Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Reactivity of metals

Time allowed: 45 minutes

Subject code **0620**

Chemistry

Questions from Paper 1, Paper 2, Paper 4 and Paper 6

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 42

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 42 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 Some reactions of three metals are listed in the table.

metal	metal reacts with dilute hydrochloric acid	metal oxide is reduced by carbon
P	yes	no
Q	yes	yes
R	no	yes

What is the order of reactivity of the metals?

	most reactive →		least reactive
A	P	Q	R
B	P	R	Q
C	Q	P	R
D	R	P	Q

Reactivity of metals Click for more variations

Answer A

2 Four metals, P, Q, R and S, are added separately to water and to dilute hydrochloric acid.

The table shows the results.

	observation with water	observation with dilute hydrochloric acid
P	no reaction	fizzes slowly
Q	fizzes rapidly	fizzes rapidly
R	no reaction	no reaction
S	fizzes slowly	fizzes rapidly

Which conclusion can be made from these observations?

A P is the least reactive of the four metals.

B Q is more reactive than S.

C Q is less reactive than P.

D R is the most reactive of the four metals.

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Answer B

3 A student is given metal Z and its oxide.

The student does some experiments to find out the position of metal Z in the reactivity series.

The results are shown.

- Metal Z reacted slowly with dilute hydrochloric acid.
- Metal Z reacted slowly with steam but not with water.
- The oxide of metal Z reacted when heated with carbon.

Which statement about the position of metal Z in the reactivity series is correct?

A It is between calcium and sodium.

B It is between copper and hydrogen.

C It is between hydrogen and iron.

D It is between magnesium and calcium.

Reactivity of metals Click for more variations

Answer C

4 Copper(II) nitrate and zinc carbonate are heated strongly in separate test-tubes.

Which row identifies the gases produced?

	copper(II) nitrate	zinc carbonate
A	oxygen and nitrogen dioxide	carbon dioxide only
B	oxygen and nitrogen dioxide	carbon dioxide and oxygen
C	nitrogen dioxide only	carbon dioxide and oxygen
D	nitrogen dioxide only	carbon dioxide only

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Answer A

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5 The reactions of four metals, W, X, Y and Z, are listed.

- Metal W displaces metal X from the oxide of metal X.
- Metal Y has a greater tendency to form positive ions than metal W.
- Aqueous ions of metal Z are reduced by metal X.

What is the order of reactivity of the metals?

	least reactive →			most reactive
A	Y	W	X	Z
B	Y	X	W	Z
C	Z	W	X	Y
D	Z	X	W	Y

Reactivity of metals Click for more variations

Answer D

6 When zinc is added to an aqueous solution containing magnesium ions, there is no reaction.

Which species has the greatest tendency to lose electrons?

A Mg **B** Mg^{2+} **C** Zn **D** Zn^{2+}

Reactivity of metals Click for more variations

Answer A

7 Reactive metals tend to have unreactive compounds. The following is part of the reactivity series.

sodium — most reactive
calcium
zinc
copper
silver — least reactive

(a) Sodium hydroxide and sodium carbonate do not decompose when heated. The corresponding calcium compounds do decompose when heated. Complete the following equations.

calcium carbonate → ..... + ...

$Ca(OH)_2$ → ..... + ... [2]

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(b) All nitrates decompose when heated.

(i) The equation for the thermal decomposition of silver(I) nitrate is given below.

$$2AgNO_3 \rightarrow 2Ag + 2NO_2 + O_2$$

What are the products formed when copper(II) nitrate is heated?

..... [1]

(ii) Complete the equation for the action of heat on sodium nitrate.

.....$NaNO_3$ → ..... + ...

[2]

(c) Which of the metals in the list on page 5 have oxides which are not reduced by carbon?

..... [1]

(d) Choose from the list on page 5, metals whose ions would react with zinc.

..... [2]

[Total: 8]

Reactivity of metals Click for more variations

7 **(a)** calcium carbonate → calcium oxide + carbon dioxide [1]
accept: correct symbol equation

$Ca(OH)_2 \rightarrow CaO + H_2O$ [1]

(b) **(i)** CuO **and** NO_2 **and** O_2; [1]
accept: names or correct formulae

(ii) $2NaNO_3 \rightarrow 2NaNO_2 + O_2$ [2]
accept: $NaNO_3 \rightarrow NaNO_2 + 1/2\ O_2$
not balanced = [1]

(c) Na / Ca; [1]

(d) Cu; Ag; [2]
accept: *ions* Cu^{2+} *and* Ag^{+}

[Total: 8]

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8 You are provided with samples of three metals, tin, zinc and silver.

Plan an investigation to show the order of reactivity of these three metals.
You are provided with common laboratory apparatus and dilute acids.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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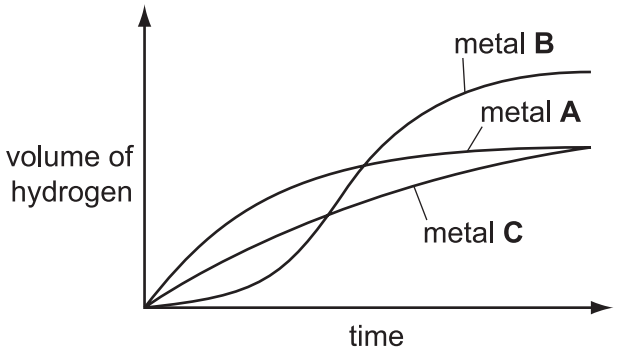
Practical skills: planning, apparatus, measuring and results Click for more variations

8	**Method 1: Monitoring the reaction of the metal with acid** 6 from: • named acid; • same or stated volume of (same concentration of) acid; • fair test idea, i.e. same surface area / size / mass / amount metal; • measure volume of gas / count bubbles / temperature change / observe complete reaction; • suitable reference to time; • conclusion / comparison, e.g. most effervescence = most reactive; **Method 2: Displacement reaction** 6 from: • react each metal; • with named acid; • to prepare salt solution of each; • react each metal with each solution of salt; • observe if displacement occurs; • conclusion / comparison;	6	**I:** use of heat unless this is identified as the output variable for the experiment

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9 Excess hydrochloric acid was added to powdered zinc. The hydrogen evolved was collected and its volume measured every 20 seconds.

The experiments were repeated at the same temperature using the same number of moles of powdered magnesium and aluminium.



(a) Identify metals **A**, **B** and **C** by choosing from zinc, magnesium and aluminium. Give a reason for each choice.

metal **A** .....

.....

metal **B** .....

.....

metal **C** .....

..... [5]

(b) Using 'moles', explain why two of the metals form the same volume of hydrogen but the third metal forms a larger volume.

.....

.....

..... [3]

[Total: 8]

Reactivity of metals Click for more variations

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9 **(a)** metal A is magnesium [1]
cond most reactive or fastest reaction [1]

metal B is aluminium [1]
cond faster reaction after removal of oxide layer / it would give more hydrogen / aluminium more reactive than zinc [1]

metal C is zinc [1]
zinc least reactive [1]
NOTE MAX [5]
If you encounter different reasoning which is correct, please award the appropriate marks.

(b) for magnesium and zinc same <u>volume</u> of hydrogen [1]

because both have valency of 2 / 1 mole of metal gives 1 mole of hydrogen / 1 mole of metal reacts with 2 moles of acid [1]

bigger volume for aluminium because its valency is 3 / 1 mole of metal gives 1.5 moles of hydrogen / 1 mole of metal reacts with 3 moles of acid [1]

If you encounter different reasoning which is correct, please award the appropriate marks.

accept balanced equations
accept ionic charges as alternative to valency

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10 A list of five metals is shown.

copper
iron
magnesium
potassium
silver

(a) All metals form positive ions.

(i) Describe how atoms form positive ions.

..... [1]

(ii) State which of the five metals in the list has the greatest tendency to form positive ions.

..... [1]

(iii) Suggest **one** of the five metals in the list which is **not** likely to show catalytic properties.

..... [1]

(iv) State which of the five metals in the list is a major component of stainless steel.

..... [1]

(b) A student adds a sample of a metal to an aqueous metal salt in a beaker to see if a displacement reaction takes place.

Complete Table 2.1 to show the colour of the solution in the beaker at the start and at the end of the experiment.

Table 2.1

metal	aqueous solution	colour at the start	colour at the end
magnesium	iron(II) sulfate	green	
silver	copper(II) sulfate		

[3]

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(c) Most Group II metals form a gas when placed into cold water. An alkaline solution is also formed.

(i) Name the gas formed when strontium is added to cold water.

..... [1]

(ii) Name the alkaline solution formed when strontium is added to cold water.

..... [1]

(iii) One Group II metal reacts very slowly when placed in cold water. When heated, the metal reacts with steam to form a white solid.

Identify this metal and name the white solid formed.

metal .....

white solid .....
[2]

(d) Under certain conditions, iron will react with steam to form an oxide of iron with the formula Fe_3O_4.

Fe_3O_4 reacts with dilute hydrochloric acid to form a mixture of iron(II) and iron(III) salts and water.

Deduce the symbol equation for the reaction between Fe_3O_4 and dilute hydrochloric acid.

..... [3]

[Total: 14]

Reactivity of metals Click for more variations

Reduced to 78% to fit the page (wider than A4).

10(a)(i)	electron loss (from outer shell)	1
10(a)(ii)	potassium	1
10(a)(iii)	magnesium or potassium	1
10(a)(iv)	iron	1
10(b)	<table><tr><td></td><td>M1 Colourless</td></tr><tr><td>M2 Blue</td><td>M3 Colour given in M2</td></tr></table>	3
10(c)(i)	hydrogen	1
10(c)(ii)	strontium hydroxide	1
10(c)(iii)	**M1** magnesium **or** Mg **M2** magnesium oxide	2
10(d)	$Fe_3O_4 + 8HCl \rightarrow 2FeCl_3 + FeCl_2 + 4H_2O$ M1 $FeCl_2$ **or** $FeCl_3$ as product of equation M2 $FeCl_2$ **and** $FeCl_3$ **and** H_2O as only products of equation M3 Correct equation	3

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