

FOR OFFICIAL USE

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Total  
Section B

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**X273/12/02**

NATIONAL QUALIFICATIONS 2013  
FRIDAY, 31 MAY  
1.00 PM – 3.30 PM

CHEMISTRY  
HIGHER (REVISED)

Fill in these boxes and read what is printed below.

Full name of centre

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Town

--

Forename(s)

--

Surname

--

Date of birth

Day    Month    Year

--	--	--	--	--	--

Scottish candidate number

--	--	--	--	--	--	--	--	--	--

Number of seat

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Reference may be made to the Chemistry Higher and Advanced Higher Data Booklet.

**SECTION A—Questions 1–30 (30 marks)**

Instructions for completion of **Section A** are given on page two.

For this section of the examination you must use an **HB pencil**.

**SECTION B (70 marks)**

- 1 All questions should be attempted.
- 2 The questions may be answered in any order but all answers are to be written in the spaces provided in this answer book, **and must be written clearly and legibly in ink**.
- 3 Rough work, if any should be necessary, should be written in this book and then scored through when the fair copy has been written. If further space is required, a supplementary sheet for rough work may be obtained from the Invigilator.
- 4 Additional space for answers will be found at the end of the book. If further space is required, supplementary sheets may be obtained from the Invigilator and should be inserted inside the **front** cover of this book.
- 5 The size of the space provided for an answer should not be taken as an indication of how much to write. It is not necessary to use all the space.
- 6 Before leaving the examination room you must give this book to the Invigilator. If you do not, you may lose all the marks for this paper.





**2013 Chemistry**

**Higher (Revised)**

**Finalised Marking Instructions**

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## Part One: General Marking Principles for Chemistry Higher (Revised)

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

- (a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question.
- (b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

### GENERAL MARKING ADVICE: Chemistry Higher (Revised)

The marking schemes are written to assist in determining the “minimal acceptable answer” rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates’ evidence, and apply to marking both end of unit assessments and course assessments.

#### *General information for markers*

*The* general comments given below should be considered during all marking.

1. There are **no half marks** awarded.
2. Marks should **not** be deducted for incorrect spelling or loose language as long as the meaning of the word(s) is conveyed.

**Example:** Answers like 'distilling' (for 'distillation') and 'it gets hotter' (for 'the temperature rises') should be accepted.

3. A right answer followed by a wrong answer should be treated as a cancelling error and no marks should be given.

**Example:** What colour is seen when blue Fehling’s solution is warmed with an aldehyde?

The answer 'red, green' gains no marks.

4. If a right answer is followed by additional information which does not conflict, the additional information should be ignored, whether correct or not.

**Example:** Why can the tube not be made of copper?

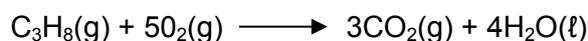
If the correct answer is related to a low melting point, 'Copper has a low melting point and is coloured grey' would **not** be treated as having a cancelling error.

5. Full marks are usually awarded for the correct answer to a calculation on its own; the part marks shown in the marking scheme are for use when working is given. An exception is when candidates are asked to 'Find, by calculation, '.

6. A mark should be deducted for incorrect or missing units **only when stated in the marking scheme**. No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.
7. As a general rule, where a wrong numerical answer (already penalised) is carried forward to another step, no further penalty is incurred provided the result is used correctly. The exception to this rule is where the marking instructions for a numerical question assign separate "concept marks" and an "arithmetic mark". In such situations, the marking instructions will give clear guidance on the assignment of partial marks.
8. Ignore the omission of one H atom from a full structural formula provided the bond is shown.
9. A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the marking scheme**.
10. When formulae of ionic compounds are given as answers it will only be necessary to show ion charges if these have been specifically asked for. However, if ion charges are shown, they must be correct. If incorrect charges are shown, no marks should be awarded.

11. If an answer comes directly from the text of the question, no marks should be given.

**Example:** A student found that 0.05 mol of propane, C<sub>3</sub>H<sub>8</sub> burned to give 82.4 kJ of energy.

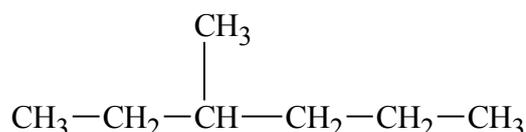


Name the kind of enthalpy change which the student measured.

No marks should be given for 'burning' since the word 'burned' appears in the text.

12. A guiding principle in marking is to give credit for correct chemistry rather than to look for reasons not to give marks.

**Example 1:** The structure of a hydrocarbon found in petrol is shown below.



Name the hydrocarbon.

Although the punctuation is not correct, '3, methyl-hexane' should gain the full mark.

**Example 2:** A student measured the pH of four carboxylic acids to find out how their strength is related to the number of chlorine atoms in the molecule.

Structural formula	pH
CH <sub>3</sub> COOH	1.65
CH <sub>2</sub> ClCOOH	1.27
CHCl <sub>2</sub> COOH	0.90
CCl <sub>3</sub> COOH	0.51

The results are shown.

How is the strength of the acids related to the number of chlorine atoms in the molecule?

Although not completely correct, an answer such as 'the more Cl<sub>2</sub>, the stronger the acid' should gain the full mark.

13. Unless the question is clearly about a non-chemistry issue, eg costs in industrial chemistry, a non-chemical answer gains no marks.

**Example:** Why does the (catalytic) converter have a honeycomb structure?

A response such as 'to make it work' may be correct but it is not a chemical answer and the mark should not be given.

**Part Two: Marking Instructions for each Question**

**Section A**

Question		Acceptable Answer
1		B
2		D
3		C
4		C
5		D
6		D
7		A
8		C
9		D
10		B
11		A
12		C
13		D
14		C
15		A

Question		Acceptable Answer
16		C
17		B
18		C
19		B
20		A
21		A
22		D
23		C
24		B
25		A
26		B
27		A
28		A
29		B
30		D

Question			Acceptable Answer/s	Max Mark	Unacceptable
1	a	i	$K(g) \rightarrow K^+(g) + e^-$ (1) $K(g) \rightarrow K^+(g) + e$ (1)	1	Missing or incorrect state symbols
1	a	ii	<p>Answers can be given either in terms of potassium or of chlorine</p> <p>Answers starting with "it" are assumed to refer to Potassium</p> <p><b>Either</b></p> <p>K has more shells/levels <b>or</b> electron further from nucleus or diagram showing this (1)</p> <p>Correct and clear use of <u>greater</u> shielding/screening (or clear explanation thereof) (1)</p> <p>So less energy required to remove electron/ weaker attraction for the electron (1)</p> <p><b>or</b></p> <p>Cl has fewer shells <b>or</b> electron closer to nucleus (1)</p> <p>Correct and clear use of <u>less</u> shielding/screening (or clear explanation thereof) (1)</p> <p>So more energy required <u>to remove electron</u>/stronger attraction for the electron (1)</p>	3	
1	b		8	1	Circling OH groups but not stating the number

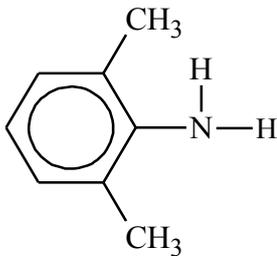
Question		Acceptable Answer/s	Max Mark	Unacceptable
2	a	<p>It can react with radicals to form stable molecules (1)</p> <p><b>or</b></p> <p>It can terminate radical (reactions) (1)</p> <p><b>or</b></p> <p>It reacts with radicals to stop further radical reactions (1)</p> <p><b>or</b></p> <p>It mops-up (free) radicals (1)</p> <p><b>or</b></p> <p>It has an unpaired/free electron (1)</p>	1	Provides electrons (0)
2	b	<p><math>C_6H_8O_6 \rightarrow C_6H_6O_6 + 2H^+ + 2e^-</math></p> <p>(state symbols not required, negative sign on electron not required)</p>	1	

Question		Acceptable Answer/s	Max Mark	Unacceptable
3	a	<p>Stating that one (<math>\text{CHCl}_3</math>) is polar <b>and/or</b> the other (<math>\text{CCl}_4</math>) is non-polar <b>(1)</b></p> <p>Identifying that <math>\text{CHCl}_3</math> has permanent dipole/permanent dipole attractions <b>and</b> identifying that <math>\text{CCl}_4</math> has London dispersion forces <b>(1)</b></p> <p>Other mark is for a statement linking intermolecular forces/polarity to the solubility in water. Statements such as the following would be acceptable</p> <ul style="list-style-type: none"> <li>• Water is polar <b>(1)</b></li> <li>• Water has permanent dipole/permanent dipole attractions <b>(1)</b></li> <li>• Water is a good solvent for polar molecules <b>(1)</b></li> <li>• Like dissolves like <b>(1)</b></li> </ul>	3	
3	b	<p>-97 (2)</p> <p>A single mark is available if either of the following operations is correctly executed</p> <p><b>Either</b></p> <p>the four relevant values for the bond enthalpies of the C–H, Cl–Cl, C–Cl and H–Cl bonds (or multiples thereof) are retrieved from the databook; 243, 414, 326, 428 (ignore signs) <b>(1)</b></p> <p><b>or</b></p> <p>the enthalpy values for bond formation are taken away from the enthalpy values for bond breaking without arithmetic error <b>(1)</b> (units not required)</p>	2	

Question			Acceptable Answer/s	Max Mark	Unacceptable
4	a	i	Tollen's or <u>acidified</u> dichromate or Fehling's or Benedict's (please note – although Benedict's reagent would not work in practice, because it appears in Higher textbooks, revision guides and the PPA materials for the traditional Higher, it can be accepted) (accept other spellings if phonetically correct)	1	
4	a	ii	Carboxylic acid	1	
4	b	i	It keeps oil & water soluble materials mixed or Allow immiscible substances to mix or To allow fat and water to mix or To form a suspension	1	to stop it separating (with no mention of water & oil soluble components)  to stop layers forming
4	b	ii	$  \begin{array}{ccccc}  & \text{H} & & \text{H} & & \text{H} \\  &   & &   & &   \\  \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - \text{H} \\  &   & &   & &   \\  & \text{OH} & & \text{OH} & & \text{OH}  \end{array}  $ Any structural formula for glycerol	1	
4	c		6·7 (mg) – units not required  A single mark is available if either of the following manipulations is correctly executed.  Correct use of percentage  $\text{eg mass of chocolate} = \frac{28}{100} \times 17 \text{ g} = 4.76 \text{ g}$  Correct use of proportion theobromine  $\text{eg mass of theobromine} = 1.4 \times a \text{ mass}$	2	

Question		Acceptable Answer/s	Max Mark	Unacceptable
4	d	<p>This is an open ended question</p> <p><b>1 mark:</b> The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</p> <p><b>2 marks:</b> The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood.</p> <p><b>3 marks:</b> The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one.</p>	3	<p>The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.</p>

Question		Acceptable Answer/s	Max Mark	Unacceptable
5	a	<p>75 % (2)</p> <p>Total mass of reactants/products = 240 g (1)</p> <p><math>Atom\ Economy = \frac{180}{240} \times 100\% = 75\% (1)</math></p> <p>(Accept 0.75 also, this would be atom economy as a fraction)</p>	2	
5	b	<p>40 % (2)</p> <p>1 mark is given for either calculating the theoretical yield, or for working out the numbers of moles of reactant and product formed. eg 6.55(g) or both 0.0364 and 0.0146</p> <p>1 mark is given for calculating the % yield; either using the actual and theoretical masses, or using the actual number of moles of products and actual number of moles of reactant.</p>	2	$\%yield = \frac{2.62}{5.02} \times 100$ $= 52.2\%$

Question			Acceptable Answer/s	Max Mark	Unacceptable
6	a	i	Carboxyl (group) (1) or Carboxylic (acid) (1)	1	
6	a	ii		1	
6	a	iii	$\text{Na}^+ \text{O}^- \text{—} \overset{\text{O}}{\parallel} \text{C} \text{—} \text{CH}_2 \text{—} \text{N} \begin{cases} \text{CH}_2 \text{—} \text{CH}_3 \\ \text{CH}_2 \text{—} \text{CH}_3 \end{cases}$ <p>or shortened formula. Charges not required but if shown, both +ve and –ve charges must be correct(1).</p>	1	Covalent bond shown between Na-O
6	b		25 (minutes) or 8.0 to 8.4 (minutes) (units not required. Ignore incorrect units)	1	

Question			Acceptable Answer/s	Max Mark	Unacceptable
6	c		<p>Volume = 31.5 cm<sup>3</sup> or 31.5 ml or 0.0315 l or equivalent (3)</p> <p><b>One mark is allocated to the correct statement of units of volume. This is the mark in the paper earmarked to reward a candidate's knowledge of chemical units.</b></p> <p>So volume = 31.5 or 0.0315 (2)</p> <p>One mark is available if either of the following steps is correct</p> <p>Calculation of mass of lidocaine eg 4.5 × 70 = 315 (mg)</p> <p>Calculation of a volume of solution required eg <math>a \text{ mass} \times \frac{1}{10} = a \text{ volume}</math></p>	3	
6	d	i	<p>Benzocaine is a smaller/Tetracaine is bigger (1) <b>or</b> weaker London Dispersion Forces with Benzocaine (1) <b>or</b> weaker Van der Waal's forces for Benzocaine (1) <b>or</b> Benzocaine has lower b.pt (1) <b>or</b> Benzocaine more soluble/attracted in/ to mobile phase (1) <b>or</b> Benzocaine less strongly attracted to stationary phase (1) <b>or</b> Benzocaine is more polar (1)</p>	1	Benzocaine takes less time to travel through the apparatus
6	d	ii	<p>The peaks for lidocaine and caffeine overlap <b>or</b> Candidate wording for idea of masking</p>	1	The retention times are similar

Question			Acceptable Answer/s	Max Mark	Unacceptable
6	d	iii	Peak for tetracaine at correct RT with approximately half original height		
					<b>1</b>

Question			Acceptable Answer/s	Max Mark	Unacceptable
7	a	i	<p>For successful generation of gas; must have iron sulfide, hydrochloric acid and appropriate glassware to transfer the gas to the gas collection/ measurement apparatus without loss of gas <b>(1)</b></p> <p>For the successful collection and measurement of the gas; must have a syringe or collect the gas in a measuring cylinder over a non-aqueous liquid <b>(1)</b></p>	2	
7	a	ii	<p>0.29 (g) (units not required)</p> <p>1 mark is awarded for a correct strategy to work out number of moles of hydrogen sulfide (a volume of hydrogen sulfide in whatever unit is shown being divided by a molar volume in whatever unit).</p> <p>1 mark is awarded for correct strategy to work out the mass of the iron(II) sulfide (eg a number of moles of FeS is multiplied by something clearly intended to be the GFM of FeS).</p> <p>1 mark is awarded for correct arithmetic in both of these steps. (This includes the correct value for the GFM of FeS). This arithmetic mark can only be awarded if both of the concept marks are awarded.</p>	3	
7	b	i	<p>Covalent molecular <b>or</b> discrete covalent</p>	1	
7	b	ii	<p><math>\text{Al}_2\text{S}_3 + 6\text{H}_2\text{O} \rightarrow 2\text{Al}(\text{OH})_3 + 3\text{H}_2\text{S}</math> Correct formulae for all but one substance, whether balanced or not – 1 mark</p>	2	

Question			Acceptable Answer/s	Max Mark	Unacceptable
8	a		<p>–803, 726, 283 (any two values from this list) (1)</p> <p>+206 kJ mol<sup>-1</sup> (for value, no follow through, units not required) (1)</p>	2	
8	b		<p style="text-align: right;">1</p> <p>temperature <del>decrease</del>/keep the same/increase</p> <p>pressure decrease/keep the same/<del>increase</del></p>		
9	a		9.0	1	
9	b		4	1	
10	a		<p><math>I_2 + 2e^- \rightarrow 2I^-</math> (1)</p> <p><b>or</b></p> <p><math>I_2 + 2e \rightarrow 2I^-</math> (1)</p> <p>Ignore state symbols</p> <p>Allowing reversible arrows providing the equation is written the correct way round.</p>	1	
10	b	i	<p>first titre is a rough (or approximate) result/practice</p> <p><b>or</b></p> <p>first titre is not accurate/not reliable/rogue</p> <p><b>or</b></p> <p>first titre is too far away from the others</p> <p><b>or</b></p> <p>you take average of concordant/close results (1)</p>	1	

Question			Acceptable Answer/s	Max Mark	Unacceptable
10	b	ii	<p>0.045 (mol l<sup>-1</sup> – units not required) 3 marks</p> <p><b>Partial marks can be awarded using a scheme of two “concept” marks, and one “arithmetic” mark.</b></p> <p>1 mark for knowledge of the relationship between moles, concentration and volume. This could be shown by any <u>one</u> of the following steps:</p> <ul style="list-style-type: none"> <li>• Calculation of moles thiosulfate(aq) eg 0.1 × 0.01815 = 0.001815</li> <li>• Calculation of conc<sup>n</sup> I<sub>2</sub> eg (0.000908) ÷ 0.02 = 0.045</li> <li>• Insertion of correct pairings of values for conc<sup>n</sup> and volume in a valid titration formula such as</li> </ul> $\frac{C_1 V_1}{b_1} = \frac{C_2 V_2}{b_2} \quad \text{eg} \quad \frac{18.15 \times 0.10}{b_1} = \frac{C_2 \times 20.0}{b_2}$ <p>1 mark for knowledge of relationship between moles of S<sub>2</sub>O<sub>3</sub><sup>2-</sup> and I<sub>2</sub>. This could be shown by any <u>one</u> of the following steps:</p> <ul style="list-style-type: none"> <li>• Calculation of moles I<sub>2</sub> from moles S<sub>2</sub>O<sub>3</sub><sup>2-</sup> eg 0.001815/2 = 0.000908</li> <li>• Insertion of correct stoichiometric values in a valid titration formula such as</li> </ul> $\frac{C_1 V_1}{b_1} = \frac{C_2 V_2}{b_2} \quad \text{eg} \quad \frac{18.15 \times 0.10}{2} = \frac{C_2 \times 20.0}{1}$ <p>1 mark is awarded for correct arithmetic throughout the calculation. This mark can only be awarded if both concept marks have been awarded.</p>	3	
10	b	iii	<p>Mass of sodium thiosulfate = 3.96 g (1) Mention of rinsings (1) Mention of make up to the mark (1)</p>	3	

Question			Acceptable Answer/s	Max Mark	Unacceptable
11	a	i	(anaerobic) fermentation <b>or</b> Anaerobic respiration	1	
11	a	ii	10.1 to 10.3 (% abv)	1	11
11	b	i	114 or 113.75	1	
11	b	ii	£3.30 (do not penalise for rounding at intermediate stages)  One mark is available if the candidate has either Carried out a calculation to take into account the dilution of the whisky e.g. used a scaling factor of $\frac{46}{65}$  <b>or</b> Has correctly calculated the cost for a given volume of alcohol by use of the e.g. used the scaling factor of $\frac{1300}{195}$	2	
11	b	iii	5-butyl-4-ethyltetrahydrofuran-2-ol <b>or</b> 4-ethyl-5-butyltetrahydrofuran-2-ol	1	
11	c	i	addition or hydration	1	
11	c	ii	no change	1	

Question	Acceptable Answer/s	Max Mark	Unacceptable
12	<p>This is an open ended question</p> <p><b>1 mark:</b> The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</p> <p><b>2 marks:</b> The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood.</p> <p><b>3 marks:</b> The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one.</p>	3	<p>The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.</p>

Question			Acceptable Answer/s	Max Mark	Unacceptable
13	a		<p>or equivalent 1,3-dimethylcyclohexane structure with both methyl groups in axial positions</p>	1	<p>Structures with missing H-atoms</p> <p>Any structure with a methyl group in the equatorial position.</p>
13	b	i	<p>The bigger the group the greater the strain  <b>or</b>  The larger the (halogen) atom the greater the strain  <b>or</b>  The more atoms in a group, the greater the strain  <b>or</b>  Any other statement which is consistent with the values presented</p>	1	<p>Incorrect reference to a group as a "molecule"</p>
13	b	ii	<p>7.6 (kJ mol<sup>-1</sup>)  (Units not required, ignore incorrect units)</p>	1	

[END OF MARKING INSTRUCTIONS]

## SECTION A

### Read carefully

- 1 Check that the answer sheet provided is for **Chemistry Higher (Revised) (Section A)**.
- 2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate Number) and **Centre Name** printed on it.

Do not change any of these details.

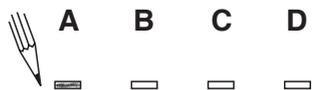
- 4 If any of this information is wrong, tell the Invigilator immediately.
- 5 If this information is correct, **print** your name and seat number in the boxes provided.
- 6 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).
- 7 There is only **one correct answer** to each question.
- 8 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.
- 9 At the end of the examination, put the **answer sheet for Section A inside the front cover of your answer book**.

### Sample Question

To show that the ink in a ball-pen consists of a mixture of dyes, the method of separation would be

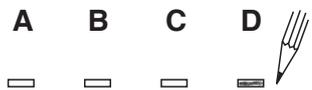
- A chromatography
- B fractional distillation
- C fractional crystallisation
- D filtration.

The correct answer is **A**—chromatography. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).



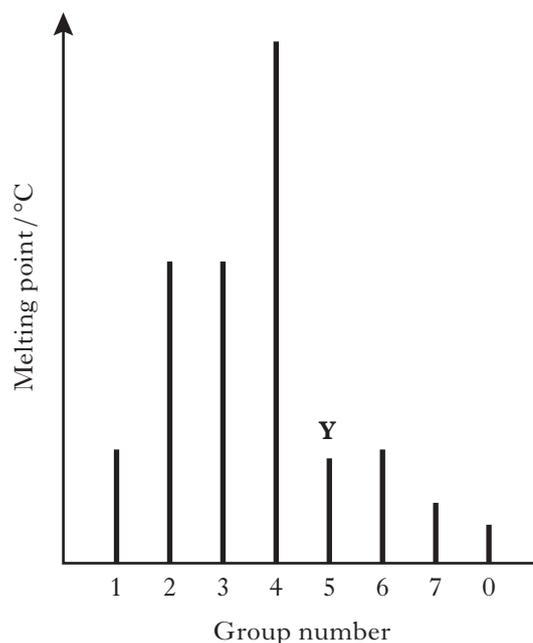
### Changing an answer

If you decide to change your answer, carefully erase your first answer and using your pencil, fill in the answer you want. The answer below has been changed to **D**.



- Which of the following elements has the greatest attraction for bonding electrons?
  - Lithium
  - Chlorine
  - Sodium
  - Bromine
  
- Which of the following elements exists as discrete molecules?
  - Boron
  - Carbon (diamond)
  - Silicon
  - Sulfur
  
- Which of the following statements is true?
  - The potassium ion is larger than the potassium atom.
  - The chloride ion is smaller than the chlorine atom.
  - The sodium atom is larger than the sodium ion.
  - The oxygen atom is larger than the oxide ion.
  
- Which type of bonding is **never** found in elements?
  - Metallic
  - London dispersion forces
  - Polar covalent
  - Non-polar covalent

- The diagram shows the melting points of successive elements across a period in the Periodic Table.



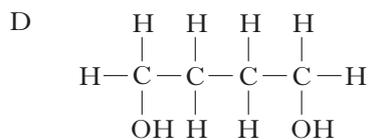
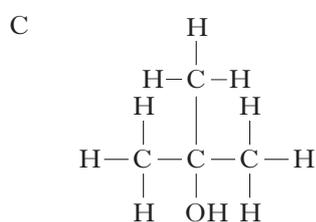
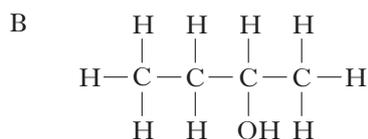
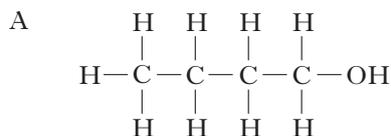
Which of the following is a correct reason for the low melting point of element **Y**?

- It has weak ionic bonds.
- It has weak covalent bonds.
- It has weakly-held outer electrons.
- It has weak forces between molecules.

**[Turn over**

6. The structures for molecules of four liquids are shown below.

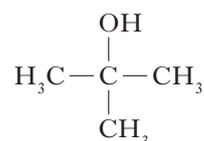
Which liquid will be the most viscous?



7. Which of the following elements is the strongest reducing agent?

- A Lithium  
B Bromine  
C Fluorine  
D Aluminium

8.



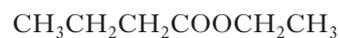
Which of the following compounds is an isomer of the structure shown above?

- A Butanal  
B Butanone  
C Butan-1-ol  
D Butanoic acid

9. A compound with molecular formula  $\text{C}_6\text{H}_{12}\text{O}_2$ , could be

- A hexanal  
B hexan-2-ol  
C hexan-2-one  
D hexanoic acid.

10. An ester has the following structural formula



The name of this ester is

- A propyl propanoate  
B ethyl butanoate  
C butyl ethanoate  
D ethyl propanoate.

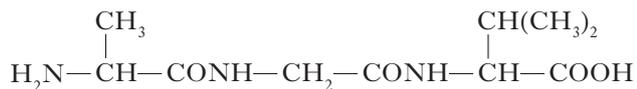
11. Esters are formed by the reaction between which **two** functional groups?

- A A hydroxyl group and a carboxyl group  
B A hydroxyl group and a carbonyl group  
C A hydroxide group and a carboxyl group  
D A hydroxide group and a carbonyl group

12. Oils are generally

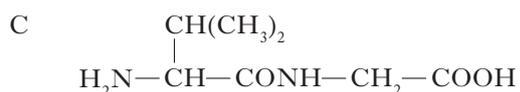
- A solid at room temperature and contain a high proportion of unsaturated molecules  
B solid at room temperature and contain a high proportion of saturated molecules  
C liquid at room temperature and contain a high proportion of unsaturated molecules  
D liquid at room temperature and contain a high proportion of saturated molecules.

13. A tripeptide **X** has the structure

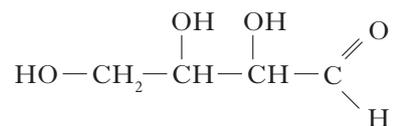


Partial hydrolysis of **X** yields a mixture of dipeptides.

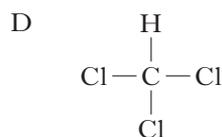
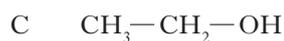
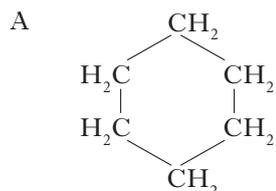
Which of the following dipeptides could be produced on hydrolysing **X**?



14. Erythrose can be used in the production of a chewing gum that helps prevent tooth decay.



Which of the following compounds will be the **best** solvent for erythrose?

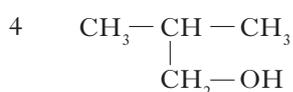
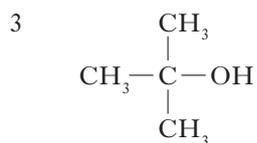
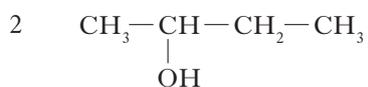
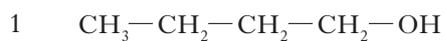


15. When a protein is denatured

- A its overall shape is distorted
- B its amide links are hydrolysed
- C it is broken into separate peptide fragments
- D it decomposes into amino acids.

[Turn over

16. Which **two** isomers would each produce an acid when warmed with acidified potassium dichromate solution?

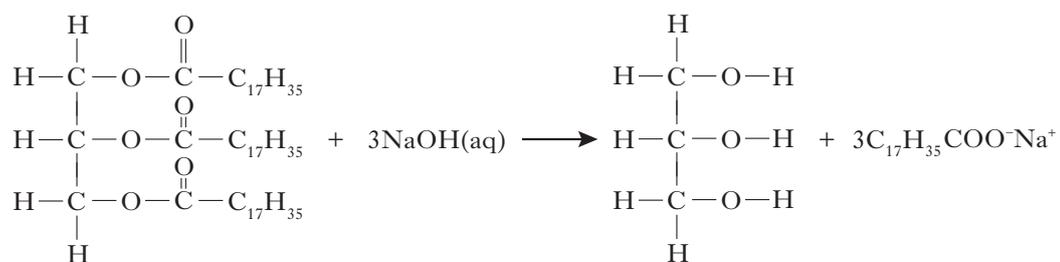


- A 1 and 2  
 B 2 and 3  
 C 1 and 4  
 D 3 and 4

17. Which of the following organic compounds is an isomer of hexanal?

- A 2-Methylbutanal  
 B 3-Methylpentan-2-one  
 C 2,2-Dimethylbutan-1-ol  
 D 3-Ethylpentanal

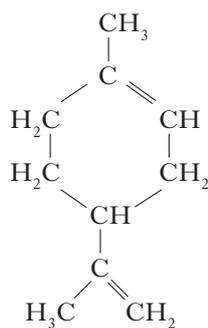
18. Soaps are produced by the following reaction.



This reaction is an example of

- A condensation  
 B esterification  
 C hydrolysis  
 D oxidation.

19. Limonene is one of the terpene molecules responsible for the flavour of lemons.



How many isoprene units are used in the production of one limonene molecule?

- A 1  
B 2  
C 3  
D 4
20. A mixture of magnesium bromide and magnesium sulfate is known to contain 3 mol of magnesium and 4 mol of bromide ions.

How many moles of sulfate ions are present?

- A 1  
B 2  
C 3  
D 4

21.  $2\text{C}_2\text{H}_2(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\ell)$   
ethyne

What volume of gas would be produced by the complete combustion of  $100\text{ cm}^3$  of ethyne gas?

All volumes were measured at atmospheric pressure and room temperature.

- A  $200\text{ cm}^3$   
B  $300\text{ cm}^3$   
C  $400\text{ cm}^3$   
D  $800\text{ cm}^3$

22.  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$

The equation represents a mixture at equilibrium.

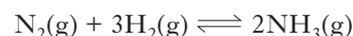
Which line in the table is true for the mixture after a further 2 hours of reaction?

	Rate of forward reaction	Rate of back reaction
A	decreases	decreases
B	increases	increases
C	unchanged	decreases
D	unchanged	unchanged

23. In which of the following would an increase in pressure result in the equilibrium position being moved to the left?

- A  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$   
B  $\text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + \text{H}_2(\text{g})$   
C  $\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + 3\text{H}_2(\text{g})$   
D  $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightleftharpoons 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$

24. Ammonia is made by the Haber Process.



The equilibrium position lies to the left.

Which line in the table is correct?

	Atom Economy	Percentage Yield
A	high	high
B	high	low
C	low	high
D	low	low

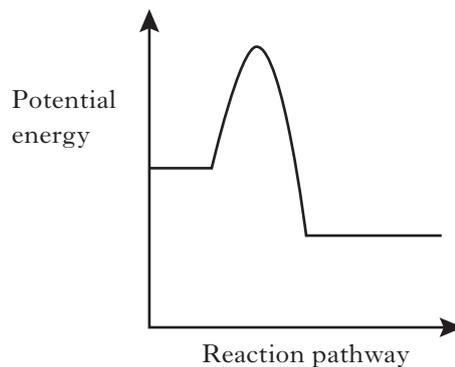
[Turn over

25. In which of the following will **both** changes result in an increase in the rate of a chemical reaction?

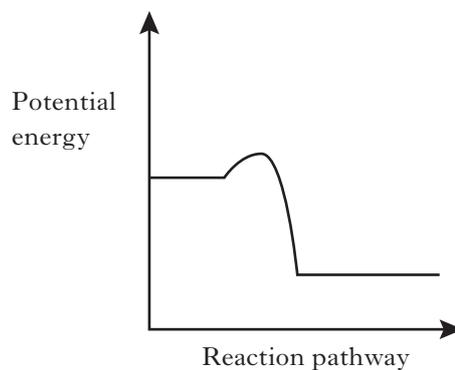
- A A decrease in activation energy and an increase in the frequency of collisions.
- B An increase in activation energy and a decrease in particle size.
- C An increase in temperature and an increase in the particle size.
- D An increase in concentration and a decrease in the surface area of the reactant particles.

26. Which of the following diagrams represents an exothermic reaction which is most likely to take place at room temperature?

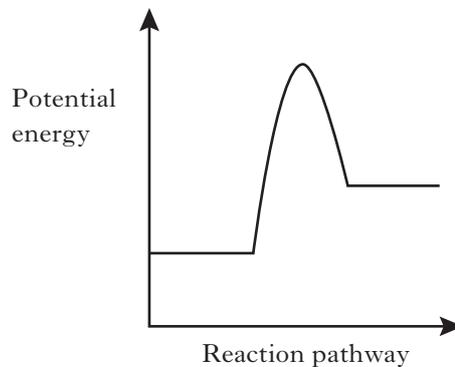
A



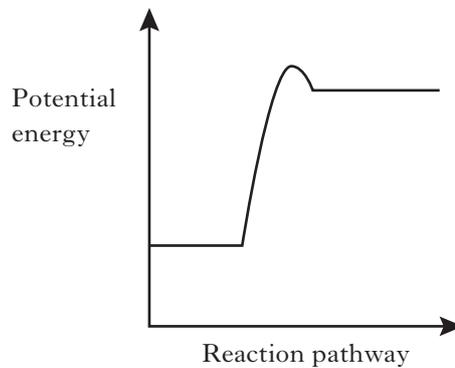
B



C



D

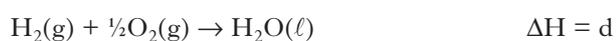
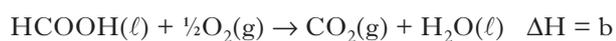


27. The enthalpy of combustion of methanol is  $-727 \text{ kJ mol}^{-1}$ .

What mass of methanol has to be burned to produce  $72.7 \text{ kJ}$ ?

- A 3.2 g
- B 32 g
- C 72.7 g
- D 727 g

28.



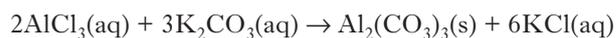
What is the relationship between a, b, c and d?

- A  $a = c + d - b$
- B  $a = b - c - d$
- C  $a = -b - c - d$
- D  $a = c + b + d$

29.  $45 \text{ cm}^3$  of a solution could be most accurately measured out using a

- A  $50 \text{ cm}^3$  beaker
- B  $50 \text{ cm}^3$  burette
- C  $50 \text{ cm}^3$  pipette
- D  $50 \text{ cm}^3$  measuring cylinder.

30. Aluminium carbonate can be produced by the following reaction.



The most suitable method for obtaining a sample of the aluminium carbonate is

- A collection over water
- B distillation
- C evaporation
- D filtration.

**Candidates are reminded that the answer sheet MUST be returned INSIDE the front cover of this answer book.**

**[Turn over**

**[BLANK PAGE]**

Marks

## SECTION B

All answers must be written clearly and legibly in ink.

1. Attempts have been made to make foods healthier by using alternatives to traditional cooking ingredients.

(a) An alternative to common salt contains potassium ions and chloride ions.

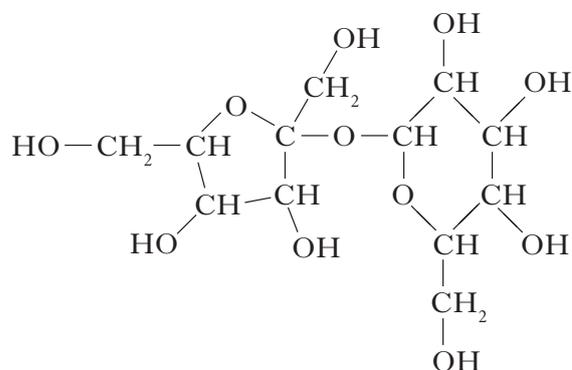
(i) Write an ion-electron equation for the first ionisation energy of potassium.

1

(ii) **Explain clearly** why the first ionisation energy of potassium is smaller than that of chlorine.

3

(b) A calorie-free replacement for fat can be made by reacting fatty acids with the hydroxyl groups on a molecule of sucrose. A structural formula for sucrose is shown.



How many fatty acid molecules can react with one molecule of sucrose?

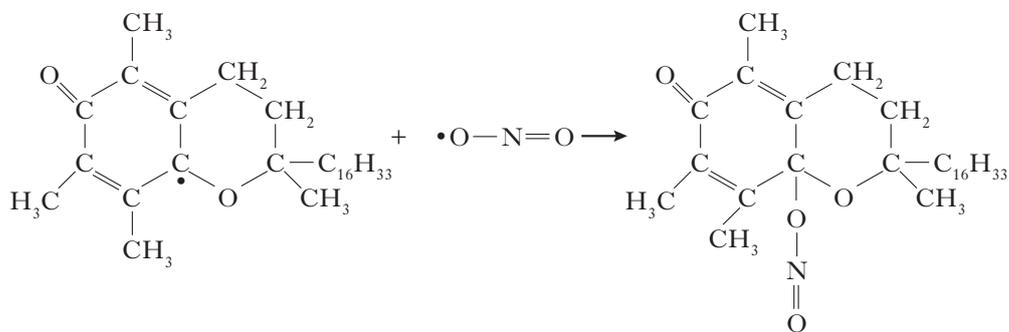
1

(5)

Marks

2. Suncreams contain antioxidants.

- (a) The antioxidant, compound **A**, can prevent damage to skin by reacting with free radicals such as  $\text{NO}_2\cdot$ .



Compound **A**

Why can compound **A** be described as a free radical scavenger in the reaction shown above?

1

- (b) Another antioxidant used in skin care products is vitamin C,  $\text{C}_6\text{H}_8\text{O}_6$ . Complete the ion-electron equation for the oxidation of vitamin C.

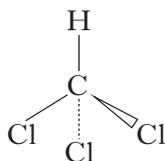


1

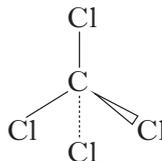
(2)

Marks

3. The structures below show molecules that contain chlorine atoms.



trichloromethane



tetrachloromethane

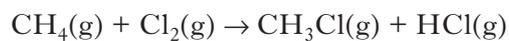
- (a) The compounds shown above are not very soluble in water. Trichloromethane is around ten times more soluble in water than tetrachloromethane.

**Explain clearly** why trichloromethane is more soluble in water than tetrachloromethane.

Your answer should include the names of the intermolecular forces involved.

3

- (b) Chloromethane can be produced by the reaction of methane with chlorine.



Using bond enthalpies from the data booklet, calculate the enthalpy change, in  $\text{kJ mol}^{-1}$ , for this reaction.

2

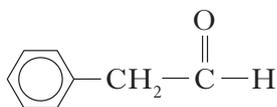
(5)

Marks

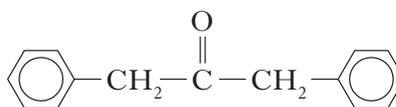
4. Chocolate contains various compounds.

(a) Many of the flavour and aroma molecules found in chocolate are aldehydes and ketones.

Two examples are shown below.



phenylethanal



1,3-diphenylpropan-2-one

Phenylethanal can be easily oxidised but 1,3-diphenylpropan-2-one cannot.

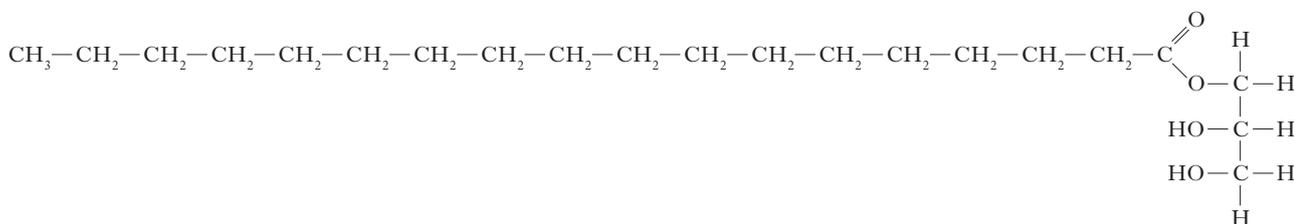
(i) Name a chemical that could be used to distinguish between these two compounds.

1

(ii) Name the type of organic compound formed when phenylethanal is oxidised.

1

(b) Glycerol monostearate is an emulsifier used in chocolate.



(i) Why is glycerol monostearate added to chocolate?

1

(ii) Draw a structural formula for glycerol.

1

Marks

**4. (continued)**

- (c) Theobromine, a compound present in chocolate, can cause illness in dogs and cats.

To decide if treatment is necessary, vets must calculate the mass of theobromine consumed.

1.0 g of chocolate contains 1.4 mg of theobromine.

Calculate the mass, in mg, of theobromine in a 17 g biscuit of which 28% is chocolate.

**Show your working clearly.**

2

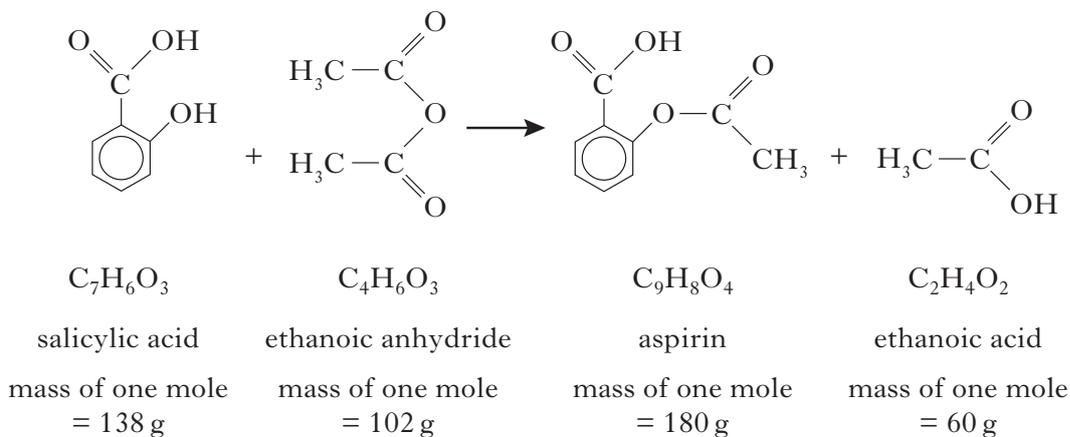
- (d) The flavour and texture of chocolate comes from a blend of compounds.

**Using your knowledge of chemistry**, describe how you could show that there are ionic compounds and covalent compounds present in chocolate.

3  
(9)

Marks

5. Aspirin, a common pain-killer, can be made by the reaction of salicylic acid with ethanoic anhydride.



- (a) Calculate the atom economy for the formation of aspirin using this method.

**Show your working clearly.**

2

- (b) In a laboratory preparation of aspirin, 5.02 g of salicylic acid produced 2.62 g of aspirin.

Calculate the percentage yield of aspirin.

**Show your working clearly.**

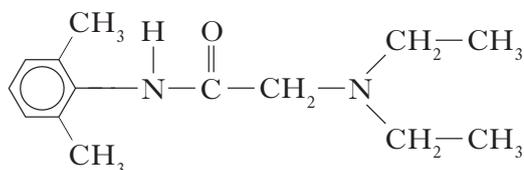
2

(4)

Marks

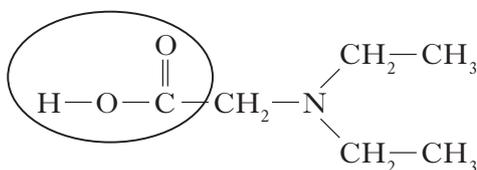
6. Dental anaesthetics are substances used to reduce discomfort during treatment.

(a) Lidocaine is a dental anaesthetic.



Lidocaine causes numbness when applied to the gums. This effect wears off as the lidocaine is hydrolysed.

One of the products of the hydrolysis of lidocaine is compound **C**.



compound **C**

(i) Name the functional group circled above.

1

(ii) Draw a structural formula for the other compound produced when lidocaine is hydrolysed.

1

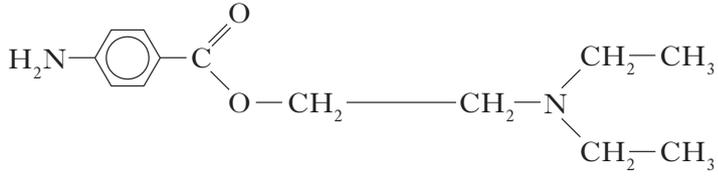
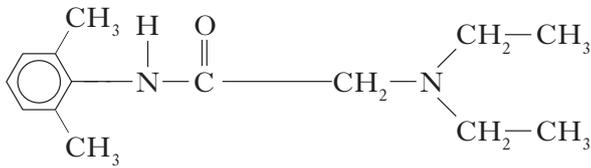
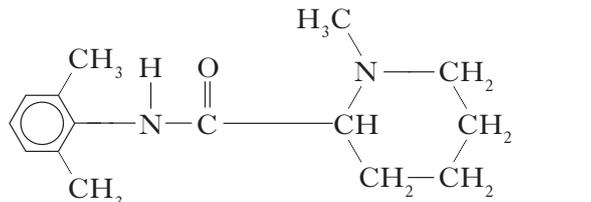
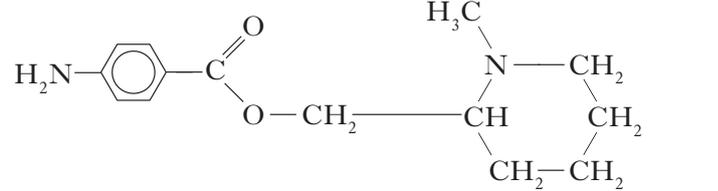
(iii) Draw a structural formula for the organic compound formed when compound **C** reacts with NaOH(aq).

1

Marks

## 6. (continued)

(b) The table below shows the duration of numbness for common anaesthetics.

Name of anaesthetic	Structure	Duration of numbness/ minutes
procaine		7
lidocaine		96
mepivacaine		114
anaesthetic X		

Estimate the duration of numbness, in minutes, for anaesthetic X.

1

*Marks*

**6. (continued)**

(c) The maximum safe dose of lidocaine for an adult is 4.5 mg of lidocaine per kg of body mass.

1.0 cm<sup>3</sup> of lidocaine solution contains 10 mg of lidocaine.

Calculate the maximum volume of lidocaine solution that could be given to a 70 kg adult.

**Show your working clearly.**

3

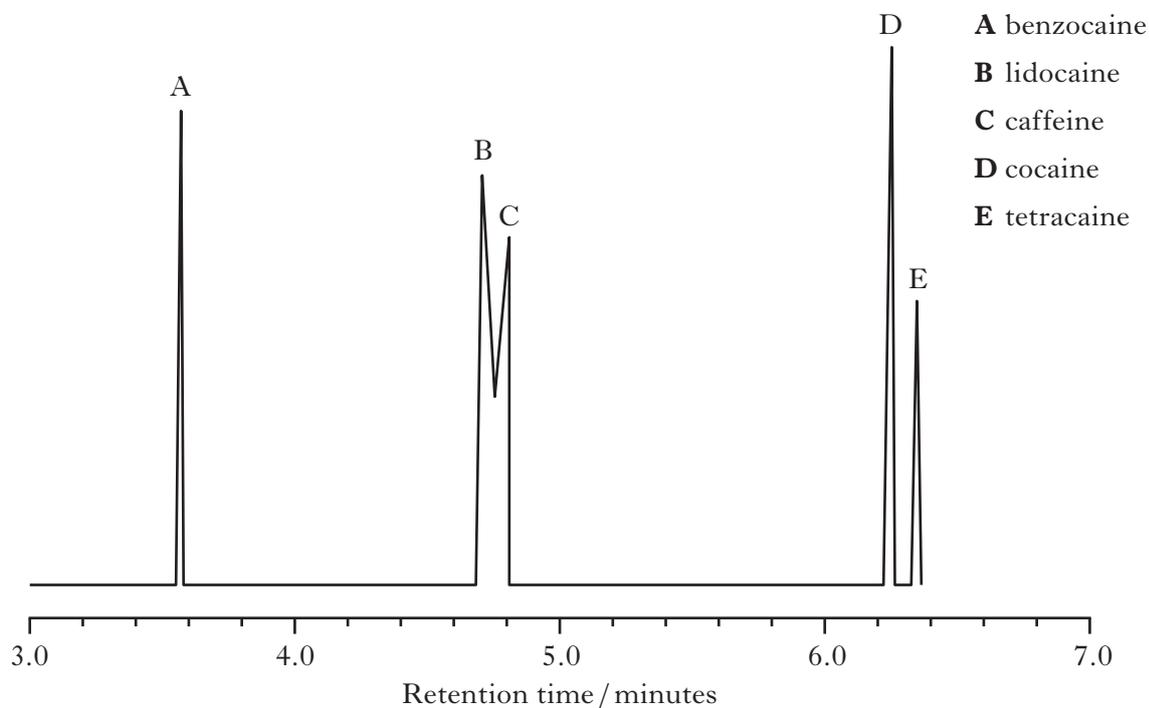
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Marks

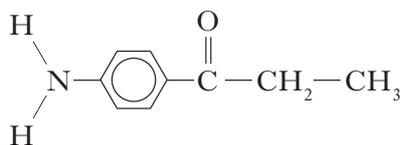
## 6. (continued)

- (d) When forensic scientists analyse illegal drugs, anaesthetics such as lidocaine are sometimes found to be present.

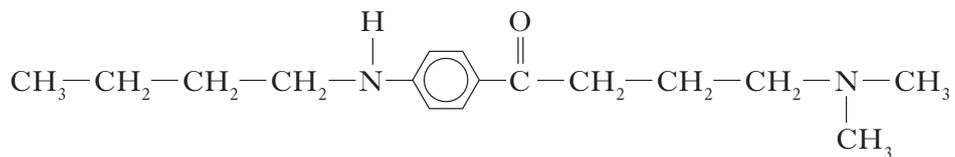
The gas chromatogram below is from an illegal drug.



- (i) The structures of benzocaine and tetracaine are shown below.



benzocaine



tetracaine

Suggest why benzocaine has a shorter retention time than tetracaine.

1

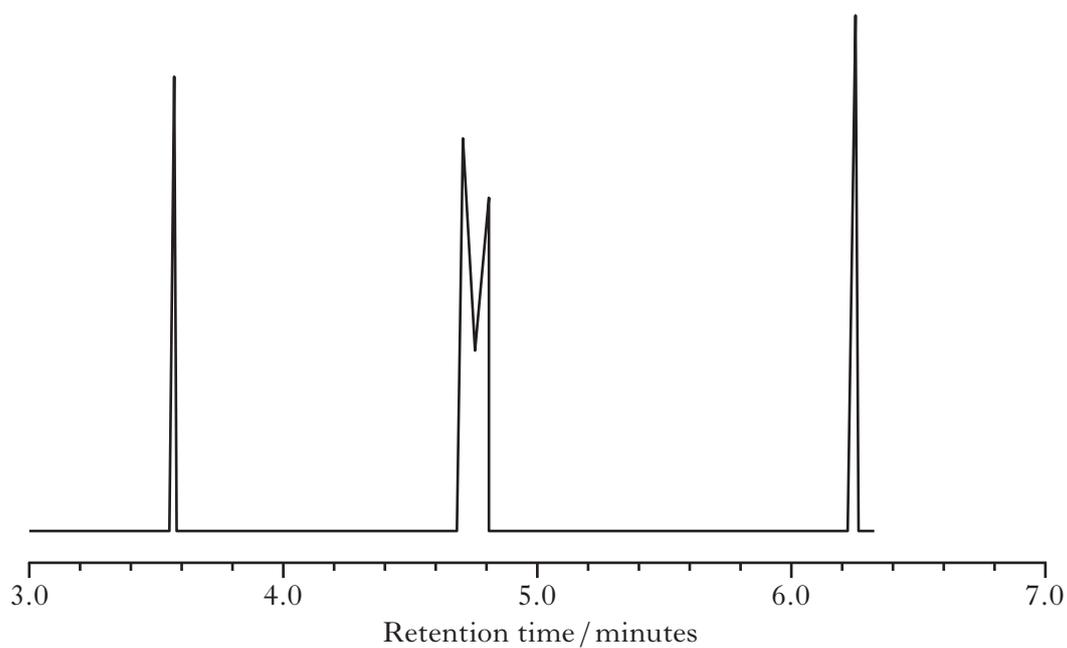
Marks

**6. (d) (continued)**

- (ii) Why is it difficult to obtain accurate values for the amount of lidocaine present in a sample containing large amounts of caffeine?

**1**

- (iii) Add a peak to the diagram below to complete the chromatogram for a second sample that only contains half the amount of tetracaine compared to the first.

**1****(10)****[Turn over**

Marks

7. Hydrogen sulfide is a toxic gas with the smell of rotten eggs.

- (a) Hydrogen sulfide gas can be prepared by the reaction of iron(II) sulfide with excess dilute hydrochloric acid:



- (i) Hydrogen sulfide gas is very soluble in water.

Draw a diagram to show an assembled apparatus that could be used to measure the volume of  $\text{H}_2\text{S}$  gas produced when a sample of iron(II) sulfide reacts with hydrochloric acid.

Your diagram should be labelled and should show the names of any chemicals used.

2

- (ii) Calculate the mass, in g, of iron(II) sulfide required to produce  $79 \text{ cm}^3$  of hydrogen sulfide gas.

(Take the molar volume of hydrogen sulfide to be  $24 \text{ litres mol}^{-1}$ .)

**Show your working clearly.**

3

Marks

**7. (continued)**

(b) Hydrogen sulfide gas produced from iron(II) sulfide is often contaminated with hydrogen gas and gaseous arsenic compounds.

- (i) Arsenic(III) sulfide is an orange-yellow powder which is insoluble in water. Below 310 °C it can sublime, turning from a solid to a gas.

Name the type of bonding and structure present in arsenic(III) sulfide.

**1**

- (ii) To avoid these contaminants, hydrogen sulfide can be made by reacting aluminium sulfide with water. Hydrogen sulfide and aluminium hydroxide are produced.

Write a balanced equation for the production of hydrogen sulfide from aluminium sulfide and water.

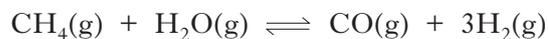
**2****(8)****[Turn over**

Marks

8. Mobile phones are being developed that can be powered by methanol.

Methanol can be made by a two-stage process.

- (a) In the first stage, methane is reacted with steam to produce a mixture of carbon monoxide and hydrogen.



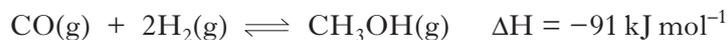
Use the data below to calculate the enthalpy change, in  $\text{kJ mol}^{-1}$ , for the forward reaction.



Show your working clearly.

2

- (b) In the second stage, the carbon monoxide and hydrogen react to produce methanol.



Circle the correct words in the table to show the changes to temperature and pressure that would favour the production of methanol.

(An additional table, if required, can be found on *Page thirty-four*.)

temperature	decrease / keep the same / increase
pressure	decrease / keep the same / increase

1  
(3)

Marks

9. Dark blue compounds can be made by reacting ammonia with copper ions. To determine the number of ammonia molecules that react with each copper ion, a student prepared the following mixtures and measured their colour intensity.

Mixture	A	B	C	D	E	F
Volume of $0.1 \text{ mol l}^{-1} \text{ Cu}^{2+}$ solution, $\text{cm}^3$	7.5	5.0	2.5	2.0	1.5	1.0
Volume of $0.1 \text{ mol l}^{-1} \text{ NH}_3$ solution, $\text{cm}^3$	2.5	5.0	7.5	8.0	8.5	
Colour intensity	0.61	1.23	1.83	1.96	1.47	0.98

(An additional table, if required, can be found on *Page thirty-four*.)

- (a) Complete the table to show the volume of  $\text{NH}_3$  solution required for the final experiment.
- (b) The number of ammonia molecules that react with each copper ion can be found from the mixture with the greatest colour intensity.  
How many ammonia molecules react with each copper ion?

1

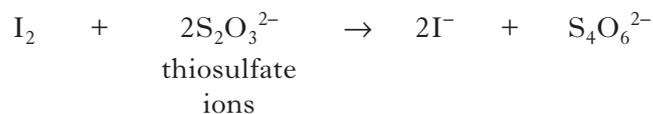
1  
(2)

[Turn over

Marks

10. Solutions containing iodine are used to treat foot rot in sheep.

The concentration of iodine in a solution can be determined by titrating with a solution of thiosulfate ions.



- (a) Write an ion-electron equation for the reaction of the oxidising agent in the titration.

1

- (b) Three 20.0 cm<sup>3</sup> samples of a sheep treatment solution were titrated with 0.10 mol l<sup>-1</sup> thiosulfate solution.

The results are shown below.

Sample	Volume of thiosulfate/cm <sup>3</sup>
1	18.60
2	18.10
3	18.20

- (i) Why is the volume of sodium thiosulfate used in the calculation taken to be 18.15 cm<sup>3</sup>, although this is not the average of the three titres in the table?

1

*Marks***10. (b) (continued)**

- (ii) Calculate the concentration of iodine, in  $\text{mol l}^{-1}$ , in the foot rot treatment solution.

**Show your working clearly.**

**3**

- (iii) Describe how to prepare  $250 \text{ cm}^3$  of a  $0.10 \text{ mol l}^{-1}$  standard solution of sodium thiosulfate,  $\text{Na}_2\text{S}_2\text{O}_3$ .

Your answer should include the mass, in g, of sodium thiosulfate required.

**3****(8)**

Marks

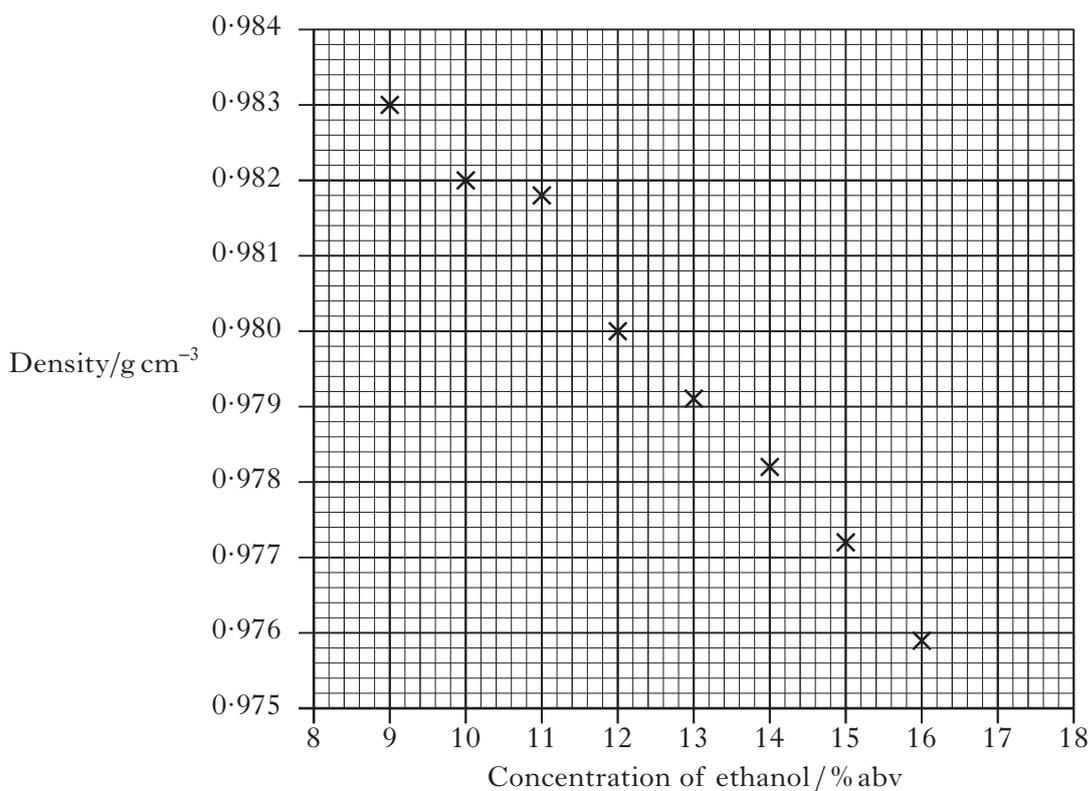
11. Ethanol has many uses.

(a) Ethanol is found at relatively low concentrations in wine.

(i) Name the chemical reaction that produces ethanol in wine.

1

(ii) Standard ethanol solutions were used to produce a graph of density against concentration of ethanol, given as a percentage of alcohol by volume (% abv).



What is the concentration of ethanol, in units of % abv, in a solution of density  $0.9818 \text{ g cm}^{-3}$ ?

1

Marks

**11. (continued)**

(b) Whisky contains a higher concentration of ethanol.

- (i) Before 1980, the concentration of alcohol in drinks was measured in terms of degrees proof.

The concentration of alcohol in two drinks is shown in the table below, both as % abv and degrees proof.

<b>Sample</b>	<b>Alcohol concentration / % abv</b>	<b>Alcohol concentration / degrees proof</b>
Wine	14.0	24.5
Sherry	20.0	35.0

A cask strength whisky has an alcohol concentration of 65% abv.

Calculate the alcohol concentration of this whisky in degrees proof.

1

- (ii) A barrel containing 195 litres of cask strength whisky costs £1300.

The cask strength whisky is diluted with water to reduce the concentration of alcohol from 65% abv to 46% abv before it is bottled.

Calculate the cost of the cask strength whisky needed to produce a 0.70 litre bottle.

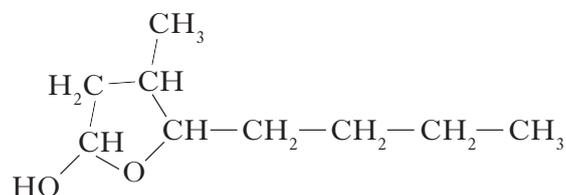
**Show your working clearly.**

2

Marks

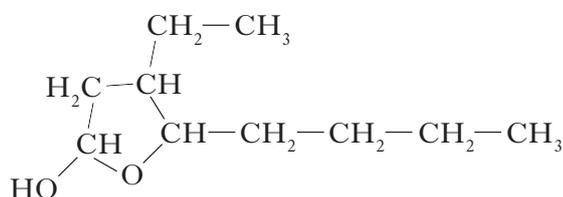
## 11. (b) (continued)

- (iii) 5-Butyl-4-methyltetrahydrofuran-2-ol is a flavour compound found in whisky stored in oak barrels.



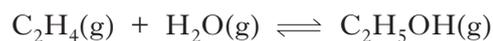
5-butyl-4-methyltetrahydrofuran-2-ol

Write the systematic name for the compound shown below.



1

- (c) Ethanol, for use in industrial processes, can be produced by reacting ethene gas with steam.



- (i) What name is given to this type of chemical reaction?

1

- (ii) What would happen to the equilibrium position if a catalyst was used?

1  
(8)

*Marks*

12. Cooking involves many chemical reactions. Proteins, fats, oils and esters are some examples of compounds found in food. A chemist suggested that cooking food could change compounds from being fat-soluble to water-soluble.

**Use your knowledge of chemistry** to comment on the accuracy of this statement.

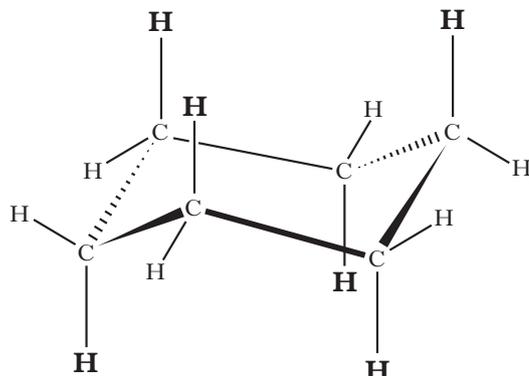
(3)

[Turn over

Marks

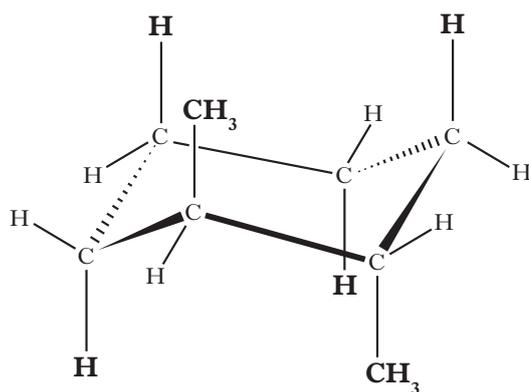
13. Cycloalkanes are found in nature.

A representation of cyclohexane is shown below.



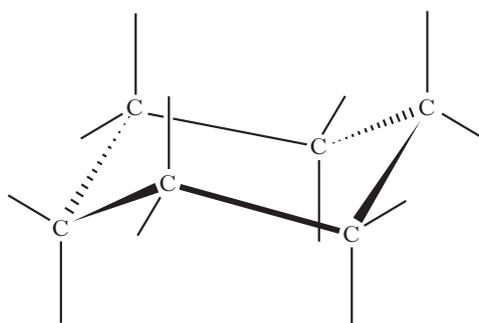
The six hydrogen atoms marked in **bold** are said to be in axial positions.

In the molecule of **1,2-dimethylcyclohexane** shown below, two methyl groups are in axial positions.



(a) Complete the structure shown below to show a molecule of **1,3-dimethylcyclohexane** in which both the methyl groups are in axial positions.

(An additional diagram, if required, can be found on *Page thirty-four*.)



1

Marks

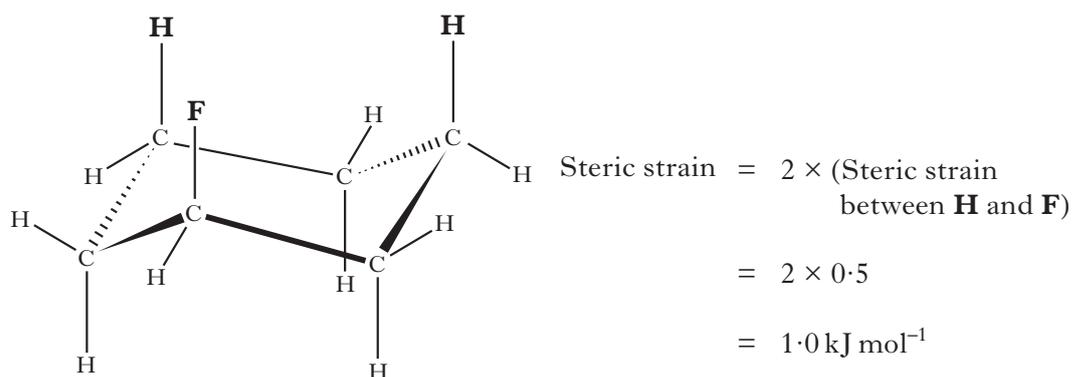
## 13. (continued)

- (b) Axial groups **on the same side** of a cyclohexane ring can repel each other. The strength of the repulsion is known as the “steric strain”.

The table below shows values which allow the steric strain to be calculated.

Axial groups	Steric strain /kJ mol <sup>-1</sup>
H and H	0.0
H and F	0.5
H and Br	1.0
H and CH <sub>3</sub>	3.8
H and (CH <sub>3</sub> ) <sub>3</sub> C	11.4

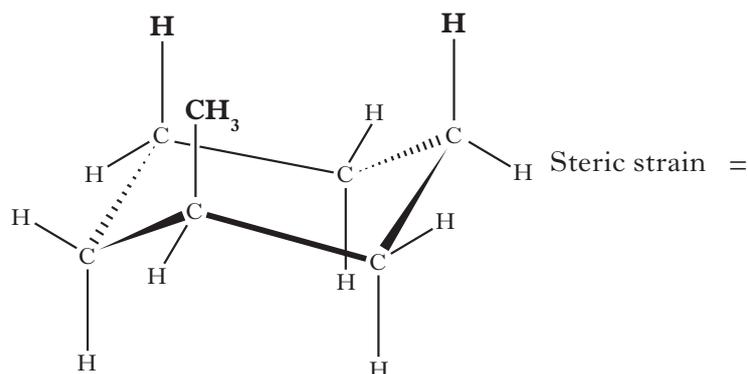
For example:



- (i) Write a general statement, linking the size of the steric strain to the type of axial group present.

1

- (ii) Calculate, in kJ mol<sup>-1</sup>, the steric strain for the molecule shown below.

1  
(3)

[END OF QUESTION PAPER]

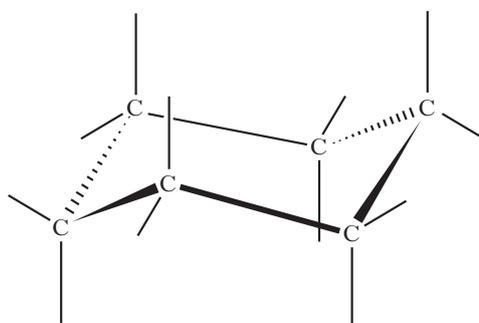
## ADDITIONAL TABLE FOR USE IN QUESTION 8(b)

temperature	decrease / keep the same / increase
pressure	decrease / keep the same / increase

## ADDITIONAL TABLE FOR USE IN QUESTION 9(a)

Mixture	A	B	C	D	E	F
Volume of $0.1 \text{ mol l}^{-1} \text{ Cu}^{2+}$ solution, $\text{cm}^3$	7.5	5.0	2.5	2.0	1.5	1.0
Volume of $0.1 \text{ mol l}^{-1} \text{ NH}_3$ solution, $\text{cm}^3$	2.5	5.0	7.5	8.0	8.5	
Colour intensity	0.61	1.23	1.83	1.96	1.47	0.98

## ADDITIONAL DIAGRAM FOR USE IN QUESTION 13(a)



**ADDITIONAL SPACE FOR ANSWERS**

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**2013 Chemistry**

**Higher (Revised)**

**Finalised Marking Instructions**

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## Part One: General Marking Principles for Chemistry Higher (Revised)

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

- (a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question.
- (b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

### GENERAL MARKING ADVICE: Chemistry Higher (Revised)

The marking schemes are written to assist in determining the “minimal acceptable answer” rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates’ evidence, and apply to marking both end of unit assessments and course assessments.

#### *General information for markers*

*The* general comments given below should be considered during all marking.

1. There are **no half marks** awarded.
2. Marks should **not** be deducted for incorrect spelling or loose language as long as the meaning of the word(s) is conveyed.

**Example:** Answers like 'distilling' (for 'distillation') and 'it gets hotter' (for 'the temperature rises') should be accepted.

3. A right answer followed by a wrong answer should be treated as a cancelling error and no marks should be given.

**Example:** What colour is seen when blue Fehling’s solution is warmed with an aldehyde?

The answer 'red, green' gains no marks.

4. If a right answer is followed by additional information which does not conflict, the additional information should be ignored, whether correct or not.

**Example:** Why can the tube not be made of copper?

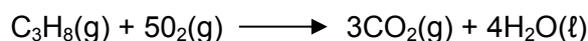
If the correct answer is related to a low melting point, 'Copper has a low melting point and is coloured grey' would **not** be treated as having a cancelling error.

5. Full marks are usually awarded for the correct answer to a calculation on its own; the part marks shown in the marking scheme are for use when working is given. An exception is when candidates are asked to 'Find, by calculation, '.

6. A mark should be deducted for incorrect or missing units **only when stated in the marking scheme**. No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.
7. As a general rule, where a wrong numerical answer (already penalised) is carried forward to another step, no further penalty is incurred provided the result is used correctly. The exception to this rule is where the marking instructions for a numerical question assign separate "concept marks" and an "arithmetic mark". In such situations, the marking instructions will give clear guidance on the assignment of partial marks.
8. Ignore the omission of one H atom from a full structural formula provided the bond is shown.
9. A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the marking scheme**.
10. When formulae of ionic compounds are given as answers it will only be necessary to show ion charges if these have been specifically asked for. However, if ion charges are shown, they must be correct. If incorrect charges are shown, no marks should be awarded.

11. If an answer comes directly from the text of the question, no marks should be given.

**Example:** A student found that 0.05 mol of propane, C<sub>3</sub>H<sub>8</sub> burned to give 82.4 kJ of energy.

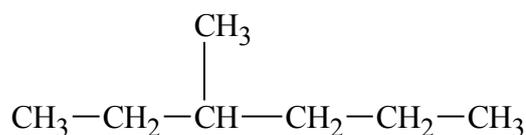


Name the kind of enthalpy change which the student measured.

No marks should be given for 'burning' since the word 'burned' appears in the text.

12. A guiding principle in marking is to give credit for correct chemistry rather than to look for reasons not to give marks.

**Example 1:** The structure of a hydrocarbon found in petrol is shown below.



Name the hydrocarbon.

Although the punctuation is not correct, '3, methyl-hexane' should gain the full mark.

**Example 2:** A student measured the pH of four carboxylic acids to find out how their strength is related to the number of chlorine atoms in the molecule.

Structural formula	pH
CH <sub>3</sub> COOH	1.65
CH <sub>2</sub> ClCOOH	1.27
CHCl <sub>2</sub> COOH	0.90
CCl <sub>3</sub> COOH	0.51

The results are shown.

How is the strength of the acids related to the number of chlorine atoms in the molecule?

Although not completely correct, an answer such as 'the more Cl<sub>2</sub>, the stronger the acid' should gain the full mark.

13. Unless the question is clearly about a non-chemistry issue, eg costs in industrial chemistry, a non-chemical answer gains no marks.

**Example:** Why does the (catalytic) converter have a honeycomb structure?

A response such as 'to make it work' may be correct but it is not a chemical answer and the mark should not be given.

**Part Two: Marking Instructions for each Question**

**Section A**

Question			Acceptable Answer
1			B
2			D
3			C
4			C
5			D
6			D
7			A
8			C
9			D
10			B
11			A
12			C
13			D
14			C
15			A

Question			Acceptable Answer
16			C
17			B
18			C
19			B
20			A
21			A
22			D
23			C
24			B
25			A
26			B
27			A
28			A
29			B
30			D

Question			Acceptable Answer/s	Max Mark	Unacceptable
1	a	i	$K(g) \rightarrow K^+(g) + e^-$ (1) $K(g) \rightarrow K^+(g) + e$ (1)	1	Missing or incorrect state symbols
1	a	ii	<p>Answers can be given either in terms of potassium or of chlorine</p> <p>Answers starting with "it" are assumed to refer to Potassium</p> <p><b>Either</b></p> <p>K has more shells/levels <b>or</b> electron further from nucleus or diagram showing this (1)</p> <p>Correct and clear use of <u>greater</u> shielding/screening (or clear explanation thereof) (1)</p> <p>So less energy required to remove electron/ weaker attraction for the electron (1)</p> <p><b>or</b></p> <p>Cl has fewer shells <b>or</b> electron closer to nucleus (1)</p> <p>Correct and clear use of <u>less</u> shielding/screening (or clear explanation thereof) (1)</p> <p>So more energy required <u>to remove electron</u>/stronger attraction for the electron (1)</p>	3	
1	b		8	1	Circling OH groups but not stating the number

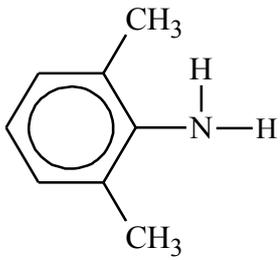
Question		Acceptable Answer/s	Max Mark	Unacceptable
2	a	<p>It can react with radicals to form stable molecules (1)</p> <p><b>or</b></p> <p>It can terminate radical (reactions) (1)</p> <p><b>or</b></p> <p>It reacts with radicals to stop further radical reactions (1)</p> <p><b>or</b></p> <p>It mops-up (free) radicals (1)</p> <p><b>or</b></p> <p>It has an unpaired/free electron (1)</p>	1	Provides electrons (0)
2	b	<p><math>C_6H_8O_6 \rightarrow C_6H_6O_6 + 2H^+ + 2e^-</math></p> <p>(state symbols not required, negative sign on electron not required)</p>	1	

Question		Acceptable Answer/s	Max Mark	Unacceptable
3	a	<p>Stating that one (<math>\text{CHCl}_3</math>) is polar <b>and/or</b> the other (<math>\text{CCl}_4</math>) is non-polar <b>(1)</b></p> <p>Identifying that <math>\text{CHCl}_3</math> has permanent dipole/permanent dipole attractions <b>and</b> identifying that <math>\text{CCl}_4</math> has London dispersion forces <b>(1)</b></p> <p>Other mark is for a statement linking intermolecular forces/polarity to the solubility in water. Statements such as the following would be acceptable</p> <ul style="list-style-type: none"> <li>• Water is polar <b>(1)</b></li> <li>• Water has permanent dipole/permanent dipole attractions <b>(1)</b></li> <li>• Water is a good solvent for polar molecules <b>(1)</b></li> <li>• Like dissolves like <b>(1)</b></li> </ul>	3	
3	b	<p>-97 (2)</p> <p>A single mark is available if either of the following operations is correctly executed</p> <p><b>Either</b></p> <p>the four relevant values for the bond enthalpies of the C–H, Cl–Cl, C–Cl and H–Cl bonds (or multiples thereof) are retrieved from the databook; 243, 414, 326, 428 (ignore signs) <b>(1)</b></p> <p><b>or</b></p> <p>the enthalpy values for bond formation are taken away from the enthalpy values for bond breaking without arithmetic error <b>(1)</b> (units not required)</p>	2	

Question			Acceptable Answer/s	Max Mark	Unacceptable
4	a	i	Tollen's or <u>acidified</u> dichromate or Fehling's or Benedict's (please note – although Benedict's reagent would not work in practice, because it appears in Higher textbooks, revision guides and the PPA materials for the traditional Higher, it can be accepted) (accept other spellings if phonetically correct)	1	
4	a	ii	Carboxylic acid	1	
4	b	i	It keeps oil & water soluble materials mixed or Allow immiscible substances to mix or To allow fat and water to mix or To form a suspension	1	to stop it separating (with no mention of water & oil soluble components)  to stop layers forming
4	b	ii	$  \begin{array}{ccccc}  & \text{H} & & \text{H} & & \text{H} \\  &   & &   & &   \\  \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - \text{H} \\  &   & &   & &   \\  & \text{OH} & & \text{OH} & & \text{OH}  \end{array}  $ <p>Any structural formula for glycerol</p>	1	
4	c		<p>6.7 (mg) – units not required</p> <p>A single mark is available if either of the following manipulations is correctly executed.</p> <p>Correct use of percentage</p> <p>eg <i>mass of chocolate</i> = <math>\frac{28}{100} \times 17 \text{ g} = 4.76 \text{ g}</math></p> <p>Correct use of proportion theobromine</p> <p>eg <i>mass of theobromine</i> = <math>1.4 \times a \text{ mass}</math></p>	2	

Question		Acceptable Answer/s	Max Mark	Unacceptable
4	d	<p>This is an open ended question</p> <p><b>1 mark:</b> The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</p> <p><b>2 marks:</b> The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood.</p> <p><b>3 marks:</b> The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one.</p>	3	<p>The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.</p>

Question		Acceptable Answer/s	Max Mark	Unacceptable
5	a	<p>75 % (2)</p> <p>Total mass of reactants/products = 240 g (1)</p> <p><math>Atom\ Economy = \frac{180}{240} \times 100\% = 75\% (1)</math></p> <p>(Accept 0.75 also, this would be atom economy as a fraction)</p>	2	
5	b	<p>40 % (2)</p> <p>1 mark is given for either calculating the theoretical yield, or for working out the numbers of moles of reactant and product formed. eg 6.55(g) or both 0.0364 and 0.0146</p> <p>1 mark is given for calculating the % yield; either using the actual and theoretical masses, or using the actual number of moles of products and actual number of moles of reactant.</p>	2	$\%yield = \frac{2.62}{5.02} \times 100$ $= 52.2\%$

Question			Acceptable Answer/s	Max Mark	Unacceptable
6	a	i	Carboxyl (group) (1) or Carboxylic (acid) (1)	1	
6	a	ii		1	
6	a	iii	$\text{Na}^+ \text{O}^- \text{—} \overset{\text{O}}{\parallel} \text{C} \text{—} \text{CH}_2 \text{—} \text{N} \begin{cases} \text{CH}_2 \text{—} \text{CH}_3 \\ \text{CH}_2 \text{—} \text{CH}_3 \end{cases}$ <p>or shortened formula. Charges not required but if shown, both +ve and –ve charges must be correct(1).</p>	1	Covalent bond shown between Na-O
6	b		25 (minutes) or 8.0 to 8.4 (minutes) (units not required. Ignore incorrect units)	1	

Question			Acceptable Answer/s	Max Mark	Unacceptable
6	c		<p>Volume = 31.5 cm<sup>3</sup> or 31.5 ml or 0.0315 l or equivalent (3)</p> <p><b>One mark is allocated to the correct statement of units of volume. This is the mark in the paper earmarked to reward a candidate's knowledge of chemical units.</b></p> <p>So volume = 31.5 or 0.0315 (2)</p> <p>One mark is available if either of the following steps is correct</p> <p>Calculation of mass of lidocaine eg 4.5 × 70 = 315 (mg)</p> <p>Calculation of a volume of solution required eg <math>a \text{ mass} \times \frac{1}{10} = a \text{ volume}</math></p>	3	
6	d	i	<p>Benzocaine is a smaller/Tetracaine is bigger (1) <b>or</b> weaker London Dispersion Forces with Benzocaine (1) <b>or</b> weaker Van der Waal's forces for Benzocaine (1) <b>or</b> Benzocaine has lower b.pt (1) <b>or</b> Benzocaine more soluble/attracted in/ to mobile phase (1) <b>or</b> Benzocaine less strongly attracted to stationary phase (1) <b>or</b> Benzocaine is more polar (1)</p>	1	Benzocaine takes less time to travel through the apparatus
6	d	ii	<p>The peaks for lidocaine and caffeine overlap <b>or</b> Candidate wording for idea of masking</p>	1	The retention times are similar

Question			Acceptable Answer/s	Max Mark	Unacceptable
6	d	iii	Peak for tetracaine at correct RT with approximately half original height		
					<b>1</b>

Question			Acceptable Answer/s	Max Mark	Unacceptable
7	a	i	<p>For successful generation of gas; must have iron sulfide, hydrochloric acid and appropriate glassware to transfer the gas to the gas collection/ measurement apparatus without loss of gas <b>(1)</b></p> <p>For the successful collection and measurement of the gas; must have a syringe or collect the gas in a measuring cylinder over a non-aqueous liquid <b>(1)</b></p>	2	
7	a	ii	<p>0.29 (g) (units not required)</p> <p>1 mark is awarded for a correct strategy to work out number of moles of hydrogen sulfide (a volume of hydrogen sulfide in whatever unit is shown being divided by a molar volume in whatever unit).</p> <p>1 mark is awarded for correct strategy to work out the mass of the iron(II) sulfide (eg a number of moles of FeS is multiplied by something clearly intended to be the GFM of FeS).</p> <p>1 mark is awarded for correct arithmetic in both of these steps. (This includes the correct value for the GFM of FeS). This arithmetic mark can only be awarded if both of the concept marks are awarded.</p>	3	
7	b	i	<p>Covalent molecular <b>or</b> discrete covalent</p>	1	
7	b	ii	<p><math>\text{Al}_2\text{S}_3 + 6\text{H}_2\text{O} \rightarrow 2\text{Al}(\text{OH})_3 + 3\text{H}_2\text{S}</math> Correct formulae for all but one substance, whether balanced or not – 1 mark</p>	2	

Question			Acceptable Answer/s	Max Mark	Unacceptable
8	a		<p>–803, 726, 283 (any two values from this list) (1)</p> <p>+206 kJ mol<sup>-1</sup> (for value, no follow through, units not required) (1)</p>	2	
8	b			1	
		temperature	decrease/keep the same/increase		
		pressure	decrease/keep the same/increase		
9	a		9.0	1	
9	b		4	1	
10	a		<p>I<sub>2</sub> + 2e<sup>-</sup> → 2I<sup>-</sup> (1)</p> <p>or</p> <p>I<sub>2</sub> + 2e → 2I<sup>-</sup> (1)</p> <p>Ignore state symbols</p> <p>Allowing reversible arrows providing the equation is written the correct way round.</p>	1	
10	b	i	<p>first titre is a rough (or approximate) result/practice</p> <p>or</p> <p>first titre is not accurate/not reliable/rogue</p> <p>or</p> <p>first titre is too far away from the others</p> <p>or</p> <p>you take average of concordant/close results (1)</p>	1	

Question			Acceptable Answer/s	Max Mark	Unacceptable
10	b	ii	<p>0.045 (mol l<sup>-1</sup> – units not required) 3 marks</p> <p><b>Partial marks can be awarded using a scheme of two “concept” marks, and one “arithmetic” mark.</b></p> <p>1 mark for knowledge of the relationship between moles, concentration and volume. This could be shown by any <u>one</u> of the following steps:</p> <ul style="list-style-type: none"> <li>• Calculation of moles thiosulfate(aq) eg 0.1 × 0.01815 = 0.001815</li> <li>• Calculation of conc<sup>n</sup> I<sub>2</sub> eg (0.000908) ÷ 0.02 = 0.045</li> <li>• Insertion of correct pairings of values for conc<sup>n</sup> and volume in a valid titration formula such as</li> </ul> $\frac{C_1 V_1}{b_1} = \frac{C_2 V_2}{b_2} \quad \text{eg} \quad \frac{18.15 \times 0.10}{b_1} = \frac{C_2 \times 20.0}{b_2}$ <p>1 mark for knowledge of relationship between moles of S<sub>2</sub>O<sub>3</sub><sup>2-</sup> and I<sub>2</sub>. This could be shown by any <u>one</u> of the following steps:</p> <ul style="list-style-type: none"> <li>• Calculation of moles I<sub>2</sub> from moles S<sub>2</sub>O<sub>3</sub><sup>2-</sup> eg 0.001815/2 = 0.000908</li> <li>• Insertion of correct stoichiometric values in a valid titration formula such as</li> </ul> $\frac{C_1 V_1}{b_1} = \frac{C_2 V_2}{b_2} \quad \text{eg} \quad \frac{18.15 \times 0.10}{2} = \frac{C_2 \times 20.0}{1}$ <p>1 mark is awarded for correct arithmetic throughout the calculation. This mark can only be awarded if both concept marks have been awarded.</p>	3	
10	b	iii	<p>Mass of sodium thiosulfate = 3.96 g (1) Mention of rinsings (1) Mention of make up to the mark (1)</p>	3	

Question			Acceptable Answer/s	Max Mark	Unacceptable
11	a	i	(anaerobic) fermentation <b>or</b> Anaerobic respiration	1	
11	a	ii	10.1 to 10.3 (% abv)	1	11
11	b	i	114 or 113.75	1	
11	b	ii	£3.30 (do not penalise for rounding at intermediate stages)  One mark is available if the candidate has either Carried out a calculation to take into account the dilution of the whisky e.g. used a scaling factor of $\frac{46}{65}$  <b>or</b> Has correctly calculated the cost for a given volume of alcohol by use of the e.g. used the scaling factor of $\frac{1300}{195}$	2	
11	b	iii	5-butyl-4-ethyltetrahydrofuran-2-ol <b>or</b> 4-ethyl-5-butyltetrahydrofuran-2-ol	1	
11	c	i	addition or hydration	1	
11	c	ii	no change	1	

Question		Acceptable Answer/s	Max Mark	Unacceptable
12		<p>This is an open ended question</p> <p><b>1 mark:</b> The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</p> <p><b>2 marks:</b> The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood.</p> <p><b>3 marks:</b> The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one.</p>	3	<p>The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.</p>

Question			Acceptable Answer/s	Max Mark	Unacceptable
13	a		<p>or equivalent 1,3-dimethylcyclohexane structure with both methyl groups in axial positions</p>	1	<p>Structures with missing H-atoms</p> <p>Any structure with a methyl group in the equatorial position.</p>
13	b	i	<p>The bigger the group the greater the strain  <b>or</b>  The larger the (halogen) atom the greater the strain  <b>or</b>  The more atoms in a group, the greater the strain  <b>or</b>  Any other statement which is consistent with the values presented</p>	1	<p>Incorrect reference to a group as a "molecule"</p>
13	b	ii	<p>7.6 (kJ mol<sup>-1</sup>)  (Units not required, ignore incorrect units)</p>	1	

[END OF MARKING INSTRUCTIONS]