Chem1311Ch3Ep5Transcript

00:00:02

Hello, and welcome to episode 5 of mass relationships in chemical reactions.

00:00:11

Previously, in mass relationships in chemical reactions.

00:00:16

We learned how to balance equations.

00:00:20

And well, isn't that enough accomplishment for one episode?

00:00:27

In today's episode.

00:00:30

We will apply.

00:00:31

The equation-based method to reactions stoichiometry calculations.

00:00:37

We will solve limiting reactant problems.

00:00:42

And we will calculate percent yield.

00:00:46

And we most certainly will not do this.

00:00:56

The most commonly used, and traditional method to carry out reaction stoichiometry.

00:01:02

Follows this diagram with three separate steps.

00:01:07

THREE SEPARATE STEPS.

00:01:11

It of course requires a balanced equation, just like the equation-based method.

00:01:20

These three separate steps, however, are just additional chances to make a mistake, and are really only needed if we accept the false premise that it is not possible to go directly from mass of A to mass of B.

00:01:41

But that's a lie.

00:01:43

[Love the way you Lie by Rihanna}

00:01:59

So how do we learn this awesome method of solving stoichiometry problems?

00:02:05

That's the best part.

00:02:07

You have already used the variation of it to solve compositions stoichiometry problems.

00:02:14

Let's now try it on a typical reaction stoichiometry problem.

00:02:24

You have an ask, “what mass of carbon dioxide?”

00:02:29

For this we will need a molar mass.

00:02:34

The given quantity is grams of glucose.

00:02:40

Let's look for those two substances in the balanced equation.

00:02:47

For the ask, we find the mass of 6 moles of carbon dioxide.

00:02:56

And for the given quantity, we get the mass of 1 mole of glucose.

00:03:02

Notice that the ask still goes on top.

00:03:08

Now that we have a relation between the two.

00:03:13

We place the given quantity in the 1st frame.

00:03:19

And our conversion factor in the 2nd frame.

00:03:25

Making sure that the units grams of glucose cancel.

00:03:34

And the answer to three significant digits is 1250 grams of carbon dioxide.

00:03:42

Don't forget to mind the significant digits.

00:03:51

The traditional method your textbook uses requires 3 separate steps to arrive to exactly.

00:03:57

The same answer.

00:04:00

However, I've already told you how I feel about traditions.

00:04:05

And well.

00:04:08

Let's move on from this.

00:04:14

One thing that is not stressed enough though, is to check if your answer is reasonable by ballparking.

00:04:22

This is possible.

00:04:23

If you have only the one step with some quick mental math.

00:04:32

Of course, just by looking, we can tell that the answer should be larger than the given.

00:04:38

But by how much?

00:04:42

This is where rounding and factoring come in.

00:04:48

Now we can tell that the mass of the CO_2.

00:04:52

Should be about 1 1/2 times the mass of the glucose.

00:04:57

Which it is.

00:05:00

If you hate to do mental math, which is a hobby of mine by the way, then just enter your numbers twice in your calculator just to be sure you haven't mistyped anything.

00:05:13

You definitely don't want to lose points just simply because you mistyped when you enter them in your calculator.

00:05:25

Here's the next example.

00:05:30

The ask is grams of lithium.

00:05:33

Which we can find in the balanced equation.

00:05:38

The given quantity has grams of hydrogen as the unit.

00:05:45

So we also find it in the balanced equation.

00:05:51

To solve, we place the given quantity in the 1st frame.

00:05:58

And we place our conversion factor in the 2nd frame.

00:06:05

To get an answer of 68.1 grams of lithium to three significant digits.

00:06:12

And about 7 times what our ask was, just as we expected.

00:06:23

Of course, you are probably thinking that more examples would be great.

00:06:30

And I will give you some more.

00:06:32

After all, I'm not a monster.

00:06:38

In this example, the ask is mass of sodium bromide.

00:06:48

Which we will have to find in the balanced equation.

00:06:52

There it is.

00:06:56

And the given quantity has units of grams of silver bromide.

00:07:02

Which we also find in the balanced equation.

00:07:07

Next, we whip out our periodic table to find out both masses.

00:07:16

And ballparking, we notice that we will have a smidge over half.

00:07:22

As our final answer, half of the given quantity.

00:07:28

To solve, we place the given quantity in the 1st frame.

00:07:34

And our conversion factor in the 2nd frame.

00:07:41

This cancels the grams of silver bromide.

00:07:45

And if we mind the significant digits.

00:07:49

We get a final answer of 23.4 grams of sodium bromide.

00:08:02

You may notice that this is exactly the same process we have been using for the other type of

00:08:13

Stoichiometry problems we've been solving. Composition stoichiometry.

00:08:17

The only difference is the source of your conversion factors.

00:08:26

A slight variation of the straight stoichiometry problems we've been solving is the limiting reactant model.

00:08:35

This reaction, the diagram, illustrates the principle involved.

00:08:41

If you have limited quantities of carbon monoxide and hydrogen.

00:08:46

You will have to stop the reaction, once one of the two runs out.

00:08:52

The substance that runs out first is called the limiting reactant.

00:08:57

The one that does not run out is called the excess reactant.

00:09:04

You may have more than one excess reactant, but you will only have 1 limiting reactant.

00:09:13

In this example, hydrogen is the limiting reactant because it ran out.

00:09:20

Whereas a carbon monoxide is in excess because at the end of the reaction you still have some leftover.

00:09:29

Notice right there in the middle one leftover carbon monoxide molecule.

00:09:44

Here is a typical example of a limiting reactant problem.

00:09:48

Except for part C, part C is a little bit over the top, but we'll answer it anyway.

00:09:55

We are going to start with Part B because once we know the answer to that we will also know the answer to part A.

00:10:15

You can think of a limiting reactant problem as two straight reaction stoichiometry problems.

00:10:24

You will have a single ask.

00:10:27

Mass of urea in this case.

00:10:30

And two given quantities.

00:10:33

The mass of the ammonia and the mass of the carbon dioxide.

00:10:40

Using the periodic table, we can calculate the masses.

00:10:45

And now we're ready to start solving the problem.

00:10:51

We will set up both our given quantities in the 1st frame of their own set.

00:10:59

We place the two different conversion factors in the corresponding second frames.

00:11:06

Making sure that all the units.

00:11:11

Cancel and only units of urea remain.

00:11:22

And then we simply get both answers.

00:11:27

So, which is right?

00:11:30

We will always choose.

00:11:33

The smaller answer.

00:11:35

Because the limiting reactant always yields the smaller answer.

00:11:42

That means that ammonia is our limiting reactant, and it will produce.

00:11:48

1123 grams of urea.

00:12:01

Simply because it's the smaller quantity.

00:12:08

Part C.

00:12:09

Wants us to calculate how much carbon dioxide is leftover after the reaction.

00:12:19

To answer this, we need to first determine how much urea was not made.

00:12:29

And that amount is 435 grams of urea. By subtracting what the carbon dioxide would have produced minus the actual yield, which is 1123.

00:12:52

Then we're going to convert it back to grams of carbon dioxide, and for that we will use the 435 grams of urea as our given quantity.

00:13:04

Grams of carbon dioxide will be our ask.

00:13:10

Cancel our grams of urea.

00:13:13

And that gives us 318 grams of carbon dioxide that are not expected to react.

00:13:39

Up until now, we have assumed that the reactants will react completely, and that no product will be lost in the process.

00:13:50

Real life is never that simple.

00:13:55

When we calculate the amount of product that we expect from a given amounts of reactants, that is called the theoretical yield.

00:14:03

And it assumes perfect conditions.

00:14:06

With rainbows and unicorns and everything else.

00:14:13

The amount you recover in the laboratory.

00:14:17

Is called the actual yield or the experimental yield.

00:14:22

The actual yield is always lower than the theoretical yield.

00:14:28

Because life sucks.

00:14:30

Even for chemists.

00:14:38

The reaction yield is expressed as a percentage of the theoretical yield, and it can't be calculated using this formula.

00:14:57

Let's calculate the percent yield of this reaction.

00:15:01

The theoretical yield part is just simply a limiting reactant problem like the one we just carried out.

00:15:09

We will start with that.

00:15:13

The actual yield that we are given will be needed later, so we're going.

00:15:17

To set it aside for now.

00:15:26

The ask for this problem is mass of titanium.

00:15:32

And we are given the masses of titanium chloride and of magnesium.

00:15:39

As our given quantities.

00:15:44

We then go to the periodic table to figure out our conversion factors.

00:15:53

And next we place those given quantities.

00:15:57

In the 1st frame of their respective sets.

00:16:04

We will place the conversion factors in the 2nd frame of these two corresponding sets, making sure our units cancel.

00:16:19

And that gives us 8.94 * 10 to the sixth and 1.11 * 10 to the seventh grams of titanium respectively.

00:16:32

And of course, we choose a smaller number as the theoretical yield.

00:16:41

So in this case, titanium chloride was our limiting reactant.

00:16:48

To calculate the percent yield, we plug in the values we just calculated and the actual yield we were given.

00:16:59

And our answer is 88.5%.

00:17:04

Which is a very respectable yield.

00:17:09

And now you may think, hey.

00:17:12

What about the units?

00:17:15

I'm glad you asked.

00:17:17

Percent yields have no units because both the actual and theoretical yields will have the same unit.

00:17:26

So they will cancel out.

00:17:29

Very sad.

00:17:33

At this point, I strongly recommend watching both problem-solving videos for more examples.

00:17:40

If you still have questions and need help, please follow the office hours or the discussion links in canvas.

00:17:48

I'm here to help.

00:17:50

Really I am.

00:17:54

And that's all there is.

00:17:58

There isn't any more.