AP Exam Review 2020 Practice Exam #1

Question 1 should take 15 minutes to complete. Question 2 should take 25 minutes for you to complete.

Question 1

$$M\ (s) + Cl_2\ (g) \text{---> } MCl_2\ (s)$$

The reaction of a metal with chlorine gas proceeds as indicated above.

(a) List the types of bonds that must break and those that must form for the reaction above.

(b) Do you agree with this statement below? Explain.

The formation of bonds in the above reaction uses up more energy than the breaking of bonds releases so the reaction is endothermic.

(c) How would the following factor affect the lattice energy of MCl_2?

* A large radius versus a small radius for M^{2+}

(d) How would a high ionization energy versus a low ionization energy for M change $\Delta H_{reaction}$?

Question 2

In a laboratory determination of the empirical formula of tin oxide, Sn_xO_y, a sample of tin is weighed in a crucible. Nitric acid is added and then the mixture is heated, and the reaction proceeds to give Sn_xO_y, NO_2 and H_2O. The unbalanced reaction equation is shown below. The products are further heated in the crucible to obtain the dried tin oxide.

$$Sn\ (s) + HNO_3\ (aq) \rightarrow Sn_xO_y\ (s) + H_2O\ (g) + NO_2\ (g)$$

The following data is collected:

Mass crucible (g)	11.25
Mass Sn and crucible (g)	12.25
Mass of dried Sn_xO_y and crucible (g)	12.52

(a) Determine the mass of Sn and mass of dried Sn_xO_y.

(b) Determine the empirical formula of Sn_xO_y.

(c) Explain the effect on the calculated empirical formula that would result from each of the following experimental errors:

(i) The reaction mixture bubbles over the crucible upon reaction of the HNO_3 (aq) with the Sn (s).

(ii) The tin oxide product is not heated sufficiently to dry it completely.

(d) Is the reaction below an oxidation-reduction reaction? Justify your answer.

$$Sn\ (s) + HNO_3\ (aq) \rightarrow Sn_xO_y\ (s) + H_2O\ (g) + NO_2\ (g)$$

(e) $Sn_xO_y(s)$ has a high melting point when compared to H_2O (s) Explain such an observation using the strength of the particle forces present in the compounds.

(a) Break: Cl-Cl covalent

Form: M^{2+} ... Cl^- ionic
:
Cl^-

(b) No! Bond formation releases energy and bond breaking uses energy. We don't know the magnitude of those values so no determination of ΔH_{rx} can be made.

(c) If M^{2+} is smaller then the lattice energy for MCl_2 will be higher according to Coulombs law because the ions (M^{2+} and Cl^-) would get closer.

(d) If it takes more energy to ionize M, then the overall ΔH_{rx} would be smaller, since this energy has been "used" and will be subtracted from the energy released as product bonds form.

118.7 g Sn
150.79 SnO_2

(e) 12.25 g crucible + Sn
− 11.25 g crucible
1.00 g Sn

12.52 g Sn_xO_y + crucible
− 11.25 g crucible
1.27 g Sn_xO_y

(f) $1.00\ g\ Sn \times \frac{1\ mol\ Sn}{118.7\ g\ Sn} = 0.00842\ mol\ Sn$

1.27 g Sn_xO_y
− 1.00 g Sn
0.27 g O

$0.27\ g\ O \times \frac{1\ mol\ O}{16.00\ g\ O} = 0.0169\ mol\ O$

$\frac{0.00842\ mol\ Sn}{0.00842\ mol\ Sn}$ $\frac{0.0169\ mol\ O}{0.00842\ mol\ Sn}$

SnO_2

(g) If some of the reaction product is lost by "bubbling over" the crucible,

(i) then the final mass of product will be less than it should be. This decreases the mass of Sn_xO_y and subsequently the mass of O in the compound, resulting in a ratio of O to Sn that is less than the 2 : 1 ratio determined from the data.

(ii) If the Sn_xO_y is not heated enough to dry it, the product mass will appear greater than it should, making the O mass then appear greater. This would make the O to Sn ratio greater than the 2 : 1 ratio determined from the data.

h. Yes, $Sn^0 \rightarrow Sn^{+?}$ (oxidation)
So the oxidation # of Sn changes, making this redox.

Also, in $\overset{+1}{H}\overset{+5}{N}\overset{-6}{O_3} \rightarrow \overset{+4}{N}O_2$ (reduction)

(j) Sn_xO_y (s) is ionic, so ions with "large" charges are separated during melting, requiring a lot of energy since these bonds are strong. More energy = higher m.p.

In H_2O, hydrogen bonds between H_2O molecules are broken during melting. These are relatively weak compared to ionic bonds so less energy is required to break these, meaning the mp is lower.