LECTURE 17

1. The health risks of accidental exposure to a toxic heavy metal, such as lead, mercury, or cadmium, may be reduced through treatment with a chelating agent, which binds to the metal and forms a complex that can be eliminated from the body. Methylamine (CH_3NH_2) and ethyldiamine ($NH_2CH_2CH_2NH_2$) chelate cadmium as shown in the following reactions.

(1) $Cd^{2+} + 2CH_3NH_2 \rightarrow Cd(CH_3NH_2)_2^{2+}$ $\Delta H = -7.03$ kcal/mol, $\Delta S = -1.58$ cal/(molK)

(2) $Cd^{2+} + NH_2CH_2CH_2NH_2 \rightarrow Cd(NH_2CH_2CH_2NH_2)^{2+}$ $\Delta H = -7.02$ kcal/mol, $\Delta S = 3.15$ cal/(molK)

(a) Based on strictly thermodynamic analysis, and assuming a body temperature of 37°C and that ΔH and ΔS are independent of temperature, which would you administer to a patient exposed to cadmium? Explain.

(b) Over what temperature ranges are reaction (1) and reaction (2) spontaneous?

2. Consider the following compounds: (a) $Al_2O_3(s)$; (b) $H_2O_2(l)$; (c) NO(g). Using the table of thermodynamic data below:

(i) Determine which of the above compounds are **stable with respect to decomposition** into their elements under standard conditions at room temperature. Explain your answer.

(ii) Determine which of the above compounds become **more stable** and which become **less stable** with respect to their elements as the temperature is raised. Explain your answer.

Selected thermodynamic data at 25°C from Appendix 2A (Adapted from Atkins and Jones)

Substance	Mass (g/mol)	$\Delta H_f°$ (kJ/mol)	$\Delta G_f°$ (kJ/mol)	S° (J/Kmol)
Al(s)	26.98	0	0	28.33
$Al_2O_3(s)$	101.96	-1676	-1582	50.92
$AlCl_3(s)$	133.33	-704.2	-628.8	110.67
$Cl_2(g)$	70.9	0	0	223.07
Cl(g)	35.45	121.7	105.7	165.2
HCl(g)	36.46	-92.31	-95.3	29.12
$H_2(g)$	2.0158	0	0	130.7
$H_2O_2(l)$	34.02	-187.8	-120.35	109.6
$N_2(g)$	28.02	0	0	191.61
NO(g)	30.01	90.25	86.55	210.76
$O_2(g)$	32	0	0	205.14
$O_3(g)$	48	142.7	163.2	238.93

3. For (a) CH_3OCH_3; (b) CH_3COOH; (c) CH_3CHO; (d) CH_3CH_2OH.

(i) Which of the above can act as a hydrogen bond donor?

(ii) Which of the above can act as a hydrogen bond acceptor?

Hint: draw Lewis structures before answering this question.

5.111 Principles of Chemical Science
Fall 2014