GAS STOICHIOMETRY Worksheet

1. How many mL of 0.50 M nitric acid are required to release 3.44 liters of hydrogen gas at 1.33 atm and 45 °C?

$$2\ HNO_3 + Zn \rightarrow Zn(NO_3)_2 + H_2$$

2. What volume of oxygen, measured at 35 °C and 752 mm Hg, is required to burn 3.26 grams of calcium?

$$2\ Ca\ (s) + O_2\ (g) \rightarrow 2\ CaO\ (s)$$

3. What is the molarity of a 5 L sodium hydroxide solution that would completely react with 2 L of carbon dioxide gas measured at STP?

$$2\ NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

4. How many liters of dry hydrogen gas, measured at 796 torr and 25 °C, will be released by decomposing 255 milliliters of H_2O (g) at 1.33 atm and 25 °C?

$$2\ H_2O \rightarrow 2\ H_2 + O_2$$

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Answers

1. How many mL of 0.50 M nitric acid are required to release 3.44 liters of hydrogen gas at 1.33 atm and 45 °C?

$$2\ HNO_3 + Zn \rightarrow Zn(NO_3)_2 + H_2$$

Temperature in Kelvin: 45 °C = 273 + 45 = 318 K

Number of moles of H_2: n = PV/RT = (1.33 atm x 3.44 L)/(0.082 L-atm mol^{-1} K^{-1} x 318 K) = 0.175 mol H_2

0.175 mol H_2 x (2 mol HNO_3 x 1 mol H_2) x (1000 mL HNO_3/0.5 mol HNO_3) = 700 mL HNO_3

2. What volume of oxygen, measured at 35 °C and 752 mm Hg, is required to burn 3.26 grams of calcium?

$$2\ Ca\ (s) + O_2\ (g) \rightarrow 2\ CaO\ (s)$$

3.26 g Ca x (1 mol Ca/40.1 g Ca) x (1 mol O_2/2 mol Ca) = 0.0406 mol O_2

Temperature in Kelvin: 45 °C = 273 + 35 = 308 K

Pressure in atm: 752 mm Hg/760 mm-atm-1 Hg = 0.0989 atm

V = nRT/P = (0.0406 mol x 0.082 L-atm mol^{-1} K^{-1} x 308 K)/0.0989 atm = 1.04 L O_2

3. What is the molarity of a 5 L sodium hydroxide solution that would completely react with 2 L of carbon dioxide gas measured at STP?

$$2\ NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

2 L CO_2 x (1 mol CO_2/22.4 L CO_2) x (2 mol NaOH/1 mol CO_2) = 0.179 mol NaOH

Molarity: M = 0.179 mol NaOH/5 L NaOH = 0.0357 M

4. How many liters of dry hydrogen gas, measured at 796 torr and 25 °C, will be released by decomposing 255 milliliters of H_2O (g) at 1.33 atm and 25 °C?

$$2\ H_2O \rightarrow 2\ H_2 + O_2$$

Temperature in Kelvin: 273 + 25 = 298 K

Pressure in atm: 796 torr/760 torr atm-1 = 1.047 atm

Number of moles of H_2O: PV/RT = (1.33 atm x 0.255 L)/(0.082 L-atm mol^{-1} K^{-1} x 298 K) = 0.0139 mol H_2O

0.0139 mol H_2O x (2 mol H_2/2 mol H_2O) = 0.0139 mol H_2

Volume of H_2: V = nRT/P = (0.0139 mol x 0.082 L-atm mol^{-1} K^{-1} x 298 K)/1.047 atm = 0.325 L H_2