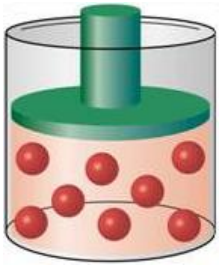
Name: _____ Class: _____ Date: _____

Instructions: Answer the following questions. Show ALL work for problems to receive full credit. Make sure to include proper units and significant figures for all answers. You are allowed the use of a molecular model kit.

[6 pt] 1. Assume that you have a sample of gas in a cylinder with a movable piston, as shown below. Will the piston move up or down after each of the following changes are made. Explain.



(a) The temperature is increased 1(a) **up**

Up because V and T are DP.
May prove using ratios.

(b) The atmospheric pressure is increased. 1(b) **down**

Down because P and V are IP
May prove using ratios.

(c) If you remove 5 mols of gas. 1(c) **down**

Down because V and n are DP.
May prove using ratios.

[5 pt] 2. Consider the following chemical reaction: $4Al(s) + 3O_2(g) \longrightarrow 2Al_2O_3(s)$. What is the volume (in L) of O_2 required to form 50.0 grams of Al_2O_3 at a temperature of 315 K and pressure of 1.0 atm? 2. **19 L**

g A $\longrightarrow$ mol A $\longrightarrow$ mol B $\longrightarrow$ L B

$$\frac{50.0\,\text{g Al}_2\text{O}_3}{} \times \frac{1\,\text{mol Al}_2\text{O}_3}{101.9\,\text{g Al}_2\text{O}_3} \times \frac{3\,\text{mol O}_2}{2\,\text{mol Al}_2\text{O}_3} \times \frac{0.0821\,\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} \times \frac{315\,\text{K}}{} \times \frac{}{1\,\text{atm}} = 19.03447\,\text{L}$$

[5 pt] 3. What is the Pressure in a cylinder containing 25.6 many mols of Argon with a volume of 50.0 L at a temperature of 100.0 ℃ ? 3. **15.7 atm**

PV = nRT solve for $\text{P} = \frac{n\,\text{R}\,\text{T}}{\text{V}}$

$$\text{P} = \frac{25.6\,\text{mol}}{} \times \frac{0.0821\,\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} \times \frac{373\,\text{K}}{} \times \frac{}{50.0\,\text{L}} = 15.679\,\text{atm}$$

[6 pt] 4. Assume that you have a sample of gas in a cylinder with a movable piston. Will the piston move up or down **AND** by what factor/amount) after each of the following changes are made. Explain.

(a) If the number of moles is decreased by half, while the pressure and temperature are held constant? 4(a) **Decrease 1/2x**

(b) If the temperature is doubled while the pressure and number of mols of gas is kept constant 4(b) **Increase 2x**

(c) The pressure is halved and the temperature is doubled? 4(c) **Increase 4x**

[5 pt] 5. How many moles of gas is contained in a standard scuba cylinder that is 80.0 L at pressure of 3,500. PSI at a temperature of 25 ℃ ? 5. **780 mol**

PV=nRT solve for n = $\frac{\text{P V}}{\text{R T}}$

$$n = \frac{3500.\ \text{PSI}}{} \times \frac{1\,\text{atm}}{14.7\ \text{PSI}} \times \frac{80.0\,\text{L}}{} \times \frac{\text{mol} \cdot \text{K}}{0.0821\,\text{L} \cdot \text{atm}} \times \frac{}{298\,\text{K}} = 778.54\,\text{mol}$$

[5 pt] 6. Given the reaction: $3H_2SO_4(aq) + 2Al(s) \longrightarrow Al_2(SO_4)_3 + 3H_2(g)$. If 300.0 grams of Al are reacted with excess sulfuric acid, how many Liters of Hydrogen gas at 400. mmHg and 20.0 ℃ are created? 6. **762 L**

$$\frac{300.0\,\text{g Al}}{} \times \frac{1\,\text{mol Al}}{26.98\,\text{g Al}} \times \frac{3\,\text{mol H}_2}{2\,\text{mol Al}} \times \frac{0.0821\,\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \times \frac{293\,\text{K}}{} \times \frac{}{400\,\text{mmHg}} \times \frac{760\,\text{mmHg}}{1\,\text{atm}} = 762.316L$$

[5 pt] 7. What is the Pressure in a scuba cylinder that contains 265 mol of air at 25.0 ℃ in an 80.0 gallon tank? 7. **21.4 atm**

$$\text{P} = \frac{n\,\text{R T}}{\text{V}} = \frac{265.0\,\text{mol Air}}{} \times \frac{0.0821\,\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \times \frac{298.15\,\text{K}}{} \times \frac{}{80.\ \text{gal}} \times \frac{1\,\text{gal}}{3.785\ \text{L}} = 21.4\,\text{atm}$$

[10 pt] 8. For each of the following situations state whether the indicated variable will (D)ecrease, (I)ncrease, or (S)tay the same **AND** indicate by what factor it will change. Explain your answers.

(a) Will the pressure (D/I/S) if in a **sealed container** the temperature is in- 8(a) **Increase 4x**
creased by a factor of 4?

(b) Will the volume (D/I/S) if in a **movable piston** the number of mols of gas 8(b) **Increase 4x**
is doubled and the temperature is doubled?

(c) Will the volume (D/I/S) in a **sealed container** if the Temperature is de- 8(c) **Decrease 1/2x**
creased by half?

(d) Will the pressure in a **movable piston** (D/I/S) if the volume is doubled 8(d) **Decrease to 1/4**
while at the same time the temperature is cut in half?

(e) In a balloon at room temperature (25 °C) will the volume (D/I/S) if if the 8(e) **Decrease x1/2**
pressure is doubled?

[5 pt] 9. A hot air balloon is inflated to a volume of 500.0 L at a pressure of 650. mmHg and a 9. **0.644 atm**
temperature of 35.0 °C . The balloon is taken to an altitude of 15,000 feet into the air where the volume has increased to 550.0 L and the temperature is -18.0 °C . What is the pressure at this altitude (in atm)

$$\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2} \text{ therefore } \frac{650\,\text{mmHg} \cdot 500.\,\text{L}}{1 \cdot 308.15\,\text{K}} = \frac{P_2 \cdot 550\,\text{L}}{1 \cdot 255.15\,\text{K}} = 489.277\ \text{mmHg}$$

solve (make sure to covert mmHg to atm.

$$P_2 = \frac{489.277\,\text{mmHg}}{} \times \frac{1\,\text{atm}}{760\,\text{mmHg}} = 0.643784446\,\text{atm}$$

[5 pt] 10. Consider the following chemical reaction: 10. **173 L**

$$\underline{2}C_2H_2(g) + \underline{3}O_2(g) \longrightarrow \underline{2}CO_2(g) + \underline{2}H_2O(g).$$

What is the volume (in L) of O_2 required to combust 250.0 grams of C_2H_2 at a temperature of 365 K and pressure of 2.50 atm?

g A $\longrightarrow$ mol A $\longrightarrow$ mol B $\longrightarrow$ L B

$$\frac{250.0\,\text{g}\,C_2H_2}{} \times \frac{1\,\text{mol}\,C_2H_2}{26.0358\,\text{g}\,C_2H_2} \times \frac{3\,\text{mol}\,O_2}{2\,\text{mol}\,C_2H_2} \times \frac{0.0821\,\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} \times \frac{365\,\text{K}}{} \times \frac{}{2.5\,\text{atm}} = 172.646\,\text{L}$$

[10 pt] 11. For each of the following situations state whether the indicated variable will (D)ecrease, (I)ncrease, or (S)tay the same **AND** indicate by what factor it will change. Explain your answers.

(a) Will the pressure (D/I/S) if in a **sealed container** the temperature is de- 11(a) **Decrease 1/2x**
creased by half?

(b) Will the volume (D/I/S) if in a **movable piston** the pressure is halved and 11(b) **Increase 4x**
the temperature is doubled?

(c) Will the volume (D/I/S) in a **sealed container** if the number of moles is 11(c) **Decrease 1/2x**
decreased by half?

(d) Will the pressure in a **sealed container** (D/I/S) if the volume is doubled 11(d) **Same / cancel**
while at the same time doubling the temperature?

(e) In a balloon at room temperature (25 ℃) will the volume (D/I/S) if it is 11(e) **Decrease**
placed in liquid nitrogen at -196 ℃?

[5 pt] 12. What is the Volume (in L) of a cylinder filled with 53.0 mols of O_2 gas at a temperature of 302 K and a pressure of 1500. PSI? 12. **12.9 L**

$$V = \frac{n\,R\,T}{P} = \frac{53.0\,\text{mol}\,O_2}{} \times \frac{0.08206\,\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} \times \frac{302\,\text{K}}{} \times \frac{}{1500.\ \text{PSI}} \times \frac{14.7\ \text{PSI}}{1\,\text{atm}} = 12.8781\,\text{atm}$$

[5 pt] 13. A balloon is inflated to a volume of 500.0 L at a pressure of 800. mmHg and a temperature of 28.0 ℃. The balloon is taken to the bottom of the ocean at approximately 1200 feet deep where the volume has decreased to 12.5 L and the temperature is -15.0 ℃. What is the pressure of the ocean (in atm) at 1200 feet deep? 13. **36.1 atm**

$$\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2} \text{ therefore } \frac{800\,\text{mmHg}\cdot 500.\,\text{L}}{1\cdot 301\,\text{K}} = \frac{P_2 \cdot 12.5\,\text{L}}{1\cdot 258\,\text{K}}$$

solve (make sure to covert mmHg to atm.

$$P_2 = \frac{27,429\,\text{mmHg}}{} \times \frac{1\,\text{atm}}{760\,\text{mmHg}} = 36.09022556\,\text{atm}$$

[5 pt] 14. How many mols of air can a scuba diving cylinder with a volume of 80.0 L at 3.80×10^5 Pa and temperature of 25 ℃ hold? 14. **12 mol Air**

$$n = \frac{P\ V}{n\,R} = \times \frac{3.80 \times 10^5}{} \times \frac{1\,\text{atm}}{101325\text{Pa}} \times \frac{80.0\,\text{L}}{} \times \frac{\text{mol}\cdot\text{K}}{0.0821\,\text{L}\cdot\text{atm}} \times \frac{}{298\,\text{K}} = 12.26\,\text{mol}$$

[5 pt] 15. What is the temperature (in ℃) if 1,500. liters of carbon dioxide at 25.0 ℃ is compressed to 2.0 liters at a constant pressure? 15. **-272.6 ℃**

$$\frac{1\cdot 1500\,\text{L}}{1\cdot 298\,\text{K}} = \frac{1\cdot 2.0\,\text{L}}{1\cdot T_2}$$

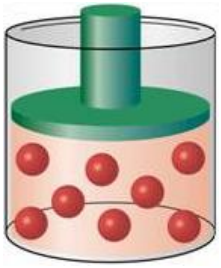
$T_2 = 0.40\,\text{K} = -272.6\,℃$

*won't be picky on SF since answer works out strangely.

16. What is the pressure if 1,500. liters of carbon dioxide at 1.0 atm of pressure is condensed (at constant temperature to a volume of 2.0 liters. 16. **750 atm**

(1500)(1) = (P2)(2.O)

[6 pt] 17. Assume that you have a sample of gas in a cylinder with a movable piston, as shown below. Will the piston move up or down after each of the following changes are made. Explain.



(a) The temperature is decreased at constant pressure.

Down because V and T are DP.
May prove using ratios.

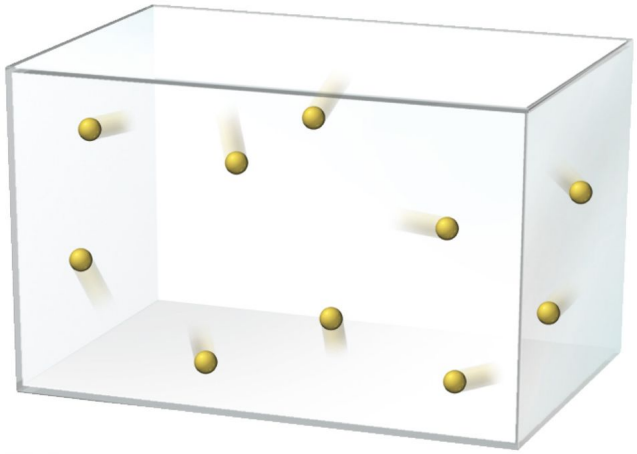
(b) The atmospheric pressure is decreased.

Up because P and V are IP
May prove using ratios.

(c) If you add 5 more mols of gas.

Up because V and n are DP.
May prove using ratios.

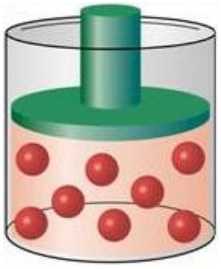
[3 pt] 18. The picture represents a gas sample at a pressure of 1 atm, a volume of 1 L and a temperature of 25 °C. Draw a similar picture showing what would happen to the sample of the volume were reduced to 0.5 L while the temperature was increased to 250 °C. What would happen to the pressure?



Picture should show:
(1) Smaller box
(2) Molecules moving faster (bigger arrows or something similar).

The pressure would **INCREASE** because P is IP to volume and DP to T. (or shown using ratio's)

19. Assume that you have a sample of gas in a cylinder with a movable piston, as shown below. Will the piston move up or down after each of the following changes are made. Explain.



(a) The temperature is increased at constant pressure. 19(a) **Increase**

Temperature and Volume are DP

(b) The atmospheric pressure is increased. 19(b) **Decrease**

Pressure and Volume are IP

(c) The gas molecules form dimers (two single atoms react to form one new molecule). 19(c) **Decrease**

Volume and number of mols are DP. (2 mols of gas condensed to form 1 mol of gas)

20. How many mols of Argon gas are in a cylinder with a volume of 50.0 L at a pressure of 600 mm Hg at a temperature of 25.0 ℃? 20. **1.61 mol Ar**

$$n = \frac{PV}{RT} = \frac{50.0\,\text{L}}{} \times \frac{600\,\text{mmHg}}{} \times \frac{1\,\text{atm}}{760\,\text{mmHg}} \times \frac{\text{mol} \cdot \text{K}}{0.0821\,\text{L} \cdot \text{atm}} \times \frac{}{295.15\,\text{K}}$$

[5 pt] 21. How many moles of gas is contained in a standard scuba cylinder that is 80.0 L at pressure of 3,500. PSI at a temperature of 25 ℃? 21. **780 mol**

PV=nRT solve for n = $\frac{\text{P V}}{\text{R T}}$

$$n = \frac{3500.\ \text{PSI}}{} \times \frac{1\,\text{atm}}{14.7\ \text{PSI}} \times \frac{80.0\,\text{L}}{} \times \frac{\text{mol} \cdot \text{K}}{0.0821\,\text{L} \cdot \text{atm}} \times \frac{}{298\,\text{K}} = 778.54\,\text{mol}$$