AP Questions: Gases

1971

$$2\ HCOONa + H_2SO_4 \rightarrow 2\ CO + 2\ H_2O + Na_2SO_4$$

A 0.964 gram sample of a mixture of sodium formate and sodium chloride is analyzed by adding sulfuric acid. The equation for the reaction for sodium formate with sulfuric acid is shown above. The carbon monoxide formed measures 242 milliliters when collected over water at 752 torr and 22.0°C. The vapor pressure of water is 19.8 torr at 22.0°C. Calculate the percentage of sodium formate in the original mixture.

1973 B

A 6.19 gram sample of PCl_5 is placed in an evacuated 2.00 liter flask and is completely vaporized at 252°C.

(a) Calculate the pressure ion the flask if no chemical reaction were to occur.

(b) Actually at 252°C the PCl_5 is partially dissociated according to the following equation:

$$PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$$

The observed pressure is found to be 1.00 atmosphere. In view of this observation, calculate the partial pressure of PCl_5 and PCl_3 in the flask at 252°C.

1976 D

When the molecular weight of a volatile liquid is calculated from the weight, volume, temperature, and pressure of a sample of that liquid when vaporized, the assumption is usually made that the gas behaves ideally. In fact at a temperature not far above the boiling point of the liquid, the gas is not ideal. Explain how this would affect the results of the molecular weight determination.

1982 D

(a) From the standpoint of the kinetic-molecular theory, discuss briefly the properties of gas molecules that cause deviations from ideal behavior.

(b) At 25°C and 1 atmosphere pressure, which of the following gases shows the greatest deviation from ideal behavior? Give two reasons for your choice.

CH_4 SO_2 O_2 H_2

(c) Real gases approach ideality at low pressure, high temperature, or both. Explain these observations.

1986 B

Three volatile compounds X, Y, and Z each contain element Q. The percent by weight of element Q in each compound was determined. Some of the data obtained are given below.

Compound	Percent by Weight of Element Q	Molecular Weight
X	64.8%	?
Y	73.0%	104.
Z	59.3%	64.0

(a) The vapor density of compound X at 27 degrees Celsius and 750. mm Hg was determined to be 3.53 grams per liter. Calculate the molecular weight of compound X.

(b) Determine the mass of element Q contained in 1.00 mole of each of the three compounds.

(c) Calculate the most probable value of the atomic weight of element Q.

(d) Compound Z contains carbon, hydrogen, and element Q. When 1.00 gram of compound Z is oxidized and all of the carbon and hydrogen are converted to oxides, 1.37 grams of CO_2 and 0.281 gram of water are produced. Determine the most probable molecular formula.

1984 C

The van der Waals equation of state for one mole of a real gas is as follows:

$$(P + {}^{a}/_{V}2)(V - b) = RT$$

For any given gas, the values of the constants a and b can be determined experimentally. Indicate which physical properties of a molecule determine the magnitudes of the constants a and b. Which of the two molecules, H_2 or H_2S, has the higher value for a and which has the higher value for b? Explain.

One of the van der Waals constants can be correlated with the boiling point of a substance. Specify which constant and how it is related to the boiling point.

1990 B

A mixture of $H_2(g)$, $O_2(g)$, and 2 millilitres of $H_2O(l)$ is present in a 0.500 litre rigid container at 25°C. The number of moles of H_2 and the number of moles of O_2 are equal. The total pressure is 1,146 millimetres mercury. (The equilibrium vapor pressure of pure water at 25°C is 24 millimetres mercury.)

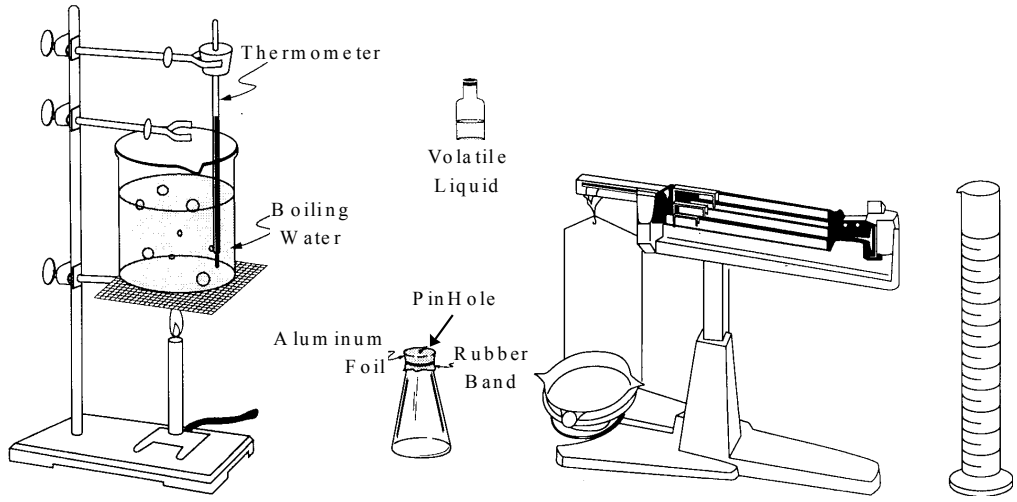
The mixture is sparked, and H_2 and O_2 react until one reactant is completely consumed.

(a) Identify the reactant remaining and calculate the number of moles of the reactant remaining.

(b) Calculate the total pressure in the container at the conclusion of the reaction if the final temperature is 90°C. (The equilibrium vapor pressure of water at 90°C is 526 millimetres mercury.)

(c) Calculate the number of moles of water present as vapor in the container at 90°C.

1991 D



An experiment is to be performed to determine the molecular mass of a volatile liquid by the vapor density method. The equipment shown above is to be used for the experiment. A barometer is also available.

(a) What data are needed to calculate the molecular mass of the liquid?

(b) What procedures are needed to obtain these data?

(c) List the calculations necessary to determine the molecular mass.

(d) If the volatile liquid contains non-volatile impurities, how would the calculated value of the molecular mass be affected? Explain your reasoning.

1993 D

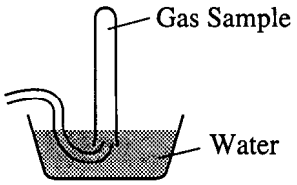
Observations about real gases can be explained at the molecular level according to the kinetic molecular theory of gases and ideas about intermolecular forces. Explain how each of the following observations can be interpreted according to these concepts, including how the observation supports the correctness of these theories.

(a) When a gas-filled balloon is cooled, it shrinks in volume; this occurs no matter what gas is originally placed in the balloon.

(b) When the balloon described in (a) is cooled further, the volume does not become zero; rather, the gas becomes a liquid or solid.

(c) When NH_3 gas is introduced at one end of a long tube while HCl gas is introduced simultaneously at the other end, a ring of white ammonium chloride is observed to form in the tube after a few minutes. This ring is closer to the HCl end of the tube than the NH_3 end.

1994 B



A student collected a sample of hydrogen gas by the displacement of water as shown by the diagram above. The relevant data are given in the following table.

GAS SAMPLE DATA	
Volume of sample	90.0 mL
Temperature	25°C
Atmospheric Pressure	745 mm Hg
Equilibrium Vapor Pressure of H_2O (25°C)	23.8 mm Hg

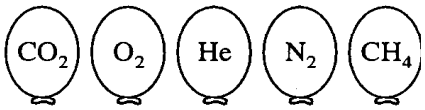
(a) Calculate the number of moles of hydrogen gas collected.

(b) Calculate the number of molecules of water vapor in the sample of gas.

(c) Calculate the ratio of the average speed of the hydrogen molecules to the average speed of the water vapor molecules in the sample.

(d) Which of the two gases, H_2 or H_2O, deviates more from ideal behavior? Explain your answer.

1996 D



Represented above are five identical balloons, each filled to the same volume at 25°C and 1.0 atmosphere pressure with the pure gases indicated.

(a) Which balloon contains the greatest mass of gas? Explain.

(b) Compare the average kinetic energies of the gas molecules in the balloons. Explain.

(c) Which balloon contains the gas that would be expected to deviate most from the behavior of an ideal gas? Explain.

(d) Twelve hours after being filled, all the balloons have decreased in size. Predict which balloon will be the smallest. Explain your reasoning.