AP Chemistry
Final Exam Review

Group members _____ Key

Directions: Work together with your group to answer each of the following questions.

1. A sample of a pure compound was found to contain 1.201 grams of carbon, 0.202 grams of hydrogen, and 7.090 grams of chlorine. What is the empirical formula of the compound?

$1.201\,g\,C \left| \frac{mol}{12\,g} \right| = .100\,mol / .100 = 1$

$.0202\,g\,H \left| \frac{mol}{1\,g\,H} \right| = .200\,mol / .100 = 2$ =

$C H_2 Cl_2$

$7.09\,g\,Cl \left| \frac{mol\ Cl}{35.45\,g\ Cl} \right| = .200\,mol / .100 = 2$

2. A freshmen chemist analyzed a sample of copper (II) sulfate pentahydrate for water of hydration by weighing the hydrate, heating it to convert it to anhydrous copper (II) sulfate, and then weighing the anhydride. The % water was determined to be 30 %. The theoretical value was 33%. Which of the following choices is definitely NOT the cause of the ~~error?~~ exp yield

a) After the student weighed the hydrate, a piece of rust fell from the tongs into the crucible.
b) Moisture driven from the hydrate condensed on the inside of the crucible cover before the student weighed the anhydride.
c) The original sample contained some anhydrous copper (II) sulfate.
d) The original sample was wet.

↳ only one makes greater

$\%\,H_2O = \frac{mass\ H_2O}{mass\ hydrate} \times 100 = \frac{mass\ hydrate - mass\ anhydrate}{mass\ hydrate}$ (added mass)

3. Given the following information:

Reaction 1:	$H_2(g) + 1/2\ O_2(g) \rightarrow H_2O(l)$	$\Delta H^o = -286$ kJ
Reaction 2:	$CO_2(g) \rightarrow C(s) + O_2(g)$	$\Delta H^o = 394$ kJ
Reaction 3:	$2CO_2(g) + H_2O(l) \rightarrow C_2H_2(g) + 5/2\ O_2(g)$	$\Delta H^o = 1300$ kJ

Find the ΔH^o for the reaction $C_2H_2(g) \rightarrow 2C(s) + H_2(g)$

$H_2O(l) \rightarrow H_2(g) + \frac{1}{2}O_2$ $\Delta H = +286$ kJ

$2CO_2 \rightarrow 2C + 2O_2$ $\Delta H = 788$ kJ

$C_2H_2 + \frac{5}{2}O_2 \rightarrow 2CO_2 + H_2O$ $\Delta H = -1300$ kJ

$\Delta H = -226$ kJ

4. The combustion of carbon monoxide yields carbon dioxide. Calculate the volume of oxygen gas (in liters) needed to produce 22 grams of carbon dioxide at STP.

$$2CO + O_2 \rightarrow 2CO_2$$

$$\frac{22g\,CO_2 \mid 1\,mol\,CO_2 \mid 1\,mol\,O_2 \mid 22.4L}{44g\,CO_2 \mid 2\,mol\,CO_2 \mid 1\,mol\,O_2} = 5.6L$$

A 5. For a substance that remains a gas under the ideal conditions listed, deviation from the ideal gas law would be most pronounced at . . .

a) -100°C and 5.0 atm
b) -100°C and 1.0 atm
c) 0°C and 1.0 atm
d) 100°C and 1.0 atm
e) 100°C and 5.0 atm

High P + Low temp!

E 6. 100 grams of O_2(g) and 100 grams of He(g) are in separate containers of equal volume. Both gases are at 100°C. Which of the following statement(s) is/are true?

a) Both gases have the same pressure.
b) The average kinetic energy of the O_2 molecules is greater than that of the He molecules.
c) The average kinetic energy of the He molecules is greater than that of theO_2 molecules.
d) There are equal numbers of He molecules and O_2 molecules.
e) The pressure of the He(g) would be greater than the O_2(g).

C 7. Which of the following series of elements is listed in order of increasing atomic radius?

a) Na, Mg, Al, Si
b) C, N, O, F
c) O, S, Se, Te
d) I, Br, Cl, F
e) K, Kr, O, Au

D 8. Which one of the following would have an answer with three significant digits?

a) 103.1 + 0.0024 + 0.16
b) $(3.0 \times 10^4)(5.022 \times 10^{-3})/(6.112 \times 10^2)$
c) $(4.3 \times 10^5)/(4.225 + 56.0003 - 0.8700)$
d) $(1.43 \times 10^3 + 3.1 \times 10^1)/(4.11 \times 10^{-6})$
e) $(1.41 \times 10^2 + 1.012 \times 10^4)/(3.2 \times 10^{-1})$

31
1430
1461

B 9. Which of the following elements most readily shows the photoelectric effect?

a) Noble gases
b) Alkali metals
c) Halogen elements
d) Transition metals
e) The chalcogen family

10. The four quantum numbers (n, l, m_l, m_s) that describe the valence e- in the Cs atom are:

a) 6, 0, -1, +1/2
b) 6, 1, 1, +1/2
c) 6, 0, 0, +1/2
d) 6, 1, 0, +1/2
e) 6, 0, 1, -1/2

6S

11. A piece of metal weighing 500. grams is put into a boiling water bath. After 10 minutes, the metal is immediately placed in 250. grams of water at 40.°C. The maximum temperature that the system reaches is 50.°C. What is the specific heat of the metal? (The C_p of water is 4.184 J/g-°C)

$g_{lost\ metal} = g_{gained\ by\ H_2O}$

$m C \Delta t = (250g)(4.184)(10°C) = 10,460J = (500g)(C)(100-5$

B 12. When subjected to the flame test, a solution that contains K^+ ions produces the color _____.

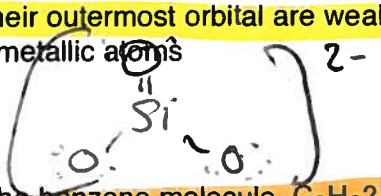
a) yellow
b) violet
c) crimson
d) green
e) orange
f) white

$C_{mol} = 0.4184 \frac{J}{g°C}$

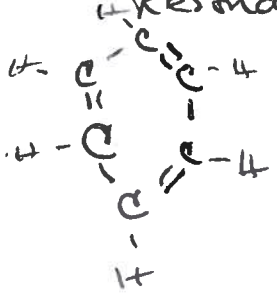
D 13. A characteristic of the structure of metallic atoms is that

a) they tend to share their electrons with other atoms.
b) their atoms are smaller and more compact than those of nonmetallic elements.
c) their outermost orbital of electrons is nearly complete, and they attract electrons from other atoms
d) the small number of electrons in their outermost orbital are weakly held and easily lost
e) they have heavier nuclei than nonmetallic atoms

14. What is the geometry of SiO_3^{2-}?



Trigonal Planar
Resonance

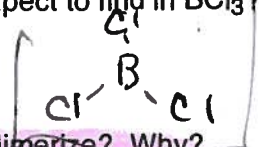


15. How many total sigma bonds are in the benzene molecule, C_6H_6?

12 sigma ; 3 π

16. What type of hybridization would you expect to find in BCl_3?

sp^2



17. Which of the following is most likely to dimerize? Why?

ClO_2^-, Cl_2O, ClO_2

it has an odd # of electrons!

D 18. As the atomic number of the elements increases down a column,

a) the atomic radius decreases
b) the atomic mass decreases
c) the elements become less metallic
d) ionization energy decreases
e) the number of electrons in the outermost energy level increases

D 19. What ions would you find in solution if potassium perchlorate was dissolved in water?

a) KCl, O_2
b) K^+, Cl^-, O^{2-}
c) KCl, O^{2-}
d) K^+, ClO_4^-
e) K^+, Cl^-, O^{2-}

$CaCO_3 \rightarrow CaO + CO_2$

20. A test tube containing $CaCO_3$ is heated until all of the compound decomposes. If the test tube plus the calcium carbonate originally weighed 30.08 grams and the loss of mass during the experiment was 4.400 grams, what was the mass of the empty test tube?

test tube + $CaCO_3$ = 30.08 g

CO_2 = 4.400 g

test tube + CaO = 25.68 g

4.400 g CO_2 | mol CO_2 / 44 g CO_2 | mol $CaCO_3$ / mol CO_2 | 100.1 g / mol $CaCO_3$ = 10.1 g $CaCO_3$

30.08 g − 10.1 g = 20.0 g test tube

21. How many pi bonds are each of the following? CO_2, H_2O, SO_2, N_2

$\ddot{O}=C=\ddot{O}$ (2) H_2O (0) SO_2 (1) $N\equiv N$ (2)

22. Write a set of 4 quantum numbers for the highest energy valence electron in a ground state aluminum atom.

$3s^2 3p^1$

n l m_l m_s

3 1 −1, 0, 1 −½ or ½

s p d f

0 1 2 3

23. Rank the following molecules in order of strongest intermolecular forces to weakest intermolecular forces: H_2, N_2, CO_2, NH_3

Strongest → Weakest

$NH_3 > CO_2 > N_2 > H_2$

24. $S(s) + O_2(g) \dashrightarrow SO_2(g)$ $\Delta H^o = x$

$S(s) + 3/2\ O_2(g) \dashrightarrow SO_3(g)$ $\Delta H^o = y$

Based upon the information above, what is the standard enthalpy change for the following reaction in terms of x and y?

$2\ SO_2(g) + O_2(g) \dashrightarrow 2\ SO_3(g)$

$2(SO_2 \rightarrow S + O_2 \quad \Delta H = -x)$

$+\ 2(S + 3/2\ O_2 \rightarrow SO_3 \quad \Delta H = y)$

$-2x + 2y = \Delta H$

25. How much water must be added to a 50.0 mL solution of 6.0 M HNO_3 in order to produce a 0.40 M solution of HNO_3?

$M_1V_1 = M_2V_2$

$(50.0\text{mL})(6.0\text{M}\ HNO_3) = (.40\text{M})\ x$

$x = 750\text{ mL}$

So you need to add 700 mL H_2O

26. Which of the following can be determined directly from the difference between the boiling point of a pure solvent and the boiling point of a solution of a nonionic solute in the solvent if k_b for the solvent is known?

I. The mass of the solute in solution.
II. The molality of the solution.
III. The volume of the solution.

$\Delta T = k_b m$

a) I only b) II only c) III only d) I and II only e) I and III only

27. A boiling water bath is sometimes used instead of a flame in heating objects. Which of the following could be an advantage of a boiling water bath over a flame?
a) The relatively low heat capacity of water will cause the object to more hot quickly.
b) The relatively high density of water will cause the object to become more hot quickly.
c) The volume of the boiling water remains constant over time.
d) The temperature of the boiling water remains constant.
e) The vapor pressure of the boiling water is equal to zero.

28. Why would it be impossible to effectively separate the gases N_2 and C_2H_4 by the effusion process?

Since N_2 & C_2H_4 Both have the same MM
And since effusion Rates are indirectly propotional
to the MM No way to seperate

29. $H_2(g) + Cl_2(g) \text{------>} 2\,HCl(g)$
Based upon the information given in the table below, what is the ΔH^o for the above reaction?

Bond	bond energy (kJ/mol)
H-H	440
Cl-Cl	240
H-Cl	430

$\Delta H = \sum$ Bonds Broken $- \sum$ bonds formed
$= (440 + 240) - [(2)\,430]$
$= -180$ KJ/mol

30. How many grams of silver chloride would be formed if you mixed 0.500 L of 0.200 M HCl and 0.500 L of 0.400 M silver nitrate?

$HCl + AgNO_3 \rightarrow AgCl + HNO_3$
.10 mol   .200 mol
↑ L.R

.100 mol HCl | mol AgCl / 1 mol HCl | 107.8 + 35.45 / mol AgCl = 14.3g AgCl

31. Dimethylhydrazine, the fuel used in the Apollo lunar descent module, has a molar mass of 60.10 g/mole. It is made up of carbon, hydrogen and nitrogen atoms. The combustion of 2.859 g of the fuel in excess oxygen yields 4.190 g. carbon dioxide and 3.428 g. of water with nitrogen has also being produced. Knowing this determine the following:

A. What are the empirical and molecular formulas of dimethylhydrazine?

$O_2 + C_\square H_\square N_\square \rightarrow H_2O + N_2 + CO_2$
2.859g   3.428g   4.190g

Mass of C = 4.190g CO_2 | 12g C / 44g CO_2 = 1.143g C (+1) | mol / 12.0g C = .095 mol C / .095 = 1

Mass of H = 3.428 g H_2O | 2g H / 18g H_2O = .3809g H (+1) | mol H / 1g H = .3809/.095 = 4

process?

Since N_2 & C_2H_4 Both have the same MM
And since effusion Rates are indirectly proportional
to the MM No way to separate

29. $H_2(g)$ + $Cl_2(g)$ ------> 2 HCl(g)

Based upon the information given in the table below, what is the ΔH^o for the above reaction?

Bond	bond energy (kJ/mol)
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HCl + $AgNO_3$ → AgCl + HNO_3
.100 mol / .200 mol ↑ L.R

.100 mol HCl | mol AgCl / 1 mol HCl | 107.8 + 35.45 / mol AgCl = 14.3 g AgCl

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2.859 g, 3.428 g, 4.190 g

Mass of C = 4.190 g CO_2 | 12 g C / 44 g CO_2 = 1.143 g C (+1) | mol / 12.0 g C = .095 mol C / .095 = (1)

Mass of H = 3.428 g H_2O | 2 g H / 18 g H_2O = .3809 g H (+1) | mol H / 1 g H = .3809 / .095 = (4)

Mass of N = 2.859 g − (1.143 g C + 0.3809 g H) = 1.335 g N (+1) | mol / 14 g N = .095 / .095 (1)

E.F = CH$_4$N (+2)

$\frac{MM}{EM} = \frac{60 g}{30 g} = 2$ so MF = $C_2H_8N_2$ (+1)