APPROVED SOLUTION

CADET _____ SECTION/HR _____ TIME OF DEPARTURE _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101/151, AY10-1
Written Partial Review I
16 September 2009
55 minutes

TEXT: Silberberg, Chemistry: The Molecular Nature of Matter and Change, 5th Edition
SCOPE: Lessons 1-10

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
Chemistry Reference Data Cards, 5th Edition
Pencil and Eraser

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. ANSWER ALL QUESTIONS. **SHOW ALL WORK**.

3. There are 5 numbered pages in this writ. Report any illegible or missing pages to the OIC in the hallway. Write your name on every page in the spaces provided.

(TOTAL WEIGHT 200 POINTS)

DO NOT WRITE IN THIS SPACE			
PROBLEM	MAX SCORE	CUT	POINTS
A	50		
B	35		
			/85
C	40		
D	50		
E	25		
			/115
		TOTAL SCORE	/200

APPROVED SOLUTION

Problem	Weight
A	50

Cadet _____

1. (20 pts) Complete the following table by writing the correct amounts of each subatomic particle for the following isotopes and writing the isotope (including mass number and atomic number) for the specified species:

Isotope	Protons (p^+)	Neutrons (n^0)	Electrons (e^-)	Period #	Group #	Group Name
$^{88}_{38}Sr$	**38**	**50**	**38**	**5**	**2A (2)**	**Alkaline Earth Metals**
$^{78}_{34}Se$	**34**	44	**34**	4	6A (16)	Chalcogen

2. Circle the best choice from each selection to complete the following sentence:

a. (4 pts) For an element from Group 7A of the Periodic Table, the most common monatomic ion has a charge of (**-7** / **-1** / **+1** / **+7**), and its group name is (**Noble Gases** / **Earth Metals** / **Halogens**).

b. (6 pts) Elemental oxygen is a (**monatomic element** / **compound** / **diatomic element**). The atoms form (**ionic** / **covalent** / **structural**) bonds with each other in which they (**share** / **borrow** / **transfer**) electrons.

3. (10 pts) Give the systematic name for the following substances:

a. Ag_2O _____**silver oxide**_____

b. Se_2S_6 _____**diselenium hexasulfide**_____

c. $Cu(C_2H_3O_2)_2$ _____**copper(II) acetate**_____

4. (10 pts) Write the chemical formula given the systematic name:

a. __ **Cl_2O**_____ dichlorine monoxide

b. __ **$Mg(NO_3)_2 \bullet 6\ H_2O$**_____ magnesium nitrate hexahydrate

c. ___**$CsHCO_3$**_____ cesium bicarbonate

Problem	Weight
B	35

Cadet _____

1. (12 pts) Given the three multiple choice problems regarding mixtures, compounds, and elements, ***circle*** the best answer for each problem.

Saltwater is a mixture:

a. It does not retain any of the properties of the components of which it is composed.
(b.) The components of the mixture can vary in their parts by mass.
c. It cannot be separated into its components by physical changes.
d. A and C are correct.

A compound such as ammonia:

a. Is a group of two or more elements chemically bound together.
b. Can also be considered a substance.
c. Has fixed parts by mass.
(d.) All the above.

An element such as gold (metal):

(a.) Consists of only one type of atom
b. Is not classified as a substance.
c. Is not the simplest type of matter that retains characteristic properties.
d. All of the above.

2. (10 pts) If a chemist uses 6.0 mL of argon which has a density of 1.78 g/L in an experiment, how many ***grams*** are used?

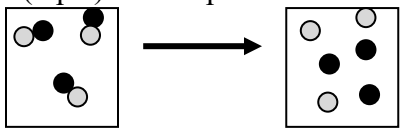
$$\frac{6.0\ \text{mL}}{} \left| \frac{1 \times 10^{-3}\ \text{L}}{1\ \text{mL}} \right| \frac{1.78\ \text{g}}{\text{L}} = \underline{\underline{\mathbf{1.1 \times 10^{-2}\ g}}}\ \textit{ans}$$

3. (8 pts) Circle the best choice from each selection to complete the following sentence.

In the lab, you used (**density** / **mass** / **volume**) to identify a substance. It is an example of a(n) (**extensive** / **intensive** / **colligative**) property. Briefly ***explain*** your answers.

Intensive properties are independent of amount present, and therefore some, like density, can be used to identify an unknown substance.

4. (5 pts) Is the picture below is an example of a chemical or physical change. Explain.



Chemical change; the substances are converted into a substances with different compositions.

Problem	Weight
C	40

Cadet _____

1. Millions of Americans have spent a total of 1.7 billion dollars on tooth whitening products. Most tooth whiteners use a chemical agent called carbamide peroxide ($CH_6N_2O_3$, $\mathcal{M}$ = 94.08 g/mol) that undergoes an oxidation reduction reaction when mixed with water.

a. (12 pts) Given 25.00 mL of water and 2.00 g of pure $CH_6N_2O_3$, calculate its molarity.

$$\frac{2.00\text{ g } CH_6N_2O_3}{} \left| \frac{1\text{ mol } CH_6N_2O_3}{94.08\text{ g } CH_6N_2O_3} \right| \frac{}{25.00\text{ mL}} \left| \frac{1000\text{ mL}}{1\text{ L}} \right. = \underline{\underline{\textbf{0.850 } \boldsymbol{M}\textbf{ } CH_6N_2O_3}}\ \textit{ans}$$

b. (12 pts) Pure carbamide peroxide ($CH_6N_2O_3$) is a skin, eye, and respiratory irritant. Most over-the-counter products reduce the concentration to avoid health hazards. What is the final volume (in **mL**) of the solution in part 1a (above) if you ***dilute*** it to a final concentration of 0.127 *M* of $CH_6N_2O_3$?

$$\frac{0.8503\ M\ CH_6N_2O_3}{} \left| \frac{25.00\text{ mL}}{} \right| \frac{}{0.127\ M\ CH_6N_2O_3} = \underline{\underline{\textbf{167 mL}}}\ \textit{ans}$$

2. (16 pts) Unlike today, people in medieval times used nitric acid (HNO_3), a strong acid, to whiten their teeth. Given the balanced chemical reaction below, what volume (in **mL**) of 1.200×10^{-3} *M* HNO_3 will form from the complete reaction of 35.00 mL of 0.01350 *M* NO_2?

$$3\ NO_2\ (aq) + H_2O\ (l) \rightarrow 2\ HNO_3\ (aq) + NO\ (g)$$

$$\frac{35.00\text{ mL } NO_2}{1000\text{ mL}} \left| \frac{1\text{ L}}{\text{L } NO_2} \right| \frac{0.01350\text{ mol } NO_2}{3\text{ mol } NO_2} \left| \frac{2\text{ mol } HNO_3}{1.200\text{x}10^{-3}\text{ mol } HNO_3} \right| \frac{\text{L } HNO_3}{1\text{L}} \left| \frac{1000\text{ mL}}{} \right.$$

$$= \underline{\underline{\textbf{262.5 mL } HNO_3}}\ \textit{ans}$$

Problem	Weight
D	50

Cadet _____

A synthetic fiber, acrylic, consists of 85% acrylonitrile monomer. The garment industry uses this polymer to make pashmina or cashmina, a less expensive alternative to cashmere. The monomer, acrylonitrile, (C_3H_3N, $\mathcal{M}$ = 53.06 g/mol) is made from propylene (C_3H_6, $\mathcal{M}$ = 42.08 g/mol) by a reaction with nitrogen monoxide using the following chemical equation:

$$4\ C_3H_6\ (g) + 6\ NO\ (g) \rightarrow 4\ C_3H_3N\ (s) + 6\ H_2O\ (l) + N_2\ (g)$$

1. a. (25 pts) What mass of C_3H_3N can be made when **21.6 g C_3H_6** reacts with **21.6 g of NO** ($\mathcal{M}$ = 30.01 g/mol)? (***You must show all work to receive full credit!)***

$$\frac{21.6\text{ g } C_3H_6}{} \left| \frac{1\text{ mol } C_3H_6}{42.08\text{ g } C_3H_6} \right| \frac{4\text{ mol } C_3H_3N}{4\text{ mol } C_3H_6} \left| \frac{53.06\text{ g } C_3H_3N}{1\text{ mol } C_3H_3N} \right. = 27.2\text{ g } C_3H_3N$$

$$\frac{21.6\text{ g NO}}{} \left| \frac{1\text{ mol NO}}{30.01\text{g NO}} \right| \frac{4\text{ mol } C_3H_3N}{6\text{ mol NO}} \left| \frac{53.06\text{ g } C_3H_3N}{1\text{ mol } C_3H_3N} \right. = \mathbf{25.5\text{ g } C_3H_3N}$$

ans

b. (4 pts) What is the limiting reactant?

NO is the limiting reactant

2. a. (15 pts) If the percent yield is only 75% from the reaction above, what is the actual yield of this reaction?

$$\%\text{ yield} = \frac{\text{actual yield}}{\text{theorectical yield}} \times 100\%$$

$$\text{actual yield} = \frac{\text{theorectical yield} \times \%\text{ yield}}{100\%}$$

$$= .75 \times 25.5\text{ g}$$

$$= \mathbf{19\text{ g } C_3H_3N}$$

ans

b. (6 pts) ***List two*** factors that could have caused the percent yield of acrylic to be less than the theoretical yield.

Any two of the following: <u>Side reactions</u>, <u>incomplete reaction (equilibrium)</u>, <u>losses in transfer</u>

Problem	Weight
E	25

Cadet _____

Oenology, the study of wine making dates back to ancient times. Currently, the winemaking industry has three different varieties of wine: table, sparkling and fortified wines. Due to its unique characteristics, wine makers use a species of grapes called *Vitis vinifera*. The fermentation of the grapes (the production of wine) follows the chemical reaction below:

$$\underset{\text{glucose}}{\_\_\_\_\_C_6H_{12}O_6\,(s)} \xrightarrow{\text{Yeast}} \underset{\text{ethanol}}{\_\_\_\_C_2H_5OH\,(l)} + \underset{\text{carbon dioxide}}{\_\_\_\_CO_2\,(g)}$$

1. (6 pts) Balance the chemical reaction above.

$$\underline{\mathbf{1}}\ C_6H_{12}O_6\,(s) \longrightarrow \underline{\mathbf{2}}\ C_2H_5OH\,(l) + \underline{\mathbf{2}}\ CO_2\,(g)$$

2. (4 pts) What is the empirical formula for glucose ($C_6H_{12}O_6$) _ **CH_2O**_?

3. (15 pts) What is the molar mass of glucose ($C_6H_{12}O_6$)?

C:	12.01	x	6	=	72.06	g/mol
H:	1.008	x	12	=	12.096	g/mol
O:	16.00	x	6	=	96.00	g/mol
					180.156	g/mol
				=	**180.16 g/mol**	
					ans	

CADET _____ SECTION/HR _____ TIME OF DEPARTURE _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101/151, AY10-1
Written Partial Review II
21 October 2009
55 minutes

TEXT: Silberberg, Chemistry: The Molecular Nature of Matter and Change, 5th Edition
SCOPE: Lessons 12-22

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			/100
		TOTAL SCORE	/200

Problem	Weight
A	50

Cadet _____

1. (10 pts) Indicate whether a precipitation reaction will occur when the following solutions are mixed by completing the **balanced** molecular equation below ***(including state symbols)***.

$Pb(NO_3)_2(aq) + 2NaI(aq) \rightarrow$ ***$PbI_2(s) + 2NaNO_3(aq)$***

2. (7 pts) When present at equal concentrations, why is HI a better electrolyte than HCN?

HI completely dissociates into ions because it is a strong acid, and HCN only partially dissociates into ions because it is a weak acid.

3. (15 pts) If a chemist titrates 0.025 L of lactic acid ($HC_3H_5O_3$) with 12.55 mL of 0.105 *M* $Ca(OH)_2$ to reach the equivalence point, what is the initial concentration of lactic acid?

$2HC_3H_5O_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(C_3H_5O_3)_2(aq) + 2H_2O(aq)$ (*balanced*)

12.55 mL $Ca(OH)_2$	1 L	0.105 mol $Ca(OH)_2$	2 mol $HC_3H_5O_3$	
	1000 mL	L	1 mol $Ca(OH)_2$	0.025 L $HC_3H_5O_3$

= **.11 *M* $HC_3H_5O_3$**

ans

4. a. (12 pts) Write the oxidation numbers in the blanks provided for the indicated atoms in the following reaction:

$$\underset{-4}{CH_4}(g) + 2\underset{0}{O_2}(g) \rightarrow \underset{+4}{C}\underset{-2}{O_2}(g) + 2H_2O(l)$$

b. (6 pts) Circle the best choice from each selection to complete the following sentence:

In a REDOX reaction, the species which gains electrons is always described as being (**ionized** / **reduced** / **oxidized** / **titrated**), and this substance serves as the (**ionizing** / **reducing** / **oxidizing** / **titrating**) agent.

Problem	Weight
B	50

Cadet _____

1. a. (15 pts) The temperature and pressure on Mars are 133.15 K and 2.96×10^{-4} atm at Point A and 293.15 K and 1.1×10^{-2} atm at Point B. If a balloon has a volume of 125 L at Point A, what would its volume be at Point B?

$n_1 = n_2$, so it cancels out of the general gas law :

$$\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2} \qquad V_2 = \frac{V_1P_1T_2}{T_1P_2}$$

125 L	2.96×10^{-4} atm	293.15 K			=	**7.4 L** ans
			133.15 K	1.1×10^{-2} atm		

b. (10 pts) What is the effect of the following on the volume of 1 mol of an ideal gas? Circle the best choice from each selection to complete the following sentences:

1) Increasing the external pressure by 5 atm would (**increase / decrease**) the volume. This is an example of (**Avogadro's / Boyle's / Charles'**) Law.
2) Changing the temperature from 330K to 348K would (**increase / decrease**) the volume. This is an example of (**Avogadro's / Boyle's / Charles'**) Law.

2. (15 pts) Calculate the number of moles of nitrogen gas present in a 175 L tank at 1.20×10^{-3} atm and -5.0ºC.

$$PV = nRT \qquad n = \frac{PV}{RT}$$

$$T(K) = \left(\frac{1K}{1^\circ C}\right)\left(-5.0^\circ C + 273.15^\circ C\right) = 268.15\,K$$

1.20×10^{-3} atm	175 L	mol*K		=	**9.54×10^{-3} mol N_2** ans
		0.08206 L*atm	268.15 K		

3. (10 pts) Mars has an atmospheric pressure of 8.663 torr. If the atmosphere consists of 0.95 CO_2, 0.03 N_2 and 0.019 Ar, by mole fraction, what is the partial pressure of Ar (**atm**) in Mars' atmosphere?

$$P_A = X_A x\, P_{total}\,;\, X_A = \frac{P_A}{P_{total}}$$

0.019 Ar	8.663 torr	atm	=	**2.2×10^{-4} *atm*** ans
		760 torr		

Problem	Weight

Cadet _____

C 50

1. a. (14 pts) Write the formation equation for solid ammonium chloride (NH_4Cl).

$\frac{1}{2}\ N_2(g) + 2H_2(g) + \frac{1}{2}\ Cl_2(g) \rightarrow NH_4Cl(s)$

b. (6 pts) In a formation equation, the $\Delta H^o_{rxn} = \Delta H^o_f$ of the product. At 298 K, the ΔH^o_f for solid ammonium chloride (NH_4Cl) is -314.4 kJ/mol. At standard conditions, is this reaction endothermic or exothermic? Briefly explain your reasoning.

$\frac{1}{2}\ N_2(g) + 2H_2(g) + \frac{1}{2}\ Cl_2(g) \rightarrow NH_4Cl(s)$ $\quad \Delta H^o_{rxn} = -314.4$ kJ/mol

Exothermic, because ΔH^o_{rxn} is less than zero.

2. (30 pts) In a volatile reaction, nitric acid (HNO_3) and ammonia (NH_3) form ammonium nitrate (NH_4NO_3). Determine ΔH_{rxn} for ammonium nitrate

$2N_2(g) + 4H_2(g) + 3O_2(g) \rightarrow 2NH_4NO_3(s)$ $\qquad \Delta H_{rxn} =$ _____

ANS

given the following set of reactions:

	$N_2(g) + 3H_2(g) \rightarrow 2NH_3(aq)$	$\Delta H_{rxn} = -161.66$ kJ	
Flip	$2HNO_3(aq) \rightarrow H_2(g) + N_2(g) + 3O_2(g)$	$\Delta H_{rxn} = 413.14$ kJ	***change sign***
2x	$NH_3(aq) + HNO_3(aq) \rightarrow NH_4NO_3(s)$	$\Delta H_{rxn} = -57$ kJ	***double***

Soln:

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(aq)$	$\Delta H_{rxn} =$ ***(-161.66)*** = ***-161.66 kJ***
$H_2(g) + N_2(g) + 3O_2(g) \rightarrow 2HNO_3(aq)$	$\Delta H_{rxn} =$ ***-(413.14) = -413.14 kJ***
2 $NH_3(aq) +$***2*** $HNO_3(aq) \rightarrow$ ***2*** $NH_4NO_3(s)$	$\Delta H_{rxn} =$ ***(2 x -57) = -114 kJ***
$2N_2(g) + 4H_2(g) + 3O_2(g) \rightarrow 2NH_4NO_3(s)$	$\Delta H_{rxn} =$ ***-688.80 kJ*** $\quad \Delta H_{rxn} =$ **-689 kJ**

ans

Problem Weight Cadet _____

D 50

1. (20 pts) The Oklahoma City bombing involved an explosive mixture of ammonium nitrate and nitromethane (ANNM), also known as "poor man's RDX". Use the ***balanced chemical reaction*** below to determine the standard heat of reaction (ΔH^o_{rxn}) for this explosion.

$\Delta H^o_{f(NH_4NO_3)}$= -365.56 kJ/mol

$\Delta H^o_{f(CH_3NO_2)}$= -113 kJ/mol

$$3NH_4NO_3(s) + 2CH_3NO_2(l) \rightarrow 4N_2(g) + 2CO_2(g) + 9H_2O(g)$$

$\Delta H^o_{rxn} = \sum m\Delta H^o_{f(products)} - \sum n\Delta H^o_{f(reactants)}$

$$\Delta H^o_{rxn} = \left[\frac{4 \text{ mol } N_2}{} \left| \frac{0 \text{ kJ}}{\text{mol } N_2} + \right| \frac{2 \text{ mol } CO_2}{} \left| \frac{-393.5 \text{ kJ}}{\text{mol } CO_2} + \frac{9 \text{ mol } H_2O}{} \right| \frac{-241.826 \text{ kJ}}{\text{mol } H_2O} \right]$$

$$- \left[\frac{3 \text{ mol } NH_4NO_3}{} \left| \frac{-365.56 \text{ kJ}}{\text{mol } NH_4NO_3} + \frac{2 \text{ mol } CH_3NO_2}{} \right| \frac{-113 \text{ kJ}}{\text{mol } CH_3NO_2} \right] = -1640.754 \text{ kJ} \text{ or } \underline{\underline{\textbf{-1641 kJ}}}$$

ANS

2. (10 pts) Fill in the table with appropriate information about three categories of explosives.

CATEGORY	**FUNCTION**	**EXAMPLE**
Pyrotechniques	Produce heat, smoke, light, or noise, produce delays	**Green Star Cluster**
High Explosives	**Create shock waves, burst, shatter, penetrate, lift and heave, create air blast, generate brisance**	**TNT, RDX, PETN**
Propellant	propel projectiles and rockets, start internal combustion engine, rotate turbines and gyros	Nitrocellulose

3. (20 pts) The Army uses Tetryl, a sensitive explosive, in M14 anti-personnel mines. Write the balanced chemical reaction for the explosion of 1 mole of Tetryl ($C_7H_5N_5O_8$) into its gaseous products:

$C_7H_5N_5O_8(s) \rightarrow 2.5H_2O(g) + 5.5CO(g) + 2.5N_2(g) + 1.5C(s)$

1) 5 H makes 2.5 H_2O (5.5 O left)

2) 5.5 C makes 5.5 CO (0 O left)

3) No O left therefore step is omitted

4) No O left therefore step is omitted

5) 5N makes 2.5 N_2

6) 1.5 C left therefore 1.5C

CADET _____ SECTION/HR _____ TIME OF DEPARTURE _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101/151, AY10-1
Written Partial Review III
17 November 2009
55 minutes

TEXT: Silberberg, Chemistry: The Molecular Nature of Matter and Change, 5th Edition
SCOPE: Lessons 25-31

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			/200

Problem	Weight
A	50

Cadet _____

1. (10 pts) The Bohr model of the atom can predict the spectral lines of which of the following species? **(Circle all that apply)**

(H) He Li Li^+ (Li^{2+}) (Be^{3+})

Briefly explain your answer.

The Bohr model accurately accounts for the spectral lines of only the hydrogen atom and other <u>one electron species</u>.

2. (14 pts) During a single game, Angel Stadium receives a total of 3.9×10^{12} J of solar radiation. How many photons with an average wavelength of 220 nm has the stadium received?

$E_{photon} = \frac{hc}{\lambda}$

$$\frac{6.626 \times 10^{-34}\ \text{J s}}{\text{photon}} \left| \frac{2.998 \times 10^{8}\ \text{m}}{\text{s}} \right| \frac{}{220\ \text{nm}} \left| \frac{1 \times 10^{9}\ \text{nm}}{1\ \text{m}} \right. = 9.03 \times 10^{-19}\ \text{J/ photon}$$

Number of photons:

$$\frac{3.9 \times 10^{12}\ \text{J}}{} \left| \frac{1\ \text{photon}}{9.03 \times 10^{-19}\ \text{J}} \right. = \mathbf{4.3 \times 10^{30}\ photons}$$

ans

3. (12 pts) Sunscreen with UVB protection protects against solar radiation with frequencies 9.4 x 10^{14} to 1.2 x 10^{15} Hz. Determine the maximum energy (**J/photon**) of this radiation.

$E = h\upsilon$

$$\frac{6.626 \times 10^{-34}\ \text{J s}}{\text{photon}} \left| \frac{1.2 \times 10^{15}\ \text{Hz}}{} \right| \frac{1}{1\ \text{Hz s}} =$$

7.95×10^{-19} J/ photon or **8.0×10^{-19} J/ photon**

ans

4. (9 pts) Circle the best choice from each selection below, based on atomic trends of the periodic table. When viewed from *left* to *right*:

a. first ionization energy (**increases** / **decreases** / **does not change**).

b. electronegativity (EN) (**increases** / **decreases** / **does not change**).

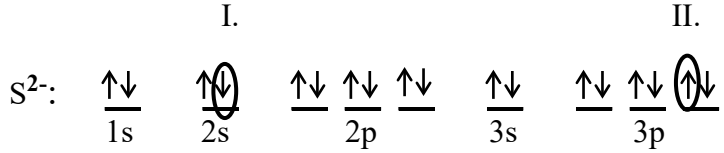
c. atomic radius (**increases** / **decreases** / **does not change**).

5. (5 pts) Use effective nuclear charge to explain your answer for *atomic radius* from part 4c (above).**The number of protons increases as you move left to right across a period (Z increases), but the principal quantum number (n) stays constant, thus the number of core electrons does not change and shielding does not increase. The valence electrons experience a greater effective nuclear charge resulting in a smaller atomic size.**

Problem	Weight
B	40

Cadet _____

1. (16 pts) From the orbital diagram below, complete the table with the appropriate quantum numbers for the two circled electrons.



Electron Location	***n***	***ℓ***	***mℓ***	***ms***
I.	**2**	**0**	**0**	**+1/2, -1/2**
II.	**3**	**1**	**-1, 0, +1**	**+1/2, -1/2**

2. (8 pts) Write the full electron configuration for the **bromide ion:**

Br^-: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6$

3. (10 pts) Draw the partial orbital diagram for **vanadium:**

V: [Ar] ⇅ (4s) ↑ ↑ ↑ _ _ (3d)

4. (6 pts) How many electrons in an atom can have the following quantum numbers in common? (**Fill in the blank**).

a. $n = 2, l = 1, m_l = 0$ _____**2**_____

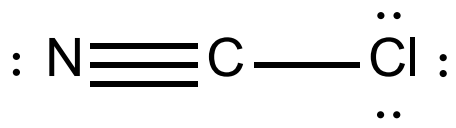
b. $5p$ _____**6**_____

c. $n = 4, l = 3, m_l = -3, m_s = -1/2$ _____**1**_____

Problem Weight Cadet _____

C 45

1. a. (11 pts) Draw the Lewis structure for cyanogen chloride (CNCl) **(Hint: the chemical formula does not represent the bonding order).**

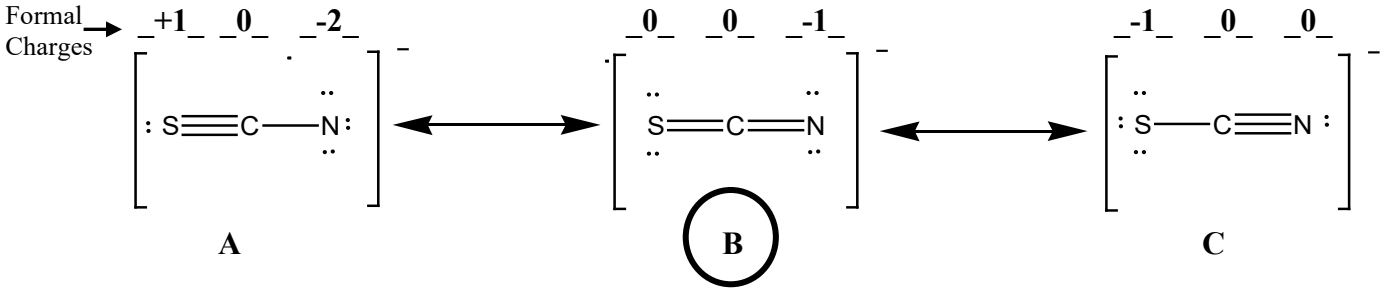


Use cyanogen's molecular formula and your structure to circle the correct answers:

b. (3 pts) Cyanogen has **(metallic / (covalent) / ionic)** bonds between each atom.

c. (3 pts) Based upon the type of bonding, they **((share) / transfer)** their electrons.

2. a. (16 pts) Given one resonance structure for thiocyanate ion (**SCN^-**), draw two ***additional*** resonance structures in the brackets.



b. (6 pts) Indicate the formal charges for each atom in the designated blanks above the resonance structure. ***Use the space below to show your work from structure (A).***

Formal Charge of atoms = valence e^- - (unshared valence e^- + ½ shared valence e^-)

A: FC (S) = 6 – (2 + ½ (6)) = +1
FC (C) = 4– (0+ ½ (8)) = 0
FC (N) = 5– (6+ ½ (2)) = -2

B: FC (S) = 6 – (4 + ½ (4)) = 0
FC (C) = 4– (0+ ½ (8)) = 0
FC (N) = 5– (4+ ½ (4)) = -1

C: FC (S) = 6 – (6 + ½ (2)) = -1
FC (C) = 4– (0+ ½ (8)) = 0
FC (N) = 5– (2+ ½ (6)) = 0

c. (6 pts) Based on your data, **circle the *letter* (A / (B) / C) of the best resonance structure** for thiocyanate ion.

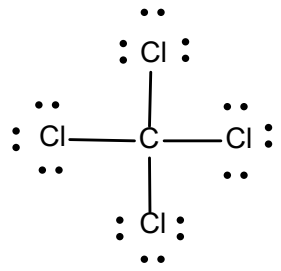
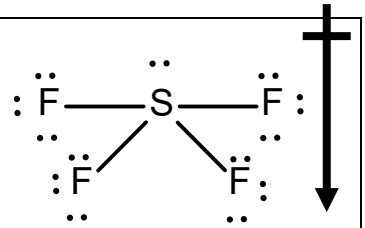
Briefly explain why you selected your answer for *best resonance structure*.

Resonance structure ____ meets the criteria for the best resonance structure.

- **The more <u>negative formal charge</u> resides on the <u>more electronegative atom</u>**
- **<u>Smaller formal charges</u> (positive or negative) are <u>preferable</u> to larger ones**

Problem Weight Cadet _____

D 65

1. (48 pts) Complete the table for the following two substances:		
Electron group arrangement of the central atom	***Tetrahedral***	***Trigonal bipyramidal***
Molecular Shape	***Tetrahedral***	***Seesaw***
Ideal Bond Angle(s)	***109.5^o***	***90° and 120°***
Will this molecule deviate from the ideal bond angle?	***no***	***yes***
Are the bonds in this molecule polar?	***yes***	***yes***
Is the molecule polar? (**if yes**, *draw molecular dipole on the Lewis structure above*)	***no***	***yes***
Orbital hybridization of central atom	***sp^3***	***sp^3d***
Total # of σ bonds	***4***	***4***
Total # of π bonds	***0***	***0***

2. (12 pts) Circle the best word or phrase to complete the following **general** statements:

   a. C—N bonds are (**shorter** / **longer**) than N—O bonds.

   b. Bond energy (**increases** / **decreases** / **stays the same**) with decreasing bond length.

   c. Bond length (**increases** / **decreases** / **stays the same**) with increasing bond order.

   d. Unlike the N=O bond, the N—O bond (**can** / **cannot**) rotate about the bond axis.

3. (5 pts) Briefly explain your answer for *rotation about the bond axis* from part 2d (above).

Sigma (σ) bonds have *end-to-end overlap* and thus allow rotation around the bond axis.
Pi (π) bonds have *side-to-side overlap* that restricts rotation.

APPROVED SOLUTION

CADET _____ SECTION/HR _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101/151, AY15-1
Written Partial Review I
17 September 2014
55 minutes

TEXT: Silberberg, Chemistry: The Molecular Nature of Matter and Change, 7th Edition
SCOPE: Lessons 1-10

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
10th Edition Chemistry Reference Data Card (RDC)

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. ANSWER ALL QUESTIONS. **SHOW ALL WORK**.

3. There are 4 numbered pages in this WPR. Report any illegible or missing pages to the OIC in the hallway. Write your name on every page in the spaces provided.

(TOTAL WEIGHT 200 POINTS)

DO NOT WRITE IN THIS SPACE			
PROBLEM	MAX SCORE	CUT	POINTS
A	50		
B	40		
			/90
C	50		
D	60		
			/110
		TOTAL SCORE	/200

APPROVED SOLUTION

Problem	Weight
A	50

Cadet _____

1. (27 pts) Circle the best choice from each selection to complete the following sentences:

a) A *solid* has a (**fixed / varying**) shape that (**does / does not**) conform to the container shape.

b) A (**liquid / gas**) has a (**fixed / varying**) shape that conforms to the container shape and fills the entire container, thus, does *not* have a surface.

c) Density is an (**intensive / extensive**) property because it (**does / does not / could**) depend on the quantity of the substance present.

d) Significant figures are a reflection of the (**uncertainty / accuracy / error**) inherent in a number or measurement. The (**greater / fewer**) the number of these figures, the (**more / less**) certain the measurement is.

2. (23 pts) Fill in all blanks to complete the following table:

Chemical Formula	*Systematic Name*
NO_3	**nitrogen trioxide**
Rb_2S	rubidium sulfide
$FeCl_3$	iron(III) chloride
$Zn(NO_3)_2$	**zinc nitrate**
$MgSO_4 \cdot 7H_2O$	**magnesium sulfate heptahydrate**

Problem	Weight
B	40

Cadet _____

1. (15 pts) Indicate which step of the scientific method best describes each of the following statements:

A) A scientist notices that some substances are highly combustible while others are less combustible. ***observation***

B) A scientist proposes that a substance called phlogiston is released when a metal combusts. ***hypothesis***

C) A scientist proposes that slightly combustible materials contain less phlogiston than highly combustible ones. ***hypothesis***

D) A scientist combusts different metals and discovers that they gain mass when they combust. ***experiment***

E) A scientist disproves the model or theory that phlogiston is behind combustion by doing experiments that disprove its necessity and existence. ***further experiment***

2. Complete the following sentences by using words from the word bank (*do not use any word more than once*):

Noble	Hydrogen	Sulfur
Phosphorus	Nitrogen	Alkali
Chlorine	Alkaline Earth	Halogens
Ionic	Oxygen	Transition
Chalcogens	Covalent	Carbon

a) (4 pts) Elements in group 2A are known as ***alkaline earth*** metals.

b) (12 pts) Elemental ***hydrogen*** , ***nitrogen*** , ***chlorine*** , and ***oxygen*** are all examples of diatomic molecules.

c) (5 pts) ***covalent*** bonding is characterized by a sharing of electrons.

d) (4 pts) Elements in group 8A are known as ***noble*** gases.

Problem	Weight
C	50

Cadet _____

1. (12 pts) Calculate the mass percent of nitrogen in ammonium nitrate (NH_4NO_3). The molar mass ($\mathcal{M}$) of ammonium nitrate is 80.05 g/mol.

[3.6] (modified)

$$\text{mass \% of A} = \left(\frac{\text{mass of A in the whole}}{\text{mass of the whole}} \times 100\right)\%$$

$$\text{mass \%} = \frac{2 \text{ mol N}}{1 \text{ mol } NH_4NO_3} \left| \frac{14.01 \text{ g N}}{\text{mol N}} \right| \frac{1 \text{ mol } NH_4NO_3}{80.05 \text{ g } NH_4NO_3} \left| 100\% \right. = \mathbf{35.00\%} \; \underline{\underline{\frac{\mathbf{N}}{\mathbf{NH_4NO_3}}}}$$

ANS

2. a. (6 pts) What is the empirical formula for naphthalene ($C_{10}H_8$)? C_5H_4

b. (12 pts) Balance the chemical reaction for the combustion of naphthalene:

$$\underline{\mathbf{1}}\ C_{10}H_8(l) + \underline{\mathbf{12}}\ O_2(g) \rightarrow \underline{\mathbf{10}}\ CO_2(g) + \underline{\mathbf{4}}\ H_2O(g) \quad (\textit{unbalanced})$$

3. (20 pts) Upon combustion, an unknown hydrocarbon (*remember: this substance only contains hydrogen and carbon*) reacts with O_2 to form 44.91 g CO_2 ($\mathcal{M}$ = 44.01 g/mol) and 24.51 g H_2O ($\mathcal{M}$ = 18.02 g/mol). Determine the empirical formula of the unknown hydrocarbon.

$$\text{mol C} = \frac{44.91 \text{ g } CO_2}{44.01 \text{ g } CO_2} \left| \frac{\text{mol } CO_2}{\text{mol } CO_2} \right| \frac{\text{mol C}}{\text{mol } CO_2} = \mathbf{1.02045 \text{ mol C}}$$

$$\text{mol H} = \frac{24.51 \text{ g } H_2O}{18.016 \text{ g } H_2O} \left| \frac{\text{mol } H_2O}{\text{mol } H_2O} \right| \frac{2 \text{ mol H}}{\text{mol } H_2O} = \mathbf{2.72091 \text{ mol H}}$$

$$C_{\frac{1.02045}{1.02045}} H_{\frac{2.72091}{1.02045}} = (C_1 H_{2.6664}) \times 3 = \underline{\underline{C_3 H_8}}$$

ANS

Problem	Weight
D	60

Cadet _____

1. $Ba(OH)_2$ neutralizes HIO_3 according to the following balanced reaction:

$$Ba(OH)_2(aq) + 2\ HIO_3(aq) \rightarrow Ba(IO_3)_2(s) + 2\ H_2O(l)$$

a) (24 pts) What is the maximum amount (in **g**) of $Ba(IO_3)_2$ ($\mathcal{M}$ = 487.1 g/mol) that could theoretically form if 43.3 mL of 0.115 *M* $Ba(OH)_2$ were to react with 17.9 mL of 0.316 *M* HIO_3?

$$\text{g } Ba(IO_3)_2 = \frac{43.3 \text{ mL } Ba(OH)_2}{1000 \text{ mL}} \left| \frac{1 \text{ L}}{\text{L } Ba(OH)_2} \right| \frac{0.115 \text{ mol } Ba(OH)_2}{1 \text{ mol } Ba(IO_3)_2} \left| \frac{1 \text{ mol } Ba(IO_3)_2}{487.1 \text{ g } Ba(IO_3)_2} \right| = \mathbf{2.4255\ g\ Ba(IO_3)_2}$$

$$\text{g } Ba(IO_3)_2 = \frac{17.9 \text{ mL } HIO_3}{1000 \text{ mL}} \left| \frac{1 \text{ L}}{\text{L } HIO_3} \right| \frac{0.316 \text{ mol } HIO_3}{2 \text{ mol } HIO_3} \left| \frac{1 \text{ mol } Ba(IO_3)_2}{487.1 \text{ g } Ba(IO_3)_2} \right| = \mathbf{1.3776\ g\ Ba(IO_3)_2}$$

1.38 g $Ba(IO_3)_2$
ANS

b) (6 pts) Which reactant limits the production of $Ba(IO_3)_2$? _ **HIO_3**_____

c) (15 pts) Would you anticipate the actual yield to be less than or more than the theoretical yield you calculated? Briefly explain your answer by providing two reasons why the actual yield seldom equals the theoretical yield.

The actual yield would be less than the theoretical yield because there could be side reactions between the reactants that yield different products, the reaction could be incomplete and stop before going to completion, or physical loss of reactants could occur during the process.

d) (15 pts) If you were to take the initial 43.3 mL of 0.115 *M* $Ba(OH)_2$ solution and dilute it to a final volume of 150.00 mL, what would be the new concentration (in *M*)?

$$M_{conc}V_{conc} = M_{dil}V_{dil}$$
(dilution equation)

$$M\ Ba(OH)_2 = \frac{0.115\ M\ Ba(OH)_2}{150.00 \text{ mL}} \left| \frac{43.3 \text{ mL}}{} \right| = \mathbf{0.033196\ M\ Ba(OH)_2} = \mathbf{0.0332\ M\ Ba(OH)_2}$$

ANS

APPROVED SOLUTION

CADET _____ SECTION/HR _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101/151, AY15-1
Written Partial Review II
22 October 2014
55 minutes

TEXT: Silberberg, Chemistry: The Molecular Nature of Matter and Change, 7th Edition
SCOPE: Lessons 12-22

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
10th Edition Chemistry Reference Data Card (RDC)

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. ANSWER ALL QUESTIONS. **SHOW ALL WORK**.

3. There are 4 numbered pages in this WPR. Report any illegible or missing pages to the OIC in the hallway. Write your name on every page in the spaces provided.

(TOTAL WEIGHT 200 POINTS)

THIS SPACE FOR INSTRUCTOR USE ONLY			
PROBLEM	**MAX**	**CUT**	**POINTS**
A	**50**		
B	**50**		
			/100
C	**50**		
D	**50**		
			/100
		TOTAL SCORE	**/200**

APPROVED SOLUTION

Problem	Weight
A	50

Cadet _____

1. (15 pts) Using your knowledge of both solubility and acid-base chemistry, predict the products of the following reactions and complete the chemical equations (remember to balance them):

a. __*1*__ $Sr(OH)_2(aq)$ + __*2*__ $HI(aq)$ → ***$SrI_2(aq)$ + 2 $H_2O(l)$***

b. __*3*__ $MgS(aq)$ + __*2*__ $Na_3PO_4(aq)$ → ***$Mg_3(PO_4)_2(s)$ + 3 $Na_2S(aq)$***

2. a. (20 pts) Use the following balanced reaction to complete the table below:

$$MnO_4^-(aq) + 8\ H^+(aq) + 5\ Fe^{2+}(aq) \rightarrow Mn^{2+}(aq) + 4\ H_2O(l) + 5\ Fe^{3+}(aq)$$

(1) Oxidation Number of Mn in MnO_4^-: ___*+7*_____

(2) Oxidation Number of Fe in Fe^{2+}: ___*+2*_____

(3) Oxidation Number of Mn in Mn^{2+}: ___*+2*_____

(4) Oxidation Number of Fe in Fe^{3+}: ___*+3*_____

(5) Atom / Monatomic ion oxidized: ___***Fe^{2+}***___

(6) Atom / Monatomic ion reduced: ___***Mn***____

(7) Oxidizing agent: ___***MnO_4^-***_

(8) Reducing agent: ___***Fe^{2+}***___

b. (15 pts) What volume (in **mL**) of a 0.018 *M* MnO_4^- solution is required to completely react with 40**.** mL of 0.125 *M* Fe^{2+} solution in accordance with the REDOX reaction above?

$$\text{mL } MnO_4^- = \frac{40.\text{ mL } Fe^{2+}}{} \left| \frac{1\text{ L}}{1000\text{ mL}} \right| \frac{0.125\text{ mol } Fe^{2+}}{\text{L}} \left| \frac{1\text{ mol } MnO_4^-}{5\text{ mol } Fe^{2+}} \right| \frac{\text{L}}{0.018\text{ mol } MnO_4^-} \left| \frac{1000\text{ mL}}{1\text{ L}} \right| = \mathbf{56\text{ mL } MnO_4^-}$$

ANS

Problem	Weight
B	50

Cadet _____

1. (21 pts) Circle the best choice from each selection to complete the following statements:

a. The volume of a sealed bag of potato chips will (**increase** / **not change** / **decrease**) if left out in the hot sun, an application of (**Avogadro's** / **Boyle's** / **Charles'**) Law.

b. The volume of a sealed bag of pretzels will (**increase** / **not change** / **decrease**) if the pressure is reduced in an ascending plane cabin, an application of (**Avogadro's** / **Boyle's** / **Charles'**) Law.

c. The volume of a leaking balloon will (**increase** / **not change** / **decrease**) over time, an application of (**Avogadro's** / **Boyle's** / **Charles'**) Law.

2. a. (18 pts) A salvage diver releases a balloon from an underwater site at a depth of 23 m. At this depth, the balloon contains 93 L of helium at 291 K. When the balloon reaches the surface, it has expanded to 367 L. If the surface is at 0.98 atm and 297 K, calculate the pressure on the balloon at the release point underwater (in **atm**).

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \quad \textit{(General Gas Law)}$$

$$P\ (\text{atm}) = \frac{0.98\ \text{atm} \mid 367\ \text{L} \mid 291\ \text{K}}{93\ \text{L} \mid 297\ \text{K}} = \mathbf{3.8\ atm}$$

ANS

b. (11 pts) Briefly explain whether you would anticipate the helium in the salvage balloon to behave more ideally at the surface or underwater. As part of your answer, be sure to consider both the temperature and pressure at each point.

The helium would behave more ideally at the surface, where the higher temperature and lower pressure would both allow the particles less opportunity to interact with each other in a non-ideal way, through interparticle attractions and the increased significance of each gas particle's actual volume.

Problem	Weight
C	50

Cadet _____

1. a. (15 pts) Calculate the change in heat (in **kJ**) associated with cooling a 38 g ice cube from -10°C to -23°C.

[6.7] $q = c \times \text{mass} \times \Delta T$

$$q_w = \frac{2.06\ \text{J}}{\text{g K}} \left| \frac{38\ \text{g}}{} \right| \left| \frac{(-23 - (-10.))\ ^\circ\text{C}}{} \right| \left| \frac{1\ \text{K}}{1\ ^\circ\text{C}} \right| \frac{\text{kJ}}{1000\ \text{J}} = \underline{\underline{-1.0\ \text{kJ}}}$$

ANS

b. (9 pts) The final temperature would be (**-23°C** / **higher than -23°C** / **lower than -23°C**) if the same amount of heat were removed from a larger ice cube. This is because the (**specific heat capacity** / **heat capacity**) of that larger sample would be (**greater than** / **less than** / **the same as**) it was for the smaller sample.

2. a. (20 pts) The destruction of ozone in the atmosphere can occur according to the following reaction. Use the below known equations to calculate $\Delta H°_{rxn}$ (in **kJ**) for this reaction

$$Cl(g) + O_3(g) \rightarrow ClO(g) + O_2(g) \qquad \Delta H°_{rxn} = \underline{\underline{\textbf{\textit{-163 kJ}}}}$$

You may use the following reactions:

$ClO(g) + O_3(g) \rightarrow Cl(g) + 2\ O_2(g)$ $\quad \Delta H°_{rxn} =$ -123.2 kJ ***reverse = 123.2 kJ***

~~***Cl(g) + 2 O₂(g)***~~ ***→ ClO(g) +*** ~~***O₃(g)***~~

$O_3(g) \rightarrow 3/2\ O_2(g)$ $\quad \Delta H°_{rxn} =$ -143 kJ ***double =*** ***-286 kJ***

- 162.8 kJ

~~***2 O₃(g)***~~ ***→*** ~~***3 O₂(g)***~~

b. (6 pts) This process is (**exothermic** / **isothermic** / **endothermic**) because the reaction is (**reacting with** / **gaining heat from** / **releasing heat to**) its surroundings.

Problem	Weight
D	50

Cadet _____

1. (20 pts) Use the information on p.5 of the RDC to write formation equations for the following compounds. Be sure to include the overall $\Delta H°_{rxn}$ values (in **kJ**).

a. $Mg_3N_2(s)$: ***3 Mg(s) + N_2(g) → Mg_3N_2(s)*** ***ΔH_{rxn} = -461 kJ***

b. $AlCl_3(s)$: ***Al(s) + 3/2 Cl_2(g) → $AlCl_3$(s)*** ***ΔH_{rxn} = -704.2 kJ***

2. a. (20 pts) Methanogenic bacteria synthesize methane (CH_4) from hydrogen according to the following reaction:

$$4\ H_2(g) + CO_2(g) \rightarrow CH_4(g) + 2\ H_2O(l)$$

Calculate $\Delta H°_{rxn}$ (in **kJ**) for this reaction.

[6.9] $$\Delta H^{o}_{rxn} = \sum m\Delta H^{o}_{f\,(products)} - \sum n\Delta H^{o}_{f\,(reactants)}$$

$$\Delta H°_{rxn} = \frac{2\ mol\ H_2O}{}\left|\frac{-285.840\ kJ}{mol\ H_2O}\right. + \frac{1\ mol\ CH_4}{}\left|\frac{-74.87\ kJ}{mol\ CH_4}\right. - \frac{1\ mol\ CO_2}{}\left|\frac{-393.5\ kJ}{mol\ CO_2}\right. - \frac{4\ mol\ H_2}{}\left|\frac{0\ kJ}{mol\ H_2}\right. = \underline{\underline{-253.1\ kJ}}$$

ANS

b. (10 pts) How would the change in energy associated with the production of 4 moles of methane (CH_4) compare to the value calculated above? Circle one response and briefly explain your answer below.

(1) quadruple (2) double (3) equal, it would be the same

(4) one-quarter (5) half (6) too little information to tell

Explain here: ***the value above is the amount of heat released in the formation of a single mole of methane. The energy released would be four times as much if four times as much product formed.***

APPROVED SOLUTION

CADET _____ SECTION/HR _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101/151, AY15-1
Written Partial Review III
20 November 2014
55 minutes

TEXT: Silberberg, Chemistry: The Molecular Nature of Matter and Change, 7th Edition
SCOPE: Lessons 24-32

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
10th Edition Chemistry Reference Data Card (RDC)

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. ANSWER ALL QUESTIONS. **SHOW ALL WORK**.

3. There are 5 numbered pages in this WPR. Report any illegible or missing pages to the OIC in the hallway. Write your name on every page in the spaces provided.

(TOTAL WEIGHT 200 POINTS)

THIS SPACE FOR INSTRUCTOR USE ONLY			
PROBLEM	**MAX**	**CUT**	**POINTS**
A	**30**		
B	**40**		
			/70
C	**40**		
D	**40**		
E	**50**		
			/130
		TOTAL SCORE	**/200**

APPROVED SOLUTION

Problem	Weight
A	30

Cadet _____

1. (14 pts) Thermally excited cesium ions (Cs^+) in cesium chloride (CsCl) demonstrate a strong emission at 453 nm. What is the total energy (in **J**) of these emissions for 5.00 g of CsCl? ***Note: assume that all the heat produced is converted to emitted light.***

[7.2] $E = h\nu = \frac{hc}{\lambda}$ *(Planck's Equation)* $E_T = nE = nhc/\lambda$ =

5.00 g CsCl	1 mol CsCl	1 mol Cs^+	6.022×10^{23} Cs^+	1 photon	6.626×10^{-34} J s	2.998×10^{8} m		10^9 nm	= **7840 J**
	168.35 g CsCl	1 mol CsCl	1 mol Cs^+	Cs^+	photon	s	453 nm	m	*ANS*

1.79×10^{22} photons 4.39×10^{-19} J/photon

2. (14 pts) How fast must a 0.36g, 4.5mm spherical steel bb (a bb is a projectile pellet) travel in order to have a deBroglie wavelength equal to that of the above photons (453 nm)?

[7.5] $\lambda = \frac{h}{mu}$ *(de Broglie's Equation)*

$u = h / m\lambda$ = $\frac{6.626\times10^{-34}\text{ J s}}{\text{bb}} \left|\frac{\text{bb}}{0.36\text{ g}}\right| \left|\frac{}{453\text{ nm}}\right| \left|\frac{\text{kg m}^2}{\text{J s}^2}\right| \left|\frac{1000\text{ g}}{\text{kg}}\right| \left|\frac{10^9\text{ nm}}{\text{m}}\right|$ = **4.1×10^{-24} m/s** *ANS*

3. (2 pts) Circle the best choice to complete the following sentence:

The bb would have to (**slow down** / **speed up**) **maintain speed**) in order to have a shorter deBroglie wavelength than 453 nm.

Problem	Weight
B	40

Cadet _____

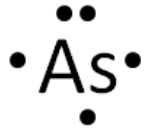
1. (7 pts) Circle one choice from each selection to make the following statement true:

Shielding (**increases** / **maintains** / **reduces**) the effective nuclear charge (Z_{eff}) an electron experiences; a (**higher** / **lower**) Z_{eff} makes the electron (**easier** / **more difficult**) to remove.

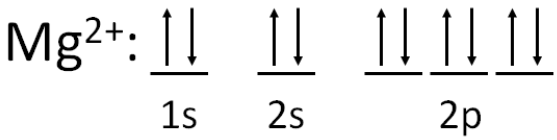
2. a. (8 pts) Write the condensed electron configuration for arsenic (As) below:

$$\textbf{\textit{As: [Ar] } 4s^2 3d^{10} 4p^3}$$

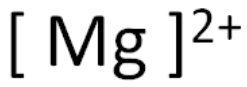
b. (4 pts) Write the Lewis dot symbol for As:



3. a. (8 pts) Draw the orbital diagram for magnesium ion (Mg^{2+}) below:



b. (4 pts) Write the Lewis dot symbol for Mg^{2+}:



3. (9 pts) How many orbitals in an atom can have the following designations? Place your answer in the blank provided:

a. n = 2 ___***4***___ b. 4p ___***3***___ c. 3d ___***5***___

Problem	Weight
C	40

Cadet _____

1. (21 pts) Circle the best choice from each selection to complete the following sentences:

a. (**Electron affinity** / **Electronegativity** / **Ionization energy**) is the relative ability of a bonded atom to attract shared electrons.

b. The (**electron deficient** / **expanded valence shell** / **free radical**) exception to the octet rule describes a central atom that can accommodate more than eight electrons in its outermost energy level; This occurs only with central atoms that are period (**1** / **2** / **3** / **4** / **5**) or larger.

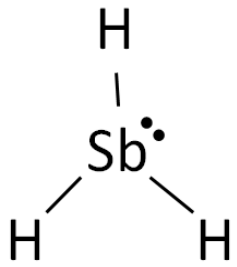
c. The (**bond polarity** / **dipole moment** / **molecular polarity**) of a molecule is a measure of the (**bond polarity** / **dipole moment** / **molecular polarity**) of that molecule, the overall distribution of electronic charge within it.

d. As bond order increases, bond energy (**increases** / **decreases** / **remains constant**) and bond length (**increases** / **decreases** / **remains constant**).

2. (9 pts) Indicate the polarity of the following bonds by drawing arrows over the top of each:

a. H—F b. O—S c. H—C

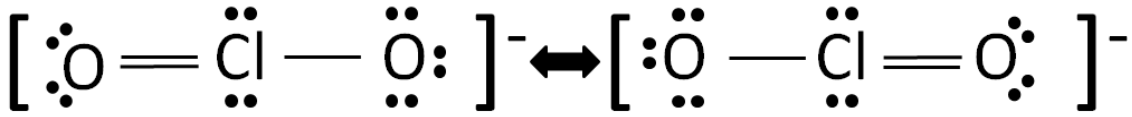
3. (10 pts) Draw a Lewis structure for SbH_3.



Problem	Weight
D	40

Cadet _____

1. (28 pts) Complete the worksheet below for the compound indicated.
Be sure to include any important resonance structures:

Systematic Name	chlorite ion
Chemical Formula	ClO_2^-
Number of Valence Electrons	***20***
Central Atom	***Cl***
Lewis Structure	
Formal Charges on each atom	Cl = ***0*** O = ***0*** O = ***-1***

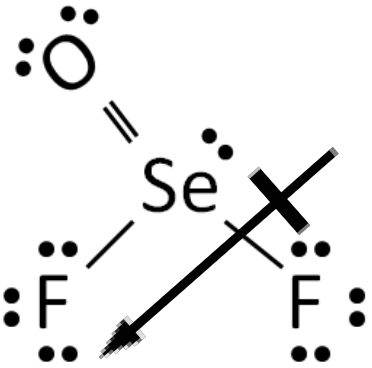
2. (12 pts) Circle the best choice from each selection to complete the following sentence:

The bonds in the above polyatomic ion are (**covalent** / **ionic**) bonds. The bonding electrons in those bonds are (**polarized** / **shared** / **transferred**) by the atoms they bond. The electrons that form a bond between chlorine and oxygen are (**evenly** / **unevenly**) distributed between the atoms they bond based on those atoms' electronegativity values.

Problem	Weight
E	50

Cadet _____

1. (38 pts) Complete the worksheet below for the compound indicated:

Lewis Structure	
Electron Group Arrangement	***tetrahedral***
Molecular Shape	***trigonal pyramidal***
Ideal Bond Angle	***109.5°***
Bond Polarity (ΔEN)	Se — O = ***1.1*** Se — F = ***1.6***
Polar or Non-Polar Molecule *If polar, draw the dipole moment (polar arrow) on the structure above*	***polar (away from lone pair)***
Hybridization of Central Atom	***sp^3***
Number of σ Bonds	***3***
Number of π Bonds	***1***

2. (12 pts) Circle the best choice from each selection to complete the following sentence:

The selenium-fluorine bonds (**could** / **could not**) rotate because they demonstrate (**side-to-side** / **end-to-end**) orbital overlap; the selenium-oxygen double bond (**could** / **could not**) rotate because it demonstrates (**side-to-side** / **end-to-end**) orbital overlap.

APPROVED SOLUTION

CADET _____ SECTION/HR _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101, AY16-1
Written Partial Review I
18 September 2015
55 minutes

TEXT: Moog, Farrell, Chemistry: A Guided Inquiry, 6th Edition
SCOPE: Lessons 01-11

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
Chemistry Reference Data Card (RDC)

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. ANSWER ALL QUESTIONS. **SHOW ALL WORK**.

3. There are 4 numbered pages in this WPR. Report any illegible or missing pages to the OIC in the hallway. Write your name on every page in the spaces provided.

(TOTAL WEIGHT 200 POINTS)

THIS SPACE FOR INSTRUCTOR USE ONLY			
PROBLEM	**MAX**	**CUT**	**POINTS**
A	**60**		
B	**50**		
C	**40**		
D	**50**		
		TOTAL SCORE	**/200**

APPROVED SOLUTION

Problem	Weight
A	60

Circle the best choice from each of the following selections to complete the following sentences:

1. The (***electron*** / ***neutron*** / ***proton***) is a subatomic particle that resides (***inside*** / ***outside***) of the nucleus and carries a net negative charge.

2. The (***atomic*** / ***charge*** / ***mass***) number of an atom or monatomic ion is the sum of all of its protons and neutrons.

3. In their nuclei, different isotopes of the same element have the same number of (***electrons*** / ***neutrons*** / ***protons***) and different numbers of (***electrons*** / ***neutrons*** / ***protons***).

4. The periodic table of the elements is formed in columns, called (***divisions*** / ***groups*** / ***periods***) and rows, called (***divisions*** / ***groups*** / ***periods***).

5. Atoms and ions that are isoelectronic have the exact same number of (***electrons*** / ***neutrons*** / ***protons***).

6. Atomic radius generally (***decreases*** / ***increases*** / ***remains the same***) from left to right across a row on the periodic table and generally (***decreases*** / ***increases*** / ***remains the same***) from top to bottom along a column.

7. First ionization energy generally (***decreases*** / ***increases*** / ***remains the same***) from left to right across a row on the periodic table and generally (***decreases*** / ***increases*** / ***remains the same***) from top to bottom along a column.

8. As the frequency of a photon increases, its energy (***decreases*** / ***increases*** / ***remains the same***) and the wavelength (***decreases*** / ***increases*** / ***remains the same***).

9. (***The aufbau principle*** / ***Hund's Rules*** / ***The Pauli exclusion principle***) indicate(s) that no two electrons can occupy the same orbital with the same spin.

Problem	Weight
B	50

Cadet _____

1. (10 pts) Calculate the number of atoms in 50.7 grams of carbon.

$$C = \frac{50.7\text{ g C}}{12.011\text{ g C}} \left| \frac{\text{mol C}}{\text{mol C}} \right| \frac{6.022\text{x}10^{23}\text{ C}}{\text{mol C}} = \underline{\underline{\boldsymbol{2.54\text{x}10^{24}\ C}}} \quad \textbf{ANS}$$

2. (15 pts) Consider an element with the following isotopic realative abundances:

94.93%	31.97 amu
0.76%	32.97 amu
4.29%	33.97 amu

a. What is the average atomic mass (in amu) of this atom?

$$\text{amu} = \underbrace{0.9493 \mid 31.97\text{ amu}}_{30.349121\text{ amu}} + \underbrace{0.0076 \mid 32.97\text{ amu}}_{0.250572\text{ amu}} + \underbrace{0.0429 \mid 33.97\text{ amu}}_{1.457313\text{ amu}} = \underline{\underline{\boldsymbol{32.06\text{ amu}}}} \quad \textbf{ANS}$$

$$= 32.057006\text{ amu}$$

b. What element is this? ***Sulfur***

3. (10 pts) The K^+ ion and the argon atom are isoelectronic; explain why it would take more energy to remove the outermost electron from K^+ than from argon. Use complete sentences.

Because they are isoelectronic, the relative energy required to remove the outermost electron is primarily a function of the higher core charge. K+ would have a core charge of +9 while argon's core charge is only +8.

4. (15 pts) Based on the following data, predict the radius of the sulfide ion (S^{2-}): ***184*** pm

Atom or ion	Measured Radius (pm)
P	110
P^{3-}	212
Cl	100
Cl^-	181

Briefly explain your prediction using complete sentences.

S^{2-} would be isoelectronic with both P^{3-} and Cl^-. P^{3-} has a core charge of +5 and Cl^- has a core charge of +7. S^{2-}, with a core charge of +6 would fall in between these two other ions.

Problem	Weight
C	40

1. (25 pts) Complete the table regarding electromagnetic radiation for the following 3 photons. Show all work below to receive full credit. *It is not necessary to fill in the blacked out boxes*.

Photon	**Energy (J)**	**Wavelength (m)**	**Frequency (s^{-1})**	**Region of Spectrum**
Photon A	$1.99\text{x}10^{-15}$	$9.99\ \text{x}10^{-11}$	$3.00\text{x}10^{18}$	***x-ray***
Photon B		***$3.10\text{x}10^{-3}$***	$9.67\text{x}10^{10}$	***Microwave***
Photon C	***$2.98\text{x}10^{-19}$***	$6.67\text{x}10^{-7}$		***Visible (Red/Orange)***

$$c = \lambda f \Rightarrow \lambda = c/f = \lambda\,(\text{m}) = \frac{2.998\text{x}10^{8}\ \text{m}}{\text{s}} \Big| \frac{\text{s}}{9.67\text{x}10^{10}} = \boldsymbol{3.10\text{x}10^{-3}\ m}\ \textbf{ANS}$$

$$E = hf = hc/\lambda = E\,(\text{J}) = \frac{6.626\text{x}10^{-34}\ \text{J s}}{\text{photon}} \Big| \frac{2.998\text{x}10^{8}\ \text{m}}{\text{s}} \Big| \frac{\text{photon}}{6.67\text{x}10^{-7}\ \text{m}} = \boldsymbol{2.98\text{x}10^{-19}\ J}\ \textbf{ANS}$$

2. (15 pts) The first ionization energy of calcium is approximately 600 kJ/mol. Would photon A (from above) be able to ionize ***a single calcium atom***? Show your work and write a complete sentence explaining your answer.

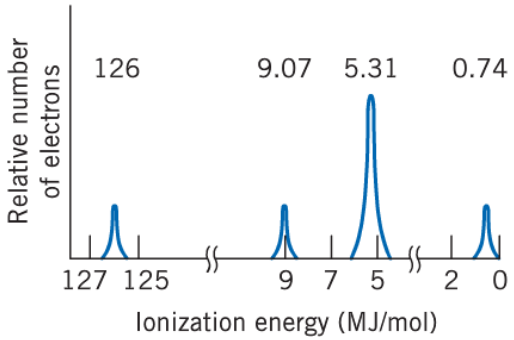
$$\text{IE for Calcium (J/atom)} = \frac{600\ \text{kJ}}{\text{mol}} \Big| \frac{1000\ \text{J}}{\text{kJ}} \Big| \frac{\text{mol}}{6.022\text{x}10^{23}\ \text{atoms}} = \boldsymbol{9.96\text{x}10^{-19}\ J/atom} < \boldsymbol{1.99\text{x}10^{-15}\ J/photon\ A}$$

<u>Yes</u>, photon A has $1.99\text{x}10^{-15}$ J of energy, <u>exceeding the amount required t</u>o ionize a single calcium atom ($9.96\text{x}10^{-19}$J).

Problem	Weight
D	50

Cadet _____

Use this photoelectron spectrum (PES) for the following questions:



1. (12 pts) Write the electron configuration for this atom. ***$1s^2\ 2s^2\ 2p^6\ 3s^2$***

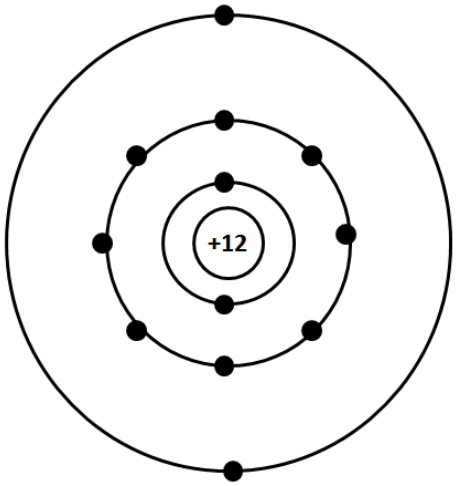
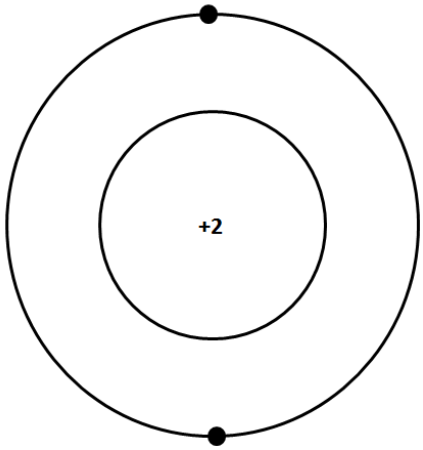
2. (10 pts) Briefly explain why the electrons represented by the peak at 126 MJ/mol have a higher ionization energy than the electrons represented by the peak at 0.74 MJ/mol.

The electrons at 126 MJ/mol are the 1s electrons, they are closest to the nucleus and as such require the most energy to overcome their coulombic attraction to the nucleus (IE is inversely proportional to distance).

3. (10 pts) Why is the peak at 5.31 MJ/mol 3 times as high as all of the other peaks?

The peak at 5.31 MJ/mol represents the most populous electron subshell, 2p, with 6 electrons. All of the other subshells are s subshells with only 2 electrons. The peak is 3 times as high because there are 3 times as many electrons available in that subshell to be ejected.

4. (13 pts) Use the PES to construct a shell model and a core charge concept model for this atom.

Shell Model	Core Charge Concept Model
	

5. (5 pts) What neutral atom would this PES represent? ***Mg***

APPROVED SOLUTION

CADET _____ SECTION/HR _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101, AY16-1
Written Partial Review II
23 October 2015
55 minutes

TEXT: Moog, Farrell, Chemistry: A Guided Inquiry, 6th Edition
SCOPE: Lessons 13-23

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
Chemistry Reference Data Card (RDC)

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. Be sure to do the following ***to receive full credit***:
   a. Print legibly
   b. ***Show all work***
   c. Use complete sentences for all explanations
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(TOTAL WEIGHT 200 POINTS)

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A	**60**		
B	**50**		
C	**40**		
D	**50**		
	TOTALS		**/200**

APPROVED SOLUTION

Problem	Weight
A	60

Circle the best choice from each of the following selections to complete the following sentences:

1. A negatively charged particle is called a(n) (***anion*** / ***cation*** / ***polyatomic ion***).

2. Covalent compounds generally result from (***metals*** / ***metalloids*** / ***nonmetals***) bonding with (***metals*** / ***metalloids*** / ***nonmetals***)

3. Bond energy is the energy required to (***break*** / ***create*** / ***preserve***) a bond between adjacent atoms within a molecule or polyatomic ion.

4. Molecular shape results from the electrostatic (***attractions*** / ***bonds*** / ***repulsions***) between (***bonding*** / ***nonbonding*** / ***bonding and nonbonding***) domains about a central atom.

5. The relative ability of an atom in a molecule to attract shared electrons is called (***electron affinity*** / ***electronegativity*** / ***partial charge***).

6. (***Covalent*** / ***Ionic*** / ***Metallic***) bonds are characterized by electron transfer between atoms and their subsequent electrostatic attraction.

7. With respect to a C-O bond, a C-N bond would be (***less*** / ***more***) polar (***longer*** / ***shorter***), and have a (***equal*** / ***higher*** / ***lower***) bond energy.

8. Between H_3CCl, CF_4, and CCl_4, (***H_3CCl*** / ***CF_4*** / ***CCl_4***) has the most polar bond and (***H_3CCl*** / ***CF_4*** / ***CCl_4***) has the largest dipole moment.

9. Molecules with (***higher*** / ***lower***) molecular weights and (***larger*** / ***no*** / ***smaller***) dipole moment(s) tend to have higher boiling points.

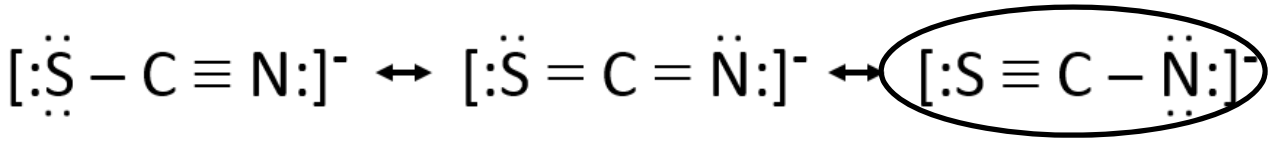
Problem	Weight
B	50

Cadet _____

1. (26 pts) Complete the following table by writing the chemical formula or name, as appropriate:

Formula	**Name**
$XeBr_4$	xenon tetrabromide
CS	***carbon monosulfide***
SnS_2O_3	***tin(II) thiosulfate***
O_2F_2	***Dioxygen difluoride***
$Ca_3(BO_3)_2$	calcium borate
$CoCl_2 \cdot 6\ H_2O$	***cobalt(II) chloride hexahydrate***

2. a. (12 pts) Three possible structures for thiocyanate ion are represented below. ***Circle*** the ***least*** important structure ***and*** briefly explain how one can tell it less important than the other two:



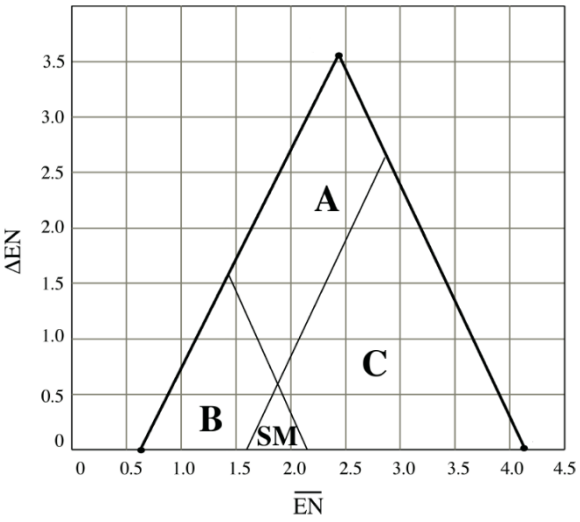
This structure is the least important because it has the <u>highest formal charges</u>; however, the negative formal charge is on the more electronegative atom.

b. (12 pts) Of the atoms in thiocyanate ion (above), nitrogen is the most electronegative. Briefly explain what makes nitrogen the most electronegative by comparing its atomic structure to that of the other two atoms.

Nitrogen is the most electronegative atom because it has a <u>smaller valence shell (n=2) than sulfur (n=3)</u> and a <u>higher core charge (+5) than carbon (+4)</u>.

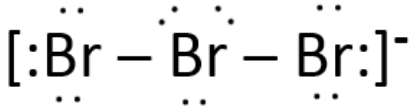
Problem	Weight
C	40

1. (12 pts) Consider the bond-type triangle to the right. Draw a line to connect the regions from the diagram with the bond-type each represents on the right (one has been done for you):



Region	**Bond Type**
A	Covalent
B	Ionic
C	Metallic
SM	Semi-metallic

2. (8 pts) Given the structure for the polyatomic ion tribromide (Br_3^-) below, indicate whether the bonding within the polyatomic ion is either polar covalent, non-polar covalent, or ionic. Briefly explain your answer.



Within the tribromide ion, the bromines are bound by nonpolar covalent bonds. This is because they are <u>nonmetals</u> that are <u>sharing the electrons</u> and there is <u>no difference in electronegativity</u> between similar atoms.

3. (8 pts) In a compound such as CsF, indicate whether the bonding between cesium and fluorine is either polar covalent, non-polar covalent, or ionic. Briefly explain your answer.

The bonding between the cesium ion and the fluoride ion is <u>ionic</u>. There is a <u>metal bound with a nonmetal</u> and the <u>electrons are not shared</u>; instead, the ions are <u>electrostatically attracted to eachother because of their opposite charges.</u>

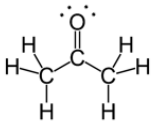
4. (12 pts) Given two compounds, CsF and RbF, which would have the higher melting point? Briefly explain your answer.

<u>Rubidium fluoride</u> would have the higher melting point because <u>the charge on cesium is equal to the charge of rubidium</u>, so the stronger ionic bond would be <u>the shorter bond, composed of the smaller ion, Rb^+</u>.

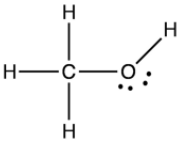
Problem	Weight
D	50

Cadet _____

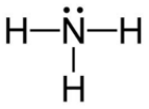
1. (12 pts) The Lewis structures for four compounds are given below.



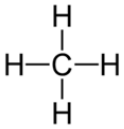
Acetone



Methanol



Ammonia

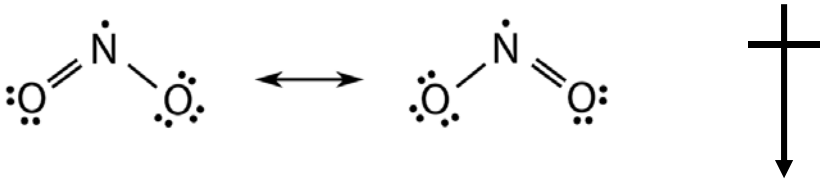


Methane

Mark each box to indicate all of the intermolecular forces a sample of each would exhibit:

Intermolecular Force	Acetone	Methanol	Ammonia	Methane
Hydrogen Bonding		***X***	***X***	
Dipole-Dipole	***X***	***X***	***X***	
Dispersion Forces	***X***	***X***	***X***	***X***

2. a. (12 pts) Nitrogen dioxide (NO_2) has an unpaired electron, it is highly reactive because of this "free radical". Experimental evidence indicates that it is polar and all of the bonds are the same length. Draw the best Lewis Structure to depict nitrogen dioxide.



b. (4 pts) Draw the dipole moment (arrow) to depict the molecular dipole next to your Lewis Structure for NO_2 (above).

c. (12 pts) Would nitrogen dioxide have a lower boiling point than carbon dioxide? Be sure to discuss the intermolecular forces in each as part of your answer.

No, because a sample of nitrogen dioxide would exhibit dipole-dipole interactions while a sample of carbon dioxide only experiences dispersion forces, it would take more average kinetic energy (a higher temperature) for the NO_2 molecules to overcome their IMFs.

3. (10 pts) Hydrogen bonding in a sample of water is an intermolecular force. Briefly contrast it with the covalent bond between hydrogen and oxygen atoms in a single water molecule.

The hydrogen bonding in water is a nonbonding, intermolecular force that attracts water molecules to each other. The H-O bond within a water molecule is a bonding, intramolecular force that holds individual water molecules together.

APPROVED SOLUTION

CADET _____ SECTION/HR _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101, AY16-1
Written Partial Review III
08 December 2015
55 minutes

TEXT: Moog, Farrell, Chemistry: A Guided Inquiry, 6th Edition
SCOPE: Lessons 25-37

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
Chemistry Reference Data Card (RDC)

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. Be sure to do the following ***to receive full credit***:
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(TOTAL WEIGHT 200 POINTS)

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PROBLEM	**MAX**	**CUT**	**POINTS**
A	**60**		
B	**55**		
C	**60**		
D	**25**		
	TOTALS		**/200**

APPROVED SOLUTION

Problem	Weight
A	60

Circle the best choice from each selection to complete the following statements:

1. Molarity is a measure of how much (***solute*** / ***solution*** / ***solvent***) is dissolved into a given amount of (***solute*** / ***solvent***).

2. A sample of a soluble salt would (***only dissociate*** / ***only dissolve*** / ***dissolve and dissociate***) in water and (***is*** / ***is not***) an electrolyte.

3. Simply, (***Boyle's*** / ***Charles'*** / ***Dalton's***) Law indicates that an increase in pressure of a gas results in (***a decrease*** / ***an increase*** / ***no change***) in its volume.

4. For a gas, standard temperature is (***-273º C*** / ***0º C*** / ***25º C*** / ***100º C***) and standard pressure is (***0 torr*** / ***1 torr*** / ***100 torr*** / ***760 torr***).

5. Atom combination to form bonds is always an (***endothermic*** / ***exothermic*** / ***isothermic***) process, resulting in a change in enthalpy value (***equal to*** / ***greater than*** / ***less than***) zero.

6. The timing effect gained by a fuse makes it an example of a(n) (***explosive*** / ***propellant*** / ***pyrotechnic***).

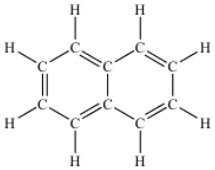
7. (***Kinetic*** / ***Molar*** / ***Specific***) heat capacity is a measure of the amount of energy required to raise the temperature of 1 g of a substance by 1 K.

Circle the best choice from each selection to answer the following questions:

8. How many grams of oxygen atoms are present in 386 g of $Zn_3(PO_4)_2$ ($\mathcal{M}$ = 386.080 g/mol)?

   a. 32 g
   b. 64 g
   c. 128 g
   d. 256 g

9. Based on the given structure of naphthalene, what is its empirical formula?



   a. CH
   b. C_2H
   c. C_5H_4
   d. $C_{10}H_8$

10. If 75 g of water at 100º C are mixed with 25 g of water at 0º C, what would be the final temperature of the water (assuming no heat is lost to the surroundings)?

   a. 25º C
   b. 50º C
   c. 67º C
   d. 75º C

Problem	Weight
B	55

Cadet _____

1. (16 pts) Combustion analysis results from an experiment conducted on 33.7 g of an unknown compound containing carbon, hydrogen, and oxygen indicate that it is 40.% carbon and 6.7% hydrogen (by mass). What is the empirical formula of this compound?

$$\frac{33.7\text{ g } C_xH_yO_z \mid 0.40\text{ g C} \mid \text{mol C}}{\mid 1\text{ g } C_xH_yO_z \mid 12.011\text{ g C}} = 1.122\text{ mol C}$$

$$\frac{33.7\text{ g } C_xH_yO_z \mid 0.067\text{ g H} \mid \text{mol H}}{\mid 1\text{ g } C_xH_yO_z \mid 1.0079\text{ g H}} = 2.240\text{ mol H}$$

100% - 40.% - 6.7% = 53.3% O

$$\frac{33.7\text{ g } C_xH_yO_z \mid 0.533\text{ g O} \mid \text{mol O}}{\mid 1\text{ g } C_xH_yO_z \mid 15.999\text{ g O}} = 1.123\text{ mol O}$$

$$\underset{\frac{1.122}{1.122}}{C}\ \underset{\frac{2.240}{1.122}}{H}\ \underset{\frac{1.123}{1.122}}{O} = \underline{\underline{CH_2O}}\ \textit{ANS}$$

2. (9 pts) Colligative property analysis indicates that the molar mass of an unknown compound with the empirical formula CH_2O is approximately 180 g/mol; what is the molecular formula?

CH_2O = 30.0258 g/mol; 180/30.0258 = 6; there are 6 empirical formulae per molecule:

$C_6H_{12}O_6$.
ANS

3. (15 pts) Chloride ions from table salt can be used to detect the presence of lead in drinking water in accordance with the following precipitation reaction:

$$Pb^{2+}(aq) + 2\ Cl^-(aq) \rightarrow PbCl_2(s)$$

Theoretically, how much $PbCl_2$ ($\mathcal{M}$ = 278.1 g/mol) can form from the complete reaction of 23.3 mL of 0.477 *M* Cl^- solution?

$$g\ PbCl_2 = \frac{23.3\text{ mL } Cl^- \mid \text{L} \mid 0.477\text{ mol } Cl^- \mid \text{mol } PbCl_2 \mid 278.1\text{ g } PbCl_2}{\mid 1000\text{ mL} \mid \text{L } Cl^- \mid 2\text{ mol } Cl^- \mid \text{mol } PbCl_2} = \underline{\underline{1.55\text{ g } PbCl_2}}\ \textit{ANS}$$

4. (15 pts) A 2L bottle of soda contains approximately 0.3 moles of CO_2. What volume would this CO_2 occupy if it were captured in a balloon attached to the top of the bottle as the soda went flat (assume complete transfer of all dissolved CO_2 from the soda to the balloon) at 298 K and 0.98 atm?

$$PV = nRT \rightarrow V = nRT/P = \frac{0.3\text{ mol} \mid 0.08206\text{ L atm} \mid 298\text{ K} \mid}{\mid \text{mol K} \mid \mid 0.98\text{ atm}} = \underline{\underline{7L}}\ \textit{ANS}$$

Problem	Weight
C	60

Some values from the RDC are reproduced on the back of this WPR

1. (14 pts) Write a chemical reaction to predict the products formed upon detonation of PETN (on your RDC).

$$C_5H_8N_4O_{12}(s) \rightarrow 4\ H_2O(g) + 3\ CO_2(g) + 2\ CO(g) + 2\ N_2(g)$$

2. (11 pts) Using ΔH^o_{ac} values, explain which has the stronger bonds: $CO_2(g)$ or $H_2O(g)$.

CO_2 has the stronger bonds between atoms. It has double bonds between the C and O atoms and a ΔH^o_{ac} = -1608.531 kJ/mol, indicating an average bond energy of almost 800 kJ/mol. Despite having shorter bonds, H_2O has only singly bound atoms with a ΔH^o_{ac} = -926.29 kJ/mol, indicating an average bond energy of only 460 kJ/mol.

3. a. (15 pts) What is the standard change in enthalpy (ΔH^o_{rxn}) associated with the decomposition of ozone to oxygen?

$$2\ O_3(g) \rightarrow 3\ O_2(g)$$

$$\Delta H^o_{rxn} = \Sigma m\ \Delta H^o_{ac(products)} - \Sigma n\ \Delta H^o_{ac(reactants)}$$

$$\Delta H^o_{rxn} = \frac{3\ \text{mol } O_2}{\text{mol } O_2} \left| \frac{-498.340\ \text{kJ}}{} \right. - \frac{2\ \text{mol } O_3}{\text{mol } O_3} \left| \frac{-604.8\ \text{kJ}}{} \right. = \underline{\underline{-285.4\ \text{kJ}}}$$

ANS

b. (11 pts) Using the value you just calculated, determine the change in enthalpy associated with the production of 143g of O_2 ($\mathcal{M}$ = 31.998 g/mol) in accordance with the reaction above.

$$\Delta H^o_{rxn} = \frac{143\ \text{g } O_2}{31.998\ \text{g } O_2} \left| \frac{\text{mol } O_2}{3\ \text{mol } O_2} \right. \left| \frac{-285.4\ \text{kJ}}{} \right. = \underline{\underline{-425\ \text{kJ}}}$$

ANS

4. (9 pts) The value for ΔH^o_{ac} for liquid water is -970.30 kJ/mol. Propose a reasonable value for the ΔH^o_{ac} for ice and use the kinetic theory of heat to explain the freezing process of turning liquid water into ice.

The ΔH^o_{ac} for ice will be less than -970.30 kJ/mol, for example -1 MJ/mol. As heat is removed from the liquid water, the molecules slow down and the strong intermolecular forces between them (primarily hydrogen bonding) will not only attract them together but prevent them from moving about the sample as they crystallize into a lattice structure.

Problem	Weight
D	25

Cadet _____

1. (13 pts) Write balanced nuclear reactions for each of the following processes:

   a. Alpha decay of ^{228}Th $\quad {}^{228}_{90}\mathrm{Th} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{224}_{88}\mathrm{Ra}$

   b. Formation of ^{125}Te by electron capture $\quad {}^{125}_{53}\mathrm{I} + {}^{0}_{-1}\mathrm{e}^{-} \rightarrow {}^{125}_{52}\mathrm{Te}$

2. (12 pts) Both fission and fusion have the potential to generate large amounts of energy; however, they each have costs and benefits associated with them. Demonstrate your familiarity with the science behind each in answering the following questions. Do not appeal to emotion as you propose each argument. Provide ***only one*** argument for each prompt.

   a. What is ***one*** argument unique to ***fission*** that its proponents could offer to encourage its continued exploration and development as an energy source?

Fission is currently in use all over the world and the fuel is widely available. It has been in use in the US since 1960 and generates very little air pollution.

   b. Provide ***one*** counter argument unique to ***fission*** that opponents could offer.

Fission generates radioactive hazardous waste with long half-lives that presents a long-term waste management and disposal problem. The materials can be proliferated and require governmental tracking.

   c. What is ***one*** argument unique to ***fusion*** that its proponents could offer to encourage its continued exploration and development as an energy source?

Conceptually, it could generate the highest amount of energy with no radioactive byproducts and neither the fuels nor the byproducts present a management or proliferation concern.

   d. Provide ***one*** counter argument unique to ***fusion*** that opponents could offer.

Currently, the technology does not exist to make this a viable energy source; the temperature required exceeds that which most materials can handle so the devices capable of containing the reaction use as much or more power than the reaction generates.

The following data (also on your RDC) may be helpful in answering some of the questions in this WPR:

Substance	$\Delta H°_{ac}$ (kJ/mol)	$\Delta G°_{ac}$ (kJ/mol)	$\Delta S°_{ac}$ (J/mol·K)
$C(g)$	0	0	0
$CO(g)$	-1076.377	-1040.156	-121.477
$CO_2(g)$	-1608.531	-1529.078	-266.47
$H_2O(l)$	-970.30	-875.354	-320.57
$H_2O(g)$	-926.29	-866.797	-202.23
$N_2(g)$	-945.408	-911.26	-114.99
$N(g)$	0	0	0
$O_2(g)$	-498.340	-463.462	-116.972
$O(g)$	0	0	0
$O_3(g)$	-604.8	-532.0	-244.24

CADET _____ SECTION/HR _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101, AY16-2
Written Partial Review I
08 February 2016
55 minutes

TEXT: Moog, Farrell, Chemistry: A Guided Inquiry, 6th Edition
SCOPE: Lessons 01-11

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
Chemistry Reference Data Card (RDC)

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. Be sure to do the following ***to receive full credit***:
   a. Print legibly
   b. ***Show all work***
   c. Use complete sentences for all explanations
   d. Answer all questions

3. There are 4 numbered pages in this WPR. Report any illegible or missing pages to the OIC in the hallway. Write your name on every page in the spaces provided.

(TOTAL WEIGHT 200 POINTS)

THIS SPACE FOR INSTRUCTOR USE ONLY			
PROBLEM	**MAX**	**CUT**	**POINTS**
A	**60**		
B	**40**		
C	**50**		
D	**50**		
		TOTAL SCORE	**/200**

Problem	Weight
A	60

Circle the best choice from each of the following selections to complete the following sentences:

1. The removal of a(n) (***electron*** / ***neutron*** / ***proton***) from a neutral atom creates an ion with a positive charge called a cation.

2. The (***atomic*** / ***charge*** / ***mass***) number of an atom or monatomic ion is the total of all of its (***electrons*** / ***neutrons*** / ***protons***)

3. *In their nuclei*, ^{13}C and ^{14}C have the same number of (***electrons*** / ***neutrons*** / ***protons***) and a different number of (***electrons*** / ***neutrons*** / ***protons***).

4. The elements F, Cl, Br, and I are often referred to as halogens; these elements are all in the same (***group*** / ***period*** / ***quadrant***) of the periodic table and have the same (***core charge*** / ***electrons*** / ***protons***).

5. $^{23}Na^{+}$ and $^{19}F^{-}$ are (***isobaric*** / ***isoelectronic*** / ***isotopes***) because they have the exact same number of (***electrons*** / ***neutrons*** / ***protons***).

6. The atomic radius of fluorine is (***greater than*** / ***less than*** / ***the same as***) boron. Additionally, the atomic radius of fluorine is (***greater than*** / ***less than*** / ***the same as***) iodine.

7. (***The aufbau principle*** / ***Hund's Rules*** / ***The Pauli exclusion principle***) indicate(s) that no two electrons can occupy the same orbital with the same spin.

8. Photons in the gamma (γ) region of the EM spectrum have (***equal*** / ***greater*** / ***less***) energy and travel at speeds (***equal to*** / ***faster than*** / ***slower than***) photons in the microwave region.

9. As wavelength of a photon increases across the electromagnetic spectrum, the energy (***decreases*** / ***increases*** / ***remains the same***).

Problem	Weight
B	40

Cadet _____

1. a. (10 pts) What is the mass (in grams) of 1.19×10^{17} C atoms?

$$m(g) = \frac{1.19\times10^{17}\text{ C atoms}}{6.022\times10^{23}\text{ C atoms}} \left|\frac{\text{mol C}}{\text{mol C}}\right| \frac{12.011\text{ g C}}{\text{mol C}} = \underline{\underline{2.37\times10^{-6}\text{ g C}}}$$

ANS

b. (6 pts) Would 1.19×10^{17} ^{13}C atoms have the same mass as the above? Briefly explain your answer.

No, because the molar mass of carbon (12.011 g/mol) is the weighted average of all of its naturally occurring isotopes, ^{12}C, ^{13}C, and ^{14}C; a similar amount of the ^{13}C isotope would have a slightly larger mass due to the additional neutron in its nucleus compared to the more abundant ^{12}C atoms.

2. (14 pts) Neon has three naturally occurring isotopes, complete the table below for Neon; *show all work to receive full credit:*

Isotope	Abundance	Mass (amu)
^{20}Ne	90.480%	19.9924
^{21}Ne	0.270%	20.9938
^{22}Ne	***9.250%***	***21.99***

100.000 % Ne
- 90.480 % ^{20}Ne
- 0.270 % ^{21}Ne
9.250 % ^{22}Ne

ANS

(0.9048)(19.9924 amu)+ (0.0027)(20.9938 amu)+ (0.09250)(X) = 20.180 amu

↓ ↓ ↓ ↓

18.0891 amu + 0.0566 amu + 0.09250 X = 20.180 amu

X = ***21.991 amu***

ANS

3. (10 pts) Use the atomic structures of K^+ and Ar to explain why it would require more energy to remove an electron from a potassium ion (K^+) than to remove an electron from an argon (Ar) atom.

Potassium ion and argon are isoelectronic, so they have the same number of electrons and the same valence shell (n=3). This means that the ionization energy for each becomes a function of core charge; potassium ion has a larger core charge (+9) than argon (+8), attracting the valence electrons more strongly, requiring more energy to remove them.

Problem	Weight
C	50

1. Use the following information to help you answer 1a-c, below: genetic material is stored in DNA, which is composed of complementary sugar bases. These sugars are structured in a double helix and the energy required to damage this structure at any point is approximately $8x10^{-19}$ J.

   a. (4 pts) Generally, cellular phones using the 4G network operate at 740 MHz ($7.4x10^{8}$ Hz).

In what region of the electromagnetic spectrum do these phones operate? ***TV Waves***.

   b. (10 pts) Calculate the energy of a single photon of this frequency.

$$E = hf = \frac{6.626x10^{-34}\ \text{J·s} \mid 740\ \text{MHz} \mid 10^{6}\ \text{Hz} \mid}{\text{photon} \mid \mid \text{MHz} \mid \text{Hz·s}} = \underline{\underline{4.9x10^{-25}\ \textit{J / photon}}}$$

ANS

   c. (2 pts) Do cellphone transmissions have enough energy per photon to break DNA? ***No***.

2. (14 pts) Circle the atom from each pair that has a *lower* ionization energy:

   a. ***bromine*** or ***iodine***

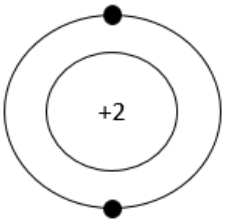
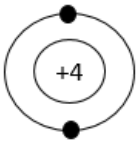
   b. ***carbon*** or ***nitrogen***

   c. ***potassium*** or ***argon***

   d. Briefly explain your selection from 2.c. (potassium or argon).

Because potassium (n=4) is larger than argon (n=3) and has a much lower core charge (+1) than argon (+8) the attraction of the valence electrons to the nucleus is less, resulting in a lower ionization energy for potassium.

3. (20 pts) Complete the table for the following atoms/ions:

Atom / ion:	**Be**	**Be^{2+}**
Number of Inner Shell Electrons:	***2***	***0***
Number of Valence Electrons:	***2***	***2***
Core Charge:	***+2***	***+4***
Sketch of Core Charge Concept Model:		

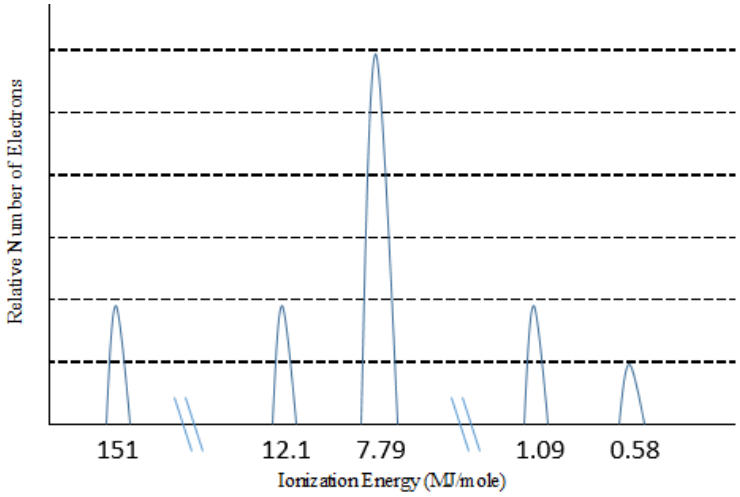
Problem	Weight
D	50

Cadet _____

Use the following photoelectron spectroscopy (PES) data from p.92 of Spencer to answer the questions:

	IE (MJ/*mol*)				
Element	1*s*	2*s*	2*p*	3*s*	3*p*
Na	104	6.84	3.67	0.50	
Mg	126	9.07	5.31	0.74	
Al	151	12.1	7.79	1.09	0.58

1. a. (20 pts) Construct a photoelectron spectrum for ***aluminum*** (*be sure to label your axes*):



b. (12 pts) Write the electron configuration for ***aluminum***: ***$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$***

2. a. (10 pts) When conducting a PES experiment, a scientist has a photon source capable of generating photons with up to 120 MJ/mol. What is the maximum amount of energy a single photon could have (in J)?

$$\text{J / photon} = \frac{120\ \text{MJ}}{\text{mol}} \left| \frac{\text{mol}}{6.022\times10^{23}\ \text{photon}} \right| \frac{10^6\ \text{J}}{\text{MJ}} = \underline{\underline{2.0\times10^{-16}\ \text{J/photon}}}$$

ANS

b. (8 pts) For which, if any, *of the three atoms in the table above* would this 120 MJ/mol source be sufficient to observe all of the peaks in their PESs? Briefly explain your answer.

This would only be sufficient to completely resolve sodium (Na), as the 1s electrons in both Mg and Al would require even higher energy photons to ionize them.

CADET _____ SECTION/HR _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101, AY16-2
Written Partial Review II
24 March 2016
55 minutes

TEXT: Moog, Farrell, Chemistry: A Guided Inquiry, 6th Edition
SCOPE: Lessons 13-23

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
Chemistry Reference Data Card (RDC)

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. Be sure to do the following ***to receive full credit***:
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   b. ***Show all work***
   c. Use complete sentences for all explanations
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(TOTAL WEIGHT 200 POINTS)

THIS SPACE FOR INSTRUCTOR USE ONLY			
PROBLEM	**MAX**	**CUT**	**POINTS**
A	**60**		
B	**50**		
C	**45**		
			/155
D	**45**		**/45**
		TOTAL SCORE	**/200**

Problem	Weight
A	60

Circle the ***best*** choice from each of the following selections to complete the following sentences:

1. A(***gas*** / ***liquid*** / ***solid***) will expand to fill the entire volume of its container.

2. A cation is formed when an atom (***gains an electron*** / ***gains a proton*** / ***loses an electron***). It can then be attracted to a(n) (***anion*** / ***cation*** / ***polyatomic ion***).

3. Moog defines *bond energy* as "the energy required to (***form*** / ***sever*** / ***stabilize***) the bond that holds two adjacent atoms together in a molecule" (Moog, 2015, p.82).

4. When nonmetals combine in the formation of polyatomic ions, they form (***covalent*** / ***ionic*** / ***metallic***) bonds within the polyatomic ion.

5. Higher AVEEs belong to atoms with (***larger*** / ***neutral*** / ***smaller***) core charges and (***inner*** / ***larger*** / ***smaller***) valence shells.

6. Molecular shape arises as a result of electrostatic (***attractions*** / ***neutralizations*** / ***repulsions***) between (***bonding*** / ***nonbonding*** / ***bonding and nonbonding***) domains around a central atom.

7. (***AVEE*** / ***electronegativity*** / ***ionization energy***) is the measure of an atom's ability to attract electrons in a bond towards itself.

8. Dipole moments on molecules arise as a function of the polar bonds within a molecule and the molecule's (***electronegativity*** / ***partial charges*** / ***molecular shape***).

9. The melting point of ionic solids generally increases as charges on the ions (***cancel*** / ***decrease*** / ***increase***) and ionic radii (***attract*** / ***decrease*** / ***increase***).

10. Ionic compounds (***conduct*** / ***do not conduct*** / ***semi-conduct***) electricity as solids.

11. Intermolecular forces are (***bonding*** / ***intramolecular*** / ***nonbonding***) forces.

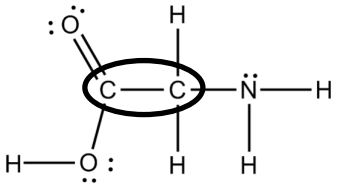
Problem	Weight
B	50

Cadet _____

1. (16 pts) Complete the following table, giving the name or formula as appropriate:

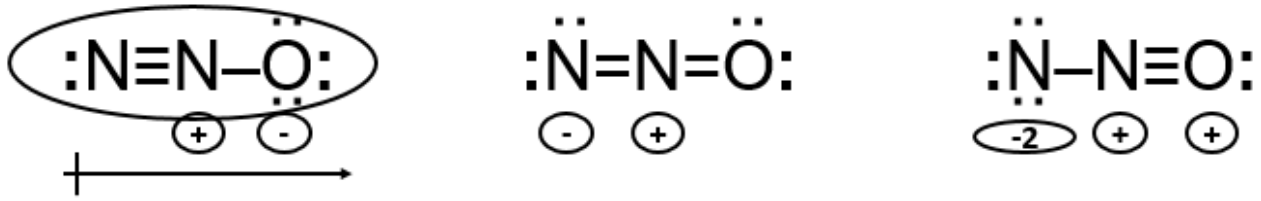
Formula	Compound Name
PF_5	***phosphorus pentafluoride***
I_2O_5	diiodine pentoxide
$Al_2(CO_3)_3$	aluminum carbonate
Au_3N	***gold(I) nitride***
$NaClO_3 \cdot 5\ H_2O$	***sodium chlorate pentahydrate***

2. (10 pts) Given the following structure for the amino acid glycine (Gly), ***circle the bond*** that you would anticipate to be the longest. Use complete sentences to ***briefly explain*** your choice:



The C-C bond would be the longest because it is a <u>single bond</u> between <u>the largest atoms</u> (both carbon) in the molecule.

3. a. (10 pts) ***Write in the formal charges*** on all of the following proposed Lewis structures for N_2O, as appropriate. Understanding that the more negative formal charges should reside on the more electronegative atoms, ***circle which structure is the best***.



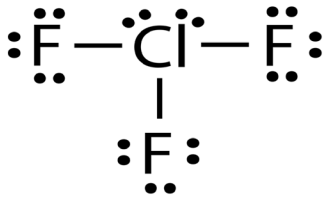
b. (14 pts) Use the first (far left) structure for N_2O to answer the following questions:

1) How many electron domains surround the central nitrogen? ***<u>2</u>***
2) How many of these domains are bonding domains? ***<u>2</u>***
3) How many of these domains are nonbonding domains? ***<u>0</u>***
4) What is the hybridization of the central nitrogen? ***<u>sp</u>***
5) What is the shape of this molecule? ***<u>linear</u>***
6) Would this molecule be polar? circle one: (***yes*** / ***no***)
   a) ***If "yes", draw the dipole moment*** on the structure above.

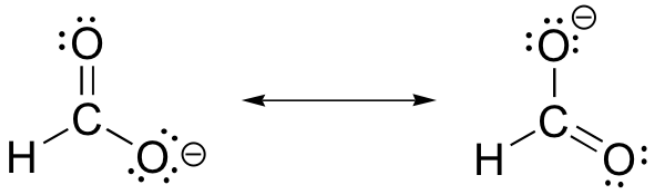
Problem	Weight
C	45

1. (20 pts) Draw the directed Lewis structures. Indicate the total number of valence electrons for each in the blanks provided and be sure to include any important resonance structures and formal charges, as appropriate.

a. ClF_3 total valence electrons: ***28***



b. HCO_2^- (*C is central*) total valence electrons: ***18***



2. (10 pts) The partial charge of F in HF is -0.29, predict a reasonable value for the partial charge of H in HCl and briefly explain how your prediction is valid.

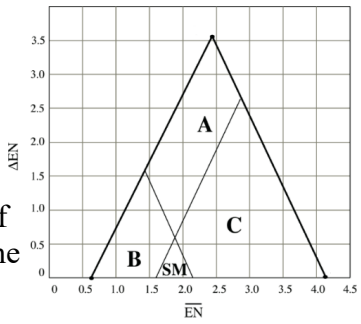
H could have any positive partial charge between 0 and 0.29, like +0.17. The partial charge is positive because chlorine has a higher AVEE than H; however, it would be less than +0.29 because chlorine has a lower AVEE than F.

3. (15 pts) Use the bond triangle to answer the following questions:

a. What region characterizes covalent bonding? ***C***

b. In what region would you expect to find the bonding in $SnCl_2$? ***A***

c. Consider two atoms with similar and low electronegativities. What type of bonding would most likely attract them to each other? Briefly ***explain how*** the electronegativities would result in this type of bonding.

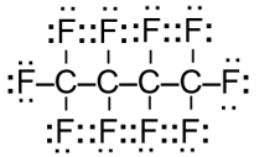


The bonding should be metallic. The low ENs would indicate that neither atom will attract the shared electrons strongly. The small difference in ENs would indicate that neither atom is going to attract the shared electrons significantly more than the other. This would result in a pooling of the shared electrons.

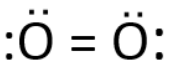
Problem	Weight
D	45

Cadet _____

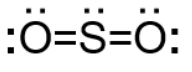
In the movie *The Abyss* (1989), humans were able to survive deep underwater at high pressure by breathing a solution of perfluorocarbons (PFCs), such as perfluorobutane (below). Use the following Lewis structures, as necessary, to answer the questions on this page:



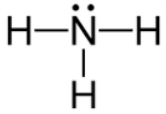
perfluorobutane (C_4F_{10})



oxygen (O_2)



sulfur dioxide (SO_2)



Ammonia (NH_3)

1. (12 pts) Place an "X" in the boxes below indicating all of the IMFs that would be present in a pure sample of each substance (*note: not all IMFs are represented in this table*):

Intermolecular Force	perfluorobutane	oxygen	sulfur dioxide	ammonia
Hydrogen Bonding				***X***
Dipole-Dipole			***X***	***X***
Dispersion Forces	***X***	***X***	***X***	***X***

2. (9 pts) Briefly explain which would have the higher boiling point, oxygen or perfluorobutane.

Perfluorobutane would have the higher BP because both molecules only have dispersion forces; however, the perfluorobutane is larger (heavier) with a greater surface area, making it more polarizable.

3. (12 pts) Oxygen dissolves in PFCs readily because they have similar intermolecular forces; however, oxygen does not dissolve in water to the same extent.

a. What is the strongest IMF that could attract an oxygen molecule to a water molecule?

Dipole-induced dipole forces could attract an oxygen molecule to a water molecule.

b. Consider the IMFs in water. Briefly explain why the IMF you listed in 3.a. (above) is not strong enough to allow oxygen to dissolve in water at levels humans would need to survive.

The stronger hydrogen bonding between water molecules prevents it from dissolving at significantly high levels.

4. (12 pts) Briefly contrast the hydrogen bonding in a sample of methanol (CH_3OH) with the covalent bond between the hydrogen atom and oxygen atom in a single methanol molecule.

The hydrogen bonding in methanol is a nonbonding, intermolecular force that attracts methanol molecules to each other. The H-O bond within a methanol molecule is a bonding, intramolecular force that holds individual molecules together.

CADET _____ SECTION/HR _____

DEPARTMENT OF CHEMISTRY AND LIFE SCIENCE

CHEMISTRY 101, AY16-2
Written Partial Review III
15 April 2016
55 minutes

TEXT: Moog, Farrell, Chemistry: A Guided Inquiry, 6th Edition
SCOPE: Lessons 24-32

Authorized References
TI-30XIIS Calculator or equivalent & Reference Sheet
Chemistry Reference Data Card (RDC)

1. Do not mark on this exam or open it until "begin work" is given.

2. Solve problems in the space provided. Be sure to do the following ***to receive full credit***:
   a. Print legibly
   b. ***Show all work***
   c. Use complete sentences for all explanations
   d. Answer all questions

3. There are 4 numbered pages in this WPR. Report any illegible or missing pages to the OIC in the hallway. Write your name on every page in the spaces provided.

(TOTAL WEIGHT 200 POINTS)

THIS SPACE FOR INSTRUCTOR USE ONLY			
PROBLEM	**MAX**	**CUT**	**POINTS**
A	**60**		
B	**60**		
C	**40**		
D	**40**		**/45**
		TOTAL SCORE	**/200**

Problem	Weight
A	60

Circle the ***best*** choice from each of the following selections to complete the following sentences:

1. The total charge of all species on both sides of a balanced chemical reaction must be (***equal*** / ***negligible*** / ***zero***)

2. The empirical formula for tetracycline, $C_{22}H_{24}N_2O_8$, is (***CHNO*** / ***$C_{11}H_{12}NO_4$*** / ***$C_{22}H_{24}N_2O_8$***).

3. The ability of a(n) (***electrolyte*** / ***solute*** / ***solvent***) to dissolve a (***nonelectrolyte*** / ***salt*** / ***solute***) is largely dependent on the IMFs of both substances.

4. Generally, (***covalent*** / ***ionic*** / ***molecular***) compounds can dissociate in water; the more they dissociate, the stronger (***concentrates*** / ***electrolytes*** / ***nonelectrolytes***) they are.

5. Kinetic molecular theory postulates that gas particles experience (***attractive*** / ***elastic*** / ***inelastic***) collisions and move in (***arcs*** / ***straight lines*** / ***waves***).

6. (***Boyle's*** / ***Charles'*** / ***Dalton's***) Law describes volume of a gas as it relates to temperature; volume and temperature are (***directly*** / ***inversely*** / ***logarithmically***) related.

7. The particles of an ideal gas are considered to have (***moderate*** / ***negligible*** / ***partial***) volume with respect to the volume of their container.

8. In a chemical reaction between two reactants, one would expect the final mass of the products to be (***greater than*** / ***equal to*** / ***less than***) the initial mass of the reactants because it is unlikely that both reactants were present in exact stoichiometrically equivalent amounts.

9. Gas particles are more likely to behave ideally at (***higher*** / ***lower*** / ***moderate***) temperatures and (***higher*** / ***lower*** / ***moderate***) pressures, where they would have (***less*** / ***more*** / ***significant***) opportunities for their intermolecular forces to attract adjacent particles.

Problem	Weight
B	60

Cadet _____

1. (14 pts) What is the mass of one mole of ammonium selenide, $(NH_4)_2Se$?

(2 mol N)(14.007 g/mol N) + (8 mol H)(1.0079 g/mol H) + (1 mol Se)(78.96 g/mol Se) = 115.04 g

2. (15 pts) Write the balanced chemical reaction that occurs when sodium metal reacts with liquid water to form sodium ions and hydroxide ions. Hydrogen gas (H_2) also forms.

$$\mathbf{2\ Na(s) + 2\ H_2O(l) \rightarrow 2\ Na^+(aq) + 2\ OH^-(aq) + H_2(g)}$$

3. Iron can oxidize to iron(III) oxide (rust, $\mathcal{M}$ = 159.687 g/mol) in the presence of oxygen gas ($\mathcal{M}$ = 31.998 g/mol) via the following overall reaction:

$$4\ Fe(s) + 3\ O_2(g) \rightarrow 2\ Fe_2O_3(s)$$

a. (18 pts) What is the maximum mass of rust that could form if 4.0 grams of each reactant were allowed to react with each other? *Remember to show all work to receive full credit.*

$$4.0\text{ g } O_2 \left| \frac{\text{mol } O_2}{31.998\text{ g } O_2} \right| \frac{2\text{ mol } Fe_2O_3}{3\text{ mol } O_2} \left| \frac{159.687\text{ g } Fe_2O_3}{\text{mol } Fe_2O_3} \right| = 13\text{ g } Fe_2O_3$$

$$4.0\text{ g Fe} \left| \frac{\text{mol Fe}}{55.845\text{ g Fe}} \right| \frac{2\text{ mol } Fe_2O_3}{4\text{ mol Fe}} \left| \frac{159.687\text{ g } Fe_2O_3}{\text{mol } Fe_2O_3} \right| = \mathbf{5.7\ g\ Fe_2O_3}$$

ANS

b. (13 pts) What mass of *each* reactant would remain if the maximum amount of rust formed?

0 grams of the limiting reactant, Fe, and 2.3 grams of the excess reactant, O_2.

$$4.0\text{ g } O_2 - \frac{5.7\text{ g } Fe_2O_3}{159.687\text{ g } Fe_2O_3} \left| \frac{\text{mol } Fe_2O_3}{2\text{ mol } Fe_2O_3} \right| \frac{3\text{ mol } O_2}{\text{mol } O_2} \left| \frac{31.998\text{ g } O_2}{\text{mol } O_2} \right| = 2.3\text{ g } O_2$$

Problem	Weight
C	40

1. (15 pts) Bisphenol A (BPA) is a covalent compound and was a common component in several plastics until studies linked it with health concerns, especially in developing fetuses. It has the chemical formula $C_{15}H_{16}O_2$ ($\mathcal{M}$ = 228.290 g/mol).

   a. (4 pts) By mass, which element (C, H, or O) is the largest component of BPA? ***C***

   b. (14 pts) What is the percent composition by mass of oxygen in BPA?

$$\frac{15.999\text{ g O}}{\text{mol O}} \left| \frac{2\text{ mol O}}{\text{mol BPA}} \right| \frac{\text{mol BPA}}{228.290\text{ g BPA}} \left| 100\% \right. = \underline{\underline{\textbf{14.016\%}}}$$

ANS

2. (12 pts) What would be the concentration (in mol/L, or *M*) of chloride ions in 3.0 grams of magnesium chloride ($MgCl_2$, $\mathcal{M}$ = 95.211 g/mol) dissolved in 700 mL of water?

$$M\ Cl^- = \frac{3.0\text{ g } MgCl_2}{95.211\text{ g } MgCl_2} \left| \frac{\text{mol } MgCl_2}{\text{mol } MgCl_2} \right| \frac{2\text{ mol } Cl^-}{700\text{ mL}} \left| \frac{1000\text{ mL}}{\text{L}} \right| \frac{M \cdot \text{L}}{\text{mol}} = \underline{\underline{\textbf{0.09 M } Cl^-}}$$

ANS

3. (10 pts) Which of the following is the strongest electrolyte: 0.3 *M* potassium chloride (KCl), 0.3 *M* magnesium chloride ($MgCl_2$), or 0.3 *M* BPA ($C_{15}H_{16}O_2$)? Briefly explain your choice.

3 M $MgCl_2$ would be the strongest electrolyte because there are 3 moles of ions for every mole of the salt. KCl would only have two moles of ions per mole of salt. BPA is a covalently bound molecule and would not dissociate into ions at all; BPA is not an electrolyte.

Problem	Weight
D	40

Cadet _____

1. (12 pts) The explosive ethylene dinitramine (EDNA) is a solid with the formula $C_2H_7N_4O_4$. Write the chemical reaction describing the detonation of *one mole* of this explosive.

$C_2H_7N_4O_4(s) \rightarrow 3.5\ H_2O(g) + 0.5\ CO(g) + 1.5\ C(s) + 2\ N_2(g)$

2. (16 pts) Consider the thermal decomposition of potassium chlorate ($\mathcal{M}$ = 122.548 g/mol) into potassium chloride ($\mathcal{M}$ = 74.551 g/mol) and oxygen in accordance with the following reaction:

$$2\ KClO_3(s) \rightarrow 2\ KCl(s) + 3\ O_2(g)$$

If 175 mL of gas were collected over water at 22.6ºC and 738 torr, what mass of potassium chlorate must have thermally decomposed? *Hint: the "vapor pressure of water" table on the back page may be helpful in answering this question.*

$$PV = nRT \Rightarrow n = PV/RT = \frac{(738 - 20.565)\ \text{torr} \mid 175\ \text{mL}}{\mid} \cdot \frac{\text{mol} \cdot \text{K}}{0.08206\ \text{L} \cdot \text{atm}} \cdot \frac{}{(22.6 + 273.15)\ \text{K}} \cdot \frac{\text{atm}}{760\ \text{torr}} \cdot \frac{\text{L}}{1000\ \text{mL}} = 0.0068069\ \text{mol}\ O_2$$

$$\frac{0.0068069\ \text{mol}\ O_2 \mid 2\ \text{mol}\ KClO_3 \mid 122.548\ \text{g}\ KClO_3}{\mid 3\ \text{mol}\ O_2 \mid \text{mol}\ KClO_3} = \underline{\underline{0.556\ \text{g}\ KClO_3}}$$

ANS

3. (12 pts) Use kinetic molecular theory (KMT) to explain Avogadro's hypothesis, that *equal volumes of different gases collected under similar conditions contain the same number of particles.*

If ideal gasses all have the same properties (no electrostatic (IMF) attraction, elastic collisions, straight line movement, and negligible particle volume) then the identity of the gasses is no longer consequential, as they will all behave similarly. Algebraically, the following equations are not specific to molar masses, IMF, or atomic/molecular size and presuppose these postulates: e.g. for gas_1 and gas_2, if $P_1=P_2$, $V_1=V_2$, and $T_1=T_2$ and $n=PV/RT$, then $n_1=n_2$.

Vapor Pressure Of Water (torr)					
Temp °C	0.0	0.2	0.4	0.6	0.8
16	13.634	13.809	13.967	14.166	14.347
17	14.530	14.715	14.903	15.092	15.284
18	15.477	15.673	15.871	16.071	16.272
19	16.477	16.685	16.894	17.105	17.319
20	17.535	17.753	17.974	18.197	18.422
21	18.650	18.880	19.113	19.349	19.587
22	19.827	20.070	20.316	20.565	20.815
23	21.066	21.324	21.583	21.845	22.110
24	22.377	22.648	22.922	23.198	23.475
25	23.756	24.039	24.326	24.617	24.912
26	25.209	25.509	25.812	26.117	26.426
27	26.739	27.055	27.374	27.696	28.021
28	28.349	28.680	29.015	29.354	29.697
29	30.043	30.392	30.745	31.102	31.461
30	31.824	32.191	32.561	32.934	33.312