9.2 Reactivity series

01. 0620_s13_qp_62 Q: 6

Two metals, **A** and **B**, each react with dilute sulfuric acid to produce hydrogen.

Plan an investigation to show which metal, **A** or **B**, is the more reactive metal. You may include a diagram in your answer.

You are provided with:

- standard laboratory equipment
- powdered metals **A** and **B**
- dilute sulfuric acid.

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..... [6]

02. 0620_s14_qp_62 Q: 6

Cerussite is an ore of lead. Cerussite is lead carbonate, $PbCO_3$.

In the reactivity series, lead is between iron and copper.

Plan an investigation to obtain a sample of lead from a large lump of cerussite.

You are provided with common laboratory apparatus and chemicals.

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..... [6]

[Total: 6]

03. 0620_s16_qp_63 Q: 2

A student investigated what happens when dilute hydrochloric acid and copper(II) sulfate solution react with different metals.

Five experiments were carried out.

(a) *Experiment 1*

A measuring cylinder was used to pour 10 cm^3 of dilute hydrochloric acid into a boiling tube.
The temperature of the hydrochloric acid was measured.
1 g of zinc was added to the boiling tube and the mixture stirred with a thermometer.
The maximum temperature reached by the mixture was measured.

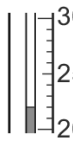
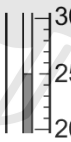
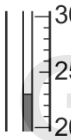
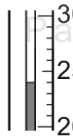
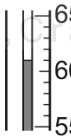
Experiment 2

Experiment 1 was repeated using 1 g of iron instead of zinc.

Experiment 3

Experiment 1 was repeated using 1 g of magnesium instead of zinc.

Use the thermometer diagrams to record the results in the table. Complete the final column in the table.

experiment	thermometer diagram	initial temperature of acid / °C	thermometer diagram	maximum temperature reached / °C	temperature rise / °C
1					
2					
3					

[3]

(b) The gas produced in experiment 3 was tested with a lighted splint and the result recorded below.

test ...lighted splint.....

result ...popped.....

Name the gas given off in experiment 3.

..... [1]

(c) *Experiment 4*

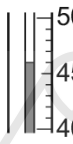
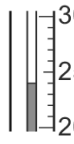
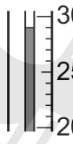
A measuring cylinder was used to pour 10 cm^3 of copper(II) sulfate solution into a boiling tube.
The temperature of the solution was measured.
1 g of magnesium was added to the boiling tube and the mixture stirred with a thermometer.
The maximum temperature reached by the mixture was measured.

Experiment 5

Experiment 4 was repeated using 1 g of iron instead of magnesium.
The observation was recorded below.

.....The solution turned colourless and a brown deposit formed.....

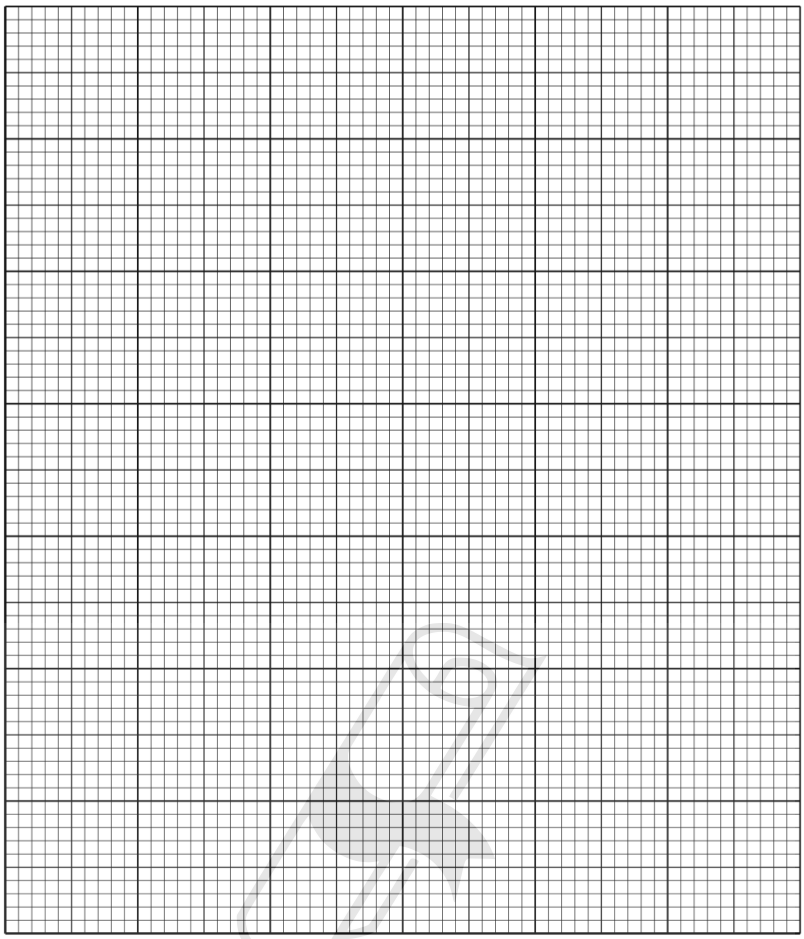
Use the thermometer diagrams to record the results in the table. Complete the final column in the table.

experiment	thermometer diagram	initial temperature of acid / °C	thermometer diagram	maximum temperature reached / °C	temperature rise / °C
4					
5					

[2]

(d) Draw a labelled bar chart for the results of experiments 1, 2, 3, 4 and 5 on the grid below.

temperature rise / °C



[3]

(e) Use the results for experiments 1, 2 and 3 to answer the following questions.

(i) Which experiment, 1, 2 or 3, produced the largest temperature rise?

..... [1]

(ii) Suggest why this experiment produced the largest temperature rise.

.....

..... [1]

(f) Explain the observations in experiment 5.

.....

.....

..... [2]

(g) Suggest why potassium was **not** used as one of the metals in these experiments.

..... [1]

(h) Give **one** advantage of using a measuring cylinder to add the hydrochloric acid to the boiling tube.

..... [1]

(i) Suggest and explain **one** improvement to increase the accuracy of these experiments.

.....

.....

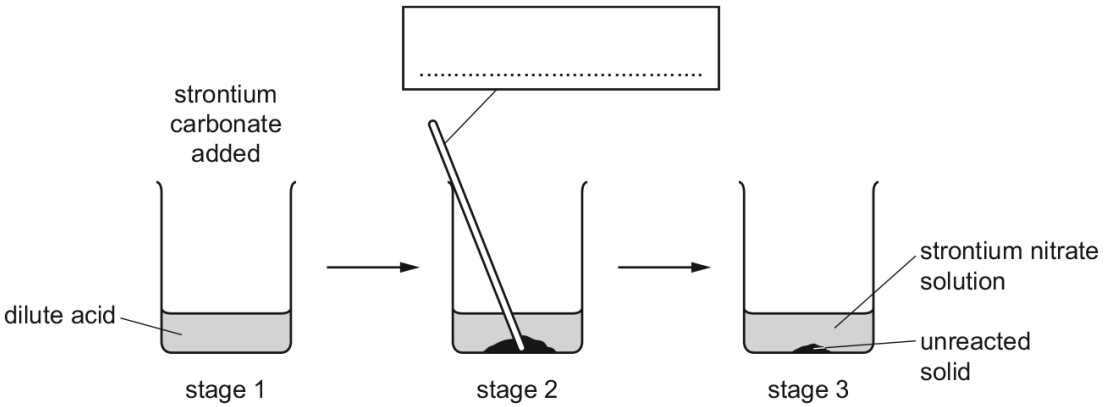
..... [2]

[Total: 17]

04. 0620_s17_qp_61 Q: 1

A student prepared strontium nitrate crystals.

The diagram shows some of the stages in this preparation.



(a) (i) Complete the box to identify the apparatus. [1]

(ii) What is used to add the strontium carbonate to the acid in stage 1?

..... [1]

(iii) Name the dilute acid used.

..... [1]

(iv) Give **one** expected observation in stage 2.

..... [1]

(b) Why is heat **not** necessary in stage 2?

..... [1]

(c) Which of the reactants is in excess? Explain your answer.

.....

..... [2]

(d) Describe how crystals of strontium nitrate could be obtained from the mixture in stage 3.

.....

.....

..... [3]

[Total: 10]

05. 0620_s19_qp_62 Q: 1

A student did the following steps to make zinc chloride crystals from solid zinc oxide.

step 1 Pour 40 cm^3 of dilute hydrochloric acid into a beaker. Add a small amount of zinc oxide. Warm the mixture and stir it.
step 2 Continue to add zinc oxide to the beaker until all of the dilute hydrochloric acid has reacted.
step 3 Remove the excess zinc oxide.
step 4 Obtain crystals of zinc chloride from the solution.

(a) Name the apparatus used in **step 1** to:

(i) add the zinc oxide

..... [1]

(ii) warm the mixture.

..... [1]

(b) How did the student know that all of the dilute hydrochloric acid had reacted in **step 2**?

.....

..... [1]

(c) **(i)** What is meant by the term *excess* in **step 3**?

..... [1]

(ii) How is the excess zinc oxide removed in **step 3**?

..... [1]

(d) Describe how the crystals are obtained in **step 4**.

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..... [3]

(e) Suggest how the method would differ if zinc carbonate were used instead of zinc oxide.

..... [1]

[Total: 9]

06. 0620_s20_qp_61 Q: 4

Cobalt, manganese and nickel are metals. They react with dilute hydrochloric acid to form hydrogen gas.

Plan an investigation to find the order of reactivity of these three metals.

You are provided with:
- samples of each metal
- dilute hydrochloric acid
- common laboratory apparatus.

Your plan must make it clear how your investigation will be a fair test and how you will use your results to place the metals in order of reactivity.

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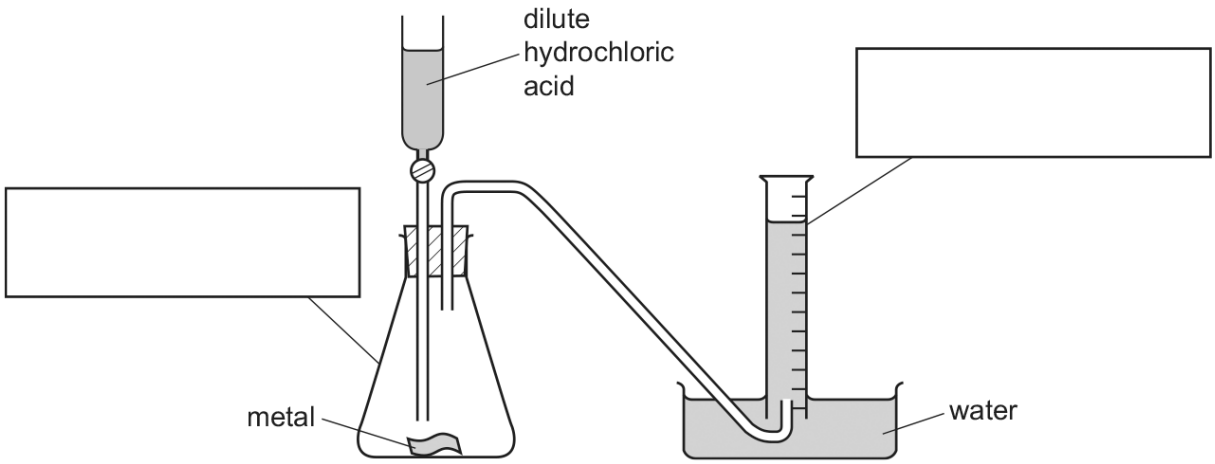
..... [6]

07. 0620_w12_qp_62 Q: 1

1 The apparatus below was used to prepare hydrogen and measure the volume of gas produced.



(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

(b) **(i)** Why would copper metal **not** be used in this preparation?

.....

(ii) Name a suitable metal that could be used in this preparation.

..... [2]

(c) Draw a labelled diagram to show a **different** method of collecting and measuring the hydrogen.

[2]

(d) State a test for hydrogen.

test .....

result ..... [2]

[Total: 8]

08. 0620_w12_qp_63 Q: 5

A student investigated the temperature changes when zinc and magnesium react with aqueous iron(II) sulfate solution.

Two experiments were carried out.

Experiment 1

Using a measuring cylinder, 40 cm^3 of aqueous iron(II) sulfate was poured into a beaker and the initial temperature of the solution was measured. The initial temperature of the solution was 25 °C in each experiment.
0.2 g of zinc powder was added to the beaker and the maximum temperature of the mixture measured and recorded.

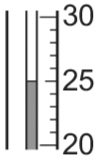
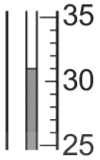
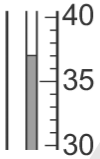
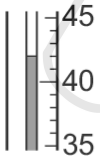
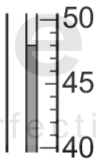
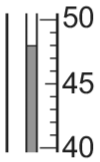
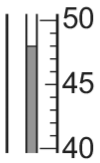
The experiment was repeated using increasing masses of zinc powder. The results are in the table below.

mass of zinc added / g	maximum temperature / °C	temperature rise / °C
0.0	25.0	0.0
0.2	30.0	5.0
0.4	34.5	9.5
0.6	39.0	14.0
0.8	44.0	19.0
1.0	44.0	19.0
1.2	44.0	19.0

Experiment 2

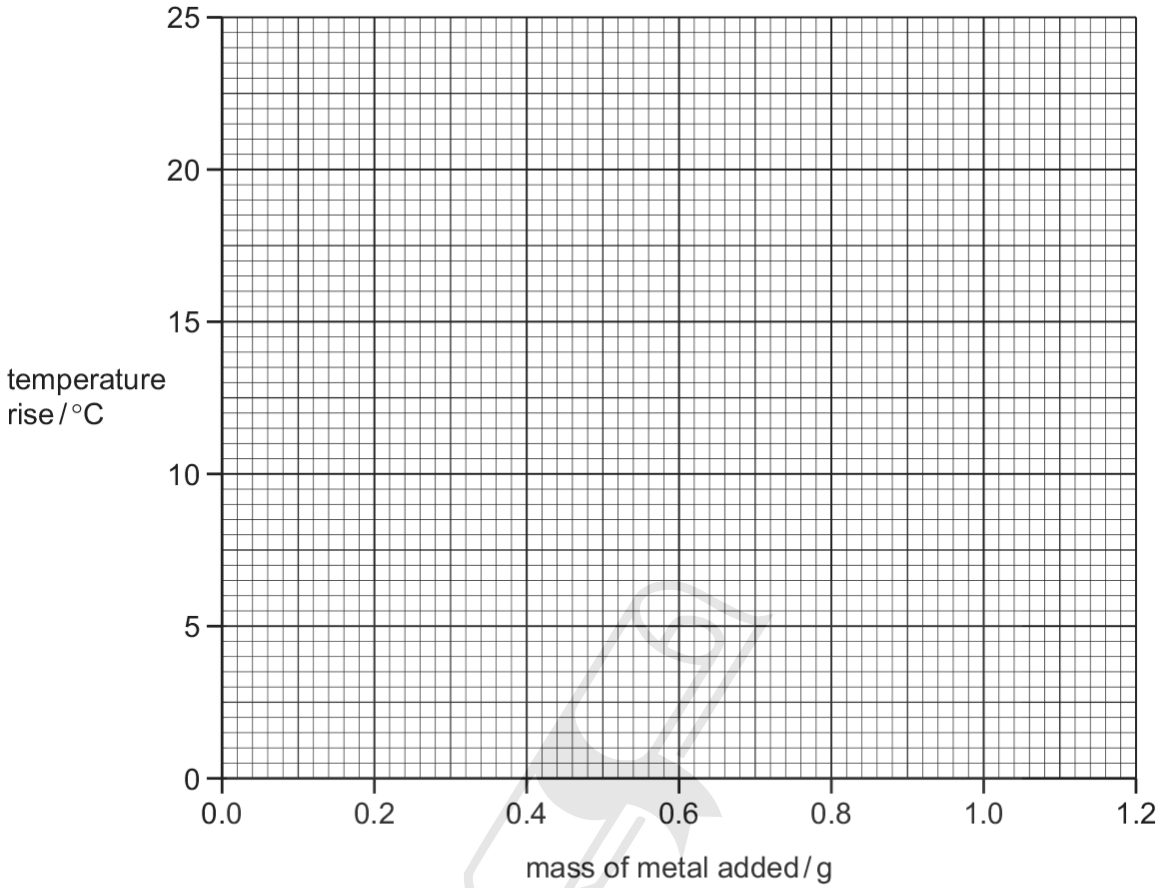
Experiment 1 was repeated using magnesium powder.

(a) Use the thermometer diagrams in the table to record the maximum temperatures reached and complete the table.

mass of magnesium added / g	thermometer diagram	maximum temperature reached / °C	temperature rise / °C
0.0			
0.2			
0.4			
0.6			
0.8			
1.0			
1.2			

[3]

(b) Plot the results for both experiments on the grid below. For each experiment draw a graph with two intersecting straight lines. Label the graphs.



[5]

(c) **Use your graphs** to find

(i) the mass of zinc required to produce a temperature rise of 12 °C.

..... [1]

(ii) the temperature rise produced by 0.3 g of magnesium.

..... [1]

(d) What is the minimum mass of magnesium required to produce the maximum temperature?

..... [1]

(e) Which reagent is in excess in Experiment 1? Explain your answer.

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..... [2]

(f) Experiment 2 was repeated using copper powder. Suggest how the results of this experiment would compare with those using zinc and magnesium.

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..... [2]

[Total: 15]

09. 0620_w13_qp_62 Q: 4

A student investigated what happened when dilute hydrochloric acid and aqueous copper(II) sulfate solution reacted with different metals.

Five experiments were carried out.

(a) *Experiment 1*

Using a measuring cylinder 10 cm^3 of dilute hydrochloric acid was poured into a boiling tube. The temperature of the solution was measured.
1 g of zinc powder was added to the boiling tube and the mixture stirred with the thermometer. The maximum temperature of the mixture was measured.

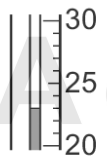
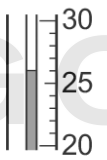
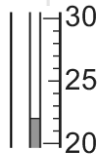
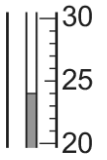
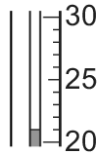
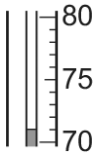
(b) *Experiment 2*

Experiment 1 was repeated using 1 g of iron powder instead of zinc. The initial and maximum temperatures were measured.

(c) *Experiment 3*

Experiment 1 was repeated using 1 g of magnesium powder instead of zinc. The initial and maximum temperatures were measured.

Use the thermometer diagrams to record the temperatures in the table. Complete the table.

experiment	thermometer diagram	initial temperature / °C	thermometer diagram	maximum temperature / °C	temperature rise / °C
1					
2					
3					

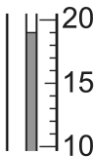
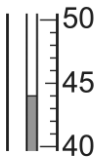
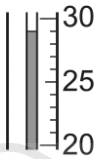
[3]

(d) *Experiment 4*

Using a measuring cylinder, 10 cm^3 of aqueous copper sulfate was poured into a boiling tube. The temperature of the solution was measured.
1 g of magnesium powder was added to the boiling tube and the mixture stirred with the thermometer.
The gas was tested with a lighted splint and a loud pop was observed. The maximum temperature of the mixture was measured.

(e) *Experiment 5*

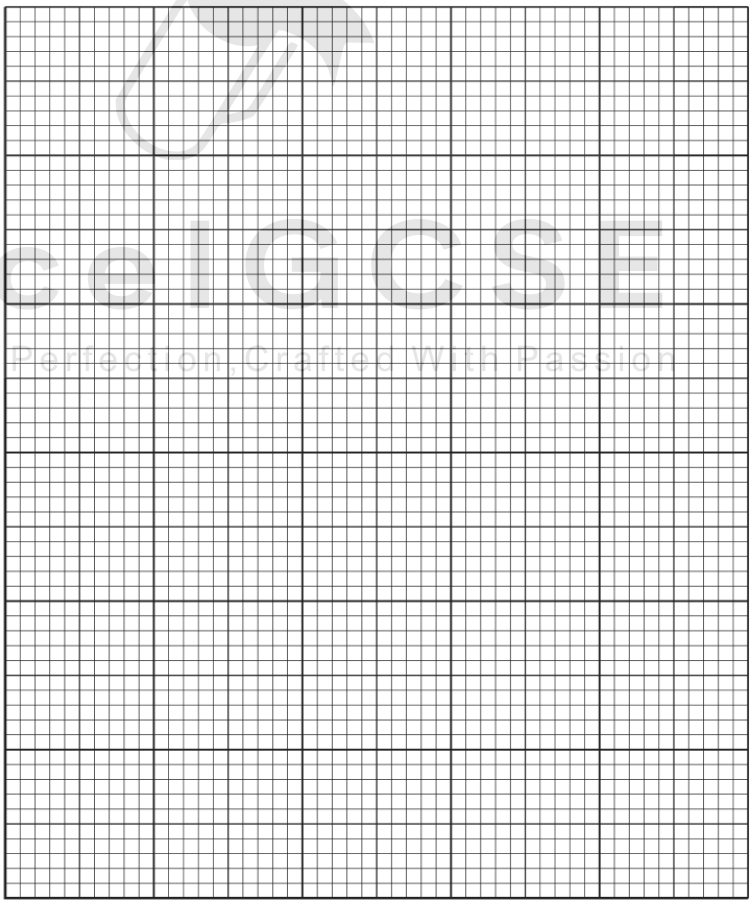
Experiment 4 was repeated using 1 g of iron powder instead of magnesium. A red-brown solid was formed.
Use the thermometer diagrams to record the temperatures in the table. Complete the table.

experiment	thermometer diagram	initial temperature / °C	thermometer diagram	maximum temperature / °C	temperature rise / °C
4					
5					

[3]

(f) Draw a labelled bar chart for the results of Experiments 1, 2, 3, 4 and 5 on the grid below.

temperature rise / °C



[5]

Use the results and observations to answer the following questions.

(g) **(i)** Which Experiment produced the largest temperature rise?

..... [1]

(ii) Suggest why this Experiment produced the largest temperature rise.

..... [1]

(h) Name the gas given off in Experiment 4.

..... [1]

(i) **(i)** Identify the red-brown solid formed in Experiment 5.

..... [1]

(ii) What type of chemical reaction occurs when iron reacts with aqueous copper(II) sulfate in Experiment 5?

..... [1]

(j) Predict the effect on the temperature change if 1 g of magnesium ribbon was used in Experiment 3. Explain your answer.

effect .....

explanation .....

..... [2]

(k) Suggest why potassium was not used as one of the metals in these experiments.

.....

..... [1]

[Total: 19]

10. 0620_w15_qp_62 Q: 6

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.

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..... [6]

[Total: 6]

11. 0620_w17_qp_61 Q: 4

Iron, tin and zinc all react with dilute hydrochloric acid to produce hydrogen.
Plan an experiment to determine the order of reactivity of iron, tin and zinc.
You are provided with powdered samples of the metals and common laboratory apparatus.

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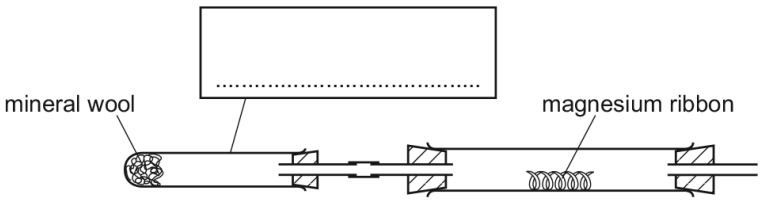
..... [6]

[Total: 6]

12. 0620_w17_qp_62 Q: 1

Some magnesium ribbon was cleaned.
Steam was then passed over the magnesium ribbon as it was heated, using the apparatus shown.



(a) What liquid is absorbed on the mineral wool?

..... [1]

(b) (i) Use **two** arrows to show **two** places where heat is applied. [1]

(ii) Complete the box to name the apparatus. [1]

(c) Suggest how the magnesium ribbon was cleaned.

..... [1]

(d) (i) Complete the diagram to show how the hydrogen produced could be collected and its volume measured. Label your diagram. [2]

(ii) State the effect of a lighted splint on the hydrogen produced.

..... [1]

(e) Suggest why the tube containing the magnesium cracks after the reaction.

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..... [1]

[Total: 8]

13. 0620_w21_qp_62 Q: 4

Cobalt is a metal. Cobalt is between copper and iron in the reactivity series. The mineral spherocobaltite contains the compound cobalt(II) carbonate and no other metal ions. Cobalt(II) carbonate is insoluble in water and reacts with dilute acids to form an aqueous solution of a salt.

Describe how you would obtain a sample of cobalt metal starting with a large lump of spherocobaltite. You have access to all normal laboratory apparatus and chemicals.

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..... [6]

01. 0620_s13_ms_62 Q: 6

note: all methods can gain the first three marks but only methods that would give usable results can gain the last three marks

known / same mass / amount of metal (1)

known / same volume / amount of acid (1)

test both **A** and **B** (1)

a method of collecting results (1)

time or run side by side (1)

comparison of results (1)

max 6 [6]

02. 0620_s14_ms_62 Q: 6

crush (1)

with…pestle and mortar / hammer

OR

reason…to increase the surface area / to make smaller pieces / to increase the rate of reaction (1)
[2]

Followed by:

heat (1)

with carbon (1)

any **two** from: carbon is more reactive / displaces Pb / takes away oxygen / forms carbon dioxide / reduction (2) [4]

OR

heat (1)

with a named metal between Mg and Pb in reactivity series, e.g. Fe (1)

more reactive / displaces Pb / takes away oxygen / reduction (1)

separation of Pb and metal oxide (1) [4]
allow: heat to melt lead and run off / decant

OR

heat (1)

with carbon / CO (1)

PbO (1)

heat with carbon / CO (1) [4]

OR

heat (1)

with iron (1)

PbO (1)

separation (1) [4]

OR

dilute acid (1)
allow: any dilute acid
ignore: heating

$Pb^{2+}_{(aq)}$ / salt / solution (1)

iron (1)

displaces lead (1) [4]

OR

dilute acid (1)
allow: any dilute acid
ignore: heating

$Pb^{2+}_{(aq)}$ / salt / solution (1)

electrolysis (1)
ignore: heating

lead deposited (at cathode) (1) [4]

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03. 0620_s16_ms_63 Q: 2

(a)	initial temperature boxes completed correctly: 22, 21, 24; maximum temperature boxes completed correctly: 25, 23, 61; temperature differences completed correctly: 3, 2, 37;	**3** 1 1 1
(b)	hydrogen;	**1**
(c)	all temperature boxes completed correctly: 21, 46 and 24, 29; differences completed correctly: 25, 5;	**2** 1 1
(d)	*y*-axis scale linear and highest temperature change over half way up *y*-axis; all 5 bars at the correct height; bars clearly labelled;	**3** 1 1 1
(e)(i)	experiment 3;	**1**
(e)(ii)	magnesium is the most reactive metal;	**1**
(f)	copper formed; iron is more reactive / displacement reaction;	**2** 1 1
(g)	potassium is too reactive / dangerous;	**1**
(h)	quick / easy to use;	**1**
(i)	insulate / lag tube / use a lid; to reduce heat losses; **OR** use a pipette / burette; instead of measuring cylinder / more accurate;	**2** 1 1 1 1

04. 0620_s17_ms_61 Q: 1

(a)(i)	stirrer / glass rod	1
(a)(ii)	Spatula	1
(a)(iii)	nitric (acid)	1
(a)(iv)	bubbles / fizz / effervescence	1
(b)	the reaction is (fast) at room temperature	1
(c)	strontium carbonate	1
	solid is left behind	1
(d)	filter	1
	heat / evaporate	1
	to crystallising point / glass rod test / until saturation point	1

05. 0620_s19_ms_62 Q: 1

(a)(i)	spatula	1
(a)(ii)	Bunsen (burner)	1
(b)	solid remains / ZnO stops dissolving / reacting	1
(c)(i)	more than enough to react	1
(c)(ii)	filtration / filter	1
(d)	heat / evaporate solution	1
	to crystallising point / until saturated	1
	leave to cool	1
(e)	heating / warming not necessary (in step 1)	1

06. 0620_s20_ms_61 Q: 4

Question	Answer	Marks
	add metals to HC*l* in a beaker / flask / test-tube **fair test – max 4** • same volume HC*l* • some concentration HC*l* • same temperature acid • same mass / moles / amount metals • same surface area / form of metal **measure** • start timing when solid added • stop timing when all solid gone / reaction to stop	6

Question	Answer	Marks
	OR • start timing when solid added • stop timing when collected set volume of gas **OR** • start timing when solid added • measure volume of gas after a set time **OR** • measure temperature at start • measure temperature after reaction **OR** highest temperature reached **conclusion** • shortest time is most reactive **OR** • biggest volume of gas most reactive **OR** • biggest temperature change most reactive	

07. 0620_w12_ms_62 Q: 1

(a) flask (1)
measuring/graduated cylinder (1) [2]

(b) **(i)** does not react/unreactive/not reactive enough/below hydrogen in the reactivity series (1) [1]

(ii) magnesium/zinc/iron/aluminium (1) [1]

(c) diagram of (gas) syringe (1)
syringe labelled (1) [2]

(d) lighted splint/flame test (1)
pops (1) [2]

08. 0620_w12_ms_63 Q: 5

(a) Temperature boxes completed correctly (2), –1 for each incorrect [3]

25 31 37 42 48 48 48

Temperature rises calculated correctly (1)

0 6 12 17 23 23 23

(b) all points correctly plotted (3), –1 for any incorrect [5]

smooth straight line graphs drawn with a ruler (1)

labels (1)

(c) **(i)** value from graph (1) 0.50 – 0.52 g allow: 0.5 g ignore units [1]

(ii) value from graph (1) 8.5 – 9.0 °C [1]

allow: 9 °C ignore units

(d) 0.8 g (1) [1]

(e) zinc (1) [2]

temperature stays same when increasing amounts added/no more heat given off/no further reaction (1)

(f) no temperature changes (1) does not react owtte/(1) [2]

09. 0620_w13_ms_62 Q: 4

(c) table of results for Experiments 1, 2 and 3
initial temperature boxes completed correctly (1)
23, 22, 21
maximum temperature boxes correctly completed (1)
26, 24, 71
temperature rises correct (1)
3, 2, 50 [3]

(e) table of results for Experiments 4 and 5
initial and maximum temperature boxes completed correctly (2)
19, 21 44, 29 [2]

all temperature rises correct in tables (1)
25, 8 [1]

(f) appropriate scale for *y* axis (1)
bars inserted at correct heights (3) –1 for any incorrect
not: a line graph
labels (1) [5]

(g) **(i)** temperature rises greatest in Experiment 3 (1)

(ii) magnesium is most reactive / more reactive (1) [2]

(h) hydrogen (1) [1]

(i) **(i)** copper (1)

(ii) displacement/redox/exothermic (1) [2]
allow: oxidation/reduction

(j) solid would react slower/temperature rises would be lower/less temperature change (1)
smaller/less surface area (1) [2]
or
same temperature (1)
same mass of magnesium used (1)

(k) dangerous/too reactive/explodes/owtte (1) [1]

10. 0620_w15_ms_62 Q: 6

	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

11. 0620_w17_ms_61 Q: 4

	reaction with acid method max [6]: **M1** fixed volume of acid **M2** to fixed mass of metal **M3** measure volume of gas / temperature change **M4** named apparatus for the measurement **M5** after time **M6** repeat with other metals **M7** compare / conclude *displacement method* **M1** add each metal to named tin salt solution **M2** observe if deposit is formed **M3** results, e.g. Zn and Fe positive **M4** repeat with named iron salt **M5** results, e.g. Zn positive **M6** conclude	**6**

12. 0620_w17_ms_62 Q: 1

(a)	water	**1**
(b)(i)	arrow under mineral wool **AND** arrow under magnesium ribbon	**1**
(b)(ii)	boiling tube	**1**
(c)	use sandpaper / glass paper / steel wool	**1**
(d)(i)	gas syringe / measuring cylinder over a trough of water	**1**
	labelled	**1**
(d)(ii)	'pops'	**1**
(e)	**large** amount of energy released / **high** temperature reached	**1**

13. 0620_w21_ms_62 Q: 4

Question	Answer	Marks
	reduction method Any 6 from: • crush rock / break into smaller pieces / powder • using a suitable method, e.g. pestle and/or mortar, hammer • add more reactive metal / suitable gas • carbon / coke / zinc / aluminium / magnesium / CO / hydrogen specified • heat • In a suitable container (e.g. crucible, evaporating basin) • cobalt displaced / cobalt formed **electrolysis method** Any 6 from: • crush rock / break into smaller pieces / powder • using a suitable method, e.g. pestle and / or mortar, hammer • add a (dilute) acid • suitable strong acid named (e.g. HC*l*, H_2SO_4, HNO_3) • electrolysis (of solution) • specified inert material for electrodes (e.g. carbon, platinum) • cobalt obtained at the negative electrode / cathode **displacement method** Any 6 from: • crush rock / break into smaller pieces / powder • using a suitable method, e.g. pestle and / or mortar, hammer • add a (dilute) acid • suitable strong acid named (e.g. HC*l*, H_2SO_4, HNO_3) • add metal more reactive than cobalt • name of metal added specified (e.g. iron, zinc, magnesium) • Cobalt displaced / cobalt formed	6