Textbook Answers p110 Ideal gas Law

4. a) 117 g $NaN_3 \left(\frac{mol}{23.0+3(14.0)g}\right) = 1.80\ mol\ \ NaN_3$

$1.8\ mol\ \ NaN_3 \left(\frac{3\ mol\ N_2}{2\ mol\ \ NaN_3}\right) = 2.70\ mol\ \ N_2$

$$\mathrm{PV} = \mathrm{nRT}$$

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

b) $2.70\ mol\ \ N_2 \frac{6.02X10^{23} molecules}{mol} = 1.63\ X10^{24}\ molecules\ \ N_2$

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 ^oC.

In reality, there are two more reactions involved after the one given in the textbook. The initial one is: $2\ NaN_3 \rightarrow 2\ Na + 3\ N_2$ (eq1) and then

$2\ Na + 2/5\ KNO_3 \rightarrow 1/5\ K_2O + Na_2O + 1/5\ N_2$ **(eq2)**

And finally: $K_2O + Na_2O + SiO_2 \rightarrow Na_2K_2SiO_4$ (alkaline silicate glass)

The actual volume of a full air bag with a is 60.0 L and the temperature of the gas is 230 ^oC. 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

$$PV = nRT$$

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

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

From equation 1, with the consumption of every 2 moles of **NaN_3,** 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 N_2.

1.4526 $mol\ of\ N_2 \left(\frac{2\, mol\, NaN_3}{3+\frac{1}{5}N_2 mol\ of\ N_2}\right)$ = 1.4526/3.2*2 = 0.9078 mol of NaN_3

0.9078 mol of $NaN_3 \left(\frac{65.0\, g}{mol}\right)$ = 59 g

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

P 113

7. When P an dT are constant, volume is proportional to moles by Avogadro's law.

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

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

$$P_{CO2} = \frac{3.5}{100}(102.6) = 3.6\, kPa$$

$$P_{O2} = \frac{4.0}{100}(102.6) = 4.1\, kPa$$

$$P_{H2O} = \frac{92.5}{100}(102.6) = 95\, kPa$$

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. 1000L = 1 m^3

0.250m^3 (1000L/m^3) = 250 L

AT STP: 250 L (mole/22.4L) = 11.16 mole

11.16 mole(6.02 X 10^{23} molecules/mole)= 6.72 X 10^{24} molecules

57. $\frac{vHe}{vO2} = \sqrt{\frac{dO2}{dHe}}$

Density is proportional to molar mass, so:

$$\frac{vHe}{0.076} = \sqrt{\frac{32}{4.0}}$$

$$vHe = 0.22\ m/s$$