GCE

Specimen Papers with Mark Schemes

# Edexcel Advanced Subsidiary GCE in Chemistry (Nuffield) (8086)

First examination 2001

# Edexcel Advanced GCE in Chemistry (Nuffield) (9086)

First examination 2002

January 2000

Edexcel

Success through qualifications

# Contents

## Question Papers



## Mark Schemes

The GCE awarding bodies have prepared new specifications to incorporate the range of features required by the new GCE and subject criteria. The specimen assessment material accompanying the new specifications is provided to give centres a reasonable idea of the general shape and character of the new planned question papers in advance of the first operational examination.

| Centre Number | | | | | | Paper Reference | Surname |
|---|---|---|---|---|---|---|---|
| Candidate Number | | | | | | Candidate Signature | Other Names |

# 6251/01

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# Edexcel GCE

## Chemistry (Nuffield)

## Specimen Unit Test 1

## Advanced Subsidiary / Advanced

| Question number | Leave Blank |
|---|---|
| Section A | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| Total | |

Time: 1 hour 20 minutes

Materials required for the examination

Nil

Items included with these question papers

Nil

### Instructions to Candidates

In the boxes above, write your Centre Number, Candidate Number, the Paper Reference, your signature, your surname and other names.

The Paper Reference is shown towards the top left-hand corner of the page.

Answer ALL questions in the spaces provided in this question paper.

Show all the steps in any calculations. Calculators may be used.

Final answers to calculations should be given to an appropriate number of significant figures.

### Information for Candidates

A periodic table is printed on the back cover of this question paper.

The marks for individual questions and the parts of questions are shown in round brackets: e.g (2).

There are 9 questions in this question paper. The total marks for this paper is 60.

| Question Number | Max Mark |
|---|---|
| Section A | 9 |
| 5 | 8 |
| 6 | 7 |
| 7 | 9 |
| 8 | 14 |
| 9 | 13 |
| Total | 60 |

### Advice to Candidates

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

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**Turn over**

Do not write in this margin

## SECTION A

Answer **ALL** the questions in the spaces provided.

1. In terms of s, p, d electrons, complete the electronic configuration of the sulphur atom. Use the Periodic Table as a source of data.

$1s^2$ . . . . . .

**(1)**

2. Naturally-occurring gallium contains 60.2 % of $^{69}Ga$ and 39.8 % of $^{71}Ga$ by mass. Calculate the average molar mass of gallium. Your answer should be given to three significant figures and include appropriate units.

**(3)**

3. A homologous series of aldehydes starts with compounds with the molecular formulae

$CH_2O$ $C_2H_4O$

Give molecular, structural and displayed formulae for the aldehyde with three carbon atoms.

(a) Molecular. . . . . .

(b) Structural. . . . . .

(c) Displayed

**(3)**

4. (a) Explain what you understand by a **weak** acid.

. . . . . .

. . . . . .

. . . . . .

**(1)**

(b) Give an example of a weak acid.

. . . . . .

**(1)**

**SECTION A, TOTAL 9 Marks**

Do not write in this margin

[*Turn over*

**SECTION B**

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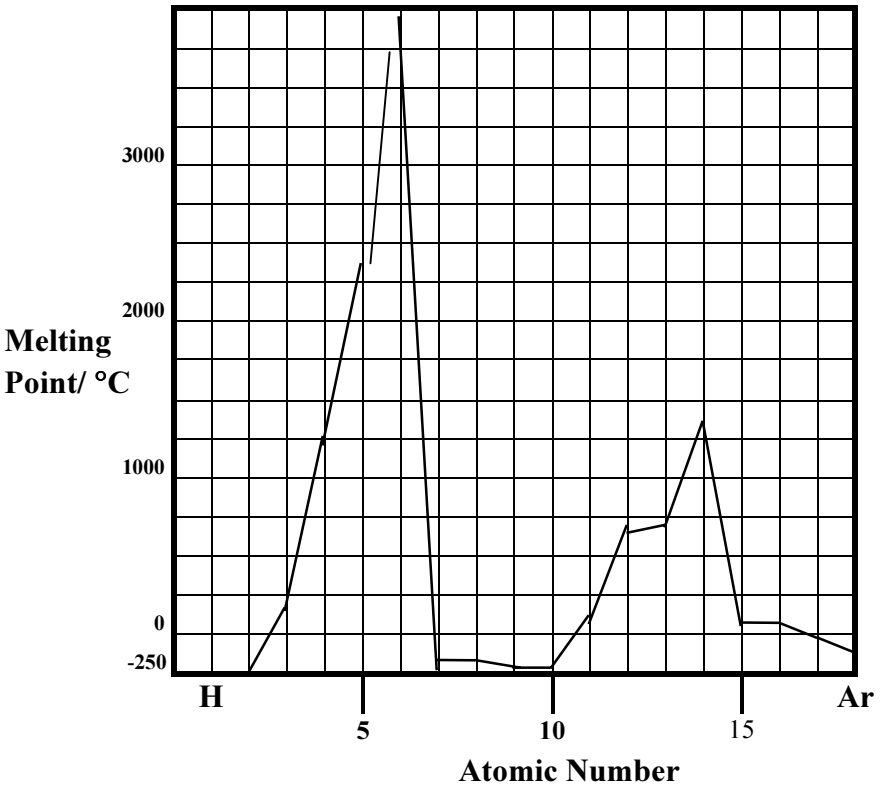
5. This question is about the principle of **periodicity** of physical properties. The graph shows the melting points of the elements from hydrogen to argon.




(a) In what way does the graph demonstrate **periodicity** in the elements mentioned?

. . . . . .

. . . . . .

. . . . . .

**(1)**

(b) Why do elements of some Groups have much lower melting points than the elements in other Groups?

. . . . . .

. . . . . .

. . . . . .

. . . . . .

**(2)**

(c) Given that the principle of periodicity applies to chemical formulae, what formula would be expected for

strontium oxide . . . . . germanium fluoride? . . . . . .
Use the Periodic Table as a source of data.

**(2)**

(d) Suggest in what way a graph showing the **boiling points** of the elements would be (i) similar to the one shown and (ii) different from the one shown.

(i) Similar . . . . . .

**(1)**

(ii) Different . . . . . .

**(1)**

(e) Name ONE **physical** property not already mentioned in this question which also shows periodicity.

. . . . . .

**(1)**

**TOTAL 8 Marks**

Do not write in this margin

[*Turn over*

6. This question concerns some reactions of a compound **M** which has the structure

Do not write in this margin

$$CH_3—CH_2—CH_2—CH_2—OH$$

(a) Name the substance **M**.

. . . . . .

**(1)**

(b) Is **M** a primary, secondary or tertiary alcohol? Justify your answer.

Type of alcohol . . . . . .

Reason . . . . . .

. . . . . .

**(2)**

(c) Give structural formulae for TWO organic compounds, which could be obtained by oxidizing **M** using a mixture of sodium dichromate(VI) and sulphuric acid and heat.

(i) (ii)

**(2)**

(d) Compound **M** can be dehydrated. Name a suitable dehydrating agent and give the structural formula for the organic product.

Name of dehydrating agent . . . . . .

Structural formula of product.

**(2)**

**TOTAL 7 Marks**

Do not write in this margin

7. The nitrates of the elements in Group 2 of the Periodic Table decompose when they are heated.

(a) When magnesium nitrate decomposes **two** gases are evolved and a white solid remains.

(i) Write the formula for magnesium nitrate . . . . . .

**(1)**

(ii) Name the two gases evolved. . . . . .

. . . . . .

**(2)**

(iii) Name the white solid residue . . . . . .

**(1)**

(b) Nitrates of most Group 1 metals decompose in a different way from those in Group 2.

When 1.45 g of sodium nitrate, $NaNO_3$, is strongly heated it gives 1.17 g of a pale yellow solid and 204 $cm^3$ of the colourless gas referred to in (a)(ii).

[One mole of gas occupies 24.0 $dm^3$ at the temperature and pressure used for the gas measurement. Use the Periodic Table as a source of data.]

(i) How many moles of sodium nitrate, $NaNO_3$, are being heated?

**(2)**

(ii) How many moles of gas are given off?

**(1)**

(iii) Use your answers to (b)(i) and (ii) to complete and balance the equation for the decomposition of sodium nitrate on heating and hence deduce the formula of the pale yellow solid.

$NaNO_3(s) \rightarrow$ . . . . . .(s) + . . . . . (g)

**(2)**

**TOTAL 9 Marks**

[*Turn over*

8. This question is about barium hydroxide.

Do not write in this margin

(a) (i) Describe how you would carry out a flame test on some solid barium hydroxide.

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

**(3)**

(ii) What flame colour would you expect?

. . . . . .

**(1)**

(iii) What changes give rise to flame colours?

. . . . . .

. . . . . .

. . . . . .

**(2)**

(b) 10.0 $cm^3$ portions of barium hydroxide solution, $Ba(OH)_2(aq)$ of unknown concentration, were titrated with hydrochloric acid of concentration 0.100 mol $dm^{-3}$. 16.2 $cm^3$ of hydrochloric acid was required for complete neutralization.

(i) Name a suitable indicator to use and give the colour change expected.

Indicator . . . . . .

Colour changes from . . . . . to . . . . . .

**(3)**

(ii) Write the balanced equation, with state symbols, for the reaction between barium hydroxide and hydrochloric acid to give barium chloride solution and water.

**(2)**

(iii) Calculate the concentration, in mol $dm^{-3}$, of the barium hydroxide solution.

Do not write in this margin

**(3)**

**TOTAL 14 Marks**

[*Turn over*

Do not write in this margin

9. This question is about zinc and some of its compounds.

Zinc is extracted from zinc sulphide by a process which begins with roasting of the sulphide ore in air.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + SO_2(g)$$

Values for $\Delta H_f^e$ at 298 K for the compounds in the equation are given below:

$$\triangle H_f^{\ominus} [ZnS(s)] = -200 \text{ kJ mol}^{-1}$$

$$\triangle H_f^{\ominus} [ZnO(s)] = -348 \text{ kJ mol}^{-1}$$

$$\triangle H_f^{\ominus} [SO_2(g)] = -297 \text{ kJ mol}^{-1}$$

(a) (i) Complete the Hess cycle showing the formation of the compounds on both sides of the equation from their elements.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

**(2)**

(ii) Calculate $\Delta H^e$ for this reaction giving the sign and appropriate units in your answer.

**(2)**

(iii) Is the reaction exothermic or endothermic?

. . . . . .

**(1)**

(b) (i) By considering the equation for the roasting of the sulphide ore in air, what environmental pollution problem could arise from the process?

. . . . . .

**(1)**

(ii) What **type** of substance could be used to react with and so remove this pollutant?

. . . . . .

**(1)**

(c) By considering your answers to part (a)(iii) and (b) suggest TWO things a manufacturer might do to make the production of zinc more profitable.

Explain how each of your suggestions would make the process more economic.

. . . . . .

. . . . . .

. . . . . .

. . . . . .

**(3)**

(d) (i) Suggest a reaction by which zinc could be obtained from zinc oxide. Justify your answer by reference to the reactivity series.

. . . . . .

. . . . . .

. . . . . .

**(2)**

(ii) What type of reaction is this?

. . . . . .

**(1)**

**TOTAL 13 Marks**

**END**

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**Periodic Table**
**(Appendix I)**

| Centre Number | | | | | | Paper Reference | Surname |
|---|---|---|---|---|---|---|---|
| Candidate Number | | | | | | Candidate Signature | Other Names |

# 6252/01

# Edexcel GCE

# Chemistry (Nuffield)

## Specimen Unit Test 2

## Advanced Subsidiary / Advanced

Time: 1 hour 30 minutes

Materials required for the examination

AB4

Items included with these question papers

Nil

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| Question number | Leave Blank |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| Total | |

**Instructions to Candidates**

In the boxes above, write your Centre Number, Candidate Number, the Paper Reference, your signature, your surname and other names. The Paper Reference is shown towards the top left-hand corner of the page.

In the boxes on the Answer Book provided, write the name of the examining Body (Edexcel), your Centre Number, Candidate Number, the Subject Title, the Paper Reference, your surname, other names and signature.

Answer ALL questions in Section A in the spaces provided in this question paper.

Answer ALL questions in Section B in the Answer Book.

Show all the steps in any calculations. Calculators may be used.

Final answers to calculations should be given to an appropriate number of significant figures.

**Information for Candidates**

A periodic table is printed on the back cover of this question paper.

The marks for individual questions and the parts of questions are shown in round brackets: e.g (2).

There are 5 questions in this question paper. The total marks for this paper is 60.

**Advice to Candidates**

You should aim to spend no more than 55 minutes on Section A and 35 minutes on Section B.

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

Up to 2 marks will be awarded for the quality of written communication used in question 5.

| Question Number | Max Marks |
|---|---|
| Section A | |
| 1 | 15 |
| 2 | 9 |
| 3 | 8 |
| 4 | 13 |
| Section B | |
| 5 | 15 |
| Total | 60 |



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## SECTION A

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Answer **ALL** the questions in the spaces provided.

You should aim to spend no more than 55 minutes on this section.

1. (a) Boron, nitrogen and oxygen form fluorides with molecular formulae $BF_3$, $NF_3$ and $OF_2$.

Draw the shapes you would expect for these molecules and suggest a value for the bond angle in each case.

$BF_3$

FBF bond angle =

$NF_3$

FNF bond angle =

$OF_2$

FOF bond angle =

**(6)**

(b) Why do the bond angles of FNF and FOF differ?

Do not write in this margin

. . . . . .

. . . . . .

. . . . . .

. . . . . .

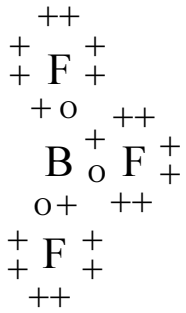
. . . . . .

. . . . . .

**(3)**

(c) $BF_3$ and $NF_3$ react together readily to give a solid with composition $BF_3NF_3$.

Complete a 'dot-and-cross' diagram for the electronic structure of $BF_3NF_3$ showing outer shell electrons only and name the type of bond involved.




Type of bond . . . . . .

**(2)**

[*Turn over*

(d) (i) The standard enthalpy change of atomization of nitrogen trifluoride $\Delta H^{e}_{at}$ [$NF_3$(g)] = + 834 kJ $mol^{-1}$.

Use this information to calculate the bond energy of the N-F bond.

**(1)**

(ii) Another fluoride of nitrogen has the formula $N_2F_2$.

Complete a 'dot-and-cross' diagram for the electronic structure of $N_2F_2$ showing outer shell electrons only.

**(2)**

(iii) The N-F bond energy in $N_2F_2$ is 282.0 kJ $mol^{-1}$. Suggest a reason for the difference between this value and the value you calculated for the N-F bond in $NF_3$ in (i).

. . . . . .

. . . . . .

**(1)**

**TOTAL 15 Marks**

Do not write in this margin

2. (a) Pure samples of the hydrogen halides, HCl, HBr and HI, are prepared by adding a suitable acid to the corresponding potassium halides.

Do not write in this margin

(i) Give the name or formula for the acid which can be used to prepare all three hydrogen halides.

. . . . . .

**(1)**

(ii) Draw a diagram of the apparatus you would use to prepare a pure dry sample of hydrogen bromide which is denser than air.

**(2)**

(b) A test-tube containing hydrogen chloride gas is inverted in water.

Describe and explain what you would observe.

Observation . . . . . .

. . . . . .

Explanation . . . . . .

. . . . . .

**(2)**

[*Turn over*

(c) A hot wire is plunged into test-tubes containing each of the hydrogen halides.

Do not write in this margin

(i) Name the hydrogen halide which decomposes.

. . . . . .

**(1)**

(ii) State the colour of the gas formed when decomposition takes place.

. . . . . .

**(1)**

(iii) Write a balanced equation for this decomposition.

**(2)**

**TOTAL 9 Marks**

3. Water companies use chlorine to purify water for domestic use. Concentrations of chlorine are carefully monitored by testing water samples.

Excess potassium iodide was added to a 1000 $cm^3$ sample of water.

The iodine formed reacted with 14.0 $cm^3$ of 0.00100 M sodium thiosulphate solution.

(a) Calculate the number of moles of sodium thiosulphate, $Na_2S_2O_3$, used in the reaction.

**(1)**

(b) The ionic equation for the reaction between iodine and sodium thiosulphate is

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

Calculate the number of iodine molecules, $I_2$, used in the reaction.

**(1)**

(c) Complete the equation for the reaction between chlorine molecules, $Cl_2$, and iodide ions

$Cl_2(aq) + 2I^-(aq) \rightarrow$

**(1)**

(d) Write down the number of moles of chlorine in the sample.

. . . . . .

**(1)**

(e) Calculate the mass of chlorine molecules, $Cl_2$, (molar mass 71.0 g $mol^{-1}$) in the original sample.

**(1)**

[*Turn over*

(f) The maximum accepted concentration of chlorine in drinking water is 0.5 parts per million by mass.

Show by calculation of the amount of chlorine in 1 000 000 g of water that the sample of water tested above is acceptable.

You may assume 1000 $cm^3$ of water has a mass of 1000 g.

Do not write in this margin

**(1)**

(g) Suggest TWO reasons why the concentration of chlorine in water must not exceed 0.5 ppm.

. . . . . .

. . . . . .

. . . . . .

**(2)**

**TOTAL 8 Marks**

**NOW TURN OVER FOR QUESTION 4**

[*Turn over*

Do not write in this margin

4. (a) Chloroethene, $C_2H_3Cl$, is the monomer from which the important plastic poly(chloroethene), PVC, is made.

(i) Draw the displayed formula of chloroethene.

**(1)**

(ii) What type of forces are there between molecules of chloroethene?

. . . . . .

. . . . . .

**(1)**

(b) (i) A possible route for making chloroethene in the laboratory is as follows:

$$C_2H_4 \xrightarrow{\text{Step 1}} C_2H_4Cl_2 \xrightarrow{\text{Step 2}} C_2H_3Cl$$

ethene — 1,2-dichloroethane — chloroethene

Suggest a reagent for Step 1.

. . . . . .

. . . . . .

Suggest a reagent and conditions for Step 2.

Reagent. . . . . .

Conditions. . . . . .

. . . . . .

**(4)**

(ii) 1,2-dichloroethane can be used to make ethane-1,2-diol. Suggest a reagent and conditions for this reaction.

Reagent. . . . . .

Conditions. . . . . .

. . . . . .

**(2)**

(iii) 1,2-dichloroethane reacts with ammonia under suitable conditions. Draw the **displayed** formula of the main organic product of this reaction.

Do not write in this margin

**(2)**

(c) (i) Complete the **balanced** equation for the formation of poly(chloroethene) from chloroethene.

n $C_2H_3Cl \rightarrow$

**(1)**

(ii) Poly(chloroethene), also known as PVC, can be produced with any degree of flexibility from rigid to pliable.

Suggest TWO uses of PVC which demonstrate this.

. . . . . .

. . . . . .

. . . . . .

**(2)**

**TOTAL 13 Marks**

**NOW TURN OVER FOR SECTION B**

[*Turn over*

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**SECTION B**

**THIS QUESTION SHOULD BE ANSWERED IN THE SEPARATE ANSWER BOOK PROVIDED.** Complete all the details on the front of the answer book.

You should aim to spend no more than 35 minutes on this section. This time recommendation includes reading time.

Read straight through the passage on pages 26 and 27 on **ARGON IN THE SPOTLIGHT**, and then more carefully, in order to answer the following questions.

5. (a) Give a chemical reason for the derivation of the name "argon".

**(1)**

(b) (i) Who was responsible for the discovery of argon?

**(1)**

(ii) Which investigation led to the discovery of argon?

**(1)**

(c) Why is air compressed slowly in the liquefaction process?

**(1)**

(d) Why is nitrogen not suitable for a gas in electric light bulbs?

**(1)**

(e) Suggest the product of the reaction of oxygen and carbon in steel making.

**(1)**

(f) Explain why argon is so unreactive in terms of its electronic structure.

**(1)**

(g) **Describe how argon is manufactured from air**, in not more than 100 words.

**(8)**

You are NOT asked to summarise the whole passage, nor to include equations in your summary.

**At the end of your summary state the number of words you have used.**

*Credit will be given for answers written in good English, using complete sentences and using technical words correctly and chemical names rather than formulae. Avoid copying long sections from the original text. Numbers count as one word, as do standard abbreviations, units and hyphenated words. Any title you give your passage does not count in your word total.*

*There are penalties for the use of words in excess of 100.*

**TOTAL 15 Marks**

[*Turn over*

## ARGON IN THE SPOTLIGHT

It may seem surprising that uses exist for a colourless, odourless, totally unreactive gas like argon. Being denser than air, it cannot be used to lift balloons as its fellow Group member helium can, yet more argon is used than all the other members of the Noble gas group put together. How was it discovered? Why are unreactive substances of interest to chemists? Of what possible use can it be?

1994 was the centenary of the discovery of argon by Sir William Ramsay. Ramsay discovered argon whilst investigating apparent differences in the density of nitrogen made in different ways.

The name argon was chosen because of its chemical unreactivity. The word is derived from the Greek *argos* meaning lazy or easy.

Like the noble metals they were named after, the noble gases exist uncombined in nature, but thinly spread out. Physical rather than chemical processes are needed to separate them from their surroundings. The noble gases are obtained by fractional distillation of liquefied air.

Filtered air is compressed in five or six stages. The effect of each compression is to heat up the gas mixture. To minimise this, the air is compressed slowly. The air is then allowed to expand rapidly to give a maximum cooling effect and the process of compression followed by expansion is carried out repeatedly until the air is liquefied.

Between the second and third stages, carbon dioxide is removed by passing the air through aqueous sodium hydroxide. Residual moisture is removed by passage through silica gel or activated alumina.

After the compression stages, dry carbon dioxide-free air is fractionally distilled. This separates liquid oxygen from nitrogen. As nitrogen has a lower boiling point (77 K) than oxygen (90 K), nitrogen boils first and leaves the top of the distillation column as a gas. Oxygen collects at the bottom of the column as a liquid. Because the boiling point of argon is nearer the boiling point of oxygen, argon is mainly found in the liquid oxygen fraction. This fraction is passed to another distillation column where 80-90 % pure argon is produced. Residual oxygen is removed by reaction with hydrogen. This reaction produces water, so the resulting gas is then dried to leave pure argon.

Most of the uses of argon arise because it is the most abundant, hence the cheapest, noble gas. Its very unreactivity is an advantage. Many electric light bulbs are filled with argon, as this enables them to run at higher temperatures, where there is a more efficient transformation of electrical energy to light energy. Although nitrogen is much cheaper and unreactive at normal temperatures, it combines with the hot filaments to form nitrides, which would not conduct electricity.

The steel industry is the largest single user of argon. The gas is used as an inert stir gas to ensure homogeneity as oxygen is blown through the molten metal to adjust the carbon content.

So lazy, unreactive argon really can be useful in different ways, and it has also helped chemists to understand chemical bonding.

(523 words)

Adapted from "Argon- in the spotlight" by Gordon Woods, *Chemistry Review*, May 1995.

**DO NOT FORGET TO ANSWER PARTS (a), (b), (c), (d), (e), (f) AND (g) IN THE SEPARATE ANSWER BOOK PROVIDED.**

**At the end of the examination check that all the details at the front of the answer book are correct and tie it loosely to this question paper.**

**END**

**Periodic Table**
**(Appendix I)**

| Centre Number | | | | | | Paper Reference | Surname |
|---|---|---|---|---|---|---|---|
| Candidate Number | | | | | | Candidate Signature | Other Names |

**6254/01**

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# Edexcel GCE

## Chemistry (Nuffield)

### Specimen Unit Test 4

### Advanced

Time: 1 hour 30 minutes

| Question number | Leave Blank |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| Total | |

Materials required for the examination

Nil

Items included with these question papers

Nil

**Instructions to Candidates**

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**Information for Candidates**

A periodic table is printed on the back cover of this question paper.

The marks for individual questions and the parts of questions are shown in round brackets: e.g (2).

There are 6 questions in this question paper. The total marks for this paper is 60.

| Question Number | Max Mark |
|---|---|
| 1 | 10 |
| 2 | 6 |
| 3 | 13 |
| 4 | 11 |
| 5 | 10 |
| 6 | 10 |
| Total | 60 |

**Advice to Candidates**

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

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Answer **ALL** the questions in the spaces provided.

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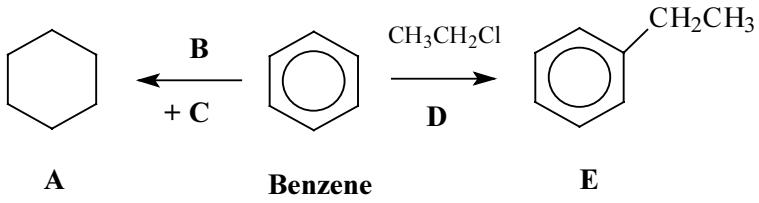
1. Two reactions of benzene are summarised in the diagram




(a) What is the meaning of the circle in the diagram of both benzene and substance **E**?

. . . . . .

. . . . . .

. . . . . .

**(2)**

(b) Name the substances **A** to **E**:

**A**. . . . . .

**B**. . . . . .

**C**. . . . . .

**D**. . . . . .

**E**. . . . . .

**(5)**

(c) Name the type of reaction involved in the formation of:

**A**. . . . . .

**E**. . . . . .

**(3)**

**TOTAL 10 Marks**

2. Two organic compounds, **X** and **Y**, both have the molecular formula $C_4H_8O$. Both **X** and **Y** give yellow precipitates when added to Brady's reagent (2,4-dinitrophenylhydrazine).

Do not write in this margin

(a) What can be deduced about **X** and **Y**?

. . . . . .

**(1)**

(b) Compound **X** gives a red precipitate when warmed with Benedict's solution but **Y** shows no reaction when treated this way.

What further deductions can be made about the natures of **X** and **Y**?

. . . . . .

. . . . . .

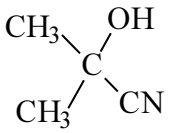
**(1)**

(c) Draw the displayed formula of compound **Y** and give its systematic name.

Name of compound **Y** . . . . . .

**(2)**

(d) The compound




is a product of the reaction between an organic compound and an inorganic reagent.

(i) Give the structural formula of the original organic compound.

. . . . . .

**(1)**

(ii) Give the name or formula of the inorganic reagent.

. . . . . .

**(1)**

**TOTAL 6 Marks**

[*Turn over*

3. The decomposition of dinitrogen pentoxide, $N_2O_5$, has been studied in solution. When an organic solvent is used, one product (nitrogen dioxide) is retained in solution, while oxygen gas is given off as the other product.

Do not write in this margin

The equation for the overall process is:

$$N_2O_5 \rightarrow 2NO_2 + \tfrac{1}{2} O_2$$

(a) Draw a diagram of the apparatus which could be used to follow the rate of this reaction.

**(2)**

(b) The rate equation for the reaction is

$$\text{rate} = k\,[N_2O_5]$$

A suggested mechanism for the reaction is

1st step $N_2O_5 \rightarrow NO_2 + NO_3$

2nd step $NO_2 + NO_3 \rightarrow NO + O_2 + NO_2$

3rd step $NO + NO_3 \rightarrow 2NO_2$

(i) What is the order of reaction with respect to $N_2O_5$?

. . . . . .

**(1)**

(ii) What are the units of the rate constant $k$?

. . . . . .

**(1)**

(iii) Suggest which is the rate-determining step.

Explain your reasoning.

Rate-determining step . . . . . .

Explanation . . . . . .

. . . . . .

**(2)**

Do not write in this margin

[*Turn over*

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(c) The rate constant $k$ was measured at different temperatures.

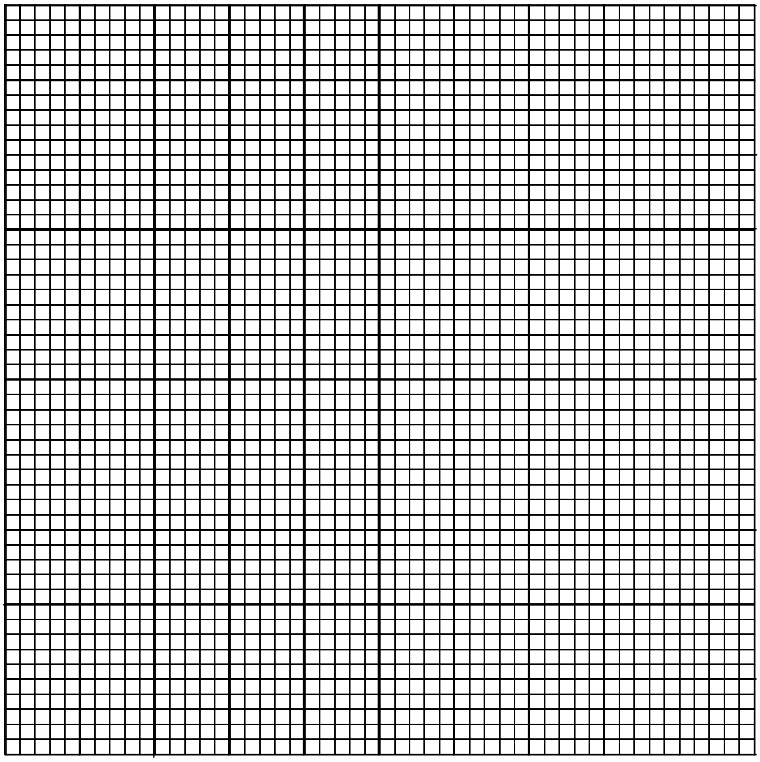
(i) The table below shows data for temperature and rate constant. Most of the data have been converted into values of 1/temperature and ln $k$.

Complete the table by calculating the missing values.

| *temperature* / K | *1/temperature* / $K^{-1}$ | *k* | *ln k* |
|---|---|---|---|
| 283 | $3.53 \times 10^{-3}$ | $3.83 \times 10^{-6}$ | - 12.47 |
| 293 | $3.41 \times 10^{-3}$ | $1.71 \times 10^{-5}$ | - 10.97 |
| 303 | $3.30 \times 10^{-3}$ | $6.94 \times 10^{-5}$ | - 9.58 |
| 313 | $3.19 \times 10^{-3}$ | $2.57 \times 10^{-4}$ | - 8.27 |
| 323 | | $8.78 \times 10^{-4}$ | |

**(2)**

(ii) Plot a graph of ln $k$ on the vertical axis against 1/temperature on the horizontal axis.



**(2)**

(iii) The relationship between rate constant, $k$, and temperature is given by the equation:

$$\ln k = C - \frac{E_A}{R} (1/T)$$

Where:
T is the temperature in kelvin
$E_A$ is the activation energy in J $mol^{-1}$
C and R are constants, R = 8.31 J $K^{-1}$ $mol^{-1}$

(You do not need to know or find the value of C.)

Use your graph from (ii) to calculate the activation energy, $E_A$, for the reaction.

**(3)**

**TOTAL 13 Marks**

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[*Turn over*

Do not write in this margin

4. When a lighted splint is applied to a mixture of hydrogen and oxygen gases under standard conditions an explosion occurs and water is produced.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l) \qquad \Delta H^{\ominus}\ (298) = -\ 572\ kJ\ mol^{-1}$$

(a) (i) Has the entropy of the system increased, decreased or remained unchanged after the reaction?

Give a reason for your answer.

. . . . . .

. . . . . .

. . . . . .

. . . . . .

**(1)**

(ii) Calculate the entropy change of the surroundings at 298 K. Your answer should include sign and units.

**(2)**

(iii) Do you think the **total** entropy change was positive or negative?

Give a reason for your answer.

. . . . . .

. . . . . .

. . . . . .

**(1)**

(b) It has been suggested that hydrogen gas would be an ideal fuel and that it could be made by thermally decomposing steam. This would involve driving the equilibrium

$$2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g)$$

towards the right-hand side.

(i) Write the expression for the equilibrium constant, $K_p$, for this equilibrium including all appropriate symbols. Give its units.

Expression

Units . . . . . .

**(2)**

(ii) Would the proportion of hydrogen at equilibrium be greater at high temperatures?

Justify your answer.

. . . . . .

. . . . . .

. . . . . .

**(2)**

(c) State and explain the **environmental** advantages of hydrogen over fossil fuels.

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

**(3)**

**TOTAL 11 Marks**

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[*Turn over*

5. This question is about propanoic acid, $C_2H_5CO_2H$.

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(a) $K_a$ for propanoic acid is $1.3 \times 10^{-5}$ mol $dm^{-3}$.

(i) Complete the equation below for the dissociation of propanoic acid.

$C_2H_5CO_2H(aq) \rightleftharpoons$

**(1)**

(ii) Write the expression for $K_a$

$K_a =$

**(1)**

(iii) Calculate the pH of a 0.10 M solution of the acid. Only an approximate calculation is required.

**(2)**

(b) (i) In the titration of a solution of propanoic acid with sodium hydroxide solution, what would you expect the approximate value of the pH to be when equal numbers of moles of the acid and alkali had reacted?
No further calculation is required.

Approximate value of pH . . . . . .

Justify your answer . . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

**(2)**

(ii) Name a suitable indicator you could use to determine the end point in this titration.

. . . . . .

**(1)**

(c) (i) The pH of a buffer solution is given by the equation

$$pH = -\lg K_a - \lg \frac{[\text{acid}]_{eqm}}{[\text{base}]_{eqm}}$$

What ratio of propanoic acid solution and sodium propanoate solution, both 0.100 M would be needed to make a buffer solution of pH 4.2? Give your answer to an appropriate number of significant figures.

**(2)**

(ii) Use your answer to (i) to calculate the volume of the propanoic acid solution you would need to mix with the sodium propanoate solution to make 1 $dm^3$ of this buffer.

**(1)**

**TOTAL 10 Marks**

Do not write in this margin

[*Turn over*

6. This question is about 2-hydroxybenzoic acid and some of its reactions.

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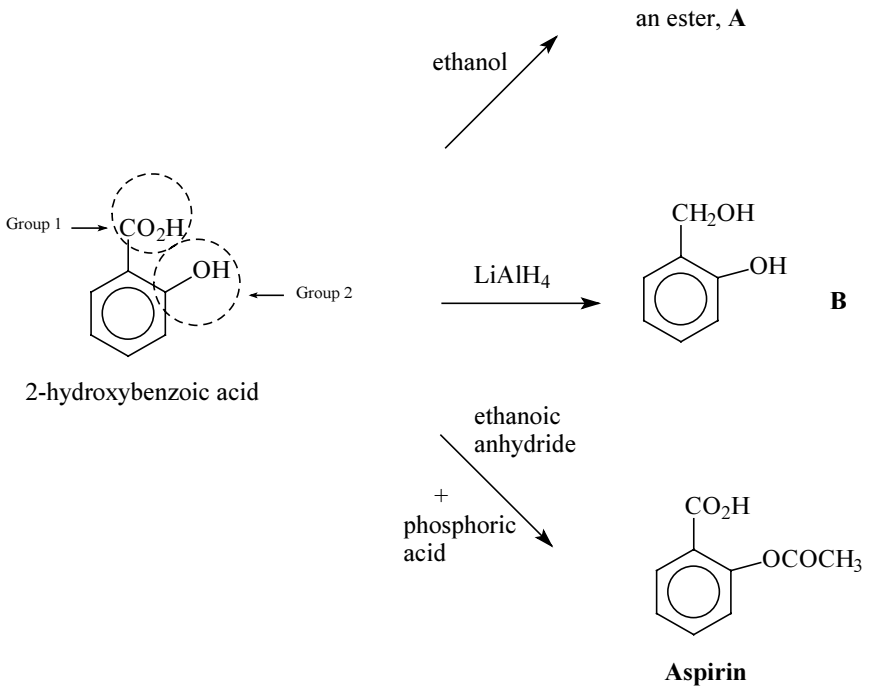


(a) Give the names of the groups enclosed by the dotted lines.

Group 1 . . . . . .

Group 2 . . . . . .

**(2)**

(b) When 2-hydroxybenzoic acid is reacted with ethanol under suitable conditions it forms an ester, **A**.

Write a balanced equation for the reaction which occurs.

**(2)**

(c) In the formation of compound **B**

(i) Give the name or formula of the attacking ion derived from $LiAlH_4$.

. . . . . .

**(1)**

(ii) Explain why the 2-hydroxybenzoic acid molecule is susceptible to attack by this ion.

. . . . . .

. . . . . .

**(1)**

(d) Why is phosphoric acid added to the mixture of 2-hydroxybenzoic acid and ethanoic anhydride used to prepare aspirin?

. . . . . .

. . . . . .

**(1)**

(e) Aspirin may be reacted with dilute aqueous sodium hydroxide to modify its structure before being used as a drug.

(i) Give the structural formula of the compound which forms when aspirin is reacted with dilute aqueous sodium hydroxide at room temperature.

**(1)**

(ii) Suggest TWO advantages of using the compound in (e)(i) as a drug instead of aspirin.

. . . . . .

. . . . . .

. . . . . .

**(2)**

**TOTAL 10 Marks**

**END**

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**Periodic Table**
**(Appendix I)**

**6255/02**

# Edexcel GCE

## Chemistry (Nuffield)

Specimen Unit Test 5B
(Special Studies)

Advanced

Time: 45 minutes

| Materials required for the examination | Items included with these question papers |
|---|---|
| AB8 | Nil |

**Instructions to Candidates**

In the boxes on the Answer Book provided, write the name of the Examining Body (Edexcel), your Centre Number, Candidate Number, the Subject Title, the Paper Reference, your surname, other names and signature. The Paper Reference is shown towards the top left-hand corner of the page.

Answer **ONE** question in the Answer Book.

Show all the steps in any calculations. Calculators may be used.

Final answers to calculations should be given to an appropriate number of significant figures.

**Information for Candidates**

A periodic table is printed on the back cover of this question paper.

The marks for individual questions and the parts of questions are shown in round brackets: e.g (2).

There are 5 questions in this question paper. All questions carry equal marks.

The total marks for this paper is 30.

**Advice to Candidates**

You must ensure that your answers to parts of questions are clearly numbered.

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

N1234 R6255


Edexcel
Success through qualifications

***Turn over***

Answer **ONE** question in the separate answer book provided.

## 1. BIOCHEMISTRY

(a) (i) (A) What are the three components that form a nucleotide? **(2)**

(B) Why is DNA classified as a polymer? **(2)**

(C) What is meant by the double helix of DNA? **(1)**

(D) Describe how the double helix is held together. **(2)**

(ii) Explain why the conversion of ADP to ATP in metabolism is of importance to mammals. **(3)**

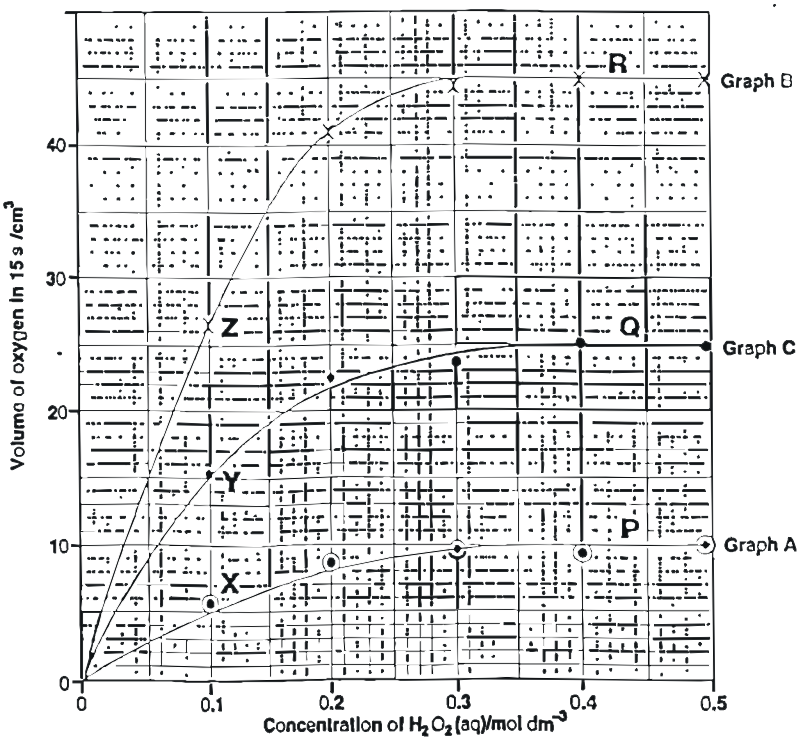
(iii) The activities of three samples of the enzyme catalase, obtained from fresh liver, were compared by finding the volume of oxygen liberated from various concentrations of hydrogen peroxide solutions.

The graphs of the volume of oxygen evolved in 15 seconds were plotted against the initial concentrations of the hydrogen peroxide solutions.

Graph **A** was obtained using equal sized pieces of liver in the reaction mixture. The dry mass of the liver in each reaction mixture was 0.2 g.

Graph **B** was obtained using a crude liver extract in phosphate buffer solution. The dry mass in each reaction mixture was 0.04 g.

Graph **C** was obtained using a propanone fraction, suitably diluted, prepared from the crude extract. The dry mass in each reaction mixture was 0.01 g.



(A) The experimenter was not certain whether the maximum values (**P**, **Q** and **R**) or the volumes from 0.1 mol $dm^{-3}$ $H_2O_2$ (**X**, **Y** and **Z**) would give the fairest comparison of activities. State, justifying your choice, which points you would have selected. **(3)**

(B) Explain the differences in activities of the three sets of results. **(3)**

**(16 marks)**

(b) In answering this question you are expected to concentrate on the biochemistry of the processes involved.

(i) What is a hormone? What are the functions of hormones? **(4)**

(ii) What sources of insulin are there for diabetics? Are there differences in the insulin from different sources?

Why is insulin needed by diabetics? **(6)**

(iii) In recent years certain steroid hormones have been used by some athletes to stimulate the building of protein deposits, but the advisability of using such compounds has been questioned. It is difficult to discover whether an athlete has been taking hormones.

Use your knowledge of biochemistry to discuss this statement. **(4)**

**(14 marks)**
**TOTAL 30 Marks**

2. **CHEMICAL ENGINEERING**

(a) (i) (A) Why is it important for the chemical engineer to be able to measure fluid flow rates? **(1)**

(B) Show by means of fully labelled sketches the characteristics of the streamline flow and the turbulent flow of liquids in pipes. Indicate clearly the type of flow adjacent to the pipe walls and include a flow velocity profile. **(3)**

(C) What is the significance of the Reynolds Number, Re, in relation to fluids flowing in pipes?

$$Re = \frac{\rho u d}{\mu}$$

$\rho$ = fluid density /kg $m^{-3}$
u = fluid velocity /m $s^{-1}$
d = pipe diameter /m
$\mu$ = fluid viscosity / kg $m^{-1}$ $s^{-1}$ **(3)**

(D) Chemical engineers normally prefer one type of fluid flow in pipes. State what type of flow is preferred and give three detailed reasons to support this preference. **(4)**

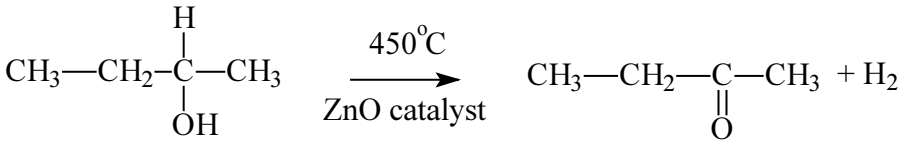
(ii) (A) For a distillation column, explain what is meant by the term **reflux ratio**? **(1)**

(B) Explain why the distillate composition changes during the course of the batch distillation of a binary mixture, such as a mixture of ethanol and propanone.

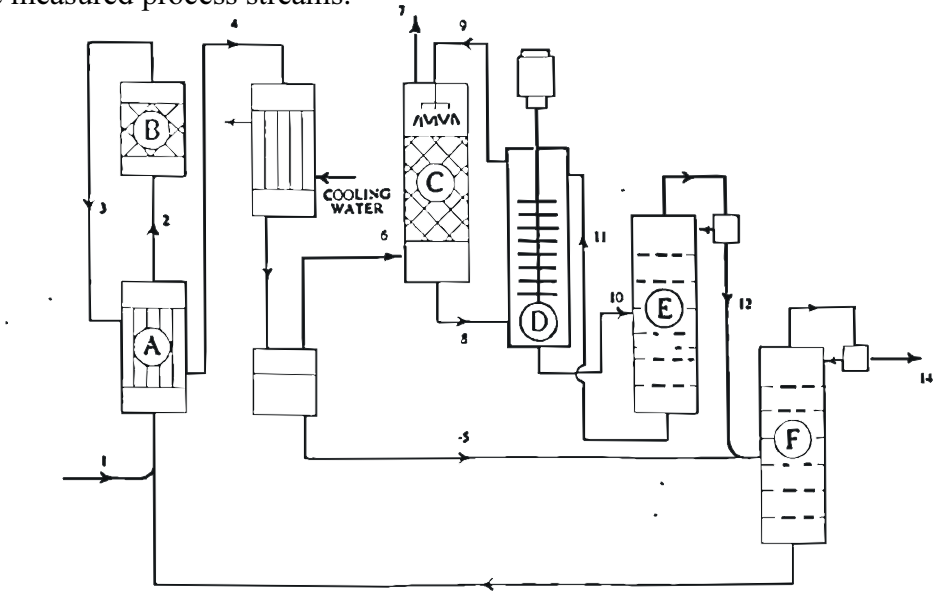
State and explain how the quality of such distillate can be maintained constant.

**(4)**
**(16 marks)**

(b) The diagram represents a simplified flow scheme showing the unit operations involved in an industrial process for the manufacture of butanone. Butan-2-ol is catalytically dehydrogenated at a temperature of 450 °C:




The table gives details of the composition and flow rates (measured in kg $hr^{-1}$) for each of the measured process streams.




| Stream | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Component | | | | | | | | | | | | | | |
| Butan-1-ol | 1400 | 1556 | 170 | 170 | 155 | 15 | 1 | 14 | | 14 | | 14 | 156 | |
| Butanone | | 2 | 1350 | 1350 | 1133 | 217 | 4 | 223 | 10 | 214 | 1 | 213 | 2 | |
| Hydrogen | | | 38 | 38 | | 38 | 38 | | | | | | | |
| Trichloromethane | | | | | | | | | | 896 | 896 | | | |
| Water | | | | | | | | 1920 | 1920 | 15 | 15 | | | |
| TOTAL | 1400 | 1558 | 1558 | 1558 | 1288 | 270 | 43 | 2157 | 1930 | 1139 | 912 | 227 | 158 | |

(i) What is meant by the term **unit operation**? **(1)**

(ii) For the items of equipment **A**, **B**, **C**, **D** and **E** name the unit operation being carried out and explain the purpose of the operation in this process. **(8)**

(iii) Complete the **mass balance** over item **F** and thus determine the flow rate (measured in kg $hr^{-1}$) for each component in process stream 14. What is the percentage purity of the butanone product? **(3)**

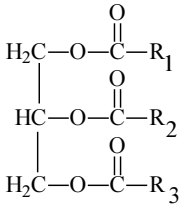
(iv) State, giving reasons, whether the process would be operated below, at or above atmospheric pressure. **(2)**

**(14 marks)**
**TOTAL 30 Marks**

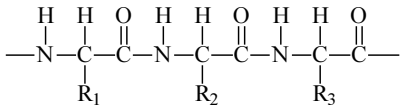
[*Turn over*

3. **FOOD SCIENCE**

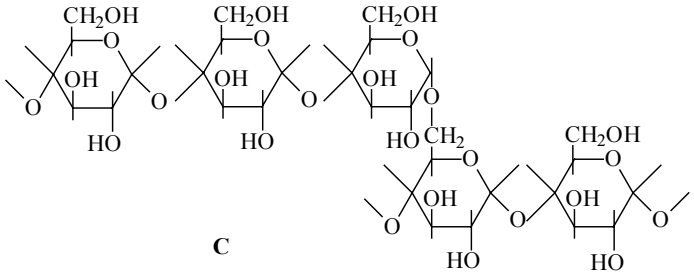
(a) **A**, **B** and **C** represent three different types of nutrient.



**A**



**B**



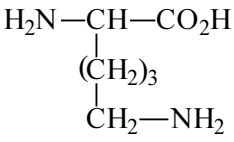
**C**

(i) Identify the three different **types of nutrient** represented by **A**, **B** and **C**. **(3)**

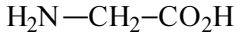
(ii) Give ONE reason, in each case, why the three types of nutrients you have listed in (i) are necessary for a healthy diet. **(3)**

(iii) Why is cellulose not considered to be a nutrient even though it is essential in a healthy diet? **(1)**

(iv) Draw the structure of ONE dipeptide which can be formed by condensing lysine and glycine. Clearly indicate the peptide linkage, showing all bonds.



Lysine



Glysine **(2)**

(v) Explain how intermolecular bonds are responsible for the maintenance of the tertiary structure of a protein. **(4)**

(vi) Cereal proteins generally are deficient in lysine which is an **essential amino acid**. Describe what is meant by the term in bold. **(2)**

(vii) What property of the cereal protein, gluten, contributes to the texture of bread?

What is the difference between strong and weak flour that makes them more suitable for different products? **(4)**

**(19 marks)**

(b) Milk leaving the udder of a healthy cow contains only a few bacteria. When it arrives at the factory the bacterial count may be as high as $10^7$ organisms per $cm^3$.

(i) What factors contribute to the increase in the bacterial count? **(2)**

(ii) What preventative measures should be taken to maintain a low bacterial count? **(3)**

(iii) Compare the methods of preparing pasteurised and sterilised milk, outlining TWO advantages of each method. **(6)**

**(11 marks)**
**TOTAL 30 Marks**

[*Turn over*

4. **MATERIALS SCIENCE**

(a) (i) What are the uses in materials science of:

(A) X-ray diffraction;

(B) X-ray radiography;

(C) electron beams? **(3)**

(ii) Iron exists in the **face-centred cubic** (fcc) form at high temperatures and in the **body-centred cubic** (bcc) form at low temperatures.

What is meant by the terms in bold? You may find a diagram helpful in your answer. **(2)**

(iii) State, giving reasons, whether iron will contract or expand or remain unchanged in volume when cooling from the fcc to the bcc form. **(2)**

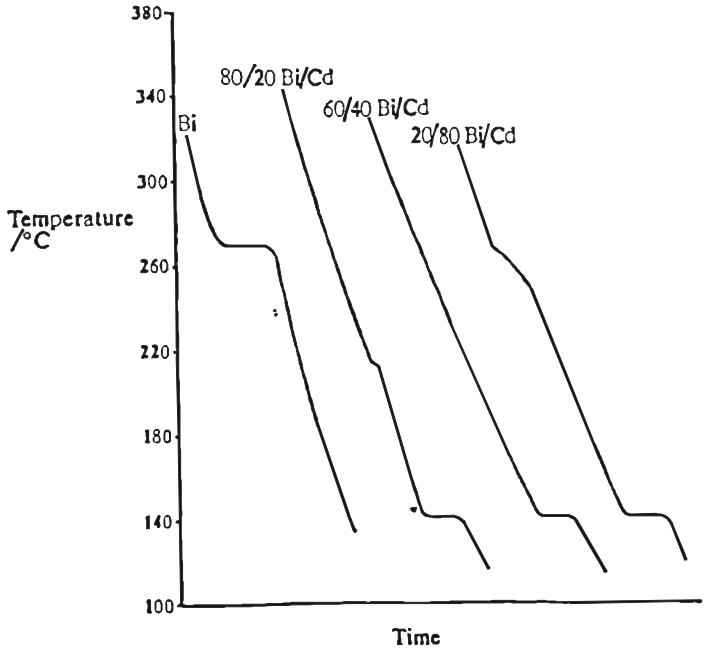
(iv) Copper and nickel form alloys which are **substitutional solid solutions**, whereas iron and carbon, in steel, form **interstitial solid solutions**.

What is meant by the terms in bold? **(2)**

(v) Explain why the Cu/Ni and the Fe/C systems form different types of solid solutions. **(2)**

(vi) Explain the meaning of the term **eutectic**. **(2)**

(vii) The diagram shows cooling curves obtained from an experiment using the two metals cadmium ($T_m$ = 321 °C) and bismuth.




(A) Sketch the cooling curve from the diagram for 20/80 mass% Bi/Cd alloy and indicate the arrest and inflexion by the letters **A** and **I** respectively. **(1)**

(B) Explain the origin of the arrests and inflexions. **(2)**

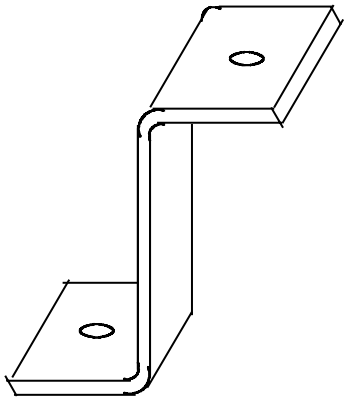
(C) Draw labelled diagrams of the microstructures for the alloys 80/20 mass% Bi/Cd and 60/40 mass% Bi/Cd. **(2)**

**(18 marks)**

**QUESTION 4 CONTINUES OVERLEAF**

[*Turn over*

(b) The component below was made from an annealed mild steel plate.



The two holes were drilled and the component bent into shape, both at room temperature. The component was then bolted onto a concrete structure, using mild steel bolts, and the entire structure exposed in the atmosphere

(i) Describe, giving reasons, how the hardness will vary in all parts of this component (actual hardness values are not required) **(2)**

(ii) Describe and explain the expected corrosion behaviour of the component while in service. **(5)**

(iii) What would be the effect of using copper rather than mild steel bolts to secure the component? **(2)**

(iv) What are the advantages/disadvantages of welding as opposed to bolting from the viewpoint of corrosion? **(3)**

**(12 marks)**
**TOTAL 30 Marks**

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[*Turn over*

5. **MINERAL PROCESS CHEMISTRY**

(a) (i) Explain the meaning of the following terms as used in mineral process chemistry:

(A) values; **(1)**

(B) gangue material; **(1)**

(C) cut-off grade; **(1)**

(D) average crustal abundance **(1)**

(ii) The ratio of *cut-off grade/average crustal abundance* is known as the concentration factor. The values for the elements **A** and **B** are:

| *Element* | *Cut-off grade* (% by mass) | *Average crustal abundance* (% by mass) | *Concentration factor* |
|---|---|---|---|
| **A** | 0.4 | $5 \times 10^{-3}$ | 80 |
| **B** | 17 | 5 | 3.4 |

State which of the elements **A** or **B** will command the higher market price per tonne. Give TWO reasons for your answer. **(4)**

(iii) 100 g of a finely powdered concentrate containing zinc sulphide is processed using a leach solution. This produced 250 $cm^3$ of aqueous zinc sulphate solution.

A 25.0 $cm^3$ sample of the zinc sulphate solution was titrated with 0.100 M EDTA, using a suitable indicator. It was found that 17.7 $cm^3$ of 0.100 M EDTA were required for complete reaction.

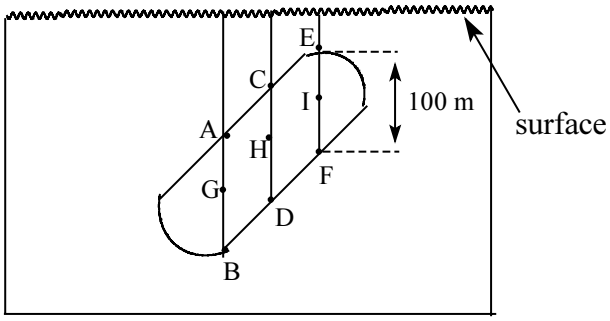
Suggest a suitable indicator.

Calculate the mass of zinc metal extracted from the 100 g of finely powdered concentrate.

Calculate the grade of the concentrate with respect to zinc, assuming the leach extraction process to be 85% efficient. (Molar mass of Zn = 65.5 g $mol^{-1}$) **(6)**

**(14 marks)**

(b) The diagram below represents a hypothetical ore body containing copper.
The average density of the ore body is 2.9 g $cm^{-3}$ and the market value of the copper is £1200 per tonne.




| *Location* | *Grade of Cu* /mass % |
|---|---|
| A | 0.54 |
| B | 0.71 |
| C | 0.36 |
| D | 0.80 |
| E | 0.91 |
| F | 0.40 |
| G | 1.21 |
| H | 2.01 |
| I | 0.98 |

(i) How would the market value of the copper be known? **(1)**

(ii) Why are different figures given for the different locations? **(1)**

(iii) Describe how the grades at the different locations are obtained. **(2)**

(iv) The estimated volume of the ore body is $2 \times 10^6$ $m^3$. Estimate the mass of the ore body. **(2)**

(v) The average grade is 0.88; estimate the copper content of the ore and hence the market value. **(2)**

(vi) The deposit could be exploited by open-pit or underground mining.
Discuss the pros and cons in this particular case and state which method you would use. **(5)**

(vii) What is the likely amount of waste generated? How would the waste be disposed of? **(3)**

**(16 marks)**
**TOTAL 30 Marks**

---

**END**

**Periodic Table**
**(Appendix I)**

| Centre Number | | | | | | Paper Reference | Surname |
|---|---|---|---|---|---|---|---|
| Candidate Number | | | | | | Candidate Signature | Other Names |

# 6256/01

For examiner's use only

For Team Leader's use only

# Edexcel GCE

# Chemistry (Nuffield)

## Specimen Unit Test 6 (Synoptic)

## Advanced

| Question number | Leave Blank |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| Total | |

Time: 2 hours

Materials required for the examination

Nil

Centre to provide
Students' Book
Nuffield Advanced Science Book of Data

Items included with these question papers

Nil

### Instructions to Candidates

In the boxes above, write your Centre Number, Candidate Number, the Paper Reference, your signature, your surname and other names. The Paper Reference is shown towards the top left-hand corner of the page.

Answer ALL questions in the spaces provided in this question paper.

Show all the steps in any calculations. Calculators may be used. Final answers to calculations should be given to an appropriate number of significant figures.

### Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets: e.g (2).

There are 6 questions in this question paper. The total marks for this paper is 60.

| Question Number | Max Mark |
|---|---|
| 1 | 10 |
| 2 | 10 |
| 3 | 10 |
| 4 | 10 |
| 5 | 10 |
| 6 | 10 |
| Total | 60 |

### Advice to Candidates

The time allowed to answer this paper means that you do not have time to look up all the information you may wish to refer to in your answers. You should plan to restrict your use of prescribed texts to relevant passages of background reading or for confirmation of data or equations. Text copied directly from the Students' Book will not gain you credit.

This question paper is designed to give you the opportunity to make connections between different areas of Chemistry (Nuffield) and to use skills and ideas developed throughout the course in new contexts. You should include in your answers relevant information from the whole of your course, where appropriate

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

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*Turn over*

Answer **ALL** the questions in the spaces provided.

Do not write in this margin

You may use the *Students' Book* and the *Book of data* in answering this paper.

*The time allowed to answer this paper means that you do not have time to look up all the information you may wish to refer to in your answers. You should plan to restrict your use of the Students' Book to relevant passages of background reading or for confirmation of data or equations.*

Text copied directly from the *Students' Book* will not gain you marks.

1. The reaction

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

is used industrially for the production of sulphur trioxide.

$\Delta H^{e}_{reaction}$ is about - 200 kJ mol$^{-1}$

(a) Use the *Book of data* to calculate an accurate value for the enthalpy change of the reaction. The enthalpy change of formation, $\Delta H^{e}_{f}$ , of $SO_3(g)$ is –381 kJ mol$^{-1}$.

**(2)**

(b) (i) Predict and explain the sign of the entropy changes which would occur during the reaction.

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(ii) Predict and explain the total entropy change when the pressure is increased.

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**(4)**

(c) Discuss the changes which the manufacturer of sulphur trioxide could carry out to make the process more economic.

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**(4)**

**TOTAL 10 Marks**

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*[Turn over*

2. The structure of the silkworm moth sex attractant, bombykol, is

$$H_3C—(CH_2)_2—CH=CH—CH=CH—(CH_2)_8—CH_2OH$$

(a) Predict some of the properties you would expect for bombykol.

You should comment on:

(i) the likely solubility of bombykol in water;

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(ii) the number of possible geometric isomers;

(iii) its likely reaction with four reactants of your choice.
Write equations or reaction schemes for the reactions you choose, showing the structures of the organic products clearly.

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**(8)**

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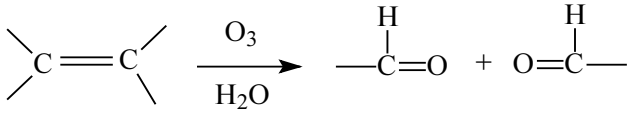
(b) When bombykol is treated with ozone in the presence of water the molecule splits into fragments wherever there is a C=C double bond.




The aldehyde groups are converted to carboxylic acids in oxidizing conditions.

Predict the oxidation products formed when bombykol is reacted with ozone in oxidizing conditions.

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**(2)**

**TOTAL 10 Marks**

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[*Turn over*

3. A solution of cobalt(II) chloride was reacted with ammonia and ammonium chloride while a current of air was blown through the mixture. A red compound, **X**, was produced which contained a complex ion of cobalt. The compound had the following composition:

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| | % by mass |
|---|---|
| Co | 23.6 |
| N | 27.9 |
| H | 6.0 |
| Cl | 42.5 |

(a) Use the data to calculate the empirical formula of the compound **X.**

**(3)**

(b) In the reaction in which **X** is formed from cobalt(II) chloride, explain the role of:

(i) the air,

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(ii) the ammonium chloride.

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**(3)**

(c) A solution of cobalt(II) chloride reacts with concentrated hydrochloric acid to form a stable complex ion. A solution of calcium chloride does not form a corresponding complex. Use your knowledge of atomic structure to explain this difference, and suggest other differences you would expect between the chemistry of cobalt and calcium.

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**(4)**

**TOTAL 10 Marks**

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[*Turn over*

4. (a) (i) From the *Book of data* tabulate electrode systems and the associated $E^{e}$ values involving the following elements. You need only list those where the elements are acting as oxidizing agents:

$I_2(aq)$ $Br_2(aq)$ $Cl_2(aq)$ $F_2(g)$ $O_2(g)$

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(ii) Arrange the five substances in order of strength as oxidizing agents, putting the strongest first.

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**(3)**

(b) Some iron(II) salts in aqueous solution are partly hydrolysed to iron(II) hydroxide, $Fe(OH)_2$.

It is observed that this iron(II) hydroxide becomes oxidized on storage to iron(III) hydroxide, probably by the oxygen of the air.

Write a cell diagram corresponding to a possible reaction by which this might happen, using the appropriate electrode system from the *Book of data*.

Calculate the value and sign of $E^{\ominus}$ and use the result to comment on the feasibility of the suggested reaction.

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**(4)**

(c) When chlorine reacts directly with iron, iron(III) chloride results. Use $E^{\ominus}$ data to compare the extent to which iron reacts similarly with iodine.

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**(3)**

**TOTAL 10 Marks**

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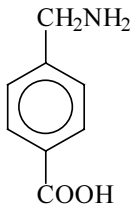
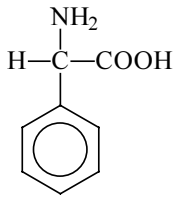
*[Turn over*

5. The structures of the two isomers, **X** and **Y**, are shown below:




**X**




**Y**

(a) Consider THREE different spectroscopic methods which you could use in an attempt to distinguish these isomers.

Indicate the results you would expect, supporting your answer with data where appropriate.

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**(6)**

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(b) Only one of the isomers is chiral. Identify which isomer is chiral. State the physical property caused by the chirality which would allow you to distinguish the isomers.

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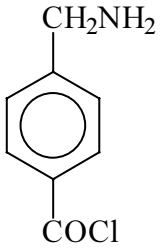
**(2)**

(c) Isomer **X** can be converted to the following compound, **Z**.




**Z**

Molecules of compound **Z** can react to form a polymer. Draw a section of the polymer, showing at least two monomer units, and indicate any other products which form.

**(2)**

**TOTAL 10 Marks**

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[*Turn over*

6. This question is about sodium oxide, $Na_2O$.

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(a) Calculate a value for the lattice energy of sodium oxide, $Na_2O$.

Draw a Born-Haber cycle as a basis for your calculation, showing clearly the different stages of the cycle. All the necessary data for the calculation may be found in the *Book of data.*

**(6)**

(b) Compare the theoretical and experimental values for the lattice energy of sodium oxide which are in the *Book of data*.

What can you deduce from a comparison of these values?

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**(2)**

(c) Sodium oxide reacts with water to form an alkaline solution. The reaction of the oxide ion can be represented as follows:

$$O^{2-}(s) + H_2O(l) \rightarrow 2OH^-(aq)$$

What type of reaction is this? Justify your answer.

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**(2)**

**TOTAL 10 Marks**

**END**

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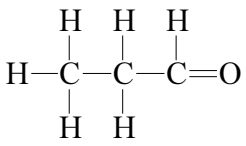
**UNIT TEST 1 (6251) MARK SCHEME**

**SECTION A**

1. $2s^2\ 2p^6\ 3s^2\ 3p^4$ **(1 mark)**

2. 60.2 x 69 = 4153.8
   39.8 x 71 = 2825.8
   Total = 6979.6
   ∴ average molar mass = 69.8 g $mol^{-1}$
   method **(1)**
   answer **(1)**
   units, sig figs **(1)**
   **(3 marks)**

3. (a) $C_3H_6O$ **(1)**
   (b) ($CH_3CH_2CHO$ or $C_2H_5CHO$ **(1)**
   (c)  **(1)**
   **(3 marks)**

4. (a) An acid which is only partially ionized in solution. **(1 mark)**

   (b) ethanoic acid, citric acid etc
   *ACCEPT* any acid with a $K_a$ value ≤ $1\times 10^{-3}$. **(1 mark)**

**SECTION A, TOTAL 9 Marks**

**SECTION B**

5. (a) There is a repeating pattern (of rising and falling melting points as you go from one period to the next). **(1 mark)**

(b) Elements with small (covalently bonded) molecules have weak forces between the molecules and hence low melting points **(1)**
Other elements have giant structures (metallic/covalent) with strong interatomic forces and hence high melting points. **(1)**
**(2 marks)**

(c) SrO **(1)**
$GeF_4$ **(1)**
**(2 marks)**

(d) (i) Same pattern. **(1 mark)**

(ii) All values higher. **(1 mark)**

(e) Atomic radius
or 1st Ionization Energy
or other correct suggestion.
*NOT* melting/boiling point
**(1 mark)**
**TOTAL 8 Marks**

6. (a) Butan-1-ol. **(1 mark)**

(b) Primary **(1)**
-OH connected to C with only one other C atom **(1)**
*OWTTE* **(2 marks)**

(c) (i) $CH_3CH_2CH_2CHO$ **(1)**

(ii) $CH_3CH_2CH_2CO_2H$ **(1)**
**(2 marks)**

(d) (conc) sulphuric acid/(conc) phosphoric acid/aluminium oxide/porous pot **(1)**
$CH_3CH_2CH{=}CH_2$ **(1)**
**(2 marks)**
**TOTAL 7 Marks**

7. (a) (i) $Mg(NO_3)_2$ **(1 mark)**

(ii) Nitrogen dioxide *OR* dinitrogen tetroxide. **(1)**
Oxygen. **(1)**
**(2 marks)**

(iii) Magnesium oxide **(1 mark)**

(b) (i) molar mass $NaNO_3$ = 85 **(1)**
mol $NaNO_3 = \frac{1.45}{85} = 0.0171$ **(1)**
**(2 marks)**

(ii) mol gas given off = $\frac{204}{24000}$
$= 8.5 \times 10^{-3}$ mol = 0.0085 mol **(1 mark)**

(iii) $2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$
formulae of $NaNO_2$ **(1)**, balancing **(1)**
**(2 marks)**
**TOTAL 9 Marks**

8. (a) (i) Nichrome/platinum wire **(1)**
(concentrated) hydrochloric acid **(1)**
Dip in barium hydroxide/acid/and put in flame. **(1)**
**(3 marks)**

(ii) (Apple) green. **(1 mark)**

(iii) Energy from the flame promotes electrons **(1)**
When they fall back to lower energy levels
they omit light of a particular wavelength **(1)**
**(2 marks)**

(b) (i) Any named indicator (not Universal Indicator or litmus) **(1)**
Correct colour change eg
phenolphthalein pink to colourless
Methyl orange yellow to red **(2)**
**(3 marks)**

(ii) $Ba(OH)_2(aq) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$
Formulae/balancing **(1)**
State symbols **(1)**
**(2 marks)**

(iii) Moles of HCl = $\frac{16.2}{1000} \times 0.1$ **(1)**
Moles of $Ba(OH)_2$ in 10 $cm^3 = {}^1/_2 \times \frac{16.2}{1000} \times 0.1$ **(1)**
$\therefore [Ba(OH)_2] = {}^1/_2 \times \frac{16.2}{1000} \times 0.1 \times \frac{1000}{10} = 0.081$ mol $dm^{-3}$ **(1)**
**(3 marks)**
**TOTAL 14 Marks**

9. (a) (i) $2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$

$2Zn(s) + 2S(s) + 3O_2(g)$ elements in standard state **(1)**
balancing **(1)**
**(2 marks)**

(ii) $\Delta H = -2 \times \Delta H_f^e\ [ZnS(s)] + 2 \times \Delta H_f^e\ [ZnO(s)] + 2 \times \Delta H_f^e\ [SO_2(g)]$ **(1)**

$= +2 \times 400 - 2 \times 348 - 2 \times 297$
$= 800 - 696 - 594$
$= -490\ kJ\ mol^{-1}$ **(1)**

**1** mark for method
**1** mark for answer **(2 marks)**

(iii) Exothermic. **(1 mark)**

(b) (i) $SO_2$ given off which causes acid rain. **(1 mark)**

(ii) Basic (alkaline). **(1 mark)**

(c) Reaction exothermic so heat given off **(1)**
Which could be used to heat factory, produce steam etc **(1)**
Use $SO_2$ to produce sulphuric acid/plaster. **(1)**
Which could be sold **(1)**
**Any three** **(3 marks)**

(d) (i) Heat with element above zinc in the reactivity series **(1)**
e.g Aluminium. **(1)**
**(2 marks)**

(ii) Reduction. **(1 mark)**

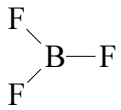
**TOTAL 13 Marks**

**END**

**UNIT TEST 2 (6252) MARK SCHEME**

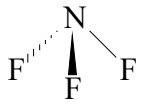
**SECTION A**

1. (a)



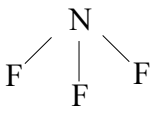
FBF = 120(°)

*NOT* < 120 or >120
Any reasonable "Y" shaped molecule
*ACCEPT* shape defined by orbitals

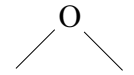


FNF = 107(°) (accept 100-108.5°)

*ACCEPT*



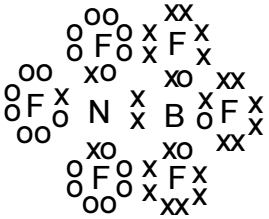
*ACCEPT* 120 angled diagram if tetrahedral or pyramidal quoted **($^1/_2$)**
*IGNORE* lone pair



FOF= 105(°) (accept 95-107°providing less than $NF_3$)
angle must be > 90 **($^1/_2$)** **(6 marks)**

(b) Two lone pairs on oxygen, only one lone pair on nitrogen **(1)**
Lone pairs occupy more space/more repulsion than bonded pairs **(1)**
So F atoms pushed closer together in $OF_2$ **(1)**
**(3 marks)**

(c)



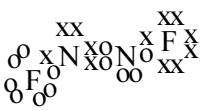
**(1)** Dative (covalent) **(1)**

dots and crosses need not be distinguished except
N must form the dative covalent bond
ALL outer shell electrons must be shown. **(2 marks)**

(d) (i) $E(N\text{-}F) = \frac{+834}{3}$

$= +278 \text{ kJ mol}^{-1}$ (*only acceptable answer)* **(1 mark)**

(ii)



**1** mark for double bond
**1** mark for the rest

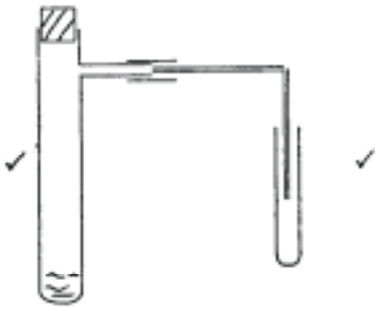
No need to distinguish between dots and crosses **(2 marks)**

(iii) Bond energies vary with the nature of the other atoms attached to the atoms participating in a bond.
ACCEPT 'bond energy varies with environment/surroundings'.
Double bond affects the N-F bond strength.
Reasonable discussion in terms of delocalisation. **(1 mark)**

**Total 15 Marks**

2. (a) (i) Phosphoric acid/$H_3PO_4$
Name or correct formula **(1 mark)**

(ii)



*OR* equivalent
(conical flasks acceptable)

| | |
|---|---|
| Upward delivery | **max(1)** |
| No rubber bung | **max(1)** |
| Totally enclosed | **(0)** |
| Collected over water | **(0)** |

**(2 marks)**

(b) Water rises up inverted test-tube *OR* gas dissolves in water **(1)**
HCl is very (soluble) in water *OR* reacts with water *OR* forms hydrochloric acid **(1)**
**(2 marks)**

(c) (i) hydrogen iodide/HI (or hydrogen bromide/HBr). **(1 mark)**

(ii) Brown/purple. **(1 mark)**

(iii) $2HI \rightarrow H_2 + I_2$
*OR* $2HBr \rightarrow H_2 + Br_2$
products **(1)** balancing **(1)** **(2 marks)**

**TOTAL 9 Marks**

3. (a) 14 x 0.00100/1000
= $1.40 \times 10^{-5}$ (mol) or $1.4 \times 10^{-5}$ (mol)
*OR* 0.000014 (mol)
*OR* figure in any correct form. **(1 mark)**

(b) $\frac{1.4 \times 10^{-5}}{2}$ accept (*a*) answer divided by 2
= $7.00 \times 10^{-6}$ (mol) or $7 \times 10^{-6}$ **(1 mark)**

(c) $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$
*IGNORE* state symbols. **(1 mark)**

(d) $7.00 \times 10^{-6}$ mol or answer to part (*b*). **(1 mark)**

(e) Mass = n x M
= $7.00 \times 10^{-6} \times 71$
= $497 \times 10^{-6} = 4.97 \times 10^{-4}$ g or 0.000497
*OR* 0.0005 or $5 \times 10^{-4}$
*OR* answer to (*d*) multiplied by 71 **(1 mark)**

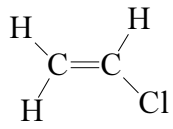
(f) 1000 g contains $497 \times 10^{-6}$ g
$10^6$ g contains $497 \times 10^{-6} \times 10^3$
ie 0.497 ppm or 0.5 ppm
Mark is for the method (x 1000 or ÷ 1000) **(1 mark)**
If answer but no method **(0)**

(g) Chlorine is poisonous/toxic/is a toxin/harmful/irritant.
Damaging to respiratory system/irritating to eyes.
Or unacceptable smell/taste.
Not 'dangerous'.

**Any two reasonable points**. **(2 marks)**

**TOTAL 8 Marks**

4. (a) (i) Correct **displayed** formula



**(1 mark)**

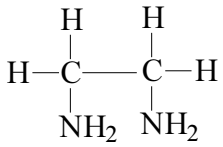
(ii) Dipole/dipole and/or van der Waals **(1 mark)**

(b) (i) Step 1
reagent: chlorine **(1)**

Step 2
reagent: potassium hydroxide **(1)**
conditions: in ethanol solution **(1)**
reflux or heat **(1)**
**(4 marks)**

(ii) Potassium hydroxide. **(1)**
in aqueous solution. **(1)**
**(2 marks)**

(iii)



**(2)**

*if only one* $NH_2$ **(1)** **(2 marks)**

(c) (i) $nC_2H_3Cl \rightarrow (\text{-}CH_2\text{-}CHCl\text{-})_n$
*ACCEPT* $(C_2H_3Cl)_n$ **(1 mark)**

(ii) Use and explanation in terms of desirable property for two different uses:
use that requires flexible polymer eg raincoat or sail; **(1)**
use that requires rigid polymer eg drain pipe or window frames. **(1)**
**(2 marks)**

**TOTAL 13 Marks**

**SECTION B**

5. (a) 'Argon' comes from the Greek word for lazy or easy and denotes **unreactivity.** **(1 mark)**
*ACCEPT* inert **.**

(b) (i) Ramsay. **(1 mark)**

(ii) Investigation of the differences in the **density** of **nitrogen made in different** ways. **(1 mark)**

(c) To **minimise heating**. **(1 mark)**

(d) At high temperature nitrogen would react with hot metal filaments to form **nitrides** which **do not conduct electricity**. **(1 mark)**

(e) Carbon reacts with oxygen to form **carbon dioxide**. **(1 mark)**

(f) Argon has a **stable** (filled) outer shell of electrons. **(1 mark)**

(g) Examiners will need to consider each answer for (i) key points and (ii) style and use of English. Candidates should have recorded their word total at the end of their answer, and this should be checked.

up to 105 words: no penalty
106 - 115 words: -1
116 - 125 words: -2
126 - 135 words: -3

and at a rate of -1 penalty for every 5 words excess thereafter, up to a maximum penalty equal to the number of key points included by the answer.

Note that words appearing in the title to the summary do not count in the word total. Normally hyphenated words, numbers and chemical formulae count as one word. The question does not ask for equations in the summary, but if included they should be counted in the word total.

$CO_2$ ≡ 2 words
NaOH (aq) ≡ 3 words
80-90% ≡ 4 words
70K ≡ 2 words
if units given ≡ 1 word
5/6 ≡ 3 words

1. Air is liquefied/cooled by a series of **slow compressions** and **rapid expansions**..... **(1)**

2. to **minimise heating** during **compression** and maximise cooling during expansion. **(1)**

3. **Carbon dioxide** is removed by passing the air through aqueous **sodium hydroxide**. **Moisture** is removed by passing through **silica gel** or **activated alumina**. **(1)**

4. (Liquid) **air** is **fractionally distilled**. **(1)**

5. **Oxygen** (fraction) is (re)**distilled** to produce **argon**. **(1)**

6. **Residual oxygen** is removed by **reaction with hydrogen**..... **(1)**

7. ....to **form water** which is **removed** by **drying**.

**Marking for key points**

One mark should be awarded for every key point clearly identified in an answer, up to a maximum of 6 marks. A tick should be made in the script at which the examiner decided to award each mark eg $^{3}\checkmark$. The total marks for key points should be placed in the body of the script at the end of the answer, out of 6.

To gain the mark for a key point the wording used by the candidate must make clear the essential chemistry of the point.

**Quality of Written Communication (2)**

This should be impression marked on a scale 2 - 1 - 0.

Candidates are expected to:

- show clarity of expression;
- construct and present coherent argument;
- demonstrate effective use of grammar, punctuation and spelling.

The answer should read fluently, with links between key points. **(2 marks)**

**SECTION B, TOTAL 15 Marks**

**END**

**UNIT TEST 4 (6254) MARK SCHEME**

1. (a) 6 electrons **(1)** are delocalized **(1)** **(2 marks)**

(b)
| | | | |
|---|---|---|---|
| A | cyclohexane | | **(1)** |
| B | hydrogen | *or vice versa* | **(1)** |
| C | nickel | | **(1)** |
| D | Aluminium chloride | | **(1)** |
| E | phenylethane (or ethylbenzene) | | **(1)** |

**(5 marks)**

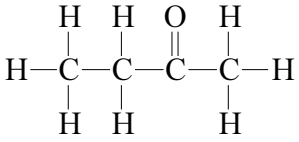
(c) Addition /reduction **(1)**
Electrophilic substitution
**(1)** **(1)** **(3 marks)**

**TOTAL 10 Marks**

2. (a) Both contain a carbonyl group/are aldehydes or ketones **(1 mark)**

(b) **X** is an aldehyde, **Y** is a ketone. **(1 mark)**

(c)



**(1) ;** butanone **(1)** *ACCEPT* butan-2-one

**(2 marks)**

(d) (i) $CH_3COCH_3$ **(1)**

(ii) $CN^-$/NaCN/KCN/HCN **(1)**
*OR* cyanide ion/sodium cyanide/potassium cyanide/hydrogen cyanide/hydrocyanic acid
**(2 marks)**

**TOTAL 6 Marks**

3. (a) Suitable container for solution (air-tight) (eg conical flask, test-tube etc) **(1)**
Suitable method for measuring gas (eg syringe, inverted measuring cylinder over water). **(1)**
**(2 marks)**

(b) (i) First order **(1 mark)**

(ii) [unit of time]$^{-1}$ eg $s^{-1}$, $min^{-1}$ **(1 mark)**

(iii) 1st step **(1)**
Because only $N_2O_5$ appears in rate equation. **(1)**
**(2 marks)**

(c) (i) $3.10 \times 10^{-3}$ *ACCEPT* $3.1 \times 10^{-3}$ **(1)**
-7.04 **(1)**
**(2 marks)**

(ii) Axes correctly labelled with sensible scales **(1)**
Points plotted accurately and straight line drawn **(1)**
**(2 marks)**

(iii) Gradient in range -12400 to - 12900 **(1)**
$E_A$ = -R x their gradient **(1)**
$E_A$ = + 105 kJ $mol^{-1}$ *OR* other value correctly calculated from candidate's gradient. **(1)**
**(3 marks)**
**TOTAL 13 Marks**

4. (a) (i) $\Delta S_{system}$ decreased because gases to liquid.
or 3 moles to 2 moles/fewer moles/molecules of products than reactants. **(1 mark)**

(ii) $\Delta S_{surroundings} = -\Delta H/T$
$= - (-57200)/298 = +1919$
$= + 1900$ J $mol^{-1}$ $K^{-1}$ (2SF;*ACCEPT* 1920 or 1919
**1** for value, **1** for sign and units **(2 marks)**

(iii) $\Delta S_{total}$ positive because (spontaneous) reaction has occurred. **(1 mark)**

(b) (i) $K_p = \dfrac{P_{H_2(g)}{}^2 \times P_{O_2(g)}}{P_{H_2O(g)}}$ **(1)**
atm **(1)**
**(2 marks)**

(ii) Greater proportion of $H_2$ as reaction in this direction endothermic. **(1)**
ACCEPT discussion using entropy or Le Chatelier. **(1)**
**(2 marks)**

(c) No $CO_2$ - (green house gas/global warming).
No carbon particles (bronchial illness).
No $SO_2$ - (acid rain).
While $H_2O$ product is environmentally harmless.
Mark by impression.

*Specific points to be given credit. "Greenhouse effect" with no further indication of cause and effect is insufficient. To gain 3 marks, a coherent and well argued answer is needed.* **(3 marks)**
**TOTAL 11 Marks**

5. (a) (i) $C_2H_5CO_2^- + H^+$ **(1 mark)**

(ii) $K_a = \dfrac{[C_2H_5CO_2^-(aq)]\,[H^+(aq)]}{[C_2H_5CO_2H(aq)]}$ **(1 mark)**

(iii) let $[H^+(aq)]_{eq} = x = [C_2H_5CO_2^-(aq)]_{eq}$
$\Rightarrow \quad 1.3 \times 10^{-5} = x^2/0.1$ **(1)**
$\Rightarrow \quad x^2 = 1.3 \times 10^{-6}$
$\Rightarrow \quad x = 1.14 \times 10^{-3}$
$\Rightarrow \quad$ pH $= 2.9(4)$ *ACCEPT* 3 *NOT* 3.0 **(1)**
**(2 marks)**

(b) (i) $7 < pH \leq 11$ ie pH between 7 and 11. **(1)**
Sodium propanoate is the salt of a weak acid and a strong base. **(1)**
**(2 marks)**

(ii) Phenolphthalein. **(1 mark)**

(c) (i) $4.2 = -\lg 1.3\times10^{-5} - \lg \frac{[\text{acid}]}{[\text{base}]}$

$\rightarrow \quad \lg \frac{[\text{acid}]}{[\text{base}]} = 4.89 - 4.2 = 0.69$ **(1)**

$\rightarrow \quad \frac{[\text{acid}]}{[\text{base}]} = 4.89 = 4.9$ **(1)**

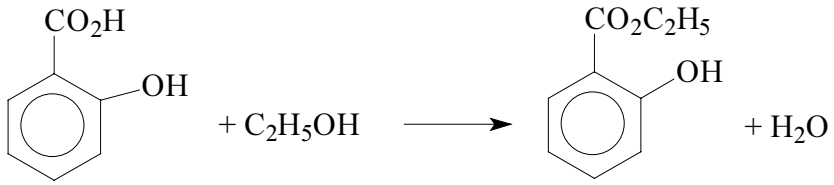
**(2 marks)**

(ii) $\frac{4.900}{5.9} = 830\ cm^3$ **(1 mark)**

**TOTAL 10 Marks**

6. (a) Group 1 = carboxyl or carboxylic acid. **(1)**
Group 2 = phenol or phenolic –OH. **(1)**
**(2 marks)**

(b)




Correct organic product **(1)**
Balanced equation **(1)**

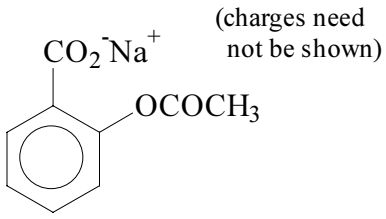
**(2 marks)**

(c) (i) $H^-$/hydride **(1 mark)**

(ii) C atom in $-CO_2H$ has partial positive charge due to electron withdrawing groups. **(1 mark)**

(d) Catalyst/provides $H^+$ ions. **(1 mark)**

(e) (i)




(charges need not be shown)

**(1 mark)**

(ii) Sodium salt less acidic. **(1)**
More soluble. **(1)**
**(2 marks)**

**TOTAL 10 Marks**

**UNIT TEST 5B (6255/02) (SPECIAL STUDIES) MARK SCHEME**

1. **BIOCHEMISTRY**

(a) (i) (A) Sugar (ribose or deoxy-ribose). **(1)**
Base (purine or pyrimidine). **(1)**
Phosphate group. **(1)**
$3 \rightarrow 2$
$2 \rightarrow 1$ **(2 marks)**

(B) In nucleic acids the nucleotides are linked together in long chains (polymer). **(1)**
Two of these chains are linked together to form DNA (polymer). **(1)**
**(2 marks)**

(C) Two nucleotide strands run anti-parallel in a helical formation. **(1 mark)**

(D) The bases link the two strands together; the bases being linked by hydrogen bonds. **(1)**
The planar base molecules stack one above the other like a pile of plates; this maximises the van der Waals interactions between the bases. **(1)**
**(2 marks)**

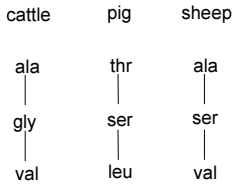
(ii) Conversion endothermic. **(1)**
Used to 'store' energy released during metabolism. **(1)**
ATP essential for many biochemical reactions in mammals. **(1)**
**(3 marks)**

(iii) (A) Maximum values. **(1)**
These give the maximum activity of the enzyme. **(1)**
Limiting value is the rate of reaction of the enzyme and not the speed of diffusion of the substrate. **(1)**
**(3 marks)**

(B) Look for one practical explanation in each of these three cases.
The enzyme is not released from the liver cells for
Graph A: only the 'surface' cells were active **(1)**
Graph B: Crude extract contains much non-enzyme material **(1)**
Graph C: Propanone fraction: much non-enzyme material has been removed. **(1)**
**(3 marks)**
**(16 marks)**

(b) (i) Substances which exert secondary control and **(1)**
co-ordinate the activities of different cells. **(1)**
Many hormones do not enter cells but interact with cell membranes. **(1)**
Hormones can also alter the role of synthesis of a particular enzyme, or the activity of an enzyme **(1)**
**(4 marks)**

(ii) Supplied by the pancreas of cattle, pig and sheep. **(1)**
Synthesised synthetically. **(1)**
Insulin from cattle, pig and sheep differ in one block of the amino acids, in a side chain. **(1)**




Insulin needed to control:
Glucose concentration and glycogen in the liver;
Carboxylic acids and fat deposits;
Amino acids and tissues (muscles) **(1)**
Many diabetics produce abnormal insulin **(1)**
Which is unable to combine in the correct way to the receptor molecule. **(1)**
However, in some diabetics normal insulin has been detected and it appears that in these cases it is the hormone binding site on the cell surface that is defective.
The action of insulin depends on both hormone and receptor having precise and complementary structures **(1)**

**Any six sensible points (6 marks)**

(iii) Problems:
use of hormones from opposite sex can produce undesirable side-effects (probably long-term); **(1)**
excess protein may turn to fat when exercise stopped (or reduced); **(1)**
excess protein in some areas may cause long-term medical problems. **(1)**

**Any two sensible points**

Practical aspects
hormones used during training can be stopped before contest **(1)**
and are then digested before tests are carried out. **(1)**

**(4 marks)**

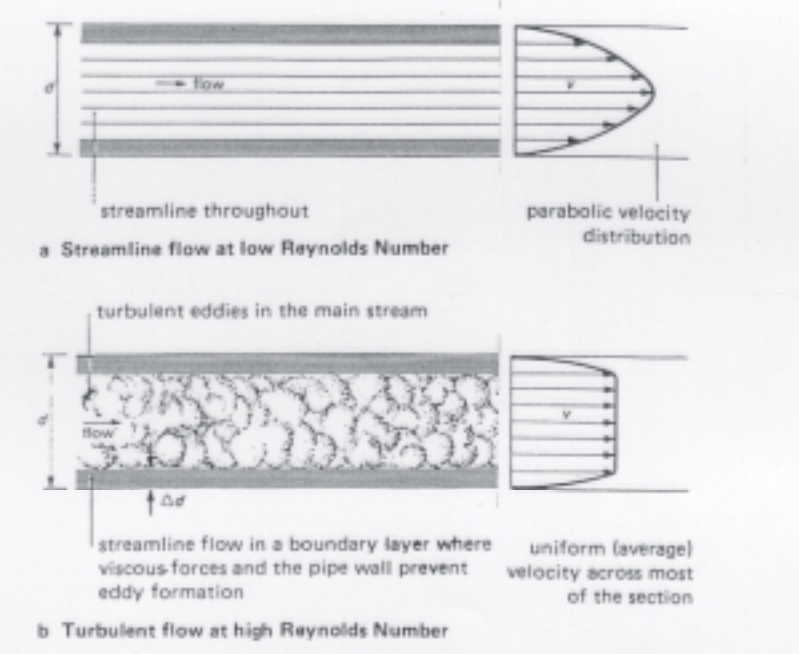
**(14 marks)**

**TOTAL 30 Marks**

## 2. CHEMICAL ENGINEERING

(a) (i) (A) The design and operation of a chemical plant depends on knowing fluid flow rates. **(1 mark)**

(B)




**(3 marks)**

(C) It is dimensionless. **(1)**
Re ≈ 2000/2500 characterises the change. **(1)**
From streamline to turbulent flow. **(1)**
**(3 marks)**

(D) Prefer turbulent flow. **(1)**
Turbulent flow gives good mixing. **(1)**
Heat transfer is much easier due to reduction of boundary layers and film coefficients (accept argument based on bulk fluid movement).
Cost of increased pipe diameter soon outstrips cost of pumping. **(1)**
**(1)**
**(4 marks)**

(ii) (A) Reflux ratio = Reflux rate /distillate rate. **(1 mark)**

(B) More volatile component distils off leaving binary. **(1)**
Mixture richer in least volatile components. **(1)**
Steadily increase the reflux ratio. **(1)**
Distillate quality is increased by increased reflux ratio. **(1)**
**(4 marks)**

(b) (i) Specific processes. **(1 mark)**

(ii) **A** heat transfer **(1)**
Preheating of butan-2-ol to required reactor temperature. **(1)**
**B** main chemical reaction **(1)**
oxidation of butan-2-ol to butanone (Dehydrogenation) **(1)**
**C** Absorption (scrubbing) **(1)**
Separation of butanone and butan-2-ol from hydrogen gas by absorption in water **(1)**
**D** Solvent extraction and liquid separation **(1)**
Butanone from water **(1)**
**E** Distillation **(1)**
Butan-2-ol from trichloroethane (extraction solvent) **(1)**
**Any eight points** **(8 marks)**

(iii) Process stream 14 = Process streams 12 + 5 - 13
Butan-2-ol 14 = 14 + 155 - 156 = 13 kg $hr^{-1}$ **(1)**
Butanone 14 = 213 + 1133 - 2 = 1344 kg $hr^{-1}$ **(1)**
% Butanone = 1344/1357 x 100% = 99.04 % (accept 99%) **(1)**
**(3 marks)**

(iv) Above atmospheric pressure. **(1)**
To facilitate flow of reactants. **(1)** **(2 marks)**
**(14 marks)**
**TOTAL 30 Marks**

3. **FOOD SCIENCE**

(a) (i)

A triglyceride/fat/glyceride/oil/lipid. **(1)**

B protein/polypeptide/peptide. **(1)**

C amylopectin/starch/carbohydrate/polysaccharide. **(1)**

**(3 marks)**

(ii)

A fat - energy (reserve)
insulation or protection
source of fat soluble vitamins/essential fatty acids
**Any one** **(1)**

B protein - enzymes
growth or repair
provider of essential amino acids
**Any one** **(1)**

C starch -main energy source. **(1)**

**(3 marks)**

(iii) Cannot be digested (or absorbed) by the human body. **(1 mark)**
*NOT* roughage.

(iv) Gly.lys or lys.gly **(1)**
with clear peptide linkage showing all bonds. **(1)**
**(2 marks)**

(v) Hydrogen bonding, ionic bonding, disulphide bridges, rigidity of peptide link, possibility of α-helix. Reference to primary, secondary, tertiary structures **(4 marks)**
Mark by impression.

(vi) Amino acid must be obtained from the diet **(1)**
as it cannot be synthesised by the body **(1)**
**(2 marks)**

(vii) The protein, gluten, forms an elastic complex when the flour is kneaded with water to form dough. **(1)**
On heating the protein is denatured and the gluten coagulates to produce a more or less rigid loaf. **(1)**
A strong flour has a higher proportion of protein. **(1)**
Strong flour gives structure: bread.
A weak flour produces a crumbly/brittle/crunchy texture; biscuits. **(1)**
**(4 marks)**
**(19 marks)**

(b) (i) Unhygienic conditions.
Contamination by dirt on udder. **(1)**
Contamination by dirt on dairy utensils. **(1)**
(accept on hands of milker). **(2 marks)**

(ii) Wash udder (and hands) before milking. **(1)**
Wash equipment before and after milking with suitable mild disinfectant. **(1)**
Store milk under cool conditions (to control bacterial growth). **(1)**
Transport milk to factories as soon as possible. **(1)**
**Any three points (3 marks)**

(iii) Pasteurised milk.
Milk heated rapidly to 72$^{o}$C, held for 15 seconds, then cooled rapidly **(1)**

Advantages: Pathogens are killed, made inactive **(1)**
(many enzymes, e.g. lipases are destroyed)
Fewer vitamins are destroyed than in sterilisation. **(1)**
Little effect on taste. **(1)**
**Any two points (2 marks)**

Sterilised milk.
Milk bottled, sealed and heated to above its b.p. for 20-60 minutes. **(1)**

Advantages: All micro-organisms destroyed. **(1)**
Keeps indefinitely. **(1)**
No need to store in a cool place.
**Any two points (1)**
**(2 marks)**
**(11 marks)**
**TOTAL 30 Marks**

4. **MATERIALS SCIENCE**

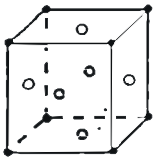
(a) (i) (A) Determination of crystal structure. **(1)**

(B) Discovery of defects. **(1)**

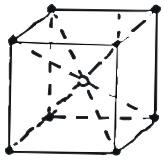
(C) Determination of compostition at discrete points. See page 9 of the Special Studies Booklet. **(1)**

**(3 marks)**

(ii)



fcc **(1)**



bcc **(1)**

**(2 marks)**

(iii) fcc has the higher atomic density **(1)**

hence for same number of atoms bcc volume is greatest - hence iron expands **(1)**

**(2 marks)**

(iv) Substitutional – similar sized foreign atoms replacing atoms of parent element. **(1)**

Interstitial - small sized foreign atoms fitting into spaces of already resident atoms. **(1)**

**(2 marks)**

(v) Cu/Ni more or less same atomic radii /both d-block/both fcc **(1)**

Fe>> C atomic radii/different packing/different Periodic Table groupings. **(1)**

**(2 marks)**

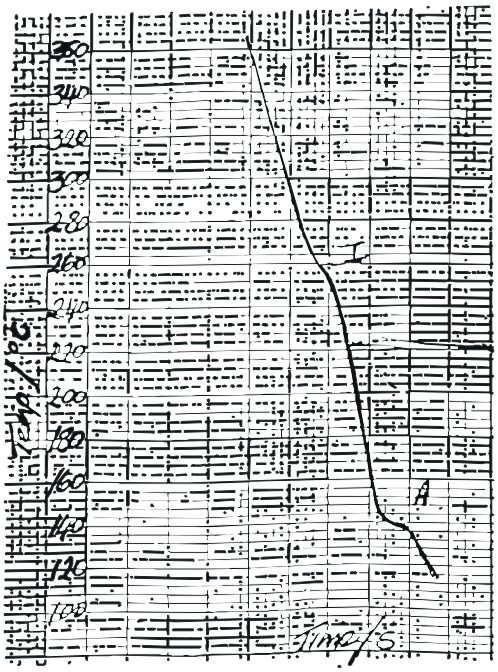
(vi) Single liquid solidifies into two intrinsically mixed solids at a fixed temperature.

(alternate solidification) **(1)**

Lowest constant melting temperature. **(1)**

**(2 marks)**

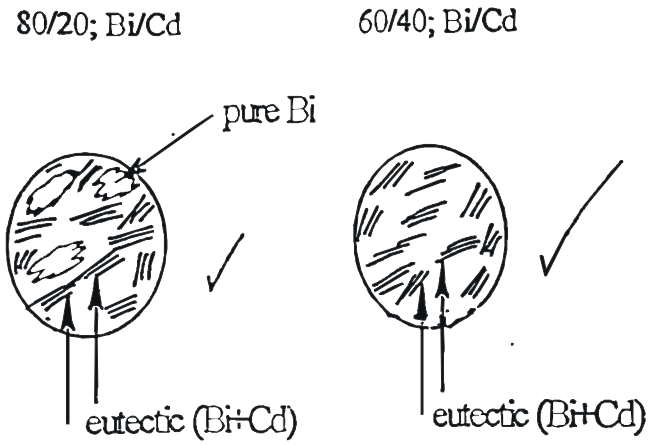
(vii) (A)




**(1 mark)**

(B) Arrest - isothermal phase change/eutectic settles out. **(1)**
Inflexion - phase change over a temperature range/one phase crystallizes out while body of liquid cools further. **(1)**
**(2 marks)**

(C)




Clear labelling in both diagrams. **(2 marks)**
**(18 marks)**

| | | | |
|---|---|---|---|
| (b) | (i) | Cold working leads to increase in hardness. | **(1)** |
| | | Hence have increased hardness at bends and around holes. | **(1)** |
| | | | **(2 marks)** |
| | (ii) | Similar metal so no problem. | **(1)** |
| | | Stress corrosion at bends and around holes. More deformed material is anodic and therefore corrodes. | **(2)** |
| | | Differential aeration beneath bolts and between mild steel components and causes different potentials leading to corrosion of the unexposed anodic areas. | **(2)** |
| | | *Mark by impression from sample answers provided at standardisation*. | **(5 marks)** |
| | (iii) | Enhanced localised corrosion of mild steel | **(1)** |
| | | due to dissimilar metals/different redox potentials. | **(1)** |
| | | | **(2 marks)** |
| | (iv) | Prevents moisture entrapment | **(1)** |
| | | and associated differential aeration problems. | **(1)** |
| | | Problems due to grain boundary precipitations. | **(1)** |
| | | Any other sensible comment. | **(1)** |
| | | **Any three points** | **(3 marks)** |
| | | | **(12 marks)** |
| | | | **TOTAL 30 MARKS** |

5. **MINERAL PROCESS CHEMISTRY**

(a) (i) (A) Economic or valuable minerals. **(1 mark)**

(B) Waste product separated from the required mineral or value. **(1 mark)**

(C) The minimum grade which can be mined economically. **(1 mark)**

(D) The percentage of an element or mineral in the earth's crust. **(1 mark)**

(ii) **A** will command the higher market price. **(1)**
The lower the cut-off grade the more waste rock that must be mined with the mineral and then separated and rejected - thus adding to the cost of production. **(1)**
The lower the crustal abundance the more rare the workable deposits of the ore - the greater expense of exploration. **(1)**
*Mark by impression from sample answers provided at standardisation.* **(4 marks)**

(iii) Xylenol orange indicator **(1)**
1 mole of EDTA reacts with 1 mole of $Zn^{2+}$ **(1)**
moles of EDTA = moles of $Zn^{2+} = \frac{0.1 \times 17.7}{1000} = 1.77 \times 10^{-3}$ **(1)**
$\therefore$ mass of $Zn^{2+}$ in 100g of concentrate $= \frac{0.1 \times 17.7}{1000} \times 10 \times 65.5$ **(1)**
$= 1.16$ g **(1)**
Grade of concentrate $= 1.16 \times \frac{100}{85} \times \frac{1}{100} \times 100 = 1.36\ \%$ **(1)**
**(6 marks)**
**(14 marks)**

(b) (i) From the journals, printed materials of the mining industry. **(1 mark)**

(ii) Ore and gangue not a homogenous mixture. **(1 mark)**

(iii) Drill to obtain core sample and **(1)**
analysis of the sample. **(1)**
**(2 marks)**

(iv) $\rho = \frac{\text{mass}}{\text{volume}}$

$\text{mass} = \rho \times \text{volume} = 2.9 \times 10^6 \times 2 \times 10^6$ **(1)**
$= 5.8 \times 10^{12}$ g **(1)**
**(2 marks)**

(v) Ore content $= \frac{5.8 \times 10^{12}}{100} \times \frac{0.88}{100} = 5.1 \times 10^4$ tonnes **(1)**
market value $= 5.1 \times 10^4 \times 1.2 \times 10^3 = £6.1 \times 10^7$ **(1)**
**(2 marks)**

(vi) Open pit - large quantities of overburden require removal
- need to have large ore body for economic development
Underground pit - small quantity of ore body with
- a high grade (> 1%)
- only about 80% removed
Transport/Road/Housing/Living support – this is dependent on size of ore body.

Choice - dependent upon demand and market value
- underground, more environmentally friendly
- open pit preferable?
Mark by impression from sample answers provided at standardisation.

**Look for five points. (5 marks)**

(vii) Waste will be closely related to volume of ore body. **(1)**
Barren rock dumped (or lanscaped) to form waste tip/site. **(1)**
Mine-water and processing liquids stored in a tailings pond. **(1)**
**(3 marks)**
**(16 marks)**
**TOTAL 30 Marks**

**UNIT TEST 6 (6256) (SYNOPTIC) MARK SCHEME**

**Quality of Written Communication**
Candidates are expected to:
- show clarity of expression;
- construct and present coherent argument;
- demonstrate effective use of grammar, punctuation and spelling.

This applies particularly to the answers to the following questions:
1(b) and (c)
3(b) and (c)
5(c)
6(b)

1. (a)

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(l)$$

$\Delta H_f$ 2(-296.8) 2(-381)

$\Delta H$ = -762 –(-593.6) = - 168.4 kJ mol$^{-1}$
Method **(1)**
Correct answer with sign and units **(1)** **(2 marks)**

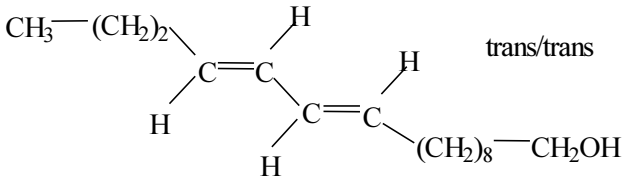
(b) (i) $\Delta S_{system}$ negative (3 moles → 2 moles) **(1)**
$\Delta S_{surroundings}$ positive ($\Delta H$ is negative and $\Delta S_{surroundings} = -\Delta H/T$) **(1)**

(ii) If pressure increased then molecules have less room to move so entropies of all reactants and products decrease; because 3 moles of reactants go to 2 moles of products, entropy of reactants decreases more than entropy of products; so $\Delta S$ reaction more likely to be positive. **(2)**
**(4 marks)**

(c) Keep temperature low to increase yield. **(1)**
Use compromise temperature to give suitable rate. **(1)**
High pressure increase yield. **(1)**
But very high pressure is expensive to produce/requires heavy duty piping. **(1)**
Use a catalyst to give suitable rate at low temperature. **(1)**
Conserve heat from emerging gases. **(1)**
**Any four points (4 marks)**
**TOTAL 10 Marks**

2. (a) (i) Insolubility in water because long hydrocarbon chain. **(1)**
Hydrogen bonds assist solubility. **(1)**

(ii) Possibility of (four) geometric isomers:
eg




one pair **(1)**
second pair **(1)**

(iii) Four reactions which could include:
reactions with sodium, bromine, acidified potassium dichromate, hydrogen, hydrogen halides etc
**1** mark for each correct organic product from a given reactant **(4)**
**(8 marks)**

(b) Products
*ACCEPT* name or formula

| | |
|---|---|
| Butanoic acid | $CH_3(CH_2)_2CO_2H$ |
| Ethanedioic acid | $(CO_2H)_2$ |
| Decanedioic acid | $HO_2C(CH_2)_8CO_2H$ |

3 acids **(2)**
2 acids or 3 aldehydes **(1)**
**(2 marks)**
**TOTAL 10 Marks**

3. (a) Formula:

| | | | |
|---|---|---|---|
| 23.6 g Co | = 23.6/59 | mol | = 0.4 mol |
| 27.9 g N | = 27.9/14 | mol | = 1.99 mol |
| 6.0 g H | = 6.0/1 | mol | = 6.0 mol |
| 42.5 g Cl | = 42.5/35.5 | mol | = 1.197 mol |

Ratio Co:N:H:Cl = 0.4 : 1.99 : 6.0 : 1.2
= 1 : 4.97 : 15 : 3.00
So empirical formula is $CoN_5H_{15}Cl_3$
Allow **1** mark for 3 correct mol calculations, **1** mark for ratios, **1** mark for final formula.

**(3 marks)**

(b) (i) Air is an oxidizing agent. **(1)**
Oxidizes $Co^{2+}$ to $Co^{3+}$ (or equation). **(1)**
(ii) $NH_3$ is ligand **(1)**
$NH_4^+$ is buffer. **(1)**
and provides $Cl^-$ **(1)**
Three points for full credit, including at least one comment on air and one on ammonium chloride. **(5 marks)**

(c) Cobalt has space in 3d orbital for dative covalent bond formation.
$Cl^-$ can form strong dative covalent bonds in complex.
Calcium not a transition metal/electrons can not readily use 3d orbital.
Cobalt and its compounds better catalysts than calcium.
Cobalt compounds coloured, calcium not.
Cobalt compounds found in more oxidation states than calcium.
*OR* other relevant comments
One mark for each well explained comment. **(4 marks)**

**TOTAL 10 Marks**

4. (a) (i) $[O_2(g) + 2H_2O(l)], 4OH^-(aq) \mid Pt$ +0.40 (V)

$I_2(aq), 2I^-(aq) \mid Pt$ +0.54 (V)

$[2H^+(aq) + O_2(g)], H_2O_2(aq) \mid Pt$ +0.68 (V)

$Br_2(aq), 2Br^-(aq) \mid Pt$ +1.09 (V)

$Cl_2(aq), 2Cl^-(aq) \mid Pt$ +1.36 (V)

$F_2(g), 2F^-(aq) \mid Pt$ +2.87 (V)

Candidates may use **either or both** bromine (either aq or l)
(Br(l) gives $E^\ominus$ +1.09V)

Candidates may use **either or both** fluorine ($F_2$ with $H^+$ gives $E^\ominus$ + 3.06V)

Candidates may use **either or both** oxygen ($O_2$ with $H^+$ gives $E^\ominus$ +0.68V)

Note: using both electrodes does not count in the correct cells total.

Where there are alternatives, the correct voltage must be given for it.
Any 4 correct cells **(1),** two more correct cells **(1)**

(ii) $F_2 > Cl_2 > Br_2 > (O_2) > I_2 > (O_2)$
Must be a clear implication of direction of strength **(1)**
(The $O_2$ depends upon which oxygen electrode system is used) **(3 marks)**

(b) $Pt \mid [Fe(OH)_2(s) + OH^-(aq), Fe(OH)_3(s) \vdots [O_2(g) + 2H_2O(l)], 4OH^-(aq) \mid Pt$ **(2)**
Whole cell correct but reversed **(1 max).**
Error in one electrode **(1)** eg Pt missing in both counts as one error.
Errors in both electrodes **(0).**
*IGNORE* state symbols.
$E^\ominus$ = + 0.96V *ALLOW* TE if cell reversed ie -0.96 V. **(1)**
Allow transferred errors if one electrode has iron in it and the other is one of the oxygen electrodes (most likely to be $E^\ominus$ = -0.37V) *OR* $O_3$.
Reaction should go to completion $E^\ominus$ positive and > 0.6 V
Candidates should consider their value and reach a consistent deduction **(1)**
**(4 marks)**

(c) According to the anti-clockwise rule
$Cl_2$ oxidizes Fe to $Fe^{2+}$ **(1)**
and also $Fe^{2+}$ to $Fe^{3+}$. **(1)**
*NOT* $Cl_2$ oxidizes Fe to $Fe^{3+}$ - must show how $I_2$ oxidizes Fe to $Fe^{2+}$ **(1)**
but no further.
*($E^\ominus$* -0.23V for $Fe^{2+} + ½I_2 \rightarrow Fe^{3+} + I^-$) **(3 marks)**

**TOTAL 10 Marks**

5. (a) Mass spectroscopy:
Expect peaks at 30 ($CH_2NH_2^+$) and 76 ($C_6H_4^+$)
in **X** only. **(2)**
Expect peaks at 74 ($CHNH_2COOH^+$) and 77 ($C_6H_5^+$) in **Y** only. **(2)**

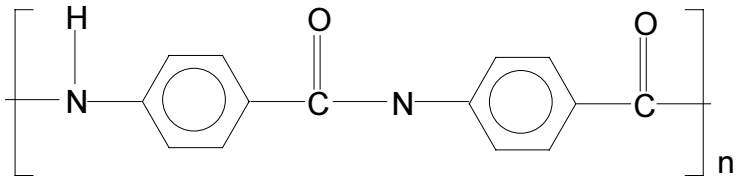
Infra red:
Not distinguished as same bond types present. **(1)**
Example(s) of absorption data. **(2 max)**

NMR:
Ratio of number of hydrogen atoms in different environments is different for each isomer. **(1)**
Illustration of different environments. **(1)**
Example of data. **(2 max)**

A maximum of **3** marks on any method to an overall maximum of **6**
Each method must be considered for full credit. **(6 marks)**

(b) **Y** chiral (chiral centre is C attached to benzene ring). **(1)**
**Y** rotates plane of polarisation of polarised light. **(1)**
**(2 marks)**

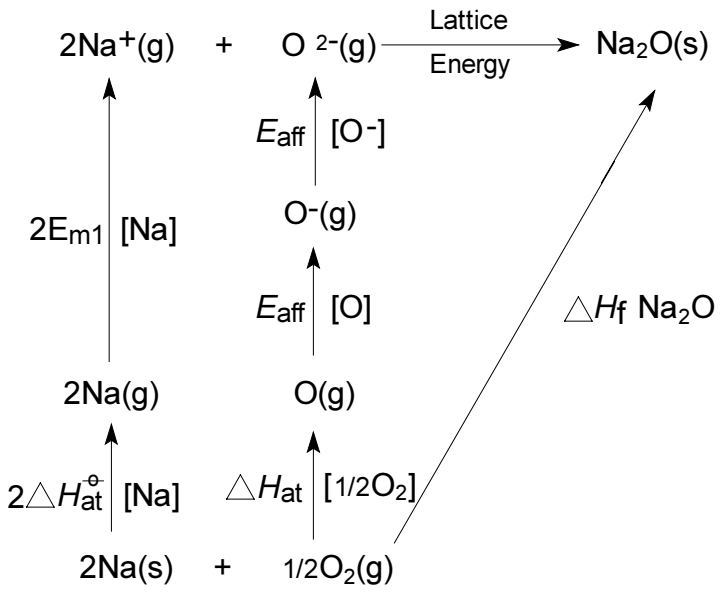
(c)




**1** mark for peptide link drawn correctly.
**1** mark for HCl forming as well. **(2 marks)**

**TOTAL 10 Marks**

6. (a)




214.6 + 249.2 + 992 - 141.1 + 798 + Lattice Energy = -414.2

Lattice Energy = -2526.9 kJ $mol^{-1}$

Cycle: 1 mark each for correctly showing
Atomization
Ionization
Lattice energy
Formation of sodium oxide

Calculation : Method **1** mark
Correct enumeration **1** mark **(6 marks)**

(b) Values very close so ions are
spherical/charge evenly distributed/separate/not polarised/no covalent character.
**Any two (2 marks)**

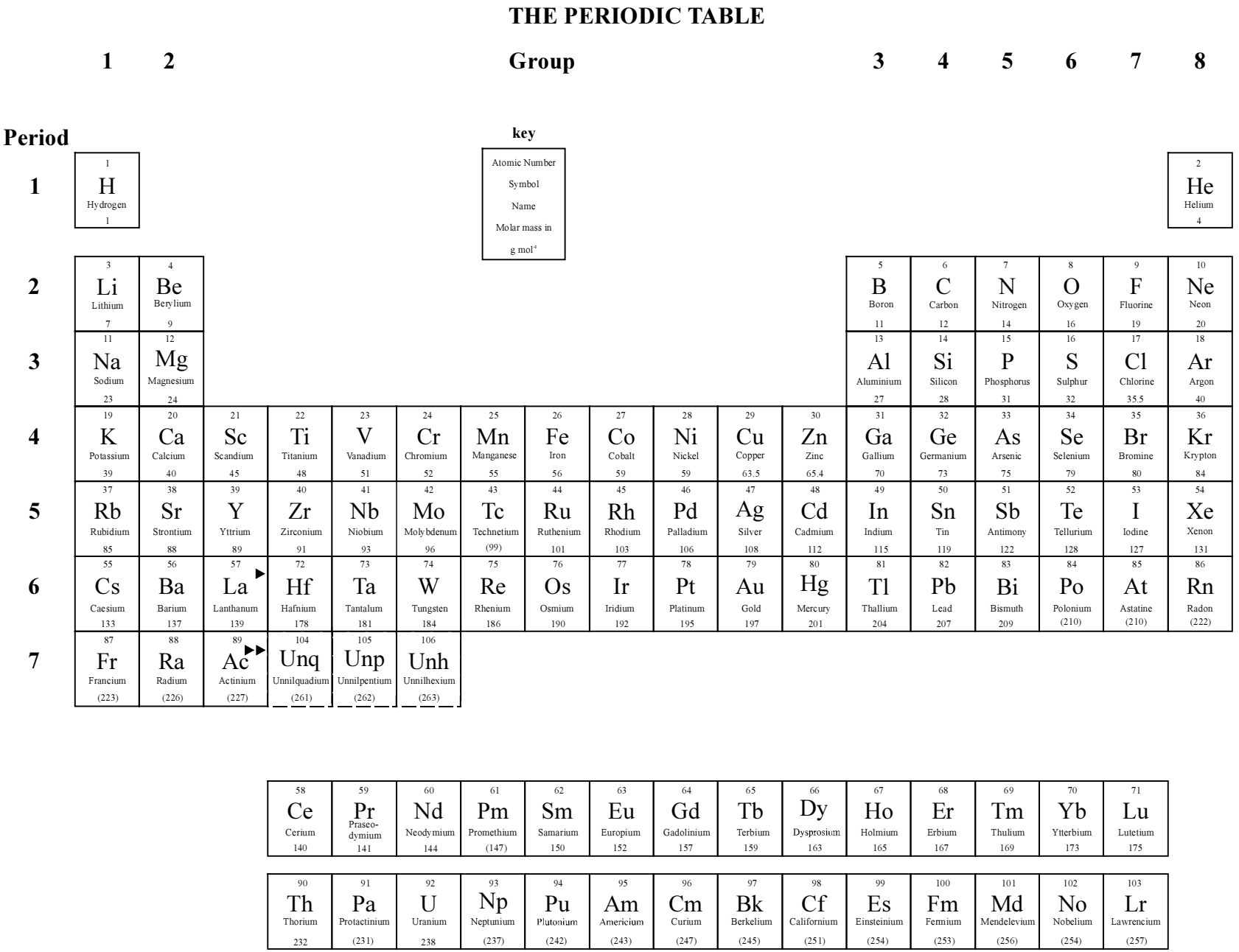
(c) $O^{2-}$: proton acceptor, Brønsted-Lowry base.

$H_2O$ proton donor, Brønsted-Lowry acid. **(2 marks)**

**TOTAL 10 Marks**

**END**

# THE PERIODIC TABLE



**APPENDIX II**

**General Guidance on Marking**

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge, and for critical and imaginative thinking. Examiners should therefore read carefully and consider every response; even if it is not what is expected it may be worthy of credit. The Principal Examiner or Team Leader should be consulted as necessary.

Scripts used in Agreement Trials at the Examiners' Standardisation meeting should be retained for reference, as should photocopied scripts used in the first coordination sample. These will have been selected to include a range of "alternative" answers, some acceptable, others not.

Examiners have been issued with Edexcel's *Instructions and Notes on the Marking of Scripts for the use of Assistant Examiners* and this should be read carefully before any marking is started.

**Using the Mark Scheme**

1. The mark scheme gives you;
   - an idea of the types of response expected
   - how individual marks are to be awarded
   - the total mark for each question
   - examples of responses that should not receive credit.
2. / means that the responses are **alternatives** and either answer should receive full credit.
3. ( ) means that a phrase/word is not essential for the award of the mark but helps the examiner to get the sense of the expected answer.
4. Phrases/words in **bold** indicate that the meaning of the phrase/word is **essential** to the answer.
5. *OWTTE* (or words to that effect) indicates that valid alternatives (which have not been specified) are acceptable.
6. *IGNORE* means that this answer is not worth a mark but does not negate an additional correct response.
7. *NOT* means that the answer is wrong and negates any additional correct response for that specific mark.
8. *ORA* (or reverse argument) indicates that the complete reverse is also valid for the award of marks.
9. *T*E (transferred error) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

**Marking**

1. You must give a tick (in red) for every mark awarded. The tick must be placed on the script close to the answer. The mark awarded for part of a question should be written in the margin close to the sub-total.
2. The sub-total marks for a question should be added together and the total written and ringed at the end of the question then transferred to the front of the script.
3. Suggestion/explanation questions should be marked correct even when the suggestion is contained within the explanation.
4. **Do not** award marks for repetition of the stem of the question.
5. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

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