DECOMPOSITION OF $CuCO_3$

BACKGROUND THEORY

Cu_2O is a red crystalline material, which is produce by the electrolytic or furnace method. CuO is a black powder prepared by the ignition of suitable salts such as carbonate ***(1)***
The mole is the mass of substance that has the same number of particles as atoms in exactly 12g of carbon-12. One mole of any substance contains Avogadro's number 6.02×10^{23} mol^{-1} ***(2)***. Avogadro discovered that at room temperature (25°C) and pressure (1 atm), all gases occupy the same volume. 1 mole of any gas will occupy a volume of $24dm^3$.

CALCULATING THE NEEDED MASS

The best method is to take one of the two equations and try to prove or disprove it. Since equation 2 has only 1 mole of every substance this would be the easiest to work out in terms of ratio. This assumption is made because the equation is "stoichiometric" ***(3)*** meaning 1 mole of $CuCO_3$ decomposes to exactly 1 mole of CuO and 1 mole of carbon dioxide. However, $24000cm^3$ would be too much gas to produce in a school lab, as that size of apparatus is not available. Gas syringe will be used but has a maximum of $100cm^3$, so it would not be sensible to produce $100cm^3$ of gas because if equation 1 turns out to be correct (which would mean oxygen will also be produced), and there would consequently be more gas. Aiming to produce $75cm^3$ of gas would leave room for error and the possibility of equation 1 occurring.

Equation 2: $CuCO_3 \rightarrow CuO + CO_2$
If 1 mole of $CuCO_3$ produces $24000cm^3$ of CO_2, to produce $75cm^3$ (for equation 2) we need:

Moles in gas	=	volume / 24000		
	=	75 / 24000		
Moles in gas	=	0.003125 moles		
Ratio	=	CO_2	:	$CuCO_3$
		1	:	1
		0.003125	:	0.003125
Moles of $CuCO_3$	=	0.003125 moles		
R.A.M of $CuCO_3$	=	63.5 + 12 + (16 × 3)		
	=	123.5		
Mass of $CuCO_3$	=	0.003125 × 123.5		
	=	0.3859375		
Mass of $CuCO_3$ needed to be decomposed	=	0.39g (2 s.f)		

Equation 1: $2CuCO_3 \rightarrow Cu_2O + 2CO_2 + \frac{1}{2}O_2$
For equation 1, volume of gas that will be produced using 0.39g of $CuCO_3$ will be:

Moles of $2CuCO_3$	=	mass / R.A.M
	=	0.39 / 123.5
Moles of $2CuCO_3$	=	0.003157894 moles

Ratio	=	$2CuCO_3$	:	$2CO_2$
	=	2	:	2
	=	0.00315784	:	0.00315784
Moles of $2CO_2$	=	0.00315784 moles		
Volume of $2CO_2$	=	moles × 24000		
	=	0.00315784 × 24000		
	=	75.78816cm^3		
Volume of $2CO_2$	=	76cm^3		

APPARATUS

- 0.39g of $CuCO_3$
- Bunsen burner
- Heat proof mat
- Tripod
- Gauze
- Bung
- Conical flask
- Delivery tube
- Gas syringe
- Clamp
- Scales (capable of weighing out 0.01g)

METHOD

- Collect and set up apparatus as shown in the drawing
- Ensure the gas syringe is at 0 before the experiment begins.
- Place the weighed mass of $CuCO_3$ into the conical flask and insert the bung tightly so that no gas escapes.
- Light the Bunsen burner and place it underneath the test tube (as shown in the drawing).
- Heat the conical flask until the $CuCO_3$ has fully decomposed. (This will be indicated by the fact that the bubbling will stop, and there will be a significant colour change of the $CuCO_3$ form bluish green to black or red).
- Continue to heat even after the bubbling has stopped for about 1 minute. This wil1 ensure that the reaction has completely ended
- Leave the apparatus unattended to for a few seconds to ensure all gas has been released.
- Then record the reading from the gas syringe which shows the volume of gas produced.
- Repeat theses stages thrice, to get a more accurate result. Then take the average for the results.

WHICH EQUATION IS CORRECT?

In previous calculation, 0.39g of $CuCO^3$ should produce 75cm^3 of gas, if equation 2 is correct. If this volume of gas or a slightly less volume (to allow for slight gas loss) is obtained during the experiment, then equation 2 is correct. But if more than 75cm^3 of gas

is produced, then it means that another gas has been produced which will be oxygen. This would then mean that equation 1 is correct.
Also, after the decomposition has fully occurred, you can try to guess which equation is happening through looking at the colour of the substance after decomposition. If it's a red compound, it may be equation 1 occurring due to the Cu_2O which is a red crystalline. Whereas if it's a black compound then it may be equation 2 occurring as CuO is a black powder.

SAFETY

$CuCO_3$ is harmful; ingestion may cause nausea or vomiting, and inhalation may cause irritation ***(4)***.
Care must be taken when dealing with Bunsen burner to avoid been burnt.

REFRENCES

(1) http://www.britannica.com/eb/article?tocId=81944&query=copper%20oxides&ct=eb
(2) OCR Chemistry 1 - p20
(3) http://www.iun.edu/~cpanhd/C101webnotes/quantchem/rxnstoich.html
(4) http://www.ctmsupplies.hemscott.net/Copper%20Carbonate.htm