STEM Chemistry Quiz/Form A (3/4/2019) **Name:** Henderson / Key

Gases Quiz

24 + 14 = 38 pts

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 $PV = nRT$ $R = 0.08206\ L \cdot atm/(mol \cdot K)$

1. The form of this quiz is Form _____. a. A

For **Questions #2–#5**: Anna Litical is conducting a constant-temperature study of the relationship between pressure (**P**), volume (**V**), 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 V are changed from trial to trial. Use this information to answer the following questions.

Trial	V (mL)	n (moles)	P (atm)
1	400.	4.0	9.6
2	800.	4.0	4.8
3	1600.	4.0	2.4
4	1600.	2.0	1.2
5	800.	2.0	2.4
6	400.	2.0	4.8
7	600.	3.0	4.8
8	1200	6.0	4.8

2. Which of the following gas law statements is supported by the data in Trials 2 and 6?
   a. $P \cdot V = n \cdot R \cdot T$ (for an ideal gas)
   b. T/n = constant (when P and V are held constant)
   c. V/n = constant (when P and T are held constant)
   d. P/n = constant (when V and T are held constant)
   e. $n \cdot T$ = constant (when P and V are held constant)

C

3. Which of the following two trials show that the doubling of the pressure causes the volume of the gas sample to halve?
   a. Trials 2 and 4 b. Trials 3 and 4 c. Trials 5 and 6 d. Trials 7 and 8
   e. Nonsense! None of these trials show this principle.

C

4. Avogadro's Law states that the volume of a gas is directly proportional to the number of moles of gas at a constant temperature and pressure. Which of the listed trials demonstrate this proportionality?
   a. Trials 1 and 5 b. Trials 4 and 5 c. Trials 5 and 6 d. Trials 6 and 8
   e. Nonsense! None of these trials show this principle.

D

5. Based on the patterns shown in this data, one would expect that 3.0 moles of the same gas sample at a pressure of 2.4 atm would have a volume of _____ mL.
   a. 300. b. 600. c. 1200. d. 2400.
   e. None of these are correct.

C

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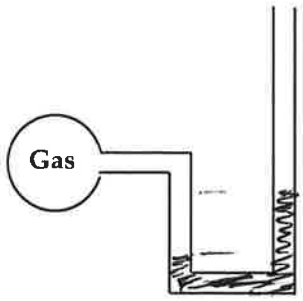
6. Which one of the following statements is true of a gas under STP conditions?
   a. All gas samples occupy 22.4 L of volume.
   b. Any gas with 22.4 L of volume contain 22.4 moles of gas.
   c. One mole of any gas occupies 22.4 L of volume.
   d. A sample of gas with 22.4 L of volume contains 0.0821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

C

A B

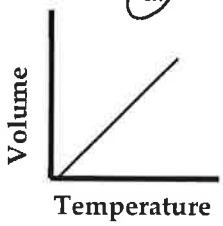
7. Container A is filled with Radon ($_{86}Rn$) gas. Container B is filled with Helium gas ($_{4}He$) at the same temperature. The average kinetic energy of the two samples of gas are the same. On average, gas particles in Container A travel _____ those in container B.
a. faster than (b.) slower than c. with the same speed as

8. 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 80 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. 79 mm Hg b. 80 mm Hg c. 81 mm Hg
d. 680 mm Hg (e.) 840 mm Hg

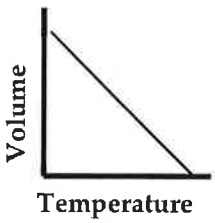


9. Which plot below represents the relationship between the volume and the temperature of a sealed container of gas (when held at a constant pressure)?

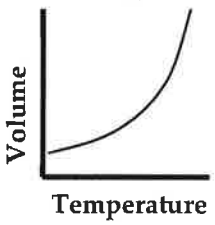
(a.)



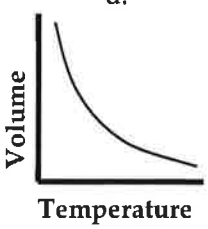
b.



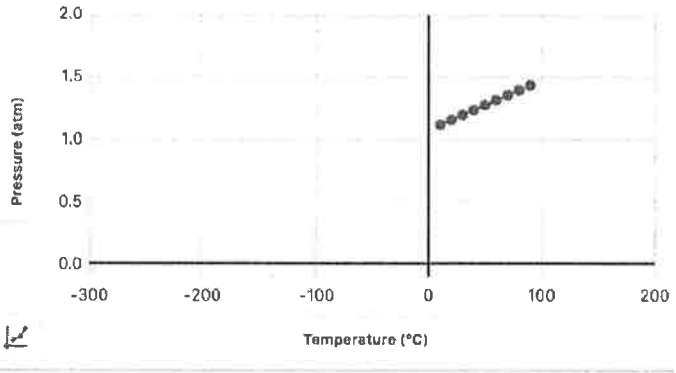
c.



d.



For **Questions #10 and #11**: 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.



10. 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

11. 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 the volume has decreased 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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12. Consider the balanced equation: $N_{2\,(g)} + 3\,H_{2\,(g)} \rightarrow 2\,NH_{3\,(g)}$

What volume of hydrogen gas (H_2) would be required to produce 9.0 L of ammonia gas (NH_3) under STP condictions?

B a. 6.0 L (b) 13.5 L c. 27.0 L d. 134 L e. 302 L

e. Nonsense! None of these are even close!

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 14.6 L. How many moles and how many grams of nitrogen gas must be pumped into the tire for a pressure of 142 psi at 36.0°C?

$V = 14.6\ L$

$P = 142\ psi \xrightarrow{\div 14.7} 9.659...\ atm$

$T = 360° \xrightarrow{+273} 309K$

$n = ??$

$$n = \frac{PV}{RT} = \frac{(9.659...\ atm)(14.6\ L)}{\left(0.08206\ \frac{L \cdot atm}{mol\ K}\right)(309\ K)} = 5.56\ mol$$

(5.56203...)

6

$$5.56203...\ mol\ N_2 \times \frac{28.0\ g}{1\ mol\ N_2} = 156\ grams$$

(155.73703...)

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

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

$$4.00\ g\ C_8H_{18} \times \frac{1\ mol\ C_8H_{18}}{g\ C_8H_{18}} \times \frac{16\ mol\ CO_2}{}$$

8

$$4.00\ gal \times \frac{3.785\ L\ C_8...}{1\ gal} \times \frac{10^3\ mL\ C_8...}{1\ L\ C_8...} \times \frac{0.703\ g\ C_8H_{18}}{1\ mL\ C_8...} \times \frac{1\ mol\ C_8H_{18}}{114.23\ g\ C_8H_{18}} \times \frac{16\ mol\ CO_2}{2\ mol\ C_8H_{18}}$$

$$\times \frac{22.4\ L\ CO_2}{1\ mol\ CO_2} = 16697\ L\ CO_2$$

STEM Chemistry Quiz/Form B (3/4/2019) **Name:** Henderson / Key

Gases Quiz

24 + 14 = 38 pts

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 $PV = nRT$ $R = 0.08206\ L \cdot atm/(mol \cdot K)$

B 1. The form of this quiz is Form _____. b. B

For **Questions #2–#5**: Anna Litical is conducting a constant-temperature study of the relationship between pressure (**P**), volume (**V**), 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 V are changed from trial to trial. Use this information to answer the following questions.

Trial	V (mL)	n (moles)	P (atm)
1	200.	2.0	9.6
2	400.	2.0	4.8
3	800.	2.0	2.4
4	800.	1.0	1.2
5	400.	1.0	2.4
6	200.	1.0	4.8
7	300.	1.5	4.8
8	600	3.0	4.8

2. Which of the following gas law statements is supported by the data in Trials 2 and 6?
   a. $P \cdot V = n \cdot R \cdot T$ (for an ideal gas)
   b. $n \cdot T$ = constant (when P and V are held constant)
   c. P/n = constant (when V and T are held constant)
   d. T/n = constant (when P and V are held constant)
   (c.) V/n = constant (when P and T are held constant)

E

$\frac{P \cdot V}{n} = 960$

3. Avogadro's Law states that the volume of a gas is directly proportional to the number of moles of gas at a constant temperature and pressure. Which of the listed trials demonstrate this proportionality?

D a. Trials 1 and 5 b. Trials 4 and 5 c. Trials 5 and 6 (d.) Trials 6 and 8
   e. Nonsense! None of these trials show this principle.

4. Which of the following two trials show that the doubling of the pressure causes the volume of the gas sample to halve?

C a. Trials 2 and 4 b. Trials 3 and 4 (c.) Trials 5 and 6 d. Trials 7 and 8
   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 pressure of 2.4 atm would have a volume of _____ mL.

D a. 300. b. 600. c. 1200. (d.) 2400.
   e. None of these are correct.

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6. 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

Helium (He) Radon (Rn)

7. Container A is filled with ~~Radon ($_{86}$Rn)~~ gas. Container B is filled with ~~Helium gas ($_{2}$He)~~ at the same temperature. The average kinetic energy of the two samples of gas are the same. On average, gas particles in Container A travel _____ those in container B.

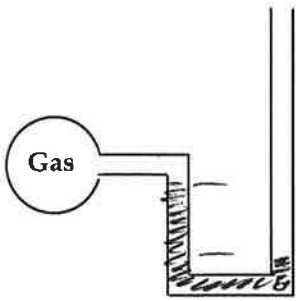
A

a. faster than b. slower than c. with the same speed as

8. 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 right arm of the U-tube was 90 mm lower than the height in the left 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?

D

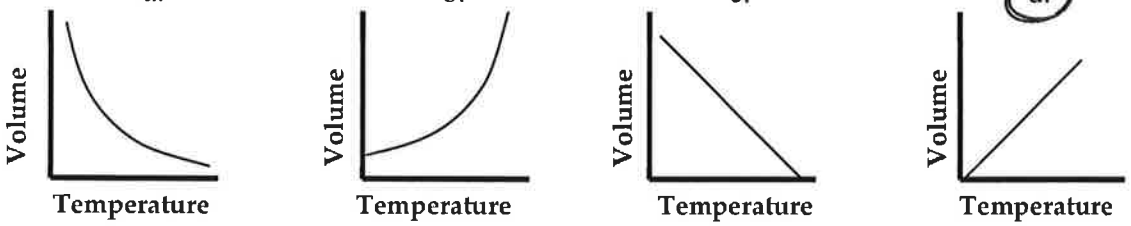
a. 89 mm Hg b. 90 mm Hg c. 91 mm Hg
d. 670 mm Hg e. 850 mm Hg



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

D

a. b. c. d.



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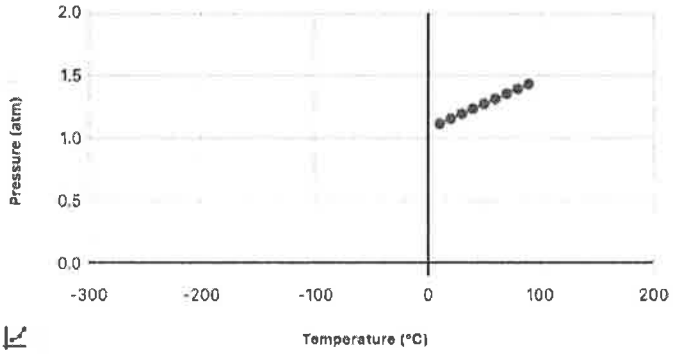

10. If the pattern shown in the data continued over a wide range of temperatures, then one might expect that the pressure would be 0 atm for a temperature of approximately _____ °C.

E

a. 0 b. 1.1 c. -100 d. 100 e. -270

11. 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.

C

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

What volume of hydrogen gas (H_2) would be required to produce 8.0 L of ammonia gas (NH_3) under STP condictions?

B a. 4.0 L (b.) 12.0 L c. 24.0 L d. 119.5 L e. 268.8 L
e. Nonsense! None of these are even close!

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 11.9 L. How many moles and how many grams of nitrogen gas must be pumped into the tire for a pressure of 138 psi at 32.5°C?

$V = 11.9\ L$

$P = 138\ psi \xrightarrow{\div 14.7} 9.3877\ atm$

$T = 32.5°C = 305.5K$

$n = ???$

$n = \frac{PV}{RT} = \frac{(9.3877\ atm)(11.9\ L)}{(0.08206\ \frac{L \cdot atm}{mol\ K})(305.5K)}$

$n = 4.46\ mol$ (4.456213... mol)

6 -

$4.456213...\ mol\ N_2 \times \frac{28\ g\ N_2}{1\ mol\ N_2} = 125\ g\ N_2$ (124.77 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 2.00 gallons of liquid octane (1 gal = 3.785 L; density of octane = 0.703 g/mL) is burned. How many liters of CO_2 gas are produced at STP? **PSYCF**
(**NOTE**: Answer = 1 pt; Converstion Factors = 5 pts … Please Show Your Conversion Factors)

$2.00\ gal\ C_8H_{18} \times \frac{3.785\ L\ C_8}{1\ gal} \times \frac{10^3\ mL\ C_8}{1\ L\ C_8} \times \frac{0.703\ g\ C_8H_{18}}{1\ mL\ C_8} \times \frac{1\ mol\ C_8H_{18}}{114.23\ g\ C_8H_{18}}$

$\times \frac{16\ mol\ CO_2}{2\ mol\ C_8H_{18}} \times \frac{22.4\ L\ CO_2}{1\ mol\ CO_2} = 8348\ L\ CO_2$

(8348.511...)

8 -

14