STEM Chemistry Quiz/Form A (3/1/2018) **Name:** Hendersa / Key

me Probs
24 pts + 12 pts = 36 pts

Gases Quiz

Useful Information and Equations:

1.00 atm = 14.7 psi = 760 mm Hg = 760 torr = 101.3 kPa

V/T = k   P•V = k   P/T = k   V/n = k $P_{tot} = P_1 + P_2 + \ldots$

@STP: 22.4 L/mol   PV = nRT   R = 0.08206 L•atm/(mol•K)

Multiple Choice: Bubble in an answer on the ScanTron form for **Questions #1-#12**.

A 1. The form of this quiz is form ______. (See top.) (a) A

For **Questions #2–#5**: Anna Litical is using a constant-volume container to study the relationship between pressure (**P**), temperature (**T**), and number of moles (**n**). Her data are shown in the table at the right. The same sample of gas is used in all trials. Only the P, n and T are changed from trial to trial. Use this information to answer the following questions.

Trial	T (K)	n (moles)	P (atm)
1	300.	2.0	4.0
2	900.	3.0	18.0
3	600.	2.0	8.0
4	600.	4.0	16.0
5	1200.	8.0	64.0
6	900.	1.0	6.0
7	600.	6.0	24.0
8	1200.	2.0	16.0

E 2. Which of the following gas law statements is supported by the data in Trials 4 and 8?
   - a. P•V = n•R•T (for an ideal gas)
   - b. P/n = constant (when V and T are held constant)
   - c. T/n = constant (when P and V are held constant)
   - d. V/n = constant (when P and T are held constant)
   - (e.) n•T = constant (when P and V are held constant)

C 3. Which of the following two trials show that the doubling of the number of moles of gas causes the pressure of the gas sample to double?
   a. Trials 1 and 3   b. Trials 1 and 4   (c.) Trials 3 and 4   d. Trials 4 and 5
   e. Nonsense! None of these trials show this principle.

B 4. John's Law states that the pressure of a gas is directly propotional to its Kelvin temperature for a constant volume container with an unchanging amount of gas. Which of the listed trials demonstrate this proportionality?
   a. Trials 1 and 4   (b.) Trials 1 and 8   c. Trials 3 and 7   d. Trials 4 and 5
   e. Nonsense! None of these trials show this principle.

C 5. Based on the patterns shown in this data, one would expect that 6.0 moles of the same gas sample at a temperature of 450 K would have a pressure of _____ atm.
   a. 8.0   b. 12.0   (c.) 18.0   d. 36.0
   e. None of these are correct.

From the Data: $\frac{n \cdot T}{P} = 150$ $P = \frac{n \cdot T}{150}$

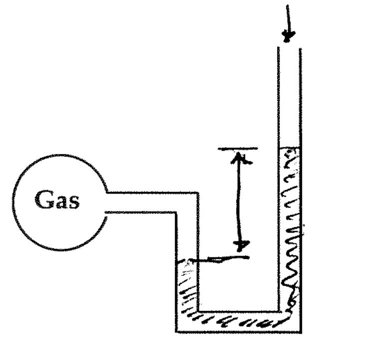
(OR) Take Row 2 P = 18 atm → ½ T will ½ P, Double n will double P

A 6. Container A is filled with Hydrogen gas. Container B is filled with Helium gas at the same temperature. On average, gas particles in Container A travel ______ those in container B.
   (a.) faster than   b. slower than   c. with the same speed as

Same T means the same KE or $\frac{1}{2}mv^2$ where v = speed, m = mass

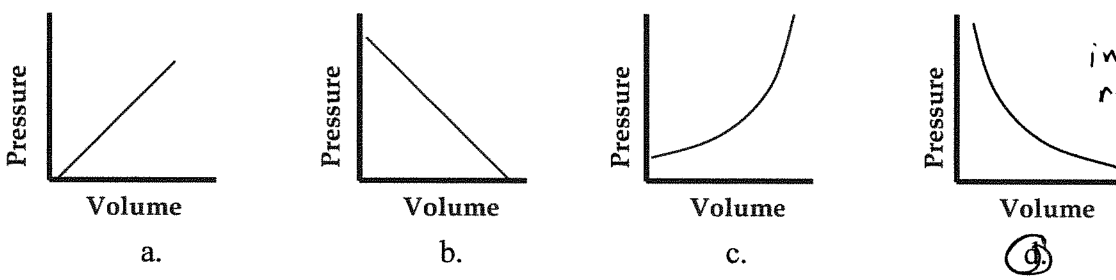
∴ smaller m particles must have larger v

7. Consider the diagram of an **open end manometer** as shown at the right. The U-tube is filled with mercury (not shown). Suppose that the height of the mercury in the left arm of the U-tube was 140 mm lower than the height in the right arm of the U-tube (draw it in if you wish). The atmospheric pressure is 1 atm. What would be the pressure of the gas enclosed in the round flask?

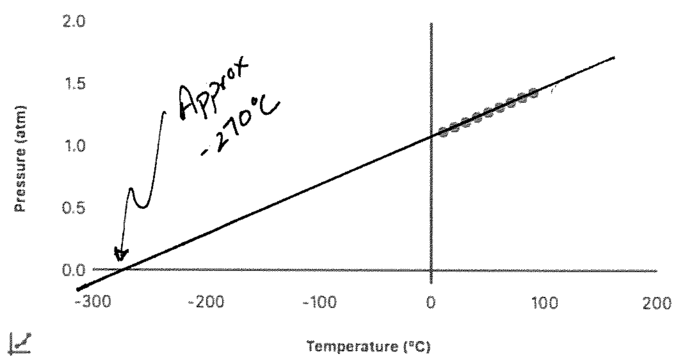


a. 139 mm Hg b. 140 mm Hg c. 141 mm Hg
d. 620 mm Hg e. 900 mm Hg

8. Which plot below represents the relationship between the pressure and the volume of a sealed container of gas (when held at a constant temperature)?



For **Questions #9 and #10**: A lab group is studying the effect of varying temperature on gas pressure for a rigid sealed container of gas. They collect data over a rather narrow temperature range; their plot is shown at the right.



9. If the pattern shown in the data continued over a wide range of temperatures, then one might expect that the pressure would be 0 atm for a temperature of approximately ________°C.
a. -270 b. -100 c. 0 d. 1.1 e. 100

10. Referring to the previous problem: Which statement best explains why the pressure would become 0 atm at such a temperature?
a. As temperatures decrease, volumes of gas decrease as well. Eventually thevolume has descreased so much that there is no longer any gas present.
b. The pressure-temperature relationship ceases to be linear at such low temperatures. Instead, it begins to curve downward at a rapid rate, reaching the 0 atm mark faster than expected.
c. ~~The container size would gradually increase~~. This leads to a increase in the area of the container wall. With force spread over such larger and larger areas, pressure reduces to 0 atm.
d. Particles move slower and slower as temperatures drop lower and lower. Eventually all particle movement ceases, collisions with container walls no longer occur, and pressure drops to 0 atm.

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11. Which one of the following statements is true of a gas under STP conditions?
    a. All gas samples occupy 22.4 L of volume.
    b. Any gas with 22.4 L of volume contain 22.4 moles of gas.
    c. One mole of any gas occupies 22.4 L of volume.
    d. A sample of gas with 22.4 L of volume contains 0.0821 moles.

C

12. Consider the balanced equation: $N_{2\,(g)}$ + $3\ H_{2\,(g)}$ → $2\ NH_{3\,(g)}$

    What volume of ammonia gas (NH_3) would be produced by the reaction of 6.00 L of hydrogen gas with excess nitrogen gas under STP conditions?
    a. 4.00 L b. 9.00 L c. 44.8 L d. 67.2 L e. 89.6 L
    e. Nonsense! None of these are even close!

A

Problems: Show your work clearly on the following problems.

13. A maker is outfitting a tire for a racing vehicle with nitrogen gas. The tire volume capacity is 12.9 L. How many moles and how many grams of nitrogen gas must be pumped into the tire for a pressure of 128 psi at 32.0°C?

$V = 12.9 L$
$P = 128 psi = 8.707... atm$
$T = 32.0°C = 305 K$

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(8.707... atm)(12.9 L)}{(0.08206 \frac{L \cdot atm}{mol \cdot K})(305 K)} = 4.48798... mol$

6

$4.48798... mol\ N_2 \times \frac{28 g\ N_2}{1 mol\ N_2} = 126 g\ N_2$ $(125.663... g\ N_2)$

15. The complete combustion of octane gasoline is represented by the following chemical equation:

$$2\ C_8H_{18}(l) + 25\ O_2(g) \text{ -----> } 16\ CO_2(g) + 18\ H_2O(g)$$

Suppose that one gallon of liquid octane (1 gal = 3.785 L; density of octane = 0.703 g/mL) is burned. How many liters of CO_2 are produced at STP? **PSYW**

$1 gallon\ C_8H_{18} \times \frac{3.785 L\ C_8H_{18}}{1 gallon\ C_8H_{18}} \times \frac{10^3 mL\ C_8H_{18}}{1 L\ C_8H_{18}} \times \frac{0.703 g\ C_8H_{18}}{1 mL\ C_8H_{18}} \times \frac{1 mol\ C_8H_{18}}{114 g\ C_8H_{18}} \times$

6

$\times \frac{16 mol\ CO_2}{2 mol\ C_8H_{18}} \times \frac{22.4 L\ CO_2}{1 mol\ CO_2} = 4180 L\ CO_2$

$(4182.677... L\ CO_2)$

12

STEM Chemistry Quiz/Form B (3/1/2018) **Name:** Henderson/Key

me Probs
24 pts + 12 pts = 36 pts

Gases Quiz

Useful Information and Equations:

1.00 atm = 14.7 psi = 760 mm Hg = 760 torr = 101.3 kPa

$V/T = k$ $P \cdot V = k$ $P/T = k$ $V/n = k$ $P_{tot} = P_1 + P_2 + \ldots$

@STP: 22.4 L/mol $PV = nRT$ $R = 0.08206$ L•atm/(mol•K)

Multiple Choice: Bubble in an answer on the ScanTron form for **Questions #1-#12.**

B 1. The form of this quiz is form ______. (See top.) (b.) B

For **Questions #2–#5**: Anna Litical is using a constant-volume container to study the relationship between pressure (**P**), temperature (**T**), and number of moles (**n**). Her data are shown in the table at the right. The same sample of gas is used in all trials. Only the P, n and T are changed from trial to trial. Use this information to answer the following questions.

Trial	T (K)	n (moles)	P (atm)
1	300.	2.0	4.0
2	900.	3.0	18.0
3	600.	2.0	8.0
4	600.	4.0	16.0
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6	900.	1.0	6.0
7	600.	6.0	24.0
8	1200.	2.0	16.0

2. Which of the following gas law statements is supported by the data in Trials 4 and 8?
   a. P•V = n•R•T (for an ideal gas)
   b. V/n = constant (when P and T are held constant)
C (c.) n•T = constant (when P and V are held constant)
   d. T/n = constant (when P and V are held constant)
   e. P/n = constant (when V and T are held constant)

3. John's Law states that the pressure of a gas is directly proportional to its Kelvin temperature for a constant volume container with an unchanging amount of gas. Which of the listed trials demonstrate this proportionality?
B a. Trials 1 and 4 (b.) Trials 1 and 8 c. Trials 3 and 7 d. Trials 4 and 5
   e. Nonsense! None of these trials show this principle.

4. Which of the following two trials show that the doubling of the number of moles of gas causes the pressure of the gas sample to double?
C a. Trials 1 and 3 b. Trials 1 and 4 (c.) Trials 3 and 4 d. Trials 4 and 5
   e. Nonsense! None of these trials show this principle.

5. Based on the patterns shown in this data, one would expect that 6.0 moles of the same gas sample at a temperature of 450 K would have a pressure of _____ atm.
C a. 8.0 b. 12.0 (c.) 18.0 d. 36.0
   e. None of these are correct.

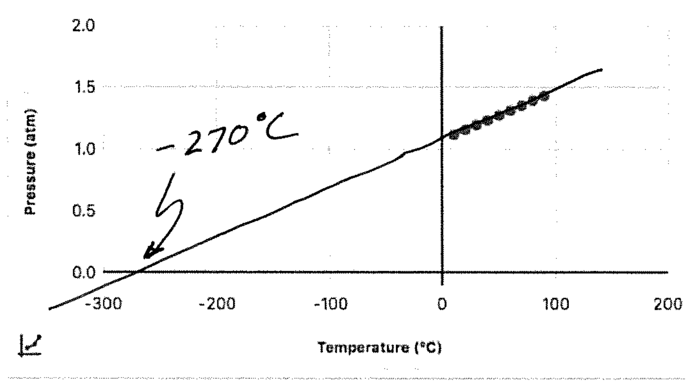
$\frac{n \cdot T}{P} = 150 \Rightarrow P = \frac{nT}{150}$

(OR) Take Row 2 P = 18 atm → ½ T will ½ P → Double n will double P

6. Container A is filled with Helium gas. Container B is filled with Hydrogen gas at the same temperature. On average, gas particles in Container A travel ______ those in container B.
B a. faster than (b.) slower than c. with the same speed as

Same T means same KE or ½ mv² where m = mass, v = speed
∴ smaller particles (H_2 or B) move faster

For **Questions #7 and #8**: A lab group is studying the effect of varying temperature on gas pressure for a rigid, sealed container of gas at constant volume. They collect data over a rather narrow temperature range; their plot is shown at the right.



7. If the pattern shown in the data continued over a wide range of temperatures, then one might expect that the pressure would be 0 atm for a temperature of approximately ________°C.
   a. 0 b. 1.1 c. -100 d. 100 e. -270

8. Referring to the previous problem: Which statement best explains why the pressure would become 0 atm at such a temperature?
   a. The pressure-temperature relationship ceases to be linear at such low temperatures. Instead, it begins to curve downward at a rapid rate, reaching the 0 atm mark faster than expected.
   b. As temperatures decrease, volumes of gas decrease as well. Eventually the volume has decreased so much that there is no longer any gas present.
   c. Particles move slower and slower as temperatures drop lower and lower. Eventually all particle movement ceases, collisions with container walls no longer occur, and pressure drops to 0 atm.
   d. The container size would gradually increase. This leads to a increase in the area of the container wall. With force spread over such larger and larger areas, pressure reduces to 0 atm.

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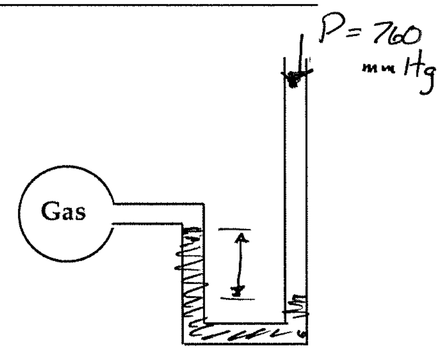
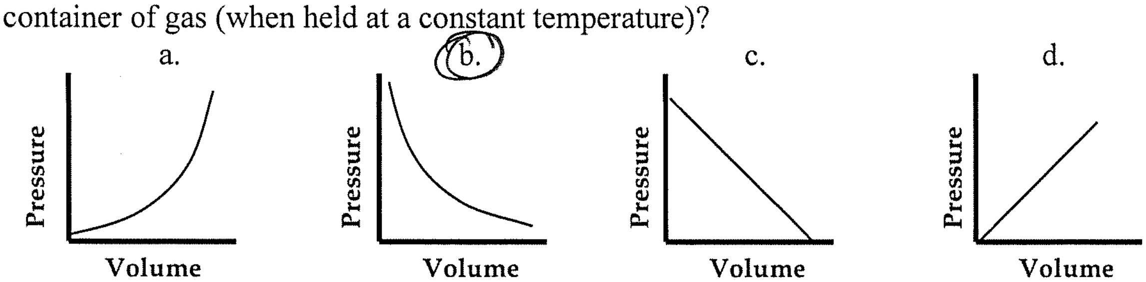
9. Consider the diagram of an **open end manometer** as shown at the right. The U-tube is filled with mercury (not shown). Suppose that the height of the mercury in the left arm of the U-tube was 120 mm higher than the height in the right arm of the U-tube (draw it in if you wish). The atmospheric pressure is 1 atm. What would be the pressure of the gas enclosed in the round flask?
   a. 119 mm Hg b. 120 mm Hg c. 121 mm Hg
   d. 640 mm Hg e. 880 mm Hg



10. Which plot below represents the relationship between the pressure and the volume of a sealed container of gas (when held at a constant temperature)?



11. Consider the balanced equation: $N_{2(g)}$ + $3\ H_{2(g)}$ → $2\ NH_{3(g)}$

What volume of ammonia gas (NH_3) would be produced by the reaction of 6.00 L of hydrogen gas with excess nitrogen gas under STP conditions?

(a.) 4.00 L b. 9.00 L c. 44.8 L d. 67.2 L e. 89.6 L

e. Nonsense! None of these are even close!

A

12. Which one of the following statements is true of a gas under STP conditions?
   a. All gas samples occupy 22.4 L of volume.
   (b.) One mole of any gas occupies 22.4 L of volume.
   c. Any gas with 22.4 L of volume contain 22.4 moles of gas.
   d. A sample of gas with 22.4 L of volume contains 0.0821 moles.

B

Problems: Please show your work clearly on the following problems.

13. A maker is outfitting a tire for a racing vehicle with nitrogen gas. The tire volume capacity is 15.8 L. How many moles and how many grams of nitrogen gas must be pumped into the tire for a pressure of 108 psi at 38.0°C? **PSYW**

$V = 15.8\ L$

$P = 108\ psi = 7.3469...\ atm$

$T = 38.0°C = 311\ K$

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(7.3469...\ atm)(15.8\ L)}{(0.08206\ \frac{L \cdot atm}{mol\ K})(311\ K)} = 4.5485...\ mol$ (~~3.4418...~~)

$mass = 4.5485...$ (~~3.4418~~) $mol\ N_2 \times \frac{28.0\ g\ N_2}{1\ mol\ N_2} = 127.35...\ g$ (~~96.4~~) $= \boxed{127\ g}$

14. The complete combustion of octane gasoline is represented by the following chemical equation:

$$2\ C_8H_{18}(l) + 25\ O_2(g) \text{ -----> } 16\ CO_2(g) + 18\ H_2O(g)$$

Suppose that one gallon of liquid octane (1 gal = 3.785 L; density of octane = 0.703 g/mL) is burned. How many liters of CO_2 are produced at STP? **PSYCF**

(**NOTE**: Answer = 1 pt; Converstion Factors = 5 pts … Please Show Your Conversion Factors)

$1\ gal\ C_8H_{18} \times \frac{3.785\ L\ C_8H_{18}}{1\ gal\ C_8H_{18}} \times \frac{10^3\ mL\ C_8H_{18}}{1\ L\ C_8H_{18}} \times \frac{0.703\ g\ C_8H_{18}}{1\ L\ C_8H_{18}} \times \frac{1\ mol\ C_8H_{18}}{114\ g\ C_8H_{18}} \times$

$\times \frac{16\ mol\ CO_2}{2\ mol\ C_8H_{18}} \times \frac{22.4\ L\ CO_2}{1\ mol\ CO_2} = \boxed{4180\ L}$

(4182.6773... L)