Problem 1: Carbonate rocks!

Curriculum links;
mole calculations, reacting masses, thermal decomposition of metal carbonates

Practical skills;
top pan balance, observation skills

The chairman of a local geology society has contacted the students to ask them to help him identify four different rock samples (all essentially metal carbonates or hydrogen carbonates). The students need to heat the samples, measure the mass change and record visual observations. Using the visual observations, the students are asked to identify each sample and using the mass changes the students are asked to determine the purity of the samples.

Extension discussion points:
- Can the students explain the trend in the thermal stabilities of the '*s*' block metal carbonates and hydrogen carbonates?
- To what degree of accuracy should the final percentage purities of the rock samples C and D be given?

Pre-Lab questions
(Remember to give full references for any information beyond A-level that you find out)

1. Identify the principal mineral in each of the sedimentary rocks a - d below?
a) Nahcolite
b) Limestone
c) Rhodochrosite
d) Smithsonite

2. Sedimentary rocks often contain metal carbonates and hydrogen carbonates. Carry out some research to find information on the thermal stabilities of 's' block metal hydrogen carbonates, 's'-block metal carbonates and transition metal carbonates. Include in your answer a word equation for the thermal decomposition of a metal carbonate and a metal hydrogen carbonate.

3. Transition and other metal carbonates can often be identified by the colour changes associated with their thermal decomposition. For each of the samples below, identify the colour changes you would expect to observe on heating a sample of each compound;

a) zinc carbonate
b) manganese carbonate
c) copper carbonate

4. A student decides to investigate the thermal decomposition of lead carbonate. She heats an impure sample of the carbonate strongly for 5 min until there is no further decrease in mass and records the following results;

Mass of empty metal crucible	= 16.65 g
Mass of crucible + lead carbonate before heating	= 23.31 g
Mass of crucible + lead oxide after heating	= 22.33 g

a) Write a word and symbol equation for the thermal decomposition of lead carbonate, $PbCO_3$.
b) What mass of carbon dioxide and therefore how many moles of carbon dioxide are given off in the reaction?
c) Use your understanding of the stoichiometry of the reaction together with your answer to part b) to calculate;
    i. the number of moles of lead carbonate in the original sample
    ii. the mass of lead carbonate in the original sample
d) Using your answer to c) ii., calculate the percentage purity of the lead carbonate sample (you may assume that any impurities in the sample are thermally stable).

Dear analyst,

I am a member of the regional group of The Geology Society and have responsibility for maintaining and updating our collection of rocks, of which we are very proud. We have over a thousand rock samples collected from countries around the world. The rarest rock we hold is a small piece of Kimberlite originating from South Africa.

Sadly, an elderly and well respected member of our group recently passed away. He had a small collection of rocks which he very kindly donated to us in his will. However in packing and transportation, four of these rocks lost their labels. From the labels found loose in the bottom of the box, we know them to be samples of;

Nahcolite

Limestone

Rhodochrosite

Smithsonite

But we do not know which is which.

Please can you help us with the identification of each sample. We have taken the liberty of grinding a small sample of each rock into a powder and labelling them A-D for your analysis. Samples of Rhodochrosite and Smithsonite often contain impurities so in addition to the identification of these samples we would appreciate an analysis of their percentage purity.

We are a society of high standing in academic circles with an excellent reputation for exactness to uphold. We are therefore relying on you for your analyses to be accurate to the highest degree possible.

Please provide a full report detailing your methods and full calculations for our records.

Many thanks for your help,

B. Rubble

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