Balancing Chemical Equations

Balance the chemical reaction:

$$\_\ MnCl_2 + \_\ NaClO + \_\ NaOH \rightarrow \_\ NaMnO_4 + \_\ NaCl + \_\ H_2O$$

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Solution:

Step 1. Apply coefficients to reactants and products

a $MnCl_2$ + b NaClO + c NaOH → x $NaMnO_4$ + y NaCl+ z H_2O

Step 2. Write the atom equations:

Mn: a = x

Cl: 2a + b = y

Na: b + c = x + y

O: b + c = 4x + z

H: c = 2z

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H: c = 2z Let c = 6, then z = 3

In this case we see that the coefficients c and z do not uniquely specify the remaining coefficients. This means that there are two independent net reactions.

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a $MnCl_2$ + b NaClO + c NaOH → x $NaMnO_4$ + y NaCl+ z H_2O

Step 2. Write the atom equations:

Mn: a = x Let x = 2,

Cl: 2a + b = y

Na: b + c = x + y then y = 9 (from Na equation)

O: b + 6 = 4x + 3, then b = 5 (from O equation)

H: c = 2z Let c = 6, then z = 3

In this case we see that the coefficients c and z do not uniquely specify the remaining coefficients. This means that there are two independent net reactions.

2 $MnCl_2$ + 5 NaClO + 6 NaOH → 2 $NaMnO_4$ + 9 NaCl+ 3 H_2O

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a $MnCl_2$ + b NaClO + c NaOH → x $NaMnO_4$ + y NaCl+ z H_2O

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However, this is a consistent and balanced reaction:

2 $MnCl_2$ + 5 NaClO + 6 NaOH → 2 $NaMnO_4$ + 9 NaCl+ 3 H_2O

Although it is not unique.

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a $MnCl_2$ + b NaClO + c NaOH → x $NaMnO_4$ + y NaCl+ z H_2O

Step 2. Write the atom equations:

Mn: a = x Let x = 3,

Cl: 2a + b = y

Na: b + c = x + y then y = 15 (from Na equation)

O: b + 6 = 4x + 3, then b = 9 (from O equation)

H: c = 2z Let c = 6, then z = 3

We se that we have another solution that is equally valid.

3 $MnCl_2$ + 9 NaClO + 6 NaOH → 3 $NaMnO_4$ + 15 NaCl+ 3 H_2O