

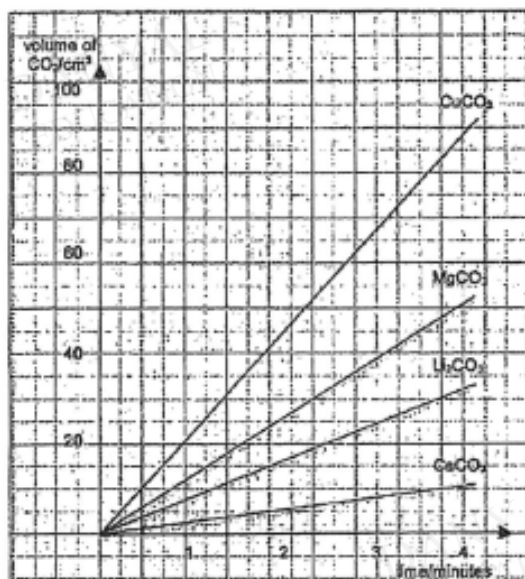
O Level Combined Chemistry Structured

Metals Test 1.0

Q1

- (a) When equal number of moles of some metal carbonates are heated strongly, they decompose to produce carbon dioxide.

The graph below shows the results of an investigation of the rate of decomposition of 0.010 mole of four carbonates. The volume of carbon dioxide produced is measured every minute.



- (i) Name the carbonate that decomposed at the fastest rate.

.....
[1]

- (ii) The more reactive the metal, the higher the temperature needed to decompose its compound. Based on the information given from the graph, arrange the 4 metals in descending order of their reactivity (the most reactive first). Explain your answers.

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[3]

- (iii) How could you tell from the graph that the decomposition of the carbonates was not complete?

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[1]

(b) Describe how the reactions of magnesium, copper and iron with dilute hydrochloric acid may be used to place them in an order of reactivity. Write a balanced chemical equation for any one of the reactions you describe.

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[5]

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Q2

- (a) (i) Calcium and zinc require different conditions to react with water. By referring to these reaction conditions, justify the relative positions of calcium and zinc in the reactivity series.

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.....[3]

- (ii) Write a balanced chemical equation for one of the reactions you described in (a)(i).

.....[2]

- (b) Metals can be extracted in many different ways.

Explain why carbon can be used to obtain iron from iron(III) oxide but not to obtain calcium from calcium oxide.

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.....[2]

- (c) The Statue of Liberty in New York is made from iron frame covered with copper plates. In 2004, work had to be carried out to stop the iron frame from rusting away.

The iron frame was rusting much faster than normal when it was in contact with copper.

Explain why copper in contact with iron causes the iron to rust at a faster rate.

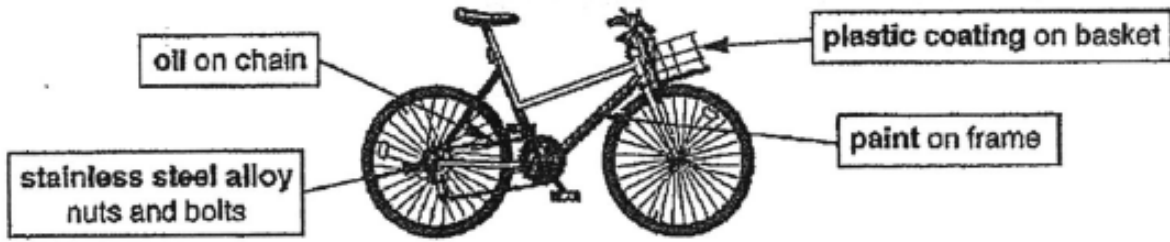
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.....
.....[2]

- (d) Suggest one reason why some countries concentrate more on recycling copper than on recycling iron.

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.....[1]

Q3

The diagram shows the rust prevention methods used on different parts of a bicycle.



(i) What is meant by the term *alloy*?

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[1]

(ii) Explain how the oil, the paint and plastic coating slow down rusting.

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[2]

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Q4

A student carried out some experiments to place four metals W, X, Y and Z in order of reactivity. The table shows the results.

- KEY:** ✓ shows a reaction happened
 x shows no reaction happened
 --- shows the experiment was not performed

	metal W	metal X	metal Y	metal Z
solution of W nitrate	—	x	x	x
solution of X nitrate	✓	—	✓	✓
solution of Y nitrate	✓	x	—	✓
solution of Z nitrate	✓	x	x	—

(a) Place the metals in order of reactivity, starting with the most reactive.

.....

[1]

(b) The student carried out further experiments to place metal M in the list. She used dilute hydrochloric acid and samples of the metals. She found out that metal M is the fourth most reactive metal.

Describe the experiments that the student carried out.

Your answer should include a description of the experiments, the measurements made and how the results showed that metal M is the fourth most reactive metal.

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[4]

Q5

To determine the reactivity series of metals, a series of experiments were conducted with four different solutions. All four solutions contain nitrate ions. The procedures for the experiment are shown below:

1. A piece of magnesium ribbon was added to 25 cm³ of each solution containing the same concentration.
2. For each experiment, the change in temperature was recorded.

The results of the experiments are listed in Table 9.1.

Table 9.1

solution of	observation	change in temperature / °C
metal A	grey-black solid deposited on the magnesium ribbon.	+14
metal B	reddish-brown solid deposited on the magnesium ribbon.	+ 42
metal C	no visible reaction.	0
metal D	grey-black solid deposited on the magnesium ribbon.	+ 32

- (a) Name the reaction that causes the change in temperature in Table 9.1.
.....[1]
- (b) Explain why there is **no** change in temperature when magnesium ribbon is added to a solution of metal C.
.....
.....[2]
- (c) Suggest the identity of metal B.
.....[1]
- (d) State the order of reactivity of the metals, A, B, C, D and magnesium, in order of increasing reactivity.
.....[1]

- (e) A piece of magnesium ribbon was also added to a solution of dilute hydrochloric acid, and bubbles were seen forming.

Suggest a test, and the expected observation, that would confirm the identity of the gas formed.

test:.....

observation:.....[2]

- (f) Pure metals are often too soft to be used widely in the industry, thus, alloys are typically used.

Explain why alloys are harder than pure metals.

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.....[3]

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Answers

Metals Test 1.0

Q1

0ai	Copper(II) carbonate Calcium, lithium, magnesium and copper Gradient for the decomposition of calcium carbonate is the least steep, followed by lithium carbonate, magnesium carbonate and copper(II) carbonate. When gradient is the least steep, the rate of decomposition is the lowest. Amount of heat required to decompose calcium carbonate is the steepest therefore calcium is the most reactive. OR Gradient for the decomposition of copper(II) carbonate is the highest, hence the rate of decomposition is the highest. Copper is the least reactive.
iii	The volume of carbon dioxide produced has not become constant after 4 minutes. OR the volume of carbon dioxide is still increasing. OR the gradient of graph is not zero.
b	Magnesium reacts vigorously with dilute hydrochloric acid to produce magnesium chloride and hydrogen gas. Iron reacts slowly with dilute hydrochloric acid to form iron(II) chloride and hydrogen gas. Copper does not react with acids. Hence magnesium is the most reactive, followed by iron and copper. Any one of the chemical equations $Mg + 2HCl \rightarrow MgCl_2 + H_2$ $Fe + 2HCl \rightarrow FeCl_2 + H_2$

Q2

<p>(a) (i) Calcium reacts <u>readily with (cold) water</u> to produce metal hydroxide and hydrogen gas.</p> <p>However, zinc <u>does not react with water</u> but only with <u>steam</u> to produce metal oxide and hydrogen gas</p> <p>Hence, <u>calcium is more reactive than zinc</u> and <u>is placed above zinc</u> in the reactivity series of metal.</p> <p>(ii) $Zn + H_2O \rightarrow ZnO + H_2$</p> <p>or</p> <p>$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$</p>	<p>1m – able to state the difference in the condition of water</p> <p>1m – using the reaction with water to state that <u>Ca is more reactive than Zn</u></p> <p>1m: Hence, <u>Ca is above Zn</u> in the reactivity series of metals.</p> <p>1m : Correct reactants and products 1m: balanced equation.</p>
<p>(b) Carbon is more reactive than iron, hence it is able to displace iron from iron oxide.</p> <p>However, carbon is less reactive than calcium and it is unable to displace calcium from its oxide</p>	<p>1m</p> <p>1m</p>
<p>(c)(i) Iron, being <u>more reactive [1m]</u> than copper, <u>will react more readily with oxygen and water [1m]</u>. Hence iron rusts faster than normal.</p>	<p>2m</p>
<p>(c)(ii)</p> <ul style="list-style-type: none"> - Percentage of copper on earth is less than iron/ less abundant - Copper has a higher monetary value than iron. 	<p>1m</p>

Q3

(i) Mixture of ----- $\frac{1}{2}$ m metals or metals and non-metals --- $\frac{1}{2}$ m (both must be given) Term mixture must be stated or no marks	1
(ii) barrier method or acts as protective coating Prevents oxygen and water from coming into contact with iron	1 1

Q4

(a) W, Z, Y, X	1
(b) Into a conical flask, add a 100 cm ³ of 0.1 mol/dm ³ HCl acid Stopper and connect flask to gas syringe. Add 10 g of metal M Note volume of gas collected after 5 minutes. Repeat experiment with 10 g of metals W, X, Y and Z. Compare the volumes. Metal M gives the volume less than W, X, Y. Z gives the smallest volume. (or any other appropriate experiment) like displacement	4

Q5

(a) Exothermic reactions [MR: endothermic reaction, displacement reaction (not considering the change in temperature)]	[1]
(b) Metal C is <u>more reactive than</u> magnesium. Thus, magnesium will <u>not displace</u> metal C. [MR: many students wrote that metal C is not reactive at all, thus, displaying a lack of understanding of the reaction taking place. Some students also merely wrote that no reaction has taken place, which is too vague]	[1] [1]
(c) <u>Copper</u> [MR: iron(III), iron(III) hydroxide/oxide, copper(II) – Lack of understanding that sodium hydroxide/aqueous ammonia is necessary for iron(III) hydroxide/oxide to be formed.]	[1]
(d) B, D, A, magnesium, C [MR: Many students missed out magnesium as one of the metals to write in. Some students also wrote the answer in decreasing reactivity instead]	[1]

<p>(e)</p>	<p>test: place a <u>lighted splint</u> near the mouth of the test-tube. [accept: insert lighted splint into test-tube/place lighted splint near the reaction BUT not place into reaction] [MR: many students simply wrote lighted splint test/use a lighted splint/insert lighted splint] observation: lighted splint <u>extinguished with a 'pop' sound.</u></p>	<p>[1] [1]</p>
<p>(f)</p>	<p>In an alloy, the atoms of the different metals or elements have <u>different sizes,</u> thus it <u>disrupts the regular arrangement of atoms in the pure metal.</u> [accept: various sizes of atoms] [marks awarded as long as students show awareness that pure metals have a regular/orderly/neat arrangement] [MR: many students were missing key words, such as the different sized atoms, or that the regular/orderly arrangement was disrupted.] Thus, <u>atoms cannot slide over each other easily.</u> [accept: harder/more difficult for atoms to slide over each other] [MR: many students wrote that it prevents atoms from sliding over each other – NOT true as it merely makes it more difficult!] In a pure metal, layers of <u>atoms slide over one another easily.</u> [MR: some students only wrote that atoms can slide over one another] [In general: some students wrote about MOLECULES instead of atoms/particles, which is incorrect!]</p>	<p>[1] [1] [1]</p>