M1. (a) both water vapour and ethanol will condense
   allow steam for water vapour
   allow they both become liquids
   allow ethane condenses at a lower temperature
   allow some of the steam hasn’t reacted
   allow it is a reversible reaction / equilibrium

(b) amount will decrease

because the equilibrium will move to the left

(c) more ethanol will be produced

because system moves to least / fewer molecules

[5]
M2. (a) because sulfur dioxide causes **acid rain**

which kills fish / aquatic life **or** dissolves / damages statues / stonework **or** kills / stunts growth of trees

*if no other mark awarded then award 1 mark for sulfur dioxide is toxic or causes breathing difficulties.*

(b) (i) **electrons** are lost

(ii) \[ \text{Cu}^{2+} + 2e^- \rightarrow \text{Cu} \]

*allow Cu^{2+} \rightarrow \text{Cu} - 2e^-*

*ignore state symbols*

(iii) copper sulfate

*allow any ionic copper compound*

(c) **(lattice of) positive ions**

delocalised electrons

*accept sea of electrons*

(electrostatic) attraction between the positive ions and the electrons

electrons can move through the metal / structure **or** can flow

*allow electrons can carry charge through the metal / structure*

*if wrong bonding named or described or attraction between oppositely charged ions then do not award M1 or M3 – MAX 2*

(d) (copper compounds are absorbed / taken up by) plants

*allow crops*

which are burned
the ash contains the copper compounds

*do not award M3 if the ash contains copper (metal)*

<table>
<thead>
<tr>
<th>/ ( A_r )</th>
<th>55.6 / 63.5</th>
<th>16.4 / 56</th>
<th>28.0 / 32</th>
</tr>
</thead>
<tbody>
<tr>
<td>moles</td>
<td>0.876</td>
<td>0.293</td>
<td>0.875</td>
</tr>
<tr>
<td>ratio</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>formula</td>
<td>( \text{Cu}_3\text{FeS}_3 )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

award **4** marks for \( \text{Cu}_3\text{FeS}_3 \), with some correct working
award **3** marks for \( \text{Cu}_3\text{FeS}_3 \), with **no** working
if the answer is not \( \text{Cu}_3\text{FeS}_3 \) award up to **3** marks for correct steps from the table apply ecf
if the student has inverted the fractions award **3** marks for an answer of \( \text{CuFeS} \)
M3. (a)  
(i) the products are at a lower energy level than the reactants
   accept products have less energy / less energy at the end than the beginning  
   1

(ii) because a catalyst provides an alternative / different pathway / mechanism / reaction route
   accept adsorption or ‘increases concentration at the surface’
   ignore absorption
   (that has) lower activation energy
   allow weakens bonds
   allow idea of increased successful collisions.
   DO NOT ALLOW answers stating catalysts provide energy for M1 and M2  
   1

(b) one pair of electrons in each overlap (8 pairs in total)
   allow any combination of dots, crosses or other symbols
   the rest of the diagram correct with four non-bonding electrons on the oxygen giving
   a total of eight electrons in oxygen outer energy level.
   gains 2 marks  
   1

(c) (i) ±3024 (J)
   correct answer with or without working gains 3 marks
   if the answer is incorrect, award up to 2 marks for the following steps:
   • \( \Delta T = 14.4(°C) \)
   • \( 50 \times 4.2 \times 14.4 \)
   allow ecf for incorrect \( \Delta T \)  
   3

(ii) 0.015(2173913)
correct answer with or without working gains 3 marks
if answer is incorrect, allow 1 mark each for any of the following steps up to a max of 2.

- 0.70g
- $M$ of ethanol = 46
- 0.70 / 46

allow ecf in final answer for arithmetical errors

(iii) $\pm 198720 \text{(J / mole)}$
$c(i) \div c(ii)$
allow ecf from (c)(i) and (c)(ii)
0.015 gives 201600
0.0152 gives 198947
0.01522 gives 198686

(d) (as the molecules get bigger or the number of carbon atoms increases) the intermolecular forces
allow intermolecular bonds

(intermolecular forces) increase
allow more / stronger (intermolecular forces)

and therefore require more (heat) energy to overcome
breaking covalent bonds or unspecified bonds max 1 mark (M3)
M4.(a) (i) silver nitrate

Allow AgNO₃

1

(ii) potassium carbonate or

Allow K₂CO₃

Sodium carbonate

Allow Na₂CO₃

1

(b) base

Allow ionic

Ignore insoluble or soluble

Ignore alkali

1

(c) (i) evaporate

or crystallise

Allow heat or boil or leave (to evaporate)

Allow cool

Ignore filtration unless given as an alternative

Do not accept freeze or solidify

1

(ii) 2 (HNO₃)

Accept multiples

1

(iii) 9

Accept nine

1

(d) 6.21 / 207

0.72 / 16

1 mark for dividing mass by A.

= 0.03

= 0.045

1 mark for correct proportions (allow multiples)

1
1 mark for correct whole number ratio (allow multiples). Can be awarded from formula.

Pb₂O₃

allow O₂Pb₂

ecf allowed throughout if sensible attempt at step 1
correct formula with no working gains 1 mark
M5.(a) lattice / giant structure

max 3 if incorrect structure or bonding or particles

ionic or (contains) ions

Na\textsuperscript{+} and Cl\textsuperscript{-}

accept in words or dot and cross diagram: must include type and magnitude of charge for each ion

electrostatic attraction

allow attraction between opposite charges

(b) hydrogen

allow H\textsubscript{2}

sodium hydroxide

allow NaOH

(c) any one from, eg:

- people should have the right to choose
- insufficient evidence of effect on individuals
- individuals may need different amounts.

allow too much could be harmful

ignore religious reasons

ignore cost

ignore reference to allergies

(d) (i) one bonding pair of electrons

accept dot, cross or e or – or any combination, eg

\[ \text{Diagram of bonding pair of electrons} \]
6 unbonded electrons on each atom

(ii) simple molecules

*max 2 if incorrect structure or bonding or particles*

accept small molecules

accept simple / small molecular structure

with intermolecular forces

accept forces between molecules

must be no contradictory particles

which are weak or which require little energy to overcome – must be linked to second marking point

*reference to weak covalent bonds negates second and third marking points*

(iii) iodine has no delocalised / free / mobile electrons or ions

so cannot carry charge

*if no mark awarded iodine molecules have no charge gains 1 mark*