AP CHEMISTRY

TOPIC 3: GASES, PART A

Day 34:

- Boyle, Charles, and Avogadro: Gas Laws
- Ideal Gas Law

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1) Explain how Mr. Craig was able to place the balloon in the flask (as shown in class).

Answers:

Place a small amount of water in the flask and heat the water to its boiling point. Once the water is forming a vapor, quickly remove the flask from the heat source and place a balloon over the opening of the flask and quickly cool the flask with cool tap water. As the water vapor cools, the volume of the gas is quickly compressed into a smaller volume AND reducing the pressure of the gas inside the flask. When this happens the atmospheric pressure "pushes" the balloon into the flask.

2) Freon-12 (CF_2Cl_2) is commonly used as the refrigerant in central home air conditioners. The system is initially charged to a pressure of 4.75 atm. Express this pressure in each of the following units:
a) mm Hg b) torr c) kPa

Answers:

a) $$\frac{4.75\ atm}{} \times \frac{760\ mm\ Hg}{1\ atm} = 3610\ mm\ Hg$$

b) $$\frac{4.75\ atm}{} \times \frac{760\ mm\ Hg}{1\ atm} \times \frac{1\ torr}{1\ mm\ Hg} = 3610\ torr$$

c) $$\frac{4.75\ atm}{} \times \frac{101.325\ kPa}{1\ atm} = 481\ kPa$$

3) An aerosol can contains 320. mL of compressed air at 4.75 atm of pressure. When all of the gas is sprayed into a balloon, the balloon inflates to a volume of 3.87 liters. What is the pressure inside the balloon. Assume the temperature remains constant.

Answers:

$\boldsymbol{P_1V_1 = P_2V_2}$;

$$P_2 = \frac{P_1V_1}{V_2} = \frac{(4.75\ atm)(0.320\ L)}{3.87\ L} = 0.393\ atm$$

4) If 3.56 mol of nitrogen gas occupies a volume of 16.75 L at 7.50 ^{0}C, what volume will 9.00 mol of nitrogen occupy at the same temperature?

Answers:

$\boldsymbol{PV_1 = n_1RT}$

$\boldsymbol{PV_2 = n_2RT}$

$$V_2 = \frac{V_1n_2}{n_1} = \frac{(16.75\ L)(9.00\ mol)}{3.56\ mol} = 42.3\ L$$

5) A particular balloon is designed by its manufacturer to be inflated to a volume of no more than 2.5 L. If the balloon is filled 2.0 L of helium gas at sea level, is released, and rises to an altitude at which the atmospheric pressure is only 500. mm Hg, will the balloon burst? (assume the temperature remains constant)

Answers:

The balloon will burst. The volume will exceed manufacture's design restraints

$$P_1V_1 = nRT$$
$$P_2V_2 = nRT$$

$$P_1V_1 = P_2V_2 \quad ; \qquad V_2 = \frac{P_1V_1}{P_2} = \frac{(1.0\ atm)(2.0\ L)}{0.658\ atm} = 3.0\ L$$

6) A compressed gas cylinder contains 1.35 x 10^4 grams of helium gas. The pressure inside the cylinder is 4870 kPa at a temperature of 15.0 ^{0}C. How much gas remains in the cylinder if the pressure is decreased to 2320 kPa at a temperature of 22.0 ^{0}C?

$$\frac{1.35\times10^4\ g}{} \times \frac{1\ mol\ He}{4.0026\ g} = 3372.81\ mol\ He$$

Answers:

$$P_1V = n_1RT_1$$
$$P_2V = n_2RT_2$$

15.0 + 273 = 288 K, 22.0 + 273 = 295 K

$$\frac{n_1T_1}{P_1} = \frac{n_2T_2}{P_2}$$

$$\frac{n_1T_1}{P_1} = \frac{n_2T_2}{P_2}$$

$$n_2 = \frac{P_2n_1T_1}{P_1T_2} = \frac{(2320\ kPa)(3372.81\ mol)(288\ K)}{(4870\ kPa)(295\ K)} = 1570\ mol$$

7) Complete the following table:

P (atm)	V (L)	n (mol)	T
7.45	***14.4 L***	3.22	133 ^{0}C
1.78 atm	35.24	2.22	345 K
800. mm Hg	2386 mL	***0.0578 mol***	255 ^{0}C

$$V = \frac{nRT}{P} = \frac{(3.22\ mol)(0.0821\ atm\cdot L)(406\ K)}{(7.45\ atm)\ (mol\cdot K)} = 14.4\ L$$

$$P = \frac{nRT}{V} = \frac{(2.22\ mol)(0.0821\ atm\cdot L)(345\ K)}{(35.42\ L)\ (mol\cdot K)} = 1.78\ atm$$

$$n = \frac{PV}{RT} = \frac{(1.05\ atm)\ (mol\cdot K)\ (2.386\ L)}{(0.0821\ atm\cdot L)\ (528\ K)} = 0.0578\ mol$$