AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.10.2 LIFE CYCLE ASSESSMENT AND RECYCLING (PACK 1)

SCORE	PERCENTAGE
/176	%

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Q1.

(a) all points correct

±1 small square

allow 1 mark for 6 or 7 plots

2

Year	Percentage (%) of bottles made from other materials
1975	5
1980	10
1985	22
1990	42
1995	70
2000	72
2005	90
2010	95

1

(b) **Level 3 (5–6 marks):**
A detailed and coherent argument is provided which considers a range of issues and comes to a conclusion consistent with the reasoning.

Level 2 (3–4 marks):
An attempt to describe the advantages and disadvantages of the production and uses is made, which comes to a conclusion. The logic may be inconsistent at times but builds towards a coherent argument.

Level 1 (1–2 marks):
Simple statements made. The logic may be unclear and the conclusion, if present, may not be consistent with the reasoning.

0 marks:
No relevant content.

Indicative content

- glass – 2 stages in production of soda-lime glass
- glass – second stage, heating sand, limestone and sodium carbonate
- HDPE – 3 stages in production
- HDPE – second stage, cracking of naphtha to obtain ethene
- HDPE – third stage, polymerisation of ethene
- fewer stages in glass production, may be quicker
- higher temperature in glass manufacture, therefore maybe higher energy requirement
- glass bottle can be reused
- consideration of collection / cleaning costs to reuse glass bottles
- other glass products can be made from recycled glass
- plastic has greater range of sizes
- both produced from limited raw materials
- higher percentage recycled materials in glass conserves raw materials

This indicative content is not exhaustive, other creditworthy responses should be awarded marks as appropriate.

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6

[9]

Q2.

(a) because it is a good conductor of electricity.

1

(b) (i) 2.1 (%)

1

(ii) correct bar for calcium at 3.6 %

1

allow error of +/– 0.05%

correct bar for iron at 5.0 %

1

allow error of +/– 0.05%

(c) (i) decomposition

1

(ii) carbon dioxide

1

(iii) carbon = 1

allow one

1

oxygen = 3

allow three

1

(iv) 44 (g)

allow forty four

1

(d) (i) to make alloys for specific uses.

1

(ii) any **three** from:

- to conserve resources of iron or iron ore
  allow steel instead of iron or iron ore
  allow limited resource or non-renewable
- to avoid the need for quarrying/mining
- to conserve energy resources or fossil fuels
- to limit the amount of carbon dioxide produced or to reduce global warming
- to reduce the amount of landfill

"it" = steel

ignore cost and reuse and time and waste

3

[13]

Q3.

(a) (i) (thermal) decomposition

allow decomposes or endothermic

1

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(ii) copper oxide

1

(b) (i) the (potassium) carbonate did not decompose/change/react (when heated)

allow temperature not high enough

*do **not** allow potassium did not decompose*

ignore references to reactivity

1

the mass did not change or the limewater did not go cloudy

1

because no carbon dioxide produced

1

(ii) the less reactive the metal the more (easily) its carbonate will decompose/react or vice versa

needs to be a relative comparison

2

*allow max **1** mark where the distinction between a metal and its carbonate is not clear*

*allow **1** mark for carbonates of reactive metals do not decompose or vice versa*

(c) (i) make it economical (to extract the metal/iron)

allow make it worth extracting

allow so they can make money/profit

1

(ii) Fe

1

balanced correctly (2,3,4,3)

not ecf

allow correct balanced equation but with $2Fe_2$ on right for one mark

1

(iii) **iron** from the blast furnace is brittle

1

steel produced is strong / flexible

allow steel has more/specific uses

allow steel is rust-resistant

1

"it" = iron

(iv) (recycling) is used to conserve iron (ore) **or** energy **or** resources **or** minimise pollution **or** reduce the need to quarry

allow reverse arguments.

1

(not reuse) because of damage, paint removal, rusting/corrosion, metal fatigue/weaker

1

(not landfill) because sites have limited space **or** loss of habitats

allow to reduce the use of landfill

1

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[15]

Q4.

(a) gold

1

(b) atom (s)

1

(c) (i) protons

any order

allow proton

1

neutrons

allow neutron

1

(ii) 3 / three

1

(d) (i) Al

ignore any numbers / charges

1

(ii) any **two** from:

- limited resource
- expensive in terms of energy / mining
- effects on the environment, such as, landfill, atmospheric pollution, quarrying

allow uses a lot of energy to extract.

2

(e) resistant to corrosion

1

does not react (with water or food)

*allow **one** mark for low density with a suitable reason given*

1

[10]

Q5.

(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

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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]

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 H_2O 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

1

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Ethical or social

any **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) *allow answers referring specifically to the naphtha fraction*

crude oil is <u>evaporated/vaporised</u> (by heating)

1

the vapours are <u>condensed</u> (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 CO_2 on burning

- produces less **waste** (than a plastic / glass milk bottle)
  allow takes up less landfill (space)

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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]

Q8.

(a) (i) low percentage / very little of metal (in the ore)

*accept <u>only</u> 0.5% metal in the ore **or** over 99% waste in the ore **or** nearly 100% waste in the ore*

*ignore reference to percentage of metal in the Earth's crust **or** energy used or pollution*

1

(ii) any **one** from

(it = iron)

- iron uses less energy / fuel for extraction

  ignore electrolysis / uses electricity / reactivity
- iron has more uses
- more demand for iron

  ignore high abundance in the Earth's crust / high percentage of metal in ore
- iron is stronger

  ignore harder
- cheaper / costs less
- easier to extract

1

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(b) (i) has melting point lower than 950°C
(it = aluminium)
allow has a low melting point
ignore boiling point

1

(ii) electrode(s) made of carbon

1

oxygen reacts with electrode(s) / carbon
accept $C + O_2 (\rightarrow CO_2)$
NB oxygen reacts with the carbon electrode(s) = ***2*** *marks*

1

(iii) any **two** from:

- saves resources / non-renewable
accept aluminium / ore will run out ***or*** *conserves aluminium*
- landfill problem
accept aluminium does not corrode
- saves energy / fuel / electricity
ignore global warming
- less carbon dioxide / carbon emissions **or** reduces carbon footprint
ignore consequences of quarrying / mining
- less quarrying / mining
ignore pollution / harms environment / costs / easy to recycle

2

[7]

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 / CO_2 emissions
- reduces use of landfill
- saves cost of a new bag
- no waste

1

Recycled

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- saves raw materials / crude oil
    - *has to be collected / transported / washed / separated / melted*
- saves energy / use of fuel
- reduces carbon / CO_2 emissions
- reduces use of landfill
- can be used for new products

ignore uses energy

1

<u>Burned</u>

- 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 / CO_2*

1

<u>Dumped</u>

- 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 CO_2 / 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) (i) C

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

1

(ii) $Fe + CO_2$

correct formulae

1

2... . + 3... .

correct balancing

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allow Fe_2 + $3CO_2$ 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 / CO_2 / CO / carbon emissions / acid rain / SO_2 / 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

[7]

Q11.

(a) atoms

1

(b) mixture

1

metal

1

structure

1

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smart

1

(c) (i) any **two** from:

- saves raw materials / iron ore
- saves energy / fuels
  accept cheaper / saves money
- make new / useful items
- make money / it is economic
- <u>reduces</u> pollution
  allow less harmful for the environment
- decreases cost of steel cans
- reduces carbon dioxide emissions
- decreases waste materials / use of landfill

2

(ii) any **one** from:

- provide information / education of the need to recycle
- legislate against / charge for waste
- reward / pay people to recycle
  accept fine people for not recycling
- put labels on the cans
- provide recycling bags / bins / areas

1

[8]

Q12.

(a) (i) polyethene / poly(ethene)
accept polythene / polyethylene

1

(ii) needs heat / energy / high temperature / fuel (for cracking)
ignore other processes

1

produces carbon dioxide / CO_2
ignore use of CO_2 ***or*** *'produces carbon'*

1

(b) any **three** from:

- use water from local sources **or** water from close to home

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- recycle bottles in the UK / close to home
  accept do not recycle in other countries / Asia
- (reduction in distance travelled) would reduce CO_2 emitted by transport
  accept use of transport with low / no carbon dioxide emissions
- use tap water
- use glass bottles / waxed cartons / metal bottles
  *do **not** accept 'do not use plastic bottles' without an alternative material*
- do not put in landfill **or** recycle <u>more</u>
- reuse / refill plastic bottles
- <u>tax</u> imported water / plastic bottles (to offset carbon cost)
- make more / all plastic bottles in UK
  answers must be about the reduction of carbon cost

3

[6]

Q13.

(a) (i) C_2H_4

1

(ii) poly(ethene)

1

(b) (i) is not biodegradable

1

(ii) not enough landfill sites / space
*accept landfill sites are filling up **or** plastics remain for <u>years</u> **or** plastics not broken down*
ignore cost / waste of resources / not biodegradable / wildlife

1

(iii) less (crude) oil / fuels / energy used
accept (crude) <u>oil</u> is a non-renewable resource

1

[5]

Q14.

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

1

carbon dioxide / CO_2 / gas is formed / given off
accept carbon monoxide / CO
*accept correctly balanced equation for **2** marks*

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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]

Q15.

(a) (i) monomers

1

(ii) crude oil

1

(b) any **three** from:

- metal may not corrode away / remains

- plastic remains / does not break down (decay) / not affected by microorganisms

  accept non-biodegradable

- should recycle / conserve resources / mend the kettle / burn (plastic) as a fuel

  accept it is a waste of materials / resources

- landfill sites are limited / filling up

- water pollution

  *ignore harms wildlife / habitats **or** problems caused by burning the kettle*

3

[5]

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Q16.

(a) any **three** from:

- resources / aluminium / ores are conserved
  accept converse argument
- less / no mining **or** less associated environmental problems
  eg quarrying / eyesore / dust / traffic / noise / loss of land / habitat
  ignore just pollution
- less / no waste (rock) / landfill
  *do **not** accept 'wastes 50% of the ore'*
- no purification / separation (of aluminium oxide)
- (aluminium extraction / production) has high energy / electricity / heat / temperature requirements
- less carbon dioxide produced
  accept no carbon dioxide produced
  ignore references to cost

3

(b) statement
ignore density

1

linked reason
eg
(pure) Al / it is weak / soft (1)
as layers / rows can slide (over each other) (1)
or
alloy / other metals / they make it stronger / harder (1)
stops layers / rows sliding over each other (1)
accept disrupts the structure owtte if no other mark awarded
*accept to form an alloy **or** to change properties for **1** mark*

1

[5]

Q17.

(a) any **two** from:

- naphtha has a different / low(er) boiling point
  accept different volatility
- condenses at a different temperature / height / place in the column / when it reaches it's boiling point
- different size of molecules

2

(b) (i) $C_{10}H_{22} \rightarrow C_6H_{14} + \mathbf{2}C_2H_4$
allow multiples

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1

(ii) (hydrocarbon) heated / vapours

1

(passed over a) catalyst / alumina / porous pot

ignore other catalysts

1

(iii) it / ethene is unsaturated **or** decane and hexane / they are saturated

accept decane and hexane are alkanes / C_nH_{2n+2}

***or** ethene is an alkene / C_nH_{2n}*

***or** different homologous series / general formula*

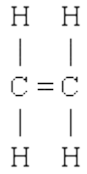
1

ethene has a double (carbon carbon) bond **or** decane and hexane have only single (carbon carbon) bonds

accept ethene has a reactive double (carbon carbon) bond
*for **2** marks*

1

(c) all bonds drawn correctly



1

(d) **economic argument** against recycling

any **one** from:

- poly(ethene) / plastic must be collected / transported / sorted / washed
- this uses (fossil) fuels which are expensive

1

environmental argument against recycling

any **one** from:

- uses (fossil) fuels that are non-renewable / form CO_2 / CO / SO_2 / NO_x / particulates

  ignore pollution / harmful gases / etc

- washing uses / pollutes water

1

counter arguments

any **two** from:

- collect / transport alongside other waste
- use biofuels (instead of fossil)

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- landfill is running out
- landfill destroys habitats
- incinerators are expensive to build
- saves raw materials / crude oil
- saves energy needed to make new plastic
- incinerators may produce harmful substances
- incinerator ash goes to landfill
- poly(ethene) is non-biodegradable
- poly(ethene) can be made into other useful items
- more jobs / employment for people

2

[12]

Q18.

(a) (i) hydrogen

must be name

1

(ii) a line of four or more ethene molecules joined to the original two with single bonds

*at least two other ethene molecules joined to the original two in a chain gains **1** mark*

2

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

- non-biodegradable
  accept remains a long time
- landfill sites are filling up / limited
  accept land / space used up
- <u>waste of a resource</u> / could be recycled / reused
  ignore references to tablets / animals

2

(ii) any **one** from:

- (two) different polymers / plastics / materials
- need to be separated
- limited collection points / many need to be collected
- tablets may still be present

1

[6]

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Q19.

(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

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- any other advantage of landfill

2

[10]

Q20.

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

1

(ii) reduction

accept displacement

accept redox

1

(iii) $Fe + CO_2$

*do **not** accept Fe_2 / Fe_4*

1

correct balancing

accept multiples and halves

$\mathbf{2}Fe_2O_3 + \mathbf{3}C \rightarrow \mathbf{4}Fe + \mathbf{3}CO_2$

allow Fe_2 / Fe_4 as ecf

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*

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3

[10]

Q21.

(a) (i) $Cu_2S + 2O_2 \rightarrow 2CuO + SO_2$

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

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named alloys

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

<u>for recycling</u>

- 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

  <u>against recycling</u>
- 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]

Q22.

(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*

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*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]

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