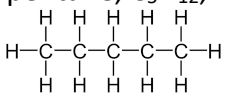
MP Jansen
12/AP/IB Chemistry

Oxidation Numbers: Practice

1. a) Is the oxidation number of an element always equal to its charge in a compound? Explain, using KCl, an ionic compound, and CH_4, a covalent compound, as examples. {3}

   b) Consider pentane, C_5H_{12}, whose structural formula, drawn in two dimensions, is shown:



   Using the oxidation number rules only, verify that C's oxidation number in pentane, C_5H_{12}, is –12/5.

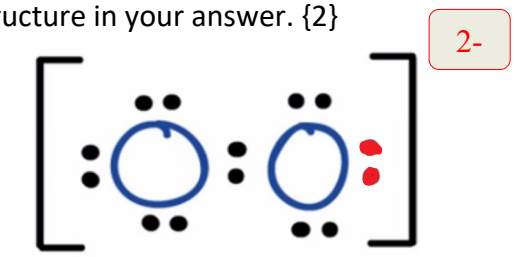
   c) Using an electron dot diagram of pentane, determine the oxidation number of each C atom in the molecule. Explain why the terminal C atoms have a different oxidation number than the "middle" C atoms. {3}

   d) Under what circumstances will a fractional oxidation number for a particular element in a compound be calculated? {1}

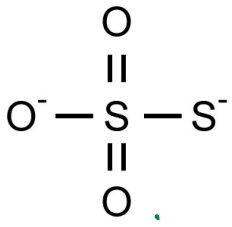
2. a) Explain why the oxidation number of O in most compounds is –II. {1}

   b) Why is the oxidation number of O +2 when oxygen is bonded to fluorine, as in OF_2? Explain with the aid of a Lewis (electron dot) structure. {2}

   c) Explain why the oxidation number of O in a peroxide ion (O_2^{2-})-containing compound is –1. The Lewis dot structure of the peroxide ion is shown below; annotate the following structure in your answer. {2}



3. Consider sodium thiosulfate, $Na_2\underline{S}_2O_3$.
   a) Given that there are no O to O bonds in this polyatomic ion, determine the oxidation number of each S atom in the thiosulfate ion, $S_2O_3^{2-}$, algebraically. Do not consult the Lewis structure shown—yet. {2}



   b) The Lewis strcture of the thiosulfate ion is illustrated. (Notice that the central S atom has > 8 electrons in its valence shell. That's okay; we'll look more closely at this kind of thing in the next unit.) Add lone pairs of electrons to the "outside" atoms (each outside atom obeys the octet rule) as necessary. Using the Lewis structures, determine the ON of each S atom. {5}
   c) Do your answers to parts (a) and (b) make sense? {1}

4. Explain why the oxidation number of an element in its standard state is always 0. Use Fe and Br_2 to illustrate your answer. Include a Lewis structure for Br_2 in your answer. {2}

5. Determine the oxidation number of the underlined element in each of the following compounds. (Some answers at the end.) {10}
   a) $\underline{Cr}O_4^{2-}$, $Ca_3(\underline{P}O_4)_2$, $K_3\underline{P}O_4$, $\underline{Mn}O_2$, $\underline{S}O_3^{2-}$, $H_2\underline{S}O_4$, $Mg(\underline{N}O_2)_2$, $K\underline{N}O_3$, $\underline{C}O$, $\underline{C}O_2$, $H_2\underline{C}_2O_4$, $H\underline{Sb}(OH)_6$.
   b) $H_2\underline{S}$, $\underline{C}_6H_6$, $\underline{N}O$, $\underline{S}O_3$, $\underline{N}_2H_4$. {7}
   c) Why can the ON of C in each of the following compounds not be determined by using the "rules" alone? That is, why is it necessary to draw a Lewis structure of each compound in order to determine the ON of C? Now get busy → K$\underline{C}$N, NaO$\underline{C}$N.

6. (Some answers at the end.)
   a) Determine the oxidation number of Cl in each of the following: NaCl, Cl_2, NaOCl, $NaClO_2$, $NaClO_3$, $NaClO_4$. {6}
   b) What is the oxidation number of Cr in $\underline{Cr}_2O_7^{2-}$? What is the oxidation number of Mn in K$\underline{Mn}O_4$? {2}
   c) Use you answers to parts (a) and (b) to relate an atom's maximum (ie most positive) oxidation number to its position in the periodic table. {1}

7. ". . . a team led by Mingfei Zhou at Fudan University in China has successfully formed the $[IrO_4]^+$ cation in the gas phase using pulsed-laser vaporisation of an iridium metal target, and identified it using photodissociation spectroscopy."[1] Determine the oxidation state of iridium in the $[\underline{Ir}O_4]^+$ cation.

[1] *Chemistry World*, October 23, 2014

8. a) Use the oxidation number concept—and other considerations—to explain why CO_2 makes an effective fire extinguisher. {3}
   b) Watch the following video. Explain with the aid of a chemical equation why CO_2 should NOT be used to extinguish burning magnesium. Additionally, explain the oxidation and reduction that occur in the reaction.
   https://www.youtube.com/watch?v=0dSMzg0UPPo

9. Consider the reaction of sodium hypochlorite with ammonia in aqueous solution, represented by the chemical equation:

   $NaOCl(aq) + NH_3(aq) \rightarrow NH_2Cl(aq) + NaOH(aq)$

   Write Lewis structures of the reactants and products to prove that this is a redox reaction. {4}

10. a) Explain why it is dangerous to grind a mixture of powdered Al with $KClO_4$ in a mortar and pestle. Think in terms of a redox reaction that leads to the production of stable—and expected products. Write the (unbalanced) chemical equation that represents the reaction. {4}
    b) Repeat part (a) for the analogous reaction between elemental sulfur and $KClO_3$. {4}

Some answers (courtesy of Adam Murai, '15)

5. a) +VI, +V, +V, +IV, +IV, +VI, +III, +V, +II, +IV, +III, +V.
   b) -II, -I, +II, +VI, -II.
6. a) -I, 0, +I, +III, +V, +VII.
   b) +VI, +VII
7. +IX
9. in NH_3, N is -III; in NH_2Cl, N is -II; in NaOCl, Cl is +1; in NH_2Cl, Cl is 0

—fin—