CHEM 362 – Fall 2019
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Chem 362
Mini Exam #1
September 12, 2018
Chapters 1 and 2
Total points is 50

1. *Inorganic Chemistry (5 pts) short answer*

   a. What is inorganic chemistry? (2 pts)
   make your answer concise but complete

Inorganic Chemistry **is the chemistry of the elements other than that of C combined with H, O, N, S, halogens, and the physical properties that these elements and their compounds exhibit.**

Inorganic Chemistry **covers a vast area of aqueous as well as non-aqueous chemistry. Types of inorganic compounds range from ionic solids to gases and molecular compounds.**

Inorganic Chemistry **is the chemistry of life as much as it is the chemistry of metallurgy**.

   b. Your textbook and the class notes described twelve classes of reactions that are important in the field of inorganic chemistry.
   Name three of them and write a sentence or two about each type of reaction. (3 pts)

1. **Acid – Base. According to the definition of Bronsted-Lowry, the neutralization of a proton donor by a proton acceptor. According to the definition of Lewis, the formation of anadduct between an electron-pair donor and an electron-pair acceptor. A lesser known definition is that of Lux-Flood, namely the reaction of an oxide ion acceptor with an oxide. For the Lewis definition, a *Lewis base* that can donate an *electron pair* reacts with a *Lewis acid* that can accept this electron pair.**
2. **Addition. A reaction in which a group, molecule, or ion combines with another. Common examples are additions across a multiple bond and addition to an atom that is able to undergo coordination sphere expansion (an increase in occupancy). This reaction is the converse of elimination.**
3. **Elimination. A reaction in which a group, molecule, or ion is separated from another. Examples are dehydrohalogenations, and eliminations from metal centers that are able to undergo coordination number reduction (a decrease in occupancy). This is the reverse of an addition reaction.**
4. **Redox (a reaction in which an atom, ion or molecule gains (reduction) or loses (oxidation) an electron or electrons.**
5. **Insertion. The interposition of a new molecule, group, or ion between atoms in a structure such that the added molecule, group, or ion separates the two parts of the structure that were formerly bound together.**
6. **Substitution (Displacement). The exchange of one atom, molecule or ion for another in a compound.**

7. **Rearrangement (Isomerization). A conversion of one isomer into another (cis-trans for example).**
8. **Metathesis (Exchange). An exchange of comparable groups, such that two compounds form two new ones.**
9. **Solvolysis. A reaction with solvent; when the solvent is water it is called hydrolysis.**
10. **Chelation. A reaction in which a group (typically called a ligand) is able to bond to a central metal ion simultaneously through more than one donor atom.**
11. **Cyclization. A reaction that leads to the formation of a ring.**
12. **Nuclear reaction. A reaction that changes the atomic number or mass number of an atom.**

2. *Thermodynamics and Kinetics (8 points)*

   a. Use the space below to draw a reaction energy profile. (3 pts)
   You decide where you want to place reactants and products

Y axis – energy
X axis – reaction coordinate or time
Label E_a and G
Label reactant/product

   b. What is the Δ G for your reaction profile? (is Δ G < 0, Δ G > 0, or Δ G = 0) What does this tell you about the reaction? (1 pt)

If products lower in energy than reactants, <0
If products greater, >0
If equal =0

   c. Describe what changes, if any, would occur to the reaction profile diagram under the effect of a catalyst (1 pt)

Decrease activation energy

   d. Reaction $2A_{(s)} + B_{(g)} \rightarrow A_2B_{(g)}$ has an equilibrium constant K < 1. What does that tell us about ΔG and ΔH? (3 pts)

ΔS = 0, therefore ΔG > 0 b/c K < 1. Therefore, ΔH > 0

3. *Electronic Structure (5 pts)*

   a. There are three principles for electronic configuration (or how electrons are arranged in an atom). Name them and give a brief description (3 pts)

1. Aufbau Principle – add electrons from lowest to highest levels

2. Hund's Rule – Add electrons in orbitals of the same energy with same spin before pairing spins

3. Pauli Exclusion Principle – No two electrons can have the same 4 quantum numbers

b. What are the two parts of the Wavefunction, Ψ, for an orbital and to what aspect of the orbital properties does each one contribute? (2 pts)

Radial – size
Angular - shape

4. *Orbitals and Electronic Configuration (12 pts)*

a. There are four Quantum numbers for every electron in an atom. List them. (4 pts)

n, l, m_l,m_s

b. Is the Bohr atom model capable of being extended to other atoms besides H? State why or why not? (2 pts)

No. A Electrons are not discrete particles with precisely defined positions and velocities. Bohr himself used the idea put forth by Max Planck that electromagnetic energy (photons or any wave) is quantized: E = *h*ν Electrons have the same wave-like properties that photons have.

c. What is shielding and how does it affect ionization energy? (2 pts)

When you put electrons in orbitals with the same Quantum number, n, (same shell), as you keep adding more, they are less shielded from the positive charge of the nucleus. The leads to it being more difficult to remove electrons (higher I.E.) in other words… The Effective Nuclear Charge increases as you go across a row

d. What is the quantum number ℓ for: (4 pts)

1. an s orbital **0**
2. a p orbital **1**
3. a d orbital **2**
4. an f orbital **3**

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5. *Periodic Trends (14 pts)*

a. Indicate whether the following statements are true or false. For all statements, explain *why* it is true or false. (1 pt each))

i. Atomic radius decreases down a group **T** **F**

False – Radius increases because increasing quantum number (n)

ii. Electronegativity increases across a period **T** **F**

True – easier to pull electron into valence shell

iii. Bromine would be the least likely halogen to form an ion **T** **F**

False – ionization energy decreases going down table due to shielding

iv. Helium has a greater ionization energy than Hydrogen **T** **F**

True – see electron config, also FI increases left to right

b. Which element in each pair has the least negative ΔH_{EA} (lesser tendency to accept an electron): (5 pts) *circle your answer*

Li or Cl? **Cs** or K? **Br** or I? S or **Se**? **Re** or Os?

c. What is the sign of the ΔH_{EA} *(not the EA number but the enthalpy)* for elements on the right side of the periodic table? (1 pt)

negative

d. Which element in the periodic table has the most negative ΔH_{EA} *(releases energy when it gains an electron)* (2 pts)

F is the common answer but it is actually Cl because of size and electron repulsion issues for the smaller F atom. (It turns out that both effective nuclear charge and atom size play a role) You will get credit for knowing that elements on the far right have a greater tendency to accept an electron and that the trend is increasing tendency to accept an electron as you go from left to right across a row in the periodic table

e. Which element in the periodic table has the most positive ΔH_{EA} *(requires the most energy when it gains an electron)* (2 pts)

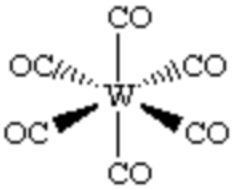
Fr is the common answer but it is actually Hg.
You will get credit for knowing that elements on the far left have the least tendency to accept an electron and that the trend is decreasing tendency to accept an electron as you go from top to bottom of a column in the periodic table

6. *Electron Counting (6 pts)*
Using your method of choice, give the electron count for these molecules; *Show your work in terms of the number of electrons for each atom and group of atoms (ligand),*

a.

Ti 4 e-
Cl 1 e- X 2 = 2
Cp 5 e- x 2 = 10
16 e-

b.



W = 6e-
CO donates 2 e- X 6 = 12 e-
total is 18e- around the W center