This print-out should have 8 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

LDE Bond Order 001

001 5.0 points

Using molecular orbital theory, determine the bond order for O_2^-?

1. 1.5 **correct**

2. 1

3. 3

4. 2.5

5. 2

Explanation:

The molecule would have 17 total electrons, 10 of which would be bonding and 7 of which would be anti-bonding. Therefore the bond order would be: $(10 - 7)/2 = 1.5$.

LDE Paramagnetism 001

002 5.0 points

Which of the following species is not paramagnetic?

1. CN

2. N_2^{3+}

3. F_2^-

4. OF

5. B_2^{2-} **correct**

Explanation:

The answer choices F_2^-, OF, CN, and N_2^{3+} all have an odd number of total electrons and therefore must be paramagnetic.

LDE Ranking Bonding Trends 003

003 5.0 points

Using molecular orbital theory, rank the following species in terms of increasing bond length: O_2, B_2^+, CN^-, and F_2.

1. $B_2^+ < O_2 < F_2 < CN^-$

2. $CN^- < F_2 < O_2 < B_2^+$ **correct**

3. $CN^- < B_2^+ < O_2 < F_2$

4. $F_2 < CN^- < O_2 < B_2^+$

5. $F_2 < O_2 < B_2^+ < CN^-$

Explanation:

Bond order is inversely proportional to bond length, and the bond order for the species O_2, B_2^+, CN^-, and F_2 are 2, 0.5, 3 and 1 respectively.

LDE Delocalization 001

004 5.0 points

Choose the compound below that does not exhibit delocalization.

1. C_6H_6

2. O_3

3. CO_3^{2-}

4. NO_3^-

5. CO_2 **correct**

Explanation:

Ozone, benzene, nitrate and carbonate are all famous examples or delocalization. Carbon dioxide does not exhibit delocalization.

LDE Ideal Gas 001

005 5.0 points

The basis for hydrogen fuel cell technology is the hydrolysis of water using an electric current to produce hydrogen gas which can then be collected and combusted later. The balanced reaction for the hydrolysis of water is:

$$2\ H_2O(\ell) \longrightarrow O_2(g) + 2\ H_2(g)$$

If we completely hydrolyzed 0.054 kg of water in a 22 L container at 298 K, what would be the total final pressure of the system in

atmospheres?

1. 3.33 atm

2. 0.84 atm

3. 6.67 atm

4. 10 atm **correct**

5. 0.001 atm

Explanation:

Hydrolyzing 0.054 kg of water (3 mol) would yield 3 mol of oxygen gas and 6 mol of hydrogen gas, for a total of 9 mol of gas ($n = 9$ mol).

$$P = \frac{nRT}{V} = 10 \text{ atm}$$

LDE Ideal Gas 002

006 5.0 points

If a 10 L gaseous system at 400 K and 4 atm is heated to 800 K and allowed to expand to 20 L, what will the new pressure of the system be?

1. 1 atm

2. 8 atm

3. 16 atm

4. 4 atm **correct**

5. 2 atm

Explanation:

Doubling the temperature from 400 K to 800 K will double the pressure and doubling the volume from 10 L to 20 L will halve the pressure, resulting in no net change in pressure.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$P2 = \frac{P_1V_1T_2}{V_2T_1} = \frac{4 \cdot 10 \cdot 800}{20 \cdot 400} = 4 \text{ atm}$$

LDE Kinetic Theory 001

007 5.0 points

Which of the following statements is/are true?

I) At a given temperature, larger molecules have greater average kinetic energy than smaller molecules.

II) As the temperature of a gaseous system rises, the gas molecules' average speed increases.

III) Gas molecules diffuse much more slowly than they move.

1. I, III

2. III only

3. II, III **correct**

4. II only

5. I, II, III

6. I only

7. I, II

Explanation:

At a given temperature, all gas molecules, regardless of their size, have the same average kinetic energy. The temperature of the system is directly proportional to the average kinetic energy of the molecules, and therefore their average velocity/speed as well. Because diffusion is net directional motion, not random motion, it occurs much more slowly than the gas molecules move.

LDE Ranking Gases 001

008 5.0 points

Rank the following gases in terms of decreasing ideality: Cl_2, H_2, CO_2, CH_4.

1. $Cl_2 > CH_4 > CO_2 > H_2$

2. $CO_2 > Cl_2 > CH_4 > H_2$

3. $H_2 > CH_4 > CO_2 > Cl_2$ **correct**

4. $CO_2 > CH_4 > H_2 > Cl_2$

5. $CH_4 > H_2 > Cl_2 > CO_2$

Explanation:

Because all of the gases are non-polar, the only consideration for non-ideality is the size. Larger molecules, evaluated by atomic mass, are less ideal.