AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.4.1 REACTIVITY OF METALS (PACK 2)

SCORE	PERCENTAGE
/171	%

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Q1.

(a) (i) contains enough metal to <u>make it economical</u> to extract

1

(ii) Fe (+) CO_2

formula of both products must be correct

1

(Fe_2O_3) (+) ....3....(CO)

→

.....2.....(Fe) (+) .....3...(CO_2)

balancing correct

allow correct balancing using Fe_2

1

(iii) reduction

accept redox

1

(b) (i) oxygen <u>reacts</u> with the carbon to produce carbon dioxide

allow carbon monoxide for carbon dioxide

1

OR

carbon dioxide is produced (1)

which escapes as a gas (1)

1

(ii) to give steels with <u>different</u> / particular properties or for <u>different</u> / <u>particular</u> uses

ignore to make different alloys

1

(c) copper is very expensive

accept the metal (iron / steel) costs less than copper

ignore energy

1

because copper ores are 'low grade' / running out

allow copper is rare

ignore nickel

1

[9]

Q2.

(a) (i) conducts electricity

1

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(ii) mixture (of metals)

(it = alloy)

1

(b) any **two** from:

ignore pollution without qualification

- noise
- dust

  allow dirt
- traffic
- eyesore

2

[4]

Q3.

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

*accept only 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

(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

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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]

Q4.

(a) (i) removal of oxygen

accept definition in terms of electrons ***or*** *oxidation numbers*

ignore oxides

1

(ii) 2 (Cl_2)

allow correct multiples

1

(iii) no atoms are lost / made (during a chemical reaction)

or

the atoms are rearranged (during a chemical reaction)

accept because of (the law of) conservation of mass / matter

1

(b) (i) sodium is more reactive (than titanium)

accept sodium is very reactive ***or*** *titanium is less reactive*

do ***not*** *accept sodium is more reactive than argon*

1

(ii) any **one** from:

- sodium / titanium would react with oxygen / air
  accept air / oxygen is reactive
- sodium / titanium does not react with argon
  accept argon is unreactive / inert / a noble gas / in group O

1

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(c) (i) all atoms are the same / it only contains one type of atom

accept all ions are the same

*do **not** accept only got one atom*

*do **not** accept all atoms are the same size*

ignore particles

1

(ii) two different / types atoms / elements / ions

accept more than one type of atom / ion / element

*do **not** accept different size*

1

bonded / joined together

accept definite proportions

*do **not** accept mixture*

1

[8]

Q5.

(a) (carbon =) 1

1

(oxygen =) 3

1

(b) (i) heated

1

(ii) carbon dioxide

1

(c) (i) combustion

1

(ii) carbon is more reactive than zinc

1

(iii) zinc boils (in the furnace / below 1300°C)

ignore melting point / changes of state

1

lead does not boil / (only) melts in the furnace / boils above 1300°C

*if no other mark awarded allow zinc has a lower boiling point **or** lead has a higher boiling point*

***or** they / zinc **and** lead have different boiling points for **1** mark*

1

[8]

Q6.

(a) (i) copper / Cu

1

(ii) 50(p)

1

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(iii) 25

1

(iv) tin

1

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

- high cost of copper
  allow metal is expensive
- less copper available ***or*** (copper ores exhausted / **only** low-grade ores available)
  allow copper is non-renewable
- high demand for copper
- high percentage (%) of copper in the coin
- inflation (of cost)

1

(ii) any **one** from:

- stronger / harder
  ignore rust
- cost of copper **or** copper is more expensive to extract **or** steel is cheap
  allow cheaper (to make)
- less copper available

  or
  (copper ores exhausted / **only** low-grade ores available)
- high demand for copper
- less copper is needed

1

[6]

Q7.

(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
allow $Fe_2 + 3CO_2$ for this mark

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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]

Q8.

(a) atoms

1

(b) mixture

1

metal

1

structure

1

smart

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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]

Q9.

(a) conducts (electricity) **or**
accept flexible

allows electrons / current to flow
ignore conducts heat

1

(b) electron

1

(c) (i) lithium>copper>tungsten **or**

Li>Cu>W
all correct
*allow **1** mark for one metal in the correct position*

2

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(ii) has high / highest melting point
accept has high / highest boiling point

or

can withstand the highest temperature

1

(d) unreactive

1

[6]

Q10.

(a) (i) many ethene / molecules / monomers
accept double bonds open / break

1

join to form a long hydrocarbon / chain / large molecule
accept addition polymerisation
ignore references to ethane
*correct equation gains **2** marks*

1

(ii) (can be deformed but) return to their original shape (when heated or cooled)
ignore 'it remembers its shape'

1

(iii) cross links / extra bonds in PEX
accept inter-molecular bonds
ignore inter-molecular forces

1

molecules / chains in PEX are held in position
accept rigid structure

1

molecules / chains in PEX unable to slide past each other / move
it = PEX throughout

1

(b) any **four** from:

- less (hydrocarbon) fuels used
allow less energy
- less / no electrical energy used
allow no electrolysis
- reduce carbon / carbon dioxide emissions
allow less global warming
- reduce / no pollution by sulfur dioxide / acid rain
- continuous process

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allow less / no transportation

- conserve copper which is running out or only low-grade ores available
- reduce the amount of solid waste rock that needs to be disposed
  allow less waste
- reduce the need to dig large holes (to extract copper ores)
  allow less mining
  ignore costs / sustainability / non-renewable

4

[10]

Q11.

(a) (an alloy) that can return to its original shape (after being deformed / bent / twisted)
accept (on heating / cooling) it returns to its shape

1

(b) any **two** from:

- brass / it is a mixture
  accept brass / it is not pure
- zinc changes structure / disrupts patterns or layers
- copper metal atoms / layers able to slide over each other
  accept zinc prevents atoms / layers sliding over each other

2

(c) (i) oxygen / O_2 / O

1

(ii) lead remains (in furnace) because of its high boiling point

1

zinc boils / evaporates (out of furnace) because of its low boiling point 1 if neither mark awarded then allow **1** mark for different boiling points
ignore references to melting points

1

[6]

Q12.

(a) any **one** from:

- light(er) / less dense
  ignore stronger
- resistant to acids / alkalis / chemical
  accept resistant to corrosion

1

(b) any **two** from:
it must be clear
list principle applies

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allow reverse argument
ignore reference to temperature

- magnesium is more reactive than titanium
  magnesium is above titanium in the reactivity series
- titanium is more reactive than carbon
- magnesium is more reactive than carbon
- magnesium is most reactive
- carbon is least reactive

2

(c) any **three** from:
it = titanium
*ignore references to cost / easier / usefulness alone **or** references to incorrect processes*

- takes a long time to process
- low abundance (of ore)
- small amount produced
- batch process used **or** blast furnace is continuous
- more stages used to manufacture titanium
  allow ≥ 3 / many / several
- more energy used (per tonne of titanium)
  allow high energy requirement
  ignore references to temperature
- magnesium / chlorine is expensive
- labour intensive

3

[6]

Q13.

(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

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accept multiples and halves

2Fe_2O_3 + **3**C → **4**Fe + **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*

3

[10]

Q14.

(a) (i) any **one** from:

- iron ore is a limited resource / non-renewable
- iron is in high demand
- provide jobs
- economic advantage

1

(ii) any **two** from:

- would damage (wildlife) habitats / countryside / greenfield sites

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- extra traffic
- visual (pollution) / eyesore
- noise (pollution) / sound (pollution)
- dust (pollution)
- river (pollution)
- carbon dioxide (from traffic) / adds to greenhouse effect / global warming
- damage roads / buildings by vibrations / shockwaves

2

(b) (i) carbon monoxide / carbon

accept formulae CO / C

1

(ii) atoms

accept (particles) are all the same (size) / type for one mark

1

are all the same (size) / type

1

(iii) any **two** from:

- impurities / carbon / different (sized) atoms **or** elements **or** metals
- changes the structure / disrupts the pattern or layers
- prevents layers sliding over each other
- it is an alloy

2

Q15.

(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:

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- 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 / <u>making</u> alloys

1

or

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

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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]

Q16.

(a) (i) 5(%)

1

(ii) 0.35

$\frac{5}{10} \times 7$

for 1 mark

2

(b) (i) reduction

accept (it's) reduced
*do **not** accept redox / deoxidation*

1

(ii) heat with / reduce / react with **or** (chemical) reaction

1

with a metal / element / substance higher in reactivity

ignore displace
*accept higher <u>named</u> elements **or** symbol*
accept carbon monoxide / coal / coke

*correct word equation for **2** marks*
*correct formulas for **1** mark*
*correct <u>balanced</u> symbol equation for **2** marks*

1

or

electrolysis:
molten (1)
electrolysis (1)

[6]

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Q17.

(a) react with oxygen / oxidise / burn in oxygen / burning / combustion **or** tungsten to tungsten oxide **or** makes an oxide

key idea is oxidation
ignore breaking ignore fire / flames / exothermic
ignore react with air

1

(b) it is (very) unreactive / not reactive / inert / does not react with tungsten **or** it is a noble gas **or** it is in group 0 or 8 or 18

*do **not** accept unreactive / inert metal **or** argon is not <u>very</u> reactive*

1

full outer shell (of electrons) / 8 electrons in outer shell

1

does not need to gain / lose / swap / transfer / share electrons **or** does not need to form bonds

does not bond ionically / covalently

1

[4]

Q18.

(a) (very) small percentage / amount (in the Earth's crust)

any indication that there is a small amount, eg not much (left)
accept rare (elements) / rarer
accept not commonly found
ignore cannot find easily
ignore hard to extract

1

(b) (i) oxygen / O^{2} / O

*do **not** accept O^{2}*

1

(ii) any **one** from:

- potassium / K
- sodium / Na
- calcium / Ca
- magnesium / Mg

symbols must be correct
write name and incorrect symbol,
ignore symbol

1

(c) (i) heating (with) **or** hot air blown into furnace

accept high temperatures or (very) hot

1

carbon / carbon monoxide / coke / coking coal

*do **not** accept coal / charcoal accept balanced equation only*

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or
carbon reacts with O_2 **or** carbon / coke burning (1)
accept balanced equation only CO / CO_2

CO reacts with the ore (1)
for naming the reducing agent

1

(ii) cost of melting ore / electricity
makes aluminium expensive (owtte)
or (large amount of) electricity used
or because you have to use electrolysis
or aluminium is higher in the reactivity series
or aluminium is harder to reduce
or unable to reduce with carbon
or the cost of purifying the bauxite
*do **not** accept harder to extract / produce*
*more energy is **not** enough*

1

[6]

Q19.

(a) mixture
***not** compound*

1

of a metal with other element(s) / metals
***not** of elements*
***not** of a metal with other substances*

1

(b) steel
allow stainless steel

1

(c) stronger / increased strength / harder / less malleable / less brittle
***not** corrosion / rusting*

1

(d) copper and zinc

1

[5]

Q20.

(a) gives out

heat
each for 1 mark

2

(b) chromium and aluminium oxide

1

(c) (i) chromium oxide

1

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(ii) oxygen removed/gains electrons

1

[5]

Q21.

(a) lead oxide + carbon = lead + carbon dioxide
(A symbol equation was accepted if correct)

1

(b) oxygen removed (or addition of electrons)

1

[2]

Q22.

(a) unreactive / near bottom of reactivity series

1

(b) carbon more reactive / higher up reactivity series

1

(c) very reactive / near top of reactivity series

1

cannot use displacement methods / can only be extracted by electrolysis / had to wait discovery of electricity

1

[4]

Q23.

(a) $Zn + \mathbf{2}HC1 \rightarrow ZnC1_2 + H_2$

1

(b) (i) 12.5

1

(ii) steeper curve same volume of gas evolved

do not credit two intersects of straight lines
accept a sharp bend

2

(iii) any **two** from:

stir it

accept mix it better

heat it

accept warm it

use a more finely divided catalyst

accept use a better catalyst or more finely divided zinc
do not credit use acid of a higher

2

(c) (i) any **one** from

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zinc is more reactive than copper

accept zinc is above copper in the reactivity series

zinc displaces copper

accept it is higher than copper in the reactivity series

1

(ii) zinc + copper sulphate → copper + zinc sulphate

*ignore the presence of acid **or** water*

accept a balanced equation

1

[8]

Q24.

(a) (i) rings of 2, 8 and 3 electrons

credit 2, 8, 3 pay particular attention to the outer shell in diagrams

1

(ii) rings of 2, 8 and 7 electrons

credit 2, 8, 7 pay particular attention to the outer shell in diagrams

1

(b) (i)

labels not required on atoms
charges need to be shown on ions
reference to outer shell is required otherwise a maximum of two marks

structure of atoms/ions marks

(ring of 2, 8, 1 for sodium) **or** the outer shell of sodium only contains 1 electron

*credit 2, 8, 1 **or** an ion 2, 8 **or** two circles and 1 electron in outer shell*

1

(ring of 2, 6 for oxygen) **or** outer shell only contains 6 electrons

*credit 2, 6 **or** an ion 2, 8 **or** two circles*

1

transfer of electrons mark

two sodiums needed to supply two outer electrons to oxygen to complete the (one oxygen's) outer shell

award maximum of two marks if a covalent structure is given

credit two rings of electrons for sodium showing outer electrons transferring to outer shell of one oxygen for three marks

do not accept diagrams showing overlapping rings for third mark

1

(ii) loses an electron

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credit atoms lose electrons ***or*** *oxygen takes the electron*
ignore oil rig

1

[6]

Q25.

(a) An arrow indicating a position between aluminium and zinc.

1

(b) electrolysis

1

because calcium is more reactive (than aluminium **or** carbon)

accept it is more reactive
or *very reactive*

1

OR

in a blast furnace

1

because calcium is less reactive (than carbon **or** lower)

1

(c) any equation from

1 mark for correct formulae
1 mark for balancing

$2ZnO + C \rightarrow 2Zn + CO_2$

$ZnO + CO \rightarrow Zn + CO_2$

$ZnO + C \rightarrow Zn + CO$

1

[5]

Q26.

(i) idea that:
carbon is above lead in the reactivity series } NOT

for 1 mark

carbon is below aluminium in the reactivity series } OXIDE

for 1 mark

carbon can remove oxygen from/reduce lead <u>oxide</u>
or cannot remove oxygen from aluminium <u>oxide</u>
not aluminium more reactive than lead

for 1 mark

OR similar ideas in comparing bond strengths

3

(ii) (carbon + lead oxide) →*<u>lead</u> + *<u>carbon dioxide</u>

each for 1 mark

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accept correct formulae CO_2 and CO **NOT** carbon oxide

2

[5]

Q27.

(a) hydrogen

for 1 mark

1

(b) oxygen

for 1 mark

1

[2]

Q28.

correct use of 'react'/'reaction'/reactants'/combine
(not mixed/added/join)
correct use of 'produce'/'products'/gives/forms/makes/creates
reactants correctly identified

each for 1 mark

products correctly identified
(Reactants must be correctly identified for 'react'
mark to be awarded. Similarly for products)
(magnesium reacts with zinc oxide to produce magnesium
oxide and zinc or similar, will gain all 4 marks)
Oxidise or reduce given correctly can be credited <u>both</u>
the marks for react and produce

[4]

Q29.

(a) *ideas that it is a*

- compound of metal/metal oxide/combined (NOT mixed) cpd/
  named cpd O^{2-}/S^{2-}/CO_3^{2-} etc
- found naturally/in rocks/in Earth's Crust

for 1 mark each

2

(b) reduction (accept smelting/refining but <u>not</u> electrolysis)

for 1 mark

1

(c) One example. Al or above in Reactivity Series
ie Group I or II metals NOT Pb/Cu or compounds

for 1 mark

1

[4]

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