

Problem Set 6: Ideal Gas Law and Gas Stoichiometry

HCHE 111L: Introduction to Elementary Inorganic Chemistry

Due Date: Friday October 6th, 2017

Problem 1

A 1.54 L gas bulb in a chemistry laboratory contains oxygen gas at 21°C and 758 torr. The air conditioning in the laboratory breaks down (cause....you know....its Morehouse) and the temperature rises to 31°. Calculate the final pressure of the gas given this increase in temperature.

Problem 2

A 20.6 L sample of “pure” air is collected in Greenland at a temperature of -20.0°C and a pressure of 1.01 atm and is forced into a 1.05 L bottle for shipment to Europe for analysis.

- a) Compute the pressure inside the bottle just after it is filled.
- b) Compute the pressure inside the bottle as it is open and exposed to the 21°C comfort of the European laboratory.

Problem 3

Consider a weather balloon filled with helium (He) that has a volume of 1.0×10^4 L at 1.00 atm and 30°C.

- a) What mass of helium (in kilograms) is necessary to fill such a balloon?
- b) The balloon rises to an altitude at which the pressure inside the balloon dropped to 0.60 atm and the temperature drops to -20°C. What is the volume of the balloon then?

Problem 4

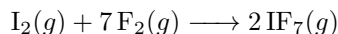
The Stirling engine, a heat engine invented by a Scottish minister, has been considered for use in automobile engines because of its efficiency. In such an engine, a gas goes through a four-step cycle of (1) expansion at a constant T, (2) cooling at constant V, (3) compression at constant T to its original volume, and (4) heating at constant V to its original temperature.

- a) Suppose the gas starts at a pressure of 1.23 atm, and the volume of the gas changes from 0.350 L to 1.31 L at a constant T. Calculate the pressure of the gas at the end of this step in the cycle.

- b) Assuming the conditions of part a) which step in the Stirling cycle is occurring?

Problem 5

Iodine heptafluoride (IF_7) can be made at elevated temperatures by the reaction



Suppose 63.6 L of gaseous IF_7 is made by this reaction at 300°C and a pressure of 0.459 atm.

- a) Calculate the number of **molecules** of IF_7 created in this process.
- b) If the gas is then heated to 400°C at a pressure of 0.980 atm, what is the volume?

Problem 6

Calcium Carbide (CaC_2) is a hard gray-black solid that has a very high melting point. This compound reacts strongly with liquid water to produce $\text{Ca}(\text{OH})_2$ and an unknown gas in the following manner:



A 12.8 g sample of CaC_2 was treated with excess water. The resulting gas was collected in an evacuated 5.00 L glass bulb with a mass of 254.49 g. **AFTER BEING FILLED WITH THE GAS** the bulb had a mass of 259.70 g and a pressure of 0.988 atm when its temperature was 26.8°C .

- a) Calculate the number of moles of the unknown gas.
- b) Some students are arguing over which gas is produced in this process. Some think it is oxygen gas (O_2), some think it's ethane (C_2H_2), and a few others think it is methane (CH_4). Use the data in part a) to calculate the molar mass of the unknown gas to identify which compound it is.
- c) Write a balanced chemical equation for this process.
- d) Considering the mass of this gas from part a), calculate the theoretical yield (in grams) of the unknown gas.