**Tips for Balancing Difficult Chemical Equations**

**Balancing Chemical Equation Demonstrated** : Balance the chemical equation below.

**Al(OH)3(aq) + Li2CO3(aq) ——> LiOH(aq) + Al2(CO3)3(s)**

How do we start to balance a chemical equation?

Answer: Same as before, first we write down the chemical equations on our paper and then we draw a line down the yield sign to separate the two halves of a chemical equation.

|  |  |
| --- | --- |
| Al(OH)3(aq) + Li2CO3(aq) — | —> LiOH(aq) + Al2(CO3)3(s) |
| Al = 1 | Al = 2 |
| OH = 3 | OH = 1 |
| Li = 2 | Li = 1 |
| CO3 = 1 | CO3 = 3 |

Then we count up all the elements on each side of the equation and assume that all the coefficients are 1. However, in this case we have polyatimic ions. If the polyatomic ions appear the same on both sides of the chemical equations, we can count the polyatomic ions as one whole instead of individual elements. This makes counting much simpler.

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| --- | --- |
| Al(OH)3(aq) + Li2CO3(aq) — | —> LiOH(aq) + Al2(CO3)3(s) |
| Al = 1 | Al = 2 |
| OH = 3 | OH = 1 |
| Li = 2 | Li = 1 |
| CO3 = 1 | CO3 = 3 |

Now start balancing the equation by adding coefficients. I will start with the Aluminum on the left side.

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| --- | --- |
| 2 Al(OH)3(aq) + Li2CO3(aq) — | —> LiOH(aq) + Al2(CO3)3(s) |
| Al = 2 | Al = 2 |
| OH = 6 | OH = 1 |
| Li = 2 | Li = 1 |
| CO3 = 1 | CO3 = 3 |

Next I try the CO3 on the left side.

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| --- | --- |
| 2 Al(OH)3(aq) + 3 Li2CO3(aq) — | —> LiOH(aq) + Al2(CO3)3(s) |
| Al = 2 | Al = 2 |
| OH =6 | OH = 1 |
| Li = 6 | Li = 1 |
| CO3 = 3 | CO3 = 3 |

Then I Li and OH on the right side.

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| --- | --- |
| 2 Al(OH)3(aq) + 3 Li2CO3(aq) — | —> 6 LiOH(aq) + Al2(CO3)3(s) |
| Al = 2 | Al = 2 |
| OH =6 | OH = 6 |
| Li = 6 | Li = 6 |
| CO3 = 3 | CO3 = 3 |

All the elements and polyatomic ions are the same on both sides so I am done.

COMPLETE ANSWER: 2 Al(OH)3(aq) + 3 Li2CO3(aq) ——> 6 LiOH(aq) + Al2(CO3)3(s)

**Balancing Chemical Equation Demonstrated**: Balance the chemical equation below.

**C5H7OH(l) + O2(g) ——> CO2(g) + H2O(g)**

How do we start to balance a chemical equation?

Answer: Same as before, first we write down the chemical equations on our paper and then we draw a line down the yield sign to separate the two halves of a chemical equation.

|  |  |
| --- | --- |
| C5H7OH(l) + O2(g) — | —> CO2(g) + H2O(g) |
| C = 5 | C = 1 |
| H = 8 | H = 2 |
| O = 3 | O = 3 |

Then we count up all the elements on each side of the equation and assume that all the coefficients are 1.

|  |  |
| --- | --- |
| C5H7OH(l) + O2(g) — | —> CO2(g) + H2O(g) |
| C = 5 | C = 1 |
| H = 8 | H = 2 |
| O = 3 | O = 3 |

Start to try to balance them with coefficients we are going to start with 5 in front of the CO2 on the right side. It is best to balance the carbons and hydrogen first in these kinds of reactions.

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| C5H7OH(l) + O2(g) — | —> 5 CO2(g) + H2O(g) |
| C = 5 | C = 5 |
| H = 8 | H = 2 |
| O = 3 | O = 11 |

Then I would change the hydrogen on the right by putting a 4 in front of H2O.

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| --- | --- |
| C5H7OH(l) + O2(g) — | —> 5 CO2(g) + 4 H2O(g) |
| C = 5 | C = 5 |
| H = 8 | H = 8 |
| O = 3 | O = 14 |

Now we run into a problem. The oxygens are an even number on the right side and an odd number on the left side. To simplify my problem all we have to do is make the oxygens an even number on the left side (reactants). How do I do that? Change the coefficient of C5H7OH to 2.

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| --- | --- |
| 2 C5H7OH(l) + O2(g) — | —> 5 CO2(g) + 4 H2O(g) |
| C = 10 | C = 5 |
| H = 16 | H = 8 |
| O = 4 | O = 14 |

This unbalances my right side again so I go back to that side and fix it. Change coefficient in front of CO2 to 10.

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| --- | --- |
| 2 C5H7OH(l) + O2(g) — | —> 10 CO2(g) + 4 H2O(g) |
| C = 10 | C = 10 |
| H = 16 | H = 8 |
| O = 4 | O = 24 |

Lets fix the hydrogen on the right by changing the coefficient of the H2O to 8.

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| --- | --- |
| 2 C5H7OH(l) + O2(g) — | —> 10 CO2(g) + 8 H2O(g) |
| C = 10 | C = 10 |
| H = 16 | H = 16 |
| O = 4 | O = 28 |

Now we have to make the oxygen on the left side match the right. Remember that 2 oxygen are already contained in the first compound on the right side. So we can find out what the coefficient of O2 by the oxygen on the right minus 2 divided by 2 = 28 – 2 / 2 = 13

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| --- | --- |
| 2 C5H7OH(l) + 13 O2(g) — | —> 10 CO2(g) + 8 H2O(g) |
| C = 10 | C = 10 |
| H = 16 | H = 16 |
| O = 28 | O = 28 |

All the elements are the same on both sides so I am done.

COMPLETE ANSWER: 2 C5H7OH(l) + 13 O2(g) ——> 10 CO2(g) + 8 H2O(g)

**PRACTICE PROBLEMS**: Balance the chemical equations below.

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| Na3PO4(aq) + CaCl2(aq) ——> Ca3(PO4)2(s) + NaCl(aq) |
| Answer: 2 Na3PO4(aq) + 3 CaCl2(aq) ——> Ca3(PO4)2(s) + 6 NaCl(aq) |
| K2(SO3)(aq) + Mg3(PO4)2(s) ——> MgSO3(aq) + K3PO4(aq) |
| Answer: 3 K2(SO3)(aq) + Mg3(PO4)2(s) ——> 3 MgSO3(aq) + 2 K3PO4(aq) |
| C2H6(l) + O2(g) ——> CO2(g) + H2O(g) |
| Answer: 2 C2H6(l) + 7 O2(g) ——> 4 CO2(g) + 6 H2O(g) |
| C6H11OH(l) + O2(g) ——> CO2(g) + H2O(g) |
| Answer: 2 C6H11OH(l) + 17 O2(g) ——> 12 CO2(g) + 12 H2O(g) |