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Course: FVS Chemistry AB 19.3

Teacher: Kerr

Question: While observing a chemical reaction, how can you tell which reactant is limiting?

Claim: If a substance is the limiting reactant, then it will be fully consumed by the time the reaction completes because it is the reactant that reacts completely and the reaction cannot proceed further.

Evidence:

Trial 1

	$3CuCl_2(aq) + 2Al(s) \rightarrow 3Cu(s) + 2AlCl_3(aq)$			
Measured Mass (g)	2.50	0.50	N/A	N/A
Molar Mass (g/mol)	134.45	26.98	N/A	N/A
Actual Moles (mol)	0.019	0.019	N/A	N/A

The limiting reactant is copper chloride because there was still aluminum left over after the reaction stopped. The reaction has a molar ratio of $CuCl_2 : Al = 3 : 2$, which is confirmed by this trial (copper chloride is limiting because $CuCl_2 : Al$ ratio $= 1 : 1 < 3 : 2$)

Trial 2

	$3CuCl_2(aq) + 2Al(s) \rightarrow 3Cu(s) + 2AlCl_3(aq)$			
Measured Mass (g)	2.50	0.25	Filter paper alone: 0.27g Filter Paper + Cu: 0.98g Cu alone: 0.71g	N/A
Molar Mass (g/mol)	134.45	26.98	63.55	N/A
Actual Moles (mol)	0.019	0.0093	0.011g Cu	N/A

The limiting reactant is aluminum because all of the aluminum dissolved, and the molar ratio of $CuCl_2$ to $Al > 3 : 2$.

This evidence shows that the claim is true because where copper chloride should be the limiting reactant theoretically, it completely reacted and the aluminum was left over. Similarly, trial 2 (limiting reactant should theoretically be aluminum because of the ratio) saw that the aluminum fully dissolved. When comparing the two trials, it can be clearly seen that the "removal" of aluminum caused the substance which didn't allow the reaction to be completed to change.

Justification (Reasoning) of the Evidence:

This result makes sense because the limiting reactant would allow the reaction to continue if more were added, by definition. This can lead us to conclude that no more of the limiting reactant is available at the end of the reaction because then adding more of the limiting reactant could not possibly allow the reaction to continue. The reactant being unavailable at the end of the reaction is equivalent to the limiting reactant being fully consumed by reacting completely in all of its particles.