Chapter 10 exercises

Q1. Practice exercise page 397

a) In countries that use the metric system, atmospheric pressure in weathers reports is given in unit of kPa, convert pressure of 745 torr to kPa.

b) An English unit of pressure sometimes in pounds per square inch (Ib/in^2), ot psi. If a pressure is reported as 91.5 psi, express the measurement in atmosphere.

Answer:

a) 1 atm = 14.7 psi (Ib/in^2)

760 torr = 101.325 kPa

the pressure in kPa = (745 torr)(101.325 x 10^5) / (760 torr) = 99.3 kPa

b) 1 atm = 14.7 psi

pressure in atm = (91.5 psi)(1 atm) / (14.7 psi) = 6.22 atm

Q2. Practice exercise page 398

Convert a pressure of 0.975 atm into Pa and kPa.

Answer:

1 atm = 1.01325 x 10^5 Pa

Pressure in Pa = (0.975 atm)(1.01325 x 10^5) / (1 atm) = 9.88 x 10^4 Pa = 98.9 kPa

Q3. Practice exercise page 402

What happens to the density of a gas as

a) the gas heated in a constant-volume container.

b) the gas compressed at constan temperature.

c) additionat gas is added to a constant-volume container.

Answer:

a) no change. b) increase. c) increase

Q4. Practice exercise page 403

Tennis balls are usually filled with air or N_2 to a pressure above atmospheric pressure to increase their bounce. If a particular tennis ball has a volume of 144 cm^3 and contain 0.33 g of N_2 gas, what is the pressure inside the ball at 24˚C.

Answer:

PV = n RT   P = nRT / V

moles of N_2 = (0.33 g) / (28 g/mol) = 0.0118 mol

P = (0.0118 mol)(0.0821 L-atm/mol-K)(297 K) / 0.144 L) = 2.0 atm

Q5. Practice exercise page405

A large natural gas storage tank is arranged so that the pressure is maintained at 2.20 atm. On a cold day the temperature is - 15˚C (4˚F), the volume of the gas in tank is 3.25 x 10^3 m^3 . What is the volume of the same quantity of gas on a warm day when the temperature is 31˚C (88˚F).

Answer:

$P_1 V_1 / T_1 = P_2 V_2 / T_2$

2.2 atm x V_1 / (273 + 31 K) = 2.2 atm x 3.25 x 10^3 m^3 / (273 – 15 K)

V_1 = (304 K)(3.25 x 10^3 m^3) / (258 K) = 3.83 x 10^3 m^3

Q6. Practice exercise page 406

A 0.50 mole sample of oxygen gas is confined at 0˚C in a cylinder with a movable piston. The gas has an initial pressure of 1.0 atm. The piston then compresses the gas so that its final volume is half the initial volume. The final pressure of the gas is 2.2 atm. What is the final temperature of the gas in degree Celsius?

Answer:

	P	V	T
initial	1.0 atm	1	273 + 0
final	2.2 atm	½	T_2

$P_1 V_1 / T_1 = P_2 V_2 / T_2$

$1.0 \text{ atm} \times V_1 / 273 \text{ K} = 2.2 \text{ atm} \times \frac{1}{2} V_1 / T_2$

$T_2 = 2.2 \times \frac{1}{2} \times 273 / 1 \text{ atm} = 300.3 \text{ °K} = 27\text{°C}$

Q7. Practice exercise page 407

The mean molar mass of the atmosphere at the Titan moon is 28.6 g/mol. The surface temperature Is 95 K, and the pressure is 1.6 atm. Assuming ideal behavior, calculate the density of Titan atmosphere.

Answer:

$d = P \mu / RT = (1.6 \text{ atm}) (28.6 \text{ g/mol}) / (0.0821 \text{ L-atm/mol-K}) (95 \text{ K})$

$= 5.9 \text{ g/L}$

Q.8 Practice exercise page 408

Calculate the average molar mass of dry air if it has a density 1.17 g/L at 21˚C and 740.0 torr.

Answer:

$\text{Pressure} = (740 \text{ torr}) (1 \text{ atm}) / (760 \text{ torr}) = 0.974 \text{ atm}$

$d = P \mu / RT \qquad \mu = d RT / P$

$\mu = (1.17 \text{ g/L}) (0.0821 \text{ L-atm/mol-K}) (294 \text{ K}) / (0.974 \text{ atm}) = 29 \text{ g / mole}$

Q9. Practice exercise page 410

In the first step in the industrial process for making nitric acid, ammonia reacts with oxygen in the presence of a suitable catalyst to form nitric oxide and water vapor.

$4NH_{3\,(g)} + 5O_{2\,(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$

How many liters of NH_3 at 850˚C and 5.00 atm are required to react with 1.0 mole of O_2 in the reaction?

Answer:

$n = PV / RT$

mole of NH_3 = (1 mol O_2)(4 mol NH_3) / (5 mol O_2) = 0.8 mole

0.8 mol NH_3 = (5.00 atm) (V) / (0.0821 L-atm/mol-K) (1123 K)

V = (0.8 x 0.0821 x 1123) / 5 = 14.8 L

Q10. Practice exercise page 411

What is the total pressure exerted by a mixture of 2.00 g of H_2 and 8.00 g of N_2 at 273 K in 10.0 L vessel?

Answer:

mole of H_2 = (2.00 g) /92 g/mol) = 1 mole

mole of N_2 = (8.00 g) / 928 g/mol) = 0.29 mole

P_{H2} = n_{H2} RT / V = (1 mol x 0.0821 L-atm/mol-K)(273 K) / (10.0 L) = 2.24 atm

P_{N2} = n_{N2} RT / V = (0.29 mol x 0.0821 L-atm/mol-K) (273 K) / (10.0 L) = 0.65 atm

P_{total} = P_{H2} + P_{N2} = 2.24 atm + 0.65 atm = 2.89 atm

Q11. Practice exercise page 412

- The total pressure on the surface of Titan (largest moon) is 1220 torr. The atmosphere consist of 82 mole percent N_2, 12 mole percent Ar, and 6 mole percent CH_4. calculate the partial pressure of each of these gases in titan atmosphere?

Answer:

$P_1 = (n_1 / n_2) P_t$

P_{N2} = (82 / 100) x 1220 = 1000.4 torr = 1.0×10^3 torr

P_{Ar} = (12 / 100) x 1220 = 146.4 torr = 1.5×10^2 torr

P_{CH4} = (6/100) x 1220 = 73.2 torr

Q12. Practice exercise page 413

Ammonium nitrite, NH_4NO_2 is decomposed in test tube, 16.511 mL of N_2 gas collected over water at 26˚C and 745 torr total pressure. How many grams of NH_4NO_2 were decomposing?

Answer:

Vapor pressure of water at 26˚C = 25 torr

$P_{N2} = P_{tot} - P_{H2O} = 745 – 25 = 720$ torr

pressure in atm = (1 atm)(720 torr) / (760 torr) = 0.947 atm

$n_{N2} = P_{N2} V / RT$ = (0.947 atm) (0.511 / 1000 L) /(0.0821 L-atm/mol-K)(299K)

= 0.0197 mole

mole of NH_4NO_2 = (0.0197 mol N_2)(1 mol NH_4NO_2) / (1 mol N_2) = 0.0197 mol

mass of NH_4NO_2 = 0.0197 mol x 64 g/mol = 1.26 g

Q13. Practice exercise page 417

What is the rms speed of an Helium atom at 25˚C/

Answer:

U_{rms} = √ 3Rt/μ = √ 3(8.314 Kg-m^2 /s^2-mol-K) (298) / 4 x 10^{-3} Kg/mol

= 1.36 x 10^3 m/s

Q14. Practice exercise page 419

Calculate the ration of effusion rates of N_2 and O_2 , r_{N2} / r_{O2} .

Answer:

$r_{N2} / r_{O2} = \sqrt{\mu_{O2} / \mu_{N2}} = \sqrt{32 / 28} = \sqrt{1.143} = 1.07$

exercises page 427

10.31

Suppose you are given two l L flasks and hold that one contains a gas of molar mass 30, the other a gas of molar mass 60, both at the same temperature, the pressure in flask (A) is (X) atom, and the mass in the flask is 1.2 g. The pressure in the flask (B) is 0.5X, and the mass of gas in the flask is 1.2 g. Which flask contains gas of molar mass 30, and which contains the gas of molar mass 60?

Answer:

$PV = n RT \qquad P_A V_A = n_A RT$

$X (1 L) = (1.2 g / \mu_A) RT$

$0.5X (1 L) = (1.2 g/\mu_B) RT$

$X / 0.5x = (1.2 / \mu_A) RT / (1.2 / \mu_B) RT$

$1 / 0.5 = \mu_B / \mu_A = 2 / 1$

μ_B contain a gas of molar mass = 60 g/mol

μ_A contain a gas of molar mass 30 g/mol

10.35

A balloon hold approximately 175,000 ft^3 of helium, if the gas at 23˚C and 1.0 atm. What mass of Helium is in the balloon?

Answer:

$1 ft^3 = 28.3168 L$

volume in liter = $(175,000 ft^3 \times 28.3168 L) / (1 ft^3) = 4955440 L$

$PV = n RT$

(1 atm) x (4955440 L) = n x (0.0821 L-atom/mol-K) (296 K)

n = 203914.15 mole

Mass of helium = 203914.15 mol x 4 g / mol = 8.2×10^2 Kg

10.37

Calculate the number of molecules in a deep breath of air whose volume is 2.25 L body temperature 37˚C, and pressure of 735 torr.

Answer:

Pressure in atm = (735 torr x 1 atm) / (760 torr) = 0.967 atm

$PV = n RT$

(0.967 atm x 2.25 L) = n x (0.0821 L-atm/mol-K) (310 K) n = 0.0855 mol

1 mole of air contain 6.03 x 10^{23}

0.0855 mole of air contain =(0.0855 mol x 6.03 x 10^{23}) /(1 mol of air) = 5.15 x 10^{22} molecules

<u>10.39</u>

A tank contains 0.29 Kg of O_2 compressed into a volume of 2.3 L

a) Calculate the gas pressure inside the tank at 9˚C.

b) What volume would this oxygen occupy at 26˚C and 0.55 atm?

<u>Answer</u>:

a) mole of O_2 = (0.29 Kg x 1000 g) / (32 g/mol) = 9.0625 mole

PV = n RT

P x 2.3 L = 9.0625 mol x (o.0821 L-atm/mol-K) x (282 K)

P = 91.22 atm

b) PV = n RT

(0.95 atm x V) = (9.0623 mol)(0.0821 L-atm/mol-K) (299 K)

V = 2.34 x 10^2 L

<u>10.45</u>

Which gas is most dense at 1 atm and 298 K? CO_2 , N_2O, Cl_2 explain?

<u>Answer:</u>

d_{CO2} = µ P / RT = (44 g/mol x 1 atm) / (0.0821 L-atm/mol-K)(298 K) = 1.799 g/L

d_{N2O} = µ P / RT = (44 g/mol x 1 atm) / (0.0821 L-atm/mol-K)(298 K) = 1.799 g/L

d_{Cl2} = µ P / RT = (71 g/mol x 1 atm) / (0.0821 L-atm/mol-K)(298 K) = 3.147 g/L

Cl_2 has the molar mass and more condense than the other gasas

<u>10.49</u>

a) calculate the density of NO_2 gas at 0.970 atm and 35˚C.

b) Calculate the molar mass of a gas if 2.50 g occupies 0.875 L at 685 torr and 35˚C.

Answer:

a) d_{NO2} = μ P / RT = (46 g/mol of NO_2 x 0.970 atm) / (0.0821 L-atm/mol-K)(308 K)

= 1.77 g/L

b) d = μ P / RT

(2.50 g / 0.875 L) = (μ x 685 /760 torr) / (0.0821 L-atm/mol-K)(308 K)

μ = 80.2 g/mole

10.55

Oxidation of glucose, $C_6H_{12}O_6$ in our bodies produces CO_2 , which expelled from our lungs as a gas

$C_6H_{12}O_{6\ aq}$ + $6O_{2\ (g)}$ → $6CO_{2\ (g)}$ + $6H_2O_{\ (l)}$

Calculate the volume of dry CO_2 produced at body temperature 37˚C and 0.97 atm when 24.5 g of glucose is consumed in this reaction.

Answer:

mole of glucose = (24.5 g) / (180 g/mol) = 0.136

1 mole $C_6H_{12}O_6$ = 6 mole CO_2

mole of CO_2 = (0.136 mol $C_6H_{12}O_6$) x (6 mol CO_2) / (1 mol of $C_6H_{12}O_6$) = 0.816 mol

PV = n RT

(0.97 atm x V) = (0.816 mol) x (0.0821 L-atm/mol-K) x (310 K)

V = 21.41 L

10.61

A mixture containing 0.477 mole H_2 , 0.280 mole N_2 and 0.110 mole Ar, is confined in a 7.00 L vessel at 25˚C.

a) calculate the potential pressure of each of these gases.

b) Calculate the total pressure of a mixture.

Answer:

a) P_{H2} = n RT / V = (0.477 mol)(0.0821 L-atm/mol-K)(298 K) / (7.00 L) = 1.67 atm

P_{N2} = (0.280 mol)(0.0821 L-atm/mol-K)(298 K) / (7.00 L) = 0.977

P_{Ar} = (0.110 mol)(0.0821 L-atm/mol-K)(298 K) / (7.00 L) = 0.384

b) $P_t = P_{H2} + P_{N2} + P_{Ar} = 1.67 + 0.977 + 0.384 = 3.03$ atm

10.65

A mixture of gases contains 0.75 mole N_2 , 0.30 mole O_2 and 0.15 mole CO_2 . If the total pressure of the mixture is 1.56 atm, what is the partial pressure of each component?

Answer:

$P_{tot} = P_{N2} + P_{O2} + P_{CO2} = 1.5$ atm

$n_{tot} = 0.75 + 0.30 + 0.15 = 1.2$

$P_{N2} = X_{N2} * P_t = (n_{N2} / n_{tot}) * P_t = (0.75 / 1.2) * 1.5$ atm $= 0.94$ atm

$P_{O2} = X_{O2} * P_t = (n_{O2} / n_{tot}) * P_t = (0.30 / 1.2) * 1.5$ atm $= 0.373$ atm

$P_{CO2} = X_{O2} * P_t = (n_{O2} / n_{tot}) * P_t = (0.15 / 1.2) * 1.5$ atm $= 0.186$ atm