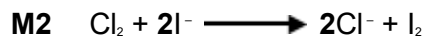


**M1.** (a) (i) **M1** iodine **OR**  $I_2$  **OR**  $I_3^-$   
*Ignore state symbols*  
*Credit M1 for "iodine solution"*



**OR**



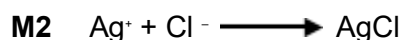
*Penalise multiples in M2 except those shown*

**M2** accept correct use of  $I_3^-$

**M3** redox or reduction-oxidation or displacement

3

(ii) **M1** (the white precipitate is) silver chloride  
**M1** must be named and for this mark ignore incorrect formula



*For M2 ignore state symbols*

*Penalise multiples*

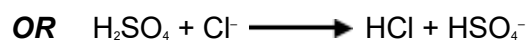
**M3** (white) precipitate / it dissolves

**OR** colourless solution

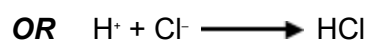
*Ignore references to "clear" alone*

3

(b) (i) **M1**  $H_2SO_4 + 2Cl^- \longrightarrow 2HCl + SO_4^{2-}$   
*For M1 ignore state symbols*



*Penalise multiples for equations and apply the list principle*



**M2** hydrogen chloride **OR** HCl **OR** hydrochloric acid

2

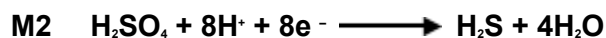
(ii) **M1 and M2 in either order**  
*For M1 and M2, ignore state symbols and credit multiples*



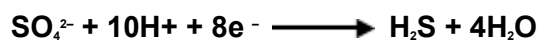
OR



*Do not penalise absence of charge on the electron  
Credit electrons shown correctly on the other side of  
each equation*



OR



*Additional equations should not contradict*

M3 oxidising agent / oxidises the iodide (ions)

OR

electron acceptor

M4 sulfur OR S OR S<sub>2</sub> OR S<sub>8</sub> OR sulphur

4

(iii) M1 The NaOH / OH<sup>-</sup> / (sodium) hydroxide reacts with / neutralises the H<sup>+</sup> / acid / HBr (lowering its concentration)

OR a correct neutralisation equation for H<sup>+</sup> or HBr with NaOH or with hydroxide ion

*Ignore reference to NaOH reacting with bromide ions*

*Ignore reference to NaOH reacting with HBrO alone*

M2 Requires a correct statement for M1

The (position of) equilibrium moves / shifts(from L to R)

- to replace the H<sup>+</sup> / acid / HBr that has been removed / lost
- OR to increase the H<sup>+</sup> / acid / HBr concentration
- OR to make more H<sup>+</sup> / acid / HBr / product(s)
- OR to oppose the loss of H<sup>+</sup> / loss of product(s)
- OR to oppose the decrease in concentration of product(s)  
*In M2, answers must refer to the (position of) equilibrium shifts / moves and is not enough to state simply that it / the system / the reaction shifts to oppose the change.*

M3 The (health) benefit outweighs the risk or wtte

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

3

[15]



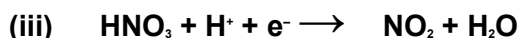
*Or multiples*  
*Ignore state symbols*

1

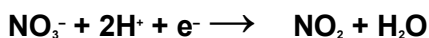


M2  $\text{NO}_2 (+) 4$   
*Ignore working out*  
*M1 Credit (V)*  
*M2 Credit (IV)*

2



OR



*Or multiples*  
*Ignore state symbols*  
*Ignore charge on the electron unless incorrect and*  
*accept loss of electron on the RHS*

1

(b) (i) In either order

**M1 Concentration(s) (of reactants and products)**  
**remain(s) constant / stay(s) the same / remain(s)**  
**the same / do(es) not change**

**M2 Forward rate = Reverse / backward rate**

*For M1 accept [ ] for concentration*  
*NOT “equal concentrations” and NOT “concentration(s)*  
*is/are the same”*  
*NOT “amount”*

*Ignore “dynamic” and ignore “speed”*

*Ignore “closed system”*

*It is possible to score both marks under the heading of a single feature*

2

(ii) M1

The (forward) reaction / to the right is endothermic  
or takes in / absorbs heat

OR

The reverse reaction / to the left is exothermic or gives out / releases heat

M2 depends on correct M1 and must refer to temperature/heat

The equilibrium shifts / moves left to right to oppose the increase in temperature

*M2 depends on a correct statement for M1*

*For M2, the equilibrium shifts/moves*

*to absorb the heat OR*

*to lower the temperature OR*

*to cool the reaction*

2

(iii) M1 refers to number of moles

There are fewer moles (of gas) on the left OR more moles (of gas) on the right.

OR there is one mole (of gas) on the left and 2 moles on the right.

M2 depends on correct M1 and must refer to pressure

The equilibrium shifts / moves right to left to oppose the increase in pressure

*M2 depends on a correct statement for M1*

*For M2, the equilibrium shifts/moves to lower the pressure.*

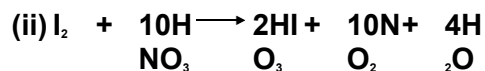
2

[10]

M3.(a) (i) M1 0

M2 (+) 5  
Accept Roman V for M2

2



Accept multiples

1



For M1, ignore state symbols

Credit multiples

Accept  $2\frac{1}{2}I_2 + \frac{1}{2}I_2$  as alternative to  $3I_2$

Electrons must be cancelled

M2 NaIO<sub>3</sub> OR IO<sub>3</sub><sup>-</sup> OR iodate ions OR iodate(V) ions etc.

For M2 Do not penalise an incorrect name for the correct oxidising agent that is written in addition to the formula.

Accept "the iodine in iodate ions" but NOT "iodine" alone

Accept "the iodine / I in iodate ions" but NOT "iodine" alone

2

(c) (i) Iodine OR I<sub>2</sub>

Insist on correct name or formula

1



Ignore state symbols



Credit multiples

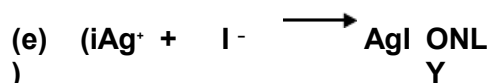
Do not penalise absence of charge on the electron

(d) hydrogen sulfide

OR H<sub>2</sub>S

OR hydrogen sulphide

1



*Ignore state symbols*

*No multiples*

1

(ii) The (yellow) precipitate / solid / it does not dissolve / is insoluble  
*ignore "nothing (happens)"*

OR turns to a white solid

*ignore "no observation"*

OR stays the same

OR no (visible/ observable) change

OR no effect / no reaction

1

(iii) The silver nitrate is acidified to

- react with / remove (an)ions that would interfere with the test  
*Ignore reference to "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

- react with / remove carbonate / hydroxide / sulfite (ions)

*If only the formula of the ion is given, it must be correct*

1

(f) (i) An electron donor

*Penalise "electron pair donor"*

OR (readily) donates / loses / releases / gives (away) electron(s)

*Penalise "loss of electrons" alone*

*Accept "electron donator"*

1

(ii)  $\text{Cl}_2 + 2\text{e}^- \longrightarrow 2\text{Cl}^-$

*Ignore state symbols*

*Do not penalise absence of charge on electron*

*Credit  $\text{Cl}_2 \longrightarrow 2\text{Cl}^- - 2\text{e}^-$*

*Credit multiples*

1

(iii) For M1 and M2, iodide ions are stronger reducing agents than chloride ions,  
because

*Ignore general statements about Group VII trends or about halogen molecules or atoms. Answers must be specific*

M1 Relative size of ions

*CE=0 for the clip if "iodine ions / chlorine ions" QoL*

*Iodide ions / they are larger / have more electron levels(shells) (than chloride ions) / larger atomic / ionic radius*

*CE=0 for the clip if "iodide ions are bigger molecules / atoms" QoL*

*OR electron to be lost/outer shell/level (of the iodide ion) is further the nucleus*

*OR iodide ion(s) / they have greater / more shielding*

*Insist on iodide ions in M1 and M2 or the use of it / they / them, in the correct context (or chloride ions in the converse argument)*

*OR converse for chloride ion*

M2 Strength of attraction for electron(s)

*Must be comparative in both M1 and M2*

*The electron(s) lost /outer shell/level electron from (an) iodide ion(s) less*

strongly held by the nucleus compared with that lost from a chloride ion

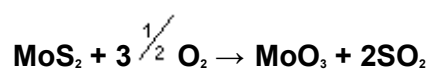
OR converse for a chloride ion

2

[15]



OR



*Allow multiples*

*Ignore state symbols*

1

(ii) M1 Environmental problem

Acid rain

OR

An effect either from acid rain or from an acidic gas in the atmosphere.

M2 Use

SO<sub>2</sub> could be used to make / to form / to produce  
(or write) H<sub>2</sub>SO<sub>4</sub> / sulfuric acid

OR

To make / to form / to produce (or write) gypsum / CaSO<sub>4</sub>  
or plaster of Paris / plaster board

*Ignore references to the greenhouse effect*

*Penalise reference to the ozone layer using the list principle*

2



*Allow multiples*

*Ignore state symbols*

1



(iv) One from

H<sub>2</sub> is

- Explosive
- (in)flammable
- easily ignited  
*Ignore “burns”*

1

(b) (i) To allow ions to move (when molten)

OR

Ions cannot move in the solid

1

(ii)  $\text{Ca}^{2+} + 2\text{e}^- \rightarrow \text{Ca}$

*Or multiples*

*Ignore state symbols*

*Ignore charge on the electron unless incorrect and  
accept loss of two electrons on the RHS*

1

(iii) (High) electricity / electrical energy (cost)

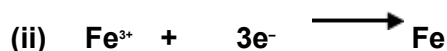
*Ignore “energy” and ignore “current”*

[8]

M5.(a) (i) reduction OR reduced OR redox OR reduction–oxidation

*Not “oxidation” alone*

1



*Ignore state symbols*

*Do not penalise absence of charge on electron*

*Credit  $\text{Fe}^{3+} \longrightarrow \text{Fe} - 3\text{e}^-$*

*Credit multiples*

1

(b) (i) Because (one of the following)

CO is not the only product *OR*

*Reference to "incomplete combustion to form CO" does not answer the question*

(Some) complete combustion (also) occurs *OR*

CO<sub>2</sub> is (also) formed

Further oxidation occurs

1

(ii) The enthalpy change / heat (energy) change at constant pressure in a reaction is independent of the route / path taken (and depends only on the initial and final states)

1

(iii) M1 The enthalpy change / heat change at constant pressure when 1 mol of a compound / substance / element

*For M1, credit correct reference to molecule/s or atom/s*

M2 is burned completely / undergoes complete combustion in (excess) oxygen

M3 with all reactants and products / all substances in standard states

*For M3*

*Ignore reference to 1 atmosphere*

*OR* all reactants and products / all substances in normal / specified states  
under standard conditions / 100 kPa / 1 bar and specified T / 298 K

3

- (c) **M1** (could be scored by a correct mathematical expression which must have all  $\Delta H$  symbols and the  $\Sigma$ )

*Correct answer gains full marks*

*Credit 1 mark ONLY for  $-1$  ( $\text{kJ mol}^{-1}$ )*

**M1**  $\Delta H_r = \Sigma \Delta H_f$  (products)  $- \Sigma \Delta H_f$  (reactants)

*Credit 1 mark ONLY for  $-27$  ( $\text{kJ mol}^{-1}$ ) i.e. assuming value for  $\text{Fe}(l) = 0$*

OR correct cycle of balanced equations with  $2\text{Fe}$ ,  $3\text{C}$  and  $3\text{O}_2$

**M2**  $\Delta H_r = 2(+14) + 3(-394) - (-822) - 3(-111)$

$= 28 - 1182 + 822 + 333$

(This also scores M1)

**M3**  $= (+) 1$  ( $\text{kJ mol}^{-1}$ )

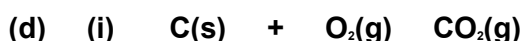
(Award 1 mark ONLY for  $-1$ )

(Award 1 mark ONLY for  $-27$ )

*For other incorrect or incomplete answers, proceed as follows*

- *check for an arithmetic error (AE), which is either a transposition error or an incorrect multiplication; this would score 2 marks (M1 and M2)*
- *If no AE, check for a correct method; this requires either a correct cycle with  $2\text{Fe}$ ,  $3\text{C}$  and  $3\text{O}_2$  OR a clear statement of M1 which could be in words and scores only M1*

3



*State symbols essential*

*Possible to include  $\text{C}(s, \text{graphite})$*

1

- (ii) These two enthalpy changes are for the same reaction / same equation / same reactants and products

*Penalise reference to  $\text{CO}_2$  being produced by a different route*

**OR**

They both make one mole of carbon dioxide only from carbon and oxygen  
(or this idea clearly implied)

***“both form  $\text{CO}_2$ ” is not sufficient (since other products might occur e.g.  $\text{CO}$ )***

**OR**

**The same number and same type of bonds are broken and formed**

1

[12]