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Student number

Name _____

Date _____

Attempt/Time taken _____

GCSE
CHEMISTRY

Topic Paper: 3 Quantitative chemistry
Part 2

Time allowed: 40 minutes

Materials

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a ruler with millimetre measurements
- a calculator, which you are expected to use where appropriate.

Instructions

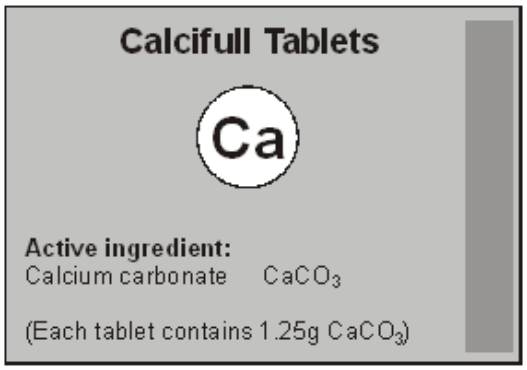
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The Periodic Table/Data Sheet is provided as in insert.
- You are reminded of the need for good English and clear presentation in your answers.
- When answering questions you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

35 Marks

Q6. Calcium carbonate tablets are used to treat people with calcium deficiency.



(a) Calculate the relative formula mass (M_r) of calcium carbonate.

Relative atomic masses: C = 12; O = 16; Ca = 40.

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Relative formula mass = ...

(2)

(b) Calculate the percentage of calcium in calcium carbonate, $CaCO_3$.

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Percentage of calcium = ... %

(2)

(c) Calculate the mass of calcium in each tablet.

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Mass of calcium = ... g

(2)

(d) An unwanted side effect of this medicine is that it can cause the patient to have 'wind' (too much gas in the intestine).

The equation below represents the reaction between calcium carbonate and hydrochloric acid (the acid present in the stomach).

$$CaCO_3\ (s) + 2HCl\ (aq) \rightarrow CaCl_2\ (aq) + H_2O\ (l) + CO_2\ (g)$$

Suggest why the patient may suffer from 'wind'.

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(1)

(Total 7 marks)

Q7. The two carbon atoms represented below are isotopes.

ISOTOPE 1		ISOTOPE 2
14 C	mass number	12 C
6	proton number	6

(a) Describe **two** ways in which the isotopes are similar.

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(2)

(b) Describe as fully as you can **one** way in which they are different.

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(2)
(Total 4 marks)

Q8. The information on the Data Sheet will be helpful in answering this question.

(a) Calculate the formula mass (M_r) of the compound iron (III) oxide, Fe_2O_3.

(Show your working.)

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(3)

(b) Calculate the mass of iron produced when 32g of iron (III) oxide is completely reduced by aluminium.

The reaction is shown in the symbol equation:

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

(Show your working.)

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Answer = ... grams

(3)
(Total 6 marks)

Q9. The picture shows a painting which was painted in a cave in France about 17 000 years ago.

By Carla Hufstedler [CC-BY-SA-2.0], via Wikimedia Commons

One of the pigments in this painting contains:

70 % of iron (Fe) and 30 % of oxygen (O)

Calculate the simplest (empirical) formula of this substance.

Relative atomic masses: O = 16; Fe = 56.

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(4)
(Total 4 marks)

Q10. Lead compounds have been used for thousands of years as colours in paint.

Johannes Vermeer [Public domain], via Wikimedia Commons

(a) A sample of a red oxide used in paint was found to contain 6.21 g of lead and 0.64 g of oxygen.

Calculate the empirical (simplest) formula of this compound.

You **must** show all your working to gain full marks.

Relative atomic masses: O = 16; Pb = 207.

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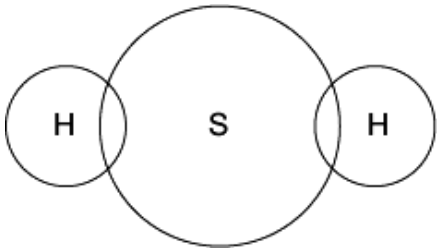
(4)

(b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.

(i) Hydrogen sulfide has the formula H_2S. The bonding in a molecule of hydrogen sulfide can be represented as:

H–S–H

Complete the diagram below to show the arrangement of the outer electrons of the hydrogen and sulfur atoms in hydrogen sulfide.
Use dots (●) and crosses (x) to represent the electrons.
You need only show the outer shell electrons.
(Atomic numbers: H = 1; S = 16.)



(1)

(ii) Hydrogen sulfide has a low boiling point.

Explain why.

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(2)

(iii) Lead white is also used in paint. The white colour slowly darkens when lead sulfide is produced.

The painting can be restored with hydrogen peroxide. This converts the black lead sulfide into white lead sulfate.

Balance the equation for the reaction between lead sulfide and hydrogen peroxide (H_2O_2).

$PbS(s) + ...H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$

(1)
(Total 8 marks)

Q11. Aspirin tablets have important medical uses.

(a) Aspirin is made when salicylic acid reacts with ethanoic anhydride.

The equation for this reaction is:

$$\underset{\text{salicylic acid}}{C_7H_6O_3} + C_4H_6O_3 \rightarrow \underset{\text{aspirin}}{C_9H_8O_4} + CH_3COOH$$

Calculate the maximum mass of aspirin that could be made from 100 g of salicylic acid.

Show clearly how you work out your answer.

The relative formula mass (M_r) of salicylic acid ($C_7H_6O_3$) is 138.
The relative formula mass (M_r) of aspirin ($C_9H_8O_4$) is 180.

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Maximum mass of aspirin = ... g

(2)

(b) (i) In an experiment a chemist calculated that the maximum yield of aspirin is 400 g.

The chemist did the experiment but only made 250 g of aspirin.

Calculate the percentage yield of aspirin for this experiment.

Show clearly how you work out your answer.

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Percentage yield of aspirin = ... %

(2)

(ii) Suggest **one** possible reason why the chemist did **not** have a percentage yield of 100%.

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(1)

(c) The use of a catalyst might reduce costs in the industrial production of aspirin.

Suggest how.

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(1)

(Total 6 marks)