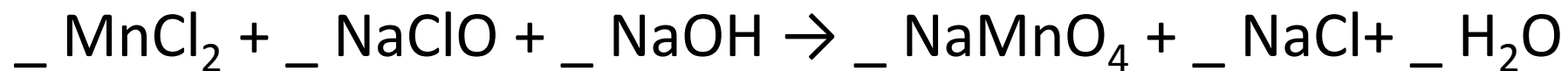


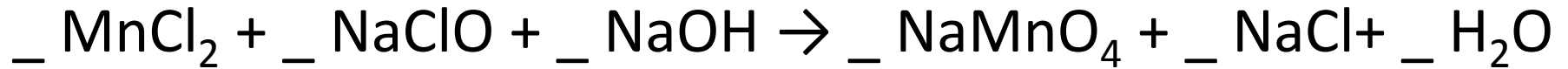
Balancing Chemical Equations

Balance the chemical reaction:



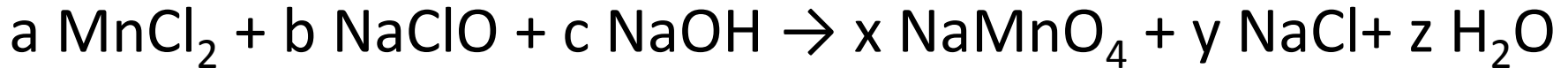
Balancing Chemical Equations

Balance the chemical reaction:



Solution:

Step 1. Apply coefficients to reactants and products



Step 2. Write the atom equations:

$$\text{Mn: } a = x$$

$$\text{Cl: } 2a + b = y$$

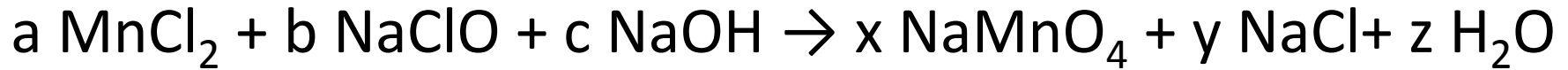
$$\text{Na: } b + c = x + y$$

$$\text{O: } b + c = 4x + z$$

$$\text{H: } c = 2z$$

Balancing Chemical Equations

Step 1. Apply coefficients to reactants and products



Step 2. Write the atom equations:

$$\text{Mn: } a = x$$

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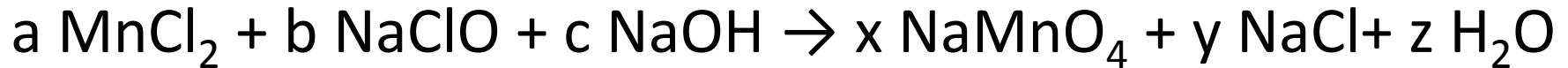
$$\text{O: } b + c = 4x + z$$

$$\text{H: } c = 2z \quad \text{Let } c = 6, \text{ then } z = 3$$

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.

Balancing Chemical Equations

Step 1. Apply coefficients to reactants and products



Step 2. Write the atom equations:

$$\text{Mn: } a = x \quad \text{Let } x = 2,$$

$$\text{Cl: } 2a + b = y$$

$$\text{Na: } b + c = x + y \quad \text{then } y = 9 \quad (\text{from Na equation})$$

$$\text{O: } b + 6 = 4x + 3, \quad \text{then } b = 5 \quad (\text{from O equation})$$

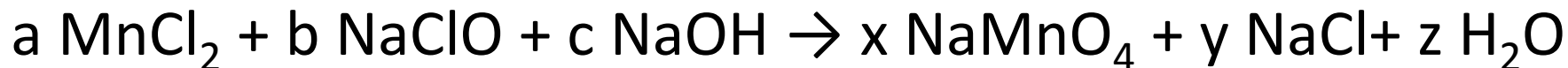
$$\text{H: } c = 2z \quad \text{Let } c = 6, \quad \text{then } z = 3$$

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.



Balancing Chemical Equations

Step 1. Apply coefficients to reactants and products



Step 2. Write the atom equations:

$$\text{Mn: } a = x \quad \text{Let } x = 2,$$

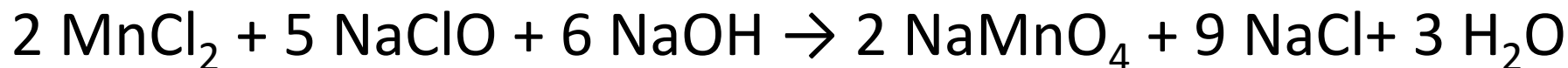
$$\text{Cl: } 2a + b = y$$

$$\text{Na: } b + c = x + y \quad \text{then } y = 9 \quad (\text{from Na equation})$$

$$\text{O: } b + 6 = 4x + 3, \quad \text{then } b = 5 \quad (\text{from O equation})$$

$$\text{H: } c = 2z \quad \text{Let } c = 6, \quad \text{then } z = 3$$

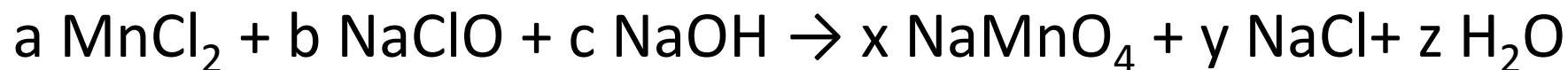
However, this is a consistent and balanced reaction:



Although it is not unique.

Balancing Chemical Equations

Step 1. Apply coefficients to reactants and products



Step 2. Write the atom equations:

$$\text{Mn: } a = x \quad \text{Let } x = 3,$$

$$\text{Cl: } 2a + b = y$$

$$\text{Na: } b + c = x + y \quad \text{then } y = 15 \quad (\text{from Na equation})$$

$$\text{O: } b + 6 = 4x + 3, \quad \text{then } b = 9 \quad (\text{from O equation})$$

$$\text{H: } c = 2z \quad \text{Let } c = 6, \quad \text{then } z = 3$$

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

