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

1. gas increases.
2. gas decreases.
3. gas remains the same.
4. gas doubles.
5. 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\_\_\_
	2. Draw an s orbital. (sphere)

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

* 1. Chlorine 1s2 2s2 2p6 3s2 3p5 or [Ne] 3s2 3p5
	2. Niobium, Nb 1s2 2s2 2p6 3s2 3p6 4s2 3d10 4p6 5s2 4d3 or [Kr] 5s2 4d3
	3. Nb2+ ion 1s2 2s2 2p6 3s2 3p6 4s2 3d10 4p6 5s0 4d3 or [Kr] 5s0 4d3

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

 A noble gas has a completely filled outer or valence shell. This means that it is not at all reactive.

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?

$$P\_{total}=P\_{O\_{2}}+P\_{water}⇒P\_{O\_{2}}=P\_{total}-P\_{water}$$

$$P\_{O\_{2}}=756 mmHg-23.8 mmHg=732.2 mmHg≈732 mmHg$$

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

$$732 mmHg×\frac{101.325 kPa}{760 mmHg}=97.61863816 kPa≈97.6 kPa$$

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

A packet of energy emitted as light.

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

 A strontium ion is smaller than a strontium atom. They both have the same number of protons, but the strontium ion has fewer electrons, so it is smaller.

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).

 Polar bonds have positive and negative ends. Polar bonds have atoms with different electronegativities bonded together. An example of polar bond is H-F and a nonpolar bond is F-F.

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

 Fusion is the combining of two nuclei to make a heavier particle. Fission is the splitting of a heavy nuclear particle into two smaller particles.

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.)

$$4000. Bq → 2000. Bq → 1000. Bq → 500.0 Bq$$

$$3 half-lives×\frac{124 s}{1 half-life}×\frac{1 min}{60 s}=6.20 min$$

* 1. Oxygen-15 is a positron emitter. Write the nuclear reaction.

$$\rightarrow +$$

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

$$D=\frac{P\left(MM\right)}{RT}=\frac{(0.982 atm)(20.180\frac{g}{mol})}{\left(0.0821\frac{L atm}{mol K}\right)\left(45+273\right)K}=0.759\frac{g}{L}$$

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 geometryLinear | Orbital geometryTetrahedral | Orbital geometryTrigonal planar |
| Molecular geometryLinear  | Molecular geometryTrigonal pyramidal | Molecular geometryBent  |
| Bond angle180°  | Bond angle< 109.5° | Bond angle< 120° |
| PolarityNonpolar | PolarityPolar | PolarityPolar |

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

 The purpose of food irradiation is to inhibit the decay of foods by inhibiting sprouting of vegetables, spoiling of meats, sterilizing meats, and kill insects and microorganisms.

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?

P = 1.30 atm

T = 25 °C + 273 = 298 K

$$n\_{O\_{2}}=20.0 mol NO×\frac{5 mol O\_{2}}{4 mol NO}=25.0 mol O\_{2}$$

$$PV=nRT⇒V=\frac{nRT}{P}=\frac{(25.0 mol)(0.0821 \frac{L atm}{mol K})(298 K)}{1.30 atm}=470 L O\_{2}$$

1. What volume of H2O (g) is produced by the reaction under the same conditions?

$$470 L O\_{2}×\frac{6 L H\_{2}O}{5 L O\_{2}}=565 L H\_{2}O$$