Boyle Charles Combined Gay-Lussac Avogadro Ideal Worksheet

A number of different gases are used in the electrical industry as an insulating medium for high-voltage circuit breakers, switchgears, and other types of electrical equipment. These often replace oil-filled circuit breakers that can contain harmful toxic chemicals called polychlorinated biphenyls (PCBs).

A chemist was hired by a railway company to determine which gas was being used in a railway switchgear. The chemist collected the following data:

Volume of gas sample taken	97.3 mL
Temperature of gas sample	20.0°C
Pressure of gas sample	100.0 kPa

The chemist calculated the density of the gas sample to be 6.00 g/L.

According to the data, which of the following gases was present in the switchgear?

1. CO_2 2. SF_6 3. C_2H_6 4. CF_2Cl_2 5. SO_3 6. UF_6

2 In 1784, Jacques Charles made the first ascent in a hydrogen-filled balloon. He produced the hydrogen for his balloon by reacting sulphuric acid, H_2SO_4, with iron filings. Fe, according to the following balanced chemical reaction.

$$Fe_{(s)} + H_2SO_{4(aq)} \rightarrow H_{2(g)} + FeSO_{4(aq)}$$

The reaction consumed 5.0×10^2 L of 18 mol/L sulphuric acid. Assume he collected the hydrogen gas at a pressure of 100.8 kPa and a temperature of 19°C.

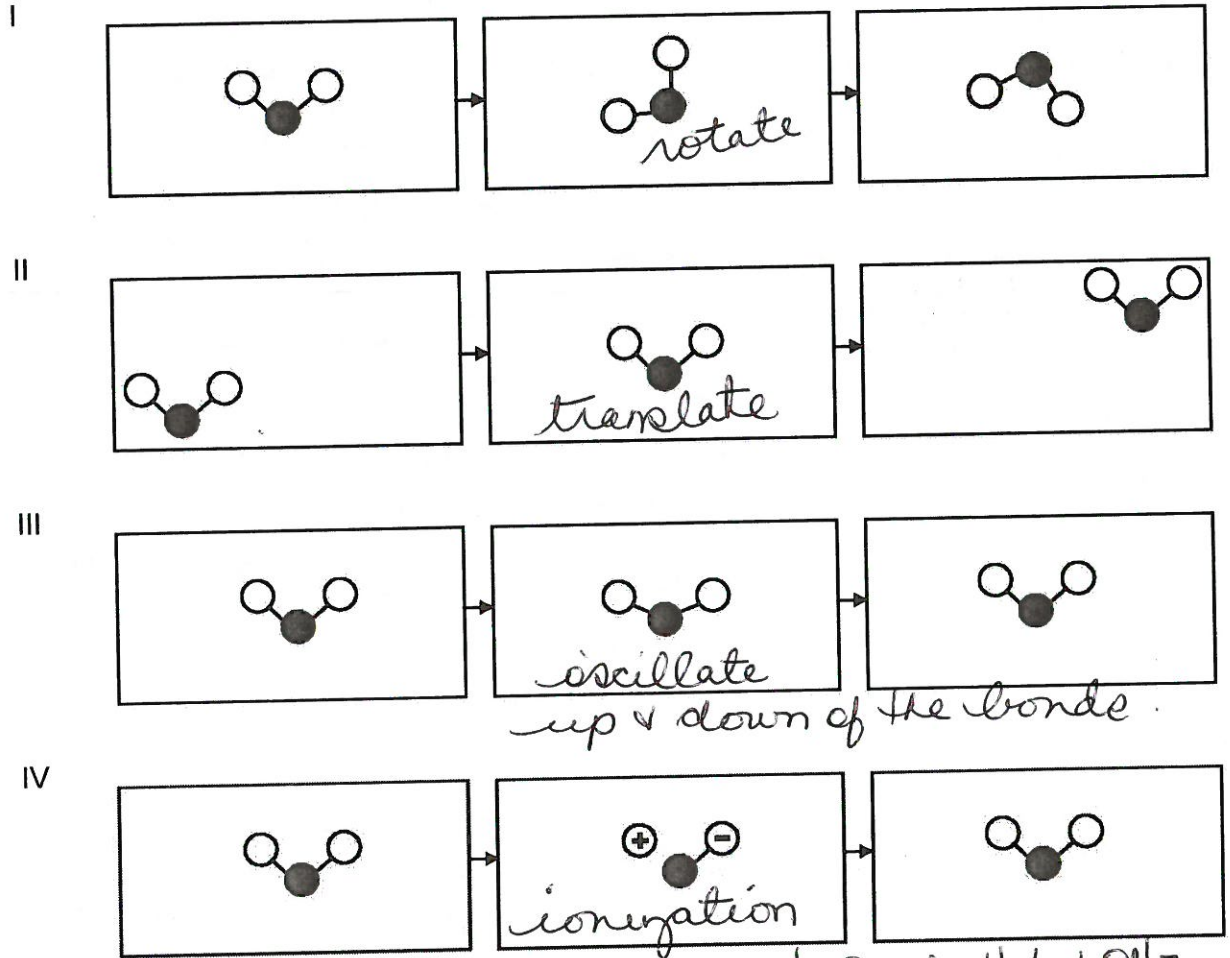
What volume of hydrogen gas would Jacques Charles have produced?

3 A tire store fills its tires with nitrogen gas, N_2. At two o'clock when the temperature is 23°C, the store fills a tire to 315 kPa of pressure and finds that it requires 84.0 g of nitrogen gas. Unfortunately, the tire valve is leaking. At eight o'clock, when the temperature is 15°C, a worker checks the pressure and finds that it has decreased to 235 kPa.

What mass of nitrogen remained in the tire?

(Assume that the capacity of the tire did not change.)

4 The following diagrams demonstrate various behaviours that a water molecule can exhibit.



$H_2O \rightarrow H^+ + OH^-$

According to the Kinetic Molecular Theory, which diagrams represent the types of kinetic energy that are predominantly displayed by water molecules in the liquid state?

all are displayed but translation is difficult bec parts are so close tog!

A) I and II only

B) I and III only

C) II and IV only

D) III and IV only

5 A company sells gas in steel cylinders. All of the cylinders have the same volume but not the same mass. The mass of each evacuated cylinder is stamped on it. A worker takes the first cylinder, which is stamped 524.3 g and fills it with ammonia gas, NH_3, until its mass is 537.2 g. The worker then takes a second cylinder, stamped 487.6 g, and fills it with fluorine gas, F_2. The contents of both cylinders must be at the same temperature and pressure.

same T, P & V ∴ same # moles

What is the total mass of the second cylinder after it has been filled?

$537.2g - 524.3g = 12.9g\ NH_3 \times \frac{1 mol\ NH_3}{17g} = 0.759 mol\ NH_3 =$

$0.759 mol\ F_2 \times \frac{38g\ F_2}{1 mol} =$

$28.8g\ F_2 + 524.3g\ cyl = 553.1g$

A) 500.5 g

B) 502.0 g

C) 516.4 g

D) 553.1 g

watch sf!

6

The Kinetic Molecular Theory describes an ideal gas model.

Among the main features of this model are:

(I) Gases consist of molecular particles moving at any given instant in straight lines. ✓

(II) Molecules collide with each other and with the container walls without loss of kinetic energy.

(III) The average kinetic energy of gas molecules is directly proportional to the Kelvin temperature.

(IV) Gas molecules are very widely spaced, relative to the size of the molecules. ✓

Which two of these Kinetic Molecular Theory features can be used to explain why gas bubbles always rise through a liquid and become larger as they move upward?

A) (I) and (III)

C) (II) and (III)

(B)) (I) and (IV)

D) (II) and (IV)

The standard value for R is 8.31 $\frac{\text{kPa} \bullet \text{L}}{\text{mol} \bullet \text{K}}$. Over time atmospheric pressure has been measured using many different units, including:

101.3 kPa

1 atmosphere (atm)

760 mm Hg

407 inches H_2O

$\frac{PV}{nT} = \frac{nRT}{nT}$

$\frac{(407 \text{ in } H_2O)(22.4 L)}{(1 mol)(273 K)} = R = 33.4 \frac{\text{in L}}{\text{mol K}}$

What would be the ideal gas constant, *R*, if the pressure were measured in inches H_2O?

(Use standard units for *V*, *n*, *T*.)

K

kPa mol

8

Kernels of corn contain, on average, 15.0% water by mass.

What volume of water vapour, measured at 100.0°C and 101.3 kPa pressure, is formed from popping 155.0 g of popcorn?

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

$\frac{PV}{P} = \frac{nRT}{P} = \frac{(155.0 g \times 0.150 \times \frac{1 mol H_2O}{18 g})(8.314)(373.0 K)}{101.3 kPa} = 39.5 L\ H_2O$

$\frac{V}{n}$

9 At which temperature and pressure is the molar volume of a gas the SMALLEST?

(A) 298 K and 25 kPa 0.697

B) 313 K and 101 kPa 25.8

C) 323 K and 50 kPa 53.7

D) 373 K and 75 kPa 41.3

$\frac{PV}{Pn} = \frac{nRT}{nP} = \frac{V}{n}$ for $\frac{V}{n}$ to be the smallest the P must be high + the T must be low

74 Worried about the environment, you want to buy the least polluting car on the market. Here is the equation of gasoline, C_8H_{18}, combustion:

$$C_8H_{18(l)} + 12.5\ O_{2(g)} \rightarrow 8\ CO_{2(g)} + 9\ H_2O_{(g)}$$

The density of gasoline is 0.7 g/mL. A car sales clerk tries to convince you to buy a car with the following characteristics:

- manual transmission ✓ yes!
- 2.8 litre engine
- 7.2 L/100 km consumption
- 2 tail pipes

You drive approximately 24 000 km a year. stoich then $PV = nRT$

What volume of CO_2 will this car produce annually at an atmospheric pressure of 101.3 kPa and a temperature of 15 °C? $+273 = 288\ K$

1) $24\,000\ \text{km} \times \frac{7.2\ \text{L gas}}{100\ \text{km}} \times \frac{0.7\ g}{1\ mL} \times \frac{1000\ mL}{1\ L} \times \frac{1\ mol\ C_8H_{18}}{114\ g} \times \frac{8\ mol\ CO_2}{1\ mol\ C_8H_{18}} =$

$8.5 \times 10^4\ mol\ CO_2$

2) $\frac{PV}{P} = \frac{nRT}{P}$

$= \frac{(8.5 \times 10^4\ mol)(8.314)(288\ K)}{(101.3\ kPa)} = 2.0 \times 10^6\ L\ CO_2$