

**M1.(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  $\text{Cl}_2 + 2\text{e}^- \longrightarrow 2\text{Cl}^-$

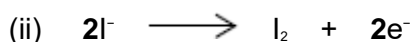
*Credit 1 or 2 electrons but not lone pair.*

*The idea of 'reduction' alone is not enough.*

1



1



**OR**



*Ignore charge on the electron unless incorrect.*

*Or multiples.*

*Credit the electrons being subtracted on the LHS.*

*Ignore state symbols.*

1



**OR**



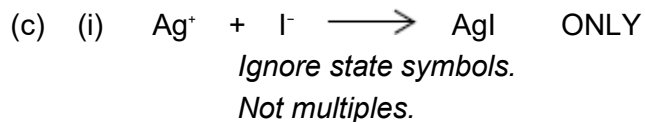
*Ignore charge on the electron unless incorrect.*

*Or multiples.*

*Credit the electrons being subtracted on the RHS.*

*Ignore state symbols.*

1



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

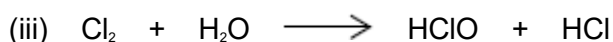
**OR**

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

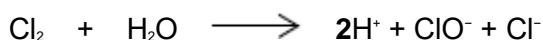
**OR**

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

1



**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

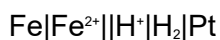
[14]

**M2.(a)** Pt|H<sub>2</sub>|H<sup>+</sup>||Fe<sup>2+</sup>|Fe

*Allow 1 for correct order of symbols but lose second mark for a wrong phase boundary(s) / Pt missing / extra Pt on RHS,*

*additional phase boundary*

Note, allow one mark only for correct symbol in reverse:



*Allow dashed lines for salt bridge*

*Ignore state symbols*

*Ignore 2 if used before H<sup>+</sup>*

2

(b) Electron donor

*Allow (species that) loses electrons*

*Do not allow reference to electron pairs*

1

(c) Cl<sub>2</sub> / chlorine

*If M1 blank or incorrect cannot score M2*

1

(Species on RHS / electron donor) has most positive / largest  $E^\ominus$  / has highest potential

*Do not allow reference to e.m.f. or E(cell)*

1

(d) (i) Cl / chlorine

1

(ii) Chlorine +1 to chlorine 0

*CE if chlorine not identified in part (i)*

*Allow chlorine +1 to chlorine -1 (in Cl<sup>-</sup>)*

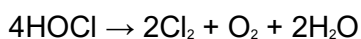
*Allow oxidation state decreases by one OR two*

*Allow oxidation state changes by -1 OR -2*

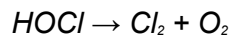
1



OR



*Allow one mark for any incorrect equation that shows*



Allow multiples

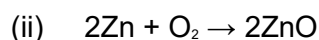
Ignore state symbols

Penalise one mark for uncancelled or uncombined species  
(eg  $\text{H}_2\text{O} + \text{H}_2\text{O}$  instead of  $2\text{H}_2\text{O}$ )

2

(f) (i) e.m.f. =  $0.40 - (-1.25) = \underline{1.65}$  (V) /  $\underline{+1.65}$  (V)  
Allow  $-1.65$  (V)

1



Allow multiples

Ignore state symbols

Do not allow uncancelled species

If more than one equation given, choose the best

1

(iii) A / stainless lid

If M1 incorrect or blank CE=0

1

$\text{O}_2$  (electrode) has a more positive  $E^\ominus$  / oxygen (electrode) requires / gains electrons from external circuit

Or reference to the overall equation and a link to electrons going into A

Allow oxygen is reduced and reduction occurs at the positive electrode

OR Zinc (electrode) has more negative  $E^\ominus$

Do not allow reference to e.m.f. or  $E(\text{cell})$

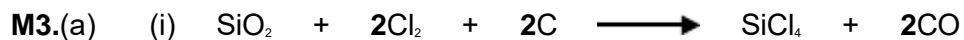
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(iv) (Cell) reaction(s) cannot be reversed / zinc oxide cannot be reduced to zinc by passing a current through it / zinc cannot be regenerated

Allow danger from production of gas / oxygen produced / hydrogen produced

1

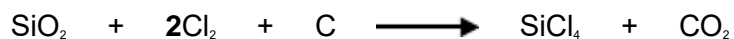
[14]



*Ignore state symbols*

*Credit multiples of either equation*

**OR**



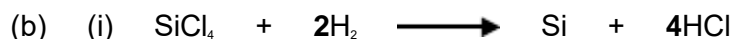
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(ii) (fractional) distillation

**OR**

G(L)C or gas (–liquid–) chromatography

1



*Ignore state symbols*

*Credit multiples*

*Penalise ionic HCl*

1

(ii) Reducing agent / reductant / reduces  $\text{SiCl}_4$  / reduces (silicon) / electron donor

1

(iii) Explosion / explosive

**OR**

(highly) flammable / inflammable

**OR**

readily / easily ignites / burns / combusts

1

(c)



Ignore state symbols  
Credit multiples

1

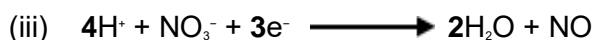
[6]



1

(ii) (+) 5  
(+) 2

2



Ignore state symbols.

Credit multiples of **this equation only**.

Ignore absence of charge on the electron.

1



Ignore state symbols.

Credit multiples of **this equation only**.

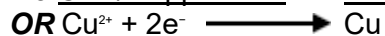
Ignore absence of charge on the electron.

1

(b) M1 add scrap / recycled / waste iron (or steel) to the aqueous solution  
*If M1 refers to iron / steel, but does not make it clear in the text that it is "scrap" / "waste" / "recycled", penalise M1 but mark on.*

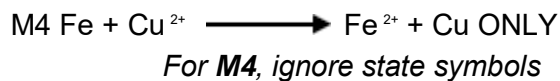
M2 the iron is a more reactive metal **OR** Fe is a better reducing agent  
*Credit zinc or magnesium as an alternative to iron for M2, M3 and M4 only, penalising M1*

M3 Cu<sup>2+</sup> / copper ions are reduced / gain electrons



**OR** copper / Cu is displaced by Fe

*Ignore absence of charge on the electron.*



4

[9]

**M5.** (a) Ti is not produced

**OR**

TiC / carbide is produced OR titanium reacts with carbon

**OR**

Product is brittle

**OR**

Product is a poor engineering material

*Penalise "titanium carbonate"*

*Ignore "impure titanium"*

*Credit "it / titanium is brittle"*

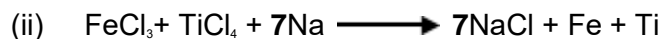
1



*Ignore state symbols*

*Credit multiples*

1



**OR** (for example)



*Ignore state symbols*

*Credit multiples including ratios other than 1:1*

*Ignore working*

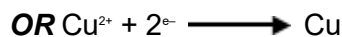
1

(c) Either order

*Penalise reference to incorrect number of electrons in **M1***

**M1** The  $\text{Cu}^{2+}$  / copper(II) ions / they have gained (two) electrons





*For M1, accept "copper" if supported by correct half-equation or simplest ionic equation*

**OR** oxidation state / number decreases (or specified from 2 to 0)

*Ignore charge on the electron*

**M2** The  $\text{Cu}^{2+}$  / copper(II) ions / they have been reduced

*For M2 do **not** accept "copper" alone*

2



*Or multiples including*



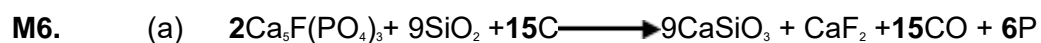
*Ignore state symbols*

*Ignore charge on the electron*

*Credit the electrons being subtracted on the LHS*

1

[6]



1

(b) **M1** ( $\text{P}_4 =$ ) **0**

**M2** ( $\text{H}_3\text{PO}_4 =$ ) **(+) 5**

*Accept Roman numeral V for M2*

2

(c)  $\text{H}_2\text{SO}_4$

**Both numbers required**

$$M_r = 2(1.00794) + 32.06550 + 4(15.99491) \\ = \mathbf{98.06102 \text{ or } 98.0610 \text{ or } 98.061 \text{ or } 98.06 \text{ or } 98.1}$$

*Calculations not required*

**and**

$\text{H}_3\text{PO}_4$

$$M_r = 3(1.00794) + 30.97376 + 4(15.99491)$$

$$= 97.97722 \text{ or } 97.9772 \text{ or } 97.977 \text{ or } 97.98 \text{ or } 98.0$$

1

- (d) (i) A substance that speeds up a reaction OR alters / increases the rate of a reaction **AND** is chemically unchanged at the end / not used up.

**Both ideas needed**

*Ignore reference to activation energy or alternative route.*

1

- (ii) The addition of water (**QoL**) to a molecule / compound

**QoL- for the underlined words**

1

- (iii) **M1**  $\text{CH}_3\text{CH}=\text{CH}_2 + \text{H}_2\text{O} \longrightarrow \text{CH}_3\text{CH}(\text{OH})\text{CH}_3$

( $\text{C}_3\text{H}_6$ )

*For M1 insist on correct structure for the alcohol but credit correct equations using either  $\text{C}_3\text{H}_6$  or double bond not given.*

**M2** propan-2-ol

2

[8]