69.72	32 **Ge** 72.63	33 **As** 74.92	34 **Se** 78.97	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** 95.95	43 **Tc** (97)	44 **Ru** 101.1	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 ***La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **†Ac** (227)	104 **Rf** (267)	105 **Db** (270)	106 **Sg** (271)	107 **Bh** (270)	108 **Hs** (277)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (282)	112 **Cn** (285)	113 **Uut** (285)	114 **Fl** (289)	115 **Uup** (288)	116 **Lv** (293)	117 **Uus** (294)	118 **Uuo** (294)

*Lanthanoid Series	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
†Actinoid Series	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

AP® CHEMISTRY EQUATIONS AND CONSTANTS

Throughout the exam the following symbols have the definitions specified unless otherwise noted.

L, mL	=	liter(s), milliliter(s)	mm Hg	=	millimeters of mercury
g	=	gram(s)	J, kJ	=	joule(s), kilojoule(s)
nm	=	nanometer(s)	V	=	volt(s)
atm	=	atmosphere(s)	mol	=	mole(s)

ATOMIC STRUCTURE

$E = h\nu$

$c = \lambda\nu$

E = energy
ν = frequency
λ = wavelength

Planck's constant, $h = 6.626 \times 10^{-34}$ J s
Speed of light, $c = 2.998 \times 10^{8}$ m s^{-1}
Avogadro's number = 6.022×10^{23} mol^{-1}
Electron charge, $e = -1.602 \times 10^{-19}$ coulomb

EQUILIBRIUM

$K_c = \dfrac{[C]^c[D]^d}{[A]^a[B]^b}$, where $a\,A + b\,B \rightleftarrows c\,C + d\,D$

$K_p = \dfrac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$

$K_a = \dfrac{[H^+][A^-]}{[HA]}$

$K_b = \dfrac{[OH^-][HB^+]}{[B]}$

$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$ at 25°C

$= K_a \times K_b$

$pH = -\log[H^+]$, $pOH = -\log[OH^-]$

$14 = pH + pOH$

$pH = pK_a + \log\dfrac{[A^-]}{[HA]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

Equilibrium Constants

K_c (molar concentrations)
K_p (gas pressures)
K_a (weak acid)
K_b (weak base)
K_w (water)

KINETICS

$\ln[A]_t - \ln[A]_0 = -kt$

$\dfrac{1}{[A]_t} - \dfrac{1}{[A]_0} = kt$

$t_{1/2} = \dfrac{0.693}{k}$

k = rate constant
t = time
$t_{1/2}$ = half-life

GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

$$P_A = P_{total} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{total} = P_A + P_B + P_C + \ldots$$

$$n = \frac{m}{M}$$

$$\text{K} = {}^\circ\text{C} + 273$$

$$D = \frac{m}{V}$$

$$KE \text{ per molecule} = \frac{1}{2}mv^2$$

Molarity, M = moles of solute per liter of solution

$$A = abc$$

P = pressure
V = volume
T = temperature
n = number of moles
m = mass
M = molar mass
D = density
KE = kinetic energy
v = velocity
A = absorbance
a = molar absorptivity
b = path length
c = concentration

Gas constant, R = 8.314 J mol^{-1} K^{-1}
= 0.08206 L atm mol^{-1} K^{-1}
= 62.36 L torr mol^{-1} K^{-1}

1 atm = 760 mm Hg = 760 torr

STP = 273.15 K and 1.0 atm

Ideal gas at STP = 22.4 L mol^{-1}

THERMODYNAMICS / ELECTROCHEMISTRY

$$q = mc\Delta T$$

$$\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$$

$$\Delta H^\circ = \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$
$$= -RT \ln K$$
$$= -nFE^\circ$$

$$I = \frac{q}{t}$$

q = heat
m = mass
c = specific heat capacity
T = temperature
S° = standard entropy
H° = standard enthalpy
G° = standard Gibbs free energy
n = number of moles
E° = standard reduction potential
I = current (amperes)
q = charge (coulombs)
t = time (seconds)

Faraday's constant, F = 96,485 coulombs per mole of electrons

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$