This is BCE#29.

I recommend you print out this page and bring it to class. Click here to show a set of five BCE29 student responses randomly selected from all of the student responses thus far in a new window.

John , here are your responses to the BCE and the Expert's response.

1. Identify the composition of the metal electrode in the beaker on the left and the composition of the metal electrode in the beaker on the right.

zinc is the metal in the right-hand beaker 92% 8% hydrogen

The electrode is made of zinc (Zn).

platinum is the metal in the left-hand beaker

The electrode is made of platinum (Pt). 16% hydrogen electrode must be a metal, Cu, Zn, $H_2(g)$, HCl(g), H^+

2. Identify the ion(s) in the beaker on the right and the ion(s) in the beaker on the left.

Zn^2+(aq) and NO3^-(aq) are the ions in the right-hand beaker 30% Zn^{2+}, NO_3^- or SO_4^{2-} soluble

Zn^{2+} and NO_3^- ions are in the beaker. 50% Zn^{2+} only

H^+(aq) and Cl^-(aq) are the ions in the left-hand beaker

H^+ and Cl^- ions are in the beaker. 16% H^+, Cl^-

8% HCl 50 H^+ only

3a. Write the half-reaction that occurs in the beaker with zinc metal.

Zn(s) --> Zn^2+(aq) + 2e^- 83%

$Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$

b. Is this an oxidation half-reaction or a reduction half-reaction?

oxidation 83%

oxidation half-reaction

4a. Write the half-reaction that occurs in the beaker with the hydrogen electrode.

2H^+(aq) + 2e^- --> H2(g) 50%

$H_2 \to 2H^+ + 2e^-$

$2H^+(aq) + 2e^-$ ----> $H_2(g)$

$e^- + H_3O \to H_2O + H_2$

$H_3O^+ \to H_3O^+ + e^-$

b. Is this an oxidation half-reaction or a reduction half-reaction?

reduction 75%

reduction half-reaction

5a. The U-tube connecting the two compartments is called a salt bridge, describe the importance of the salt bridge.

ions to flows

the salt bridge allows ions to flow to balance the charge that builds up in the anode and cathode compartments

33% transfer e^-

The ions in the salt bridge flow towards either compartment to balance the charge.

b. Explain why the ions move the direction they move.

Cations flow towards the cathode because cations are being reduced at the cathode. Anions flow towards the anode because since is oxidized and cations are being produced at the anode.

The ions move in this direction to have a charge balance in both beakers. The cations move towards the left beaker because $H^+(aq)$ ions are being removed from the solution in that compartment. Everytime two $H^+(aq)$ ion are reduced to $H_2(g)$ cations from the salt bridge must flow in that direction to balance the charge. The anions move towards the right beaker because $Zn^{2+}(aq)$ ions are being added to the solution in that compartment. Everytime a $Zn^{2+}(aq)$ ion is produced from the oxidation of Zn(s), anions from the salt bridge must flow in that direction to balance the charge.

6. Describe the movement of the electrons in the electrochemical cell. Where do the electrons originate? Where is their 'final destination'? How do they get from their origin to their destination? 42%

33% salt bridge

electrons move in the wire from anode to cathode.

The electron originate at the right-hand electrode when a Zn atom is oxidized. Producing two electrons on the surface of the Zn electrode in the right-hand beaker, forces two electrons onto the surface of the platinum electrode in the left-hand beaker. Those two electrons are captured by two $H^+(aq)$ ions, in solution, near the surface of the electrode and a $H_2(g)$ molecule is formed. The electrons can only move through the wire attached to the electrodes. This path means the electron can do work. In this case they produce a display indicating the voltage different between the two electrodes.

7. Balance the following oxidation-reduction reaction. (Note use the steps for balancing redox reactions from page 2 of the activity titled Introduction to Oxidation - Reduction Answers)

$$Fe^{2+}{}_{(aq)} + MnO_4^-{}_{(aq)} \text{ --> } Fe^{3+}{}_{(aq)} + Mn^{2+}{}_{(aq)} \text{ (acidic solution)}$$

75%

5Fe^2+(aq) + 8H^+(aq) + MnO4^-(aq) --> 5Fe^3+(aq) + Mn^2+(aq) + 4H2O(l)

To balance this reaction the first step is to separate the overall reaction into two half reactions. The two half-reactions are,

$$Fe^{2+}(aq) \text{ ---> } Fe^{3+}(aq)$$

$$MnO_4^-{}_{(aq)} \text{ --> } Mn^{2+}{}_{(aq)}$$

Now we must be sure all nonhydrogen and nonoxygen elements are balanced. In both half-reactions those elements (Fe and Mn) are balanced. Next we do two steps, one after other. Balance oxygen by adding water, and then balance hydrogen by adding H^+. In the first half-reaction with iron there is no oxygen or hydrogen. However in the second half-reaction we must add four water (H_2O) molecules to the product side of the half-reaction and then eight hydrogen ions (H^+) to the right side of the half-reaction.

$$Fe^{2+}(aq) \text{ ---> } Fe^{3+}(aq)$$

$$8H^+(aq) + MnO_4^-{}_{(aq)} \text{ --> } Mn^{2+}{}_{(aq)} + 4H_2O_{(l)}$$

Both half-reactions are mass balanced now. Next, both half-reactions must be charge balanced. Balancing charge is accomplished by determining the charge on the reactant and product side of each half-reaction, and then adding electrons to side with the greater positive charge. So in the first half-reaction the products have one more positive charge compared to the reactants so one electron is added on the product side of the half-reaction. In the second half reaction the reactants have an excess of five positive charges, so five electrons are added to the reactant side of the half-reaction.

$$Fe^{2+}(aq) \text{ ---> } Fe^{3+}(aq) + e^-$$

$$5e^- + 8H^+(aq) + MnO_4^-{}_{(aq)} \text{ --> } Mn^{2+}{}_{(aq)} + 4H_2O_{(l)}$$

One both half-reactions are mass balanced and charge balanced the number of electrons transferred need to be balanced. With the first half-reaction producing one electron and the second half-reactions gains five electrons, to balance the electrons transferred we must multiply the first half-reaction by 5 and the second half-reaction by 1.

$$5 \cdot (Fe^{2+}(aq) \text{ ---> } Fe^{3+}(aq) + e^-)$$

$$1 \cdot (5e^- + 8H^+(aq) + MnO_4^-{}_{(aq)} \text{ --> } Mn^{2+}{}_{(aq)} + 4H_2O_{(l)})$$

Finally the electrons are cancelled in both half-reactions, and the two half-reactions are added together.

$$5Fe^{2+}(aq) + 8H^+(aq) + MnO_4^-{}_{(aq)} \text{ ---> } 5Fe^{3+}(aq) + Mn^{2+}{}_{(aq)} + 4H_2O_{(l)}$$

The final completed chemical equation must be reviewed to be sure species, typically H^+ and H_2O, are not common to both the reactants and the products. If that is the case eliminate the species on the side with the smallest amount and reduce the amount on the other side of the equation.

In this equation we have no changes to the amounts of H^+ or H_2O.

8. Is there anything about the questions that you feel you do not understand? List your concerns/questions.

nothing

9. If there is one question you would like to have answered in lecture, what would that question be?

nothing