

Q1.

Copper is a transition metal.

- (a) (i) Where is copper in the periodic table?

Tick (✓) **one** box.

in the central block

in Group 1

in the noble gas group

(1)

- (ii) What is a property of copper?

Tick (✓) **one** box.

breaks easily

conducts electricity

does not conduct heat

(1)

- (b) Copper ores are quarried by digging large holes in the ground, as shown in **Figure 1**.

Figure 1



© photlurg/iStock/Thinkstock

Give **two** reasons why quarrying is bad for the environment.

(2)

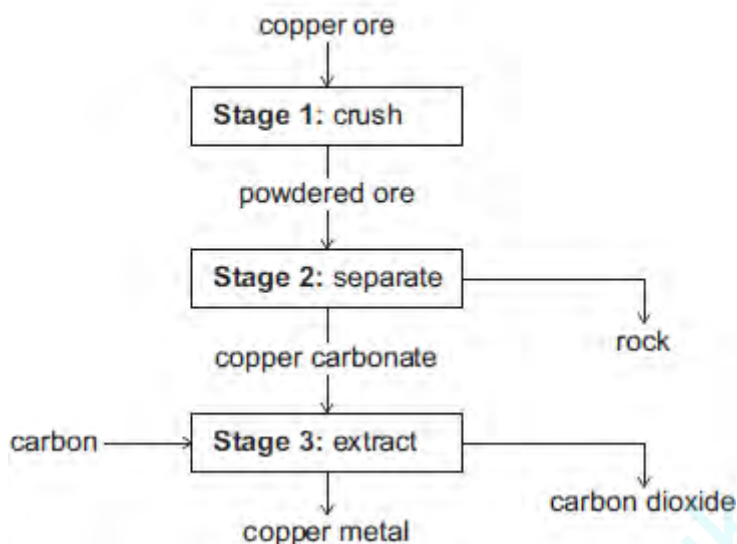
(c) Some copper ores contain only 2% copper.

Most of the ore is rock that is not needed.

In one ore, the main compound is copper carbonate (CuCO_3).

Figure 2 shows the stages used in the extraction of copper from this ore.

Figure 2



(i) Why is **Stage 2** important?

(1)

(ii) The equation for the reaction in **Stage 3** is:



From the symbol equation, a company calculated that 247 tonnes of copper carbonate are needed to produce 127 tonnes of copper and 132 tonnes of carbon dioxide are released.

Calculate the mass of carbon needed to make 127 tonnes of copper.

copper carbonate	+	carbon	→	copper	+	carbon dioxide
247 tonnes	 tonnes		127 tonnes		132 tonnes

(2)

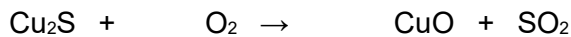
(iii) Suggest **one** reason why it is important for the company to calculate the mass of reactants in **Stage 3**.

(1)

(Total 8 marks)

Q2.

Copper is a widely used metal. The main ore of copper contains copper sulfide. Copper can be extracted from copper sulfide in a three stage process.



(1)

- (ii) Explain why there would be an environmental problem if the gas from this reaction were allowed to escape into the atmosphere.

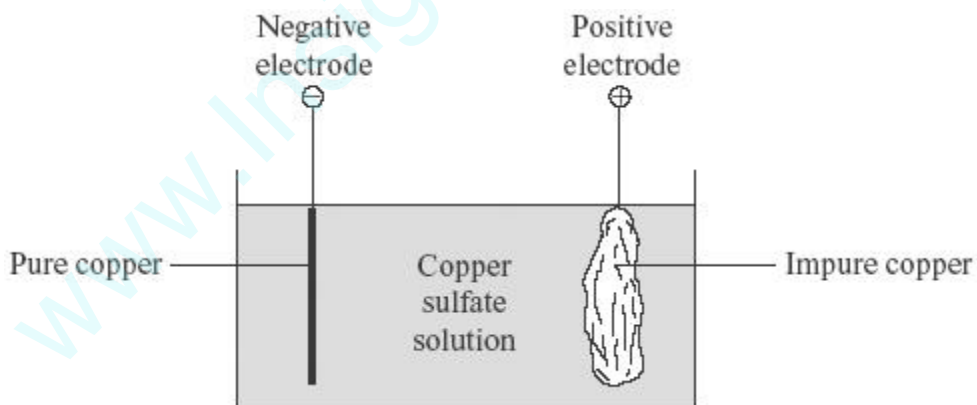
(2)

- (b) In the second stage copper oxide, CuO, is reduced using carbon.

Describe and explain what happens during this reaction.

(2)

- (c) During the third stage the copper can be purified as shown in the diagram.



- (i) What is the name of the type of process used for this purification?

(1)

- (ii) Give **one** use of purified copper.

(1)

- (d) Copper-rich ores are running out.

New ways of extracting copper from low grade ores are being researched.

Recycling of copper may be better than extracting copper from its ores.

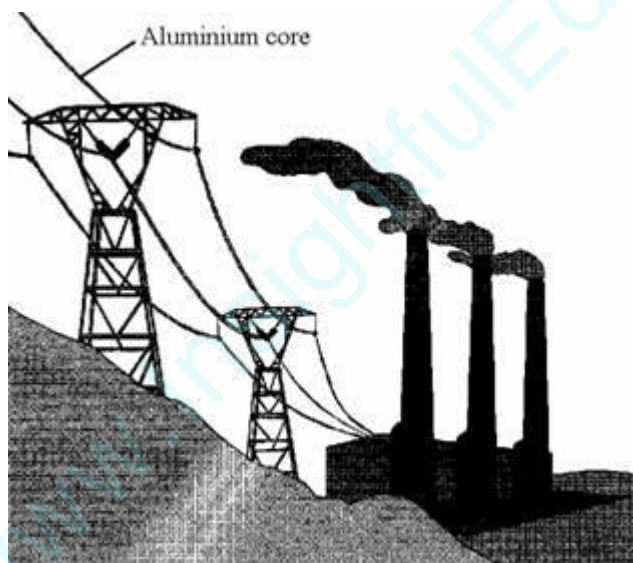
Explain why.

(3)

(Total 10 marks)

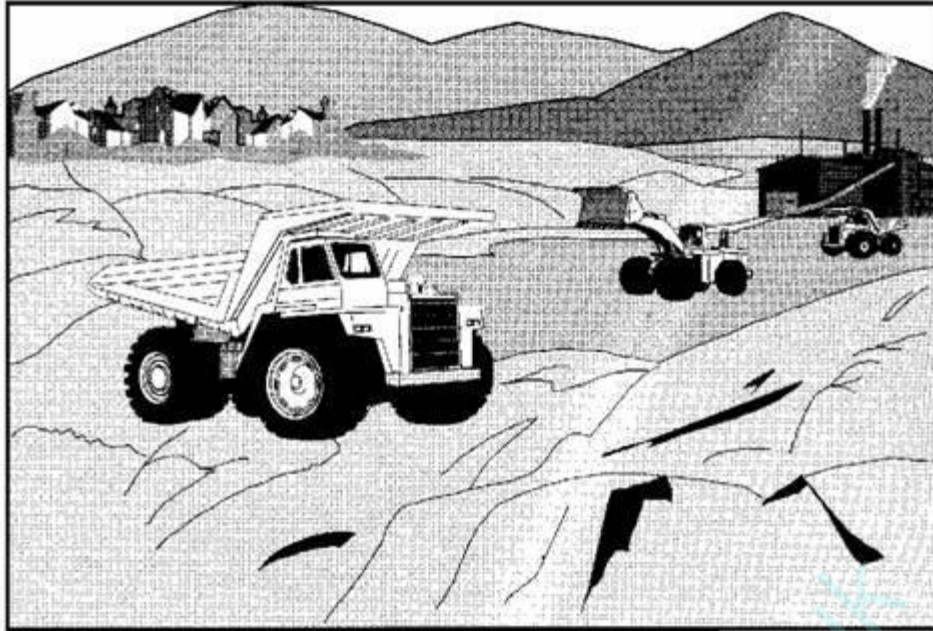
Q3.

- (a) Aluminium is more expensive than iron. Why is aluminium and not iron used for the central core in power cables?



(2)

- (b) Many industrial processes involve the removal of minerals by quarrying.



All quarrying has some effect on the environment and on people's lives. Make comments about the social, economic, health, safety and environmental effects of quarrying.

(5)

(Total 7 marks)

Q4.

Many everyday items are made from iron.

(a) Haematite is an *ore* of iron. Haematite contains iron oxide, Fe_2O_3 .

(i) What is the meaning of the term *ore*?

(1)

(ii) Iron can be produced by reacting iron oxide with carbon in a blast furnace.

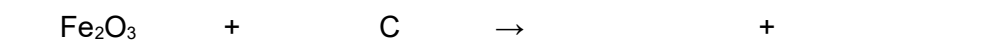
What type of reaction produces the iron?

(1)

(iii) The word equation for this reaction is:

iron oxide + carbon → iron + carbon dioxide

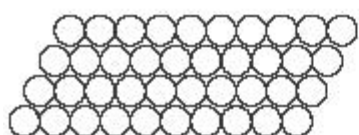
Complete and balance the symbol equation for this reaction.



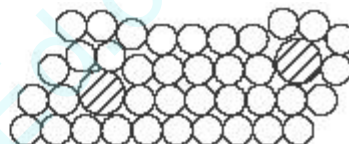
(2)

(b) Pure iron is relatively soft and not very strong.

The iron from the blast furnace is very hard and brittle. It contains about 4% carbon and is used as cast iron.



Pure iron

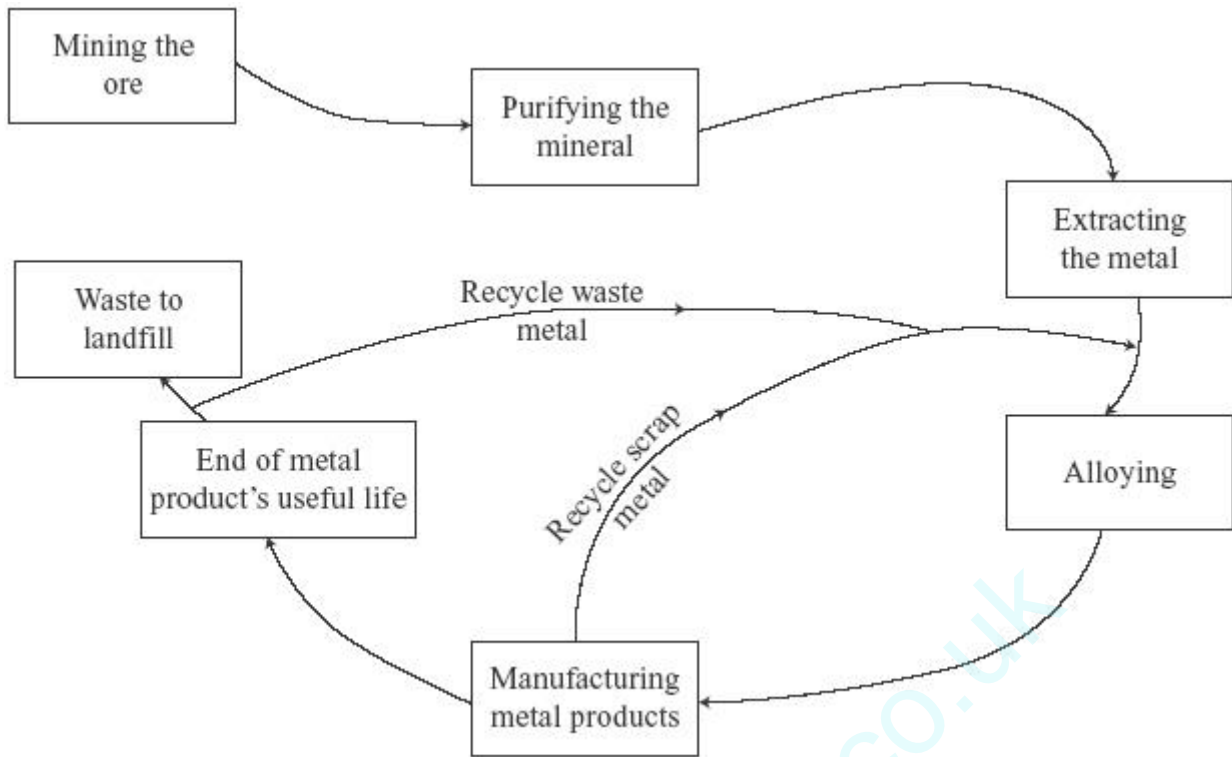


Cast iron

Explain the differences in the properties of pure iron and cast iron by referring to the diagrams.

(3)

(c) The diagram shows the way in which iron is extracted, used and recycled.



Explain why the recycling of iron is necessary for sustainable development.

(3)
(Total 10 marks)

Q5.

Polymers are used to make many materials that people need.

- (a) Plastic bags are used to carry, protect and store food. Plastic bags are made from polymers.



Plastic bag made from a polymer

- (i) Ethene is the small molecule (the monomer) used to make the polymer for this plastic bag.

Name the polymer that is made from ethene.

(1)

- (ii) Use the correct word from the box to complete the sentence about ethene.

condensing corroding cracking

Ethene is made by breaking down large hydrocarbon molecules into smaller hydrocarbon molecules by a process called _____

(1)

- (iii) The hydrocarbon ethene has the formula C_2H_4

Complete the sentence about ethene.

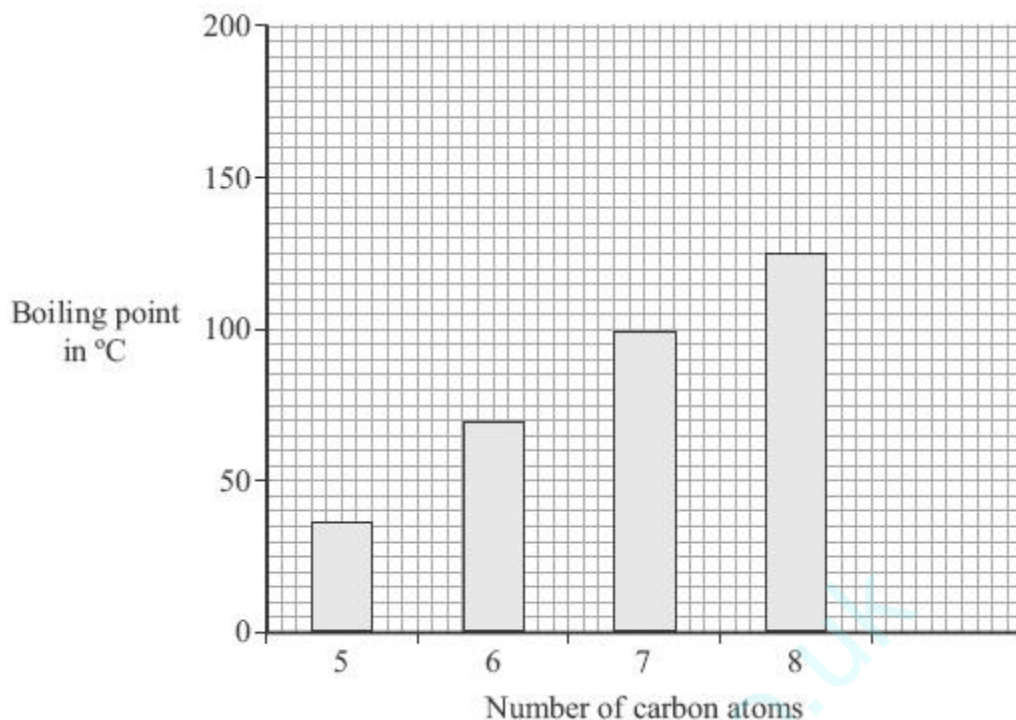
Ethene is a hydrocarbon made up of carbon and _____ atoms.

(1)

- (b) The hydrocarbons used to make ethene come from crude oil. The properties of hydrocarbons are linked to the number of carbon atoms in their molecules.

Number of carbon atoms	5	6	7	8	9
Boiling point in °C	36	69	99	125	151

- (i) Use the data in the table to complete the bar chart.



(2)

- (ii) What happens to the boiling point of a hydrocarbon as the number of carbon atoms increases?

(1)

- (iii) All the hydrocarbons in the table are found in petrol. Petrol is one of the fractions separated from crude oil.

Describe how the fractions are separated from crude oil.

(2)

- (c) Most plastic bags that are made of hydrocarbons are not biodegradable.

Used plastic bags can be:

- dumped into large holes, which is called landfill
- burned to give out heat energy, which would produce large amounts of gases.

Would burning used plastic bags be better for the environment than dumping them in landfill?

Explain your answer.

(2)
(Total 10 marks)

Q6.

Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.



By Sun Ladder (Own work) [CC-BY-SA-3.0 or GFDL],
via Wikimedia Commons

(a) Iron is extracted by heating a mixture of iron oxide and carbon in a blast furnace.

(i) Name this type of reaction.

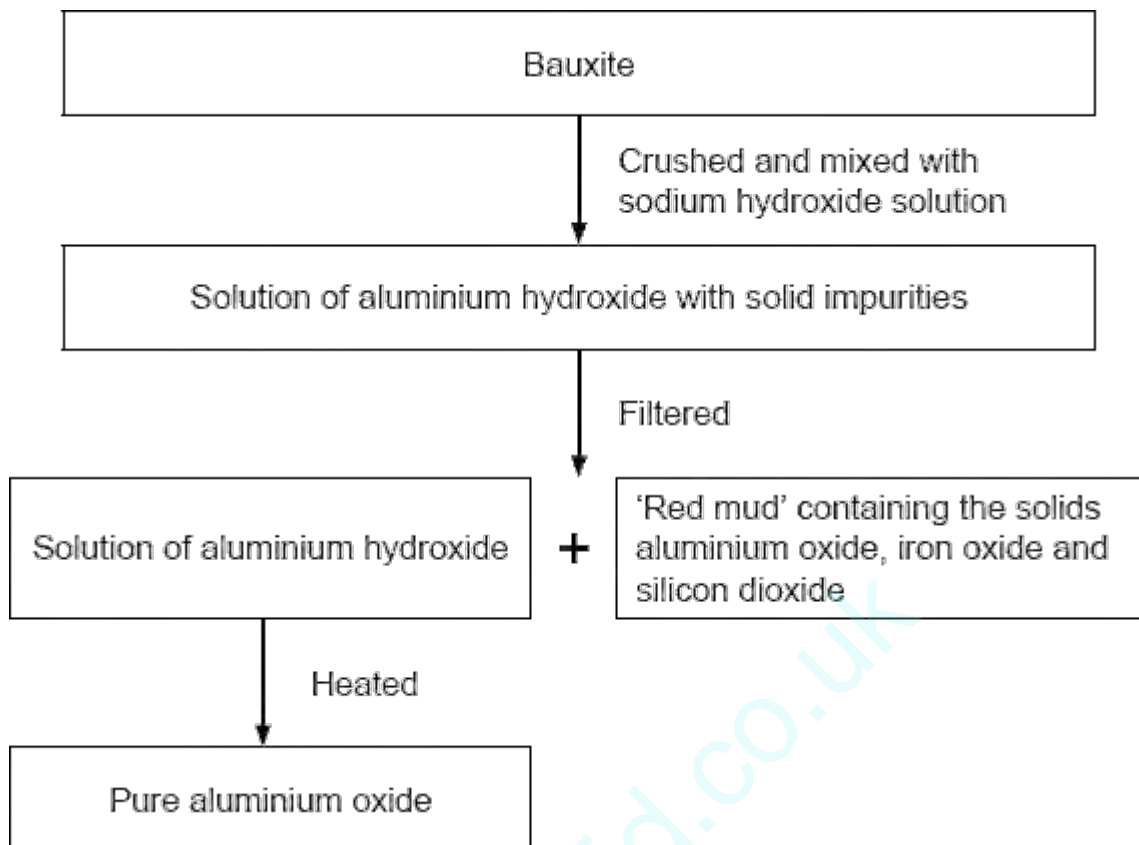
(1)

(ii) Balance the symbol equation for this reaction.



(1)

(b) Aluminium ore, bauxite, contains aluminium oxide, iron oxide and silicon dioxide.
Aluminium is extracted by electrolysis of aluminium oxide.



The 'red mud' which is dumped in very large ponds contains:

Name of solid	Percentage (%)
Aluminium oxide	10
Iron oxide	65
Silicon dioxide	25

- (i) 100 tonnes of bauxite produced 50 tonnes of pure aluminium oxide and 50 tonnes of 'red mud'.

What percentage of aluminium oxide did the bauxite contain?

Answer = _____ %

(1)

- (ii) Apart from the solids shown in the table, name **one** other substance that would be in the 'red mud'.

(1)

- (iii) The purification of the aluminium oxide is usually done near to the bauxite quarries.

Suggest **one** reason why.

(1)

(c) Aluminium is used to make many things including cans.

During one year in the USA:

- 100 billion aluminium cans were sold
- 55 billion aluminium cans were recycled.

Give **one** environmental impact of recycling aluminium cans and **one** ethical or social impact of recycling aluminium cans.

Environmental _____

Ethical or social _____

(2)

(Total 7 marks)

Q7.

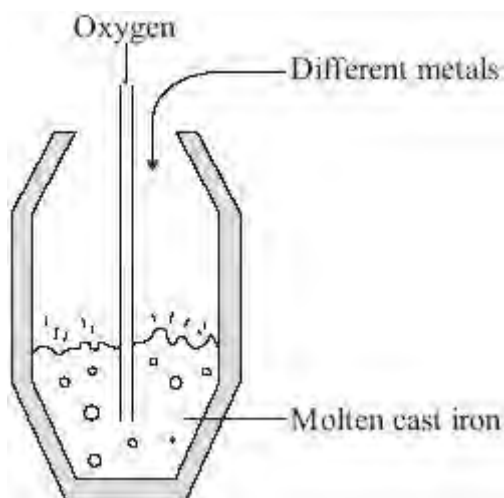
The demand for iron and steel is high.

(a) Iron that is extracted from its oxide by carbon reduction in a blast furnace is called cast iron. Cast iron contains about 4% carbon. This carbon makes cast iron very brittle.

Carbon steels can be made by the following processes.

- Blowing oxygen into molten cast iron to remove most of the carbon.
- Adding a calculated amount of carbon.

Sometimes different metals may also be added to the molten carbon steels.



- (i) Suggest how blowing oxygen into molten cast iron removes most of the carbon.

(2)

- (ii) Why are different metals sometimes added to molten carbon steels?

(1)

- (b) The percentage of iron and steel recycled in the UK has been increasing.

Year	%iron and steel recycled
1998	25
2000	35
2002	42
2004	46
2006	57

The UK government has set targets for the percentage of iron and steel to be recycled.

In 2006 the target was exceeded.

Suggest **two** reasons why the UK government wants to encourage recycling of iron and steel.

1. _____

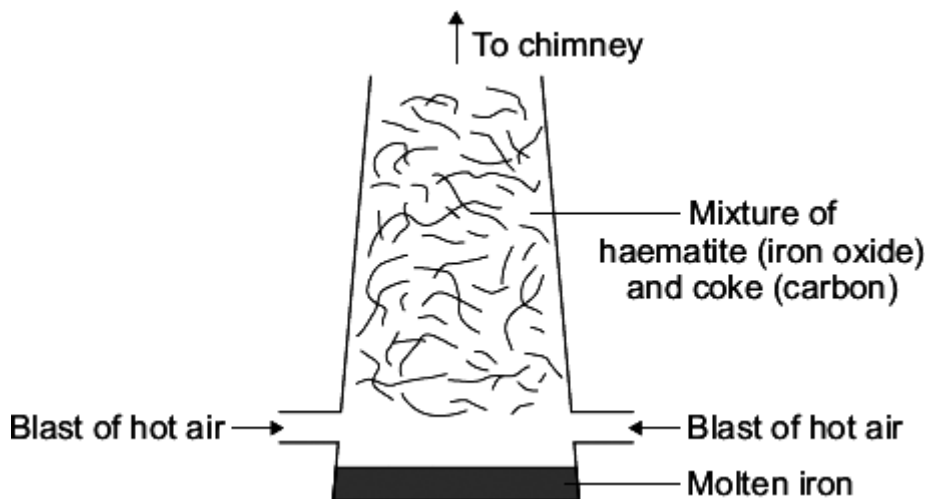
2. _____

(2)

(Total 5 marks)

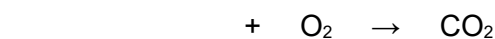
Q8.

Iron is produced by reacting a mixture of haematite and coke in a blast furnace. Haematite is an ore of iron containing iron oxide (Fe_2O_3). Coke is made from coal and is almost pure carbon.



- (a) (i) The coke burns in air. This reaction heats the furnace to above 1300 °C.

Complete the chemical equation for carbon reacting with oxygen to form carbon dioxide.



(1)

- (ii) Carbon monoxide is also formed in the furnace. Carbon monoxide reacts with iron oxide to produce iron and carbon dioxide.

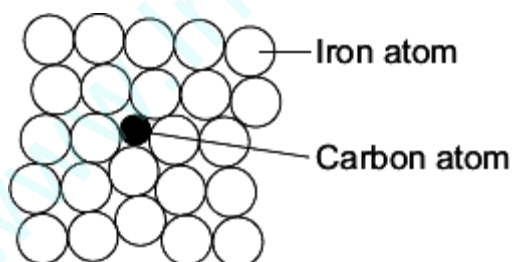


Complete and balance the chemical equation for the production of iron.



(2)

- (iii) Iron from a blast furnace is called cast iron and contains about 4% carbon.



Why is pure iron softer than cast iron?

(1)

- (b) Steel is made by reducing the percentage of carbon in cast iron and then adding different metals to form the type of steel required.

In the UK we use about 1.8 billion steel cans every year but only 30% of these are recycled. Recycling reduces waste. Producing steel from recycled cans requires only 25% of the energy needed to make steel from iron ore.

Give **three** environmental benefits of recycling a higher percentage of used steel cans.

1. _____

2. _____

3. _____

(3)
(Total 7 marks)

Q9.

Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers. The Government states that this is because plastic bags use up resources that are not renewable and that the manufacture of plastic bags produces carbon dioxide. Most of these plastic bags are made from poly(ethene). The table shows methods to deal with large numbers of used plastic bags.

Method	Description of what happens to the plastic bag
Reused	used again by the customer
Recycled	collected, transported, washed and melted to make new plastic items
Burned	collected, transported and burnt to release heat energy
Dumped	mixed with other household waste, collected, transported and disposed of at a landfill site

Use the information and your knowledge and understanding to briefly give **one advantage and one disadvantage** for each of these methods.

Reused _____

Recycled _____

Burned _____

Dumped _____

(4)
(Total 4 marks)

Q10.

Figure 1 shows a surfer on a surfboard.

Figure 1



Some surfboards are made from addition polymers.

Addition polymers are made from small alkene molecules.

(a) Which type of bonding is present in small alkene molecules?

Tick (✓) **one** box.

Covalent

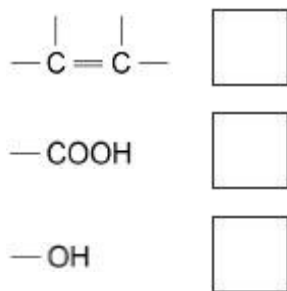
Ionic

Metallic

(1)

(b) What is the functional group in these small alkene molecules?

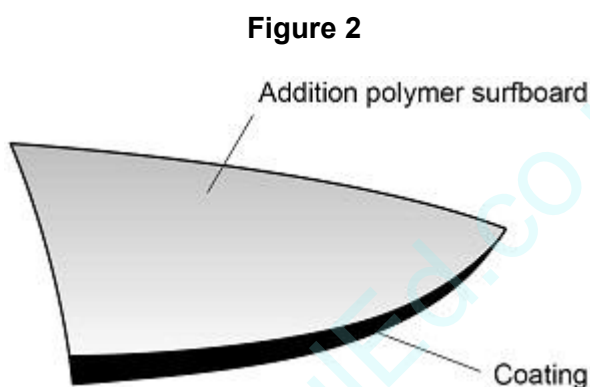
Tick (✓) **one** box.



(1)

Figure 2 shows the structure of part of an addition polymer surfboard.

The outer surface of the surfboard is coated.



The coating is made from soda-lime glass fibres surrounded by a plastic.

(c) What type of material is the coating of the surfboard?

Tick (✓) **one** box.

- | | |
|-----------|--------------------------|
| Alloy | <input type="checkbox"/> |
| Ceramic | <input type="checkbox"/> |
| Composite | <input type="checkbox"/> |
| Nanotube | <input type="checkbox"/> |

(1)

(d) Complete the sentence.

Choose answers from the box.

air	ammonia	copper
------------	----------------	---------------

limestone	sand
-----------	------

The materials used to make the soda-lime glass fibres are sodium carbonate,
 _____ and _____

(2)

(e) Suggest **two** reasons why surfboards are coated.

1 _____

2 _____

(2)

Some surfboards are made from wood.

The following table contains information about the materials in an addition polymer surfboard and a wooden surfboard.

	Addition polymer surfboard	Wooden surfboard
Relative strength	14	38
Cost (£ per m³)	140	390
Density (kg/m³)	50	150
Disposal at end of life	Difficult to recycle	Can be used as fuel

(f) Suggest **two** advantages and **two** disadvantages of using addition polymers rather than wood to make surfboards.

Use the table.

Advantages of addition polymers _____

Disadvantages of addition polymers _____

(4)

(g) Calculate the volume of wood in a wooden surfboard of mass 5.25 kg

Use the table above and the equation:

$$\text{Density in kg/m}^3 = \frac{\text{Mass in kg}}{\text{Volume in m}^3}$$

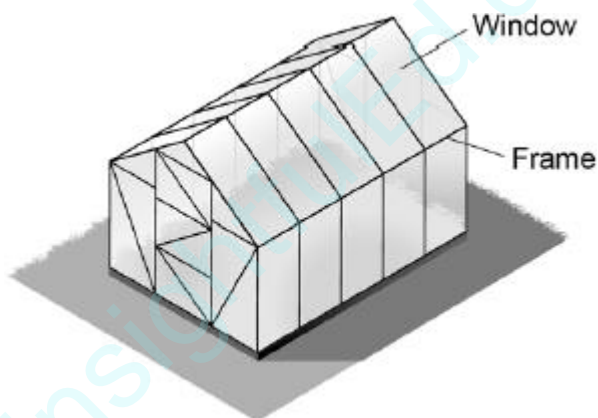
Volume = _____ m³

(3)

(Total 14 marks)

Q11.

The diagram shows a greenhouse.



A greenhouse frame can be made from wood or aluminium.

Table 1 gives some information about wood and aluminium.

Table 1

	Wood	Aluminium
Raw material	Renewable	Non-renewable
Mass of greenhouse frame in kg	80	20
Useful lifetime in years	20	50
End of useful life	Can be chopped up and used as fuel	Can be recycled into new aluminium products

(a) Evaluate the use of each material for making greenhouse frames.

Use **Table 1**.

(4)

(b) Greenhouse frames are transported by lorry.

The lorry used can carry a maximum load of 12 tonnes.

Calculate the largest number of wooden greenhouse frames which could be transported by the lorry.

Use **Table 1**.

100 kg = 1 tonne

Number of wooden greenhouse frames = _____

(2)

(c) It is more sustainable to make greenhouse frames from recycled aluminium than from aluminium from aluminium ore.

Give **two** reasons why.

1. _____

2. _____

(2)

(d) Greenhouse windows can be made from glass or from polymers.

Table 2 gives information about glass and a polymer.

Table 2

	Glass	Polymer
Density in g / cm ³	2.8	1.2
Cost in £ per m ²	20	28
Effect of sunlight	No effect	Discolours over time

Suggest **one** advantage of making greenhouse windows from the polymer rather than from glass.

Use **Table 2**.

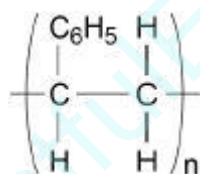
(1)

(Total 9 marks)

Q12.

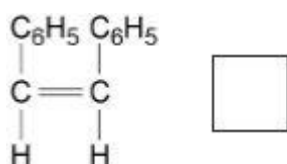
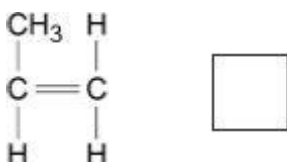
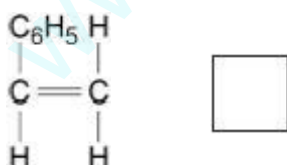
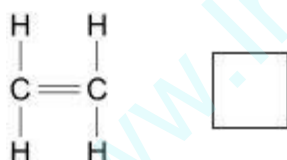
Disposable cups are made from coated paper or poly(styrene).

The diagram below represents the structure of poly(styrene).



(a) Which small molecule is used to produce poly(styrene)?

Tick **one** box.



(1)

(b) Which process is used to make poly(styrene) from small molecules?

Tick **one** box.

Cracking

Distillation

Fermentation

Polymerisation

(1)

(c) Complete the sentences.

Choose answers from the box.

ceramics	composites	four	many
monomers	polymers	two	

Poly(styrene) is produced from small molecules called _____

When poly(styrene) is made, _____ styrene molecules join to form large molecules.

These large molecules are called _____ .

(3)

(d) The table below gives some information about disposable cups.

	Coated paper cups	Polystyrene cups
Source of raw materials	Wood	Crude oil
Energy to make 1 cup in arbitrary units	550	200
Biodegradable	Yes	No
Recyclable	No	Yes

Compare the advantages and disadvantages of using coated paper and poly(styrene) to make disposable cups.

Use the table above and your knowledge and understanding of life cycle assessments (LCAs).

(4)

(Total 9 marks)

Q13.

This question is about copper and alloys of copper.

Solders are alloys used to join metals together.

Some solders contain copper.

The table below shows information about three solders, **A**, **B** and **C**.

Solder	Melting point in °C	Metals in solder
A	183	tin, copper, lead
B	228	tin, copper, silver
C	217	tin, copper, silver

- (a) Solder **B** and solder **C** are now used more frequently than solder **A** for health reasons.

Suggest **one** reason why.

Use the table above.

(1)

(b) Suggest **one** reason why solders **B** and **C** have different melting points.

Use the table above.

(1)

Copper can be obtained by:

- processing copper ores
- recycling scrap copper.

(c) Suggest **three** reasons why recycling scrap copper is a more sustainable way of obtaining copper than processing copper ores.

1 _____

2 _____

3 _____

(3)

Copper is extracted from low-grade ores by phytomining.

(d) Describe how copper is extracted from low-grade ores by phytomining.

(4)

(e) Phytomining has **not** been widely used to extract copper.

Suggest **two** reasons why.

1 _____

Q14.

This question is about materials used to make plates.

Plates are made from ceramics, paper or poly(propene).

- (a) Paper plates are biodegradable and recyclable.

Which stage of a life cycle assessment (LCA) would contain this information?

Tick (✓) **one** box.

Disposal at the end of useful life

Extracting and processing raw materials

Manufacturing and packaging

Use and operation during lifetime

(1)

- (b) Which **two** processes are used to make ceramic plates?

Tick (✓) **two** boxes.

Forming a composite

Galvanising with zinc

Heating in a furnace

Melting sand and boron trioxide

Shaping wet clay

(2)

Poly(propene) is produced from an alkene.

- (c) Complete the sentences.

The name for very large molecules such as poly(propene) is _____.

The name of the alkene used to produce poly(propene) is _____.

(2)

(d) The alkene needed to make poly(propene) is produced from crude oil.

Which **two** processes are used to produce this alkene from crude oil?

Tick (✓) **two** boxes.

Chromatography

Cracking

Fermentation

Fractional distillation

Quarrying

(2)

(e) What type of bond joins the atoms in a molecule of poly(propene)?

Tick (✓) **one** box.

Covalent

Ionic

Metallic

(1)

The table below shows information about two polymers used to make plates.

Polymer	Effect of heating the polymer
A	does not melt
B	melts at 50 °C

(f) What type of polymer is polymer **A**?

Use the table above.

(1)

(g) Why does polymer **A** behave differently to polymer **B** when heated?

You should refer to crosslinks in your answer.

(1)

(Total 10 marks)

Q15.

Disposable cups are made from coated paper or poly(styrene).

The table below shows information on the life cycle assessments (LCAs) of disposable cups.

	Coated paper cups	Poly(styrene) cups
Raw materials	Wood	Crude oil
Mass of 1 cup in g	8.3	1.9
Energy to produce 1 cup in kJ	550	200
Energy released when 1 cup is burned in kJ	166	76
Biodegradable	Yes	No
Recyclable	No	Yes

(a) Evaluate the use of coated paper compared with poly(styrene) to make disposable cups.

Use the table above and your knowledge and understanding of LCAs.

(6)

- (b) Calculate the energy needed to produce 1.00 kg of coated paper cups.
Use the table above.
Give your answer in standard form.

Energy = _____ kJ

(2)

- (c) Melamine is a polymer used to make non-disposable cups.
Melamine does **not** melt when it is heated.
Explain why.

(2)

(Total 10 marks)

Q16.

Read the article and then answer the questions.

**Supermarkets launch eco-friendly plastic milk bags.
Could this be the end of the milk bottle?**



Milk bottles are made from glass or from plastic.

Glass milk bottles contain 0.5 litres of milk. When the milk is used up the empty bottles are returned to be re-used. Glass milk bottles are re-used 24 times on average. The glass to make new milk bottles is produced when a mixture of sand, limestone, soda and recycled glass is heated to about 1600 °C in a furnace. There are almost unlimited amounts of the raw materials needed to produce this glass. About 35% of used glass is recycled.

The most common plastic milk bottles contain 2 litres of milk. When the milk is used up the empty bottles are discarded as waste. The plastic used to make these milk bottles is poly(ethene). Poly(ethene) is produced from crude oil by first using fractional distillation, then cracking the naphtha fraction and finally polymerising the ethene. About 5% of used poly(ethene) is recycled.

The new plastic milk bags contain 2 litres of milk. The milk bags are also made from poly(ethene). A milk bag uses 75% less poly(ethene) than is used to make the poly(ethene) milk bottles. When the milk is used up the empty bags are discarded as waste.

- (a) Describe what happens in fractional distillation so that fractions, such as naphtha, are separated from crude oil.

(3)

- (b) Supermarkets claim that using milk bags instead of milk bottles would have less environmental impact.

Do you agree with this claim?

Use the information in the article and your knowledge and understanding to make appropriate comparisons to justify your answer.

(4)

(Total 7 marks)

Q17.

This question is about life cycle assessments (LCAs).

- (a) Milk bottles can be made from glass or from a polymer.

The table below shows information about milk bottles of equal volume.

	Glass	Polymer
Raw materials	Limestone Sand Sodium carbonate	Crude oil
Energy needed to process raw materials in kilojoules	6750	1710
Energy needed to manufacture bottle in kilojoules	750	90

Mass of bottle in grams	200	20
Mean number of times used during lifetime of bottle	25	1
One disposal method at end of useful life	Recycled to make different glass products	Recycled to make different polymer products

Evaluate the use of glass for milk bottles compared with the use of a polymer for milk bottles.

Use features of life cycle assessments (LCAs) in your answer.

Use the table above.

(6)

- (b) Milk is also sold in cardboard cartons.

A carton is made using 40 cm³ of cardboard.

The density of the cardboard is 0.40 g/cm³.

Calculate the mass of the carton.

Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Mass = _____g

(3)
(Total 9 marks)

Q18.

This question is about materials used to make food plates.

Food plates are made from paper, polymers or ceramics.

The table below shows information about plates of the same diameter made from each of these materials.

	Food plate material		
	Paper	Polymers	Ceramics
Raw material	Wood	Crude oil	Mined clay
Number packaged in 10 dm ³ cardboard box	500	100	50
Average number of times used	1	400	1000
Biodegradable?	Yes	No	No
Recyclable?	Yes	Yes	No

(a) The table above does **not** show information about energy usage.

Suggest **two** pieces of information about energy usage which would help to produce a complete life cycle assessment (LCA) for the three food plate materials.

1 _____

2 _____

(2)

(b) Evaluate the use of these materials for making food plates.

You should use features of life cycle assessments (LCAs).

Use the table above.

(4)

(c) Describe how ceramic food plates are produced from clay.

(2)

(Total 8 marks)

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Mark schemes

Q1.

- (a) (i) central block 1
- (ii) conducts electricity 1
- (b) any **two** from:
- visual pollution
 - noise pollution
 - dust pollution
 - habitat destruction. 2
- (c) (i) to concentrate the ore / copper carbonate
or
to remove / separate the rock 1
- (ii) 12 (tonnes)
If answer is incorrect allow one mark for $(127 + 132) - 247$ or $259 - 247$ 2
- (iii) any **one** from:
- so no reactant is wasted / left unreacted
 - so they know how much product they will make
 - need to record / compensate for the carbon dioxide produced
allow so they can work out their carbon footprint. 1
- [8]

Q2.

- (a) (i) $\text{Cu}_2\text{S} + 2\text{O}_2 \rightarrow 2\text{CuO} + \text{SO}_2$
accept fractions and multiple 1
- (ii) any **two** from:
- sulfur dioxide
accept sulphur dioxide / sulphur oxide / SO_2
 - causes acid rain
ignore other comments eg global warming / ozone / global dimming / greenhouse effect
 - consequence of acid rain eg kills fish / plants 2
- (b) any **two** from:
- heat (copper oxide with carbon)

- oxygen is removed by carbon
accept copper (oxide) loses oxygen

or

*carbon gains oxygen
accept carbon oxide*

or

carbon monoxide / carbon dioxide is produced

or

carbon displaces copper
*accept a correct word or balanced
symbol equation*

- because carbon is more reactive than copper
allow a correct comparison of reactivity

2

- (c) (i) electrolysis
accept electroplating

1

- (ii) (electrical) wiring / appliances / coins / pipes / cladding for buildings / jewellery / making alloys

1

or

named alloys

- (d) any **three** explanations from:

for recycling

- less acid rain (pollution)
- copper reserves last longer / conserved

or

do not run out

- energy for extraction (saved)

or

less energy required

- less mining / quarrying
- less waste (copper) / electrical appliances dumped

or

less landfill

against recycling

- collection problems
- transport problems
- difficult to separate copper from appliances
- energy used to melt the collected copper
ignore electrolysis / pollution
ignore ideas about less machinery / plant
ignore idea of cost

3

[10]

Q3.

- (a) any **two** points **one** mark each
accept comparison between aluminium and iron

aluminium has:

- a low density
accept lighter or fewer pylons
- a good conductor of electricity
- does not corrode **or** rust
*do **not** accept does not react with air*
*do **not** accept last longer*

2

OR

- iron has:
- high density
- is a less good conductor (of electricity)
- rusts or reacts with air

- (b) any **5** from:

- employment of people **or** cost of employment
- depletion or use of resources
*do **not** accept depletion here*
- cost of energy resources
- cost of machines **or** buildings
- pollution by noise from traffic **or** quarrying

- air pollution by dust **or** traffic fumes
- danger of traffic on roads
- damage to landscape (eyesore)
- damage to habitats of wildlife
- lowers the value of houses nearby
- subsidence **or** vibration can affect roads **or** houses
- providing raw materials

do not accept danger or falling in

5

[7]

Q4.

- (a) (i) contain enough metal to make it economical / worth while to extract

1

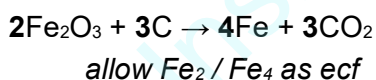
- (ii) reduction
accept displacement
accept redox

1

- (iii) Fe + CO₂
do not accept Fe₂ / Fe₄

1

correct balancing
accept multiples and halves



1

- (b) **Pure Iron**

(in pure metal all the atoms are the same size and) able to slip / slide over each other – (property soft)

OWTTE
ignore references to molecules / particles
if they say 'move' both times, allow one mark but 'crack' or 'split' is wrong..

1

Cast iron

(in cast iron) different sized atoms / larger atoms **or** structure is distorted / disrupted

OWTTE

1

so it is difficult for layers of atoms to slip / slide over each other

OWTTE

1

(c) any **three** from:

- conserves / saves resources / metal ores
- saves energy resources (used for extraction / processing)
accept cheaper / saves money
- decreases waste materials
- decreases a named pollution
*do **not** accept acid rain*

3

[10]

Q5.

(a) (i) poly(ethene)

accept polythene

1

(ii) cracking

1

(iii) hydrogen

1

(b) (i) bar labelled 9

1

bar drawn to correct height

1

(ii) (boiling point) increases

1

(iii) heat / evaporate (the crude oil)

accept separate by boiling point

1

cool / condense (hydrocarbons at different temperatures)

accept smaller molecules go to top / larger molecules stay at bottom

*accept fractional distillation for two marks **or** distillation / fractionation for **one** mark*

1

(c) **yes**

any **two** from:

- because plastic does not biodegrade **or** running out of space for landfills **or** land cannot be used for a long time
- it provides heat energy
- which can be used to generate electricity / heat homes or greenhouses
- any other advantage of burning

- any other disadvantage of landfill
- or**
- no**
- burning plastic produces carbon dioxide / carbon emissions / toxic gases
accept landfill does not produce carbon dioxide / carbon emissions
 - causes global warming / climate change / increase greenhouse effect / global dimming / acid rain
 - any other disadvantage of burning
 - any other advantage of landfill

2

[10]

Q6.

- (a) (i) reduction
accept redox / smelting 1
- (ii) 3 4 3 1
- (b) (i) 55
ignore other units
- (ii) Water
accept sodium hydroxide
accept correct formulae H₂O or NaOH 1
- (iii) any **one** from:
 - save energy / fuel for transporting the ore
accept less (cost of) transport allow transported quickly
 - (old) quarries nearby for waste/red mud 1
- (c) **Environmental**
any **one** from:
- less mining / quarrying (of bauxite)
allow loss of habitat / less qualified noise pollution
 - less landfill space needed / used
allow less red mud / waste
 - less use of fossil fuels / energy
 - less carbon dioxide produced

Ethical or socialany **one** from:

- saves resources
allow using resources more than once
- creates (local) employment
if answers reversed and both correct award 1 mark
- more people aware of the need for recycling
allow less qualified noise pollution if not given in environmental

1

[7]

Q7.

- (a) (i) reacts with carbon / C
accept burns / oxidises carbon

1

carbon dioxide / CO₂ / gas is formed / given off
accept carbon monoxide / CO
accept correctly balanced equation for 2 marks
ignore state symbols

1

- (ii) change / improve properties
accept any specific property
accept to make alloys / special steels
ignore brittle

1

- (b) any **two** from:

- to conserve ores / iron
accept ores / iron are non-renewable / non-sustainable
allow less quarrying / mining
- to prevent the use of landfills
allow reduce waste
- to conserve energy / fuel
accept fossil fuels are non-renewable
- to reduce carbon / carbon dioxide emissions
- to meet EU / International targets
ignore costs / demand

2

[5]

Q8.

(a) (i) C

must be correct symbol
*do **not** accept carbon*
any balancing must be correct

1

(ii) Fe + CO₂

correct formulae

1

2... + 3... .

correct balancing

allow Fe₂ + 3CO₂ for this mark

1

(iii) layers / atoms in pure iron are able to slide over each other

it = pure iron

accept ions for atoms

ignore molecules / particles

or

layers / atoms in cast iron are unable to slide over each other (easily)

1

(b) any **three** from:

mention of ozone = max 2

- less iron ore used

accept the idea that ores would be conserved but not unspecified conservation

- less other metals extracted / used to make different steels

accept the idea that ores would be conserved but not unspecified conservation

- less fuel used

accept the idea that fuels would be conserved
ignore reduces energy requirements

- less specified pollution

accept global warming / greenhouse effect / CO₂ / CO / carbon emissions / acid rain / SO₂ / global dimming /
*do **not** accept ozone layer*

- less / no landfill space needed

ignore reduces waste

- less / no mining needed **or** fewer specified effects of mining

accept effect such as eyesore / loss of habitat
eg 'less mining iron ore' = 2 marks

3

Q9.Reused

- saves raw materials / crude oil
 - *unable to reuse many times*
 - *bags easily split*
- saves energy / fuel / transport
- fewer bags needed / made
- reduces carbon / CO₂ emissions
- reduces use of landfill
- saves cost of a new bag
- no waste

1

Recycled

- saves raw materials / crude oil
 - *has to be collected / transported / washed / separated / melted*
- saves energy / use of fuel
- reduces carbon / CO₂ emissions
- reduces use of landfill
- can be used for new products
 - *ignore uses energy*

1

Burned

- heat / energy released can be used (for heating / generating electricity)
 - *has to be collected / transported*
- reduces use of landfill
 - *wastes the resource / plastic*
 - *releases harmful gases / toxic gases / CO₂*

1

Dumped

- collected / transported with household waste
 - *wastes the resource*
 - *plastic uses landfill*
- (slowly) biodegrades **or** produces methane which can be used as a fuel

- produces methane which is a greenhouse gas / could cause explosions
- (not biodegradable so) does not release CO₂ / green house gas into the air
 - not biodegradable / take years to decompose

ignore cost / litter / waste / global warming / habitats unless mentioned above

1

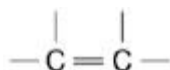
[4]

Q10.

(a) covalent

1

(b)



1

(c) composite

1

(d) limestone

1

sand

1

either order

(e)

ignore corrosion / erosion / rotting / rusting

any **two** from:
(makes the board)

- strong
- hard
- tough
- waterproof
- durable

allow long lasting

- aesthetic reasons
 - rigid
 - less friction
 - protection
- allow streamlined / smooth*
allow prevents damage

2

(f) (advantages of addition polymers)

low(er) cost
allow cheap(er)

1

low(er) density
allow light(er)

1

(disadvantages of addition polymers)

weak(er) *allow (more) likely to break* 1

hard(er) to dispose of *ignore references to recycling or use as a fuel* 1

(g) *an answer of 0.035 (m³) scores 3 marks.
allow 2 marks for an answer of 0.105 (m³)
(addition polymer)*

$$150 = \frac{5.25}{\text{volume}}$$
 1

$$(\text{volume} =) \frac{5.25}{150}$$
 1

(volume =) 0.035 (m³) 1

[14]

Q11.

(a) **Level 2 (3-4 marks):**
A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

Level 1 (1-2 marks):
Relevant points are made. These are not logically linked.

Level 0
No relevant content.

Indicative content

raw material

- wood will not run out
- aluminium (ore) will run out
- more expensive to process aluminium from its raw material

mass of frame

- wooden frame more expensive to transport
- wooden frame uses more fuel to transport
- wooden frame more difficult to handle / erect

useful lifetime

- wooden greenhouse would need replacing more often
- fewer aluminium greenhouses needed over time

end of useful life

- both materials can be put to further use
- aluminium can be recycled repeatedly

4

(b) $\frac{12000}{80}$

= 150

1
1

an answer of 150 scores 2 marks

(c) any **two** from:

- conserves finite ores
allow ores will last longer
- uses less energy
- lower energy costs
- reduces landfill
allow less waste

2

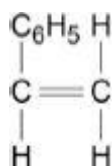
(d) (polymer windows are) lighter

1

[9]

Q12.

(a)



1

(b) polymerisation

1

(c) monomers

1

many

1

polymers

1

must be in this order

(d) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.

3-4

Level 1: Relevant features are identified and differences noted.

1-2

Level 1: Relevant features are identified and differences noted.

1-2

No relevant content

Indicative content

for coated paper cups – accept converse for poly(styrene)

advantages

- produced from a renewable resource
- biodegradable so breaks down

disadvantages

- higher energy costs
- greater use of fossil fuels and consequent pollution
- not recyclable so uses landfill

[9]

Q13.

- (a) (lead is) toxic / poisonous
allow (lead is) harmful
ignore (lead is) dangerous / deadly / lethal 1
- (b) the proportions (of metals) are different 1
- (c) any **three** from:
 • recycling conserves copper ores
 • recycling uses less energy
 • recycling reduces waste
ignore references to cost
allow copper ores are finite
allow recycling reduces use of landfill
 • mining / quarrying cause environmental impacts
allow description of environmental impact caused by mining / quarrying 3
- (d) grow plants (on land containing copper ores)
allow named plant 1
- plants are burnt (to produce ash) 1
- ash dissolved in acid (to produce a solution of a copper compound) 1
- electrolysis of solution (containing a copper compound)
or
 displacement (of copper) from solution (containing a copper compound)
allow addition of scrap iron to the solution (of a copper compound) 1
- (e) any **two** from:

- high grade ores still available
 - land not available
 - phytomining takes a long time
 - new technology
- allow demand not high enough*

2

[11]

Q14.

- (a) disposal at the end of useful life 1
- (b) heating in a furnace 1
- shaping wet clay 1
- (c) polymers 1
- propene 1
- allow (a) monomer* 1
- (d) cracking 1
- fractional distillation 1
- (e) covalent 1
- (f) thermosetting 1
- (g) polymer **A** has crosslinks (between polymer molecules)
or
 polymer **B** has no crosslinks (between polymer molecules) 1

[10]

Q15.

- (a) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given. 5-6

Level 2: Some logically linked reasons are given. There may also be a simple judgement. 3-4

Level 1: Relevant points are made. They are not logically linked. 1-2

No relevant content 0

Indicative content

raw materials

- crude oil finite **or** will run out (so will be unavailable for other uses)
- wood is a renewable resource
- wood involves land use for forestry (so less available for agriculture / food)
- wood may involve deforestation (so reduces biodiversity)

manufacturing

- both require energy which may be derived from finite fuels (so they run out more quickly)
- paper more energy intensive (so more pollution is possible)
- the need for more energy for paper potentially releases more carbon dioxide to the atmosphere (so increases global warming)
- paper involves higher water usage (so increases the potential for water pollution)
- paper cups are heavier to transport (so have higher energy requirement)
- packaging requirements similar (so neither has an advantage)

usage

- both single-use (so neither has an advantage)

disposal

- paper releases more energy if incinerated (so more energy can be used for other purposes)
- paper will decompose (so will not remain in landfill)
- poly(styrene) could release toxins on incineration
- poly(styrene) will not decompose (so will remain in landfill)
- poly(styrene) can be used to manufacture other products (so conserves energy **or** finite resources)
- both can cause litter **or** visual pollution

(b) $\frac{1000}{8.3} \times 550 \text{ (kJ)}$

1

$= 6.63 \times 10^4 \text{ (kJ)}$

allow $6.6265060240963 \times 10^4 \text{ (kJ)}$ correctly rounded

allow $66265.060240963 \text{ (kJ)}$ correctly rounded for 1 mark

1

an answer of $6.63 \times 10^4 \text{ (kJ)}$ scores 2 marks

(c) (melamine is a) thermosetting (polymer)

1

(which) contains crosslinks / bonds (between polymer chains)

*do **not** accept reference to intermolecular forces*

allow (so) it decomposes

1

Q16.

- (a) *allow answers referring specifically to the naphtha fraction*

crude oil is evaporated/vaporised (by heating)

1

the vapours are condensed (by cooling)

1

(fractions condense) / boil at different temperatures

allow fractions have different boiling points

1

- (b) any **four** from:

answer yes or no does not gain credit

ignore references to volume of milk held / number of bottles used / biodegradability / habitats / pollution / mining / dust

each marking point must be a comparison

milk bag points

- uses (75%) less **crude oil** to make (than a plastic milk bottle)
allow eg uses 75% less poly(ethene) which is made from crude oil
- uses less **energy** / fuel to make (than a plastic / glass milk bottle)
- produces less **carbon dioxide** to manufacture (than a plastic / glass milk bottle)
allow produces less greenhouse gases / causes less global warming
allow produces less CO₂ on burning
- produces less **waste** (than a plastic / glass milk bottle)
allow takes up less landfill (space)
allow an argued case for more waste eg milk bags are discarded / cannot be reused
- less fuel used for **transport** than glass milk bottles
- (produces waste because) milk bags are only used once whereas glass bottles can be **re-used**
allow milk bags are discarded but glass bottles can be reused (24 / many times)
allow glass bottles can be reused but milk bags can't

poly(ethene) points

- uses a limited **raw material** / crude oil whereas the raw materials for glass are almost unlimited

- **less** (5%) poly(ethene) is **recycled** (compared to glass (35%))
allow (35%) glass is recycled or (5%) poly(ethene) (bottles) recycled BUT milk bags aren't / are discarded
or
recycled poly(ethene) is not used to make new bags whereas recycled glass is used to make new bottles

4

[7]

Q17.

- (a) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

5-6

Level 2: Some logically linked reasons are given. There may also be a simple judgement.

3-4

Level 1: Relevant points are made. They are not logically linked.

1-2

No relevant content

0

Indicative content

raw materials

- crude oil is finite
- quarrying / mining pollute the environment
- glass uses more energy to process raw materials

manufacturing

- glass uses more energy to make bottles
- glass is heavier so takes more energy to transport

use and operation

- glass bottles are reusable
- reuse of glass conserves (natural) resources
- reuse of glass consumes energy during washing
- reuse of glass consumes water during washing

disposal

- both glass and polymer bottles can be recycled
- recycling polymer conserves finite resources
- recycling glass and polymer uses less energy than making new glass and polymer
- both methods reduce use of landfill

other points

- energy needed may be derived from fossil fuels
- use of fossil fuels causes (specified) pollution
- total energy for glass (bottle) (7500 kJ) is greater than total energy for polymer (bottle) (1800 kJ)

reasoned judgement

- (b) mass = density × volume 1
- mass = 0.40 × 40 1
- = 16 (g) 1

[9]

Q18.

- (a) any **two** from:

energy used in:

- extraction of raw materials
- processing raw materials
- allow energy used to make food plate materials*
- manufacturing
- transportation
- cleaning non-disposable plates
- disposal
- recycling

2

- (b) **Level 2:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

3–4

Level 1: Some logically linked reasons are given. There may also be a simple judgement.

1–2

No relevant content

0

Indicative content

Raw materials

- Trees are renewable
- Crude oil and clay are finite

Manufacturing and packaging

- Paper plates use the least packaging so conserve raw materials
- Paper plates need less transportation overall as more plates in a 10 dm³ cardboard box

Use and operation

- Paper plates are single use so must be replaced most often
- Ceramic plates last longer than polymer plates so must be replaced less often

Disposal

- Polymer / ceramic plates take up landfill which is running out
- Paper / polymer plates can be used to make new products
- Recycling conserves raw materials

Reasoned judgement

(c) (wet) clay is shaped

1

(and) heated in a furnace

allow (and) heated in a kiln / oven

allow (and) fired

1

[8]

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