Chemisty 534/Pretest 4.1

1. TRUE? Or FALSE?

   a) Good reducing agents have relatively low oxidation numbers.

   TRUE

   b) The oxidation number of Zr in $Zr(NO_3)_2$ is 2.

   TRUE (because it is attached to two NO_3^{-1} groups)

   c) The oxidation number of N in $(NH_4)_2Cr_2O_7$ is 3.

   FALSE, it is -3 because of NH_4^+

   d) The oxidation number for nitrogen in a molecule is always +5.

   FALSE

   e) $A + e \rightarrow A^{-1}$ is a reduction

   TRUE

   f) An atom in the reducing agent is always reduced.

   FALSE, it is oxidized

2. Given the unbalanced equation:

   $HNO_3 + H_2S \rightarrow NO + S + H_2O$

   a. Identify what is being oxidized and what is being reduced.

   N: reduced from 5 to 2

   S: oxidized from -2 to 0

   b. Identify the oxidizing agent and the reducing agent.

   HNO_3: oxidizing agent

   H_2S: reducing agent

   c. Write the two balanced half-reactions occurring in an ***acidic*** solution.

   $3H^{+1} + 3e + HNO_3 \rightarrow NO + 2H_2O$

   $H_2S \rightarrow S + 2e + 2H^{+1}$

   d. Balance the equation

(multiply 1st eqn by 2 and 2nd by 3)

$2\ HNO_3 + 3\ H_2S \rightarrow 2\ NO + 4\ H_2O + 3\ S$

3. Balance the following redox reaction occurring in a ***basic*** solution by means of the half reaction method.

$S^{-2} + NO_3^{-1} \rightarrow NO_2 + SO_2$

$4OH^{-1} + S^{-2} \rightarrow SO_2 + 6e + 2\ H_2O$

$NO_3^{-1} + 1e + H_2O \rightarrow NO_2 + 2\ OH^{-1}$

Sum:

$S^{-2} + 6\ NO_3^{-1} + 4\ H_2O \rightarrow SO_2 + 6\ NO_2 + 8\ OH^{-1}$

4. In the third world, people were inadvertently poisoned by wells created near natural deposits of arsenic. After continuously drinking water with up to 4 ppm (4 mg per litre; maximum recommended amount is 0.01 ppm) people's skin erupted in disfiguring, leprosy-like lesions. Years later, cancerous growths began to appear. The Indian government has issued chlorination tablets that will oxidize the arsenic from AsO_3^{-3} to AsO_4^{-3}, which forms an insoluble salt with Fe^{+3} found in water.
Source: Emsley, John. Nature's Building Blocks. Oxford Press. 2001

If the tablets contain ClO_3^{-1}, which of the following is the reducing agent: ClO_3^{-1} ? Or AsO_3^{-3} ?

Justify your choice.

AsO_3^{-3} is the reducing agent because As is oxidized from +3 to +5 as it loses electrons to the oxidizing agent, ClO_3^{-1}.

5. What is the periodic table's strongest oxidizing agent?

F, usually F_2 at room temperature

6. For each of the following consult a table and then:

   i. write the equations for the half-reactions:

   ii. determine the overall equation

   iii. predict whether the reaction will occur as written

a. $Cu + F_2 \rightarrow Cu^{+2} + F^{-1}$

$Cu \rightarrow Cu^{+2} + 2e$; E = -0.34

$F_2 + 2e \rightarrow 2F^{-1}$; E=2.87

$Cu + F_2 \rightarrow Cu^{+2} + 2F^{-1}$; E =+2.53, so the reaction is spontaneous (occurs on its own) as written in example.

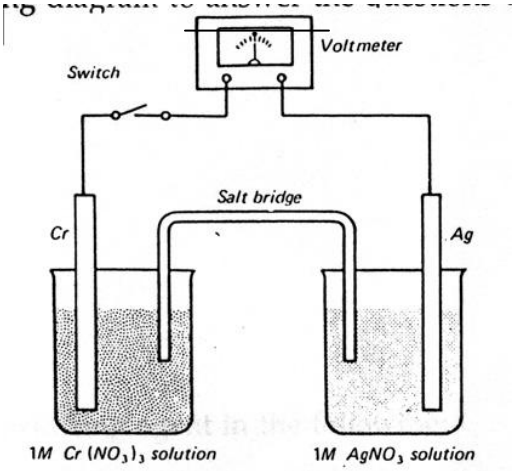
b. $Mg^{+2} + Sn \rightarrow Sn^{+2} + Mg$

$Mg^{+2} + 2e \dashrightarrow Mg$; E = -2.38 V

$Sn \dashrightarrow Sn^{+2} + 2e$; E = 0.14 V

$Mg^{+2} + Sn \dashrightarrow Sn^{+2} + Mg$; E = -2.24 V, so the reaction is not spontaneous as written.

7. Use the following diagram to answer the questions that follow:



a. When the switch is closed, electrons flow from the Cr to the Ag electrode. So, the anode is the Cr electrode.

b. Reduction occurs at the Ag electrode.

c. After the cell has been operating for some time, which electrode will show an increase in mass? Ag

d. What will happen to the voltage if the salt bridge is removed?

It goes to 0 V immediately.

e. Towards which electrode will cations migrate?

Cations always move towards the cathode.

f. What is there around the electrode that attracts cations? Why?

At the cathode: Ag^{+1} + 1e --> Ag, so Ag^{+1} ions are being depleted. This implies that negative ions (NO_3^{-1}, in this case) accumulate. It is these negative ions that attract the positive cations.

g. The other electrode attracts anions. Explain why.

At the other cathode, Cr is being oxidized to generate Cr^{+3}. As these accumulate they attract negative ions (anions).

h. What reaction occurs at the cathode?

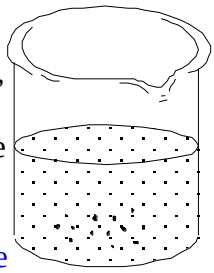
Ag^{+1} + 1e --> Ag

i. What is the oxidizing agent in this reaction?

Ag^{+1}

Flashbacks:

1. Observing a beaker containing a saturated iodine solution at equilibrium, a student notices that the solution maintains a constant color.
Knowing that iodine continues to be dissolved, briefly explain why the color no longer varies.



The iodine continues to crystallize (come out of solution) at the same rate that it dissolves.

2. Ammonia is produced in a 100-L container. When the system reaches equilibrium, 20 moles of hydrogen gas, 10 moles of nitrogen gas and 25 moles of ammonia are present.

The equation for this reaction is :

$$N_{2(g)} + 3\ H_{2(g)} \leftrightarrow 2\ NH_{3(g)} + \text{Energy}$$

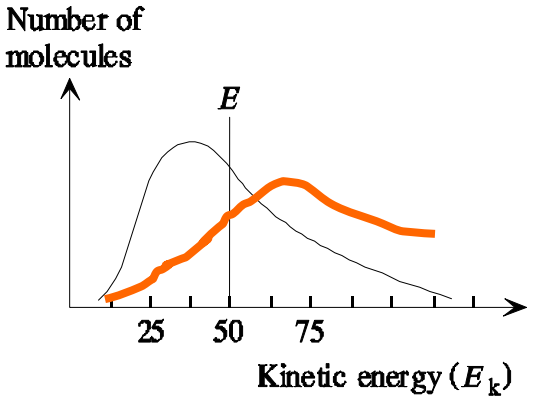
Calculate the equilibrium constant, K_e, for this reaction.

$K = [NH_{3(g)}]^2/([\ H_{2(g)}]^{\ 3}\ [\ N_{2(g)}]) = (25/100)^2/\{20/100)^3(10/100)\} = 78.1 = 8\ X10^2$

3

Given the system $A + B \rightarrow C + D$

The energy distribution graph for a given reaction is shown on the right.



Draw the distribution graph below showing the effect of an increase in temperature on the rate of this reaction? See orange curve.