AP Chemistry Review Packet

Helpful Information

Use these slides, the internet, old notes, chemistry textbook, or the following websites to help you complete the summer packet!

Chemfiesta.org
Khanacademy.org
https://library.fiveable.me/ap-chem

Scientific Notation

- In scientific notation, a given number is written as the product of two numbers: a coefficient and 10 raised to a power.

  602,000,000,000,000,000,000,000 can be written as:

  $6.02 \text{ X } 10^{23}$

Scientific Notation

- In scientific notation, the coefficient is always a number greater than or equal to one and less than ten. The exponent is always an integer (positive or negative whole number).
- $6{,}300{,}000 = 6.3 \times 10^{6}$
- $94{,}700 = 9.47 \times 10^{4}$
- $.00736 = 7.36 \times 10^{-3}$

Significant Figures

- The **significant figures** in a measurement include all of the digits that are known, plus a last digit that is estimated.
- Measurements must always be reported to the correct number of significant figures because calculated answers often depend on the number of significant figures in the values used in the calculation.

Significant Figures

- Every **nonzero** digit is significant
  - 24.7 meters
  - 0.743 meter
  - 714 meters
- Each of these measurements has **three** significant figures

Significant Figures

- Zeros appearing between nonzero digits are significant
  - 7003 meters
  - 40.79 meters
  - 1.503 meters
- Each of these has **four** significant figures

Significant Figures

- Leftmost zeros appearing in front of nonzero digits are not significant. They act as placeholders.
  - 0.0071 meter
  - 0.42 meter
  - 0.0000099 meter
- Each of these has only **two** significant figures

Significant Figures

- Zeros at the end of a number **AND** to the right of a decimal point are always significant.
    - 43.00 meters
    - 1.010 meters
    - 9.000 meters
- Each of these has **four** significant figures

Significant Figures

- Zeros at the end of a measurement that lie to the left of a decimal point are **NOT** significant if they serve as placeholders to show the magnitude of the number.
  - 300 meters (1 sig fig)
  - 7000 meters (1 sig fig)
  - 27,210 meters (4 sig figs)
  - 300 meters = 3.00×10^2 meters (3 sig figs)

Significant Figures in Calculations

- Addition and Subtraction: the answer should be rounded to the same number of decimal places as the measurement with the least number of decimal places.

12.52 meters + 349.0 meters + 8.24 meters =

369.76 meters

369.8 meters

Significant Figures in Calculations

- Multiplication and Division: answer needs to be rounded to the same number of significant figures as the measurement with the least number of significant figures.

7.55 meters x 0.34 meter =

2.567 meters^2

2.6 meters^2

Rules for Naming Compounds

Ionic Compounds

*Always starts with a metal

1. Name the cation.
   a. Use the name from periodic table
   b. Transition Metals Only
      i. Use Roman Numerals to identify the charge.
      ii. Reverse criss-cross to determine the charge of the transition metal
2. Name the anion
   a. Monatomic Ions: use name from periodic table, ends in “ide”
   b. Polyatomic Ions: use name from common ions table. Do not change ending.

Examples:

$Pb_3(PO_4)_2$
Lead (II) Phosphate

Molecular Compounds

*Always starts with a nonmetal

1. Name each element.
2. Second element ends in “ide”
3. Use prefixes to identify how many atoms are present for each.
    a. Drop “mono” for the first element only.

Mono-1
Di-2
Tri-3
Tetra-4
Penta-5
Hexa-6
Hepta-7
Octa-8
Nona-9
Deca-10

Examples:

NCl_3
Nitrogen TriChloride

P_2O_5
Diphosphorus Pentoxide

Acids

*Always starts with H

Monatomic anions always end in "ide"

Use the following to convert anions to acid names:

- Ends in "ide" → Hydro________ic Acid
- Ends in "ite" → ________ous Acid
- Ends in "ate" → _______ic Acid

Examples:

HBr
Hydrobromic Acid

H_2SO_3
Sulfurous Acid

H3PO_4
Phosphoric Acid

Bases

* Always ends in OH

Named the same way as Ionic Compounds

Examples:

NaOH
Sodium Hydroxide

CuOH
Copper (I) Hydroxide

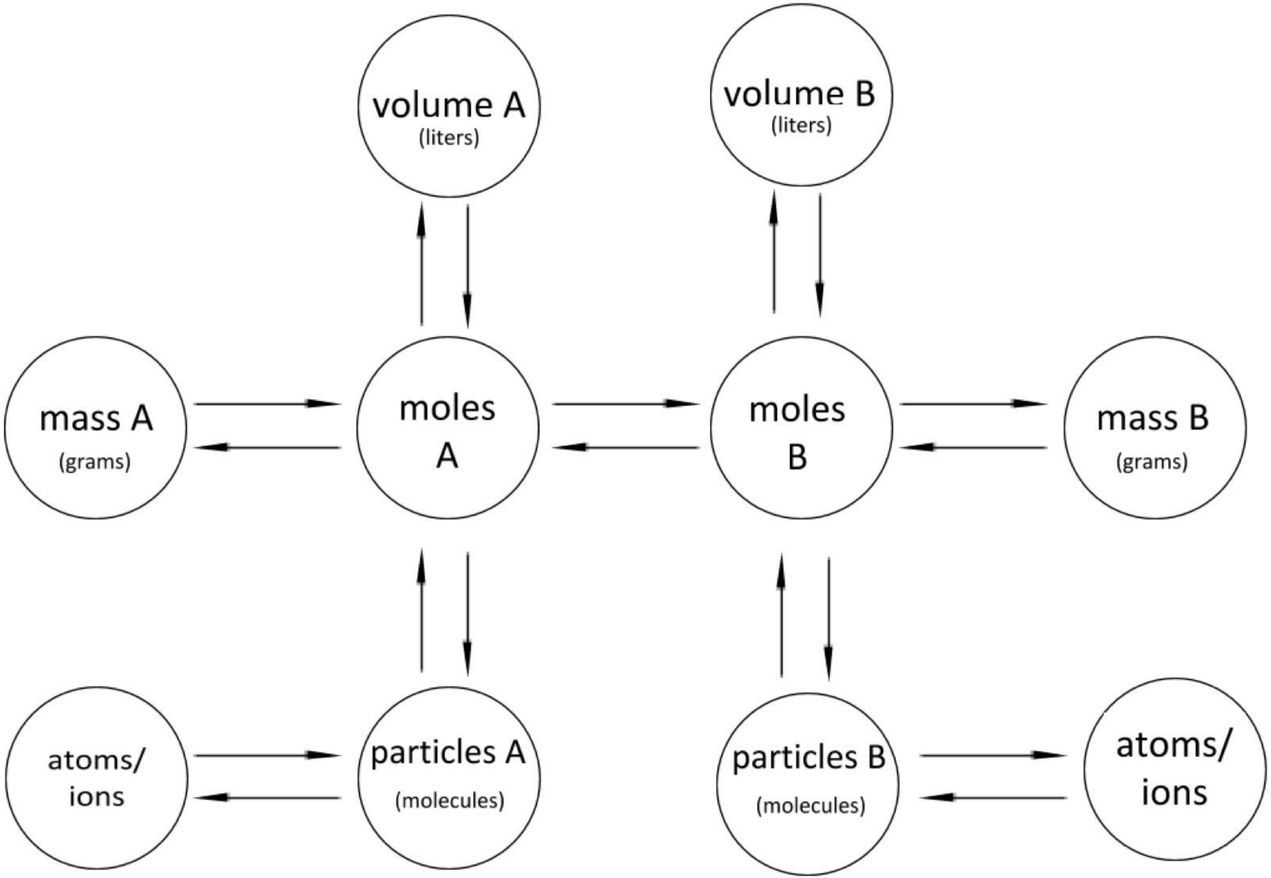
Moles & Stoichiometry

1 mole = 6.02×10^{23} particles

1 mole = molar mass

1 mole = 22.4 Liters gas @ STP

When converting from Moles A → Moles B
multiply by coefficient B/coefficient A


volume A
(liters)
volume B
(liters)
mass A
(grams)
moles
A
moles
B
mass B
(grams)
atoms/
ions
particles A
(molecules)
particles B
(molecules)
atoms/
ions

Atomic radius refers to the distance between the nucleus and the outer edge of the electron cloud. It is influenced by the nuclear pull and the number of energy levels.

Atomic radii decrease as atomic numbers increase in any given period	
DO	**DON'T**
Greater effective nuclear charge, Z_{eff}, increases the attractive force of the nucleus and therefore pulls the electron cloud closer to the nucleus resulting in a smaller atomic radius.	Don't simply stating that atomic radii decrease from left to right across a period. You will not earn points.

Atomic radii increase as atomic number increases down a column or group	
DO	**DON'T**
Increased number of energy levels (n) increases the distance over which the nucleus must attract and therefore reduces the attraction for electrons.	You must not simply saying that radii increase down a column. You will not earn points.
Full energy levels provide shielding between the nucleus and valence electrons, thus within a column, the effective nuclear charge, Z_{eff}, is somewhat constant.	Don't use shielding for explanations *across* a period. Only full energy levels, not full sublevels, are of concern in a shielding argument.

Ionic radius is the distance from the nucleus to the outer edge of the electron cloud in a charged ion. The same radii trends apply once you divide the table into the metal and non-metal sections. Within the metal section the positive ionic radii decrease from left to right with only minor changes in the transition metals. Once you get to the nonmetal section and the ions are now negative and larger they will again decrease in radii from left to right. Ionic radii increase going down all columns because of the additional energy levels present (*n*).

Positive ions are smaller than their respective neutral atoms	
DO	**DON'T**
Positive metal ions result from the loss of valence electrons. In many cases this means the outermost electrons are now in a smaller principal energy level (*n*) and are thus much closer than the electrons in original neutral atom.	Don't stop simply saying that the positive ion is smaller because it lost electrons. The mention of energy levels (*n*) is essential to earning the point on this type of question.
If the entire set of valence electrons are not removed, there will decreased electron/electron repulsions between the remaining electrons allowing the electron cloud to contract.	Don't neglect this important effect. This is especially useful when comparing ionic radii that do not involve a complete loss of a valence energy level.

Negative ions are larger than their respective neutral atoms	
DO	**DON'T**
Negative nonmetal ions result from the addition of valence electrons. Increased electron/electron repulsions also cause the electron cloud to expand.	Don't say that the ion is bigger simply because it has more electrons. Electron repulsions are a powerful force within the atom.

Ionization energy refers to the energy needed to remove an electron from a *gaseous* atom or ion, i.e. an isolated one, not part of a solid, liquid or a molecule. It is *always* endothermic.

Ionization energy increases as atomic number increases in any given period	
DO	**DON'T**
Greater effective nuclear charge, Z_{eff}, increases the attractive force of the nucleus and therefore holds the electrons more tightly.	Don't simply stating that ionization energy increases from left to right across a period. You will not earn points
Exceptions occur between groups II and III and V and VI.	Don't think that the trends are without anomalies.
1) A drop in IE occurs between groups II and III because the *p* electrons do not penetrate the nuclear region as greatly as *s* electrons do and are therefore not as tightly held.	1) Don't state that *p* electrons are farther away from the nucleus. You will not earn points.
2) A drop in IE occurs between groups V and VI because the increased repulsion created by the first pairing of electrons in the p-orbitals outweighs the increase in Z_{eff} and thus less energy is required to remove the electron.	2) Don't state that the atoms in group V are more stable because they have a half filled sublevel. This is wrong, wrong, wrong! You will not earn points.

Ionization energy decreases as atomic number increases down a column or group	
DO	**DON'T**
Increased number of energy levels (*n*) increases the distance over which the nucleus must pull and therefore reduces the Coulombic (electrostatic) attraction for electrons.	Don't simply saying that IE decreases down a column. You will not earn points.
Full energy levels provide shielding between the nucleus and valence electrons, thus within a column, the effective nuclear charge, Z_{eff}, is somewhat constant.	Don't use shielding for explanations across a period. Only full energy levels, not full sublevels, are of concern in a shielding argument. You will not earn points.

Electronegativity is an assigned property which indicates the attraction of an atom for the *pair* of outer shell electrons in a covalent bond with another atom. Electronegativity patterns are the same as electron affinity patterns for the same reasons. Both of these properties focus on the attraction that the nucleus has for electrons.

Electronegativity increases as atomic numbers increase in any given period	
DO	**DON'T**
Greater effective nuclear charge, Z_{eff}, increases the attractive force of the nucleus and therefore it strengthens the attraction for the electrons.	Don't simply state that electronegativity increases from left to right across a period. You will not earn points.

Electronegativity decreases as atomic number increases down a column or group	
DO	**DON'T**
Increased number of energy levels (*n*) increases the distance over which the nucleus must pull and therefore reduces the attraction for electrons.	Don't simply saying that electronegativity decreases down a column. You will not earn points.
Full energy levels provide shielding between the nucleus and valence electrons, thus within a column, the effective nuclear charge, Z_{eff}, is somewhat constant.	Don't use shielding for explanations across a period. Only full energy levels, not full sublevels, are of concern in a shielding argument. You will not earn points.

The seven diatomic molecules form a 7 on the periodic table, starting on atomic number 7, but that’s only 6 elements so that last one is atomic number 1

CHEM 101 B. HARKNESS

Periodic Table

1 IA																	18 VIIIA
1 H 1.008	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	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 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	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 (98)	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 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	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 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87	88	89	104	105	106	107	108	109									

5 Solubility Rules

1) All nitrates, hydrogen carbonates, acetates, and chlorates are soluble

2) All alkali metal and NH_4^+ compounds are soluble

3) All Cl^- are soluble <u>except</u> Ag^+, Hg_2^{2+}, and Pb^{2+}

4) All SO_4^{2-} are soluble <u>except</u> Ca^{2+}, Ba^{2+}, Sr^{2+}, and Pb^{2+}

5) Everything else is <u>Insoluble!</u>

The 8 Common Polyatomic Ions

acetate $C_2H_3O_2^{1-}$ (also written as CH_3COO^{1-})

ammonium NH_4^{1+}

carbonate CO_3^{2-}

chlorate ClO_3^{1-}

hydroxide OH^{1-}

nitrate NO_3^{1-}

phosphate PO_4^{3-}

sulfate SO_4^{2-}