

Textbook Answers p110 Ideal gas Law

$$4. \quad a) \quad 117 \text{ g NaN}_3 \left(\frac{\text{mol}}{23.0+3(14.0)\text{g}} \right) = 1.80 \text{ mol NaN}_3$$

$$1.8 \text{ mol NaN}_3 \left(\frac{3 \text{ mol N}_2}{2 \text{ mol NaN}_3} \right) = 2.70 \text{ mol N}_2$$

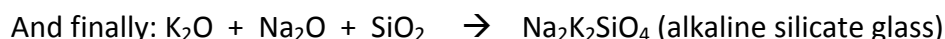
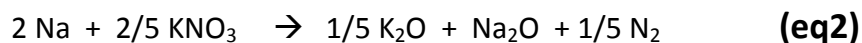
$$PV = nRT$$

$$V = \frac{nRT}{P} = \frac{2.70 \text{ mol} \left(8.31 \frac{\text{LkPa}}{\text{K mol}} \right) (20.2+273)\text{K}}{101.2 \text{ kPa}} = 65.0 \text{ L}$$

$$b) 2.70 \text{ mol N}_2 \frac{6.02 \times 10^{23} \text{ molecules}}{\text{mol}} = 1.63 \times 10^{24} \text{ molecules N}_2$$

A couple of things are wrong with the question. First, Na is not the end product of the reaction (see [University of Manitoba link](#)), and secondly, the reaction is exothermic, so that the nitrogen will be exposed to a temperature considerably greater than 20.2 °C.

In reality, there are two more reactions involved after the one given in the textbook. The initial one is: $2 \text{ NaN}_3 \rightarrow 2 \text{ Na} + 3 \text{ N}_2$ (eq1) and then



The actual volume of a full air bag with a is 60.0 L and the temperature of the gas is 230 °C. Pressure of 101.2 kPa.

Based on these values and the new equations, how many grams of sodium azide should be placed in the air bag? How does it compare with the fictitious number in the textbook?

SOLUTION

$$PV = nRT$$

$$n = \frac{PV}{RT}$$

$$n = \frac{101.2 \text{ kPa} (60.0 \text{ L})}{8.31 \frac{\text{kPaL}}{\text{Kmol}} (230 + 273)} = 1.4526 \text{ mol of nitrogen}$$

From equation 1, with the consumption of every 2 moles of **NaN₃**, we get 3 moles of nitrogen accompanying the production of two moles of Na. But these two moles of Na go on to produce 1/5 more moles of N₂.

$$1.4526 \text{ mol of } N_2 \left(\frac{2 \text{ mol NaN}_3}{3 + \frac{1}{5} N_2 \text{ mol of } N_2} \right) = 1.4526 / 3.2 * 2 = 0.9078 \text{ mol of NaN}_3$$

$$0.9078 \text{ mol of NaN}_3 \left(\frac{65.0 \text{ g}}{\text{mol}} \right) = 59 \text{ g}$$

This is close to what's used on the driver's side air bag.

P 113

7. When P and T are constant, volume is proportional to moles by Avogadro's law.

So if CO₂ = 3.5% of total volume then, $\frac{n_{CO_2}}{n_T} = \frac{3.5}{100}$

$$P_A = \frac{n_A}{n_T} P_T$$

$$P_{CO_2} = \frac{3.5}{100} (102.6) = 3.6 \text{ kPa}$$

$$P_{O_2} = \frac{4.0}{100} (102.6) = 4.1 \text{ kPa}$$

$$P_{H_2O} = \frac{92.5}{100} (102.6) = 95 \text{ kPa}$$

Check to see if they add up to the total of 102.6 kPa, and they almost do (off by 0.1 kPa due to rounding)

p 122-23

$$52. \quad 1000\text{L} = 1 \text{ m}^3$$

$$0.250\text{m}^3 (1000\text{L}/\text{m}^3) = 250 \text{ L}$$

$$\text{AT STP: } 250 \text{ L (mole}/22.4\text{L)} = 11.16 \text{ mole}$$

$$11.16 \text{ mole}(6.02 \times 10^{23} \text{ molecules/mole}) = 6.72 \times 10^{24} \text{ molecules}$$

$$57. \quad \frac{v_{He}}{v_{O_2}} = \sqrt{\frac{d_{O_2}}{d_{He}}}$$

Density is proportional to molar mass, so:

$$\frac{v_{He}}{0.076} = \sqrt{\frac{32}{4.0}}$$

$$v_{He} = 0.22 \text{ m/s}$$