



- (d)
- Dip Pt / nichrome wire in solid and place in hot/blue flame (1)
  - Na salt gives yellow colour(1)
  - Li salt give deep / magenta red / crimson colour (1)
- 3**

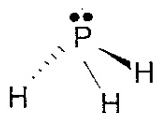
**Question total 12 marks**

- 4 (a)
- Magnesium ions are arranged in a regular lattice (1)
  - surrounded by a sea of / cloud of / delocalised electrons (1)
  - which can move through the solid when a potential is applied(1)
- 3**
- (b)
- At room temperature the ions are in a fixed position / in a lattice(1)
  - as heat applied the ions vibrate more (1)
  - eventually ions have enough energy to overcome electrostatic attraction (1)
  - ions break free are able to move as solid melts(1)
- 4**
- (c)
- Solid has ions in fixed sites / cannot move(1)
  - molten has ions free to move and carry current to electrodes(1)
- 2**

**Question total 9 marks**

- 5 (a) (i)
- Bond pairs 3 (1)
  - lone pairs 1 (1)
- 2**

(ii)



(1)

Angle (actual figure is 93) any value between 108 and 93 is acceptable (1)

- (b) (i)
- Hydrogen bonds (1)
  - Induced dipole-dipole interactions / van der Waals / London / dispersion (1)
- 2**

(ii)

- Phosphine does not have hydrogen bonds (1)
  - Lack of hydrogen bond not compensated by / increased induced dipole-dipole (1)
- 2**

- (c) (i)
- When the pair of electrons shared by two atoms (in covalent bond) (1)
  - both come from the same atom (1)
- 2**

- (ii) The lone pair on the nitrogen (1)
- 1**

- (iii)
- Tetrahedral (1)
  - has four pairs of bonding electrons (1)
  - repel as far away from each other as possible / minimum repulsion (1)
- 3**

**Question total 14 marks**

- 6 (a) An element with its highest energy electron in a *p* orbital (1) 1
- (b) (i) Colour: brown (1)  
State: liquid (1) 2
- (ii) The solution goes (from colourless to) dark brown / black solid produced (1) 1
- (c) (i)  $\text{Br}_2 + 2\text{e}^- \rightarrow 2\text{Br}^-$  (1) or  $\frac{1}{2}$  this 1
- (ii)  $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$  (1) 1
- (iii)  $\text{Br}_2 + 2\text{Fe}^{2+} \rightarrow 2\text{Br}^- + 2\text{Fe}^{3+}$  (1)  
or  $\frac{1}{2}$  this 1
- (d) (i)  $\text{Br}_2 + 2\text{NaOH} \rightarrow \text{NaBr} + \text{NaOBr} + \text{H}_2\text{O}$  (2)  
1 mark for correct bromine products  
Ionic equation acceptable 2
- (ii) Disproportionation (1) 1
- (e) (i) KBr -1 (1) KBrO<sub>3</sub> +5 (1) Br<sub>2</sub> 0(1) 3
- (ii) • Oxidising agent: KBrO<sub>3</sub> (1)  
• Oxidation number of Br in KBrO<sub>3</sub> goes down (1) 2

Question total 15 marks

- 7 (a) (i) • Energy / enthalpy change per mole (1)  
• required to remove an electron (1)  
• from 1 mole of gaseous atoms (1) 3
- (ii) • The nuclear charge on K is greater than on Na (1)  
• the outer electron is further from the nucleus (1)  
• but there is more shielding around K than Na (1) 3
- (b) (i)  $4.56 / 71(1) = 0.0642$  (1) mol 2
- (ii) Answer from (i)  $\div 2$  (1) = 0.0321 mol 1
- (iii) Answer from (ii)  $\times 24$  (1) = 0.771 dm<sup>3</sup> 1
- (iv) Answer from (iii)  $\times 3/2$  (1) = 1.16 dm<sup>3</sup> 1

Question total 11 marks

Paper total 75 marks

Jan 02

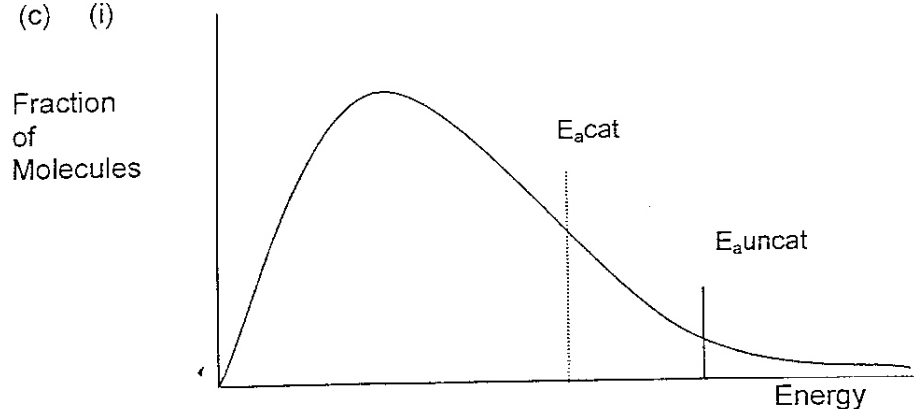
### Unit C2 (6242) Mark scheme

- 1 (a) (i) Aqueous sodium chloride or sodium chloride solution or brine or concentrated sodium chloride (1)  
*formula or words* 1
- (ii) • chlorine / Cl<sub>2</sub> (1) but not Cl  
• hydrogen / H<sub>2</sub> (1) but not H 2
- (iii) 2NaCl + 2H<sub>2</sub>O → 2NaOH + H<sub>2</sub> + Cl<sub>2</sub>  
Formulae (1), balance (1). 2
- (iv) Salt water does not evolve Cl<sub>2</sub> or other sensible suggestion showing understanding that chlorine, hydrogen or sodium hydroxide is not produced when salt is added to water.(1) 1
- (v) Prevents reaction of chlorine and sodium hydroxide (specifically)  
*or*  
allow cations / only Na<sup>+</sup> ions to pass through  
*or*  
prevents reaction of / mixing of chlorine and alkali (1) 1
- (b) (i). Cl<sub>2</sub>(aq / g) + 2OH<sup>-</sup>(aq) → OCl<sup>-</sup>(aq) + Cl<sup>-</sup>(aq) + H<sub>2</sub>O(l)  
species (1) balance (1) states (1). 3  
*Need correct species to score balance and / or state marks*
- (ii) Any from:  
Chlorine changes oxidation states.  
Chlorine disproportionates / chlorine gains and loses electron  
Chlorine goes from 0 to -1 or 0 to +1  
Chlorine is both oxidised and reduced (1) 1
- (iii) Bleach or disinfectant. (1) 1

Question total 12 marks

- 2 (a) (i) Rates of forward and back reactions the same (1). 1
- (ii) • Moves equilibrium to left hand side (1)  
• being the side with the smaller number of molecules/moles (1). 2
- (b) (i) 2NO + O<sub>2</sub> → 2NO<sub>2</sub> (1) or N<sub>2</sub>O<sub>4</sub> 1
- (ii) 4NO<sub>2</sub> + 2H<sub>2</sub>O + O<sub>2</sub> → 4HNO<sub>3</sub> (2)  
(1) species (1) balance. 2  
*Answer could be in terms of a reactions that give HNO<sub>2</sub> and HNO<sub>3</sub> as the first stage.*  
*i.e. 2NO<sub>2</sub> + H<sub>2</sub>O → HNO<sub>2</sub> + HNO<sub>3</sub>*  
*(2HNO<sub>2</sub> + O<sub>2</sub> → 2HNO<sub>3</sub>)*  
*or 3NO<sub>2</sub> + H<sub>2</sub>O → 2HNO<sub>3</sub> + NO*

(c) (i)



- Axis labels (1)
  - Starts at or near origin (not on y or x axis) skewed distribution that is reasonably asymptotic to the x-axis (1) 2
- (ii)
- $E_a$  for the uncatalysed reaction shown well to the right of the peak and  $E_a$  for catalysed reaction to the left of this, still to the right of the peak (1)
  - Some comment concerning the areas under the curve to right of  $E_a$  lines or labelled shading (1)
  - Greater number of collisions (or particles) have energy greater than the activation energy / enough energy to react (1)
  - Therefore greater number of successful collisions (1). 4

Question total 12 marks

3 (a) (i)

|         |        |         |                  |
|---------|--------|---------|------------------|
| C       | H      | O       | ÷ by $A_r$ (1)   |
| 68.2/12 | 13.6/1 | 18.2/16 | ÷ by smaller (1) |
| 5.68    | 13.6   | 1.14    |                  |
| 5       | 12     | 1       |                  |

formula  $C_5H_{12}O$  (1) 3

- (ii) Empirical formula mass = 88 = Molar mass (1)  
Thus  $C_5H_{12}O$  (1) 2

(b) (i)  $ROH + PCI_5 \rightarrow RCl + HCl + POCl_3$   
(1) for HCl, (1) for the rest 2

(ii) Steamy / misty / fumes (1) 1

(c) (i) Any of  
2-methylbutan-1-ol,  
3-methylbutan-1-ol,  
2,2-dimethylpropan-1-ol. (2) 2

- (ii) Structure of the aldehyde consequent on the alcohol in (i) (1).  
*Mark CQ on the structure of the compound in (i), so if a 2° alcohol appears it must be a ketone, if a 3° alcohol no product or distils over. Carboxylic acid scores zero.* 1

- (iii) Potassium (or sodium or ammonium) dichromate(VI) (1)  
and sulphuric acid (1)  
Potassium manganate(VII) (1) dilute sulphuric acid (1) 2
- (iv) Carboxylic acid (1) *Consequential* 1
- (d) (i) C=C (1)  
or  
Correct structure from Z with double bond shown (1) 1
- (ii) Carbon skeleton derivable from the structure of the alcohol used in  
(c)(i) (1)  
two bromine in correct places from that alkene (1)  
*Note:*  
*if 2, 2 – dimethylpropan-1-ol given in c (ii) can have 2 marks for any  
sensible chemistry based on this* 2

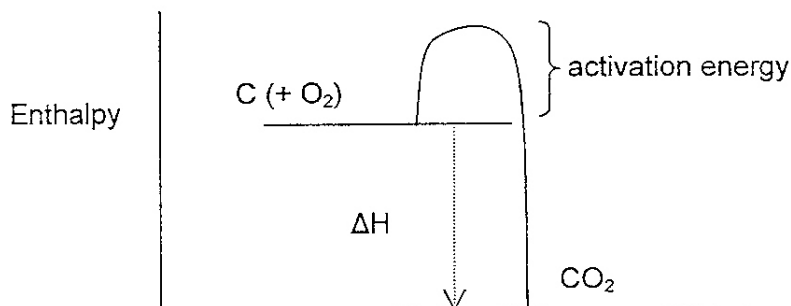
**Question total 17 marks**

- 4 (a) (i) Free radical (1) 1
- (ii) • Ethane single bonds /  $\sigma$  only (1)  
• C-H must be broken (1) could be awarded for explained  
reference to difficult to break  
• Ethene **also** has  $\pi$  bond /  $\sigma$  and  $\pi$  bonds (1)  
• where electrons are more accessible/  $\pi$  bond is weaker (and  
breaks) (1) 4
- (b) (i) 1-bromopropane (1) 1
- (ii)  $\text{CH}_3\text{CH}=\text{CH}_2$  (1) 1
- (iii)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$  (1). 1
- (iv) Nucleophile (1). 1
- (v) • C-Cl bond is stronger than C-Br (1)  
• so activation energy for reaction is higher /more kinetically  
stable (1) (in the case of the chloro- compound). 2

**Question total 11 marks**

- 5 (a) • Enthalpy or heat change or heat energy / released when 1 mol  
of substance / element or compound(need to say both)(1)  
• is burned in excess oxygen / completely / reacts completely (1)  
• at 1 atm pressure and specified temperature (1) 3
- (b)  $\Delta H = 2\Delta H_c(\text{C}) + 2\Delta H_c(\text{H}_2) - \Delta H_c(\text{CH}_3\text{COOH})$  (1) for this or  
equivalent cycle drawn;
- $\Delta H = (-394 \times 2) + (-286 \times 2) - (-874)$  (1)  
 $= -486 \text{ kJ mol}^{-1}$  (1) 3

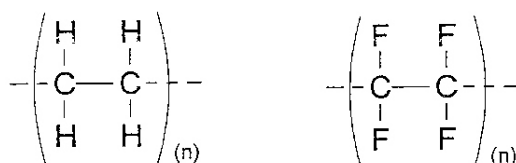
- (c) (Enthalpy of) formation /  $\Delta H_f$  (1) 1
- (d)
  - correct orientation of energy levels / labelled (at least one) (1),
  - $\Delta H$  shown - number allowed (1)
  - reaction profile showing  $E_a$  (1)
 [if based on (b) max 2]



- (e)
  - Reactants are at a higher energy level (than products) (1)
  - so the  $\text{CO}_2$  / products are thermodynamically stable with respect to reactants /  $\text{C} (+ \text{O}_2)$  (1), (or the inverse argument)
  - activation energy high enough to prevent appreciable reaction (at room temperature) (1)
  - so mixture /  $\text{C} + \text{O}_2$  is kinetically stable (1)
 (max 3 if no ref to graphite / C) 4

Question total 14 marks

6 (a) (i)



Min 2 carbon (1) x 2 3  
extension shown for both of them (1).

- (ii) Mixture of different chain lengths 1  
or  
Areas of crystalline and amorphous structure (1)

- (b)
  - C-F bond extremely strong / requires a lot of energy to break (1)
  - so resistant to hydrolysis or some specified chemical attack (1) 2
- (c)
  - Strong C-Cl means herbicide is persistent in environment / non-biodegradable / hard to breakdown (1)
  - useful for herbicidal effect (1)
  - but potentially toxic / harmful (1) 3

Question total 9 marks

Paper total 75 marks

Unit C3B. Paper 6243.02

1 (a) (i)

| Test  | Observation            | Inference  |
|---|------------------------|--|
| Flame test  | lilac flame            | $K^+$ / potassium (1)<br>not K                         |
| Dissolved in water and acidified and then tested with aqueous silver nitrate solution | pale cream precipitate | $Br^-$ / bromide / bromine ions(1)<br>not Br / bromine |

2

- (ii) Add dilute / aqueous ammonia ppt partly / does not dissolve (1)  
Add concentrated ammonia solution ppt dissolves / disappears / colourless solution forms (1).

Leave in sunlight ppt turns green / yellow / grey 1 max

2

(b)

| Test                                  | Observation               | Inference  |
|---------------------------------------|---------------------------|--|
| a solution of R reacts with Zn metal  | Bubbles                   | Hydrogen / $H_2$ (1) not H                                       |
|                                       | Squeaky pop               | hydroxonium ions / $H^+$ / $H_3O^+$ / hydrogen (1)               |
| tested with barium chloride solution. | gives a white precipitate | barium sulphate / $BaSO_4$ (1)<br>Sulphuric acid / $H_2SO_4$ (1) |

4

(c) (i)

Bromine /  $Br_2$  (1)

1

(ii)

Hydrogen bromide / HBr (1) not hydrobromic acid / HBr (aq)

1

(iii)

(Bubble through solution of) acidified potassium dichromate (1)  
turns from orange  $\rightarrow$  green (1)

or

Acidified potassium manganate(VII) (1)  
Purple  $\rightarrow$  colourless / decolourised (1)

2

(iv)

Use a fume cupboard **toxic or poisonous** sulphur dioxide  
**toxic or poisonous** bromine evolved

Wear gloves

**corrosive** acid R  
**corrosive** bromine in use (1)

2

Question total 14 marks

2 (a)

- Apparatus to show round or pear shaped flask (1) not conical
- Reflux condenser - must have inner tube and inlet and outlet for water (1)
- Controlled source of heating e.g. electric heater / hot plate (1)
- Reasonable drawing (1) of an apparatus that would work.

Eg not sealed apparatus, water must flow correctly through condenser, joint shown between flask and condenser (no obvious gaps), no extras  
Show as  $\checkmark$  Q on the script for this mark

4



- (b) (i) (Fractional) distillation 1
- (ii) The mixture may be separated because the boiling temperatures are different / 1-bromobutane has lower boiling temperature (than butan-1-ol) **(1)**  
The 1-bromobutane will distil over / vaporise first (and can be collected) **(1)**  
*allow butan-1-ol is left in the flask* 2
- (c) (i)  $Mr = 74$  **(1)**
- $11.1/Mr =$  correct answer **(1)** [0.150 mol] 2
- (ii)  $Mr = 137$  **(1)**
- Answer to (i)  $\times Mr =$  correct answer **(1)** [20.55 g] 2
- (iii)  $\frac{12.4 \times 100}{}$  = correct answer [60.3 or 60.2] **(1)**  
answer to (ii) 1
- (iv) Any **one** of:
- competing reactions
  - side reactions
  - incomplete reaction
  - product lost in purification
  - product lost in transfers. 1

**Question total 13 marks**

- 3 (a) (i) • Reaction is complete **(1)**  
• addition of **cooler** NaOH causes temp to fall **(1)** 2
- (ii)  $20.0 \text{ cm}^3$  **(1)** 1
- (iii)  $20.0 \times 2.00/1000$  **(1)** = 0.0400 mol 1
- (iv)  $20 \times 1.00 /1000$  **(1)** = 0.0200 mol 1
- (v) 1 : 2 **(1)** *MUST be consequential on working in (iii) to (iv)* 1
- (vi)  $\text{Cu}(\text{OH})_2$  **(1)** *Consequential provided that the ratio of Cu to OH is a whole number.* 1
- (b) (i)  $7.2 \text{ }^\circ\text{C}$  (or K) **(1)** 1
- (ii)  $q = 1210 \text{ J} / 1.21 \text{ kJ}$  **(1)** *Consequential on (b)(i)* 1
- (iii) •  $\Delta H = 1210 / 0.020$  **(1)** *i.e. method Mark consequentially on (a)(iv) and (b)(ii).*  
• - sign **(1)**  
• Correct units **(1)**  
• **2 max** if numerical error } *In final answer* 3

- (c)
- No stirring / poor mixing (1)
  - Specified method of stirring or mixing e.g. magnetic stirrer / swirl cup between additions (1)

or

- Solutions at different initial temperatures (1)
- Allow them to stabilise at room temperature (1)

*Do not allow anything to do with heat loss. Do not allow 'more accurate thermometer' since the one specified is good enough.*

2

**Question total 14 marks**

4

Alkene

*ACCEPT correct names or fully correct formulae for all reagents*

Reagent:

Aqueous bromine / bromine in a suitable solvent  
 potassium manganate(VII) + sulphuric acid / acidified /  
 potassium manganate(VII) + sodium hydroxide / alkaline (1)

Observation

Bromine: orange / brown / yellow → colourless / decolourised  
 KMnO<sub>4</sub> in acid : purple → colourless / decolourised  
 KMnO<sub>4</sub> in alkali: purple → green (solution) / brown ppt (1)

**Max 2**

Alcohol

Reagent:

PCl<sub>5</sub> / phosphorus pentachloride  
 Na / sodium (1)

Observation

PCl<sub>5</sub>: steamy / misty fumes / gas which turns damp blue litmus red / forms  
 dense white fumes with NH<sub>3</sub> / gives white ppt with AgNO<sub>3</sub>  
 Na: effervescence OR positive test for H<sub>2</sub> (1)  
*Do NOT allow any oxidation reaction*

**Max 2**

Chloroalkane

Reagent:

aqueous sodium hydroxide (1) followed by  
 Nitric acid + silver nitrate (1)

OR

Aqueous silver nitrate (1) followed by  
 Warm (1)

Second mark conditional on first

*IGNORE ethanol as a solvent with water present*

Observation:

white ppt (1)

**Max 3**

Alkane

A positive statement about the remaining liquid

Logical plan ✓ L

**Question total 9 marks**

**Paper total 50 marks**