...You may use calculators for all parts of the examination.

 R= 0.0821 lit.atm/mol K = 62.4 lit.torr/mol K = 8.31 J/mol K

1. A sample of 1.00 mole of hydrogen gas is mixed with 5.00 mole of helium gas. If the total pressure of the system is 3.00 atmospheres, the partial pressure of the **helium** gas is

A) 0.500 atm B) 1.00 atm C) 1.50 atm D) 2.00 atm E) 2.50 atm

2. The density of a certain gas was measured to be 2.68 grams per liter at 3.00 atm. and 27oC. What is the molecular mass of the gas? A) 16.0 B) 20.0 C) 22.0 D) 60.0 E) 132

3. Deviations from the gas laws in which PV > nRT are generally produced when

 A) there are significant intermolecular attractions B) the particles occupy a significant

 fraction of the space in the container C) the pressure is significantly decreased

 D) there are significant chemical interactions between the gas particles

4.A sample of 0.0100 mole of oxygen gas is confined at 37oC and 0.216 atmosphere. What would be the pressure of this sample at 15oC and the same volume?

 A) 0.0876 atm. B) 0.175 atm C) 0.201 atm D) 0.233 atm E) 0.533 atm

5. The density of oxygen gas at 25oC and 4.0 atmospheres pressure is approximately

 A) 1.3 gram/liter B) 2.6 gram/liter C) 3.2 gram/liter D) 5.2 gram/liter E) 7.3 gram/liter

6. An increase in the temperature of a liquid always increases the vapor pressure. Three possible explanations of this increase are:

 I. There are more vapor particles at the higher temperature, resulting in more collisions with the walls of the container.

 II. The increase in kinetic energy results in a greater force exerted per collision.

 III. The increase in temperature changes the container volume, resulting in increased collision frequency.

 Correct explanations include A) I only B) II only C) I and II only D) I, II, and III

7. A hydrocarbon with an empirical formula CH2 is found to have a mass of 5.01 grams at a pressure of 1.00 atm, a temperature of 0oC., and a volume of 2.00 liters. A possible formula

 for this hydrocarbon is A) CH2 B) C2H4 C) C3H6 D) C4H8 E) C5H10

8. Samples of F2 gas and Xe gas are mixed in a container of fixed volume. The initial partial pressure of the F2 gas is 8.0 atm. and that of the Xe gas is 1.7 atm. When all of the Xe gas reacted, forming a solid compound, the pressure of the unreacted F2 gas was 6.3 atm. The temperature remained constant. What is the formula of the compound?

 A) XeF B) XeF2 C) XeF3 D) XeF4 E) XeF6

9. A sample of an ideal gas is cooled from 50.0o C to 25.0o C in a sealed container of constant volume. Which of the following values for the gas will decrease?

 I. The density of the gas.

 II. The average distance between the molecules

 III. The average speed of the molecules.

 A) I only B) II only C) III only D) I and III E) II and III

10. What volume is occupied by 5.00 grams of oxygen gas at a pressure of 800. torr and a

 temperature of 27oC? A) 3.66 L B) 7.32 L C) 117 L D) 0.33 L E) 0.66 L

11. Collisions between gas particles and container walls result in a measurable force per unit

 area. This force per unit area varies

 I. Directly with Kelvin temperature

 II. Inversely with the volume of the container

 III. Directly with the concentration of gas particles.

 A) I only B) II only C) I and II only D) I, II, and III E) I and III only

12. Which of the following actions would be likely to change the boiling point of a sample of a pure liquid in an open container?

 I. Placing it in a smaller container

 II. Increasing the number of moles of liquid in the container

 III. Moving the container to a higher altitude.

 A) I only B) II only C) III only D) II and III only E) I, II, and III

13. A 66.0g sample of solid CO2( MM=44) vaporizes completely to fill an empty plastic bag to a final volume of 22.4 L at 0̊ C. What is the final pressure in the sealed bag? (Note: this was on an AP test, and had to be done WITHOUT calculators! ̊)

 A) 380 mm Hg B) 507 mm Hg C) 760 mm Hg D) 1140 mm Hg E) 1520 mm Hg

14. A mixture of nitrogen and helium gases containing 4.00 grams of helium, exerts a total pressure of 800. mm Hg. If the partial pressure of the nitrogen gas is 480 mm of Hg, what is the mass of the nitrogen gas in the mixture? A) 21.0 g B) 42.0 g C) 56.0 g D) 28.0 g

 E) 6.00 g the P of He must be 320 mm (800 – 480) There is one mol of He.

 So 320mm/1mol = 480mm/ x mol. x = 1.5 mol of N2, which is 42g.

(15 to 16) Hydrogen is often prepared through the reaction of dilute HCl with Zinc.

 Zn(s) + 2 HCl(aq) → H2(g) + ZnCl2(aq)



 In one such experiment, 6.54 grams of Zn are reacted with 2.00 molar HCl. The zinc is completely consumed in the reaction.

15. What is the minimum amount of 2.00 molar HCl needed to react with the entire quantity of zinc? A) 50.0 mL B) 100. mL C) 25.0 mL D) 200. mL

16. At STP, what volume of hydrogen gas would be produced in this reaction?

 A) 1.12 liters B) 2.24 liters C) 4.48 liters D) 6.54 liters

17. Which would change the equilibrium vapor pressure of a liquid in a closed system?

 I. A change in temperature.

 II. A change in the volume of the container

 III. A change in the surface area of the liquid

 A) I only B) I and II only C) I and III only D) II and III only E) I, II, and III

Questions 18 to 19 are based on two metal tanks of gas, referred to as tank A and tank B. Base your responses on the information which follows:



|  |  |  |
| --- | --- | --- |
| Tank | A (V= 5.00 L) | B (V = 5.00 L ) |
| Gas | C3H6 (propene) | C2H4 (ethene) |
| Molar mass | 42 | 28 |
| Pressure | 1.0 atm | 1.5 atm |
| Temperature | 298 K | 298 K |
| Normal boiling point | 226 K | 169 K |
| Critical temperature | 365 K | 283 K |

18. Which of the following statements is correct?

 I) The total mass of gas is the same in both tanks.

 II) The speed of molecular motion is the same in both tanks.

 III) The average kinetic energy of the ethene is greater than that of the propene

 A) I only B) II only C) III only D) I, II and III E) none of them is correct.

19. Which of the following statements is correct?

 I ) Propene has stronger London dispersion forces than ethene

 II) Under the given conditions, propene would behave more like an ideal gas than ethene.

 III) Ethene molecules are colliding with the container walls more frequently than are

 propene molecules.

 A) I only B) II only C) III only D) I and III only E) I, II and III.

20. When NaCl dissolves in water, the lattice energy is almost equal to the hydration energy. The solute-solvent attractions in this case are best described as

A) interionic attractions B) dipole-dipole attractions C) ion-dipole attractions

D) London dispersion forces.

Free response I is based on the table above, used in questions 18 and 19. Answers go in the essay booklet. (show work)

I. A. Tank A. is heated until its pressure is = to the pressure in tank B. What is the final Kelvin temperature at this new pressure? P/T = P/T, 1/298 = 1.5/x c\x = 447 K

B. What is the density of the propene under the conditions in part A, above? D = MM(P)/RT

 D= 1.72 g/L It doesn’t matter whether you use the initial conditions (P =1, T = 298) or the conditions in part A ( P = 1.5, T = 447) Same answer – the density didn’t change.

C. Gas is allowed to escape from tank B until the pressure ( with T constant) drops to 0.50 atm. What is the new density of ethene under those conditions? 0.572 g/L

II. Observations about real gases can be explained at the molecular level according to the kinetic molecular theory of gases. Explain how each of the following observations can be interpreted according to these concepts. (Note: Do NOT answer the question by simply citing a gas law. Explanations MUST be on a molecular level)

A. When a gas filled balloon is cooled it shrinks in volume; this occurs no matter what gas is originally placed in the balloon. Slower moving molecules at lower temperature exert less force on the walls of the balloon, which allows it to become smaller.

 B. Three identical balloons are inflated to equal size. One contains He, one CO2 , and

 one O2 . After 12 hours, all the balloons have decreased in size. Predict which balloon

 is smallest, and explain your reasoning. He. The balloons have lost some gas which has leaked through the balloon. The lightest gas, He, is moving faster, so more of it escapes.

 C. When a balloon with a gas in it is cooled its volume never becomes zero. The particles themselves DO take up some space. And when any gas is cooled enough, it will liquify.

 D. At STP, while the volumes of 1.00 mole of O2 , Ne, and N2 are nearly identical to each other, the volume of 1.00 mole of SO2 gas is somewhat smaller.

SO2 has stronger attractive forces, and so is NOT an ideal gas. The attractions cause the molecules to move closer to each other, decreasing the volume.

III. A. The vapor pressure of water at 25o C is 23.8 torr. In order to collect 50.0. mL of hydrogen gas over water, at a temperature of 25o, and an external pressure of 763.8 torr, what is the minimum mass of magnesium needed to react with excess HCl ?

 ( Mg(s) + 2 HCl(aq) ➞ MgCl2 (aq) + H2 (g) The pressure of the H2 = 763.8-23.8

 = 740 torr.

 Find the moles of H2  n = PV/RT = 740 torr( 0.050 L)/ (62.4 L torr/molK(298 K)

 = 1.99 x 10-3 mol. Since Mg and H2 are 1 to 1, the moles are the same, so 24.3 x 1.99 x 10-3

 = 0.048 grams.

IV. 2 CO + O2 ➞ 2 CO2 (all gases)

 A. At 400 K sufficient CO is added to a metal tank to produce a pressure of 2.00 atm.

 If the mass of the CO is 17.0 grams, what is the volume of the tank? 17.0/28 = 0.607 mol

V = nRT/P = 9.97 L

 B. Sufficient O2 is now added to increase the total pressure to 7.00 atm before any

 reaction occurs. The reaction is then initiated, and proceeds until one of the reactants

 is used up. The temperature is brought back to 400 K, and the volume of the tank

 is constant. Find the partial pressures of all gases now remaining in the tank.

 The pressure of the O2 must be 7.00 – 2.00 = 5.00 atm.

 The easiest solution is to use stoichiometry with atm. instead of moles.

 2.00 atm CO, 5.00 atm O2, so the CO is limiting, and is used up.

 -2.00 -1.00 + 2.00 atm CO2

0 atm CO 4.00 atm O2 2.00 atm. CO2

V. An unknown compound contains has the empirical formula C2H5O ( MM = 45)

A. When 1.570 grams of the compound is vaporized at 400.o C and 1.00 atm. the gas occupies a volume of 964 milliliters. What is the molar mass of the compound?

 B. What is the molecular formula for the compound?

 C. What partial pressure of carbon dioxide would result from the complete combustion of

1.500 mole of this substance at 300.o C in a tank with a volume of 4.000 liters?

MM = gRT/PV = 1.570( .0821)( 673K)/ 1.00atm)(0.964 L) = 90.0 g/mol.

90.0 is TWICE the mass of the empirical formula, so the molecular formula is C4H10O2

VI. 4.00 grams of Na metal are introduced into a 12.88 liter vessel containing Cl2 gas at a pressure of 0.95 atm, and a temperature of 298 K.

The sodium and chlorine react to form sodium chloride, until one of the reactants is completely used up.

A. Write a balanced equation for the reaction. 2 Na + Cl2 → 2 NaCl.

B. Determine the limiting factor. (show work!!) 4.00 g of Na is 4.00/23.0 =0.174 mol

 For Cl2 n = PV/RT = .95 x 12.88 /(0.0821)(298) =0.500 mol.

 0.174 mol Na is limiting, because that is much less than twice .500.

C. Once the reaction has gone to completion, assuming that the temperature comes back to 298 K, and the volume of the vessel is constant, what is the pressure of the remaining chlorine gas (if any) ? 0.174 mol Na reacts with half that much, 0.087 mol Cl2 We started with 0.500 mol Cl2, so 0.413 mol remains.