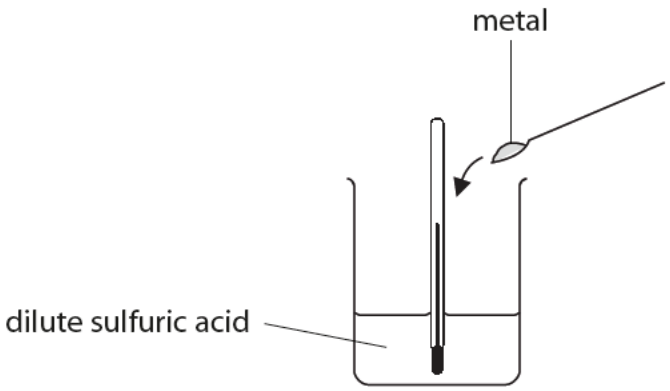
1 A student uses this apparatus to investigate the temperature changes that take place when certain metals are added to dilute sulfuric acid.



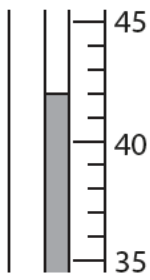
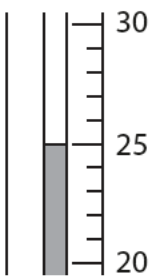
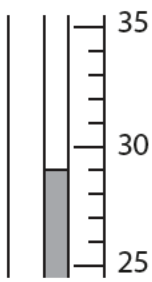
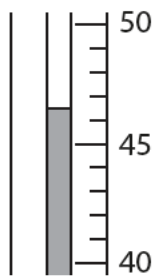
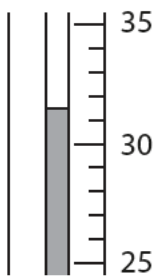
This is the student's method:

- use the five metals aluminium, copper, iron, magnesium and zinc
- add the same amount of each metal separately to 25 cm^3 of acid
- in each case the acid is in excess
- stir the mixture and record the highest temperature reached

(a) Use the diagrams of the thermometer in the table to record the highest temperature reached in each experiment.

Record all temperatures to the nearest 0.5 °C.

(3)

	Metal				
	aluminium	**opper**	**iron**	**magnesium**	**zinc**
Thermometer					
Highest temperature in °C					

(b) (i) In each experiment the initial temperature of the acid is 25 °C.

Which metal produces the largest temperature rise?

(1)

.....

(ii) Explain the result obtained with copper.

(1)

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(c) The same amount of magnesium is added to 50 cm^3 of dilute sulfuric acid.

Explain the effect this would have on the temperature change observed.

(2)

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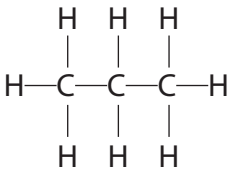
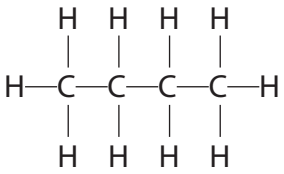
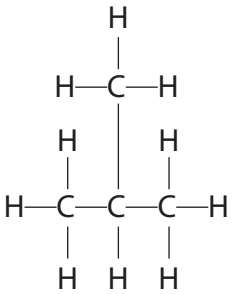
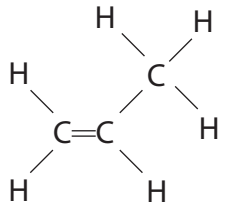
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(Total for Question 1 = 7 marks)

2 The table shows the displayed formulae of four hydrocarbons, W, X, Y and Z.

W 	**X** 
Y 	**Z** 

(a) Give the name of hydrocarbon W.

(1)

.....

(b) Give the molecular formula for hydrocarbon X.

(1)

.....

(c) Which of the hydrocarbons belong to the same homologous series of compounds?

(1)

.....

(d) Give the empirical formula of hydrocarbon Z.

(1)

.....

(e) Z is an unsaturated hydrocarbon.

Explain what is meant by the term **unsaturated hydrocarbon**.

(3)

unsaturated .....

.....

hydrocarbon .....

.....

.....

(f) (i) The substitution reaction between W and bromine is similar to the reaction between methane and bromine.

Suggest the displayed formula for a possible product of the reaction between W and bromine.

(1)

.....

(ii) State the condition required for this reaction to take place.

(1)

.....

(Total for Question 2 = 9 marks)

3 Titanium is a metal that can be extracted from its ore in a three-stage process.

stage 1 titanium ore is converted into titanium dioxide, TiO_2

stage 2 titanium dioxide is then converted into titanium chloride, $TiCl_4$

stage 3 titanium chloride is converted into titanium, Ti

(a) A titanium ore contains the composition by mass

Fe = 36.8% Ti = 31.6% O = 31.6%

Show by calculation that the empirical formula of this ore is $FeTiO_3$

(3)

(b) The equation for the conversion of titanium dioxide into titanium chloride is

$$TiO_2 + 2Cl_2 + C \rightarrow TiCl_4 + CO_2$$

Explain which element has been oxidised in this reaction.

(2)

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(c) In stage 3

- titanium chloride vapour is passed through molten magnesium in an atmosphere of argon
- the products are allowed to cool to form a solid mixture of titanium and magnesium chloride
- this mixture is crushed into a powder and then added to water to dissolve the magnesium chloride

(i) Write a chemical equation for the reaction between titanium chloride and magnesium.

(2)

.....

(ii) Suggest why this reaction cannot be successfully carried out in an atmosphere of air.

(1)

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.....

(iii) Suggest why the mixture is crushed into a powder before it is added to water.

(1)

.....

.....

(d) (i) Describe the bonding in titanium metal.

(2)

.....

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.....

.....

(ii) Explain why titanium conducts electricity.

(1)

.....

.....

(Total for Question 3 = 12 marks)

4 Neodymium is a metal used in powerful magnets.

(a) One stage in the extraction of neodymium from its ore is to heat neodymium fluoride with calcium.

The table shows the melting points of the substances in this stage of the extraction.

Melting point in °C			
calcium	calcium fluoride	neodymium	neodymium fluoride
850	1418	1024	1410

(i) Balance the equation for this reaction.

(1)

.....NdF_3 + ...Ca → .....Nd + ...CaF_2

(ii) At one point in this extraction, the temperature of the reaction mixture is 1100 °C.

Which two substances are solids at this temperature?

(1)

..... and .....

(iii) Suggest the most likely type of bonding present in neodymium fluoride.

(1)

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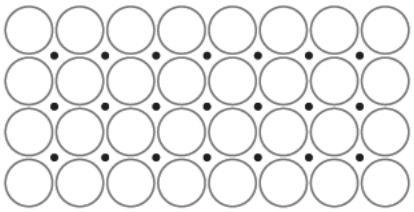
(iv) Neodymium reacts with oxygen to form neodymium oxide.

Suggest the formula of neodymium oxide.

(1)

.....

(b) The diagram shows the particles in neodymium



Key

○ neodymium ion

• electron

Explain, with reference to the diagram, why neodymium is malleable and a good conductor of electricity.

(4)

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(Total for Question 4 = 8 marks)

5 Aluminium and iron have some similar properties.

Both metals

- are malleable
- are ductile (can be drawn into a wire)
- are good conductors of electricity
- are good conductors of heat
- have a high melting point

(a) (i) Choose two properties from the list that make iron a suitable metal for saucepans.

(2)

1 .....

2 .....

(ii) Choose two properties from the list that make aluminium a suitable metal for power cables.

(2)

1 .....

2 .....

(b) Steel is an alloy containing iron.

These are three differences between steel and aluminium.

- steel can rust but aluminium resists corrosion
- steel has a higher density than aluminium
- steel is much stronger than aluminium

(i) Use information from the list to suggest why steel is the better metal for making bridges.

(1)

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(ii) Use information from the list to suggest why aluminium is the better metal for making aircraft bodies.

(1)

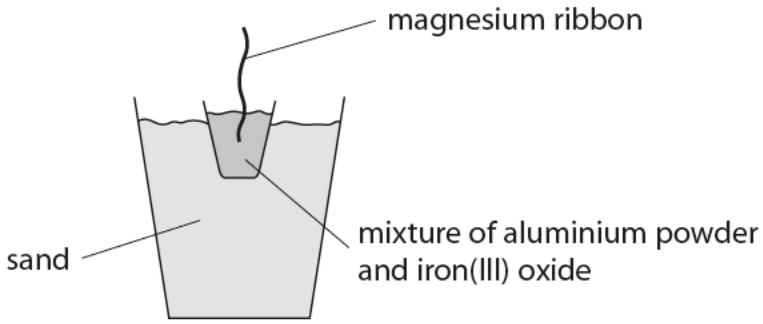
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(c) The reaction between aluminium and iron(III) oxide is known as a thermite reaction.

The diagram shows how this thermite reaction can be carried out.



The magnesium ribbon is lit to ignite the reaction mixture.

The reaction is highly exothermic.

The equation for the reaction is

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

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

(1)

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.....

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(ii) What does the reaction suggest about the reactivity of aluminium compared to the reactivity of iron?

Explain your answer.

(2)

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(iii) Which element is oxidised in this thermite reaction?

Give a reason for your answer.

(2)

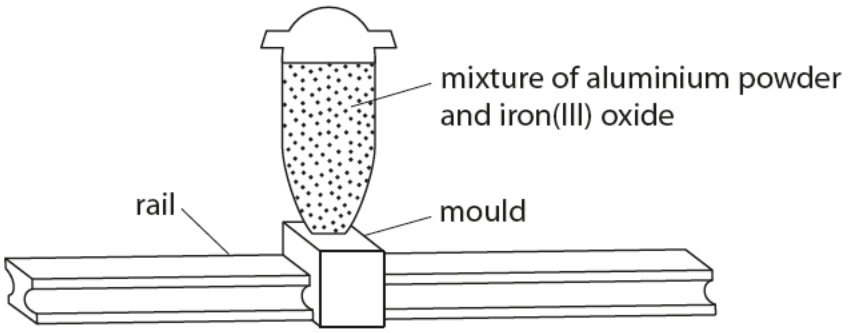
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(d) This thermite reaction can be used to join together two rails on a railway line.



The reaction mixture is ignited and molten iron pours into the mould. The mould is removed and the molten iron solidifies to create a join between the two rails.

Explain why the iron produced in the reaction is molten.

(1)

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(Total for Question 5 = 12 marks)