

# AP Chem Unit 1 Test Review Key

(1)  $X + 3(F) = \text{total mass}$        $\frac{3(19.00)}{X + 3(19.00)} = 0.648$

$X = 30.96 \text{ amu}$   
**P**

(2)  $\frac{4(35.45)}{X + 4(35.45)} = 0.4063$

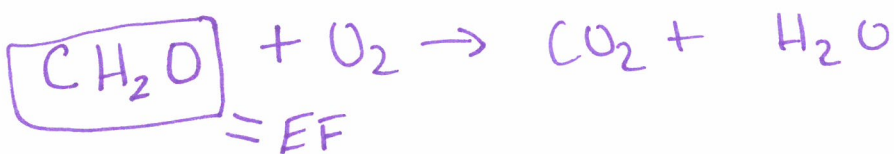
$X = 207.2 \text{ amu}$   
**Pb**

(3)  $\frac{0.3664 \text{ g CO}_2}{44.01 \text{ g}} \Big| \frac{1 \text{ mol CO}_2}{44.01 \text{ g}} = \frac{0.008325 \text{ mol}}{0.008325} = 1$

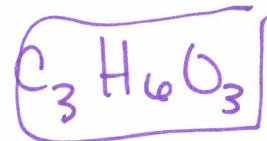
$\frac{0.1500 \text{ g H}_2\text{O}}{18.016 \text{ g}} \Big| \frac{1 \text{ mol H}_2\text{O}}{18.016 \text{ g}} = \frac{0.008326 \text{ mol}}{0.008325} = 1$

$\frac{0.2664 \text{ g O}_2}{32 \text{ g}} \Big| \frac{1 \text{ mol O}_2}{32 \text{ g}} = \frac{0.008325 \text{ mol}}{0.008325} = 1$

coeff. method



$n = \frac{90.08}{30.026} = 3$



## Element Method

$$\frac{0.3664 \text{ g CO}_2}{44.01} = \frac{0.09998 \text{ g C}}{12.01 \text{ g}} = \frac{0.008327 \text{ mol}}{0.008325} \quad (=1)$$

$$\frac{0.1500 \text{ g H}_2\text{O}}{18.016} = \frac{0.01679 \text{ g H}}{1.008 \text{ g}} = \frac{0.01656 \text{ mol}}{0.008325} \quad (=2)$$

$$0.2500 \text{ g} - (0.09998 \text{ g C} + 0.01679 \text{ g H}) = \frac{0.1332 \text{ g O}}{16.00 \text{ g}} = \frac{0.008325 \text{ mol}}{0.008325} \quad (=1)$$



$$\frac{90.08}{30.026} = 3$$



(4) Element 2 b/c the increase from IE-1 to IE-2 is the largest increase of the 4 elements indicating after  $\Delta e^-$  (V. Electron) is removed the next electron is part of a complete energy level. Therefore Element 2 has 1 Valence Electron + would be part of the alkali metals w/ have more metallic character

(b) Mg b/c the ionization energy shows a large increase between the 2<sup>nd</sup> + 3<sup>rd</sup> I.E. indicating the 3<sup>rd</sup> electron is part of a complete energy level. Therefore there are 2 valence electrons making the element part of group 2 + in period 3 that is Mg.



(d) +1

(e) Na

(f) Element 1 b/c 1<sup>st</sup> IE is highest indicating a stronger Coulombic force (pull) towards the nucleus.

(5) (a)  $1s^2 2s^2 2p^6 3s^2 = \text{Mg}$       $1s^2 2s^2 2p^6 3s^2 3p^6 = \text{Ar}$

(b) Ar is a smaller atom which means the force between the electrons + nucleus are stronger; however, Mg 3<sup>rd</sup> electron would be part of a full energy level + Ar's 3<sup>rd</sup> electron would not be part of a full energy level. Ar's 1<sup>st</sup> electron is part of a full energy level providing a 2<sup>nd</sup> reason for why its ~~IE~~ <sup>IE<sub>2</sub></sup> is higher than Mg's 1<sup>st</sup> IE.

(c) Since Mg's IE shows a significant increase b/c IE<sub>2</sub> + IE<sub>3</sub> this indicates that the 3<sup>rd</sup> electron would be part of a complete energy level. Therefore there are 2 valence electrons in Mg which means it would form a +2 ~~when~~ charge when the 2 VE are lost.



b) a) the radius increases b/c more electron energy levels are added as the atomic # increases within a group.

b)  $\text{Cl}^-$  has 1 more electron than Cl but the same # of protons meaning the nuclear charge is the same therefore when 1 more  $e^-$  is added it has more repulsive forces than attractive forces making the radius expand.

c) Mg has a full s subshell which requires more energy to remove the electron than the 1  $e^-$  that Al has in the p subshell.

d) The 3<sup>rd</sup> electron is part of a full energy level.

7) i b/c it is the largest atom w/ 5 energy levels

8) iv b/c it has a full energy level + the smallest # of energy levels

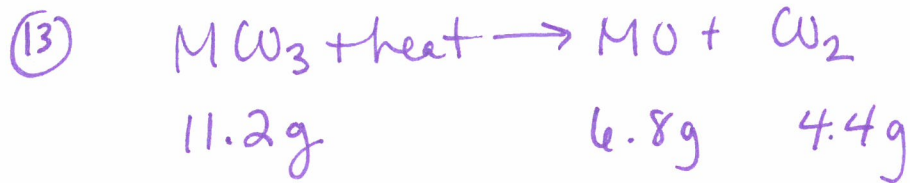
9) iv

10) iv

11) ii

12) ii

VE =  $e^-$  in outmost (highest) energy level  
b/c needs to gain 1 more  $e^-$  to have a full energy level.

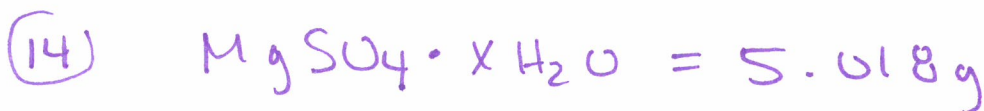


$$\frac{11.2 \text{ g } MCO_3}{x + 12.01 + 3(16)} \Bigg| \frac{1 \text{ mol } MCO_3}{1 \text{ mol } MCO_3} \Bigg| \frac{1 \text{ mol } CO_2}{1 \text{ mol } CO_2} \Bigg| \frac{44.01 \text{ g } CO_2}{44.01 \text{ g } CO_2} = \frac{4.4 \text{ g}}{4.4 \text{ g}}$$

$$\frac{492.912}{x + 60} = 4.4$$

$$x = 52 \text{ g/mol}$$

Cr

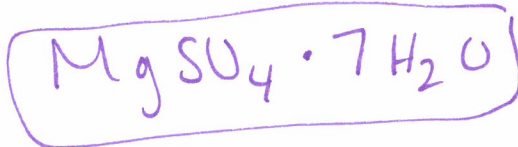


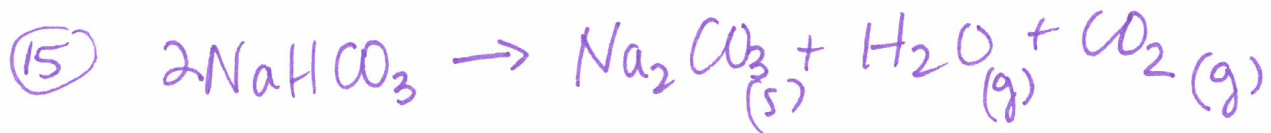
$$MgSO_4 = \underline{2.449 \text{ g}}$$

$$H_2O = 2.569 \text{ g}$$

$$\frac{2.449 \text{ g } MgSO_4}{120.38 \text{ g}} \Bigg| \frac{1 \text{ mol}}{1 \text{ mol}} = \frac{0.02034 \text{ mol}}{0.02034} = 1$$

$$\frac{2.569 \text{ g } H_2O}{18.016 \text{ g}} \Bigg| \frac{1 \text{ mol}}{1 \text{ mol}} = \frac{0.142595 \text{ mol}}{0.02034} = 7$$





$$2.0 \text{ g} - 1.8 \text{ g} = 0.2 \text{ g H}_2\text{O} + \text{CO}_2 \text{ escaped}$$

$$\frac{(18.016 \text{ g} + 44.01 \text{ g})}{2(84.008)} = \frac{0.2 \text{ g}}{x}$$

$$x = 0.54 \text{ g NaHCO}_3$$

$$\frac{0.54 \text{ g} \times 100}{2.0 \text{ g}} =$$

27% NaHCO <sub>3</sub>
73% Na <sub>2</sub> CO <sub>3</sub>

(OR)

0.2 g H <sub>2</sub> O + CO <sub>2</sub>	1 mol mix 18.016 + 44.01 g	2 mol NaHCO <sub>3</sub> 1 mol mix	84.008 g = 1 mol
			(0.54 g)

16) a)  $p = 11$   $n = 12$   $e = 11$

b)  $p = 9$   $n = 10$   $e = 9$

c)  $p = 26$   $n = 30$   $e = 26$

d)  $p = 14$   $n = 14$   $e = 14$

e)  $p = 23$   $n = 28$   $e = 23$

17) Read p. 327-332; p. 353-354

18 + 19

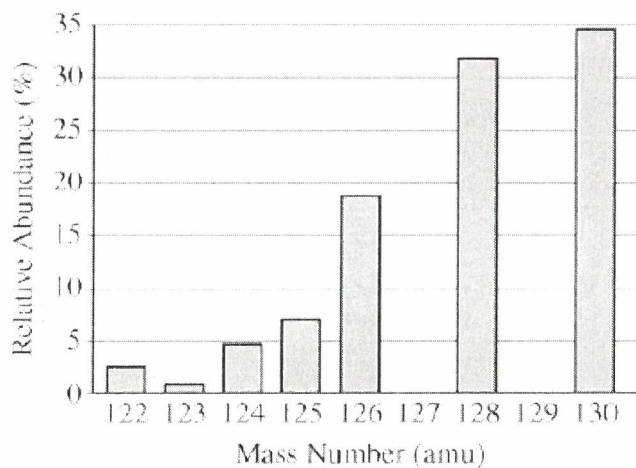
\* Not going to write them all but  
you can find them on the internet  
to check yourself.



PES & Atomic Sample AP Problems from Recent AP (& Mock) Exams

2014 Released & Mock AP Exam

3. Which of the following correctly identifies which has the higher first-ionization energy, Cl or Ar, and supplies the best justification?
- (A) Cl, because of its higher electronegativity
  - (B) Cl, because of its higher electron affinity
  - (C) Ar, because of its completely filled valence shell
  - (D) Ar, because of its higher effective nuclear charge



10. The elements I and Te have similar average atomic masses. A sample that was believed to be a mixture of I and Te was run through a mass spectrometer, resulting in the data above. All of the following statements are true. Which one would be the best basis for concluding that the sample was pure Te?
- (A) Te forms ions with a  $-2$  charge, whereas I forms ions with a  $-1$  charge.
  - (B) Te is more abundant than I in the universe.
  - (C) I consists of only one naturally occurring isotope with 74 neutrons, whereas Te has more than one isotope.
  - (D) I has a higher first ionization energy than Te does.

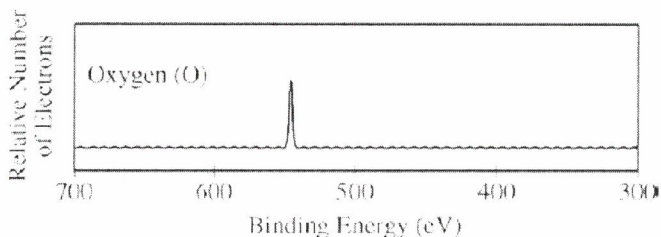
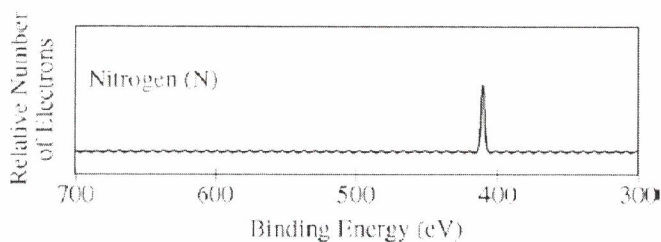
Element	Atomic Radius	First Ionization Energy
Calcium	194 pm	590 kJ/mol
Potassium	<i>larger</i>	<i>smaller</i>

58. Based on periodic trends and the data in the table above, which of the following are the most probable values of the atomic radius and the first ionization energy for potassium, respectively?
- (A) 242 pm, 633 kJ/mol
  - (B) 242 pm, 419 kJ/mol
  - (C) 120 pm, 633 kJ/mol
  - (D) 120 pm, 419 kJ/mol

Element	First Ionization Energy (kJ/mol)	Atomic Radius (pm)
B	801	85
C	1086	77
N	1400	75
O	1314	73
F	1680	72
Ne	2080	70

12. The table above shows the first ionization energy and atomic radius of several elements. Which of the following best helps to explain the deviation of the first ionization energy of oxygen from the overall trend?
- (A) The atomic radius of oxygen is greater than the atomic radius of fluorine.
  - (B) The atomic radius of oxygen is less than the atomic radius of nitrogen.
  - (C) There is repulsion between paired electrons in oxygen's  $2p$  orbitals.
  - (D) There is attraction between paired electrons in oxygen's  $2p$  orbitals.





43. The photoelectron spectra above show the energy required to remove a  $1s$  electron from a nitrogen atom and from an oxygen atom. Which of the following statements best accounts for the peak in the upper spectrum being to the right of the peak in the lower spectrum?

- (A) Nitrogen atoms have a half-filled  $p$  subshell.
- (B) There are more electron-electron repulsions in oxygen atoms than in nitrogen atoms.
- (C) Electrons in the  $p$  subshell of oxygen atoms provide more shielding than electrons in the  $p$  subshell of nitrogen atoms.
- (D) Nitrogen atoms have a smaller nuclear charge than oxygen atoms.

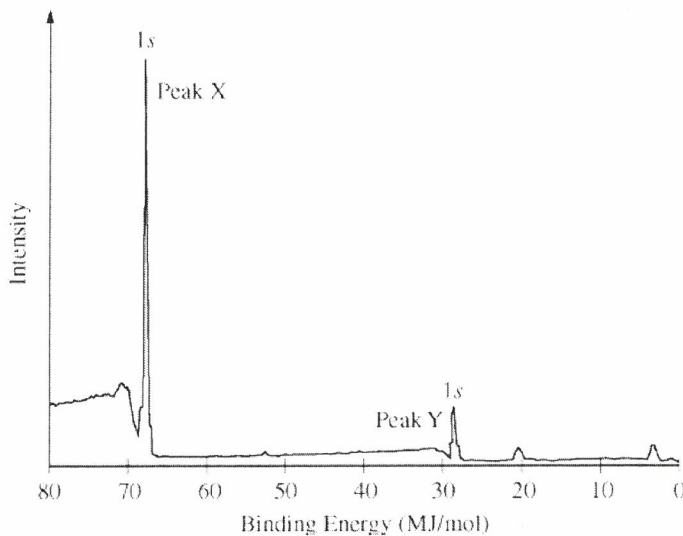
	NaF	MgO
Boiling Point ( $^{\circ}\text{C}$ )	1695	3600

	$\text{Na}^+$	$\text{Mg}^{2+}$	$\text{F}^-$	$\text{Cl}^-$	$\text{O}^{2-}$
Ionic Radius (pm)	76	72	133	181	140

54. Based on the data in the tables above, which of the following statements provides the best prediction for the boiling point of NaCl?

- (A) NaCl will have a lower boiling point than NaF because the coulombic attractions are weaker in NaCl than in NaF.
- (B) NaCl will have a boiling point between that of NaF and MgO because the covalent character of the bonds in NaCl is intermediate between that of MgO and NaF.
- (C) NaCl will have a higher boiling point than MgO because the ions are spaced farther apart in NaCl.
- (D) NaCl will have a higher boiling point than MgO because the energy required to transfer electrons from the anion to the cation is larger in NaCl than in MgO.

*larger radius = weaker coulombic attractions due to more  $e^-$  shielding + being further away from nucleus*



31. A sample containing atoms of C and F was analyzed using x-ray photoelectron spectroscopy. The portion of the spectrum showing the  $1s$  peaks for atoms of the two elements is shown above. Which of the following correctly identifies the  $1s$  peak for the F atoms and provides an appropriate explanation?

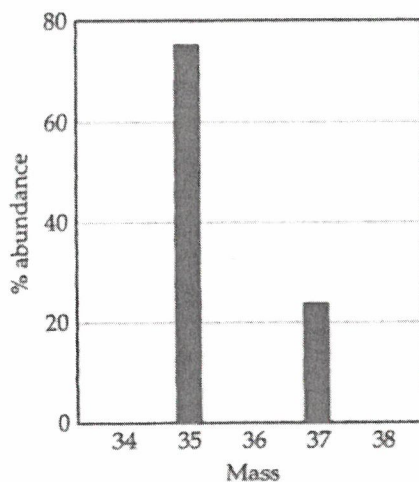
- (A) Peak X, because F has a smaller first ionization energy than C has.
- (B) Peak X, because F has a greater nuclear charge than C has.
- (C) Peak Y, because F is more electronegative than C is.
- (D) Peak Y, because F has a smaller atomic radius than C has.

## Isotopes and Mass Spectrometry Multiple Choice and FRQ Practice

### Multiple Choice: (1 point each)

1. b Bromine has two major isotopes giving it an atomic mass of 79.904 amu. Based on this information, which of the following statements can explain the atomic mass value?
- The isotope Bromine-81 is more common than Bromine-79
  - b Bromine-79 and Bromine-81 exist in approximately equal proportions.
  - Bromine-78 is about twice as abundant as Bromine-81.
  - The two major isotopes of Bromine have 45 and 46 neutrons
2. d Which is true of the  $^{243}\text{Am}^{3+}$  ion?
- 148 protons, 148 electrons, 243 neutrons
  - 95 protons, 98 electrons, 243 neutrons
  - 95 protons, 95 electrons, 148 neutrons
  - d 95 protons, 92 electrons, 148 neutrons

Use the following information to answer questions 3-8. The mass spectrum of a natural abundance of chlorine atoms is shown in the figure. Detailed analysis shows that the two stable isotopes of chlorine have masses of 34.969 amu and 36.966 amu.



3. c What are the mass numbers of the two isotopes of chlorine?
- 34.969 amu and 36.966 amu
  - 34 and 36
  - c 35 and 37
  - 17 and 17
4. d What is the approximate % abundance of the lighter isotope?
- 20
  - 25
  - d 75
  - 50

5. c How many types of molecules with different masses exist in a sample of chlorine gas if the sample exists entirely as diatomic molecules?
- a. 1  
b. 2  
c. 3  
d. 4
6. a What is the approximate mass of the most abundant naturally occurring  $\text{Cl}_2$  molecule?
- a. 70  
b. 71  
c. 72  
d. 74
7. d How many neutrons does the less abundant chlorine atom have?
- a. 17  
b. 18  
c. 19  
d. 20
8. a Why are the individual masses of the two isotopes not integers?
- a. Atomic mass of an element is the average mass of all isotopes  
b. The masses of a proton and a neutron are not integers  
c. Atomic mass of an element is the sum of the number of protons and neutrons in an atom  
d. Mass number of an element is the average mass of all isotopes
9. c A compound whose empirical formula is  $\text{C}_2\text{H}_4\text{O}$  has a molar mass that lies between 100 and 150 g/mol. What is the molecular formula of the compound?
- a.  $\text{C}_2\text{H}_4\text{O}$   
b.  $\text{C}_4\text{H}_8\text{O}_2$   
c.  $\text{C}_6\text{H}_{12}\text{O}_3$   
d.  $\text{C}_8\text{H}_{16}\text{O}_4$
10. a Find the empirical formula for a compound only one element of which is a metal. The compound's percentage composition by mass is 40.0% metal, 12.0% C, and 48% O.
- a.  $\text{CaCO}_3$   
b.  $\text{Na}_2\text{CO}_3$   
c.  $\text{NaHCO}_3$   
d.  $\text{Al}_2(\text{CO}_3)_3$

M/C Total ____/10
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## Free Response:

1. a. One isotope of sodium has a relative mass of 23 amu.
- i. Define, in terms of the fundamental particles present, the meaning of the term isotopes. (2 points)
- ii. Explain why isotopes of the same element have the same chemical properties. (1 point)
- iii. Calculate the mass, in grams, of a single atom of this isotope of sodium. (2 points)

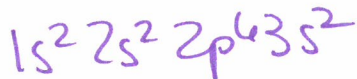
atoms of the same element with different  
# of neutrons

same # p + e

$$\frac{1 \text{ atom Na} / 1 \text{ mol Na}}{6.02 \times 10^{23} \text{ atoms}} \left| \frac{23 \text{ g Na}}{1 \text{ mol Na}} \right. = 4 \times 10^{-23} \text{ g}$$



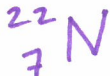
- b. Provide the electron configuration for a sodium atom, include all sublevels. (1 point)



- c. Explain why chromium is placed in the d block of the periodic table. (1 point)

it has 4 electrons in the d sublevel + has properties similar to the other transition metals

- d. An atom has half as many protons as an atom of  $^{28}\text{Si}$  and also has six fewer neutrons than an atom of  $^{28}\text{Si}$ . Provide the symbol notation for this isotope. (2 points)



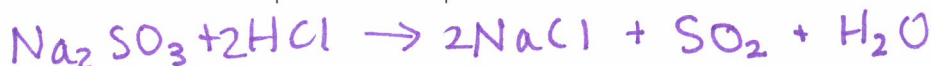
2. Analysis by mass spectrometry shows that a compound contains 36.5% of sodium and 25.5% sulfur by mass. The remaining mass is due to oxygen.

- a. Use this information to determine the empirical formula of the compound. (Hint: Assume 100g of the compound.) (3 points)

$$\begin{aligned} \frac{36.5 \text{ g Na}}{22.99 \text{ g/mol}} &= 1.59 / 0.795 = 2 \\ \frac{25.5 \text{ g S}}{32.07 \text{ g/mol}} &= 0.795 / 0.795 = 1 \\ \frac{38.0 \text{ g O}}{16 \text{ g/mol}} &= 2.375 / 0.795 = 3 \end{aligned}$$



- b. The molecule from part (a) is treated with excess hydrochloric acid. In a double replacement reaction, aqueous sodium chloride is formed and sulfur dioxide gas is evolved. Write an equation to represent this reaction. (Hint: Sulfur dioxide gas is created from an unstable product and there are 3 total products.) (1 point)



\* will not be on the test \*

3. Use the information provided for multiple choice questions 3-8 to answer the following:

- a. Calculate the mass of the chlorine molecule having the largest molecular mass. (2 points)

$$2(37) = 74 \text{ g/mol}$$

- b. Calculate the % abundance of the more abundant chlorine isotope. (2 points)

$$x(35) + y(37) = 35.453$$

$$x + y = 1$$

$$x = 1 - y$$

- c. Like chlorine, iodine is a halogen and forms similar polyatomic ions. Write the names and formulas of the 4 oxyanions and 4 oxyacids of iodine. (3 points)

$$1 - y(35) + 37y = 35.453$$

$$35 - 35y + 37y = 35.453$$

$$35 + 2y = 35.453$$

$$2y = 0.453$$

$$y = 0.2265$$

$$x = 1 - 0.2265 = 0.7735 \times 100$$

FRQ Total      / 20

77%