$$= \frac{366\ \cancel{K} \times 305\ \cancel{kPa} \times 1.0\ L}{403\ \cancel{K} \times 101\ \cancel{kPa}}$$

$$v_{bubble} = 2.7\ L$$

or

$$v_{bubble} = 1.0\ L \times \frac{305\ \cancel{kPa}}{101\ \cancel{kPa}} \times \frac{366\ \cancel{K}}{403\ \cancel{K}}$$

$$v_{bubble} = 2.7\ L$$

The final total volume of the water vapour bubble will be 2.7 L.

(b) The narrow shaft opening is necessary to restrict flow, so that pressure has the time to build up enough to spray the water high above the surface.

9.3 COMPRESSED GASES

PRACTICE

(Page 442)

Understanding Concepts

1. (a) $p_1 = 300$ kPa

$v_1 = 6.0$ L

$p_2 = 100$ kPa

$v_2 = ?$

$$p_1v_1 = p_2v_2$$

$$v_2 = \frac{p_1v_1}{p_2}$$

$$= \frac{300\ \cancel{kPa} \times 6.0\ L}{100\ \cancel{kPa}}$$

$$v_{air} = 18\ L$$

or

$$v_{air} = 6.0\ L \times \frac{300\ \cancel{kPa}}{100\ \cancel{kPa}}$$

$$v_{air} = 18\ L$$

The air volume at surface conditions will be 18 L.

(b) If you try to hold your breath while rising from a deep dive using scuba gear, the decrease in outside pressure can result in serious damage to the alveoli in your lungs, caused by the pressure differential inside and outside your chest.

(c) Temperature is assumed to be constant, as is the amount of gas.

2. The contents of aerosol cans are already under high pressure. If heating raises the temperature, the pressure will increase proportionally. If the pressure becomes too high, the can may rupture abruptly (explode), which could injure someone nearby.

Making Connections

3. Typical answers might include careers such as:
Trucks have braking systems that use compressed air to exert very high forces; drivers must be certified to operate vehicles using such systems.
Welders are trained to use a variety of pressurized gases: acetylene and oxygen that are mixed to form the fuel; inert gases such as argon that keep air away from a weld so that it does not oxidize.

Copyright © 2002 Nelson Thomson Learning

Anesthesiologists use a variety of anaesthetic gases in their work, and require training in the precise delivery and monitoring of such gases.

4. It is very important that pressure regulators not be switched among tanks of various gases, particularly if one of them is oxygen. A pressure regulator for oxygen tanks, used on another tank, such as propane or hydrogen (or vice versa), could cause oxygen to mix with a combustible substance at very high pressure, which would almost certainly cause an explosion. Oxygen regulators are colour coded, and must have a warning attached. Propane tanks are reverse threaded so that an oxygen regulator *cannot* be attached to a propane tank (or vice versa), even if you try.
5. The Donald Duck voice made while exhaling helium is due to the speed of sound in helium, which is much higher than in air. Helium atoms move much faster than air molecules at the same temperature, so the resonant sounds within the vocal tract become distorted. The danger in this practice is not from (inert) helium; it is that inhaling helium deeply and repeatedly can cause oxygen deprivation. To make Duck imitations safe, always make the helium inhalation "shallow," and take several deep breaths of air immediately afterward.

GO TO www.science.nelson.com, Chemistry 11, Teacher Centre.

SECTION 9.3 QUESTIONS

Making Connections

(Page 443)

1. Automobile tires are the most common commercial product containing compressed air. Others include scuba diving tanks and portable marine horns. Many commercial products contain other compressed gases. Examples include propane and butane fuel containers, inert (often nitrogen or argon) propellants in aerosol cans, and natural gas burners in barbecues, fireplaces, and furnaces.
2. The safety hazard of compressed gases is primarily the danger of rupture (explosion) of the container, caused by overheating or failure of some part, resulting in injury to people nearby.
3. There may be dangers inherent in the substance itself; it may be toxic, flammable, or corrosive, for instance.

9.4 THE IDEAL GAS LAW

PRACTICE

(Page 445)

Understanding Concepts

1. Volume of a gas in an air (pneumatic) shock absorber can be reduced by decreasing the amount, by lowering the temperature, or by raising the pressure.
2. An ideal gas would have zero attractive force between particles, and zero particle size. Real gases will be closest to this condition for small entities at very low pressures and very high temperatures, because then their particles will be farthest apart and moving fastest, minimizing the effect of intermolecular forces. The lower the intermolecular attraction — as in helium atoms, for example — the closer the behaviour to "ideal".
3. $n_{CH_4} = ?$

$p = 210 \text{ kPa}$

$T = 35.0°\text{C} = 308.0 \text{ K}$

$v = 500 \text{ mL} = 0.500 \text{ L}$

$R = 8.31 \text{ kPa·L/(mol·K)}$

$$pv = nRT$$

$$n_{CH4} = \frac{pv}{RT}$$

Copyright © 2002 Nelson Thomson Learning