Exam 3

Part I: Multiple Choice (2 points each)

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

Question 1. The Schrödinger equation describes the behavior of electrons. According to it and quantum mechanics,

1. an electron can reside anywhere in the atom except for the nucleus.
2. an electron exists in a stationary position just outside the nucleus of an atom.
3. an electron has a high probability of residing in a particular region of space around the nucleus called an orbital.
4. electrons are known to reside near the nucleus, but their location is impossible to predict.
5. an electron orbits the nucleus of an atom in a circular orbit.

Question 2. Valence electrons are

1. the first ten electron in an atom.
2. the outermost d electrons in an atom.
3. the unpaired electrons in an atom.
4. The outermost s and p electrons in an atom.
5. The innermost electrons in an atom.

Question 3. What is the total number of electrons present in an O2- ion?

1. 2
2. 4
3. 6
4. 8
5. 10

Question 4. An alpha particle is defined as

1. the nucleus of a helium atom composed of 2 protons and 2 neutrons.
2. energy with no mass.
3. a lone electron.
4. the nucleus of a hydrogen atom composed of 1 proton.
5. a positively charged electron.

Question 5. One instrument used to measure ionizing radiation is a

1. radioactive counter.
2. Curie counter.
3. Roentgen counter.
4. Geiger counter.
5. Gamma ray.

Question 6. As the pressure of a sample of gas is increased at constant temperature, the volume of the

gas increases.

1. gas decreases.
2. gas remains the same.
3. gas doubles.
4. gas halves.

Question 7. Which of the following is not part of the kinetic molecular theory of gases?

1. Gas particles have no attraction for one another.
2. During a collision, energy is lost by the gas particles and later is regained.
3. Gases at the same temperature have the same average kinetic energy.
4. Gas particles move in straight lines in all directions.
5. none of the above

Question 8. Which of the following bonds is the most polar?

1. O-F
2. N-F
3. O-I
4. C-N
5. F-F

Question 9. \_\_\_\_\_\_\_\_ bond involves the equal sharing of electrons?

1. Ionic bond
2. Polar covalent bond
3. Nonpolar covalent bond
4. Coordinate covalent bond
5. all of the above

Question 10. In general, in what order should the following steps be taken when responding to a chemical spill?

1. Communicate, isolate, mitigate, evacuate.
2. Isolate, evacuate, mitigate, communicate
3. Evacuate, communicate, isolate, mitigate.
4. Evaluate, isolate, mitigate, communicate.
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. Answer the following questions about an s orbital (3 points).

* 1. What is the maximum number of electrons in the orbital? \_\_\_\_\_\_
  2. Draw an s orbital.

Question 2. Write the complete and condensed electron configuration for (8 points):

* 1. Chlorine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. Niobium, Nb \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. Nb2+ ion \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Question 3. What is unique about the noble gases, from an electron point of view (3 points)?

Question 4. Which radiation has the lower frequency (2 points)?

Radiowaves from an AM radio station broadcasting at 1090 kHz or the green light (λ = 550 nm) from an LED (light emitting diode) on a sterosystem.

Question 5. During the decomposition of potassium perchlorate, KClO4, 92 mL of gas are collected by the displacement of water at 25 °C. If the atmospheric pressure is 756 mmHg, and the vapor pressure of water at 25 °C is 23.8 mmHg (6 points).

What is the partial pressure of oxygen gas?

What is the partial pressure of oxygen gas in kilopascals, kPa?

Question 6. What is a photon (2 points)?

Question 7. Which has a larger radius, a strontium atom or a strontium ion? Explain your reasoning (4 points).

Question 8. Explain how polar bonds differ from nonpolar bonds. How do you know if a bond is polar? Give an example of a polar and a nonpolar bond (5 points).

Question 9. Differentiate between fusion and fission based on your knowledge of nuclear chemistry (4 points)?

Question 10. The half-life of oxygen-15 is 124 seconds (8 points).

* 1. If a sample of oxygen-15 has an activity of 4000. Becquerel (Bq), how many minutes will elapse before it reaches an activity of 500. Becquerel (Note: A Becquerel is a unit of radioactive activity proportional to the amount of radioisotope present.)
  2. Oxygen-15 is a positron emitter. Write the nuclear reaction.

Question 11. Calculate the density of neon gas at 45 °C and a pressure of 0.982 atm (6 points).

Question 12. For each of the following draw the Lewis structure, indicate the orbital geometry, molecular geometry of the central atom, the bond angle, and polarity (16 points).

|  |  |  |
| --- | --- | --- |
| Carbon dioxide, CO2 | Phosphorus tribromide, PBr3 | Sulfur dioxide, SO2  (draw resonance structures) |
|  |  |  |
| Orbital geometry | Orbital geometry | Orbital geometry |
| Molecular geometry | Molecular geometry | Molecular geometry |
| Bond angle | Bond angle | Bond angle |
| Polarity | Polarity | Polarity |

Question 13. What is the purpose of food irradiation (3 points)?

Question 14. The industrial production of nitric acid (HNO3) is a multistep process. The first step is the oxidation of ammonia (NH3) over a catalyst with excess oxygen (O2) to produce nitrogen monoxide (NO) gas as shown by the balanced equation given here (10 points):

4 NH3 (g) + 5 O2 (g) 🡪 4 NO (g) + 6 H2O (g)

1. What volume of O2 at 1.30 atm and 25 °C is required to synthesize 20.0 mol of NO?
2. What volume of H2O (g) is produced by the reaction under the same conditions?