AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.4.3 ELECTROLYSIS (PACK 2)

SCORE	PERCENTAGE
/170	%

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Q1.

(a) any **two** from:

- outer shell electrons / electrons in highest energy level (in metals)
- electrons are delocalised / sea of electrons
- electrons are free **or** electrons move around **or** electrons are free to flow **or** electrons attracted to positive terminal
- electrons carry charge / current **or** electrons form the current / electrons transfer charge / electrons pass charge

ignore electrons carry electricity
ignore reference to positively charged atoms / ions
*if they state electrons have +ve charge = max **1** mark*
*if they state covalent bonding then max **1** mark*

2

(b) ions can move / are attracted to electrode

accept ions are free
allow 'they' for ions

or

attracted to named electrode

or

ions are charged **or** ions form / carry the current **or** ions form the charge

1

(c) (i) electron gain

ignore hydrogen reduces charge

1

(ii) sodium hydroxide **or** NaOH **or** caustic soda

*do **not** allow hydroxide alone*

1

(iii) $2Cl^- - 2\ e^- \rightarrow Cl_2$

or

$2Cl^- \rightarrow Cl_2 + 2\ e^-$

*allow fractions **or** multiples*
*allow e **or** e^-*
*do **not** allow e^+*

1

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[6]

Q2.

(a) covalent

1

(b) (i) liquid

1

(ii) fluorine

accept F / F_2

*do **not** accept fluoride*

1

(c) (i) should fluoride ions be added to drinking water?

1

(ii) any **one** from:

- not enough reliable/valid evidence
- may be other factors involved
- it is an opinion / choice / belief / ethics issue
- it can't be scientifically investigated

allow can't do an experiment

ignore test

mark independently of (c) (i)

1

[5]

Q3.

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

- they are positive / cations
- they are H^+
- opposite charges attract

ignore atom

1

(ii) potassium is more reactive (or reverse)

assume 'it' refers to hydrogen

allow potassium reacts <u>with</u> water

*allow potassium is very reactive **or** most reactive metal / element*

allow hydrogen gains electrons more easily / is reduced more easily

accept potassium is higher up the reactivity series

1

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(b) 6 **and** 2

accept correct multiples and fractions

1

(c) (i) the reaction / it is reversible **or** a description of a reversible reaction

allow 'it is an equilibrium'

allow reversible symbol drawn correctly

allow 'the reverse / back reaction'

1

(ii) **lithium nitride**

assume that 'it' or if they do not specify means lithium nitride

assume lithium / lithium nitrate refers to lithium nitride

- hydrogen is bonded / held / absorbed / has formed a compound / reacted with lithium nitride

1

plus **one** of:

- does not explode / cause a fire
- is not free / less hydrogen
- is not under pressure
- does not leak
- is only released slowly

1

- compound of hydrogen with lithium nitride / product is (more) stable / less reactive / less chance of a reaction

accept converse for hydrogen as below

assume that gas / hydrogen means gas in the cylinder

- *hydrogen (in cylinder) / gas is not bonded / held absorbed / in a compound / reacted with lithium nitride*

1

*plus **one** of:*

- *can explode / cause a fire*
- *is free*
- *is under pressure*
- *can leak*
- *releases quickly*

1

(d) (i) loss of an electron **or** loses electrons

do not accept any ref. to oxygen

1

(ii) full outer shell of 8 electrons on circle

need not be paired

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can be ×, dot or e
*do **not** accept if extra electrons added to inner shell*

1

[10]

Q4.

(a) (i) ionic

1

(ii) elements

1

(b) (i) chlorine (gas)
allow Cl_2 / Cl / Cl^2
allow chloride

1

(ii) hydrogen (gas)
allow H / H_2 / H^2

1

(iii) sodium hydroxide (solution)
allow NaOH
allow sodium solution

1

[5]

Q5.

(a) electric current / electricity

1

plus **one** from:

- is passed through ionic compound / substance / electrolyte
- passed through molten/aqueous compound / substance
  must be linked to electricity
  allow liquid compound / substance
  *do **not** allow solution / liquid alone*
- causing decomposition
  accept split up / breakdown / breaking up owtte
  ignore separated
  accept elements are formed
  ignore new substances form

1

(b) hydrogen
accept H_2
*do **not** accept H / H^2*

1

(c) one electron from each atom

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accept each carbon is bonded to three other carbon atoms leaving one (unbonded) electron owtte

1

is delocalised / free (to move)

must be linked to electrons

*answers of delocalised / free electrons only, gains **1** mark*

*accept each carbon is bonded to three other carbon atoms leaving delocalised / free electrons = **2** marks*

***maximum 1** mark if graphite described as a metal / giant ionic lattice*

1

[5]

Q6.

(a) (propanone) has a low(er) boiling point

***or** water has a high(er) boiling point **or** water evaporates slow(er)*

or (propanone) evaporates fast(er) owtte

allow propane / solution / it

*allow evaporates at lower temperature **or** boils quicker*

ignore density / reactivity / melting point

1

(b) (i) 0.29

*ignore + **or** –*

ignore units

1

(ii) any **two** sensible suggestions eg:

- weighing error
  *accept human error **or** inaccurate measurements*
- (copper) lost during washing owtte
  allow different washing of electrodes
- (copper) lost during electrolysis / reaction owtte
- electrodes not completely dry
- impurities in the electrode
- copper falling off when removing electrode / copper from cell
  ignore timing errors
  ignore 'fair test'
  ignore sludge
  ignore gases produced

2

(c) any **four** from:

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- impure copper is anode / positive (electrode)
- pure copper is cathode / negative (electrode)
- copper sulfate solution **or** any soluble copper salt in solution
- copper loses electrons **or** copper is oxidised(*)
- copper forms positive ions / particles(*)

  (*)as alternative to these two points $Cu \rightarrow Cu^{2+} + 2e^{-}$ ***= 2*** *marks*
- copper gains electrons **or** copper reduced at <u>negative electrode</u>

  or $Cu^{2+} + 2e^{-} \rightarrow Cu$ *at <u>negative electrode</u>*
- copper attracts to / collects at <u>negative electrode</u>
- sludge / impurities collect at the bottom owtte

  *allow sludge left behind **or** sludge left in solution **or** impurities separated from copper*
- impurities not attracted to electrode

  ignore get rid of impurities

4

Q7.

(a) hydrogen

accept H_2
*do **not** accept H*

1

(b) litmus paper / Universal Indicator paper / pH paper

allow any suitable <u>named</u> indicator

1

bleached / turns white **or** loses its colour

*do **not** accept bleached cloth / leaves etc.*
allow second mark unless <u>incorrect</u> indicator given
allow starch iodide paper (1)
goes black / blue black (1)
allow potassium iodide solution (1) goes brown / orange / black precipitate (1)

1

(c) because they have a negative charge **or** opposite charges attract

accept (because) it is Cl^{-}
*accept chlorine, Cl **or** chlorine ions has a negative charge*
*do **not** accept* Cl^{-} *on its own*
*do **not** accept* Cl_2 *o.e. has negative charge*

1

(d) kill bacteria / germs, etc. **or** sterilise / disinfect

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accept destroys bacteria etc.
ignore clean / purify water (owtte)
*do **not** accept just gets rid of bacteria*

1

(e) hydroxide (ion)

accept OH^-

1

[6]

Q8.

(a) (i) bulb lights up

1

bubbles / fizz / gas or chlorine given off

1

(ii) in solid, ions

1

are not free to move / (charged) particles cannot move or converse

atoms / electrons cannot move worth 0 marks

1

(b) (i) breakdown / decomposition / splitting up

***not** separation*

1

by using electricity

1

(ii) gas **A** = chlorine / oxygen

1

deposit **B** = copper

1

(c) any one from:

- manufacturer of chlorine / sodium hydroxide / hydrogen / sodium
- electroplating of steel / reference to plating

  ***not** galvanising*
- extraction of aluminium / metal reactivity series specified
- purification of copper

  ***not** making copper*

1

[9]

Q9.

(i) electrolysis

1

(ii) oxidation

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1

(iii) hydroxide ions **or** OH^-

*accept sodium hydroxide **or** hydroxide **or** OH for one mark only*

2

(iv) $H^+ + e^-$

1

H_2

ignore any state symbols

1

$2H^+ + 2e^- \rightarrow H_2$

*accept $H^+ + e^- \rightarrow H$ for **one** mark only*

1

[7]

Q10.

(a) breakdown / decomposition / splits into elements /

***not** ions*

separates into elements / produce a chemical reaction

1

using electricity

1

(b) lead bromide melted / free ions

not electrolyte

1

(c) (+) bromine

element must be appropriate to electrode

1

(–) lead

element must be appropriate to electrode

1

(d) fume cupboard / protective clothing

allow safety glasses
***not** safety mat*

1

[6]

Q11.

(a) substance brokendown / separates / splits into elements

by electric current / electricity

ions free to move e.g. when molten / in solution

allow 1 mark for "a substance that conducts electricity"

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max 2

(b) (i) copper / Cu

1

(ii) oxygen /O_2

allow CO_2

1

(c) tube over electrode

full of $CuSO_4$(aq) / water

allow sulphuric acid / sensible electrolyte

***not** any other liquid / using a syringe*

2

(d) Cu^{2+} ions removed / less Cu^{2+}

***not** copper sulphate removed*

allow 1 mark for "copper removed / less copper"

2

[8]

Q12.

(a) (i) H_2SO_4 **or** red (acidic) pH < 7

accept names of compounds

accept correct use of acidic

1

NaOH **or** purple (alkaline) pH > 7

*alkaline and neutral without any mention of pH for **1** mark only*

1

NaCl **or** green (neutral) pH 7

*ignore high **or** low pH*

1

(ii) hydrogen (ion)

accept proton

accept hydroxonium ion

1

H^+

accept H_3O^+ for hydroxonium ion

1

(b) (i) neutralisation

1

(ii) NaOH + HCl

ignore state symbols

1

NaCl + H_2O

ignore state symbols

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*maximum of **1** mark if incorrectly balanced*

1

(c) (i) sodium – 2 . 8 . 1

accept 2.8.1 written

1

chlorine – 2 . 8 . 7

accept 2.8.7 written

1

(ii) ion(s)

1

(iii) attraction between oppositely charged particles (ions)

accept attraction between + and – particles (ions)

accept electrostatic attraction

1

(d) chloride ions lose electrons to form chlorine

$Cl^- - e^- \rightarrow Cl$

1

hydrogen ions gain electrons to form hydrogen

$H^+ + e^- \rightarrow H$

1

sodium hydroxide remains in solution

Na + and OH^- remain in solution to form sodium hydroxide

1

[15]

Q13.

(a) electrolytes

1

(b) oxidation

1

electrons lost

1

(c) $2H^+ + 2e^- \rightarrow H_2$

minus sign on e^- not needed

2

(d) concentration increases

1

OH^- discharged from water / water decomposes

1

H^+ concentration increases / H_2 and O_2 evolved

1

[8]

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Q14.

(a) 2 2 multiples of ½ allowed

for 1 mark

1

(b) (i) 2. 8. 1 and 2. 8. 7

gains 3 marks

1 mark for 2 electrons in each inner shell
1 mark for 8 electrons in each second shell
1 mark for 1 electron in sodium outer shell
and 7 in chlorine outer shell

3

(ii) sodium atom loses;
electron;
chlorine atom gains;
electron

for 1 mark each

inversion = 2 marks
lose negative charge = 1 mark

4

(c) (i) KCl (accept 2KCl)

for 1 mark

1

(ii) both have on electron in outer shell/same number of electrons/
lose same number of electrons in compound formation/
both lose one electron

for 1 mark

1

(d) 0 amps;
the ions;
cannot move in the solid
solid Na chloride does not conduct

for 1 mark each

3

(e) (i) water (H_2O)

for 1 mark

1

(ii) (1) chlorine;
(2) hydrogen

for 1 mark

1

[15]

Q15.

(a) (i) 45%

for 1 mark

1

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(ii) 126 000 (consequential on (i))
for 1 mark

1

(b) (i) $Cl_2 = 71$
1 × 71/24 or correct mathematical attempt
for 1 mark

(If Cl_2 wrong take figure given)
for 1 mark

= 2.96 kg
gains 3 marks

(or alternative methods)
(if units not given - 3 marks. If units wrong - 2 marks)

3

(ii) any sensible eg. bleach/disinfectant/antiseptics/kill bacteria/ sterilise water/solvents/refrigerents/CFCs/PVC
(not water treatment or warfare)
for 1 mark

1

[6]

Q16.

(a) (i) hydrogen/H_2
for 1 mark

1

(ii) i.e. $2Cl^- - 2e^- \rightarrow Cl_2$
for 1 mark

1

(iii) hydroxide or OH^-
for 1 mark

1

(iv) sodium hydroxide/caustic soda/NaOH/bleach/ chemical name of bleach
for 1 mark

1

(b) (i) Na_2CO_3 or $(Na+)_2\ CO_3^{2-}$
for 1 mark

1

(ii) coal
water/H_2O
limestone/$CaCO_3$/calcium carbonate
any one for 1 mark

1

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(iii) calcium chloride/$CaCl_2$/sodium hydrogen carbonate/$NaHCO_3$

for 1 mark

1

(iv) decomposition/heating of limesstone
decomposition/heating of coal
decomposition/heating of sodium hydrogen carbonate

any 1 for 1 mark

1

described change e.g. $NaHCO_3 \rightarrow Na_2CO_3$
(Use judgement)
breakdown (owtte.)
by heat

for 1 mark each

2

(v) carbon dioxide/CO_2 or ammonia/NH_3

for 1 mark

1

(c) (i) zinc carbonate/$ZnCO_3$/zinc hydroxide/$Zn(OH)_2$

for 1 mark

1

(ii) It is insoluble
zinc carbonate is insoluble in water

for 1 mark

1

[13]

Q17.

(a) potassium / K

for 1 mark

1

(b) carbon dioxide / CO_2

for 1 mark

1

(c) losing
electrons
gaining
electrons

for 1 mark each

4

(d) (i) power supply, (not mains)
beaker containing solution,
(inert) electrodes and circuit
ammeter or bulb/
(or see bubbling etc. at electrodes written by drawing)

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for 1 mark each

4

(ii) reading on ammeter/bulb lights / (solution) conducts (electricity)
bubbling / gas produced
hydrogen produced
chlorine / oxygen produced
ions move
to electrodes (must be linked to ions move)
negative ions move to the positive electrode
<u>and/or</u> positive ions move to the negative electrode
negative ions lose electrons
<u>and/or</u> positive ions gain electrons

any 3 for 1 mark each

3

[13]

Q18.

(a) Gas A = Chlorine / Cl_2 <u>not</u> Cl <u>and</u> Gas B = Hydrogen / H_2 <u>not</u> H

for 1 mark

Solution C = sodium hydroxide/NaOH/spent brine

for 1 mark

2

(b) (i) 2, 2

for 1 mark

(ii) 2, 2

for 1 mark

2

(c) water/H_2O/hydrogen oxide <u>not</u> hydrogen hydroxide

for 1 mark

1

(d) ions/positive ions/negative ions/cations/anions
<u>not</u> charged particles/positive particles/negative particles
<u>not</u> H^+ / Cl^-/Na^+ / OH^-
<u>Allow</u> hydrogen <u>ions</u> etc.
<u>not</u> sulphate ions

for 1 mark

1

[6]

Q19.

(a) sodium hydroxide / caustic soda / NAOH

for 1 mark

1

(b) negative ions move to the positive electrode etc.
/because it is negative
/opposite charges attract

for 1 mark

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1

(c) loss of electrons

for 1 mark

1

[3]

Q20.

(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]

Q21.

(i) hydrogen, hydroxide and sulphate

*all **three** and no others*

any order

do not credit any formula(e)

1

(ii) the anode is positive

1

(so) only the negative ions are attracted to it

***or** (so) only the hydroxide ions and the sulphate ions are attracted (to it)*

***or** (so) only the anions are attracted (to it)*

1

(iii) $2H_2O + O_2 + 4e^-$

1

[4]

Q22.

(a) hydrogen

for 1 mark

1

(b) chloride ions are negative;
negative ions move to positive electrode

each for 1 mark

2

(c) any **one** use of chlorine e.g.
sterilisation;

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bleaching;
making plastics

any one for 1 mark

1

[4]

Q23.

copper collects at the negative electrode
copper positive ions

each for 1 mark

[2]

Q24.

(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 not 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]

Q25.

(a) $2Cl^- - 2e^- \rightarrow Cl_2$ (allow unaltered LHS to produce ½ Cl_2)
$Na^+ + e^- \rightarrow Na$ (allow × 2 for **all** terms)

(*credit* candidates who point out that hydrogen / H_2 is in fact produced)

for 1 mark each

2

(b) for product 1*, *idea of* a solid / precipitate **or** silver bromide

gains 1 mark

but solid / a precipitate of silver bromide

gains 2 marks

for product 2*, *idea of* aqueous / a solution / dissolved (in water) / **or** sodium nitrate

gains 1 mark
(do not allow liquid)

but aqueous / a solution / dissolved (in water) of sodium nitrate

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(*do not credit formulae)

gains 2 marks

4

[6]

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