Balancing

Balancing using Half-reactions

$$H_2S + HNO_3 \rightarrow H_2SO_4 + NO_2 + H_2O$$

Just by inspection who is the oxidizer and who is the reducer?

Separate ionic substances

$$H_2S + HNO_3 \rightarrow H_2SO_4 + NO_2 + H_2O$$

Sometimes reactions are given a full ions and sometime just as net ionic. Either way switch to net ionic. Anything that doesn't change gets removed.

$$H_2S + H^+ + NO_3^- \rightarrow 2H^+ + SO_4^{-2} + NO_2 + H_2O$$

They will be added back in at the end. Alternately the reaction could be given with out the water and H^+'s either.

$$H_2S + NO_3^- \rightarrow SO_4^{-2} + NO_2$$

Balancing using Half-reactions

$$H_2S + NO_3^- \rightarrow SO_4^{-2} + NO_2 + H_2O$$

The HNO_3 is going to be giving oxygen away. (oxidizer)

H_2S is going to be accepting oxygen. (Reducer)

Balancing using Half-reactions
Split into half reactions

$$H_2S + NO_3^- \rightarrow SO_4^{-2} + NO_2 + H_2O$$

$$NO_3^- \rightarrow NO_2$$

$$H_2S \rightarrow SO_4^{-2}$$

Balancing using Half-reactions
Use water to balance oxygen

$$H_2S + NO_3^- \rightarrow SO_4^{-2} + NO_2 + H_2O$$

$$NO_3^- \rightarrow NO_2 + H_2O$$

$$4H_2O + H_2S \rightarrow SO_4^{-2}$$

Balancing using Half-reactions
Use Hydronium ions to balance H

$$H_2S + NO_3^- \rightarrow H_2SO_4 + NO_2 + H_2O$$

$$2H^+ + NO_3^- \rightarrow NO_2 + H_2O$$

$$4H_2O + H_2S \rightarrow SO_4^{-2} + 10H^+$$

Balancing using Half-reactions Balance Charge

$$H_2S + NO_3^- \rightarrow H_2SO_4 + NO_2 + H_2O$$

$$1e^+ + 2H^+ + NO_3^- \rightarrow NO_2 + H_2O$$

$$4H_2O + H_2S \rightarrow SO_4^{-2} + 10H^+ + 8e^-$$

Balancing using Half-reactions
Balance half reaction electrons

$$H_2S + NO_3^- \rightarrow H_2SO_4 + NO_2 + H_2O$$

$$1e^+ + 2H^+ + NO_3^- \rightarrow NO_2 + H_2O \,(x8)$$

$$4H_2O + H_2S \rightarrow SO_4^{-2} + 10H^+ + 8e^-$$

$$8e^+ + 16H^+ + 8NO_3^- \rightarrow 8NO_2 + 8H_2O$$

$$4H_2O + H_2S \rightarrow SO_4^{-2} + 10H^+ + 8e^-$$

Balancing using Half-reactions Combine and simplify

$$H_2S + NO_3^- \rightarrow H_2SO_4 + NO_2 + H_2O$$

$$8e^+ + 16H^+ + 8NO_3^- \rightarrow 8NO_2 + 8H_2O$$

$$4H_2O + H_2S \rightarrow SO_4^{-2} + 10H^+ + 8e^-$$

$$8NO_3^- + H_2S + 6H^+ \rightarrow 8NO_2 + 4H_2O + SO_4^{-2}$$

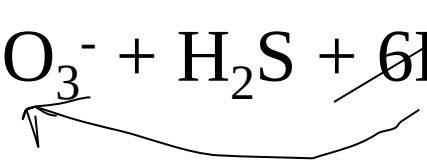
Balancing using Half-reactions Combine ions to form compounds in original formula

$$8NO_3^- + H_2S + 6H^+ \rightarrow 8NO_2 + 4H_2O + SO_4^{-2}$$

Recombine the originals ionic cations and anions

$$NO_3^- \rightarrow HNO_3$$

$$8NO_3^- + H_2S + 6H^+ \rightarrow 8NO_2 + 4H_2O + SO_4^{-2}$$



+2H+ +2H+

$$8HNO_3 + H_2S \rightarrow 8NO_2 + 4H_2O + H_2SO_4$$

Practice

- $C_{10}H_{12}O_4S + ??O_2 \rightarrow CO_2 + SO_2 + H_2O$
- What is the coefficient for Oxygen?

A. 6

B. 7

C. 12

D. 14

E. 28

Practice

- $C_{10}H_{12}O_4S + 12O_2 \rightarrow 10CO_2 + SO_2 + 6H_2O$
- What is the coefficient for Oxygen?
- Trying to figure this out by standard means would take forever.
- If it looks confusing start with inspection first.
- 12 is the answer.

Practice 2

- Which of the following is true regarding.

$H_2Se + 4O_2F_2 \rightarrow SeF_6 + 2HF + 4O_2$

A. The oxidation number of O does not change.

B. The oxidation number of H changes from -1 to + 1

C. The oxidation number of F changes from +1 to -1

D. The oxidation number of Se changes from -2 to +6

E. It is a disproportionation reaction for F.

+2 -4 +4 -6

+1-2 -2 +2 +6-1 +1-1 0

$H_2Se + 4O_2F_2 \rightarrow SeF_6 + 2HF + 4O_2$

The oxidation number of Se changes from -2 to +6

Balancing using oxidation states

$$H_2S + HNO_3 \rightarrow H_2SO_4 + NO_2 + H_2O$$

Start with net ionic equation

Separate ionic substances

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Sometimes reactions are given a full ions and sometime just as net ionic. Either way switch to net ionic. Anything that doesn't change gets removed.

$$H_2S + H^+ + NO_3^- \rightarrow 2H^+ + SO_4^{-2} + NO_2 + H_2O$$

They will be added back in at the end. Alternately the reaction could be given with out the water and H^+'s either.

$$H_2S + NO_3^- \rightarrow SO_4^{-2} + NO_2$$

Balancing using oxidation states

Assign oxidation states

+1 -2 +5 -2 +6 -2 +4 -2 +1 -2

$H_2S + NO_3^- \rightarrow SO_4^{-2} + NO_2 + H_2O$

Split into half reactions

$$\overset{+1\ -2}{H_2S} + \overset{+5\ -2}{NO_3^-} \rightarrow \overset{+6\ -2}{SO_4^{-2}} + \overset{+4\ -2}{NO_2} + \overset{+1\ -2}{H_2O}$$

$$H_2S + NO_3^- \rightarrow SO_4^{-2} + NO_2 + H_2O$$

$$NO_3^- \rightarrow NO_2$$

$$H_2S \rightarrow SO_4^{-2}$$

Split into half reactions add electrons

+1 -2 +5 -2 +6 -2 +4 -2 +1 -2

$H_2S + NO_3^- \rightarrow SO_4^{-2} + NO_2 + H_2O$

+5 +4

$+ 1e^- + NO_3^- \rightarrow NO_2$

-2 +6

$H_2S \rightarrow SO_4^{-2} + 8e^-$

Split into half reactions
Balance half reaction electrons

$$\overset{+1\ -2}{H_2S} + \overset{+5\ -2}{NO_3^-} \rightarrow \overset{+6\ -2}{SO_4^{-2}} + \overset{+4\ -2}{NO_2} + \overset{+1\ -2}{H_2O}$$

$$+ 1e^- + NO_3^- \rightarrow NO_2 \ ) \times 8$$

$$H_2S \rightarrow SO_4^{-2} + 8e^-$$

$$+ 8\ e^- + 8NO_3^- \rightarrow 8NO_2$$

$$H_2S \rightarrow SO_4^{-2} + 8e^-$$

Split into half reactions
Re-combine ionic compounds and balance by inspection

$+ 8\ e^- + 8NO_3^- \rightarrow 8NO_2$

$H_2S \rightarrow SO_4^{-2} + 8e^-$

$H_2S + 8NO_3^- \rightarrow 8NO_2 + SO_4^{-2} + H_2O$

$H_2S + 8HNO_3 \rightarrow 8NO_2 + H_2SO_4 + 4H_2O$