Gases test #2 **2019 V1** **Name:** _____

1 atm = 760 mm Hg= 101.3 kPa $PV = nRT$ $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$

4 marks each, show all you work, round final answer to sig. figs. and indicate the appropriate unit.

1. A 100 mL syringe filled with CO_2 has a mass of 32.4 g. When empty, its mass is 32.0 g. When the syringe is filled with an unknown gas, under the same conditions, it has a mass of 33.2 g.
What is the molar mass of the unknown gas?

(A) 132 g/mol B) 44 g/mol C) 12.6 g/mol D) 1.2 g/mol

$\frac{1\text{ mol } CO_2}{x} = \frac{44.01}{0.4}$ $x = 0.009089\text{ mol}$ $\frac{0.009089\text{ mol}}{1\text{ mol}} = \frac{1.2\text{ g}}{x}$ $x = 132$

2. **At which temperature and pressure is the molar volume of a gas the SMALLEST?**

A) 373 K and 75 kPa C) 323 K and 50 kPa

(B) 313 K and 101 kPa (D) 298 K and 25 kPa

↓T ↑P

3. A 1.00 L container of a gas is at a certain temperature and pressure. All of the gas is removed, placed into a 4.00 L container, and the absolute temperature is doubled. V×4 T×2
By what factor will the pressure change? P÷4 P×2 $= \frac{2}{4} = \frac{1}{2}$

A) The pressure will double. C) The pressure will increase by a factor of 8.

B) The pressure will halve. D) The pressure will decrease by a factor of 4.

Multiple Choice Answers	
1	A
2	B
3	B
4	C

4. Four moles of oxygen (O_2) occupy a volume of 44.8 litres at a pressure of 150 kPa.
What is the temperature in degrees Celsius of the oxygen?

A) -268°C B) -181°C C) -70.8°C D) 202°C

$PV = nRT$

$T = \frac{PV}{nR}$

$= \frac{(150)(44.8)}{(4)(8.31)} = 202\text{ K} - 273$

$= -70.8°C$

___/16

5. A sample of sulfur dioxide occupies a volume of 652 mL at 40.0° C and 720 mm Hg. What volume will the sulfur dioxide occupy at STP?

$T_1 = 40 + 273 = 313$

$T_2 = 0 + 273 = 273$

$P_1 = 720\text{ mmHg}$

$P_2 = 760\text{ mmHg}$

$V_1 = 652\text{mL}$

$V_2 = ?$

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

$\frac{(720)(652)}{313} = \frac{(760)V_2}{273}$

$237\,880V_2 = 128\,157\,120$

$V_2 = 538.747\text{mL}$

539 mL

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(V1)

6. A highly exothermic reaction occurs when sodium metal is added to water according to the following reaction.

$$2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow 2\ NaOH_{(aq)} + H_{2(g)}$$

What mass of sodium metal will produce 4.50×10^2 mL of hydrogen gas at 25.0°C and 101.3 kPa?

↳ 450mL = 0.450L ↳ +273 = 298K

(1) $PV = nRT$

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

$= \frac{(101.3)(0.450)}{(8.31)(298)}$

$n = 0.018408\ mol\ H_2$

(2) $\frac{1\ mol\ H_2}{0.018408} = \frac{2\ mol\ Na}{x}$ $\quad x = 0.036816\ mol\ Na$

(3) $\frac{1\ mol\ Na}{0.036816} = \frac{22.99\ g}{x}$ $\quad x = 0.84640\ g\ Na$

0.846 g Na

846g -1

7. A student filled a balloon with 2 different gases, CO_2 and N_2. The atmospheric pressure in the lab was 770.0 mmHg and the student used 0.2201 g of CO_2 and 0.5604 g of N_2. What was the partial pressure of N_2 in the balloon?

$P_T = 770.0\ mm\ Hg$

$\frac{1\ mol\ CO_2}{x} = \frac{44.01\ g}{0.2201\ g}$ $\quad x = 0.005001\ mol\ CO_2$

$\frac{1\ mol\ N_2}{x} = \frac{28.02\ g}{0.5604\ g}$ $\quad x = 0.02000\ mol\ N_2$

$n_T = 0.005001 + 0.02000 = 0.02500\ mol$

$P_{N_2} = \left(\frac{n_{N_2}}{n_T}\right) P_T$

$= \left(\frac{0.02000}{0.02500}\right) 770.0$

$P_{N_2} = 616.0\ mm\ Hg$

(82.1 kPa) because of 760.

8. A student produces 0.340 L of N_2O at 718 mm Hg, and 24.0°C. If the gas has a mass of 0.3302g. Does N_2O behave as an ideal gas in this situation? Show calculations to support your work.

$\frac{1\ mol\ N_2O}{x} = \frac{44.02}{0.3302}$ $\quad x = 0.007501\ mol\ N_2O$

$T = 24 + 273 = 297K$

$\frac{\text{Pressure}}{760\ mm\ Hg} = \frac{101.3\ kPa}{718\ mm\ Hg}$ $\quad x = 95.702\ kPa$

$PV = nRT$

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

$= \frac{(95.702)(0.340)}{(0.007501)(297)}$

$R = 14.606$

$R = 14.6$

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N_2O is not an ideal gas in this case

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Gases test #2 **2019 V2** **Name:** _____

1.00 atm = 760 mm Hg = 101.3 kPa $PV = nRT$ $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$ $P_A = \frac{n_A}{n_T}P_T$

4 marks each, show all you work, round final answer to sig. figs. and indicate the appropriate unit.

1. A empty 1.0-L container weighs 480 g. When this container is filled with nitrogen gas, N_2, its total mass is 620 g. When it is filled with an unknown gas at the same temperature and pressure, its total mass is 770 g. **Which of the following is the unknown gas?**

26 g/mol 58 g/mol

A) Acetylene, C_2H_2 (B) Butane, C_4H_{10} C) Ethane, C_2H_6 D) Methane, CH_4

$\frac{1\text{ mol}}{x} = \frac{28\text{ g}}{140}$ 5 mol $\frac{5\text{ mol}}{1\text{ mol}} = \frac{290\text{ g}}{x}$ 58 g/mol

2. A balloon is filled with a gas and the initial pressure is recorded. The absolute temperature is doubled, the volume is halved, and the number of molecules is doubled. **Which of the following best describes the final pressure of the gas?** *Assume the gas behaves as an ideal gas.*

T x 2 → P x 2
V ½ → P x 2
n x 2 → P x 2
} P x 8

A) The final pressure is the same as the initial pressure.
B) The final pressure is 2 times higher than the initial pressure.
C) The final pressure is 4 times higher than the initial pressure.
(D) The final pressure is 8 times higher than the initial pressure.

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3. Consider a gas in an airtight box. Under which circumstances would the number of gas molecules colliding each second with the inside wall of the box be increased?

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1. Increase the amount of gas in the box. ✓
2. Decrease the amount of gas in the box ✗
3. Increase the volume of the box ✗
4. Decrease the volume of the box. ✓

A) 1 and 3 (B) 1 and 4 C) 2 and 3 D) 2 and 4

Multiple Choice Answers	
1	B
2	D
3	B
4	A

4. Four moles of oxygen (O_2) occupy a volume of 44.8 litres at a pressure of 150 kPa.
What is the temperature in degrees Celsius of the oxygen?

$PV = nRT$

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(A) -70.8°C B) -181°C C) 202°C D) -268°C

$T = \frac{PV}{nR} = \frac{(150)(44.8)}{(4)(8.31)}$ ___/16

$= 202 - 273 = -70.8$

5. A sample of sulfur dioxide occupies a volume of 652 mL at 40.0° C and 720 mm Hg.
What volume will the sulfur dioxide occupy at SATP?

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

$T_1 = 40 + 273 = 313\text{ K}$

$T_2 = 25 + 273 = 298\text{ K}$

$\frac{(720)(652)}{313} = \frac{(760)V_2}{298}$

$237\,880\,V_2 = 139\,893\,720$

$V_2 = 588.083\text{ mL}$

588 mL

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Gases test #2 **2019 V3** **Name:** _____

1.00 atm = 760 mm Hg = 101.3 kPa $PV = nRT$ $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$ $P_A = \frac{n_A}{n_T}P_T$

4 marks each, show all you work, round final answer to sig. figs. and indicate the appropriate unit.

1. A empty 1.0-L container weighs 480 g. When this container is filled with nitrogen gas, N_2, its total mass is 620 g. When it is filled with an unknown gas at the same temperature and pressure, its total mass is 770 g. **Which of the following is the unknown gas?**

26 g/mol 58 g/mol
A) Acetylene, C_2H_2 (B) Butane, C_4H_{10} C) Ethane, C_2H_6 D) Methane, CH_4

$\frac{1\text{ mol}}{x} = \frac{28}{140}$ 5 mol $\frac{5\text{ mol}}{1\text{ mol}} = \frac{290}{x}$ $x = 58\text{ g/mol}$

2. Consider a gas in an airtight box. Under which circumstances would the number of gas molecules colliding each second with the inside wall of the box be increased?

1. Increase the amount of gas in the box.
2. Decrease the amount of gas in the box
3. Increase the volume of the box
4. Decrease the volume of the box.

A) 1 and 3 B) 2 and 3 (C) 1 and 4 D) 2 and 4

3. A balloon is filled with a gas and the initial conditions are recorded. The conditions are then changed so that the pressure is halved, the number of gas particles in the balloon is tripled, and the absolute temperature is doubled. **Which of the following statements is TRUE?**

$P\frac{1}{2} \rightarrow V \times 2$
$n \times 3 \rightarrow V \times 3$
$T \times 2 \rightarrow V \times 2$
$\Big\} V \times 12$

A) The final volume is the same as the initial volume.
B) The final volume is 3 times larger than the initial volume.
C) The final volume is 6 times larger than the initial volume.
(D) The final volume is 12 times larger than the initial volume.

Multiple Choice Answers	
1	B
2	C
3	D
4	A

4. Four moles of oxygen (O_2) occupy a volume of 44.8 litres at a pressure of 150 kPa.
What is the temperature in degrees Celsius of the oxygen?

$T = \frac{PV}{nR}$

(A) -70.8°C B) -181°C C) 202°C D) -268°C

$= \frac{(150)(44.8)}{(4)(8.31)} = 202 - 273 = -70$

___/16

5. A sample of sulfur dioxide occupies a volume of 652 mL at 40.0° C and 750 mm Hg.
What volume will the sulfur dioxide occupy at SATP?

$T_1 = 40 + 273 = 313$

$T_2 = 25 + 273 = 298$

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

$\frac{(750)(652)}{313} = \frac{(760)V_2}{298}$

$V_2 = 612.586$

$V_2 = 613\text{ mL}$

$V = 613\text{ mL}$

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(V2) (V3)

6. Iron (III) oxide, Fe_2O_3, can be converted to iron, **Fe**, by reacting it with carbon monoxide, **CO**, according to the following equation:

$$Fe_2O_{3(s)} + 3\,CO_{(g)} \rightarrow 2\,Fe_{(s)} + 3\,CO_{2(g)}.$$

What volume of carbon dioxide, CO_2, is released with 500 g of iron, **Fe** at 98.0 kPa and 120.0°C?

① $\frac{1\text{ mol Fe}}{x} = \frac{55.85\text{g}}{500\text{g}}$

$x = 8.95255\text{ mol Fe}$

② $\frac{2\text{mol Fe}}{8.95255} = \frac{3\text{ mol }CO_2}{x}$

$x = 13.4288\text{ mol }CO_2$

$PV = nRT$ $\quad +273 \rightarrow 393\text{K}$

$V = \frac{nRT}{P}$

$= \frac{(13.4288)(8.31)(393)}{98.0}$

$V = 447.513\text{ L}$

448L

7. A student filled a balloon with 2 different gases, CO_2 and N_2. The atmospheric pressure in the lab was 100.8 kPa and the student used 11.00 g of CO_2 and 14.01 g of N_2. What was the partial pressure of CO_2 in the balloon?

① $\frac{1\text{mol }CO_2}{x} = \frac{44.01\text{g}}{11.00\text{g}}$

$x = 0.249943\text{mol }CO_2$

② $\frac{1\text{mol }N_2}{x} = \frac{28.02\text{g}}{14.01\text{g}}$

$x = 0.500000\text{ mol }N_2$

③ $0.249943 + 0.500000 = n_T = 0.749943$ (4 sig. figs)

④ $P_{CO_2} = \left(\frac{n_{CO_2}}{n_T}\right) P_T$

$= \frac{0.24993}{0.749943}(100.8)$

$P_{CO_2} = 33.5931$

$P_{CO_2} = 33.59\text{ kPa}$

8. A student produces 340 mL of N_2O at 96.1 kPa, and 23.0°C. If the gas has a mass of 1.32g. Does N_2O behave as an ideal gas in this situation? Show calculations to support your work.

$\frac{1\text{mol }N_2O}{x} = \frac{44.02}{1.32\text{g}}$

$x = 0.0299864\text{ mol }N_2O$

$PV = nRT$

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

$= \frac{(96.1)(0.340)}{(0.0299864)(296)}$ ✗*

$R = 3.68117$

$R = 3.68$

N_2O is not acting as an ideal gas

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