Question 1 (15%): How do you balance a half-reaction if one side doesn't have hydrogen?

Question 2 (15%): How do you balance charge for a half reaction?

Question 3 (70%): Create your own steps on how to balance a redox reaction. You may use the steps that I used in the video to help you out with making your own steps. Here are the following items that must be included:

- Explain how to know if a compound can be separated into ions.
- Explain why the assigning of oxidation numbers is needed at the beginning of the steps.
- Why water is used to help balance oxygen.
- Explain why the oxidation and reduction half-reactions must have the same amount of electrons.
- Balance the following formula using your steps:

$$CuS(aq) + HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + NO(g) + S(s) + H_2O(l)$$
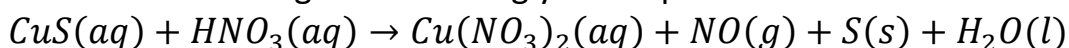
Solution:

Question 1:

It depends on the pH of solution. If pH is less 7 (acidic), than you should add water molecules. If pH is 7 (neutral), than you should add water or OH⁻. If pH is more 7 (basic), than you should add water or OH⁻.
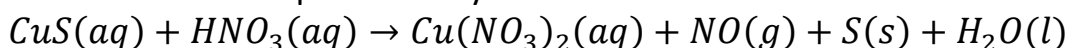
Question 2:

It could be achieved by adding or taking out electrons. Each electron has a charge equal to (-1). To determine the number of electrons required, find the net charge of each side the equation.
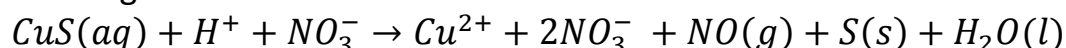
Question 3:

A compound can be separated into ions when it could be dissolved in water. Also you can use the table of solubility.

The assigning of oxidation numbers is needed at the beginning of the steps because it helps you to know which compound changes his charge, than to add necessarily number of electrons and balance the half-reaction.
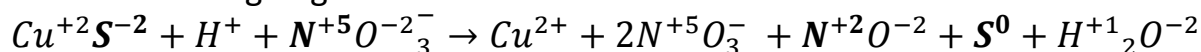
The oxidation and reduction half-reactions must have the same amount of electrons is required to equalize the number of electrons gained by reduction with the number of electrons produced by oxidation.
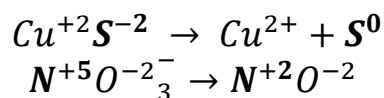
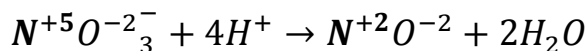$$CuS(aq) + HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + NO(g) + S(s) + H_2O(l)$$

1. Dissolving in water:

$$CuS(aq) + H^+ + NO_3^- \rightarrow Cu^{2+} + 2NO_3^- + NO(g) + S(s) + H_2O(l)$$

2. The assigning of oxidation numbers:

$$Cu^{+2}S^{-2} + H^+ + N^{+5}O^{-2}{}_3^- \rightarrow Cu^{2+} + 2N^{+5}O_3^- + N^{+2}O^{-2} + S^0 + H^{+1}{}_2O^{-2}$$

3. Dividing the equation into two halves:

$$Cu^{+2}S^{-2} \rightarrow Cu^{2+} + S^0$$
$$N^{+5}O^{-2}{}_3^- \rightarrow N^{+2}O^{-2}$$

4. Balancing oxygen atoms:

$$N^{+5}O^{-2}{}_3^- + 4H^+ \rightarrow N^{+2}O^{-2} + 2H_2O$$

5. Balancing charges:

$$Cu^{+2}S^{-2} \rightarrow Cu^{2+} + S^0 + 2\bar{e}$$
$$N^{+5}O^{-2}{}_3^- + 4H^+ + 3\bar{e} \rightarrow N^{+2}O^{-2} + 2H_2O$$
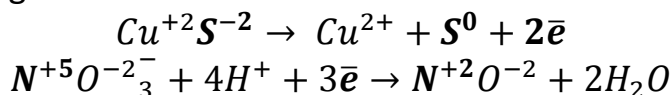
6. Multiplying each half-reaction:

$$Cu^{+2}S^{-2} - 2\bar{e} \rightarrow Cu^{2+} + S^0 + 2\bar{e}|\times 3$$
$$N^{+5}O^{-2}{}_3^- + 4H^+ + 3\bar{e} \rightarrow N^{+2}O^{-2} + 2H_2O \;|\times 2$$
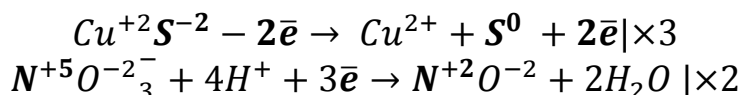
7. Adding the two half reaction:

$$3Cu^{+2}S^{-2} + 8H^+ + 2(N^{+5}O^{-2})_3^- + 6\bar{e}$$
$$\rightarrow 3Cu^{2+} + 2N^{+2}O^{-2} + 3S^0 + 4H^{+1}{}_2O^{-2} + 6\bar{e}$$

The whole equitation:

$$3CuS(aq) + 8HNO_3(aq) \rightarrow 3Cu(NO_3)_2(aq) + 2NO(g) + 3S(s) + 4H_2O(l)$$