1. In Haber synthesis of NH_3 ($N_2 + 3H_2 \rightleftharpoons 2NH_3$), which of the following statements are true? 10 points

(a) The reaction is exothermic.

(b) Decreasing temperature shifts the reaction to the right, meaning the reaction is more complete.

(c) Increasing temperature shifts the reaction to the right, meaning the reaction is more complete.

(d) In industrial process the temperature is raised to 500°C, which is not thermodynamically favorable.

(e) In industrial process a few percent of oxides of K or Al is added to increase the reaction rate by lowering the activation energy.

(f) K or Al oxides are called catalyst, which are consumed with N_2 or H_2 in the reaction.

2. Compare the relative stability of the following species and indicate their magnetic properties (that is, diamagnetic or paramagnetic): O_2, O_2^+, O_2^-, O_2^{2-} 10 points

3. What are the hybrid orbitals of the carbon atoms in the following molecules?

(a) $H_3C\text{-}CH_3$ 10 points

(b) $H_3C\text{-}CH{=}CH_2$

(c) $CH_3\text{-}C{\equiv}C\text{-}CH_2OH$

(d) $CH_3CH{=}O$

(e) $H_2C{=}C{=}CH_2$

4. The rate constant of a first-order reaction is $3.46 \times 10^{-2}\ s^{-1}$ at 298K. What is the rate constant at 350K if the activation energy for the reaction is 50.2kJ/mol? 10pts

5. From the enthalpy of formation for CO_2 and the following information, calculate the standard enthalpy of formation for carbon monoxide (CO). 10 points

$CO_{(g)} + 1/2O_{2(g)} \rightarrow CO_{2(g)}$ $\Delta H° = -283.0kJ$

Why can't we obtain it directly by measuring the enthalpy of the following reaction? $C(graphite) + 1/2O_2 \rightarrow CO_{(g)}$

6. For the reaction $H_{2(g)} + S_{(a)} \rightarrow H_2S_{(g)}$ $\Delta H° = -20.2kJ$ and $\Delta S° = +43.1Jk\text{-}1$. Which of the following statements is true? 10 points

(a) The reaction is only spontaneous at low temperature.

(b) The reaction is spontaneous at all temperatures.

參考用

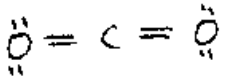
注意：背面有試題

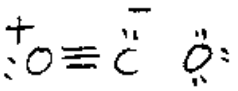
(c) ΔG° becomes less favorable as T is raised.

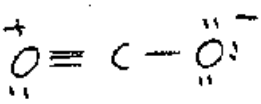
(d) The reaction is spontaneous only at high temperatures.

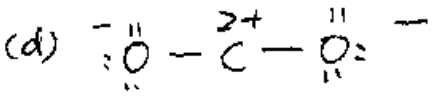
(e) The reaction is at equilibrium at 25°C under standard conditions.

7. Several resonance structures for the molecule CO_2 are shown below. Explain why some of them are likely to be of little importance in describing the bonding in this molecule. 10 points

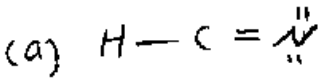
(a) 

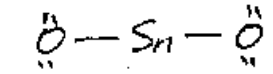
(c) 

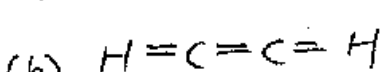
(b) 

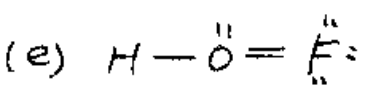
(d) 

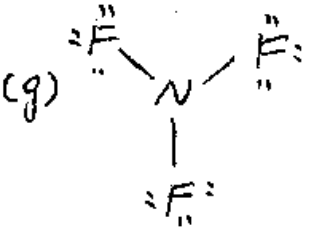
8. The following Lewis structures are incorrect. Explain what is wrong with each one and give a correct Lewis structure for the molecule. (Relative position of atoms are shown correctly). 10 points

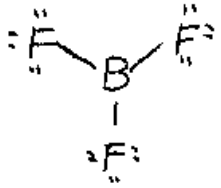
(a) 

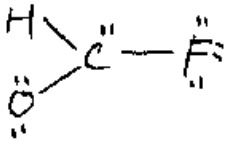
(d) 

(b) 

(e) 

(g) 

(c) 

(f) 

9. Which of the following statements regarding intermolecular forces for CBr_4, CCl_4, and CH_4 molecules are true? 10 points

(a) CH_4 has a higher melting point than CCl_4, and CCl_4 has a higher melting point than CBr_4?

(b) These three types of molecules are non-polar.

(c) The type of intermolecular force for these three compounds is called polar-induced polar.

(d) The dispersion force for CBr_4 is larger than CCl_4, and CCl_4 is larger than CH_4.

(e) The geometry of these three molecules is square planar.

參考用

10. Calculate the standard enthalpy change of the reaction 10 points

$2Al(s) + Fe_2O_3(s) \rightarrow 2Fe(s) + Al_2O_3(s)$

given that

$2Al(s) + 3/2O_2(g) \rightarrow Al_2O_3(s)$ $\quad \Delta H^\circ rxn = -1601kJ$

$2Fe(s) + 3/2O_2(g) \rightarrow Fe_2O_3(s)$ $\quad \Delta H^\circ rxn = -821kJ$