



A-Level Chemistry

Redox

Mark Scheme

Time available: 61 minutes

Marks available: 50 marks

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Mark schemes

1.

- (a) Electron acceptor

Do not allow electron pair acceptor

1

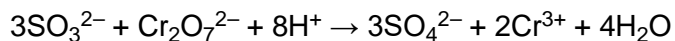
- (b) $\text{SO}_3^{2-} + \text{H}_2\text{O} \rightarrow \text{SO}_4^{2-} + 2\text{H}^+ + 2\text{e}^-$

Allow multiples in each case

1



1



1

[4]

2.

- (a) **M1** reaction of nitrogen/ N_2 and oxygen/ O_2 from the air

Must be at least one reference to air.

NOT reference to nitrogen/oxygen from the fuel.

Allow equation plus a reference to the air.

Allow combustion of nitrogen plus reference to the air.

NOT M1 if reference to reaction taking place in the catalytic converter.

1

- M2** at high temperatures

Allow high energy/heat or very hot.

Allow heat/energy in the engine provides Ea

IGNORE references to pressure/spark

1

- (b) Formation of acid rain / causes respiratory problems

Allow (contributes to) ground level ozone / (photochemical) smog / toxic / poisonous

Allow makes water acidic / reacts with water to form nitric acid / (NO_x gases are) acidic

IGNORE greenhouse gases / global warming / damages ozone layer

IGNORE vague answers such as 'harmful to environment'/polluting /harmful

NOT reference to pH rising

1

(c) **M1** $\text{NO}_2 = (+)4 \text{ NH}_3 = -3 \text{ N}_2 = 0$

1

M2 $3\text{NO}_2 + 4\text{NH}_3 \rightarrow 7/2\text{N}_2 + 6\text{H}_2\text{O}$

ALLOW multiples/fractions

($6\text{NO}_2 + 8\text{NH}_3 \rightarrow 7\text{N}_2 + 12\text{H}_2\text{O}$ OR

$1\frac{1}{2}\text{NO}_2 + 2\text{NH}_3 \rightarrow 1\frac{3}{4}\text{N}_2 + 3\text{H}_2\text{O}$)

1

(d) **M1** Catalyst in different phase/state (to reactants)

*NOT (catalyst in different phase/state to) products allow catalyst in different phase/state to reactants **and** products*

1

M2 Speeds up reaction without being used up

ALLOW speeds up the reaction by (providing alternative route for reaction and) lowering E_a

NOT does not take part in the reaction

1

(e) incomplete combustion

***ignore** equations*

ALLOW description of incomplete combustion (e.g. not enough oxygen)

Allow O_2 but NOT O for oxygen

1

[8]

3.

(a) Two correct Cl ox states: $\text{HClO} = +1$ $\text{HCl} = -1$

1

(b) Oxidation:

$\text{Cl}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{HClO} + 2\text{H}^+ + 2\text{e}^-$

Accept - 2e^- on the other side

Allow $\text{Cl}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{ClO}^- + 2\text{e}^-$

1

Reduction:

$\text{Cl}_2 + 2\text{H}^+ + 2\text{e}^- \rightarrow 2\text{HCl}$

Allow $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$

If both equations correct but incorrect order, allow 1

Ignore state symbols

1

(c) $2\text{NaOH} + \text{Cl}_2 \rightarrow \text{NaCl} + \text{NaClO} + \text{H}_2\text{O}$

Allow

$2\text{OH}^- + \text{Cl}_2 \rightarrow \text{Cl}^- + \text{ClO}^- + \text{H}_2\text{O}$

Allow NaOCl

Ignore state symbols

1

(d) $\text{mol ClO}^- = \text{conc} \times \text{vol} = 0.0109 \times 0.02$
 $= \underline{0.000218 / 2.18 \times 10^{-4} \text{ mol}}$

1

$\text{mol KI} = 0.000218 \times 2 = 0.000436 \text{ mol}$

$M2 = M1 \times 2$

If incorrect ratio, M2 & M3 = 0

1

$\text{mass KI} = M_r \times \text{mol} = 166.0 \times 0.000436$
 $= 0.072376 \text{ g}$
 $= 72.4 \text{ (mg)}$

$M3 = M1 \times 2 \times 166.0 \times 1000$

Must be to 3 sig figs

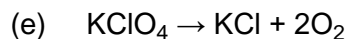
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black solid/ppt appears/forms (in a colourless solution)
 or (colourless solution) turns brown (solution)

Not purple. Not red. Not brown ppt/solid

Ignore grey.

1



Ignore state symbols

Allow multiples

1

$\Delta H = -436 - -434 = -2 \text{ kJ mol}^{-1}$

Must be negative

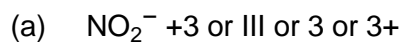
Mark independently

Allow consequential for multiples

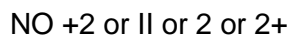
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[10]

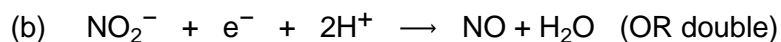
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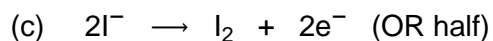
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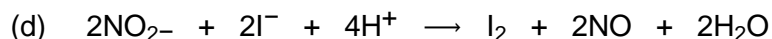
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1



1



1

(e) Oxidising agent

Allow to accept / gain electrons

Allow Oxidant

Do not allow accept / gain pairs of electrons

Do not allow Oxidise

1

(f) $\text{Mol ClO}_3^- = 0.02 \times \frac{27.4}{1000} = 5.48 \times 10^{-4}$

1

$$\text{Mol NO}_2^- = \frac{5}{2} \left(0.02 \times \frac{27.4}{1000} \right) = 1.37 \times 10^{-3}$$

1

$$[\text{NO}_2^-] = \text{mol NO}_2^- / \left(\frac{25}{1000} \right)$$

$$[\text{NaNO}_2] = 0.0548 \text{ mol dm}^{-3}$$

1

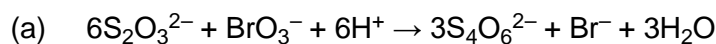
$$\text{Conc NaNO}_2 = (0.0548) \times 69.0 = 3.78 \text{ g dm}^{-3}$$

1

Minimum 2 sf

[10]

5.



Check the formulae and charges carefully and penalise any transcription errors.

Allow multiples and fractions.

Ignore state symbols.

1

(b) $\text{Mol of thio} = 25.0 \times 0.00100 / 1000 = 2.50 \times 10^{-5}$
and

$$\text{Mol of bromate(V)} = (1/6) \times 2.5 \times 10^{-5} = 4.17 \times 10^{-6}$$

If equation in Q5a is wrong, mark consequentially.

1

$$\text{Vol of bromate(V)} = (4.17 \times 10^{-6} / 0.005) \times 1000 = 0.83 \text{ cm}^3$$

Lose this mark if (correct) unit of volume not given.

Do not penalise precision.

1

(c) Use a more dilute solution of sodium bromate

Allow 'use a bigger volume of sodium thiosulfate solution'.

1

[4]

6.

(a) (i) **M1** (+) 4 **OR** IV

M2 (+) 6 **OR** VI

2

- (ii) It / Chlorine has gained / accepted electron(s)

OR

Correctly balanced half-equation eg $\text{Cl}_2 + 2\text{e}^- \longrightarrow 2\text{Cl}^-$

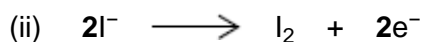
Credit 1 or 2 electrons but not lone pair.

The idea of 'reduction' alone is not enough.

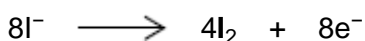
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1



OR



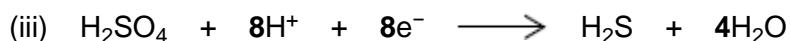
Ignore charge on the electron unless incorrect.

Or multiples.

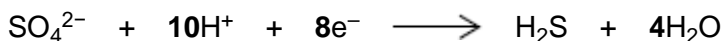
Credit the electrons being subtracted on the LHS.

Ignore state symbols.

1



OR



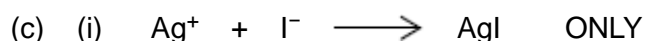
Ignore charge on the electron unless incorrect.

Or multiples.

Credit the electrons being subtracted on the RHS.

Ignore state symbols.

1



Ignore state symbols.

Not multiples.

1

- (ii) The precipitate / solid / it does not dissolve / is insoluble / remains

OR a white / cream / yellow solid / precipitate

OR stays the same

OR no (visible / observable) change

OR no effect / no reaction

Ignore 'nothing (happens)'.

Ignore 'no observation'.

1

(iii) The silver nitrate is acidified to

- react with / remove (an)ions that would interfere with the test
Credit a correct reference to ions that give a 'false positive'.
- prevent the formation of other silver precipitates / insoluble silver compounds that would interfere with the test
Do not penalise an incorrect formula for an ion that is written in addition to the name.
- remove (other) ions that react with the silver nitrate
If only the formula of the ion is given, it must be correct.
- react with / remove carbonate / hydroxide / sulfite (ions)
Ignore 'sulfate'.

1

(iv) HCl would form a (white) precipitate / (white) solid (with silver nitrate and this would interfere with the test)

*It is not sufficient simply to state either that it will interfere **or** simply that the ions / compounds react to form AgCl*

1

(d) (i) Any **one** from

Ignore 'to clean water'.

- to sterilise / disinfect water
Ignore 'water purification' and 'germs'.
- to destroy / kill microorganisms / bacteria / microbes / pathogens
Credit 'remove bacteria etc' / prevent algae.

1

(ii) The (health) benefit outweighs the risk

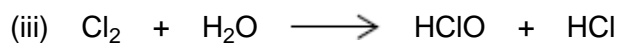
OR

a clear statement that once it has done its job, little of it remains

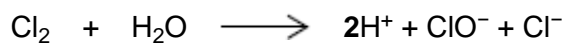
OR

used in (very) dilute concentrations / small amounts / low doses

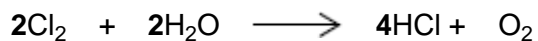
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OR



OR



Credit HOCl or ClOH

Or multiples.

Credit other ionic or mixed representations.

Ignore state symbols.

1

(e) **In either order - Both required for one mark only**

Credit correct ionic formulae.

NaClO (OR NaOCl) and NaCl

Give credit for answers in equations unless contradicted.

1

[14]