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McCord CH301
50070

Exam 1

Fall 2017

Remember to refer to the Periodic Table handout that is separate from this exam copy.
There are many conversion factors and physical constants available there.

NOTE: Please keep this exam copy intact (all pages still stapled - including this cover page). You must turn in ALL the materials that were distributed. This means that you turn in your exam copy (name and signature included), bubble sheet, periodic table handout, and all scratch paper. Please also have your UT ID card ready to show as well.

This print-out should have 17 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

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001 6.0 points

A gas sample has an initial pressure equal to P_i at equilibrium. Which of the following represents the final pressure (P_f) of the gas sample when the number of moles is doubled at constant volume and temperature?

1. None of the above

2. $P_f = P_i$

3. $P_f = 2P_i$ **correct**

4. $P_f = 0.5P_i$

5. $P_f = 4P_i$

6. $P_f = 0.25P_i$

Explanation:

The pressure and number of moles of a gas have a direct relationship. Therefore, when number of moles is doubled:

$P_f = 2P_i$

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002 6.0 points

Consider the following UNBALANCED reaction:

$$?HNO_3 + ?H_2S \rightarrow ?H_2O + ?NO_2 + ?S$$

What is the sum of the coefficients in the balanced reaction?

1. 6

2. 7

3. 12

4. 10

5. 15

6. 8 **correct**

7. 4

Explanation:

$2HNO_3 + H_2S \rightarrow 2H_2O + 2NO_2 + S$

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003 6.0 points

Consider the combustion of propane (C_3H_8) run at constant temperature and pressure:

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$$

If 7.60 L propane is reacted with 45.6 L oxygen, what is the final volume of all gases?

1. 7.60 L

2. 122 L

3. 53.2 L

4. 45.6 L

5. 60.8 L **correct**

Explanation:

Pentane is the limiting reactant with 7.60 L. You can use the amount of pentane to solve for the total volume of each product and the excess volume of oxygen.

Solve for the volume of carbon dioxide:

$7.60\,\mathrm{L\,C_3H_8} \times \frac{3\,\mathrm{L\,CO_2}}{1\,\mathrm{L\,C_3H_8}} = 22.8\,\mathrm{L}$

Solve for the volume of water vapor:

$7.60\,\mathrm{L\,C_3H_8} \times \frac{4\,\mathrm{L\,H_2O}}{1\,\mathrm{L\,C_3H_8}} = 30.4\,\mathrm{L}$

Solve for the volume of excess oxygen:

$45.6\,\mathrm{L\,O_2} - \left(7.60\,\mathrm{L\,C_3H_8} \times \frac{5\,\mathrm{L\,O_2}}{1\,\mathrm{L\,C_3H_8}}\right)$

$= 7.60\,\mathrm{L}$

Solve for the total pressure:

$22.8 + 30.4 + 7.60 = 60.8\,\mathrm{L\,total}$

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004 6.0 points

A gas sample is stored in a closed, rigid container at 50°C. How will the pressure change if you increase the temperature to 100°C?

1. The pressure will increase by a small amount **correct**

2. There will be no change in pressure

3. The pressure will double

4. The pressure will decrease by a small amount

5. The pressure will halve

Explanation:
When the temperature increases , the pressure increases. However, you must convert Celsius into Kelvin to use this direct relationship. When you convert into Kelvin, the pressure will only increase only by a small amount.

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005 4.0 points

If the Kelvin temperature of an ideal gas is doubled while maintaining a constant pressure,

1. the volume doubles. **correct**

2. the pressure doubles.

3. the volume increases by a factor of 4.

4. the volume is halved.

Explanation:
The volume of a gas is directly proportional to its absolute temperature (Charles's Law). This means that as the absolute temperature of a gas is doubled, its volume would double.

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006 6.0 points

A closed tube used to transport methane has a volume of 110 L at 280°C and 965 torr. How many moles of gas are in the tube?

1. 8.34

2. 23.1

3. 4680

4. 11700

5. 4.17

6. 3510

7. 2340

8. 3.08 **correct**

Explanation:
You can solve directly for moles (n) by rearranging the ideal gas law equation, such that:
$n = PV/RT$
$= (965)(110)/(62.36)(280 + 273.15)$
$= 3.08$

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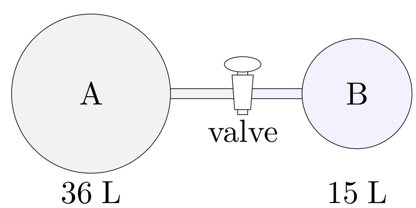
007 6.0 points

Consider the diagram shown below of two glass bulbs connected through a valve. The volume for each gas (A and B) is shown under the bulbs and the gases also happen to be at the same temperature (337K) and pressure (580 torr).



After the valve is opened, the two gases mix completely. What is the partial pressure of gas A in this new (opened valve) state?

1. 241.7 torr

2. 170.6 torr

3. 580 torr

4. 1392 torr

5. 409.4 torr **correct**

Explanation:
When the valve is opened the total available volume for both gases is now 51 liters, but the total pressure remains 420 torr. This means

(Boyle's Law) that the gas A pressure will drop by a factor of 36/51.

$(36/51)(580) = 409.4$ torr for gas A.

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008 6.0 points

Calculate the volume of NO gas produced from the following balanced chemical reaction when 66.6 grams NO_2 is reacted to completion with excess H_2O at STP.

$$3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(aq) + NO(g)$$

1. 49.7 L

2. 130 L

3. 4.8 L

4. 66.6 L

5. 10.8 L **correct**

6. 16.6 L

Explanation:

$$66.6\text{g}\,NO_2 \times \frac{1\,\text{mol}\,NO_2}{46.01\text{g}\,NO_2} \times \frac{1\,\text{mol}\,NO}{3\,\text{mol}\,NO_2} \times 22.4\text{ L / mol} = 10.8\text{L}\,NO$$

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009 6.0 points

The rate of effusion for carbon monoxide (CO) is ____ times the rate of effusion for xenon (Xe) gas .

1. 1.59

2. 3.06

3. 1.16

4. 2.17 **correct**

5. 4.69

Explanation:

The rate of effusion can be interchanged with v_{rms} to give a ratio equal to:

$\frac{v_1}{v_2} = \sqrt{\frac{M_2}{M_1}}$

Solving for the ratio of CO : Xe gives

$\frac{v_1}{v_2} = \sqrt{\frac{131.29}{28.01}} = 2.17$

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010 6.0 points

Consider three closed 10L containers at room temperature. Container 1 contains neon gas. Container 2 contains argon gas. Container 3 contains hydrogen gas. Each container has a constant pressure equal to 1.2 atm. Which of the following properties, if any, are the same between the containers?

I. Average velocity of gas particles

II. Number density

III. Kinetic energy

IV. Mass density

1. I and IV only

2. IV only

3. II and IV only

4. II and III only **correct**

5. III only

6. I, II, III and IV

7. I and III only

8. None of the above

Explanation:

When comparing different ideal gases at the same temperature, pressure, and volume, the only key differences will be the mass density and the average velocity (both of these are dependent on the molecular weight). The number of moles, number density, and kinetic energy will all be the same between the three containers.

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011 6.0 points

A 3.43 gram gas sample has a volume of

3.25 L, a pressure of 0.61 atm, and a temperature of 310 K. Which of the following gases is it?

1. O_2

2. SF_6

3. CO_2 **correct**

4. SO_2

5. NH_3

6. Ne

Explanation:
MWt = mass (m)/moles(n)
$n = PV/RT$
MWt $= mRT/PV$
$= 3.43(0.08206)(310)/(0.61 \cdot 3.25)$
$= 44$ g/mol which is CO_2

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012 6.0 points

Consider a Maxwell-Boltzmann distribution plotting three different gases at the same temperature. Which of the following conclusions can be made from the graph?

1. The gas with the highest molecular weight has the highest average kinetic energy

2. The gas with the lowest molecular weight has the highest root mean square velocity and the most narrow distribution

3. The root mean squared velocity of a gas is directly proportional to the square root of the molecular weight of its gas

4. The velocity of the gas particles is independent of the molecular weight

5. The root mean squared velocity of a gas is proportional to the inverse square root of its molecular weight **correct**

Explanation:
A Maxwell-Boltzmann plotting three different gases at the same temperature will show that all gases will have the same kinetic energy because kinetic energy is dependent only on temperature. The gas with the lowest molecular weight will have the highest root mean squared velocity with the broadest distribution. This is because velocity is proportional to the inverse square root of molecular weight.

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013 6.0 points

The compressibility factor (Z) for a gas at 400 atm is greater than one. How can you make an accurate gas law calculation for this gas at 400 atm?

1. You must correct for attractive forces because $PV > nRT$

2. This gas can be modeled ideally at this pressure because $PV < nRT$

3. This gas can be modeled ideally at this pressure because $PV = nRT$

4. You must correct for attractive forces because $PV < nRT$

5. You must correct for repulsive forces because $PV > nRT$ **correct**

6. This gas can be modeled ideally at this pressure because $PV > nRT$

7. You must correct for repulsive forces because $PV < nRT$

Explanation:
The compressibility factor can have three conditions.

If $PV > nRT$, $Z > 1$ and repulsions dominate.

If $PV < nRT$, $Z < 1$ and attractions dominate.

If $PV = nRT$, $Z = 1$ and the gas can be modeled ideally.

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014 6.0 points

Based on the hard sphere model of gases, which of the following gases is best modeled by ideal behavior?

1. Ne

2. Ar

3. Xe

4. He **correct**

5. Kr

Explanation:
The hard sphere model adjusts the ideal gas law based on the volume of the particles. Therefore, ideal gas behavior is best modeled when the gas particles are smaller in volume, which correlates with lower molecular weight. Larger gas particles (high molecular weight) are expected to deviate from ideal behavior.

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015 6.0 points

A container with a mixture of helium and neon has a total pressure of 2.40 atm. If the partial pressure of helium is 1.60 atm, what is the mole fraction of the neon gas?

1. 1.50

2. 0.333 **correct**

3. 19

4. 18

5. 0.667

6. 3.00

Explanation:
The mole fraction of Neon is given by the formula:
$X_{\text{Ne}} = P_{\text{Ne}}/P_{\text{tot}}$
Given that $P_{\text{Ne}} = P_{\text{tot}} - P_{\text{He}} = 2.40 - 1.60$,
$0.333 = (2.40 - 1.60)/2.40$

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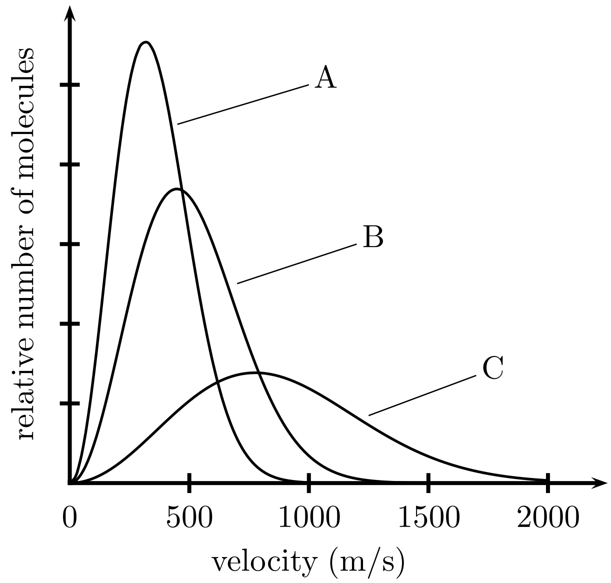
016 6.0 points

The graph shows the approximate Maxwell-Boltzmann distribution plots for O_2, HCl, and Kr at the same temperature.



What is the identity of the gas labeled A?

1. Kr **correct**

2. O_2

3. HCl

Explanation:
Kr is the heaviest gas, meaning it will be the slowest (Gas A). O_2 is the lightest gas, meaning it will move the fastest (Gas C).

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017 6.0 points

Consider the van der Waals equation for non ideal gases. Which of the following statements is true?

1. This equation can only be used to model ideal gases

2. The b term correlates with the size of particles in a gaseous system **correct**

3. A gas with a low molecular weight will have a high a value

4. $(P + \frac{an^2}{V^2})$ represents the measured pressure

5. A large b value correlates with a low molecular weight

Explanation:

The van der Waals equation for non ideal gases is given below:

$(P + \frac{an^2}{V^2})(V - nb) = nRT$

In this equation, $(P + \frac{an^2}{V^2})$ represents the ideal pressure and $(V - nb)$ represents the available volume after making the corrections. The a term corrects for attractions and the b term corrects for the size of the particles (repulsions). Mathematically, the measured pressure is less than the ideal pressure. The available volume is less than the total volume.