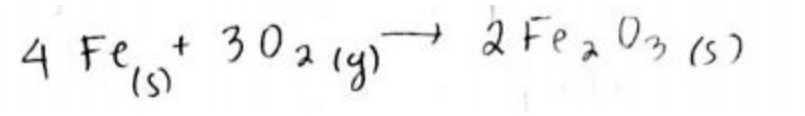
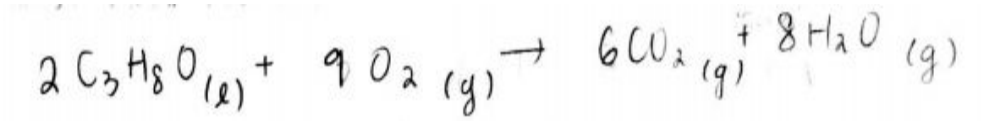
Midterm Preparation Worksheet

1. Write out and balance the following chemical reactions:

   a. Iron rusts in air as a result of a reaction with oxygen that produces iron (III) oxide (Fe_2O_3).



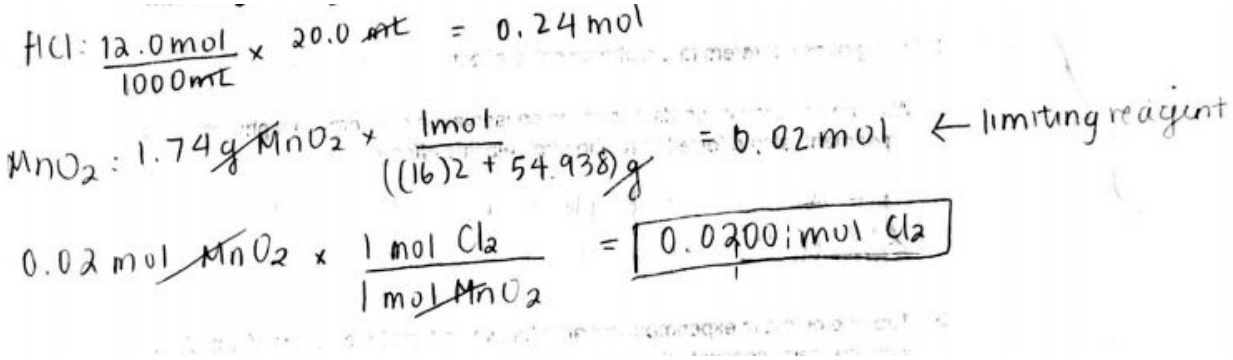
   b. Isopropyl alcohol (C_3H_8O), more commonly known as rubbing alcohol, combusts with oxygen to produce carbon dioxide and water vapor.



2. Manganese (IV) dioxide can be used to produce chlorine gas Cl_2 in the lab by the following reaction:

$$MnO_{2\,(s)} + 4\,HCl_{\,(aq)} \rightarrow Cl_{2\,(g)} + MnCl_{2\,(aq)} + 2H_2O_{(l)}$$

   How many moles of Cl_2 can be produced when 20.0mL of a 12.0M HCl solution reacts with 1.74g of MnO_2 ?



Note: This worksheet may contain problems adapted from Dr. Lavelle's past exams.

3. A solution is prepared by dissolving 55.1g of KCl in approximately 75mL of water and then adding water to a final volume of 125mL. What is the molarity of KCl (aq) in this solution?

molarity = $\frac{\text{mol}}{\text{L}}$

$55.1\,\text{g KCl} \times \frac{1\,\text{mol KCl}}{(39.10 + 35.453)\,\text{g KCl}} \times \frac{1}{0.125\,\text{L}}$

$= 5.91\,\text{M}$

4. L-Dopa, a drug used for the treatment of Parkinson's disease, is 54.82% C, 5.62% H, 7.10% N, and 32.46% O. Its molar mass is 197.19 g/mol. What is the molecular formula of L-Dopa?

Assume sample, 100g:

C: $\frac{54.82\,\text{g C}}{12.01\,\text{g/mol}} = \frac{4.565\,\text{mol C}}{0.50689} \rightarrow 9$

H: $\frac{5.62\,\text{g H}}{1.008\,\text{g/mol}} = \frac{5.5754\,\text{mol H}}{0.50689} \rightarrow 11$

N: $\frac{7.10\,\text{g N}}{14.007\,\text{g/mol}} = 0.50689\,\text{mol N}$ ← smallest → 1

O: $\frac{32.46\,\text{g O}}{16\,\text{g/mol}} = \frac{2.02875\,\text{mol O}}{0.50689} \rightarrow 4$

Empirical formula: $C_9H_{11}NO_4$

molar mass: ~197 g/mol

5. **The following question refers to the photoelectric effect.**

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5. The following question refers to the photoelectric effect.

   a. Write an equation in words illustrating conservation of energy in a photoelectric experiment (also referred to as the photoelectric effect).

   energy of incoming photon = energy to remove an e^- + kinetic energy of e^- removed

   b. The photoelectric experiment became known as the photoelectric effect. What was the major conceptual change as a result of this experiment?

   Was the major conceptual change as a result of this experiment?

   Light does not only act as a wave but also behave as a beam or ray (photons)

6.

6. For each part of this question, the same metal was used in each experiment. The velocity of an electron emitted from this metal surface by a photon is 3.6×10^3 km/s.

$\hookrightarrow 3.6 \times 10^6$ m/s

a. What is the wavelength of the ejected electron?

$$\lambda = \frac{h}{mv} = \frac{(6.63 \times 10^{-34})}{(9.1 \times 10^{-31}\text{kg})(3.6 \times 10^6 \text{ m/s})} \rightarrow \boxed{2.0 \times 10^{-10} \text{ m}}$$

b. No electrons are emitted from the surface of the metal until the frequency of the radiation reaches 2.50×10^{16} Hz. How much energy is required to remove the electron from the metal surface?

$$E = h\nu = (6.63 \times 10^{-34})(2.50 \times 10^{16} \text{ Hz}) = \boxed{1.66 \times 10^{-17} \text{ J}}$$

c. In part a, what is the wavelength of the radiation that caused photoejection of the electron?

$$KE_{ejected} + \Phi = E_{photon}$$

$$\tfrac{1}{2}mv^2 + (1.66 \times 10^{-17} \text{ J}) = E_{photon}$$

$$\tfrac{1}{2}(9.1 \times 10^{-31}\text{kg})(3.6 \times 10^6 \text{ m/s})^2 + 1.66 \times 10^{-17} \text{ J} = E_{photon}$$

$$E_{photon} = 2.25 \times 10^{-17} \text{ J} \rightarrow E = h\nu$$

$$2.25 \times 10^{-17} \text{ J} = (6.63 \times 10^{-34}) \nu = 3.39 \times 10^{16} \text{ Hz}$$

$$c = \nu\lambda$$

$$3 \times 10^8 = (3.39 \times 10^{16})\lambda$$

$$\lambda = \boxed{8.8 \times 10^{-9} \text{ m}}$$

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7. Write the subshell notation (3d, for instance) and the number of orbitals having the following quantum numbers:
   a. n = 5, l = 2

      5d

   b. n = 1, l = 0

      1s

   c. n = 2, l = 1

      2p

8. Nitrogen is found in many biological molecules including proteins and nucleic acids. Write the full electron configuration for nitrogen in the ground state and state the number of unpaired electrons.

   $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$

   3 unpaired electrons

9. Circle only two ions that are not isoelectronic with fluoride ion (F-)

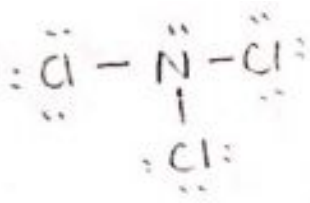
   Li+ Be2+ Mg2+ Ne O- N2- O2- Na+

10. Circle the atom that has the greatest first ionization energy.

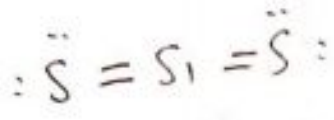
    Br Mg Kr Ca K

11. Draw the Lewis dot structures of the following molecules below. Which of these are radicals?

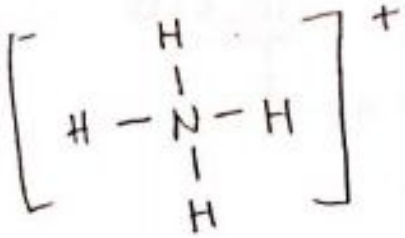
NCl_3



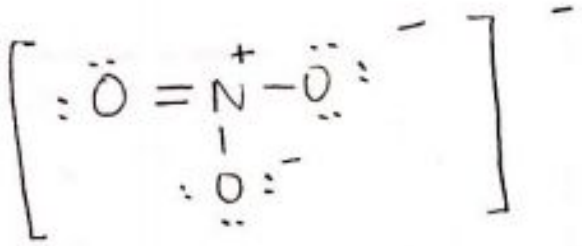
SiS_2



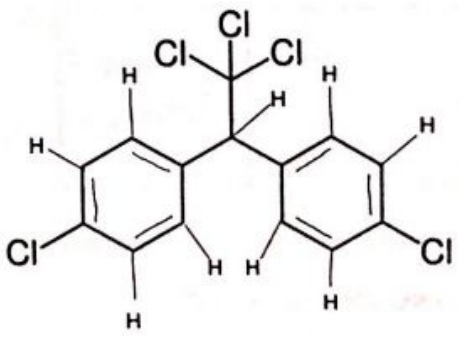
NH_4^+



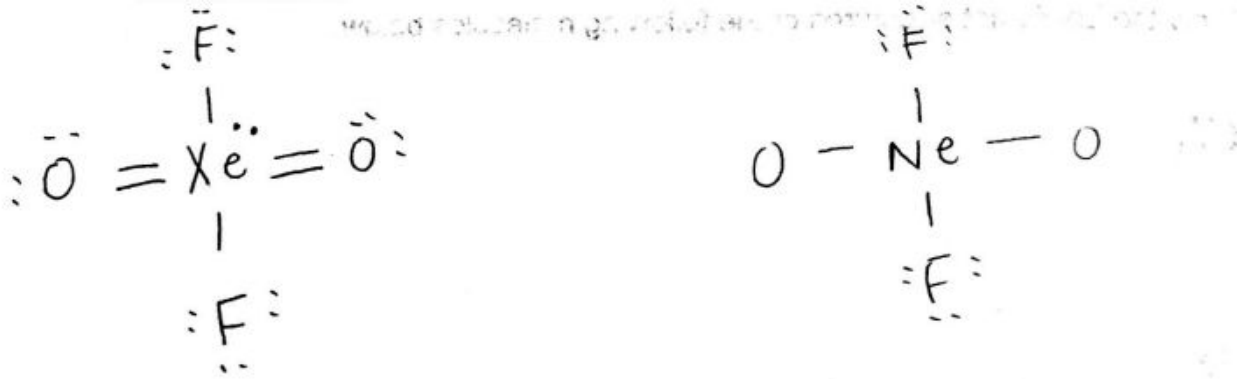
NO_3^-



12. Complete the given structure by adding double bonds so that each atom obeys the octet rule.



13. Draw the Lewis structure for XeO_2F_2. Why does this structure allow Xe to be a central atom but not Ne?



Xe has d orbitals available to allow it to have an expanded valence shells

14. Experiments indicate that two resonance structures exist for the organic molecule, (NH2)COCH3. Draw them.