Chemistry 1A
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Midterm I
(Closed Book, 80 Minutes, 80 Points)

September 16, 1997
Professor Pines

Name:_____ **TA:**_____

SID:_____ **Section:**_____

Identification Sticker

Who is this? (0 Points) Hint: When it came to gases, his ideas were hot.

Avogadro Boyle Charles Dalton Enantiomer

Test-taking strategy: PLEASE READ THIS FIRST!
Write your name on all 6 pages. This test consists of two parts: multiple choice (**answers to be circled *and* entered on the Scantron sheet**) and short answer. In order to maximize your score on the exam:

- Do the questions you know how to do first, then, go back and answer the questions you skipped.
- Budget your time carefully -- don't spend too much time on any one problem.
- Show all work for which you want credit and don't forget to include units.
- **The bottom of the last page has some useful data and equations.**

Page	Points	Page	Points
Multiple Choice		6	
4		Total:	
5			

 Name: _____

Section 1: Multiple Choice. 12 questions, 3 points each.

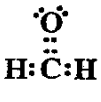
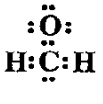
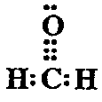
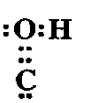
Instructions: For the following questions, circle the answer on the exam sheet **and bubble in the correct answer on your Scantron sheet.** Unless you are specifically told that there might be more than one answer to a problem, assume that only one answer is correct.

1.) You are taking test version **C**. Please fill in bubble "**C**" on the Scantron sheet.

2.) Deuterium oxide (D_2O where $D = {}^2H$) is sometimes known as "heavy water." If 1 L of H_2O weighs 1 kg, how much does 1 L of heavy water weigh? Assume no difference in *molar* volume.

A) 0.87 kg **B)** 1.0 kg **C)** 1.1 kg **D)** 2.0 kg **E)** None of these.

3.) Which of the following is the correct Lewis electron dot structure for formaldehyde, CH_2O?

A)  **B)**  **C)**  **D)**  **E)** None of these.

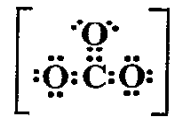
4.) What stoichiometric coefficient belongs in front of HNO_3 in the following unbalanced reaction? Note: the coefficient for KCl has been given.

$$\underline{4}\ KCl + \_\_\ HNO_3 + \_\_\ O_2 \text{ -----> } \_\_\ KNO_3 + \_\_\ Cl_2 + \_\_\ H_2O$$

A) 1 **B)** 2 **C)** 3 **D)** 4 **E)** 5

5.) What is the mass percent of sulfur in SO_2?

A) 16% **B)** 33.3% **C)** 50% **D)** 66.7% **E)** 84%

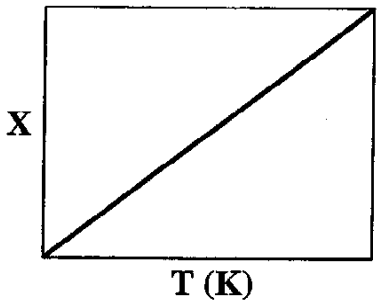
6.)  Pictured to the left is a Lewis electron dot structure for the carbonate ion, CO_3^{2-}. What is the formal charge of the carbon atom?

A) 2- **B)** 1- **C)** 0 **D)** 1+ **E)** 2+

 Name: _____

In the following 3 problems, choose the one answer that best describes "X" in the given figures.

7.)

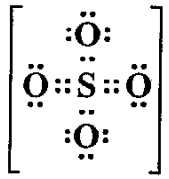


For an ideal gas at constant volume, X = ?

A) n B) 1/P C) P

D) u_{rms} E) R

8.)

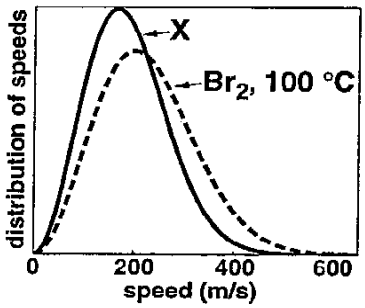


The charge of a sulfate ion, X = ?

A) 4- B) 2- C) 0

D) 2+ E) 4+

9.)



For the solid line, X = ?

A) Ar, 25 °C B) Ar, 100 °C C) Ar, 200 °C

D) Br_2, 25 °C E) Br_2, 200 °C

10.) Which of the following are ionic compounds? Mark **all** that apply.

A) CaO B) PCl_5 C) CO_2 D) Na_2S E) I_2

11.) A gas mixture at room temperature contains 10.0 moles of CO_2 and 15.0 moles of O_2. If the total pressure is 2.00 atm, what is the partial pressure of O_2?

A) 0.60 atm B) 0.80 atm C) 1.2 atm D) 2.0 atm E) 3.0 atm

12.) Which of the following compounds has the most carbon atoms present in 1.0 gram?

A) $BeCO_3$ B) $MgCO_3$ C) Na_2CO_3 D) $CaCO_3$ E) K_2CO_3

13.) At room temperature (300 K), argon (Ar) has a root-mean-square speed (u_{rms}) of 432 m/s. At what temperature will Ar have a u_{rms} of 864 m/s?

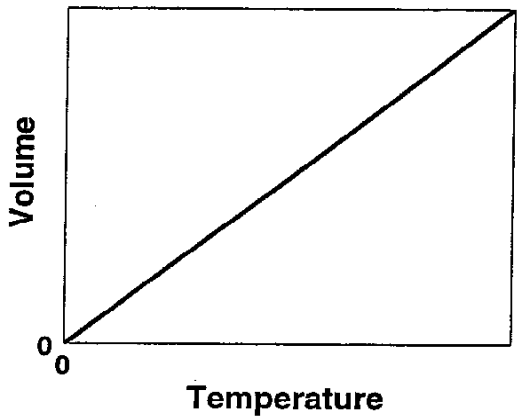
A) 75 K B) 150 K C) 450 K D) 600 K E) 1200 K

 Name: _____

Section 2: Finish the Picture. 4 questions, 5 points each.

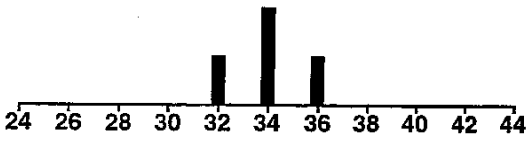
For each question in this section, provide the sketch required and, if you desire, explain your answer **in 20 words or less** in the box provided. Your explanation might allow partial credit to be assigned.

1.) Below is a graph showing the dependence of the volume of an ideal gas on the temperature in kelvins (assuming constant P). On the same graph sketch a line that shows the dependence of V on T in degrees Celsius. Use the zero on the temperature scale to represent 0 °C on your graph.



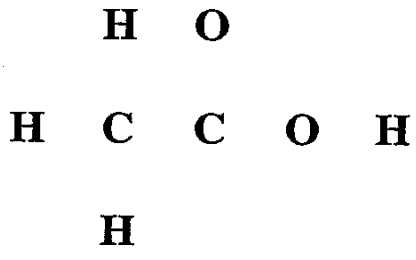
Explanation:

2.) Below is a bar graph depicting the mass spectrum (distribution of molecular masses) of O_2 assuming that the ratio of the two oxygen isotopes (^{16}O, ^{18}O) is 1:1 and that the two isotopes are randomly distributed among the molecules. Add to this graph bars that depict the mass spectrum for N_2 assuming the ratio of the two nitrogen isotopes (^{14}N, ^{15}N) is 1:1.



Explanation:

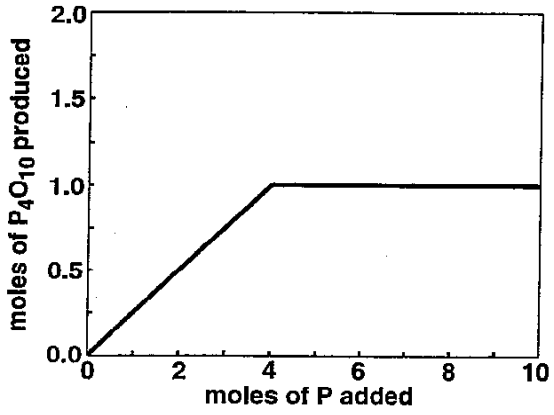
3.) Fill in all the electron dots for the Lewis electron dot structure of acetic acid, CH_3COOH.



Explanation:

 Name: _____

4.) Oxygen (O_2) reacts with phosphorus (P) to form phosphorus oxide (P_4O_{10}). The graph below shows the amount of P_4O_{10} produced versus the number of moles of phosphorus added if the reaction begins with 5.0 moles of O_2. On the same graph, sketch a line that shows P_4O_{10} produced versus the number of moles of P added if the reaction begins with 7.5 moles of O_2.



Explanation:

Section 3: Short Answer. 2 questions, 24 points total.

Answer the following two short answer questions. Partial credit will be given, so show your work whenever possible. Your final answers (including units where applicable) **must** be written in the boxes when provided.

1.) An unknown compound is found to be composed of 10.1% (by mass) hydrogen and 89.9% (by mass) carbon.

a.) (6 points) What is the empirical formula of this compound?

Empirical Formula:

b.) (6 points) 2.00 grams of the unknown hydrocarbon is vaporized at 127 °C in a 1.0 L flask. When completely vaporized, the compound has a pressure of 0.410 atm. What is the molecular formula?

Molecular Formula:

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2.) A student makes a model air bag by combining 0.5 grams of aluminum carbonate, $Al_2(CO_3)_3$, with 5.0 mL of 6.0 M acetic acid, CH_3COOH.

a.) (3 points) Balance the equation for the reaction of aluminum carbonate with acetic acid.

____$Al_2(CO_3)_3$ (s) + ____CH_3COOH (aq) ---> ____CO_2 (g) + ____H_2O (ℓ) + ____$(CH_3COO)_3Al$ (aq)

b.) (4 points) What is the limiting reagent in the student's air bag?

Limiting Reagent:

c.) (5 points) If the reaction in the air bag runs to completion, what volume of CO_2 (g) will be produced? Assume a temperature of 27 °C and a pressure of 1.0 atm. Assume ideal gas behavior.

CO_2 Volume:

Possibly Useful Information

Absolute T(K) = T(°C) + 273.15

T(°F) = 1.8 x T(°C) + 32

Avogadro's Number, $N_0 = 6.0221 \times 10^{23}$

1.000 atm = 760 torr

Gas Constant, R = 0.08206 L·atm·mol^{-1}·K^{-1}

Gas Constant, R = 8.3145 J·mol^{-1}·K^{-1}

Ideal Gas: PV=nRT

V_m = 22.414 L·mol^{-1} at STP

STP is 273.15 K, 1.00 atm

$$u_{rms} = \sqrt{\overline{u^2}} = \sqrt{\frac{3RT}{M}}$$

$$E_k = \frac{nN_0m\overline{u^2}}{2} = \frac{3}{2}nRT$$

$$\overline{\varepsilon_k} = \frac{1}{2}m\overline{u^2} = \frac{E_k}{nN_0}$$