Chemistry 20 – Lesson 32
Ideal gas law

/48

1.

/6 **The assumptions for an ideal gas are:**

- **Gas molecules are very tiny and are spaced far apart.**
- **Gas molecules are in constant, random, straight-line motion and there are no forces acting between molecules.**
- **Gas molecules undergo perfectly elastic collisions with one another (i.e. – no loss of kinetic energy).**
- **Ideal gases do not change phase into a liquid or a solid.**

The behaviour of a real gas are:

- **Gas molecules have varying sizes. When they are confined their sizes affect their interactions with one another.**
- **Gas molecules have intermolecular forces acting between them.**
- **Gas molecules do lose a small amount of energy when they collide with one another.**
- **Real gases will eventually condense into liquids if the temperature is lowered.**

2.

$$pv = nRT$$

/3

$$n_{CH_4} = \frac{pv}{RT} = \frac{210\,\text{kPa} \times 500\,\text{mL}}{8.31\,\frac{\text{kPa}\cdot\text{L}}{\text{mol}\cdot\text{K}} \times 308\,\text{K}} = \boxed{0.041\,\text{mol}}$$

3.

$$pv = nRT$$

/3

$$p_{air} = \frac{nRT}{v} = \frac{30\,\text{mol} \times 8.31\,\frac{\text{kPa}\cdot\text{L}}{\text{mol}\cdot\text{K}} \times 313\,\text{K}}{50\,\text{L}} = \boxed{1.6\times10^{3}\,\text{kPa or } 1.6\,\text{MPa}}$$

4.

$$n_{O_2} = \frac{m}{M} = \frac{50\,000\,\text{g}}{32.00\,\text{g/mol}} = 1562.5\,\text{mol}$$

/5

$$pv = nRT$$

$$v_{O_2} = \frac{nRT}{p} = \frac{1562.5\,\text{mol} \times 8.31\,\frac{\text{kPa}\cdot\text{L}}{\text{mol}\cdot\text{K}} \times 398\,\text{K}}{150\,\text{kPa}} = \boxed{3.4\times10^{4}\,\text{L or } 34\,\text{kL}}$$

5.

$$n_{NH_3} = \frac{m}{M} = \frac{10.5\,\text{g}}{17.04\,\text{g/mol}} = 0.616\,\text{mol}$$

/5

$$pv = nRT$$

$$T_{NH_3} = \frac{pv}{nR} = \frac{85.0\,\text{kPa} \times 30.0\,\text{L}}{0.616\,\text{mol} \times 8.31\,\frac{\text{kPa}\cdot\text{L}}{\text{mol}\cdot\text{K}}} = \boxed{498\,\text{K or } 225^{\circ}\text{C}}$$

6.

$$pv = nRT \quad \text{and} \quad n = \frac{m}{M}$$

/2 $$pv = \frac{mRT}{M}$$

$$M = \frac{mRT}{pv}$$

7.

/2 $$M_{gas} = \frac{mRT}{pv} = \frac{1.25\,g \times 8.31\,\frac{kPa\cdot L}{mol\cdot K} \times 273\,K}{100\,kPa \times 1.00\,L} = \boxed{28.4\,{}^{g}\!/\!{}_{mol}}$$

8.

$$n_{H_2O} = \frac{m}{M} = \frac{1.0\,g}{18.02\,{}^{g}\!/\!{}_{mol}} = 0.05549\,mol$$

/5 $$pv = nRT$$

$$v_{H_2O} = \frac{nRT}{p} = \frac{0.05549\,mol \times 8.31\,\frac{kPa\cdot L}{mol\cdot K} \times 371\,K}{103\,kPa} = \boxed{1.7L}$$

9.

$$pv = nRT$$

/3 $$v_{Cl_2} = \frac{nRT}{p} = \frac{26.5\,kmol \times 8.31\,\frac{kPa\cdot L}{mol\cdot K} \times 308\,K}{400\,kPa} = \boxed{170\,kL}$$

10.

$$pv = nRT$$

/3 $$n_{Br_2} = \frac{pv}{RT} = \frac{60\,kPa \times 18.8\,L}{8.31\,\frac{kPa\cdot L}{mol\cdot K} \times 413\,K} = \boxed{0.33\,mol}$$

11.

a.

$$pv = nRT$$

/7 $$n_{gas} = \frac{pv}{RT} = \frac{102.2\,kPa \times 1.25\,L}{8.31\,\frac{kPa\cdot L}{mol\cdot K} \times 296.4\,K} = 0.518\,mol$$

$$M_{gas} = \frac{m}{n} = \frac{9.31g - 7.02g}{0.0518\,mol} = \boxed{44.2\,{}^{g}\!/\!{}_{mol}}$$

b. **The gas may be carbon dioxide (M = 44.01 g/mol), but this is not very certain since other possibilities like dinitrogen oxide (M = 44.02 g/mol) also exist. A diagnostic test would be necessary to confirm the presence of one gas or another.**

12.

$$pv = nRT$$

/3 $$v_{CO_2} = \frac{nRT}{p} = \frac{1\,mol \times 8.31\,\frac{kPa \cdot L}{mol \cdot K} \times 1073\,K}{7500\,kPa} = 1.19\,L$$

$$V_{CO_2} = \boxed{1.19\,L/mol}$$

13.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

/3 $$V_2 = \frac{P_1T_2V_1}{P_2T_1} = \frac{102kPa \times 285\,K \times 1.00\,m^3}{96kPa \times 250K} = \boxed{1.21\,m^3}$$

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