

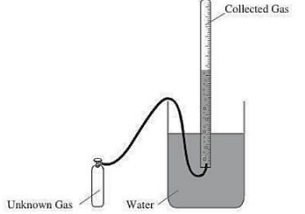
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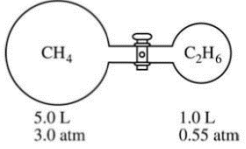
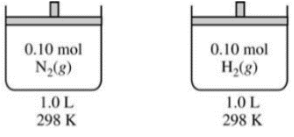
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**Directions:** Show all work in a way that would earn you credit on the AP Test! This is always the rule! Grading rubrics posted in the Google Answer Key Drive. Check your work, correct in green pen after you try them yourself in an honest way! Don't peek at rubrics while you work! **USE BINDER PAPER, STAPLE TO YOUR WORKSHEET.** Clearly label work.

**LONG ASSIGNMENT! DON'T WAIT UNTIL THE LAST MINUTE! BREAK IT INTO CHUNKS!  
SET A TIMER FOR 1.5 MIN PER FRQ PART AND SEE IF YOU FINISH ON TIME!**

<p>1999</p>	<p>5. A student performs an experiment to determine the molar mass of an unknown gas. A small amount of the pure gas is released from a pressurized container and collected in a graduated tube over water at room temperature, as shown in the diagram above. The collection tube containing the gas is allowed to stand for several minutes, and its depth is adjusted until the water levels inside and outside the tube are the same. Assume that:</p> <ul style="list-style-type: none"> <li>• The gas is not appreciably soluble in water</li> <li>• The gas collected in the graduated tube and the water are in thermal equilibrium</li> <li>• A barometer, a thermometer, an analytical balance, and a table of the equilibrium vapor pressure of water at various temperatures are also available.</li> </ul> <p>(a) Write the equation(s) needed to calculate the molar mass of the gas.</p> <p>(b) List the measurements that must be made in order to calculate the molar mass of the gas.</p> <p>(c) Explain the purpose of equalizing the water levels inside and outside the gas collection tube.</p> <p>(d) The student determines the molar mass of the gas to be <math>64 \text{ g mol}^{-1}</math>. Write the expression (set-up) for calculating the percent error in the experimental value, assuming that the unknown gas is butane (molar mass <math>58 \text{ g mol}^{-1}</math>). Calculations are not required.</p> <p>(e) If the student fails to use information from the table of the equilibrium vapor pressures of water in the calculation, the calculated value for the molar mass of the unknown gas will be smaller than the actual value. Explain.</p> 
<p>2000</p>	<p>6. Answer the following questions about <math>\text{Be}_2\text{CO}_4(s)</math> and its hydrate.</p> <p>(a) Calculate mass percent of carbon in the hydrated form of the solid that has the formula <math>\text{Be}_2\text{CO}_4 \cdot 3\text{H}_2\text{O}(s)</math></p> <p>(b) When heated to <math>220.^\circ\text{C}</math>, <math>\text{Be}_2\text{CO}_4 \cdot 3\text{H}_2\text{O}(s)</math> dehydrates completely as represented below.</p> $\text{Be}_2\text{CO}_4 \cdot 3\text{H}_2\text{O}(s) \rightarrow \text{Be}_2\text{CO}_4(s) + 3\text{H}_2\text{O}(g)$ <p>If <math>3.21 \text{ g}</math> of <math>\text{Be}_2\text{CO}_4 \cdot 3\text{H}_2\text{O}(s)</math> is heated to <math>220.^\circ\text{C}</math>, calculate</p> <ol style="list-style-type: none"> <li>(i) The mass of <math>\text{Be}_2\text{CO}_4(s)</math> formed and,</li> <li>(ii) The volume of the <math>\text{H}_2\text{O}(g)</math> released, measured at <math>220.^\circ\text{C}</math> and <math>735 \text{ mmHg}</math></li> </ol>
<p>2002B</p>	<p>2. A rigid <math>8.20 \text{ L}</math> flask contains a mixture of <math>2.50</math> moles of <math>\text{H}_2</math>, <math>0.500</math> mol of <math>\text{O}_2</math>, and sufficient Ar so that the partial pressure of Ar in the flask is <math>2.00 \text{ atm}</math>. The temperature is <math>127^\circ\text{C}</math>.</p> <ol style="list-style-type: none"> <li>(a) Calculate the total pressure in the flask.</li> <li>(b) Calculate the mole fraction of <math>\text{H}_2</math> in the flask.</li> <li>(c) Calculate the density (in <math>\text{g L}^{-1}</math>) of the mixture in the flask.</li> </ol> <p>The mixture in the flask is ignited by a spark, and the reaction represented below occurs until one of the reactants is entirely consumed.</p> $2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(g)$ <p>(d) Give the mole fraction of all species present in the flask at the end of the reaction.</p>
<p>2003</p>	<p>2. A rigid <math>5.00 \text{ L}</math> cylinder contains <math>24.5 \text{ g}</math> of <math>\text{N}_2(g)</math> and <math>28.0 \text{ g}</math> of <math>\text{O}_2(g)</math>.</p> <ol style="list-style-type: none"> <li>(a) Calculate the total pressure, in atm, of the gas mixture in the cylinder at <math>298 \text{ K}</math>.</li> <li>(b) The temperature of the gas mixture in the cylinder is decreased to <math>280 \text{ K}</math>. Calculate each of the following:             <ol style="list-style-type: none"> <li>(i) The mole fraction of <math>\text{N}_2(g)</math> in the cylinder</li> <li>(ii) The partial pressure, in atm, of <math>\text{N}_2(g)</math> in the cylinder</li> </ol> </li> <li>(c) If the cylinder develops a pinhole-sized leak and some of the gaseous mixture escapes, would the ratio of moles <math>\text{N}_2(g)</math>/moles of <math>\text{O}_2(g)</math> in the cylinder increase, decrease, or remain the same? Justify your answer.</li> </ol> <p>A different rigid <math>5.00 \text{ L}</math> cylinder contains <math>0.176 \text{ mol}</math> of <math>\text{NO}(g)</math> at <math>298 \text{ K}</math>. A <math>0.176 \text{ mol}</math> sample of <math>\text{O}_2(g)</math> is added to the cylinder, where a reaction occurs to produce <math>\text{NO}_2(g)</math></p> <ol style="list-style-type: none"> <li>(d) Write the balanced equation for the reaction.</li> <li>(e) Calculate the total pressure, in atm, in the cylinder at <math>298 \text{ K}</math> after the reaction is complete.</li> </ol>

2004B	<p>2. Answer the following questions related to hydrocarbons.</p> <p>(a) Determine the empirical formula of a hydrocarbon that contains 85.7 percent carbon by mass.</p> <p>(b) The density of the hydrocarbon in part (a) is <math>2.0 \text{ g L}^{-1}</math> at <math>50^\circ\text{C}</math> and <math>0.948 \text{ atm}</math>.</p> <p>(i) Calculate the molar mass of the hydrocarbon.</p> <p>(ii) Determine the molecular formula of the hydrocarbon.</p> <p>(c) Two flasks are connected by a stopcock as shown below. The <math>5.0 \text{ L}</math> flask contains <math>\text{CH}_4</math> at a pressure of <math>3.0 \text{ atm}</math>, and the <math>1.0 \text{ L}</math> flask contains <math>\text{C}_2\text{H}_6</math> at a pressure of <math>0.55 \text{ atm}</math>. Calculate the total pressure of the system after the stopcock is opened. Assume that the temperature remains constant.</p> <p>(d) Octane, <math>\text{C}_8\text{H}_{18}(s)</math>, has a density of <math>0.703 \text{ g mL}^{-1}</math> at <math>20^\circ\text{C}</math>. A <math>255 \text{ mL}</math> sample of <math>\text{C}_8\text{H}_{18}(l)</math> measured at <math>20^\circ\text{C}</math> reacts completely with excess oxygen as represented by the equation below.</p> $2 \text{C}_8\text{H}_{18}(l) + 25 \text{O}_2(g) \rightarrow 16 \text{CO}_2(g) + 18 \text{H}_2\text{O}(g)$ <p>Calculate the total number of moles of gaseous products formed.</p>	
2005B	<p>6. Consider two containers of volume <math>1.0 \text{ L}</math> at <math>298 \text{ K}</math>, as shown above. One container holds <math>0.10 \text{ mol N}_2(g)</math> and the other holds <math>0.10 \text{ mol H}_2(g)</math>. The average kinetic energy of the <math>\text{N}_2(g)</math> molecules is <math>6.2 \times 10^{-21} \text{ J}</math>. Assume that the <math>\text{N}_2(g)</math> and the <math>\text{H}_2(g)</math> exhibit ideal behavior.</p> <p>(a) Is the pressure in the container holding the <math>\text{H}_2(g)</math> less than, greater than, or equal to the pressure in the container holding the <math>\text{N}_2(g)</math>? Justify your answer.</p> <p>(b) What is the average kinetic energy of the <math>\text{H}_2(g)</math> molecules?</p> <p>(c) The moles of which gas, <math>\text{N}_2</math> or <math>\text{H}_2</math>, have the greater average speed? Justify your answer.</p> <p>(d) What change could be made that would decrease the average kinetic energy of the <math>\text{N}_2(g)</math> molecules in the container?</p> <p>(e) If the volume of the container holding the <math>\text{H}_2(g)</math> was decreased to <math>0.50 \text{ L}</math> at <math>298 \text{ K}</math>, what would be the change in each of the following variables? In each case, justify your answer.</p> <p>(i) The pressure within the container</p> <p>(ii) The average speed of the <math>\text{H}_2(g)</math> molecules</p>	
2006	<p>3. Answer the following questions that relate to the analysis of chemical compounds.</p> <p>(a) A compound containing the elements C, H, N, and O is analyzed. When a <math>1.2359 \text{ g}</math> sample is burned in excess oxygen, <math>2.241 \text{ g CO}_2(g)</math> is formed. The combustion analysis also showed that the sample contained <math>0.0648 \text{ g}</math> of H.</p> <p>(i) Determine the mass, in grams, of C in the <math>1.2359 \text{ g}</math> sample of the compound.</p> <p>(ii) When the compound is analyzed for N content only, the mass percent of N is found to be <math>28.84</math> percent. Determine the mass, in grams, of N in the original <math>1.2359 \text{ g}</math> sample of the compound.</p> <p>(iii) Determine the mass, in grams, of O in the original <math>1.2359 \text{ g}</math> sample of the compound.</p> <p>(iv) Determine the empirical formula of the compound.</p> <p>(b) A different compound, which has the empirical formula <math>\text{CH}_2\text{Br}</math>, has a vapor density of <math>6.00 \text{ g L}^{-1}</math> at <math>375 \text{ K}</math> and <math>0.983 \text{ atm}</math>. Using these data, determine the following.</p> <p>(i) The molar mass of the compound</p> <p>(ii) The molecular formula of the compound</p>	
2003B	<p>2. Answer the following questions that relate to chemical reactions.</p> <p>(a) Iron(III) oxide can be reduced with carbon monoxide according to the following equation.</p> $\text{Fe}_2\text{O}_3(s) + 3 \text{CO}(g) \rightarrow 2 \text{Fe}(s) + 3 \text{CO}_2(g)$ <p>A <math>16.2 \text{ L}</math> sample of <math>\text{CO}(g)</math> at <math>1.50 \text{ atm}</math> and <math>200.^\circ\text{C}</math> is combined with <math>15.39 \text{ g}</math> of <math>\text{Fe}_2\text{O}_3(s)</math>.</p> <p>(i) How many moles of <math>\text{CO}(g)</math> are available for the reaction?</p> <p>(ii) What is the limiting reactant for the reaction? Justify your answer with calculations.</p> <p>(iii) How many moles of <math>\text{Fe}(s)</math> are formed in the reaction?</p>	
<p><b>Reflection:</b> Think about the types of mistakes you made, things you need to restudy, things that tricked you, etc. One of the most important skills to develop in AP Chem is self reflection and not making the same mistakes. The joke is – you should always make NEW mistakes, not the SAME mistakes ☺</p>		