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Molar gas volume

Alisha Kakar: Under the same conditions, every gas takes up the same amount of space.

We'll use that idea for calculations involving molar gas volume.

We'll calculate a gas' volume from its mass and the other way around.

At room temperature and pressure, or RTP for short, one mole of any gas occupies 24,000 centimetres cubed.

If we need to convert from centimetres cubed to decimetres cubed, we simply divide by 1000.

Let's start with an example question, calculating a volume from a mass.

Calcium carbonate decomposes to form calcium oxide and carbon dioxide when it is heated.

We need to calculate the volume of carbon dioxide produced from completely decomposing one gram of calcium carbonate.

This question provides the MR of calcium carbonate, which is 100.

Step one, work out how many moles of calcium carbonate we have, then use that to find the moles of carbon dioxide.

To find that, we use the equation moles equals mass divided by MR.

The question tells us the calcium carbonate mass is one gram with an MR of 100.

1 gram divided by 100 equals 0.01 moles of calcium carbonate.

Step two, use the equation to find the moles of carbon dioxide produced.

This is the number we're interested in.

There are no numbers in front of either of them, which means the ratio of moles for all three is exactly the same.

It's one to one to one.

The number of moles of carbon dioxide is the same as the number of moles of calcium carbonate, which is 0.01 moles.

Step three, calculating the volume of carbon dioxide.

We use the equation volume equals moles multiplied by molar volume.

As we already know at RTP, one mole of any gas takes up 24,000 centimetres cubed.

0.01 multiplied by 24,000 gives 240 centimetres cubed.

That means the reaction produces 240 centimetres cubed of carbon dioxide gas.

That's our answer.

Let's look at calculating mass from a volume.

Lithium hydroxide absorbs carbon dioxide gas from the air.

We need to calculate the mass of lithium hydroxide needed to absorb 12 decimetres cubed of carbon dioxide.

The MR of lithium hydroxide is 24.

Step one, we start by finding how many moles of carbon dioxide there are.

This time, the equation is moles equals volume divided by molar volume.

12 divided by 24 decimetres cubed gives 0.5 moles of carbon dioxide.

Step two, find the moles of lithium hydroxide.

Since we've already calculated that we have 0.5 moles of carbon dioxide gas, we know that this will require twice as many moles of lithium hydroxide.

That's two multiplied by 0.5, which equals one mole of lithium hydroxide.

Step three, calculate the mass of lithium hydroxide.

And to do this, we use the equation mass equals moles multiplied by MR.

That's one multiplied by 24, which gives our final answer of 24 grams of lithium hydroxide.

Now it's over to you.

Have a go at this question.

Calculate the mass of sodium chloride produced from 960 centimetres cubed of chlorine and an excess of sodium.

The MR of sodium chloride is 58.5.

You can pause the video while you work it out.

The mole ratio of chlorine to sodium chloride is one to two, and therefore the calculated mass of sodium chloride is 4.68 grams.

Remember, divide to get moles and multiply to get volume or mass.

One decimetre cubed is one thousand centimetres cubed and the same number of moles of any gas takes up the same space, which is 24,000 centimetres cubed.

So under the same conditions, every gas really does take up the same amount of space.

Once you work out the moles, you can work out everything else.

And that's the power of molar gas volume.