Exam 3

Part I: Multiple Choice (2 points each)

Directions: Please circle the *best* answer for each of the following questions.

Question 1. Describe the following equation in terms of number of moles:

S (s) + 3 F2 (g) 🡪 SF6 (g)

\_\_\_mol of solid sulfur reacts with \_\_mol of fluorine gas to produce \_\_\_mol of sulfur hexafluoride.

1. 1, 2, 1
2. 1, 3, 1
3. 1, 6, 2
4. 1, 4, 2
5. 1, 6, 7

Question 2. Classify the following reaction as exothermic or endothermic and give ΔH for the reaction:

PCl5 (g) + 67 kJ 🡪 PCl3 (g) + Cl2 (g)

1. Exothermic, 67 kJ
2. Exothermic, -67 kJ
3. Endothermic, -67 kJ
4. Endothermic, 67 kJ
5. none of the above

Question 3. Predict the shape of a molecule with two bonded atoms and no lone pairs.

1. Linear
2. Bent
3. Tetrahedral
4. Trigonal planar
5. Trigonal pyramidal

Question 4. The pressure exerted by the particles of vapor above a liquid is called the \_\_\_\_\_\_\_\_\_ pressure.

1. vapor
2. atmospheric
3. molar
4. standard
5. barometric

Question 5. A kilopascal is a unit of \_\_\_\_\_\_.

1. temperature
2. volume
3. energy
4. pressure
5. mass

Question 6. In the kinetic molecular theory of gas behavior, particles of a gas tend to move \_\_\_\_ and collisions between them are \_\_\_\_\_.

1. slowly, rare
2. rapidly, rare
3. slowly, unusual
4. slowly, elastic
5. rapidly, elastic

Question 7. Identify the strongest attractive forces between molecules of Ne.

1. hydrogen bonds
2. dipole-dipole attractions
3. dispersion forces
4. ionic bonds
5. covalent bonds

Question 8. Which of the following correctly illustrated the conservation of mass for the reaction below?

4 Fe­ (s) + 3 O2 (g) 🡪 2 Fe2O3 (s)

1. 40.0 g Fe, 30.00 g O2, 70.0 g Fe2O3
2. 223 g Fe, 96.0 g O2, 319 g Fe2O3
3. 100. g Fe, 100. g O2, 200. g Fe2O3
4. 4.00 g Fe, 3.00 g O2, 2.00 g Fe2O3
5. 55.85 g Fe, 16.0 g O2, 160. g Fe2O3

Question 9. Which is the most polar bond in the following list?

1. P-H
2. C-S
3. O-H
4. I-I
5. S-O

Question 10. Wearing goggles in the chemistry laboratory is important because

1. they protect your eyes from chemicals splashing into your eyes.
2. they protect your face from burns.
3. they protect you from noxious vapors.
4. they are not necessary.
5. all of the above

Part II: Short Answer

Directions: Answer each of the following questions. Be sure to use complete sentences where appropriate. For full credit be sure to show all of your work.

Question 1. Regarding the heating curve, classify these statements as true or false (4 points).

* 1. Heat is added continually from one point to the next. True
	2. An increase in heat always produces an increase in temperature. False
	3. The temperature increases continually from one point to the next. False
	4. During a phase change, the temperature of a substance remains constant. True

Question 2. What is viscosity? How does it depend on intermolecular forces (4 points)?

Viscosity is the resistance of a liquid to flow. If a liquid has strong intermolecular interactions then the particles will not flow past each other and the viscosity will be high (i.e. the greater the attraction between molecules the higher the viscosity).

Question 3. Complete the following table (15 points)

|  |  |  |  |
| --- | --- | --- | --- |
|  | C2Cl4 | PH4+ | OF2 |
| Total Valence Electrons | 36 | 8 | 20 |
| Lewis Structure |  |  |  |
| Orbital Geometry | Trigonal Planar | Tetrahedral | Tetrahedral |
| Molecular Geometry | Trigonal Planar | Tetrahedral | Bent |
| Approximate Bond Angle | 120° | 109.5° | <109.5° |

Question 4. If a package of potato chips contains 0.132 L of air on the ground where the atmospheric pressure is 760 torr, what is the pressure in the airplane if the volume increases to 0.243 L after takeoff (8 points)?

V1 = 0.132 L

P1 = 760 torr

V2 = 0.243 L

$$P\_{1}V\_{1}=P\_{2}V\_{2}⇒P\_{2}=P\_{1}\frac{V\_{1}}{V\_{2}}=\left(760 torr\right)\left(\frac{0.132 L}{0.243 L}\right)=413 torr$$

Question 5. Indicate the effect of each change up on the pressure of a gas (increase, decrease, or no change) (5 points)

1. Decrease in volume (n, T constant). Increase
2. A leak occurs and gas escapes. Decrease
3. Removing some molecules of gas. Decreases
4. The volume and the Kelvin temperature are reduced

by one-half. No change

1. The temperature is doubled Increase

Question 6. When heated to 350 °C at 0.950 atm, ammonium nitrate decomposes to produce nitrogen, water and oxygen gases (10 points).

1. Balance the decomposition reaction:

2 NH­4NO3 (s) $→$ 2 N2 (g) + 4 H2O (g) + O2 (g)

1. How many liters of water vapor are produced when 23.7 g of ammonium nitrate decomposes (10 points)?

T = 350 °C + 273 = 623 K

P = 0.950 atm

$$m=23.7 g NH\_{4}NO\_{3}×\frac{1 mol NH\_{4}NO\_{3}}{80.052 g NH\_{4}NO\_{3}}×\frac{4 mol H\_{2}O}{2 mol NH\_{4}NO\_{3}}=0.592 mol H\_{2}O $$

$$PV=nRT⇒V=\frac{nRT}{P}=\frac{\left(0.592 mol\right)\left(0.0821 \frac{L atm}{mol K}\right)(623 K)}{0.950 atm}=31.9 L$$

Question 7. When solid calcium carbonate is heated, it decomposes to give solid calcium oxide and carbon dioxide gas. A volume of 564 mL of gas is collected over water at a total pressure of 659 mmHg and 16 °C. The vapor pressure of water at 16 °C is 14 mmHg.

CaCO3 (s) 🡪 CaO (s) + CO2 (g)

 What was the partial pressure of the carbon dioxide gas (5 points)?

V = 564 mL

Ptotal = 659 mmHg

T = 16 °C + 273 = 289 K

Pwater = 14 mmHg

Ptotal = Pcarbon dioxide + Pwater

Pcarbon dioxide = Ptotal – Pwater = 659 mmHg – 14 mmHg = 645 mmHg

Question 8. When it rains or snows, the air temperature seems warmer. Why (3 points)?

When water vapor condenses or liquid water freezes, heat is released (exothermic process), which warms the air.

Question 9. Answer the following questions using the reaction below:

1. Balance the equation (18 points):

2 N2H4 (g) + N2O4 (g) 🡪 3 N2 (g) + 4 H2O (g)

1. How many molecules of N2 will be produced by the reaction of 16 molecules of N2H4 with excess N2O4?

$$16 molecules N\_{2}H\_{4}×\frac{3 molecules N\_{2}}{2 molecules N\_{2}H\_{4}}=24 molecules N\_{2}$$

1. How many moles of N2O4 are required to react with 5.34 moles of N2H4?

$$5.34 moles N\_{2}H\_{4}×\frac{1 mol N\_{2}O\_{4}}{2 mol N\_{2}H\_{4}}=2.67 mol N\_{2}O\_{4}$$

1. How many grams of water will be formed by the reaction of 9.35 g of N2O4 with excess N2H4?

$$9.35 g N\_{2}O\_{4}×\frac{1 mol N\_{2}O\_{4}}{92.02 g N\_{2}O\_{4}}×\frac{4 mol H\_{2}O}{1 mol N\_{2}O\_{4}}×\frac{18.02 g H\_{2}O }{1 mol H\_{2}O}=7.32 g H\_{2}O $$

1. How many molecules of nitrogen gas will be produced from the reaction of 15.0 grams of N2H4 with excess N2O4?

$$15.0 g N\_{2}H\_{4}×\frac{1 mol N\_{2}H\_{4}}{32.052 g N\_{2}H\_{4}}×\frac{3 mol N\_{2} }{2 mol N\_{2}H\_{4}}×\frac{6.022×10^{23} molecules N\_{2}}{1 mol N\_{2}}=4.23×10^{23} molecules N\_{2} $$

Question 10. Place the following substances in order of increasing vapor pressure at a given temperature. Explain your order (8 points).

nitrogen trifluoride ammonia boron trichloride

NF3 NH3 BCl3



London-dispersion London-dispersion London-dispersion

Dipole-dipole dipole-dipole

 Hydrogen bonding

So, in order of increasing vapor pressure: NH3 < NF3 < BCl3