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**EP07/H/02**

**Chemistry**  
**Section 1 — Questions**

Date — Not applicable

Duration — 2 hours and 30 minutes

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

Instructions for the completion of Section 1 are given on *Page two* of your question and answer booklet EP07/H/01.

Record your answers on the answer grid on *Page three* of your question and answer booklet.

Before leaving the examination room you must give your question and answer booklet to the Invigilator; if you do not you may lose all the marks for this paper.



\* EP07H02 \*

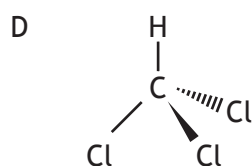
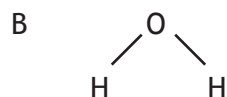
**SECTION 1 — 20 marks**

**Attempt ALL questions**

1. Which of the following elements has the greatest attraction for bonding electrons?
  - A Lithium
  - B Chlorine
  - C Sodium
  - D Bromine
  
2. For elements in Group 7 of the Periodic Table, which of the following statements is true as the group is descended?
  - A The boiling point decreases.
  - B The covalent radius decreases.
  - C The electronegativity decreases.
  - D The strength of London dispersion forces decreases.
  
3. Which of the following statements is true?
  - A The potassium ion is larger than the potassium atom.
  - B The chloride ion is smaller than the chlorine atom.
  - C The sodium atom is larger than the sodium ion.
  - D The oxygen atom is larger than the oxide ion.
  
4. Which type of bonding is never found in elements?
  - A Metallic
  - B London dispersion forces
  - C Polar covalent
  - D Non-polar covalent

5. The shapes of some common molecules are shown below and each contains at least one polar bond.

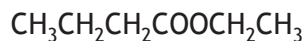
Which molecule is non-polar?



6. 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.

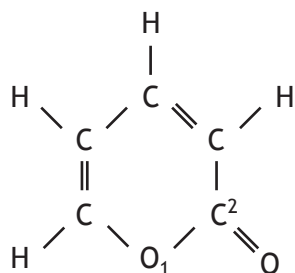
7. An ester has the following structural formula



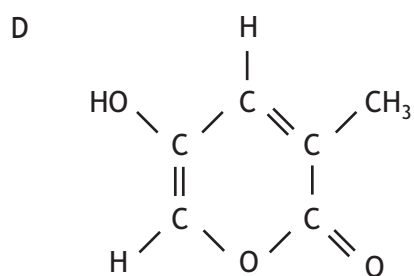
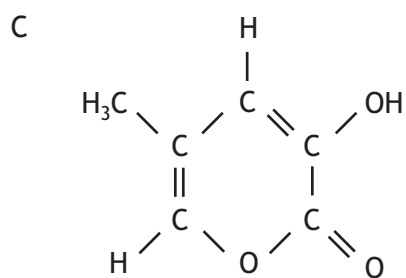
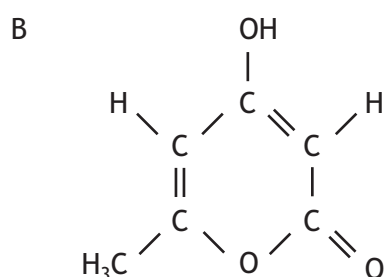
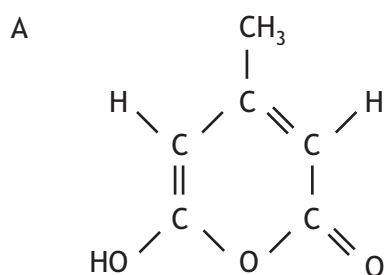
The name of this ester is

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

8. 4-Hydroxy-6-methyl-2-pyrone is a cyclic ester responsible for the smell of chocolate. The number 2 identifies the position of the carbonyl group in the pyrone ring counting from the oxygen atom within the ring.



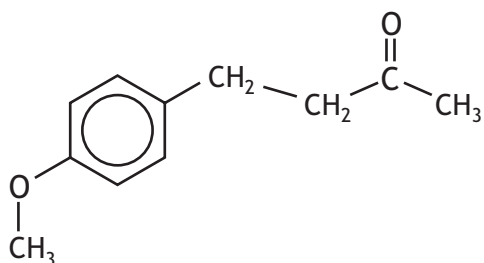
What is the structure of 4-hydroxy-6-methyl-2-pyrone?



9. Which line in the table shows correct functional groups for aldehydes and ketones, and fats and oils?

	<i>Aldehyde and ketones</i>	<i>Fats and oils</i>
A	carbonyl	hydroxyl
B	carboxyl	hydroxyl
C	carboxyl	ester link
D	carbonyl	ester link

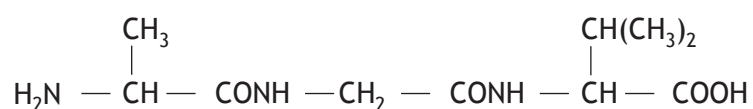
10. A compound with the following structure is used in perfumes to help provide a sweet, fruity fragrance.



This compound could be classified as

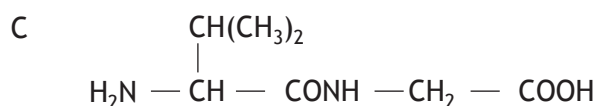
- A an ester
- B a ketone
- C an aldehyde
- D a carboxylic acid.

11. A tripeptide X has the structure

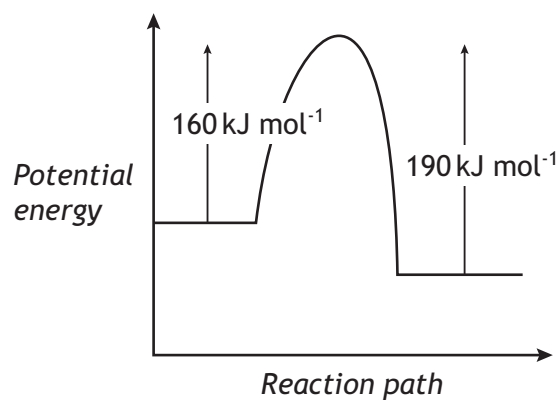


Partial hydrolysis of X yields a mixture of dipeptides.

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



12.



When a catalyst is used, the activation energy of the forward reaction is reduced to 35 kJ mol<sup>-1</sup>.

What is the activation energy of the catalysed reverse reaction?

A 30 kJ mol<sup>-1</sup>

B 35 kJ mol<sup>-1</sup>

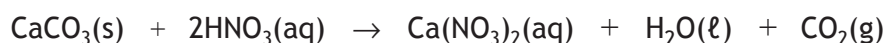
C 65 kJ mol<sup>-1</sup>

D 190 kJ mol<sup>-1</sup>

13. Which line in the table applies correctly to the use of a catalyst in a chemical reaction?

	<i>Position of equilibrium</i>	<i>Effect on value of <math>\Delta H</math></i>
A	moved to the right	decreased
B	unaffected	increased
C	moved to the left	unaffected
D	unaffected	unaffected

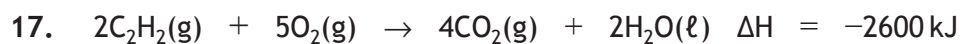
14. Calcium carbonate reacts with nitric acid as follows.



0.05 mol of calcium carbonate was added to a solution containing 0.08 mol of nitric acid.

Which of the following statements is true?

- A 0.05 mol of carbon dioxide is produced.
  - B 0.08 mol of calcium nitrate is produced.
  - C Calcium carbonate is in excess by 0.01 mol.
  - D Nitric acid is in excess by 0.03 mol.
15. 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
16. The correct method of filling a 20 cm<sup>3</sup> pipette is to draw the liquid into the pipette
- A doing it slowly at the end, until the top of the meniscus touches the mark
  - B doing it slowly at the end, until the bottom of the meniscus touches the mark
  - C to above the mark and then release liquid from the pipette until the top of the meniscus touches the mark
  - D to above the mark and then release liquid from the pipette until the bottom of the meniscus touches the mark.



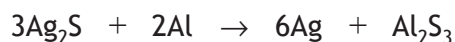
The energy released when 0.5 mole of each gas is mixed and ignited is

- A 260 kJ
- B 520 kJ
- C 650 kJ
- D 1300 kJ.

18. Which of the following is the strongest oxidising agent?

- A  $\text{Li}^+(\text{aq})$
- B  $\text{Li}(\text{s})$
- C  $\text{F}^-(\text{aq})$
- D  $\text{F}_2(\text{g})$

19. Silver jewellery discoloured by tarnish ( $\text{Ag}_2\text{S}$ ) can be cleaned by placing the item in an aluminium pot containing salt solution. The reaction occurring is shown below.

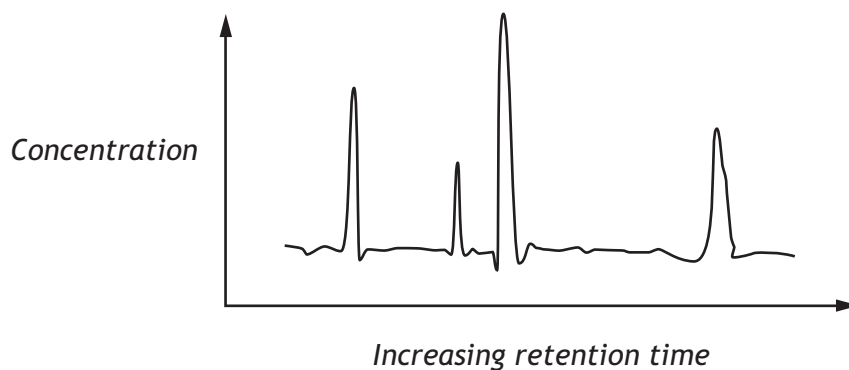


Which of the following statements is true?

- A Aluminium metal is a reducing agent.
- B Silver metal is an oxidising agent.
- C Silver ions are acting as electron donors.
- D Sulfide ions are acting as electron acceptors.



20. A chemist analysed a mixture of four dyes A, B, C and D using gas-liquid chromatography. When a polar column was used the following chromatogram was obtained.



Which of the following compounds was present in greatest concentration?

Dye	Structure
A	
B	
C	
D	

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET.]

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Mark

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**EP07/H/01**

**Chemistry**  
**Section 1 — Answer Grid**  
**and Section 2**

Date — Not applicable

Duration — 2 hours and 30 minutes



\* EP07H01 \*

Fill in these boxes and read what is printed below.

Full name of centre

--

Town

--

Forename(s)

--

Surname

--

Number of seat

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Date of birth

Day

--	--

Month

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Year

--	--

Scottish candidate number

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

**Total marks — 100**

**SECTION 1 — 20 marks**

Attempt ALL questions.

Instructions for completion of Section 1 are given on *Page two*.

**SECTION 2 — 80 marks**

Attempt ALL questions

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. You should score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.



\* EP07H0101 \*

The questions for Section 1 are contained in the question paper EP07/H/02.  
Read these and record your answers on the answer grid on *Page three* opposite.  
Do NOT use gel pens.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).
2. There is **only one correct** answer to each question.
3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

### Sample Question

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

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

The correct answer is **B**—chromatography. The answer **B** bubble has been clearly filled in (see below).

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

### Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

or

A	B	C	D
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>



\* EP07 H0102 \*

# SECTION 1 — Answer Grid



	A	B	C	D
1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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17	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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\* E P 0 7 H 0 1 0 4 \*

## SECTION 2 — 80 marks

Attempt ALL questions

MARKS

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1. Sodium is the first element in the third period of the periodic table.

Na	Mg	Al	Si	P	S	Cl	Ar
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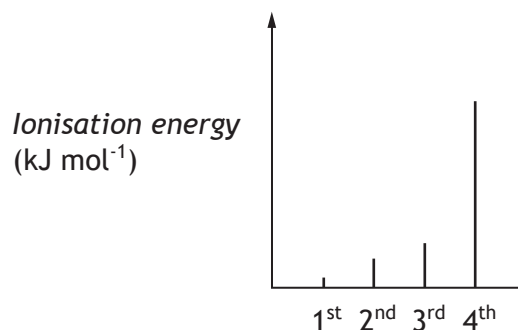
- (a) Describe the trend in electronegativity values across this period from Na to Cl.

1

- (b) Name the element in the third period that has a covalent network structure.

1

- (c) The spike graph shows the first four ionisation energies for aluminium.



Explain why the fourth ionisation energy of aluminium is much higher than the third ionisation energy.

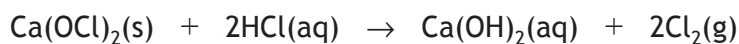
1



\* E P 0 7 H 0 1 0 5 \*

1. (continued)

- (d) Chlorine gas can be produced by heating calcium hypochlorite,  $\text{Ca(OCl)}_2$ , in dilute hydrochloric acid.



Calculate the mass of calcium hypochlorite that would be needed to produce 0.096 litres of chlorine gas.

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

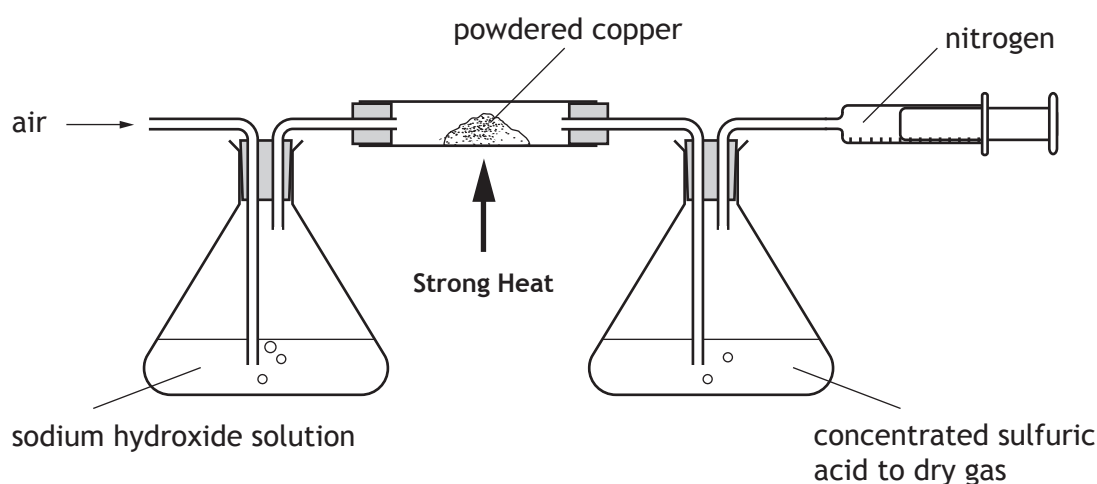
2

Show your working clearly.

- (e) Argon was discovered in 1890s when samples of nitrogen prepared by different methods were compared. The element name was derived from the Greek *argos*, which means “lazy one”.

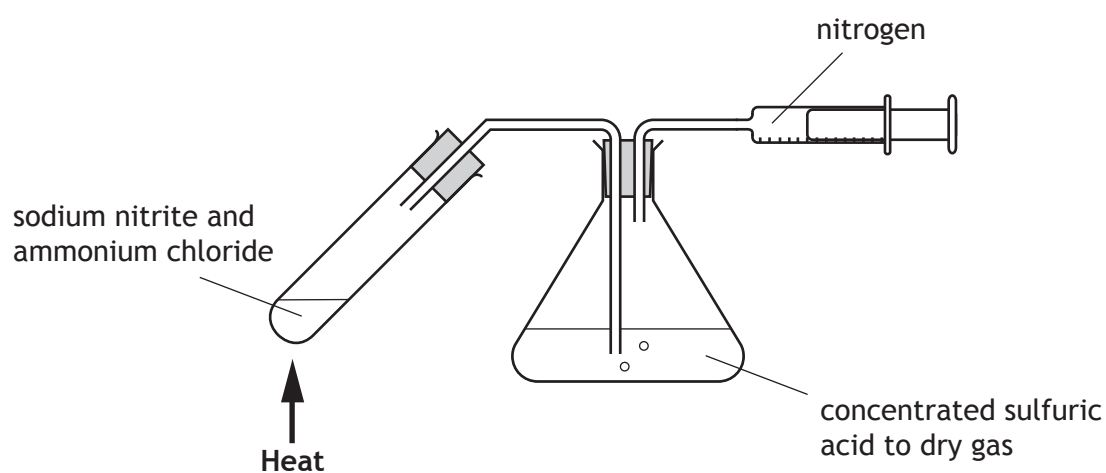
Two samples of nitrogen can be prepared as shown.

**Method 1** Removing carbon dioxide and oxygen from the air.

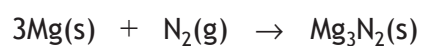


## 1. (e) (continued)

Method 2 Reaction of sodium nitrite with ammonium chloride.



Heated magnesium metal can react with nitrogen gas to give magnesium nitride.



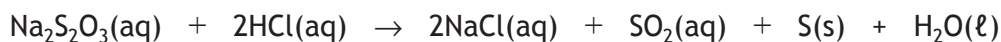
Using your knowledge of chemistry, comment on the discovery and naming of argon.

3





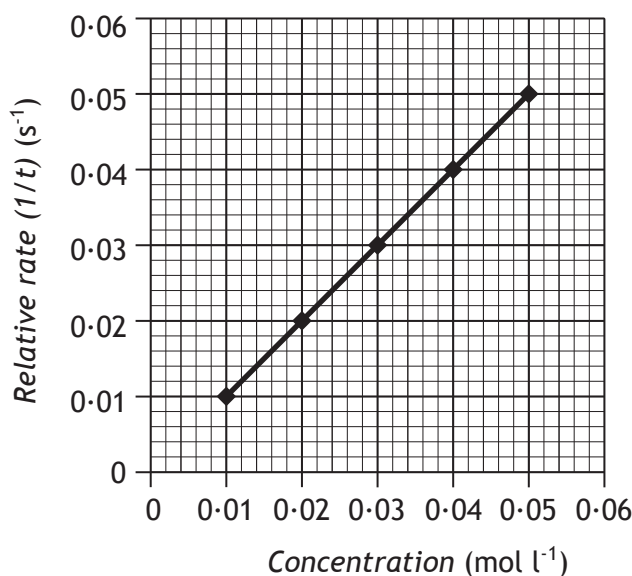
2. When dilute hydrochloric acid is added to a solution of sodium thiosulfate in a beaker, solid sulfur forms in the solution.



The effect of concentration on the rate of reaction can be studied by varying the sodium thiosulfate concentration and timing how long it takes for enough sulfur to be formed, to obscure a cross drawn on a piece of card placed below the beaker.

- (a) Use the graph to determine the time it took to obscure the cross when the concentration of the thiosulfate solution was  $0.04 \text{ mol l}^{-1}$ .

1



2. (continued)

(b) Collision theory can be used to explain the change in relative rate.

- (i) Collision theory states that for a reaction to take place particles must first collide with one another.

State **one** other condition necessary for a successful collision to take place.

1

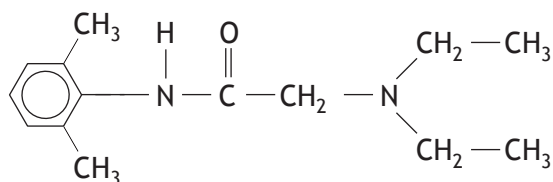
- (ii) Explain why the relative rate of reaction decreases as the concentration of thiosulfate used in the above reaction decreases.

1



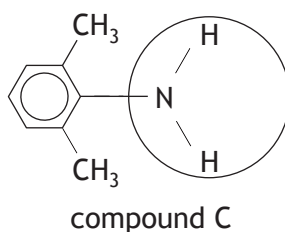
3. Dental anaesthetics are substances used to reduce discomfort during treatment.

(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.



(i) Name the functional group circled above.

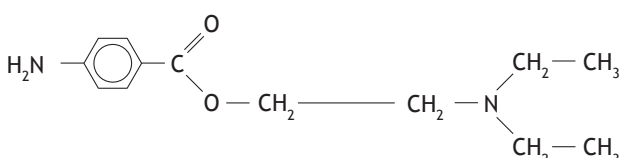
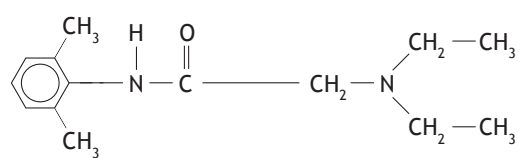
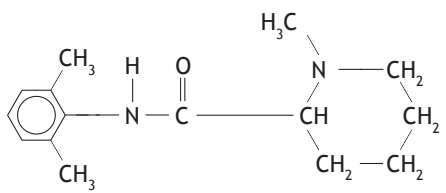
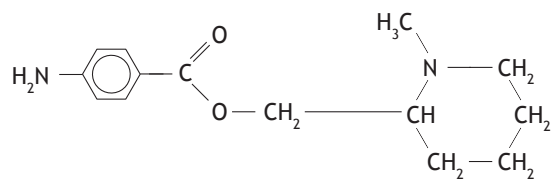
1

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

1

3. (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

(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, in cm<sup>3</sup>, of lidocaine solution that could be given to a 70 kg adult.

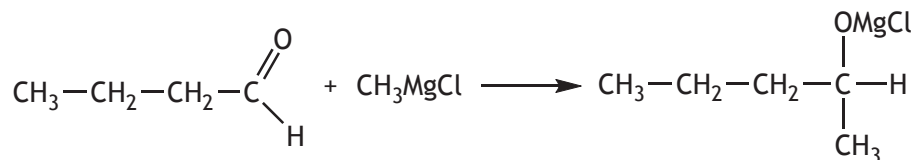
2

Show your working clearly.

4. Primary, secondary and tertiary alcohols can be prepared by the reaction of carbonyl compounds with Grignard reagents.

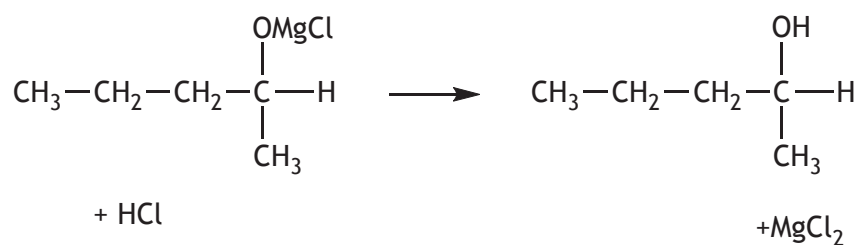
### Step 1

The Grignard reagent reacts with the carbonyl compound.



### Step 2

The reaction of the product of **Step 1** with dilute acid produces the alcohol.



- (a) Describe the difference between a primary, a secondary and a tertiary alcohol.

You may wish to include labelled structures in your answer.

1

- (b) Suggest a name for the type of reaction that takes place in **Step 1**.

1



\* E P O 7 H 0 1 1 2 \*

4. (continued)

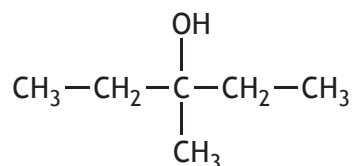
MARKS

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(c) Name the alcohol produced from butanal in the above reactions.

1

(d) The same Grignard reagent can be used to produce the alcohol below.



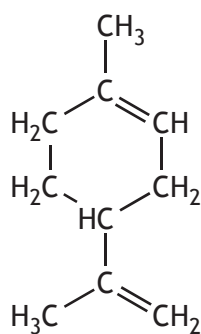
Name the carbonyl compound used in this reaction.

1



\* E P 0 7 H 0 1 1 3 \*

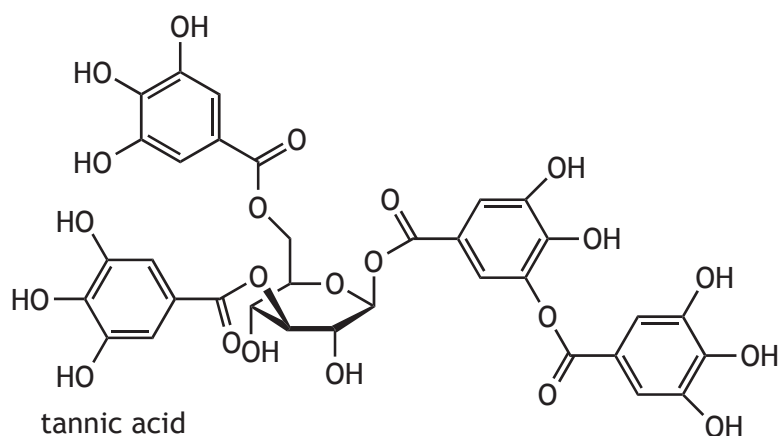
5. (a) Limonene is a terpene found in many wines.



State why limonene can be classed as a terpene.

1

- (b) Many wines also contain tannins such as tannic acid.



Explain why tannic acid will be a water-soluble compound.

1

**5. (continued)**

**(c) Ageing of wines**

Wine is a complex combination of many chemical compounds, which change as they interact with each other and their environment to give the wine its character.

A perfectly aged wine will have an optimal combination of three things: fruit flavours, fermentation flavours, and ageing flavours.

The wine-making process has two phases; the maturation phase and the ageing phase.

During the maturation phase, the grape juice is first fermented in large vats producing ethanol and smaller amounts of higher alcohols such as 3-methylbutan-1-ol and butan-2,3-diol. Exposure to oxygen at this stage causes the yeasts in the grape skins to multiply and allows other chemical reactions to take place. The wine is then transferred to wooden barrels and allowed to mature.

After maturation the wine is bottled and allowed to age. Wine experts recommend that bottled wine is stored at a constant 13 °C. At this temperature desirable chemical reactions take place slowly but unwanted chemical reactions are unable to take place.

**Using your knowledge of chemistry**, comment on how the maturation and ageing processes might affect the character of the wine.

**3**



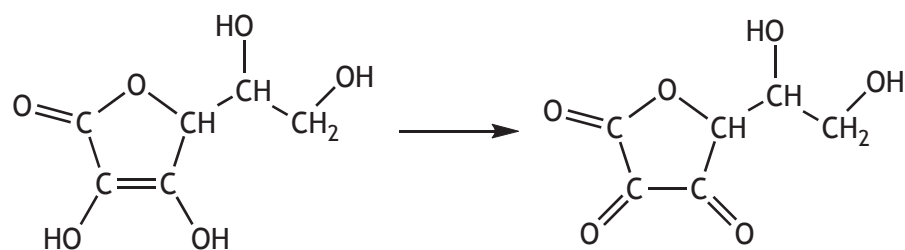


6. Vitamin C and E are antioxidants that help prevent cellular damage and skin ageing.

(a) (i) Name the type of particles that antioxidants react with, preventing cellular damage and skin ageing.

1

(ii) The equation shows the change that takes place when vitamin C molecules are oxidised.



vitamin C

Explain why this process can be described as oxidation.

1

(b) The recommended daily allowance (RDA) for vitamin E is 20 mg per day. Almonds are a good source of vitamin E and provide 26.2 mg per 100 g. Almonds are sold as 1 kg bags costing £13.99.

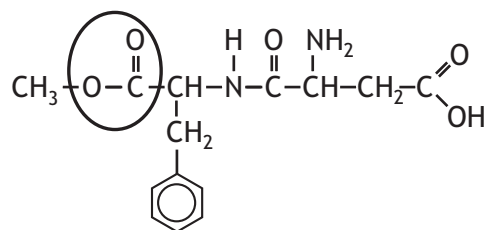
Calculate the cost of almonds that will provide the RDA of vitamin E.

2



7. Soft drinks contain many ingredients.

- (a) Aspartame is added to many soft drinks as a sweetener. Its structure is shown below.

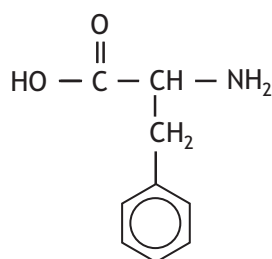
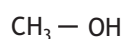


- (i) Name the functional group circled.

1

- (ii) In the stomach, aspartame is hydrolysed by acid to produce methanol and two amino acids, phenylalanine and aspartic acid.

Two of the products of the hydrolysis of aspartame are shown below.



methanol

phenylalanine

Draw a structural formula for aspartic acid.

1

- (iii) The body cannot make all the amino acids it requires and is dependent on protein in the diet for the supply of certain amino acids.

State the term used to describe the amino acids the body cannot make.

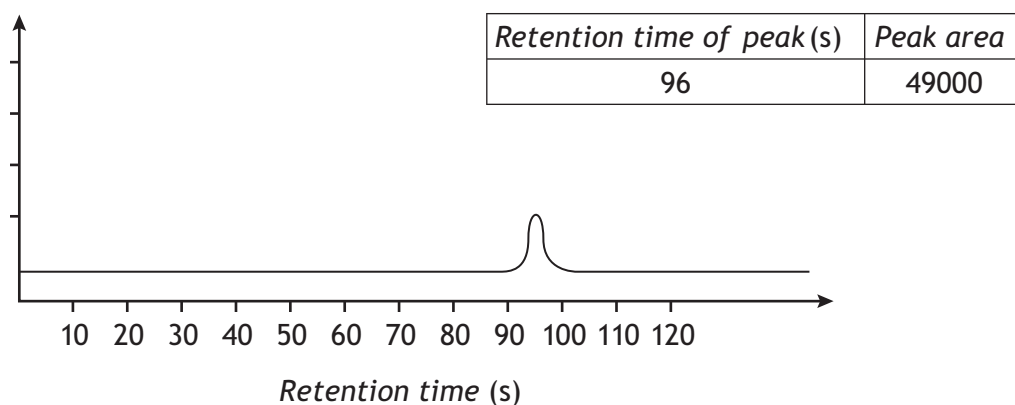
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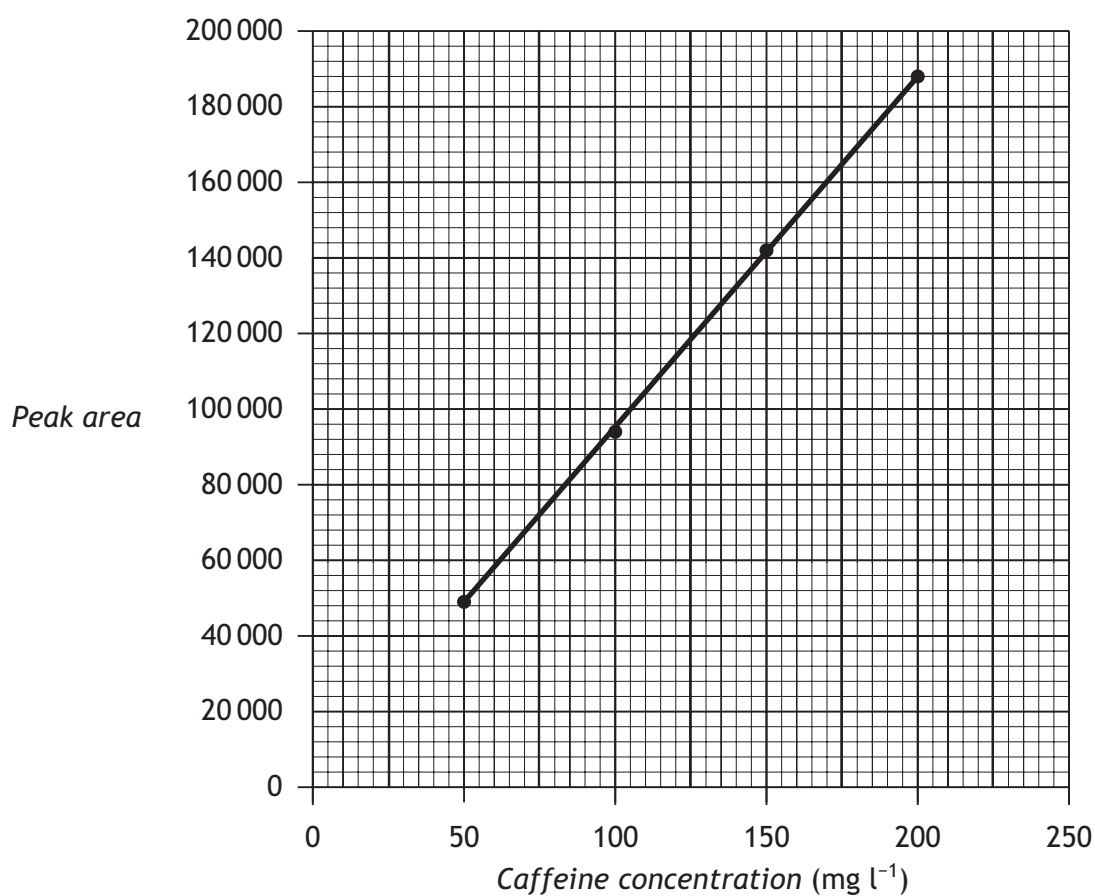
7. (continued)

- (b) Caffeine is also added to some soft drinks. The concentration of caffeine can be found using chromatography.

A chromatogram for a standard solution containing  $50 \text{ mg l}^{-1}$  of caffeine is shown below.



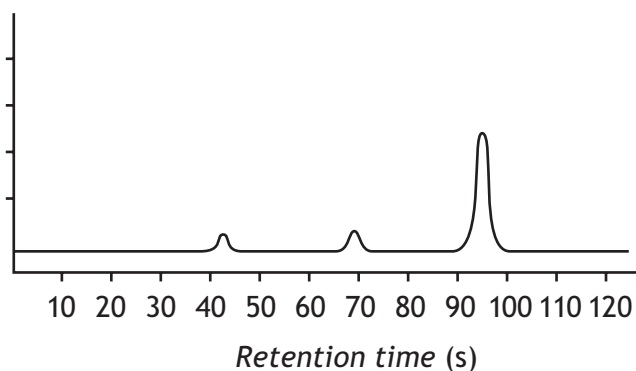
Results from four caffeine standard solutions were used to produce the calibration graph below.



7. (b) (continued)

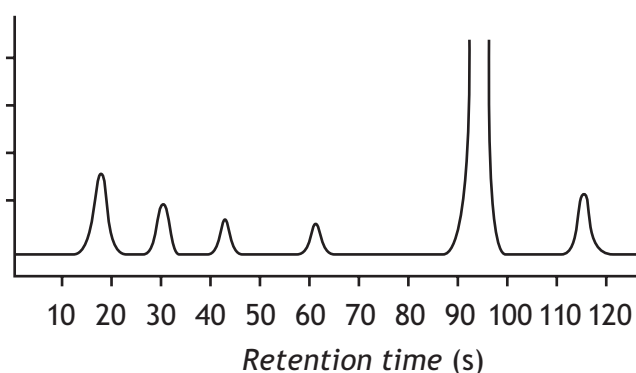
Chromatograms for two soft drinks are shown below.

Soft drink X



Retention time of peak (s)	Peak area
42	1000
69	1350
96	68000

Soft drink Y



Retention time of peak (s)	Peak area
17	7000
30	4600
43	3000
62	2500
96	-----
115	5000

(i) State the caffeine content, in  $\text{mg l}^{-1}$  of soft drink X.

1

(ii) The caffeine content of soft drink Y cannot be determined from its chromatogram.

Suggest what should be done to the sample of soft drink Y so that the caffeine content could be reliably calculated.

1



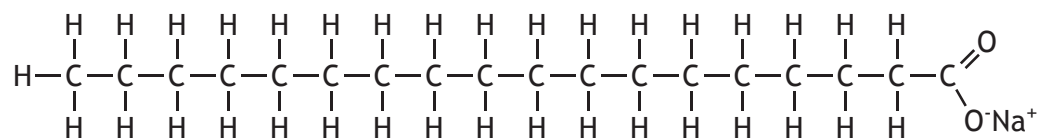
8. A fatty acid is a long chain carboxylic acid.

Examples of fatty acids are shown in the table below.

Common name	Systematic name	Structure
stearic acid	octadecanoic acid	$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$
oleic acid	octadec-9-enoic acid	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$
linoleic acid	octadec-9,12-dienoic acid	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$
linolenic acid		$\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$

(a) State the systematic name for linolenic acid.

1



sodium stearate

(b) Stearic acid reacts with sodium hydroxide solution to form sodium stearate.

**Explain fully** how sodium stearate acts to keep grease and non-polar substances suspended in water during cleaning.

3

8. (continued)

- (c) Some hair conditioners contain the fatty acid, behenic acid,  $\text{CH}_3(\text{CH}_2)_{19}\text{CH}_2\text{COOH}$ .

Behenic acid is produced by hydrolysing the edible oil, ben oil.

- (i) Name the compound, other than fatty acids, which is produced by hydrolysing the edible oil, ben oil.

1

- (ii) 5.0 g of behenic acid can be obtained from 50.0 cm<sup>3</sup> of ben oil.

1 litre of ben oil costs £90.

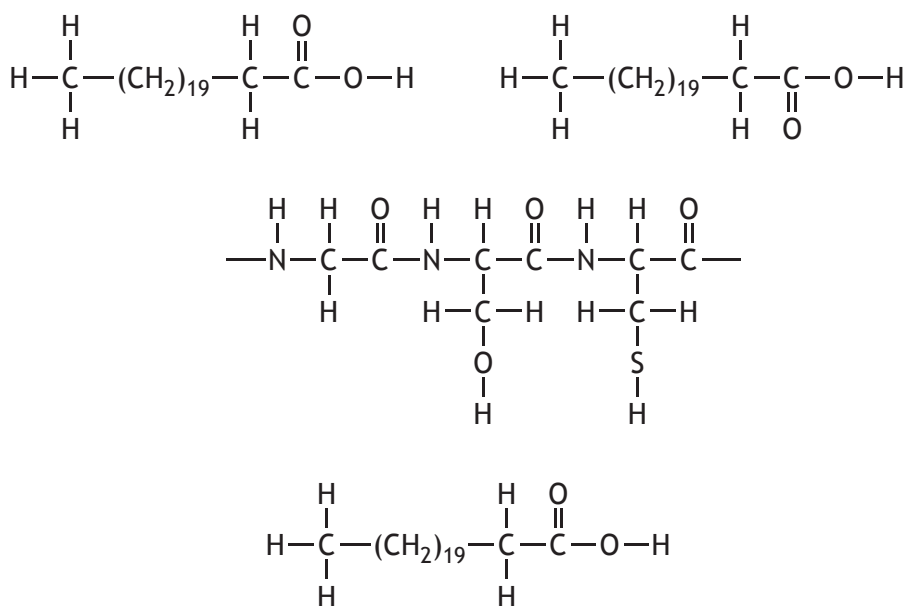
Calculate how much it would cost to buy sufficient ben oil to produce 20.0 g of behenic acid.

1

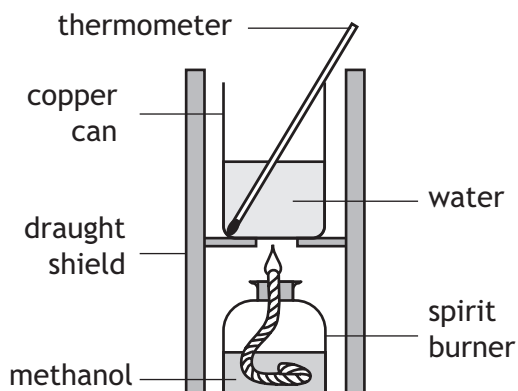
- (d) When conditioner containing behenic acid is applied to hair, the behenic acid molecules make strong intermolecular hydrogen bonds to the keratin protein molecules.

On the diagram below use a dotted line to show **one** hydrogen bond that could be made between a behenic acid molecule and the keratin.

1



9. A student used the simple laboratory apparatus shown to determine the enthalpy of combustion of methanol.



MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

- (a) (i) State the measurements that need to be taken in order to calculate the energy released by the burning methanol.

1

- (ii) The student found that burning 0.370 g of methanol produces 3.86 kJ of energy.

Use this result to calculate the enthalpy of combustion of methanol.

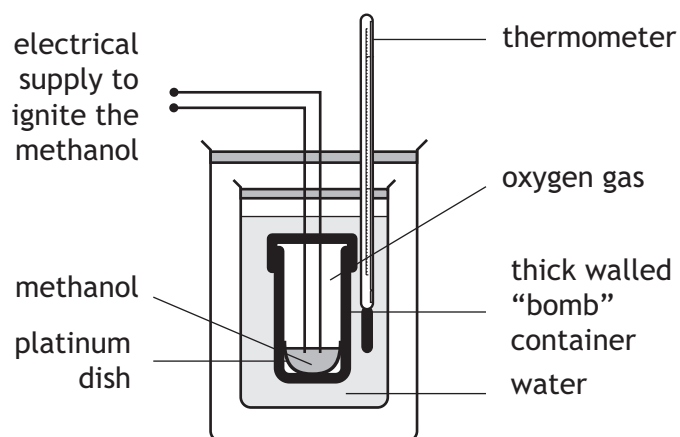
1



\* E P 0 7 H 0 1 2 2 \*

## 9. (continued)

(b) A more accurate value can be obtained using a bomb calorimeter.



One reason for the more accurate value is that less heat is lost to the surroundings than in the simple laboratory method.

State **one** other reason for the value being more accurate in the bomb calorimeter method.

1



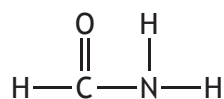


10. Methanamide,  $\text{HCONH}_2$ , is widely used in industry to make nitrogen compounds.

It is also used as a solvent as it can dissolve ionic compounds.

MARKS

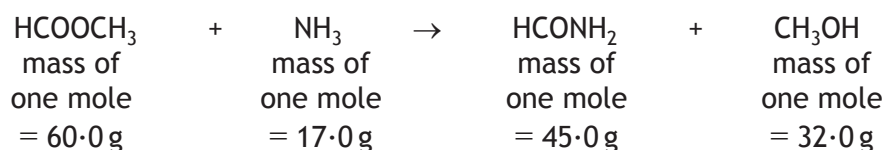
DO NOT  
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MARGIN



- (a) Suggest why methanamide is a suitable solvent for ionic compounds.

1

- (b) In industry, methanamide is produced by the reaction of an ester with ammonia.



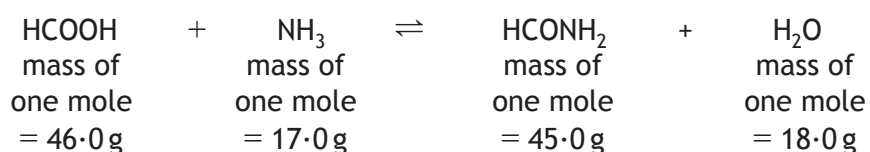
- (i) Name the ester used in the industrial manufacture of methanamide.

1

- (ii) Calculate the atom economy for the production of methanamide.

1

- (c) In the lab, methanamide can be prepared by the reaction of methanoic acid with ammonia.



When 1.38 g of methanoic acid was reacted with excess ammonia, 0.945 g of methanamide was produced.

Calculate the percentage yield of methanamide.

2

Show your working clearly.



\* E P O 7 H O 1 2 4 \*

11. Hydrogen cyanide is highly toxic. Molecules of hydrogen cyanide and molecules of nitrogen gas both have 14 electrons.

(a)

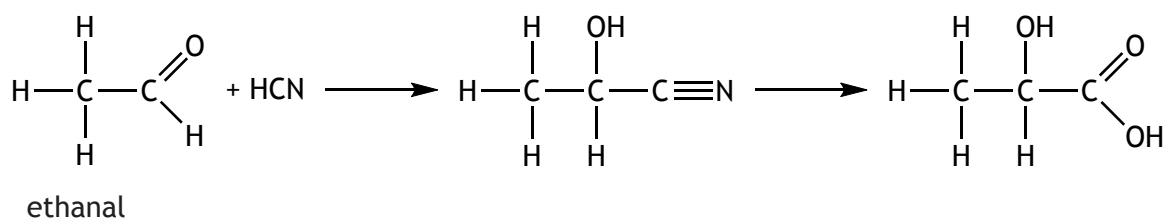
	Structure	Boiling point (°C)
Hydrogen cyanide	$\text{H}-\text{C}\equiv\text{N}$	27
Nitrogen	$\text{N}\equiv\text{N}$	-196

Explain why the boiling point of hydrogen cyanide is much higher than the boiling point of nitrogen.

In your answer you should mention the intermolecular forces involved and how they arise.

3

- (b) Hydrogen cyanide is of great importance in organic chemistry. It offers a route to increasing the chain length of a molecule.



Draw the structural formula for the acid produced when propanone is used instead of ethanal in the above reaction sequence.

1



\* E P 0 7 H 0 1 2 5 \*

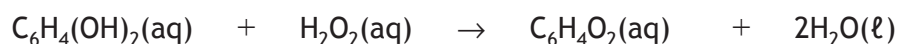
12. When in danger, bombardier beetles can fire a hot, toxic mixture of chemicals at their attacker.

This mixture contains quinone,  $\text{C}_6\text{H}_4\text{O}_2$ , a compound that is formed by the reaction of hydroquinone,  $\text{C}_6\text{H}_4(\text{OH})_2$ , with hydrogen peroxide,  $\text{H}_2\text{O}_2$ . The reaction is catalysed by a substance, catalase, produced in the beetle's body.

- (a) State the term used to describe the substance catalase.

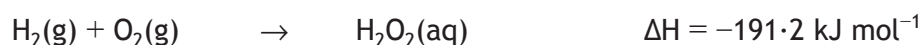
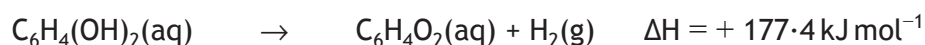
1

- (b) The equation for the overall reaction is:

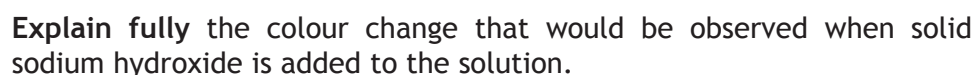


Use the following data to calculate the enthalpy change, in  $\text{kJ mol}^{-1}$ , for the above reaction.

3



- (a) When chromate ions dissolve in water the following equilibrium is established.



- Calculate the mass of iron(II) sulfate heptahydrate crystals that would be required to prepare 250 cm<sup>3</sup> of a 0.0200 mol l<sup>-1</sup> solution.

- (ii) **Describe fully** how 250 cm<sup>3</sup> of a 0.0200 mol l<sup>-1</sup> standard solution can be prepared from the weighed crystals.



13. (b) (continued)

- (iii) A  $50.0\text{ cm}^3$  sample of contaminated water containing chromate ions was titrated with  $0.0200\text{ mol l}^{-1}$  iron(II) sulfate solution.

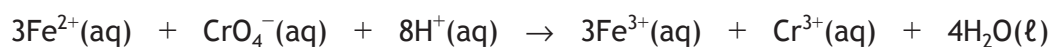
	<i>Volume of <math>0.0200\text{ mol l}^{-1}</math> iron(II) sulfate solution (<math>\text{cm}^3</math>)</i>
Titre 1	27.8
Titre 2	27.3
Titre 3	27.5

Average titre =  $27.4\text{ cm}^3$

- (A) Explain why all three results are not used when calculating the average titre.

1

- (B) The redox equation for the reaction is:

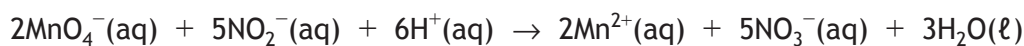


Calculate the chromate ion concentration, in  $\text{mol l}^{-1}$ , present in the sample of water.

2

- (c) The concentration of nitrite ions can be found by titrating  $50\text{ cm}^3$  water samples with acidified potassium permanganate solution.

The equation for the reaction taking place is:



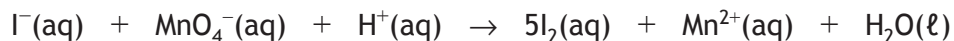
Describe the colour change that will indicate that the endpoint of the titration has been reached.

1



14. Compounds of fluorine, chlorine and iodine are all used in a range of products.

(a) Iodine can be extracted from iodide salts by reacting them with acidified permanganate solution.



Balance the above equation.

1

(b) Fluorine is an extremely reactive element.

Fluorine reacts with methane via a free radical chain reaction.

Some steps in the chain reaction are shown in the table below.

Reaction step	Name of step
$\text{F}_2 \rightarrow 2\text{F}\cdot$	initiation
$\text{F}\cdot + \text{CH}_4 \rightarrow \text{HF} + \cdot\text{CH}_3$ $\cdot\text{CH}_3 + \text{F}_2 \rightarrow \text{CH}_3\text{F} + \text{F}\cdot$	
$\cdot\text{CH}_3 + \text{F}\cdot \rightarrow \text{CH}_3\text{F}$	termination
	termination

Complete the table by:

(i) inserting the missing name for the second step;

1

(ii) inserting another possible termination reaction in the final row of the table.

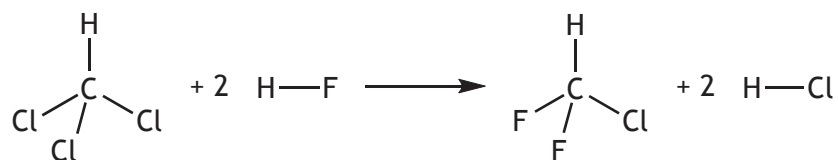
1



## 14. (continued)

(c) Tetrafluoroethene,  $C_2F_4$ , is produced in industry by a series of reactions.

- (i) The first reaction involves reacting chloromethane with hydrogen fluoride.



Use bond enthalpies from the Data Booklet to calculate the enthalpy change, in kJ, for the reaction.

2

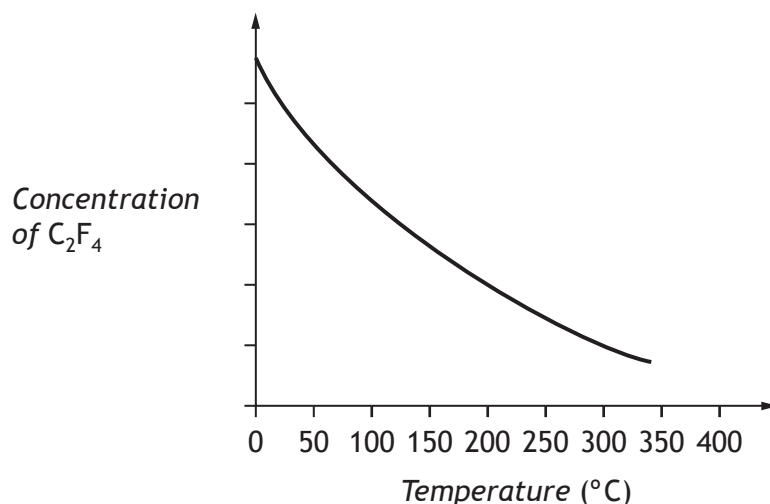


14. (c) (continued)

(ii) The final reaction in its manufacture is shown below.



The graph shows the variation in concentration of  $\text{C}_2\text{F}_4$  formed as temperature is increased.



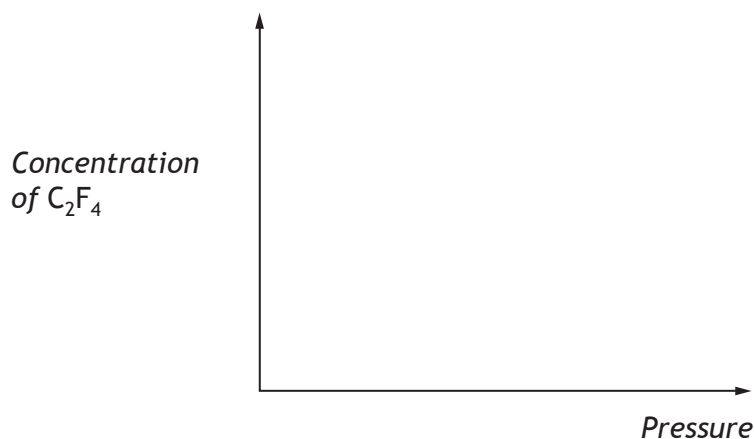
(A) State a conclusion that can be drawn about the enthalpy change for the formation of tetrafluoroethene.

1

(B) Sketch a graph to show how the concentration of tetrafluoroethene formed would vary with increasing pressure.

1

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

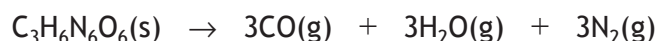




15. A chemical explosion is the result of a very rapid reaction that generates a large quantity of heat energy and, usually, a large quantity of gas.

- (a) The explosive RDX,  $\text{C}_3\text{H}_6\text{N}_6\text{O}_6$ , is used in the controlled demolition of disused buildings.

During the reaction it decomposes as shown.



Calculate the volume of gas released when 1.0 g of RDX decomposes.

Take the molar volume of the gases to be 24 litres  $\text{mol}^{-1}$ .

4

- (b) The products formed when an explosive substance decomposes can be predicted by applying the Kistiakowsky-Wilson rules. These rules use the number of oxygen atoms in the molecular formula to predict the products.

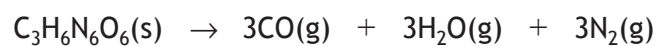
In the example below these rules are applied to the decomposition of the explosive RDX,  $\text{C}_3\text{H}_6\text{N}_6\text{O}_6$ .

Rule number	Rule	Atoms available in $\text{C}_3\text{H}_6\text{N}_6\text{O}_6$	Apply rule to show products
1	Using oxygen atoms from the formula convert any carbon atoms in the formula to carbon monoxide.	$3 \times \text{C}$	3CO formed
2	If any oxygen atoms remain then convert H atoms in the formula to water.	$3 \times \text{O}$ remain	$3\text{H}_2\text{O}$ formed
3	If any oxygen atoms still remain then convert CO formed to $\text{CO}_2$ .	No more oxygen left	No $\text{CO}_2$ formed
4	Convert any nitrogen atoms in the formula to $\text{N}_2$ .	$6 \times \text{N}$	$3\text{N}_2$ formed



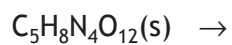
15. (b) (continued)

Decomposition equation:



By applying the same set of rules, complete the equation for the decomposition of the explosive PETN,  $\text{C}_5\text{H}_8\text{N}_4\text{O}_{12}$ .

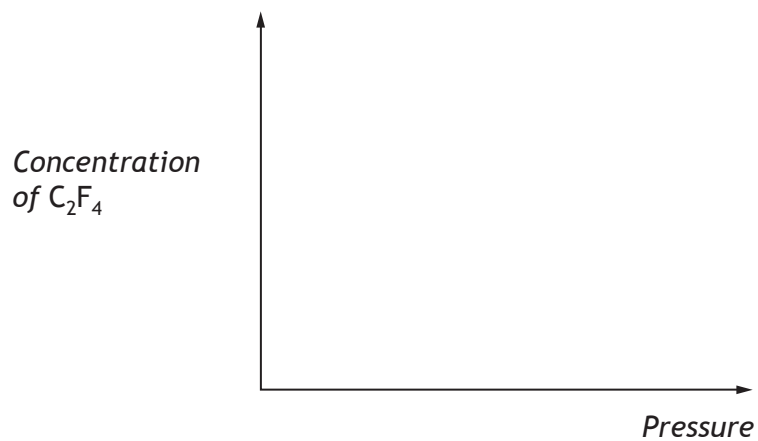
1



[END OF EXEMPLAR QUESTION PAPER]



ADDITIONAL GRAPH FOR USE IN QUESTION 14(c)(ii)



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



\* E P 0 7 H 0 1 3 5 \*

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



\* E P 0 7 H 0 1 3 6 \*



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EXEMPLAR PAPER ONLY

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**EP07/H/02**

**Chemistry  
Section 1 — Answer Grid  
and Section 2**

## Marking Instructions

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These Marking Instructions have been provided to show how SQA would mark this Exemplar Question Paper.

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## General Marking Principles for Higher Chemistry

*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 Detailed Marking Instructions, which identify the key features required in candidate responses.*

- (a) Marks for each candidate response must always be assigned in line with these General Marking Principles and the Detailed Marking Instructions for this assessment.
- (b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.
- (c) Half marks may not be awarded.
- (d) Where a candidate makes an error at an early stage in a multi-stage calculation, credit should normally be given for correct follow-on working in subsequent stages, unless the error significantly reduces the complexity of the remaining stages. The same principle should be applied in questions which require several stages of non-mathematical reasoning. 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.
- (e) Unless a numerical question specifically requires evidence of working to be shown, full marks should be awarded for a correct final answer (including units if required) on its own.
- (f) Larger mark allocations may be fully accessed whether responses are provided in continuous prose, linked statements or a series of developed bullet points.
- (g) Marks should not be deducted for inaccurate or unconventional spelling or vocabulary as long as the meaning of the word(s) is conveyed. **For example**, responses that include “distilling” for “distillation”, or “it gets hotter” for “the temperature rises”, should be accepted.
- (h) If a correct answer is followed by a wrong answer it should be treated as a cancelling error and no marks should be given. **For example**, in response to the question, “State the colour seen when blue Fehling’s solution is warmed with an aldehyde”, the answer “red, green” gains no marks.

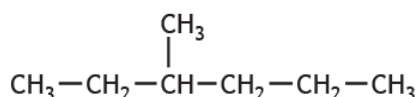
However, if a correct answer is followed by additional information which does not conflict with that, the additional information should be ignored, whether correct or not. **For example**, in response to a question concerned with melting point, “State why the tube should not be made of copper”, the response “Copper has a low melting point and is coloured grey” would **not** be treated as having a cancelling error.

- (i) Full marks are usually awarded for the correct answer to a calculation without working and the partial marks shown in the Detailed Marking Instructions are for use when working is given but the final answer is incorrect. An exception is when candidates are asked to “Find, by calculation”, when full marks cannot be awarded for the correct answer without working.
- (j) Ignore the omission of one H atom from a full structural formula provided the bond is shown.
- (k) A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the Detailed Marking Instructions**.
- (l) 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.

- (m) If an answer comes directly from the text of the question, no marks should be given.

**For example**, in response to the question, “A student found that 0.05 mol of propane,  $\text{C}_3\text{H}_8$  burned to give 82.4 kJ of energy.  $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{l})$ . Name the kind of enthalpy change that the student measured”, no marks should be given for “burning” since the word “burned” appears in the text.

- (n) A guiding principle in marking is to give credit for correct elements of a response 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. The results are shown.

<i>Structural formula</i>	<i>pH</i>
$\text{CH}_3\text{COOH}$	1.65
$\text{CH}_2\text{ClCOOH}$	1.27
$\text{CHCl}_2\text{COOH}$	0.90
$\text{CCl}_3\text{COOH}$	0.51

Describe the relationship between the number of chlorine atoms in the molecule and the strength of the acids.

- Although not completely correct, an answer such as “the more  $\text{Cl}_2$ , the stronger the acid” should gain the full mark.
- (o) Unless the question is clearly about a non-chemistry issue, eg costs in an industrial chemical process, a non-chemical answer gains no marks.
- For example**, in response to the question, “Why does the (catalytic) converter have a honeycomb structure?”, “to make it work” may be correct but it is not a chemical answer and the mark should not be given.
- (p) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:
- compare**, they must demonstrate knowledge and understanding of the similarities and/or differences between things;
  - complete**, they must finish a chemical equation or fill in a table with information;
  - describe**, they must provide a statement or structure of characteristics and/or features;
  - determine** or **calculate**, they must determine a number from given facts, figures or information;
  - draw**, they must draw a diagram or structural formula, eg “Draw a diagram to show the part of a poly(propene) molecule formed from two propene molecules”;



- **estimate**, they must determine an approximate value for something;
- **evaluate**, they must make a judgement based on criteria;
- **explain**, they must relate cause and effect and/or make relationships between things clear;
- **identify, name, give, or state**, they need only name or present in brief form;
- **predict**, they must suggest what may happen based on available information;
- **suggest**, they must apply their knowledge and understanding of Chemistry to a new situation. A number of responses are acceptable: marks will be awarded for any suggestions that are supported by knowledge and understanding of Chemistry;
- **use your knowledge of Chemistry or aspect of Chemistry to comment on**, they must apply their skills, knowledge and understanding to respond appropriately to the problem/situation presented (for example by making a statement of principle(s) involved and/or a relationship or equation, and applying these to respond to the problem/situation). They will be rewarded for the breadth and/or depth of their conceptual understanding;
- **write**, they must complete a chemical or word equation, eg “Write the word equation for the complete combustion of ethanol”.

## Detailed Marking Instructions for each question

### Section 1

Question	Response	Mark
1	B	1
2	C	1
3	C	1
4	C	1
5	A	1
6	D	1
7	B	1
8	B	1
9	D	1
10	B	1
11	D	1
12	C	1
13	D	1
14	C	1
15	A	1
16	D	1
17	A	1
18	D	1
19	A	1
20	D	1

## Section 2

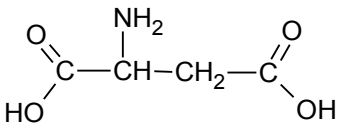
Question			Expected response	Max mark	Additional guidance
1	a		Electronegativity values increase across the period.	1	
	b		silicon	1	
	c		<ul style="list-style-type: none"> <li>fourth electron being removed is from an inner electron shell</li> </ul> <b>OR</b> <ul style="list-style-type: none"> <li>shell closer to the nucleus (and therefore requires more energy to remove)</li> </ul>	1	
	d		<ul style="list-style-type: none"> <li>0.2862 g (0.29 g) (2 marks)</li> </ul> <p>Use of correct stoichiometry (1 mole hypochlorite reacting with dilute hydrochloric acid gives 2 mole chlorine) (1 mark).</p> <ul style="list-style-type: none"> <li>Correct arithmetic (1 mark).</li> </ul>	2	Follow-through applies.
	e		<p><b>The whole candidate response should first be read to establish its overall quality in terms of accuracy and relevance to the problem/situation presented.</b></p> <p>There may be strengths and weaknesses in the candidate response: <i>assessors should focus as far as possible on the strengths, taking account of weaknesses (errors or omissions) only where they detract from the overall answer in a significant way, which should then be taken into account when determining whether the response demonstrates reasonable, limited or no understanding.</i></p> <p><b>Assessors should use their professional judgement to apply the guidance below to the wide range of possible candidate responses.</b></p>	3	<p>This open-ended question requires comment on <b>the discovery and naming of argon.</b></p> <p>Candidate responses are expected to comment on the basis of relevant chemistry ideas/concepts which might include one or more of: the electronic structure of argon, the physical and chemical properties of argon or other relevant ideas/concepts.</p>

Question			Expected response	Max mark	Additional guidance
			<p><b>3 marks:</b> The candidate has demonstrated a <b>good</b> conceptual understanding of the chemistry involved, providing a logically correct response to the problem/situation presented.</p> <p>This type of response might include a statement of principle(s) involved, a relationship or equation, and the application of these to respond to the problem/situation.</p> <p>This does not mean the answer has to be what might be termed an “excellent” answer or a “complete” one.</p>		<p>In response to this question, a <b>good</b> understanding might be demonstrated by a candidate response that:</p> <ul style="list-style-type: none"> <li>• makes comments based on one relevant chemistry idea/concept, in a <b>detailed/developed</b> response that is <b>correct or largely correct</b> (any weaknesses are minor and do not detract from the overall response)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• makes comments based on a range of relevant chemistry ideas/concepts, in a response that is <b>correct or largely correct</b> (any weaknesses are minor and do not detract from the overall response)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• otherwise demonstrates a good understanding of the chemistry involved.</li> </ul>
			<p><b>2 marks:</b> The candidate has demonstrated a <b>reasonable</b> understanding of the chemistry involved, showing that the problem/situation is understood.</p> <p>This type of response might make some statement(s) that is/are relevant to the problem/situation, for example, a statement of relevant principle(s) or identification of a relevant relationship or equation.</p>		<p>In response to this question, a <b>reasonable</b> understanding might be demonstrated by a candidate response that:</p> <ul style="list-style-type: none"> <li>• makes comments based on one or more relevant chemistry idea(s)/concept(s), in a response that is <b>largely correct</b> but has <b>weaknesses</b> which detract to a small extent from the overall response</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• otherwise demonstrates a reasonable understanding of the chemistry involved.</li> </ul>
			<p><b>1 mark:</b> The candidate has demonstrated a <b>limited</b> understanding of the chemistry involved, showing that a little of the chemistry that is relevant to the problem/situation is understood.</p> <p>The candidate has made some statement(s) that is/are relevant to the problem/situation.</p>		<p>In response to this question, a <b>limited</b> understanding might be demonstrated by a candidate response that:</p> <ul style="list-style-type: none"> <li>• makes comments based on one or more relevant chemistry idea(s)/concept(s), in a response that has <b>weaknesses</b> which detract to a large extent from the overall response</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• otherwise demonstrates a limited understanding of the</li> </ul>

Question			Expected response	Max mark	Additional guidance
					chemistry involved.
			<p><b>0 marks:</b> The candidate has demonstrated no understanding of the chemistry that is relevant to the problem/situation.</p> <p>The candidate has made no statement(s) that is/are relevant to the problem/situation.</p>		Where the candidate has <i>only</i> demonstrated knowledge and understanding of chemistry <b>that is not relevant to the problem/situation presented</b> , 0 marks should be awarded.
2	a		25 seconds	1	
	b	i	<ul style="list-style-type: none"> <li>Energy of collision must be greater than the activation energy.</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>Collision must take place with correct orientation.</li> </ul>	1	
	b	ii	Fewer collisions are taking place as concentration decreases.	1	Must mention collisions.
3	a	i	<ul style="list-style-type: none"> <li>amino group</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>amine group</li> </ul>	1	
	a	ii		1	
	b		<ul style="list-style-type: none"> <li>25 (minutes)</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>8.0 to 8.4 (minutes) (units not required. Ignore incorrect units)</li> </ul>	1	
	c		<p>Volume = 31.5 cm<sup>3</sup> or 31.5 ml or 0.0315 l or equivalent.</p> <p>So volume = 31.5 or 0.0315 <b>(2 marks)</b></p> <p>1 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.</p> <p>Mass × 1/10 = a volume.</p>	2	

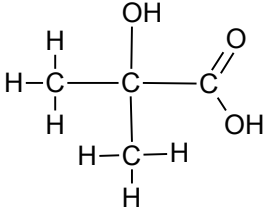
Question			Expected response	Max mark	Additional guidance
4	a		<ul style="list-style-type: none"> <li>Diagrams showing positions of OH groups in primary, secondary and tertiary alcohols.</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>Primary: hydroxyl group is attached to a carbon with 2 hydrogens attached or which is attached to one other carbon.</li> </ul> <p>Secondary: hydroxyl group is attached to a carbon with 1 hydrogen attached or which is attached to two other carbons.</p> <p>Tertiary: hydroxyl group is attached to a carbon with no hydrogens attached or which is attached to a carbon with three other carbons attached.</p>	1	
	b		addition	1	
	c		pentan-2-ol	1	
	d		pentan-3-one	1	
5	a		It consists of two isoprene units joined together.	1	
	b		<ul style="list-style-type: none"> <li>It has lots of hydroxyl groups.</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>It is able to form hydrogen bonds to water.</li> </ul>	1	
	c		<p>The whole candidate response should first be read to establish its overall quality in terms of accuracy and relevance to the problem/situation presented.</p> <p>There may be strengths and weaknesses in the candidate response: <i>assessors should focus as far as possible on the strengths, taking account of weaknesses (errors or omissions) only where they detract from the overall answer in a significant way, which should then be taken into account when determining whether the response demonstrates <b>reasonable</b>, <b>limited</b> or <b>no</b> understanding.</i></p>	3	<p>This open-ended question requires comment on how the maturation and ageing processes affect the character of wine.</p> <p>Candidate responses are expected to comment on the basis of relevant chemistry ideas/concepts which might include one or more of: chemical reactions of the alcohols, reactions of aldehydes, flavouring molecules, reactions of yeast, effect of temperature on reactions; or other relevant ideas/concepts.</p>

Question			Expected response	Max mark	Additional guidance
			Assessors should use their professional judgement to apply the guidance below to the wide range of possible candidate responses.		
			<p><b>3 marks:</b> The candidate has demonstrated a good conceptual understanding of the chemistry involved, providing a logically correct response to the problem/situation presented.</p> <p>This type of response might include a statement of principle(s) involved, a relationship or equation, and the application of these to respond to the problem/situation.</p> <p>This does not mean the answer has to be what might be termed an “excellent” answer or a “complete” one.</p>		<p>In response to this question, a good understanding might be demonstrated by a candidate response that:</p> <ul style="list-style-type: none"> <li>• makes comments based on one relevant chemistry idea/concept, in a detailed/developed response that is correct or largely correct (any weaknesses are minor and do not detract from the overall response)</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>• makes comments based on a range of relevant chemistry ideas/concepts, in a response that is correct or largely correct (any weaknesses are minor and do not detract from the overall response)</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>• otherwise demonstrates a good understanding of the chemistry involved.</li> </ul>
			<p>The candidate has demonstrated a reasonable understanding of the chemistry involved, showing that the problem/situation is understood (<b>2 marks</b>).</p> <p>This type of response might make some statement(s) that is/are relevant to the problem/situation, for example, a statement of relevant principle(s) or identification of a relevant relationship or equation.</p>		<p>In response to this question, a reasonable understanding might be demonstrated by a candidate response that:</p> <ul style="list-style-type: none"> <li>• makes comments based on one or more relevant chemistry idea(s)/concept(s), in a response that is largely correct but has weaknesses which detract to a small extent from the overall response</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>• otherwise demonstrates a reasonable understanding of the chemistry involved.</li> </ul>
			<p>The candidate has demonstrated a limited understanding of the chemistry involved, showing that a little of the chemistry that is relevant to the problem/situation is understood (<b>1 mark</b>).</p>		<p>In response to this question, a limited understanding might be demonstrated by a candidate response that:</p> <ul style="list-style-type: none"> <li>• makes comments based on one or more relevant chemistry idea(s)/concept(s), in a</li> </ul>

Question			Expected response	Max mark	Additional guidance
			The candidate has made some statement(s) that is/are relevant to the problem/situation.		response that has weaknesses which detract to a large extent from the overall response  OR <ul style="list-style-type: none"> <li>otherwise demonstrates a limited understanding of the chemistry involved.</li> </ul>
			<p><b>0 marks:</b> The candidate has demonstrated no understanding of the chemistry that is relevant to the problem/situation.</p> <p>The candidate has made no statement(s) that is/are relevant to the problem/situation.</p>		Where the candidate has only demonstrated knowledge and understanding of chemistry that is not relevant to the problem/situation presented, 0 marks should be awarded.
<b>6</b>	a	i	free radicals	<b>1</b>	
	a	ii	<ul style="list-style-type: none"> <li>decrease in the hydrogen to oxygen ratio</li> </ul> OR <ul style="list-style-type: none"> <li>increase in the oxygen to hydrogen ratio</li> </ul>	<b>1</b>	
	b		<p>£1.07 (<b>2 marks</b>)</p> <p>Mass required = <math>100 \times 20/26.2</math> = 76.3 g (<b>1 mark</b>)</p> <p>Cost = £13.99 <math>\times</math> 76.3/1000 (<b>1 mark</b>)</p>	<b>2</b>	Follow-through applies.
<b>7</b>	a	i	Ester group or link.	<b>1</b>	
	a	ii		<b>1</b>	
	a	iii	Essential amino acids.	<b>1</b>	
	b	i	69 - 70 (mg l <sup>-1</sup> - no units required. Ignore incorrect units)	<b>1</b>	
	b	ii	<ul style="list-style-type: none"> <li>sample of Y should be diluted</li> </ul> OR <ul style="list-style-type: none"> <li>less of sample Y should be used</li> </ul> OR <ul style="list-style-type: none"> <li>smaller sample of Y</li> </ul>	<b>1</b>	
<b>8</b>	a		Octadec -9,12,15 -trienoic acid	<b>1</b>	
	b		Structure of soap/soap ions in terms of hydrophobic tail and hydrophilic head ( <b>1 mark</b> ).	<b>3</b>	



Question			Expected response	Max mark	Additional guidance
			Agitation causes negatively charged oil/grease droplets to form (1 mark).  Electrical repulsion prevents droplets from recombining (1 mark).		
	c	i	<ul style="list-style-type: none"> <li>glycerol</li> </ul> OR <ul style="list-style-type: none"> <li>propan-1,2,3,-triol</li> </ul>	1	
	c	ii	(£)18	1	
	d		From a hydrogen connected to an oxygen or nitrogen to another oxygen (includes the carbonyl oxygen) or nitrogen.  Hydrogen bond correctly drawn.	1	
9	a	i	Mass (volume) of water.  Initial and highest (final) temperatures of water.	1	
	a	ii	-334 kJ mol <sup>-1</sup>	1	Accept -330, -333·8, -333·84 (significant figures).
	b		<ul style="list-style-type: none"> <li>complete combustion (or incomplete combustion in lab method)</li> </ul> OR <ul style="list-style-type: none"> <li>richer supply of oxygen (or burns in air in lab method)</li> </ul> OR <ul style="list-style-type: none"> <li>no evaporation of methanol</li> </ul>	1	
10	a		Methanamide consists of polar molecules.	1	
	b	i	methyl methanoate	1	
	b	ii	58·4%	1	
	c		<b>70% (2 marks)</b>  Either: HCOOH      →      HCONH <sub>2</sub> 1 mole              1 mole 46g                    45g 1·38g                1·35g (1 mark) % yield = 100 x 0·945/1·35 = 70% (1 mark)	2	

Question			Expected response	Max mark	Additional guidance
			<p><b>OR</b></p> <p>moles HCOOH <math>\rightarrow 1.38/46 = 0.03</math>  moles HCONH<sub>2</sub> <math>\rightarrow 0.945/45 = 0.021</math>  <b>(1 mark)</b></p> <p>HCOOH <math>\rightarrow</math> HCONH<sub>2</sub>  0.03 moles <math>\rightarrow</math> 0.03 moles  % yield = <math>100 \times 0.021/0.03</math>  = 70% <b>(1 mark)</b></p>		
11	a		<ul style="list-style-type: none"> <li>naming of intermolecular forces <b>(1 mark)</b></li> <li>description of how they arise <b>(1 mark)</b></li> <li>comparison of strength and effect on boiling point <b>(1 mark)</b></li> </ul> <p>Hydrogen cyanide molecules are polar with permanent dipole – permanent dipole attractions between molecules.</p> <p>Nitrogen molecules are non-polar. The intermolecular forces between nitrogen molecules are London dispersion forces.</p> <p>Hydrogen cyanide molecules are polar due to electronegativity difference between nitrogen and hydrogen.</p> <p>London dispersion forces are temporary dipole-temporary dipole attractions due to due to temporary.</p> <p>More energy is required to break permanent dipole – permanent dipole attractions.</p>	3	
		b		1	
12	a		enzyme	1	

Question			Expected response	Max mark	Additional guidance
	b		<p><math>-202.6 \text{ kJ mol}^{-1}</math> (ignore units) (3 marks)</p> <p><math>=177.4 + 191.2 + 2(-241.8)</math>  <math>+ 2(-43.8)</math></p> <ul style="list-style-type: none"> <li>reversing peroxide equation (1 mark).</li> <li>doubling water formation and condensation equations (1 mark).</li> <li>correct additions (1 mark).</li> </ul>	3	Follow-through applies.
13	a		<p>As sodium hydroxide dissolved the hydroxide ions would react with hydrogen ions and the equilibrium would shift to the right (1 mark).</p> <p>Concentration of <math>\text{Cr}_2\text{O}_7^{2-}</math> (aq) would decrease or concentration of <math>\text{CrO}_4^{2-}</math> (aq) would increase causing colour to become more yellow/less orange (1 mark).</p>	2	
	b	i	<p>Moles required = <math>0.005 \text{ mol}</math> (1 mark)</p> <p>Mass required = <math>0.005 \times 277.9</math>  <math>= 1.3895 \text{ g}</math> (1 mark)</p>	2	
	b	ii	<p>Crystals dissolved in a small volume of deionised (distilled) water in a beaker and transferred to a <math>250 \text{ cm}^3</math> standard flask (1 mark).</p> <p>Beaker rinsed and rinsings added to flask (1 mark).</p> <p>Flask made up to the mark with deionised (distilled) water, (stoppered and inverted several times to ensure thorough mixing of the solution) (1 mark).</p>	3	
	b	iii	<p>A</p> <ul style="list-style-type: none"> <li>First titre was not concordant.</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>It was a rough titre.</li> </ul>	1	

Question			Expected response	Max mark	Additional guidance
	b	iii	B $3.66 \times 10^{-3} \text{ mol l}^{-1}$ (2 marks) <ul style="list-style-type: none"> <li><u>Moles method</u> <math display="block">\text{Moles Fe}^{2+} = 0.0274 \times 0.02</math> <math display="block">= 5.48 \times 10^{-4}</math> <math display="block">\text{Moles CrO}_4^- = 1.83 \times 10^{-4}</math> <math display="block">\text{Concentration} =</math> <math display="block">= 1.83 \times 10^{-4} \times 1000/50</math> <math display="block">= 3.66 \times 10^{-3} \text{ mol l}^{-1}</math> </li> <li>OR               <ul style="list-style-type: none"> <li><u>Formula method</u> <math display="block">\frac{27.4 \times 0.02}{3} = \frac{50 \times X}{1}</math> (1 mark) <math display="block">\text{Concentration} = 3.66 \times 10^{-3} \text{ mol l}^{-1}</math> (1 mark) </li> </ul> </li> </ul>	2	
	c		Colourless to pink/purple.	1	
14	a		$10\text{I}^-(\text{aq}) + 2\text{MnO}_4^{2-}(\text{aq}) + 16\text{H}^+(\text{aq})$ $\rightarrow 5\text{I}_2(\text{aq}) + 2\text{Mn}^{2+}(\text{aq}) + 8\text{H}_2\text{O}(\ell)$	1	
	b	i	propagation	1	
	b	ii	<ul style="list-style-type: none"> <li><math>\bullet\text{CH}_3 + \bullet\text{CH}_3 \rightarrow \text{CH}_3\text{CH}_3</math></li> </ul> OR <ul style="list-style-type: none"> <li><math>\text{F}\bullet + \text{F}\bullet \rightarrow \text{F}_2</math></li> </ul>	1	
	c	i	-16 kJ (2 marks) $2(338) + 2(570) + 2(-484) + 2(-432)$ 1 mark for showing correct bond breaking and bond making enthalpies.	2	

Question			Expected response		Max mark	Additional guidance
	c	ii	A	<ul style="list-style-type: none"><li>• reaction is exothermic</li></ul> OR <ul style="list-style-type: none"><li>• heat is given out</li></ul> OR <ul style="list-style-type: none"><li>• <math>\Delta H &lt; 0</math> or negative</li></ul>	1	
	c	ii	B	Graph shows as pressure increases/conc <sub>n</sub> C <sub>2</sub> F <sub>4</sub> decreases. Line sloping downward.	1	
15	a		0.973 litres OR 973 cm <sup>3</sup> <ul style="list-style-type: none"><li>• 1 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.</li><li>• GFM (1 mark)</li><li>• correct stoichiometry (1 mark)</li><li>• follow-through arithmetic (1 mark)</li></ul>		4	
	b		2CO +3CO <sub>2</sub> +4H <sub>2</sub> O +2N <sub>2</sub>  Ignore state symbols that are either wrong or missing.		1	

[END OF EXEMPLAR MARKING INSTRUCTIONS]