Total
Section B

X012/301

NATIONAL
QUALIFICATIONS
2000

WEDNESDAY, 7 JUNE
9.00 AM – 11.30 AM

CHEMISTRY
HIGHER

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth
Day Month Year   Scottish candidate number   Number of seat

Reference may be made to the Chemistry Higher and Advanced Higher Data Booklet (1999 edition).

SECTION A—Part 1 Questions 1–30 and Part 2 Questions 31–34

Instructions for completion of Part 1 and Part 2 are given on pages two and eight respectively.

SECTION B

1   All questions should be attempted.

2   The questions may be answered in any order but all answers are to be written in the spaces provided in this answer book, and must be written clearly and legibly in ink.

3   Rough work, if any should be necessary, should be written in this book and then scored through when the fair copy has been written.

4   Additional space for answers and rough work will be found at the end of the book. If further space is required, supplementary sheets may be obtained from the invigilator and should be inserted inside the front cover of this book.

5   The size of the space provided for an answer should not be taken as an indication of how much to write. It is not necessary to use all the space.

6   Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.

Check that the answer sheet provided is for Chemistry Higher (Section A).

Fill in the details required on the answer sheet.

In questions 1 to 30 of this part of the paper, an answer is given by indicating the choice A, B, C or D by a stroke made in INK in the appropriate place in Part 1 of the answer sheet—see the sample question below.

For each question there is only ONE correct answer.

Rough working, if required, should be done only on this question paper, or on the rough working sheet provided—**not** on the answer sheet.

At the end of the examination the answer sheet for Section A **must** be placed **inside** this answer book.

This part of the paper is worth 30 marks.

SAMPLE QUESTION

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

      A   fractional distillation

      B   chromatography

      C   fractional crystallisation

      D   filtration.

The correct answer is B—chromatography. A **heavy** vertical line should be drawn joining the two dots in the appropriate box in the column headed **B** as shown **in the example on the answer sheet**.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus, if you want to change an answer **D** to an answer **B**, your answer sheet would look like this:
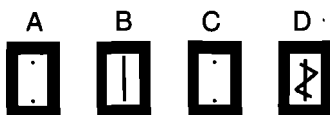
If you want to change back to an answer which has already been scored out, you should **enter a tick (✓)** to the RIGHT of the box of your choice, thus:

1. Which chloride conducts electricity when molten?

   A Calcium chloride

   B Nitrogen chloride

   C Phosphorus chloride

   D Silicon chloride

2. Which pair of solutions is most likely to produce a precipitate when mixed?

   A Magnesium nitrate + sodium chloride

   B Magnesium nitrate + sodium sulphate

   C Silver nitrate + sodium chloride

   D Silver nitrate + sodium sulphate

3. What volume of $0.4 \, mol \, l^{-1}$ sodium hydroxide solution is needed to neutralise $50 \, cm^3$ of $0.1 \, mol \, l^{-1}$ sulphuric acid?

   A $25 \, cm^3$

   B $50 \, cm^3$

   C $100 \, cm^3$

   D $200 \, cm^3$

4. Particles with the same electron arrangement are said to be isoelectronic.

   Which compound contains ions which are isoelectronic?

   A Na_2O

   B LiF

   C CaO

   D $CaBr_2$

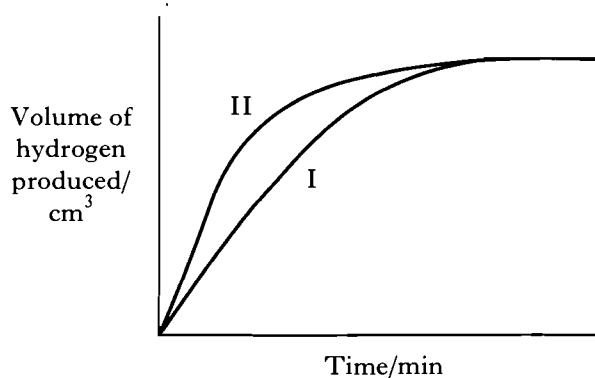5. The graph shows the variation of concentration of a reactant with time as a reaction proceeds.
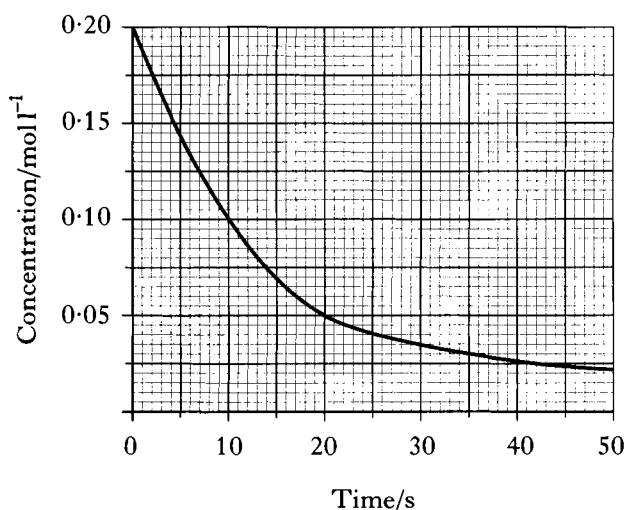
   What is the average reaction rate during the first 20 s?

   A $0.0025 \, mol \, l^{-1} s^{-1}$

   B $0.0050 \, mol \, l^{-1} s^{-1}$

   C $0.0075 \, mol \, l^{-1} s^{-1}$

   D $0.0150 \, mol \, l^{-1} s^{-1}$

6. Excess zinc was added to $100 \, cm^3$ of hydrochloric acid, concentration $1 \, mol \, l^{-1}$.

   Graph I refers to this reaction.

   Graph II could be for

   A excess zinc reacting with $100 \, cm^3$ of hydrochloric acid, concentration $2 \, mol \, l^{-1}$

   B excess zinc reacting with $100 \, cm^3$ of sulphuric acid, concentration $1 \, mol \, l^{-1}$

   C excess zinc reacting with $100 \, cm^3$ of ethanoic acid, concentration $1 \, mol \, l^{-1}$

   D excess magnesium reacting with $100 \, cm^3$ of hydrochloric acid, concentration $1 \, mol \, l^{-1}$.

7.

Reaction pathway
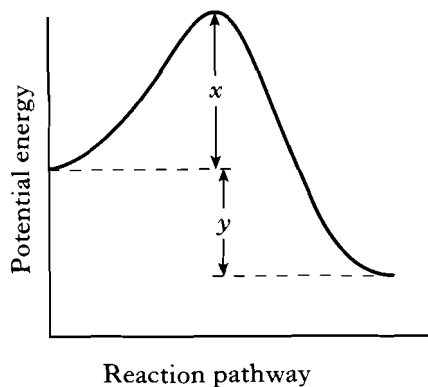
The enthalpy change for the forward reaction can be represented by

A x

B y

C $x + y$

D $x - y$.

8. The difference between the atomic size of sodium and chlorine is mainly due to the difference in the

A number of electrons

B number of protons

C number of neutrons

D mass of each atom.

9. In which molecule will the chlorine atom carry a partial positive charge ($\delta +$)?

A $Cl - Br$

B $Cl - Cl$

C $Cl - F$

D $Cl - I$

10. Which statement may be correctly applied to silicon dioxide?

A It consists of discrete molecules.

B It has a covalent network structure.

C It is similar in structure to carbon dioxide.

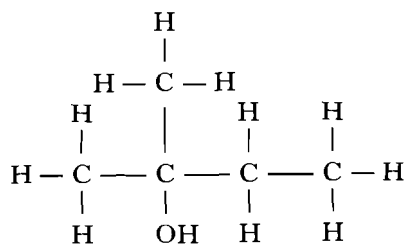D Van der Waals' attractions are important to its structure.

11. Which of the following contains one mole of neutrons?

A $1 g$ of $_{1}^{1}H$

B $1 g$ of $_{6}^{12}C$

C $2 g$ of $_{12}^{24}Mg$

D $2 g$ of $_{10}^{22}Ne$

12. Which ester is an isomer of butanoic acid?

A Ethyl ethanoate

B Ethyl methanoate

C Ethyl propanoate

D Propyl ethanoate

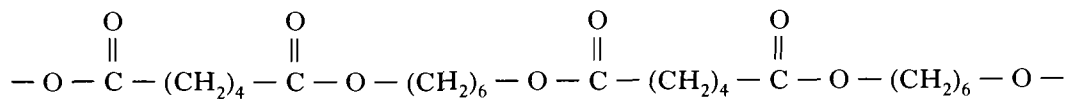**13.** What product(s) would be expected upon dehydration of the following alcohol?

A 2-methylbut-2-ene only

B 2-methylbut-2-ene and 2-methylbut-1-ene

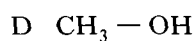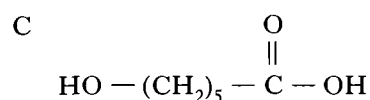C 2-methylbut-1-ene only
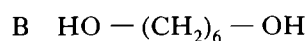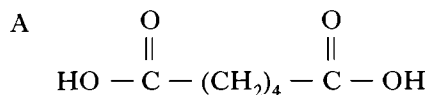
D 3-methylbut-1-ene and 2-methylbut-1-ene

14. Which consumer product is least likely to contain esters?

A Flavourings

B Perfumes

C Solvents

D Toothpastes

15. Part of a polymer chain is shown below.

$$-O-\overset{\overset{\displaystyle O}{\|}}{C}-(CH_2)_4-\overset{\overset{\displaystyle O}{\|}}{C}-O-(CH_2)_6-O-\overset{\overset{\displaystyle O}{\|}}{C}-(CH_2)_4-\overset{\overset{\displaystyle O}{\|}}{C}-O-(CH_2)_6-O-$$

Which compound, when added to the reactants during polymerisation, would stop the polymer chain from getting too long?

A $HO-\overset{\overset{\displaystyle O}{\|}}{C}-(CH_2)_4-\overset{\overset{\displaystyle O}{\|}}{C}-OH$

B $HO-(CH_2)_6-OH$

C $HO-(CH_2)_5-\overset{\overset{\displaystyle O}{\|}}{C}-OH$

D CH_3-OH

---

16. Ethene is used in the manufacture of addition polymers.

What type of reaction is used to produce ethene from ethane?

A   Addition

B   Cracking

C   Hydrogenation

D   Oxidation

17. Which polymer can dissolve in water?

A   Poly(ethenol)

B   Poly(ethyne)

C   Biopol

D   Kevlar

18. Amino acids are converted into proteins by

A   hydration

B   hydrolysis

C   hydrogenation

D   condensation.

19. Fats have higher melting points than oils because comparing fats and oils

A   fats have more hydrogen bonds

B   fats have more cross-links between molecules

C   fat molecules are more loosely packed

D   fat molecules are more saturated.

20. The costs involved in the industrial production of a chemical are made up of fixed costs and variable costs.

Which of the following is most likely to be classified as a variable cost?

A   The cost of land rental

B   The cost of plant construction

C   The cost of labour

D   The cost of raw materials

[Turn over

21. $N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$ $\Delta H = +88\,kJ$

    $N_2(g) + 2O_2(g) \rightarrow N_2O_4(g)$ $\Delta H = +10\,kJ$

The enthalpy change for the reaction

$2NO_2(g) \rightarrow N_2O_4(g)$ will be

A $+98\,kJ$

B $+78\,kJ$

C $-78\,kJ$

D $-98\,kJ$.

22. Chemical reactions are in a state of dynamic equilibrium only when

    A the rate of the forward reaction equals that of the backward reaction

    B the concentrations of reactants and products are equal

    C the activation energies of the forward and backward reactions are equal

    D the reaction involves zero enthalpy change.

23. Under the conditions used industrially, ethene and steam react as follows.

    $C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$
    $$\Delta H = -46\,kJ\,mol^{-1}$$
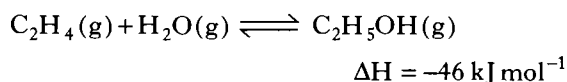
    Which set of conditions would give the best yield of ethanol at equilibrium?

    A High temperature, low pressure

    B High temperature, high pressure

    C Low temperature, high pressure

    D Low temperature, low pressure

24. Which of the following is the best description of a $0 \cdot 1\,mol\,l^{-1}$ solution of hydrochloric acid?

    A Dilute solution of a weak acid

    B Dilute solution of a strong acid

    C Concentrated solution of a weak acid

    D Concentrated solution of a strong acid

25. A trout fishery owner added limestone to his loch to combat the effects of acid rain. He managed to raise the pH of the water from 4 to 6.

    The concentration of the $H^+(aq)$

    A increased by a factor of 2

    B increased by a factor of 100

    C decreased by a factor of 2

    D decreased by a factor of 100.

26. Which of the following is the same for equal volumes of $0 \cdot 1\,mol\,l^{-1}$ solutions of sodium hydroxide and ammonia?

    A pH of solution

    B Mass of solute present

    C Conductivity of solution

    D The number of moles of hydrochloric acid needed for neutralisation

27. During a redox process in acid solution, iodate ions, $IO_3^-(aq)$, are converted into iodine, $I_2(aq)$.

    $$IO_3^-(aq) \rightarrow I_2(aq)$$
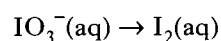
    The numbers of $H^+(aq)$ and $H_2O(\ell)$ required to balance the ion-electron equation for the formation of 1 mol of $I_2(aq)$ are, respectively

    A 6 and 3

    B 3 and 6

    C 12 and 6

    D 6 and 12.

28. The reduction of copper ions during electroplating can be represented as:

    $$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$
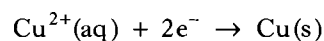
    What is the quantity of electricity needed to produce $0 \cdot 25$ mol of copper?

    A $24\,125\,C$

    B $48\,250\,C$

    C $96\,500\,C$

    D $193\,000\,C$

29. A radioactive atom of a Group 4 element emits one β-particle.

The decay product will be an atom of an element in

A Group 3

B Group 4

C Group 5

D Group 6.

30. The half-life of the isotope ^{210}Pb is 21 years.

What fraction of the original ^{210}Pb atoms will be present after 63 years?

A 0·5

B 0·25

C 0·125

D 0·0625

[Turn over

SECTION A

PART 2

In questions 31 to 34 of this part of the paper, an answer is given by circling the appropriate letter (or letters) in the answer grids provided on Part 2 of the answer sheet.

In some questions, two letters are required for full marks.

If more than the correct number of answers is given, marks may be deducted.

In some cases the number of correct responses is NOT identified in the question.

This part of the paper is worth 10 marks.

SAMPLE QUESTION

A CH_4	B H_2	C CO_2
D CO	E C_2H_6	F N_2

(a) Identify the diatomic **compound(s)**.

A	B	C
(D)	E	F

The one correct answer to part (a) is D. This should be circled.

(b) Identify the **two** substances which burn to produce **both** carbon dioxide **and** water.

(A)	B	C
D	(E)	F

As indicated in this question, there are **two** correct answers to part (b). These are A and E.

Both answers are circled.

(c) Identify the substance(s) which can **not** be used as a fuel.

A	B	(C)
D	E	(F)

There are **two** correct answers to part (c). These are C and F.

Both answers are circled.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and circle the answer you now consider to be correct. Thus, in part (a), if you want to change an answer **D** to an answer **A**, your answer sheet would look like this:

(A)	B	C
(D̸)	E	F

If you want to change back to an answer which has already been scored out, you should enter a tick (✓) in the box of the answer of your choice, thus:

(A̸)	B	C
✓(D̸)	E	F

31. The grid shows the concentration of solutions, in $mol\,l^{-1}$.

A		B		C	
	2×10^{-1}		1×10^{-1}		1×10^{-2}
D		**E**		**F**	
	1×10^{-3}		2×10^{-12}		1×10^{-12}

(a) Identify the concentration of hydrogen ions in a solution which has a pH of 2.

(b) A solution is made by pipetting $10 \cdot 0\,cm^3$ of $0 \cdot 10\,mol\,l^{-1}$ sodium hydroxide solution into a $100\,cm^3$ standard flask and making up to the mark with distilled water.

Identify the concentration of hydrogen ions in the solution.

32. The grid shows quantities of five different gases.

A		B		C		D		E	
	$7\,g$ CO		$32\,g$ CH_4		$4\,g$ H_2		$32\,g$ SO_2		$17\,g$ NH_3

(a) Identify the **two** gases which occupy the same volume.

(Assume all measurements are made under the same conditions of temperature and pressure.)
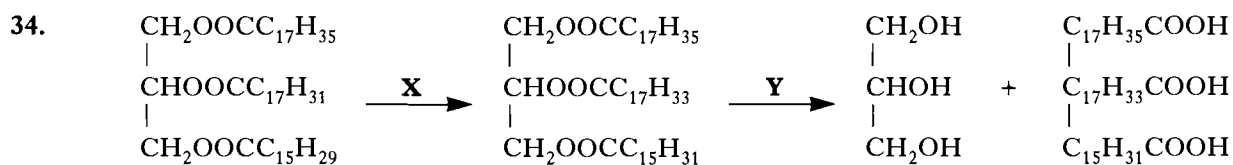
(b) Identify the **two** gases which contain the same number of atoms.

[Turn over

33. Many factors influence the rates of reactions.

A		B		C	
particle size of reactants		temperature		surface area available for reaction	
D		E		F	
activation energy		concentration		average kinetic energy of reactant molecules	

(a) Identify the factor which, if increased, causes an increase in the factor shown in box **F**.

(b) Identify the factor(s) which, if increased, would make a reaction slower.

34.

$$CH_2OOCC_{17}H_{35}$$
$$CHOOCC_{17}H_{31}$$
$$CH_2OOCC_{15}H_{29}$$
$$\xrightarrow{\textbf{X}}$$
$$CH_2OOCC_{17}H_{35}$$
$$CHOOCC_{17}H_{33}$$
$$CH_2OOCC_{15}H_{31}$$
$$\xrightarrow{\textbf{Y}}$$
$$CH_2OH$$
$$CHOH$$
$$CH_2OH$$
$$+$$
$$C_{17}H_{35}COOH$$
$$C_{17}H_{33}COOH$$
$$C_{15}H_{31}COOH$$

A		B		C	
Hydration		Addition		Hydrolysis	
D		E		F	
Oxidation		Hydrogenation		Condensation	

(a) Identify the name which could be applied to reaction **Y**.

(b) Identify the name(s) which could be applied to reaction **X**.

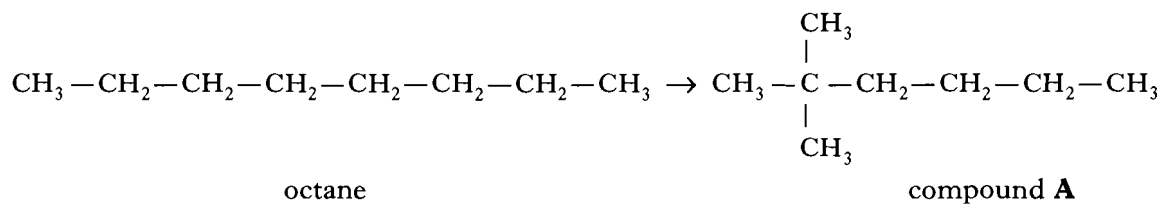**Candidates are reminded that the answer sheet MUST be returned INSIDE this answer book.**

[Turn over for Section B]

Page eleven

SECTION B

1. Petrol is produced by the reforming of a fraction obtained from crude oil.

   One such reforming reaction is:

$$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3 \rightarrow CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}} - CH_2-CH_2-CH_2-CH_3$$

                   octane   compound **A**

   (a) Which crude oil fraction is reformed to make petrol?

   1

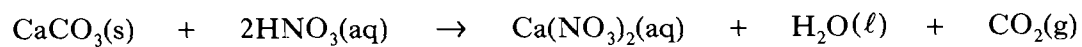   (b) Give the systematic name for compound **A**.

   1

   (c) If the petrol burned in a car engine contains straight-chain alkanes, like octane, a process called "knocking" takes place.

   Why does the presence of straight-chain alkanes result in "knocking"?

   1
   (3)

2. Calcite is a very pure form of calcium carbonate which reacts with nitric acid as follows.

$$CaCO_3(s) \quad + \quad 2HNO_3(aq) \quad \rightarrow \quad Ca(NO_3)_2(aq) \quad + \quad H_2O(\ell) \quad + \quad CO_2(g)$$

A $2 \cdot 14\,g$ piece of calcite was added to $50 \cdot 0\,cm^3$ of $0 \cdot 200\,mol\,l^{-1}$ nitric acid in a beaker.

(*a*) Calculate the mass of calcite, in grams, left unreacted.
(Show your working clearly.)

2

(*b*) Describe what could be done to check the result obtained in (*a*).

1

(3)

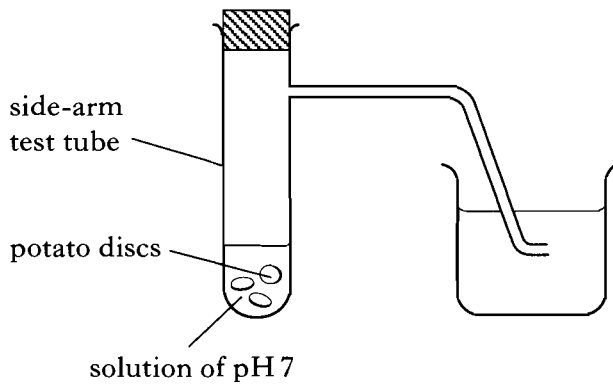**[Turn over**

3. All enzymes are globular proteins.

(*a*) What term is used to describe proteins which are **not** globular?

1

(*b*) Catalase is an enzyme, contained in potatoes.
A student was studying the effect of varying pH on the activity of catalase.
The following apparatus was set up and left for 3 minutes.

side-arm
test tube

potato discs

solution of pH 7

(i) What must be added to the side-arm test tube to study the enzyme activity at this pH?

1

(ii) Describe how the enzyme activity at this pH can be measured.

1

**(3)**

Marks

4. (*a*) Nuclear reactions can be carried out by scientists. For example, lawrencium–257 has been made by bombarding californium–252 with atoms of an isotope of a lighter element. Each successful collision was accompanied by the release of six neutrons.

Write a nuclear equation for this reaction.

1

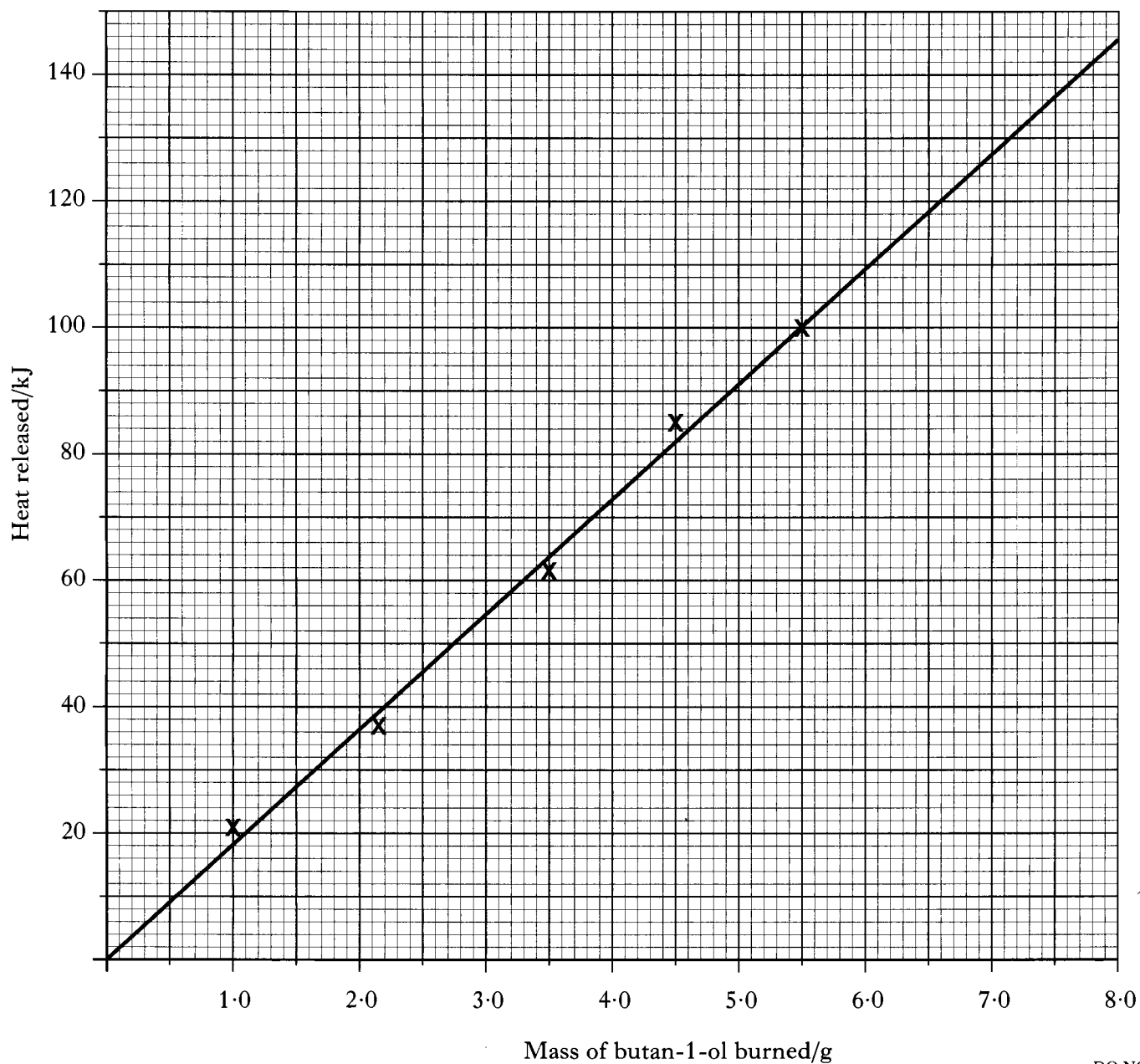(*b*) An example of a nuclear reaction which happens in nature is:

$$^{12}_{6}C \quad + \quad ^{4}_{2}He \quad \rightarrow \quad ^{16}_{8}O$$
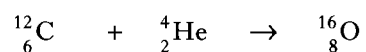
Where do reactions of this type take place all the time?

1

(2)

[Turn over

5. A group of students carried out experiments to find the enthalpy of combustion of butan-1-ol (C_4H_9OH).

Their results are shown on the graph.

Mass of butan-1-ol burned/g

Marks

(*a*) Use the graph to find the heat released by burning 0·10 mol of butan-1-ol.

1

5. (continued)

(b) Draw a labelled diagram of the assembled apparatus the students could have used to carry out the experiments.

1

(c) (i) **In another experiment** a group of students found that 0·10 mol of butan-1-ol released 143 kJ on burning.

Use this value to calculate the enthalpy of combustion of butan-1-ol.

1

(ii) The enthalpies of combustion of methanol, ethanol and propan-1-ol are given in the data booklet.

Use these values to predict the enthalpy of combustion of butan-1-ol.

1

(iii) In addition to heat loss, give another reason to explain why the experimental value for the enthalpy of combustion of butan-1-ol is significantly lower than the value given in data books.
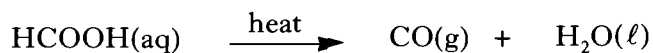
1

(5)

[Turn over

Marks

6. Methanoic acid, HCOOH, can break down to carbon monoxide and water by two different reactions, **A** and **B**.

Reaction A (catalysed)

$$HCOOH(aq) + H^+(aq) \longrightarrow CO(g) + H_2O(\ell) + H^+(aq)$$

Reaction B (uncatalysed)
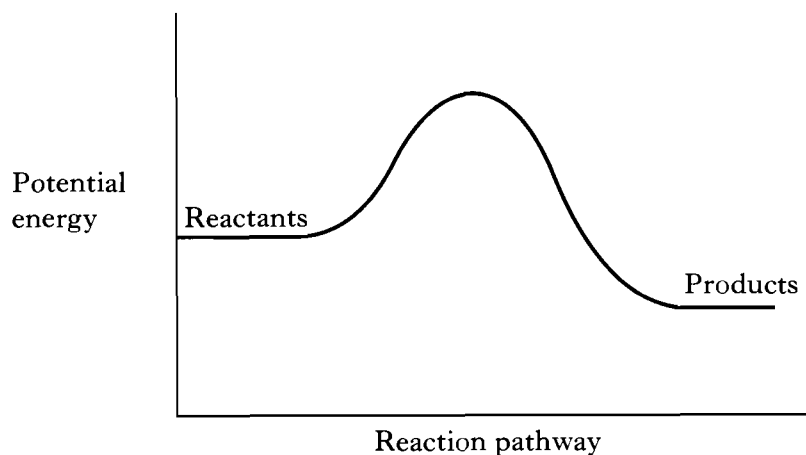
$$HCOOH(aq) \xrightarrow{\text{heat}} CO(g) + H_2O(\ell)$$

(a) (i) What is the evidence in the equation for Reaction **A** that the $H^+(aq)$ ion acts as a catalyst?

1

(ii) Explain whether Reaction **A** is an example of heterogeneous or homogeneous catalysis.

1

(b) The energy diagram for the **catalysed** reaction is:

Reaction pathway

Draw a line on the diagram to show the reaction pathway for the **uncatalysed** reaction.

1

(3)

Marks

7. Diphosphine, P_2H_4, is a hydride of phosphorus. All of the covalent bonds in diphosphine molecules are non-polar because the elements present have the same electronegativity.

   (a) What is meant by the term "electronegativity"?

<div align="right">1</div>

   (b) The balanced equation for the complete combustion of diphosphine is:

$$2P_2H_4(g) \quad + \quad 7O_2(g) \quad \rightarrow \quad P_4O_{10}(s) \quad + \quad 4H_2O(\ell)$$
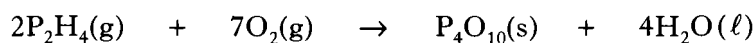
   What volume of oxygen would be required for the complete combustion of $10\,cm^3$ of diphosphine?

<div align="right">1</div>

   (c) Calculate the volume occupied by $0.330\,g$ of diphosphine.
   (Take the molar volume to be 24.0 litres mol^{-1}.)
   (Show your working clearly.)

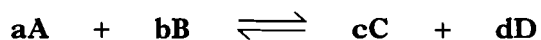<div align="right">1</div>

<div align="right">(3)</div>

[Turn over

8. The balanced equation for a reaction at equilibrium is:

$$aA \quad + \quad bB \quad \rightleftharpoons \quad cC \quad + \quad dD$$
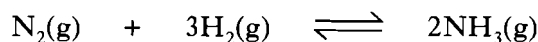
(a) For this reaction, the equilibrium constant, **K**, can be defined as:

$$K = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

where **[A]** represents the concentration of **A**, etc and **a** represents the number of moles of **A**, etc.

(i) Write down the expression for the equilibrium constant for the following equilibrium.

$$N_2(g) \quad + \quad 3H_2(g) \quad \rightleftharpoons \quad 2NH_3(g)$$

(ii) What will happen to the position of an equilibrium if the reaction is carried out over a catalyst?

(b) In industry, the reaction of nitrogen with hydrogen to produce ammonia by the Haber Process does **not** attain equilibrium.
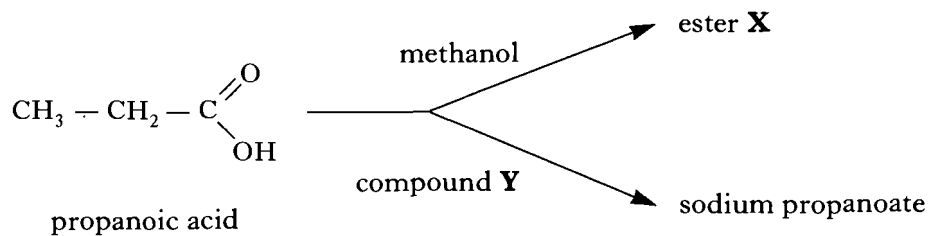
Give **one** feature of the operating conditions which leads to the Haber Process not reaching equilibrium.

1

1

1

(3)

9. Two reactions of propanoic acid are shown.

$$CH_3 - CH_2 - C \overset{O}{\underset{OH}{<}}$$

methanol → ester **X**

compound **Y** → sodium propanoate

propanoic acid

(a) Draw a structural formula for ester **X**.

1

(b) (i) Give a name for compound **Y**, which reacts with propanoic acid to form sodium propanoate.

1

(ii) Explain why solutions of sodium propanoate are alkaline.

2

(4)

[Turn over

Marks

10. In 1996, the scientists Robert Curl, Harold Kroto and Richard Smalley won the Nobel Prize in Chemistry for their contribution to the discovery of new forms of carbon called fullerenes.

(*a*) In what way does the structure of fullerenes differ from the other forms of carbon, diamond and graphite?

1

(*b*) One form of fullerene, C_{60}, forms a superconducting crystalline compound with potassium.

Its formula can be represented as K_3C_{60}.

A sample of this compound was found to contain 2·88 g of carbon.

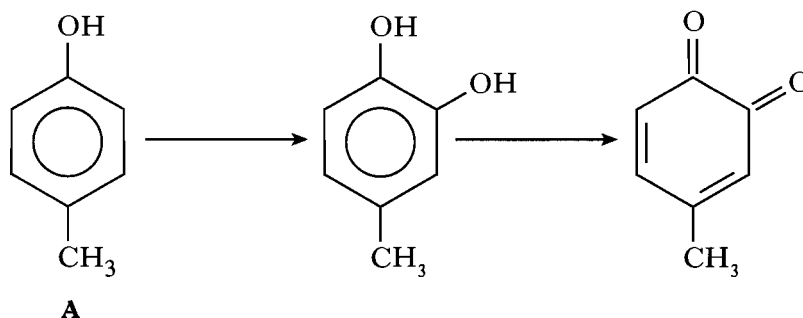(i) Calculate the number of moles of fullerene used to make this compound.

1

(ii) Calculate the mass of potassium, in grams, in the sample.

1

(3)

11. Peeled apples turn brown due to the reactions of compounds called phenols.

The first two steps in the reaction of one phenol, **A**, are:

A

(a) The same type of reaction takes place in both steps.

Give the name of this type of reaction.

1

(b) The molecular formula for compound **A** can be written as C_7H_xO.

What is the value of x?

1

(c) An enzyme called phenolase, present in apples, acts as a catalyst during the browning of apples. It has been discovered that covering a slice of apple with lemon juice stops it from going brown.

Suggest a reason for this.

1

(3)

[Turn over

**12.** Some rockets have a propellant system which combines dinitrogen tetroxide with methylhydrazine.

$$5N_2O_4 \quad + \quad 4CH_3NHNH_2 \quad \rightarrow \quad \textbf{\textit{x}}N_2 \quad + \quad \textbf{\textit{y}}H_2O \quad + \quad \textbf{\textit{z}}CO_2$$
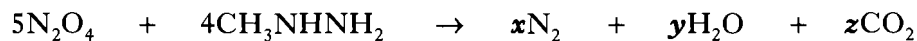
(a) State the values of $\textbf{\textit{x}}$, $\textbf{\textit{y}}$ and $\textbf{\textit{z}}$ required to balance the above equation.

1

(b) Draw the full structural formula for methylhydrazine.

1

(c) Methylhydrazine burns according to the following equation.

$$CH_3NHNH_2(\ell) + 2\tfrac{1}{2}O_2(g) \rightarrow CO_2(g) + 3H_2O(\ell) + N_2(g) \qquad \Delta H = -1305\,kJ\,mol^{-1}$$
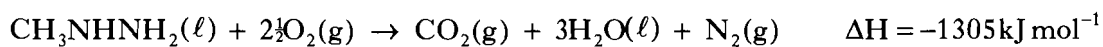
Use this information, together with information from page 9 of the data booklet, to calculate the enthalpy change for the following reaction.

$$C(s) \quad + \quad N_2(g) \quad + \quad 3H_2(g) \quad \rightarrow \quad CH_3NHNH_2(\ell)$$
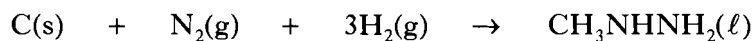
(Show your working clearly.)

3

(5)

Marks

13. Ionisation energies provide information about the structure of atoms.

    (*a*) Write the equation, showing state symbols, for the first ionisation energy of sodium.

1

    (*b*) Calculate the number of electrons lost when one mole of boron atoms is converted into one mole of boron ions with a charge of 3+.

1

(2)

[Turn over

14. Alkanols can be prepared by the reaction of carbonyl compounds with methyl magnesium bromide. The reaction takes place in two stages.

Stage 1

Methyl magnesium bromide reacts with methanal in an addition reaction across the carbonyl group.

$$H_2C=O \quad + \quad H_3C-MgBr \quad \longrightarrow \quad H_3C-CH_2-O-MgBr$$

methanal   methyl magnesium bromide

Stage 2

Reaction of the product with water produces ethanol.

$$H_3C-CH_2-O-MgBr \quad + \quad H_2O \quad \longrightarrow \quad H_3C-CH_2-OH \quad + \quad MgBrOH$$

ethanol

(a)   (i)   Suggest a name for the type of reaction which takes place in Stage 2.

1

     (ii)   Draw a structural formula for the product if propanone had been used in place of methanal in this reaction.

1

14. (*a*) (continued)

(iii) A reaction in which 5·01 g of methanal was used yielded 5·75 g of ethanol. Calculate the percentage yield.
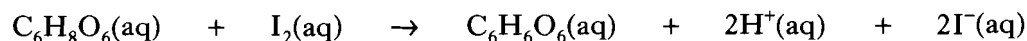
2

(*b*) State an important industrial use for methanal.

1
(5)

[Turn over

15. Vitamin C, $C_6H_8O_6$, is a powerful reducing agent. The concentration of vitamin C in a solution can be found by titrating it with a standard solution of iodine, using starch as an indicator. The equation for the reaction is:

$$C_6H_8O_6(aq) \quad + \quad I_2(aq) \quad \rightarrow \quad C_6H_6O_6(aq) \quad + \quad 2H^+(aq) \quad + \quad 2I^-(aq)$$

(a) Write an ion-electron equation for the reduction half-reaction.

1

(b) A work card gave the following instructions as part of an investigation into the vitamin C content of a tablet. Some instructions have been omitted.

Estimation of Vitamin C

1. Add a vitamin C tablet to about $50\,cm^3$ of de-ionised water in a small beaker and stir to dissolve.

2. Transfer quantitatively to a $250\,cm^3$ standard flask.

3.

$0.0200\,mol\,l^{-1}$ iodine solution

$25.0\,cm^3$ vitamin C solution
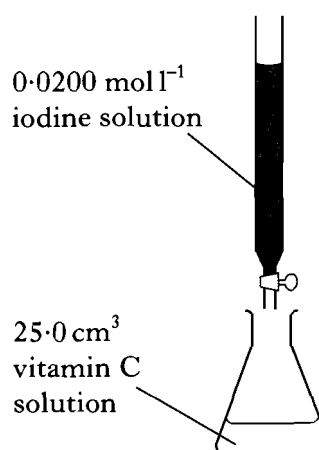
(i) To "transfer quantitatively" means that **all** of the vitamin C must be transferred into the standard flask.

Describe how this is carried out in practice.

1

15. (*b*) **(continued)**

(ii) What colour change indicates that the end-point of the titration has been reached?

(*c*) In one investigation, it was found that an average of $29 \cdot 5 \, cm^3$ of $0 \cdot 02 \, mol \, l^{-1}$ iodine solution was required to react completely with $25 \cdot 0 \, cm^3$ of vitamin C solution.

Use this result to calculate the mass, in grams, of vitamin C present in each tablet.
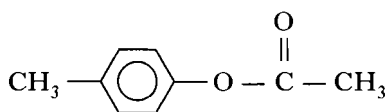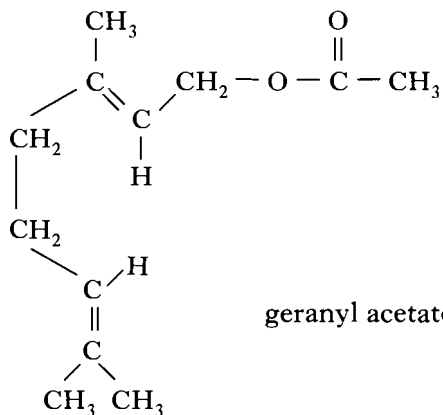
[Turn over

Marks

16. Perfumes normally contain three groups of components called the **top note**, the **middle note** and the **end note**.

(*a*) The **top note** components of a perfume form vapours most easily. Two compounds found in **top note** components are:

$$CH_3 - \text{(ring)} - O - \overset{\displaystyle O}{\overset{\|}{C}} - CH_3$$

p-cresyl acetate

geranyl acetate

(i) With reference to the structure of these compounds, why are they likely to have pleasant smells?

1

(ii) Describe a chemical test which would distinguish between these two compounds and give the result of the test.
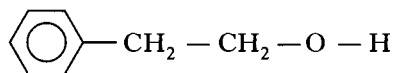
1

Marks

16. (continued)

(b) The **middle note** compounds form vapours less readily than the **top note** compounds. A typical compound of the **middle note** is:

> 2-phenylethanol
>
> $\langle\bigcirc\rangle - CH_2 - CH_2 - O - H$

Due to hydrogen bonding 2-phenylethanol forms a vapour less readily than *p*-cresyl acetate.

In the box above, draw another molecule of 2-phenylethanol and use a dotted line to show where a hydrogen bond exists between the two molecules.

1

(c) The **end note** of a perfume has a long lasting odour which stays with the user. An example of an **end note** compound is:
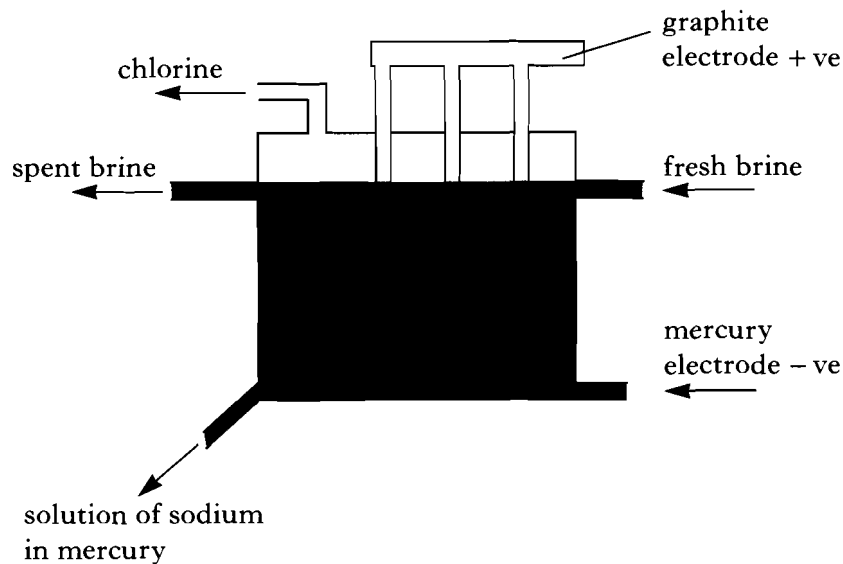
> civetone
>
> $H\diagdown \diagup(CH_2)_7$
> C
> $\|C = O$
> $C \diagup$
> $H\diagup \diagdown(CH_2)_7$
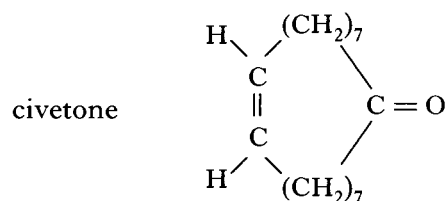
Draw the structure of the alcohol which would be formed by the reduction of civetone.

1

(4)

[Turn over for Question 17 on *Page thirty-two*

Marks

17. Chlorine can be manufactured by different industrial processes.

    (*a*) In the Castner-Kellner cell, chlorine is made by the electrolysis of brine (sodium chloride solution).

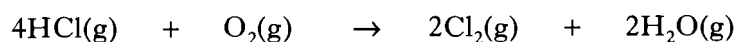   (i) Why is graphite able to conduct electricity?

1

        (ii) In the above process, the solution of sodium in mercury is treated with water to give two useful products.

        Name these **two** products.

1

    (*b*) Chlorine was once made from hydrogen chloride and air by the Deacon Process.

$$4HCl(g) \quad + \quad O_2(g) \quad \rightarrow \quad 2Cl_2(g) \quad + \quad 2H_2O(g)$$

    Suggest **one** reason why the Deacon Process was less economical to operate than the Castner-Kellner cell.

1

(3)

[END OF QUESTION PAPER]