$cm^3 = 1mL$

$1m^3 = 1000\,L$

Chemistry 20
Unit 2- Gases Unit

Key

Outcome 1 – Gases and Gas Variables

General Outcome
Students will explain molecular behaviour, using models of the gaseous state of matter.

Specific Outcomes met in Outcome 1

Students will:

20–B1.2k convert between the Celsius and Kelvin temperature scales

20–A1.4k illustrate how Boyle's and Charles's laws, individually and combined, are related to the ideal gas law ($PV = nRT$)

- express pressure in a variety of ways, including units of kilopascals, atmospheres and millimetres of mercury
- perform calculations, based on the gas laws, under STP, SATP and other defined conditions.

Lessons in which the above Specific Outcomes will be embedded

Lesson 1 – Pressure and Temperature Conversions

Lesson 2 – Boyles Law

Lesson 3 – Charles Law

Lesson 4 – The Combined Gas Law

Chemistry 20 – Chemical Bonding **Date:**
Outcome 1 – Gases and Gas Variables
Lesson 1: Pressure and Temperature Conversions

I can... identify the different units that are used to measure pressure

I can... convert between the different units of pressure

To help me learn this I will:
1. Read pgs. 148-150
2. Do # 1-3 on pg 150
3. Do the Practice Sheet #1
4. Do the examples below
5. See Mr. Gray if I am having trouble

Examples:

1. Convert the following to kPa
   a. 350 mmHg

$$\frac{350\ mmHg}{x\ kPa} = \frac{760\ mmHg}{101.325\ kPa}$$

$x = 46.7\ kPa$

   b. 4.20 atm

$$\frac{4.20\ atm}{x\ kPa} = \frac{1\ atm}{101.325\ kPa}$$

$x = 426\ kPa$

2. Convert the following to atm
   a. 625.2 kPa

$$\frac{625.2\ kPa}{x\ atm} = \frac{101.325\ kPa}{1\ atm}$$

$x = 6.170\ atm$

   b. 450 mm Hg

$$\frac{450\ mmHg}{x\ atm} = \frac{760\ mmHg}{1\ atm}$$

$x = 0.592\ atm$

3. Convert the following into mm Hg
   a. 100 kPa

$$\frac{100\ kPa}{x\ mmHg} = \frac{101.325\ kPa}{760\ mmHg}$$

$x = 750\ mmHg$

   b. 0.560 atm

$$\frac{0.560\ atm}{x\ mmHg} = \frac{1\ atm}{760\ mmHg}$$

$x = 426\ mmHg$

Chemistry 20 – Chemical Bonding **Date:**
Outcome 1 – Gases and Gas Variables

esson 2: Boyle's Law

I can... explain the relationship between the pressure and volume of a gas

I can... convert between the different units of pressure

To help me learn this I will...

1. Read pgs. 150-151
2. Do # 6-10 on pg 152
3. Do Practice Sheet #2
4. Do the examples below
5. See Mr. Gray if I am having trouble

Examples:

1. Convert the following units

a. 1.15 atm = 874 mm Hg

$\frac{1.15\text{atm}}{x\ \text{mmHg}} = \frac{1\text{atm}}{760\text{mmHg}}$

b. 345 kPa = 3.40 atm

$\frac{345\text{kPa}}{x\ \text{atm}} = \frac{101.325\text{kPa}}{1\text{atm}}$

$x = 3.40$

2. A balloon is filled to 850 mL at the surface of the ocean where the pressure is 1 atm. A scuba diver then takes the balloon 66 ft under water where the pressure is 304 kPa. What would the volume of the balloon be? Before you do the calculation, write a sentence predicting whether you think it will increase or decrease in volume (including a brief explanation). I think the balloon will decrease in volume because as pressure increases volume decreases [Bolye's Law]

$V_1 = 850\text{mL} = 0.850\text{L}$

$P_1 = 1\text{atm} = 101.325\text{kPa}$

$P_2 = 304\text{kPa}$

$V_2 = ?$

$V_1P_1 = V_2P_2$

$(0.850\text{L})(101.325\text{kPa}) = V_2(304\text{kPa})$

$V_2 = 0.283\text{L}$

$V_2 = 0.3\text{L}$

3. A gas in non-rigid, plastic container has volume of 1.15 L at SATP. If the temperature does not change and the volume reduces to 750 mL, what is the new pressure of the gas?

$V_1 = 1.15\text{L}$

$V_2 = 0.750\text{L}$

$P_1 = 100\text{kPa}$

P_2

$V_1P_1 = V_2P_2$

$(1.15\text{L})(100\text{kPa}) = (0.750\text{L})(P_2)$

$P_2 = 153\text{kPa}$

Chemistry 20 – Chemical Bonding **Date:**
Outcome 1 – Gases and Gas Variables

Lesson 3: Charles' Law

I can... explain the relationship between the temperature and volume of a gas

I can... convert temperature between degrees Celsius and Kelvin

To help me learn this I will:

1. Read pgs. 152-156
2. Do # 11-13 on pg 154
3. Do Practice Sheet #3
4. Do # 14-17 on pg 156
5. Do the examples below
6. See Mr. Gray if I am having trouble

Example:

1. Convert the following units
   a. -23.5 °C = 250 / 249.5 K
   b. 100 K = -173 °C

2. Carbon dioxide is usually formed when gasoline is burned. If 30.0 L of CO_2 is produced at a temperature of 1.00×10^3°C and allowed to reach room temperature (25.0 °C) without any pressure changes, what is the new volume of the carbon dioxide?

$V_1 = 30.0\ L$

$T_1 = 1.00 \times 10^3\ °C = 1273\ K$

$T_2 = 25.0°C = 298\ K$

$V_2 =$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{30.0\ L}{1273\ K} = \frac{V_2}{298}$

$V_2 = 7.02\ L$

3. Calculate the **decrease** in temperature that would occur when 2.00 L at 20.0 °C is reduced to 1.00 L.

$V_1 = 2.00\ L$

$t_1 = 20.0°C = 293\ K$

$V_2 = 1.00\ L$

$t_2 =$

$\frac{V_1}{t_1} = \frac{V_2}{t_2}$

$\frac{2.00\ L}{293\ K} = \frac{1.00\ L}{t_2}$

$t_2 = 147\ K$

The Decrease

$293\ K - 147\ K$

$= 146\ K$

Chemistry 20 – Chemical Bonding **Date:**
Outcome 1 – Gases and Gas Variables

Lesson 4: The Combined Gas Law

I can... explain the relationship between the temperature, pressure and volume of a gas

I can... convert temperature between degrees Celsius and Kelvin

I can... convert between the 3 different units of pressure

To help me learn this I will:

1. Read pgs. 156-160
2. Do # 20-23, 25-26 on pg 159
3. Do the worksheet titled Practice Sheet #4
4. Do the examples below
5. See Mr. Gray if I am having trouble

Examples:

1. Convert the following units

a. 101 K = -172 °C

-273

b. 100 mm Hg = 13.3 kPa

$\frac{100\text{ mm Hg}}{x\text{ kPa}} = \frac{760\text{ mm Hg}}{101.325\text{ kPa}}$

$x = 13.3$

2. A flexible, non-rigid, plastic sphere is filled with air to a volume of 1.25 L at standard pressure and temperature. It is then heated to a temperature of 80 °C at a pressure of 125 kPa. What is the new volume of this sphere?

$V_1 = 1.25\text{ L}$
$P_1 = 101.325\text{ kPa}$
$T_1 = 273\text{ K}$
$V_2 = ?$
$P_2 = 125\text{ kPa}$
$T_2 = 353\text{ K}$

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

$$\frac{(101.325\text{kPa})(1.25\text{L})}{273\text{K}} = \frac{(125\text{kPa})(V_2)}{353\text{K}}$$

$V_2 = 1.3\text{ L}$

3. The air in a tire sitting in a garage at 15°C has a volume of 30.0 L and a pressure of 250 kPa. If the tire is then taken out into the cold winter air which has a temperature of -40.5 oC, what is the new pressure of the tire? Note: the tire does not change volume.

$T_1 = 15\text{ °C} = 288\text{K}$
~~$V_1 = 30.0\text{L}$~~
$P_1 = 250\text{kPa}$
$T_2 = -40.5\text{ °C} = 232.5\text{K}$
$P_2 = ?$
~~$V_2 = 30.0\text{L}$~~

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{250\text{kPa}}{288\text{K}} = \frac{P_2}{232.5\text{K}}$$

$P_2 = $ ~~$2.0 \times 10^2\text{ kPa}$~~ 202 kPa

Chemistry 20
Unit 2- Gases Unit

Outcome 2 - Moles, Molar Volume and the Ideal Gas Law

General Outcome
Students will explain molecular behaviour, using models of the gaseous state of matter.

Specific Outcomes met in Outcome 2

Students will...

20–B1.1k describe and compare the behaviour of real and ideal gases in terms of kinetic molecular theory

20–B1.3k explain the law of combining volumes

20–A1.4k illustrate how Boyle's and Charles's laws, individually and combined, are related to the ideal gas law ($PV = nRT$)

- perform calculations, based on the gas laws, under STP, SATP and other defined conditions.

Lessons in which the above Specific Outcomes will be embedded

Lesson 1: Law of Combing Volumes

Lesson 2: Molar Volume

Lesson 3: The Ideal Gas Law

Chemistry 20 – Chemical Bonding **Date:**

Outcome 2 - Moles, Molar Volume and the Ideal Gas Law

esson 1: Law of Combing Volumes

I can... use and explain the law of combining volumes

To help me learn this I will:

1. Read pgs. 164-166
2. Do # 1-2 on pg 164
3. Do Practice Sheet #5
4. Do # 5-7 on pg 166
5. Do the examples below
6. See Mr. Gray if I am having trouble

Examples:

1. Convert the following units
   a. 101 °C = 374 K
   +273

   b. 10.5 atm = 1.06×10^3 kPa

   $\frac{10.5 \text{ atm}}{x \text{ kPa}} = \frac{1 \text{ atm}}{101.325 \text{ kPa}}$

   $= 1063.91$

When gasoline (C_8H_{18}) burns in a car engine, carbon dioxide and water vapour are produced. If 125 L of carbon dioxide is produced, what volume of water vapour is produced assuming both are at the same temp and pressure?

$2C_8H_{18} + 25O_2 \longrightarrow 16CO_2 + 18H_2O$

125 L V =

$125\text{L} \times \frac{18}{16}$

$V = 141\text{L}$ of $H_2O_{(g)}$ produced

$n = \frac{V}{V_m} = \frac{141 \text{ L}}{22.4 \text{ L/mol}} = 6.2946\ldots \text{ mol}$

$m = nM$

$= 113.429\ldots \text{g}$

$m = 113 \text{ g}$

Chemistry 20 – Chemical Bonding **Date:**

Outcome 2 - Moles, Molar Volume and the Ideal Gas Law

Lesson 2: Molar Volume

I can … use and explain molar volume and use it to calculate the volume or masses of a gas

To help me meet my learning goals I will:

1. Read pgs. 169-171
2. Do # 5-13 on pg171
3. Do Practice Sheet #6
4. Do the examples below
5. See Mr. Gray if I am having trouble

Examples:

1. Convert the following units
   a. 375 K = 102 °C

   -273

   b. 300 mm Hg = 0.395 atm

   $\frac{300\ mmHg}{x\ atm} = \frac{760\ mmHg}{1\ atm}$

2. What volume does 10.50 mol of helium occupy at STP?

   $n = 10.50\ mol$
   $P = 101.325\ kPa$
   $T = 273K$
   $V = ?$

   Ideal Gas Law

   $pV = nRT$

   $(101.325kPa)(V) = (10.50mol)(8.31)(273K)$

   $V = 235.1L$

   Molar Volume

   $V = nV_m$

   or $V = (10.50mol)(22.4L/mol)$

   $= 235.2L$

3. A sample of carbon dioxide gas at SATP occupies a volume of 300 L. What is the mass of this sample of gas?

   $V = 300L$
   $P = 100kPa$
   $T = 298K$

   ① $PV = nRT$

   $(100kPa)(300L) = n(8.31)(298K)$

   $n = 12.11\ldots\ mol$

   ② $m = nM$

   $m = (12.11mol)(44.01g/mol)$

   $m = 533g$

   M: CO_2

   $12.01\ g/mol$
   $2 \times 16.00\ g/mol$
   $44.01\ g/mol$

   or

   ① $V = nV_m$

   $300L = n(24.8L/mol)$

   $n = 12.1mol$
   $12.096\ldots\ mol$

   ② $m = nM$

   $m = (12.1mol)(44.01g/mol)$

   $m = 532g$

   $m = 532g$

Chemistry 20 – Chemical Bonding **Date:**

Outcome 2 - Moles, Molar Volume and the Ideal Gas Law

Lesson 3: The Ideal Gas Law

I can... use and explain the ideal gas law and use it to calculate the pressure, volume, amount, mass or temperature of a gas.

To help me meet my learning goals I will:

1. Read pgs. 172-174
2. Do # 3-6 on pg174-5
3. Do Practice Sheet 7
4. Do the examples below
5. See Mr. Gray if I am having trouble

Examples:

1. Convert the following units
   a. 15 °C = 288 K

   +273

   b. 300 kPa = 2.96 atm

   $\frac{300\text{kPa}}{x\text{ atm}} = \frac{101.325\text{ kPa}}{1\text{ atm}}$

2. What volume will 10.0 mol of a gas occupy if it needs to be kept at 200 kPa and 15.0 °C?

   $n = 10.0\text{ mol}$
   $P = 200\text{ kPa}$
   $t = 15.0°C = 288\text{ K}$

   $PV = nRT$
   $(200\text{kPa})(V) = (10.0\text{mol})(8.31)(288\text{K})$
   $V = 120\text{ L}$

3. What is the pressure of a 35.5 g sample of carbon dioxide gas that is kept in a container with a volume of 100 mL at a temperature of 20.0 °C?

   $m = 35.5\text{g}$
   $V = 0.1\text{L}$
   $t = 20.0°C + 273 = 293\text{K}$

   ① M: $12.01 + 2(16.00) = 44.01\text{g/mol}$

   ② $n = \frac{m}{M} = \frac{35.5\text{g}}{44.01\text{g/mol}}$
   $n = 0.80663$

   ③ $PV = nRT$
   $(P)(0.1\text{L}) = (0.80663)(8.31)(293\text{K})$
   $P = 19640.187$
   $P = 1.96 \times 10^4\text{ kPa}$