Chemistry 1A, Fall 2005

Midterm 1

Sept 20, 2005

(90 min, closed book)

KEY

Name:___________________

SID:_____________________

TA Name:________________

- This exam has 18 multiple choice questions and 10 short answer.
- For the multiple choice section, fill in the Scantron form AND circle your answer on the exam.
- You will be given a total of 90 minutes to complete the exam.

Note:

- Potentially useful equations and other information are found on the last page of this exam.
- Put your final answers in the boxes provided. Full credit cannot be gained for answers outside the boxes provided.

	Points available	Points earned
Pages 1-4, MC, Q1-18	38	
Page 5-6, SA Q 1-3	24	
Page 7, SA Q 4-5	10	
Page 8, SA Q6-7	10	
Page 9, SA Q8	5	
Page 10, SA Q9-10	13	
Total	**100**	

MULTIPLE CHOICE

Complete the following table by filling in the 20 numbered boxes. If an entry cannot be determined from the information given and the information on your periodic table, enter CBD (cannot be determined). Atomic masses are given in amu to three significant figures. Provide symbols as shown, using CBD if the complete symbol cannot be determined. Then answer the following multiple choice question (1 point each).

Symbol	Protons	Neutrons	Electrons	Charge	Mass
^{63}Ni	28	(1)	28	(2)	(3)
^{12}C	(4)	(5)	(6)	0	(7)
(8)	(9)	2	2	-1	3.00
(10)	(11)	(12)	(13)	0	14.0
(14)	14	(15)	14	(16)	(17)
(18)	82	(19)	(20)	+2	208

1.) What value should occupy box (1)?

A) 28 $\quad$ $\boxed{\text{B) 35}}$ $\quad$ C) 42 $\quad$ D) 63 $\quad$ E) CBD

2.) What value should occupy box (4)?

A) 2 $\quad$ B) 24 $\quad$ C) 12 $\quad$ $\boxed{\text{D) 6}}$ $\quad$ E)CBD

3.) What value should occupy box (8)?

A) $^{1}H^{-1}$ $\quad$ B) $^{3}He^{-1}$ $\quad$ $\boxed{\text{C) } ^{3}H^{-1}}$ $\quad$ D) $^{3}Li^{-1}$ $\quad$ E) CBD

4.) What value should occupy box (9)?

$\boxed{\text{A) 1}}$ $\quad$ B) 2 $\quad$ C) 3 $\quad$ D) 4 $\quad$ E) CBD

5.) What value should occupy box (10)?

A) ^{14}N $\quad$ B) ^{14}C $\quad$ C) ^{12}C $\quad$ D) ^{13}C $\quad$ $\boxed{\text{E) CBD}}$

6.) What value should occupy box (14)?

A) ^{14}N $\quad$ B) ^{28}Si $\quad$ C) ^{14}C $\quad$ D) ^{14}Si $\quad$ $\boxed{\text{E) CBD}}$

7.) What value should occupy box (16)?

A) -1 $\quad$ $\boxed{\text{B) 0}}$ $\quad$ C) 1 $\quad$ D) 2 $\quad$ E) CBD

8.) What value should occupy box (20)?

A) 82 $\quad$ $\boxed{\text{B) 80}}$ $\quad$ C) 84 $\quad$ D) 126 $\quad$ E) CBD

For Questions 9-15, use the information given below.

Consider a mixture of 0.300 mole of methane (CH_4) and 0.250 atm of oxygen (O_2) in a 10.5 L flask at 65˚C.

9.) What is the partial pressure of methane (atm) (3pt)?

A) 0.55 B) 1.1 C) 0.34 D) 0.26 $\boxed{\text{E) 0.79}}$

10.) How many moles of oxygen gas are present (3pt)?

$\boxed{\text{A) 0.095}}$ B) 22 C) 0.24 D) 0.67 E) 1.3

11.) What is the mole fraction of methane (3pt)?

A) 1.0 B) 0.88 C) 0.50 $\boxed{\text{D) 0.76}}$ E) 0.10

12.) What is the total pressure in the flask in atm (3pt)?

$\boxed{\text{A) 1.0}}$ B) 0.88 C) 0.50 D) 0.75 E) 0.10

13.) In the balanced combustion reaction of one mole of methane with oxygen, what is the stoichiometric coefficient of water (3pt)?

A) 1 B) 1.5 $\boxed{\text{C) 2}}$ D) 2.5 E) 3

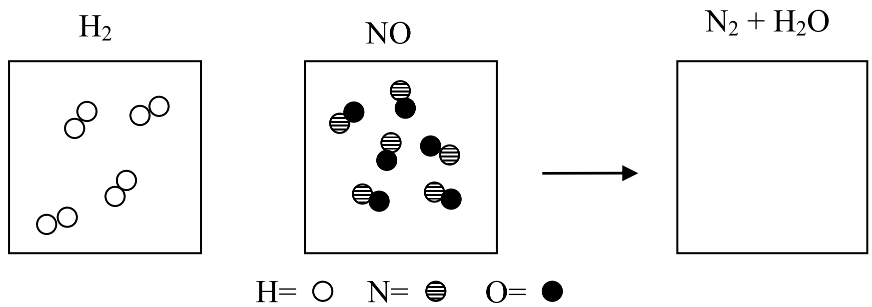
14.) If the reaction proceeds to completion, which is the limiting reagent (3pt)?

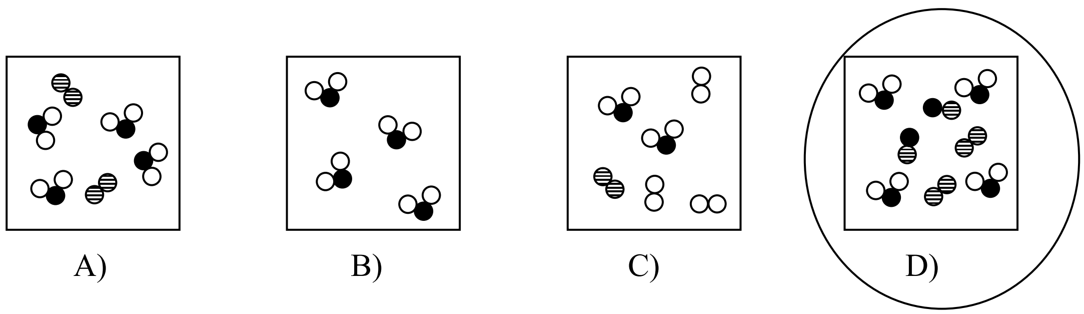
A) methane $\boxed{\text{B) oxygen}}$ C) CH_4 and O_2 are in perfect stoichiometric ratio

15.) What is the final pressure in the flask after the reaction has come to completion (assume the water formed is a liquid and does not contribute) (3pt)?

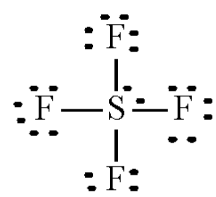
A) 0.10 B) 0.250 C) 0.30 E) 1.0

16.) Which of the diagrams below is the best post-reaction representation for the (unbalanced) chemical equation $H_2 + NO \rightarrow N_2 + H_2O$ (3pt)?



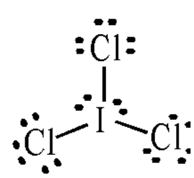


17.) What is the electron pair arrangement for SF_4, shown right (3pt)?



A) Linear
B) Trigonal planar
C) Tetrahedral
D) Trigonal bipyramidal
E) Octahedral

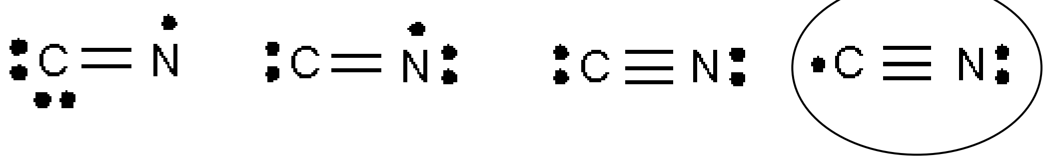
18.) What is the molecular shape of ICl_3, shown right (3pt)?



A) Linear
B) Bent
C) Trigonal planar
D) Trigonal pyramid
E) Tee-Shaped

SHORT ANSWER

1.) Which Lewis structure is better for the CN radical (3 pt)? (circle one)



2.) Arrange the following from strongest to weakest chemical bond (3 pt).

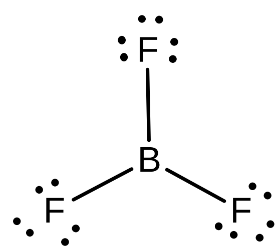
A) N_2 B) CO_2 C) CO D) H_2O

Answer:

CO > N_2 > CO_2 > H_2O

3.) Consider the Lewis structures for BF_3 and NH_3 for the following questions (18 pt).

a) Draw the Lewis structure for BF_3.



Structure:

b) What is the electron pair arrangement for BF_3 (circle one)?

A) Linear
B) Trigonal planar
C) Tetrahedral
D) Trigonal Pyramidal
E) Octahedral

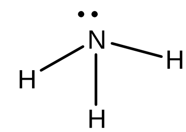
c) What is the molecular shape of BF_3 (circle one)?

A) Linear
B) Bent
C) Trigonal planar
D) Trigonal pyramid
E) Tee-Shaped

d) How would you describe the electronic character of boron in the BF_3 molecule (circle one)?

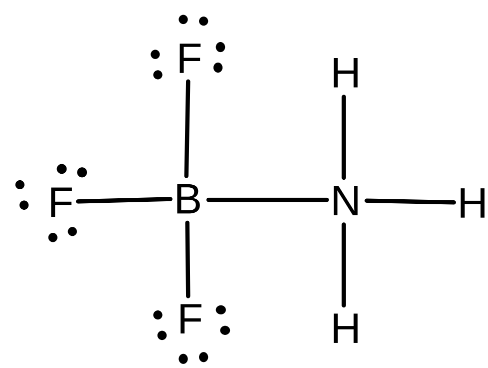
A) full octet B) electron deficient C) expanded octet

e) What is the molecular shape of NH_3 (circle one)?



A) Linear
B) Bent
C) Trigonal planar
D) Trigonal pyramid
E) Tee-Shaped

f) BF_3 reacts with NH_3. Predict the structure of the product and explain your answer.



Structure:

Explanation:

in the product, the nitrogen can share it's lone pairs with the electron deficient boron

this gives every atom an octet

4.) How many nitrogen atoms are present in 5.00 g of calcium nitrate ($Ca(NO_3)_2$) (5 pt)?

$$5.00\text{ g Ca(NO}_3)_2 \times \frac{1\text{ mole Ca(NO}_3)_2}{164\text{ g Ca(NO}_3)_2} \times \frac{2\text{ mol N atoms}}{1\text{mole Ca(NO}_3)_2} \times \frac{6.02 \times 10^{23}\text{ atoms}}{1\text{mole N atoms}} = 3.67 \times 10^{22}\text{ N atoms}$$

5.) A solution of ethanol (C_2H_5OH) in water is prepared by dissolving 75.00 mL of ethanol (density = 0.7900 g/cm^3) in enough water to make 250.0 mL of solution. What is the molarity of the ethanol in this solution (5 pt)? (1 mL = 1 cm^3)

$$75.00mL\_ethanol \times \frac{1cm^3}{1mL} \times \frac{0.7900g\_ethanol}{cm^3} \times \frac{1mole\_ethanol}{46.02g\_ethanol} = 1.287moles\_ethanol$$

$$\frac{1.287\_moles\_ethanol}{0.2500L\_solution} = 5.148\frac{moles\_ethanol}{L\_solution} or\_5.148M$$

6.) How many grams of silver chloride (AgCl) can be prepared by the reaction of 50.00 mL of 0.200 M silver nitrate ($AgNO_3$) 50.00 mL of 0.250 M calcium chloride ($CaCl_2$) (5 pt)?

$2AgNO_3$ (aq) + $CaCl_2$ (aq) → 2AgCl(s) + Ca $(NO_3)_2$ (aq)

$$0.05000\text{L AgNO}_3 \times \frac{0.200\text{ moles AgNO}_3}{\text{L}} = 0.0100\text{ moles AgNO}_3$$

$$0.05000\text{L CaCl}_2 \times \frac{0.250\text{ moles CaCl}_2}{\text{L}} = 0.0125\text{ moles CaCl}_2$$

Because the reaction shows that you need twice as much $AgNO_3$ as $CaCl_2$, it would take 0.0250 moles of $AgNO_3$ to fully react with the $CaCl_2$. We only have 0.0100 moles of $AgNO_3$, so $AgNO_3$ is the limiting reagent.

$$0.0100\text{ moles AgNO}_3 \times \frac{2\text{ moles AgCl}}{2\text{ moles AgNO}_3} \times \frac{143.32\text{ g AgCl}}{1\text{ mole AgCl}} = 1.43\text{ g AgCl}$$

<u>Laboratory</u>

7.) In the airbags experiment, a student combined 0.4932 g sodium bicarbonate with 0.8700 mL of 6.00 M acetic acid to produce sodium acetate, water, and carbon dioxide gas. Calculate the theoretical volume of the airbag in mL if the pressure is 1 atm and the temperature is 25°C. (5 pt)

$NaHCO_3$ (s) + CH_3COOH (aq) → CO_2 (g) + CH_3COONa (aq) + H_2O (l)

$$moles\_NaHCO_3 = \frac{0.4932g\_NaHCO_3}{} \times \frac{1mol\_NaHCO_3}{84.00g\_NaHCO_3} = 0.005871moles\_NaHCO_3$$

$$moles\_CH_3COOH = 0.0008700L\_CH_3COOH \times \frac{6.00mol\_CH_3COOH}{L\_solution} = 0.00522moles\_CH_3COOH$$

acetic acid is the limiting reagent

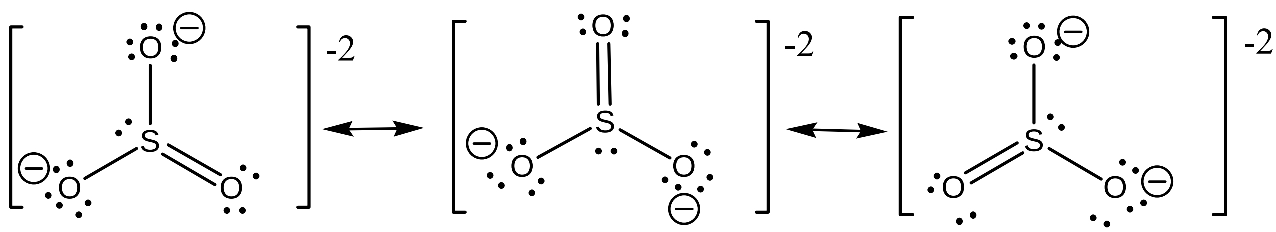
$$0.00522moles\_CH_3COOH \times \frac{1mole\_CO_2}{moles\_CH_3COOH} = 0.00522moles\_CO_2$$

using the ideal gas law…

$$V = \frac{nRT}{P} = \frac{(0.00522moles\_CO_2)(0.0821\,{}^{Latm}\!/_{molK})(298K)}{1atm} = 0.128L\_CO_2$$

9.) Draw the best Lewis structure for the sulfite ion (SO_3^{2-}) by minimizing formal charges. Clearly label all atoms with their formal charges and indicate the S-O bond order (8 pt). Show resonance structures if appropriate.

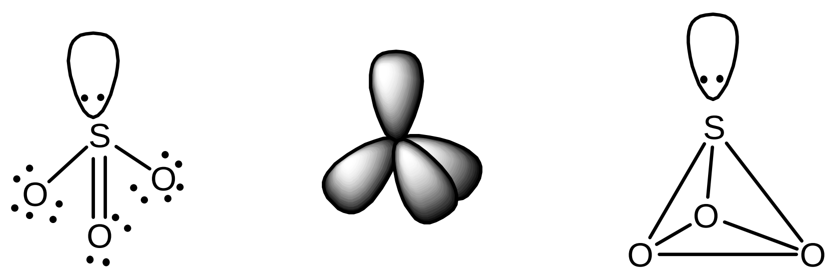
the structure shown below minimizes formal charge and places the negative formal charge on the most electronegative element



Bond order = 4/3

10.) Sketch the electron pair geometry and use VSEPR to predict the bond angels in the sulfite ion (SO_3^{2-}) (5 pt).

anything similar to these structures is acceptable…



Bond angles: less than 109.5°, probably between 104 and 109°