FOR OFFICIAL USE

Total Section B

X012/301

NATIONAL QUALIFICATIONS 2008

FRIDAY, 30 MAY 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.

SECTION A—Questions 1–40 (40 marks)

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

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

SECTION B (60 marks)

1 All questions should be attempted.

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

3 Rough work, if any should be necessary, should be written in this book and then scored through when the fair copy has been written. If further space is required, a supplementary sheet for rough work may be obtained from the invigilator.

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

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

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

SECTION A

Read carefully

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

2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.

3 Check that the answer sheet you have been given has **your name**, **date of birth**, **SCN** (Scottish Candidate Number) and **Centre Name** printed on it.

Do not change any of these details.

4 If any of this information is wrong, tell the Invigilator immediately.

5 If this information is correct, **print** your name and seat number in the boxes provided.

6 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).

7 There is **only one correct** answer to each question.

8 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.

9 At the end of the exam, put the **answer sheet for Section A inside the front cover of your answer book**.

Sample Question

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

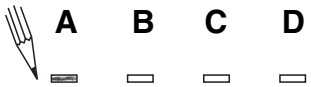
A chromatography

B fractional distillation

C fractional crystallisation

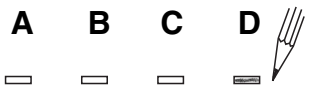
D filtration.

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



Changing an answer

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



1. Solutions of barium chloride and silver nitrate are mixed together.

The reaction that takes place is an example of

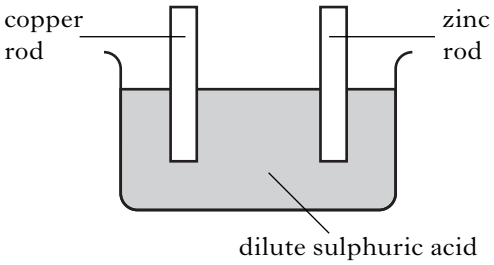
A displacement

B neutralisation

C oxidation

D precipitation.

2. Two rods are placed in dilute sulphuric acid as shown.



Which of the following would be observed?

A No gas is given off.

B Gas is given off at only the zinc rod.

C Gas is given off at only the copper rod.

D Gas is given off at both rods.

3. An element was burned in air. The product was added to water, producing a solution with a pH less than 7.

The element could be

A carbon

B hydrogen

C sodium

D tin.

4. A mixture of sodium chloride and sodium sulphate is known to contain 0·6 mol of chloride ions and 0·2 mol of sulphate ions.

How many moles of sodium ions are present?

A 0·4

B 0·5

C 0·8

D 1·0

5. The following results were obtained in the reaction between marble chips and dilute hydrochloric acid.

Time/minutes	0	2	4	6	8	10
Total volume of carbon dioxide produced/cm^3	0	52	68	78	82	84

What is the average rate of production of carbon dioxide, in cm^3 min^{-1}, between 2 and 8 minutes?

A 5

B 26

C 30

D 41

6. 5 g of copper is added to excess silver nitrate solution. The equation for the reaction that takes place is:

$$Cu(s) + 2AgNO_3(aq) \rightarrow 2Ag(s) + Cu(NO_3)_2(aq)$$

After some time, the solid present is filtered off from the solution, washed with water, dried and weighed.

The final mass of the solid will be

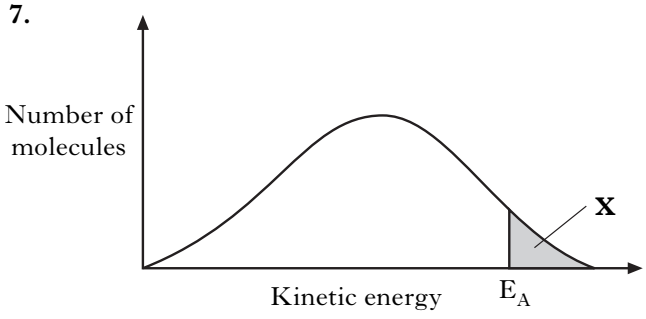
A less than 5 g

B 5 g

C 10 g

D more than 10 g.

7.



In area **X**

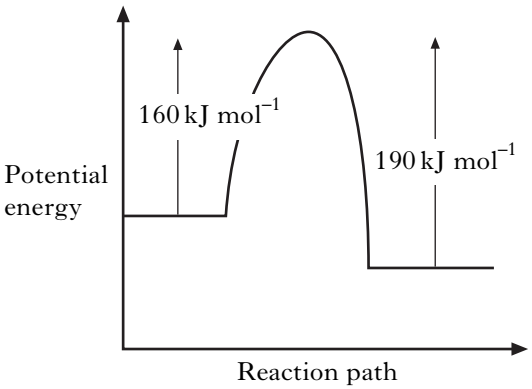
A molecules always form an activated complex

B no molecules have the energy to form an activated complex

C collisions between molecules are always successful in forming products

D all molecules have the energy to form an activated complex.

8.



When a catalyst is used, the activation energy of the forward reaction is reduced to 35 kJ mol^{-1}.

What is the activation energy of the catalysed reverse reaction?

A 30 kJ mol^{-1}

B 35 kJ mol^{-1}

C 65 kJ mol^{-1}

D 190 kJ mol^{-1}

9. As the atomic number of the alkali metals increases

A the first ionisation energy decreases

B the atomic size decreases

C the density decreases

D the melting point increases.

10. Which of the following atoms has the least attraction for bonding electrons?

A Carbon

B Nitrogen

C Phosphorus

D Silicon

11. Which of the following reactions refers to the third ionisation energy of aluminium?

A $Al(s) \rightarrow Al^{3+}(g) + 3e^-$

B $Al(g) \rightarrow Al^{3+}(g) + 3e^-$

C $Al^{2+}(g) \rightarrow Al^{3+}(g) + e^-$

D $Al^{3+}(g) \rightarrow Al^{4+}(g) + e^-$

12. Which of the following represents an exothermic process?

A $Cl_2(g) \rightarrow 2Cl(g)$

B $Na(s) \rightarrow Na(g)$

C $Na(g) \rightarrow Na^+(g) + e^-$

D $Na^+(g) + Cl^-(g) \rightarrow Na^+Cl^-(s)$

13. In which of the following liquids does hydrogen bonding occur?

A Ethanol

B Ethyl ethanoate

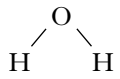
C Hexane

D Pent-1-ene

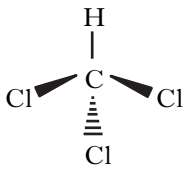
14. The shapes of some common molecules are shown. Each molecule contains at least one polar covalent bond.

Which of the following molecules is non-polar?

A H — Cl

B 

C O = C = O

D 

15. At room temperature, a solid substance was shown to have a lattice consisting of positively charged ions and delocalised outer electrons.

The substance could be

A graphite

B sodium

C mercury

D phosphorus.

16. The mass of 1 mol of sodium is 23 g.

What is the approximate mass of one sodium atom?

A 6×10^{23} g

B 6×10^{-23} g

C $3{\cdot}8 \times 10^{-23}$ g

D $3{\cdot}8 \times 10^{-24}$ g

17. In which of the following pairs do the gases contain the same number of oxygen atoms?

A 1 mol of oxygen and 1 mol of carbon monoxide

B 1 mol of oxygen and 0·5 mol of carbon dioxide

C 0·5 mol of oxygen and 1 mol of carbon dioxide

D 1 mol of oxygen and 1 mol of carbon dioxide

18. The Avogadro Constant is the same as the number of

A molecules in 16 g of oxygen

B electrons in 1 g of hydrogen

C atoms in 24 g of carbon

D ions in 1 litre of sodium chloride solution, concentration 1 mol l^{-1}.

19. $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

How many litres of nitrogen dioxide gas would be produced in a reaction, starting with a mixture of 5 litres of nitrogen monoxide gas and 2 litres of oxygen gas?

(All volumes are measured under the same conditions of temperature and pressure.)

A 2

B 3

C 4

D 5

20. Which of the following fuels can be produced by the fermentation of biological material under anaerobic conditions?

A Hydrogen

B Methane

C Methanol

D Petrol

21. Butadiene is the first member of a homologous series of hydrocarbons called dienes.

What is the general formula for this series?

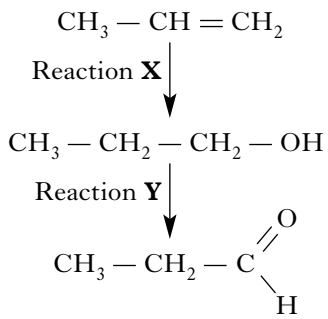
A C_nH_{n+2}

B C_nH_{n+3}

C C_nH_{2n}

D C_nH_{2n-2}

22.



Which line in the table correctly describes reactions **X** and **Y**?

	Reaction X	**Reaction Y**
A	hydration	oxidation
B	hydration	reduction
C	hydrolysis	oxidation
D	hydrolysis	reduction

23. Ammonia is manufactured from hydrogen and nitrogen by the Haber Process.

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

If 80 kg of ammonia is produced from 60 kg of hydrogen, what is the percentage yield?

A $\frac{80}{340} \times 100$

B $\frac{80}{170} \times 100$

C $\frac{30}{80} \times 100$

D $\frac{60}{80} \times 100$

[Turn over

24. Which of the following statements about methanol is **false**?

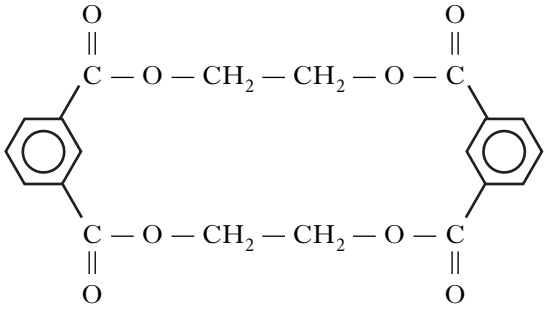
A It can be made from synthesis gas.

B It can be dehydrated to form an alkene.

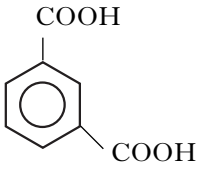
C It can be oxidised to give a carboxylic acid.

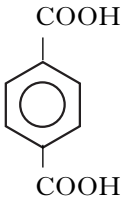
D It reacts with acidified potassium dichromate solution.

25. A by-product produced in the manufacture of a polyester has the structure shown.

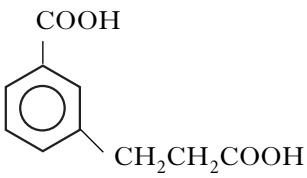


What is the structure of the diacid monomer used in the polymerisation?

A 

B 

C $HOOC - CH_2 - CH_2 - COOH$

D 

26. Which of the following statements can be applied to polymeric esters?

A They are used for flavourings, perfumes and solvents.

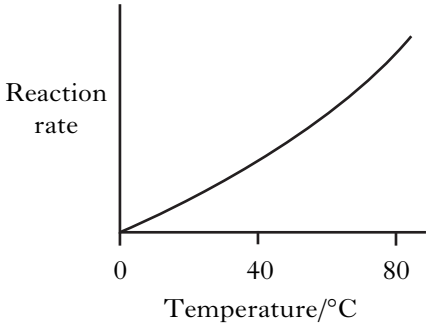
B They are manufactured for use as textile fibres and resins.

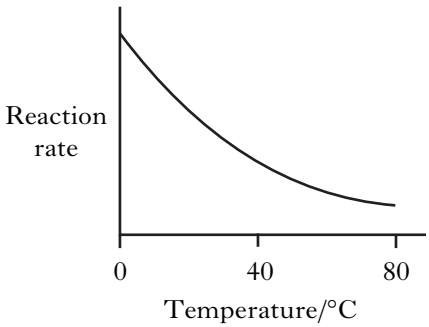
C They are cross-linked addition polymers.

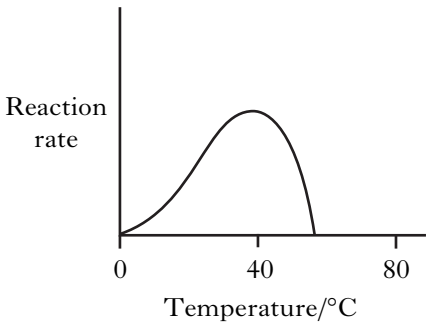
D They are condensation polymers made by the linking up of amino acids.

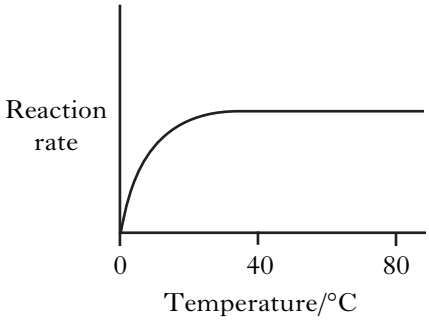
27. The rate of hydrolysis of protein, using an enzyme, was studied at different temperatures.

Which of the following graphs would be obtained?

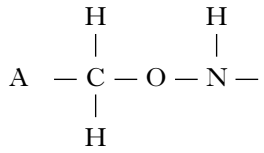
A 

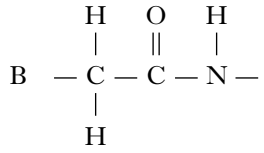
B 

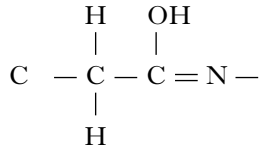
C 

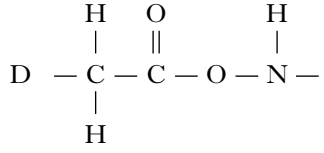
D 

28. Which of the following arrangements of atoms shows a peptide link?

A 

B 

C 

D 

29. Which line in the table shows the effect of a catalyst on the reaction rates and position of equilibrium in a reversible reaction?

	Rate of forward reaction	**Rate of reverse reaction**	**Position of equilibrium**
A	increased	unchanged	moves right
B	increased	increased	unchanged
C	increased	decreased	moves right
D	unchanged	unchanged	unchanged

30. The following equilibrium exists in bromine water.

$$\underset{\text{(red)}}{Br_2(aq)} + H_2O(\ell) \rightleftharpoons \underset{\text{(colourless)}}{Br^-(aq)} + 2H^+(aq) + \underset{\text{(colourless)}}{OBr^-(aq)}$$

The red colour of bromine water would fade on adding a few drops of a concentrated solution of

A HCl

B KBr

C $AgNO_3$

D NaOBr.

31. Which of the following is the best description of a 0·1 mol l^{-1} solution of nitric 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

32. The conductivity of pure water is low because

A water molecules are polar

B only a few water molecules are ionised

C water molecules are linked by hydrogen bonds

D there are equal numbers of hydrogen and hydroxide ions in water.

33. Which of the following statements is **true** about an aqueous solution of ammonia?

A It has a pH less than 7.

B It is completely ionised.

C It contains more hydroxide ions than hydrogen ions.

D It reacts with acids producing ammonia gas.

34. Equal volumes of solutions of ethanoic acid and hydrochloric acid, of equal concentration, are compared.

In which of the following cases does the ethanoic acid give the higher value?

A pH of solution

B Conductivity of solution

C Rate of reaction with magnesium

D Volume of sodium hydroxide solution neutralised

35. Equal volumes of 0·1 mol l^{-1} solutions of the following acids and alkalis were mixed.

Which of the following pairs would give the solution with the lowest pH?

A Hydrochloric acid and sodium hydroxide

B Hydrochloric acid and calcium hydroxide

C Sulphuric acid and sodium hydroxide

D Sulphuric acid and calcium hydroxide

[Turn over

36. Which of the following compounds dissolves in water to form an acidic solution?

A Sodium nitrate

B Barium sulphate

C Potassium ethanoate

D Ammonium chloride

37. The ion-electron equations for a redox reaction are:

$2I^-(aq) \rightarrow I_2(aq) + 2e^-$

$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(\ell)$

How many moles of iodide ions are oxidised by one mole of permanganate ions?

A 0·2

B 0·4

C 2

D 5

38. In which of the following reactions is the hydrogen ion acting as an oxidising agent?

A $Mg + 2HCl \rightarrow MgCl_2 + H_2$

B $NaOH + HNO_3 \rightarrow NaNO_3 + H_2O$

C $CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$

D $CH_3COONa + HCl \rightarrow NaCl + CH_3COOH$

39. An atom of ^{227}Th decays by a series of alpha emissions to form an atom of ^{211}Pb.

How many alpha particles are released in the process?

A 2

B 3

C 4

D 5

40. 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

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

Marks

SECTION B

All answers must be written clearly and legibly in ink.

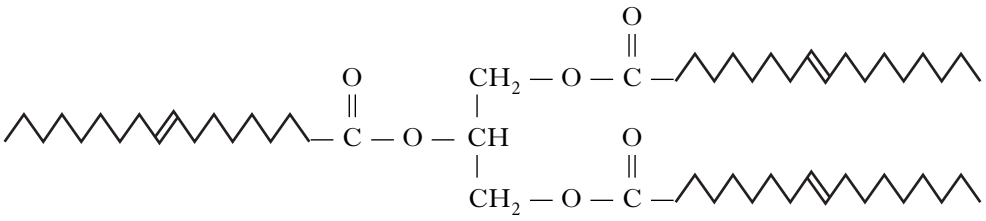
1. The formulae for three oxides of sodium, carbon and silicon are Na_2O, CO_2 and SiO_2.

Complete the table for CO_2 and SiO_2 to show both the bonding and structure of the three oxides at room temperature.

Oxide	Bonding and structure
Na_2O	ionic lattice
CO_2	
SiO_2	

(2)

2. A typical triglyceride found in olive oil is shown below.



(*a*) To which family of organic compounds do triglycerides belong?

1

(*b*) Olive oil can be hardened for use in margarines.
What happens to the triglyceride molecules during the hardening of olive oil?

1

(*c*) Give **one** reason why oils can be a useful part of a balanced diet.

1

(3)

Marks

3. A student carried out the Prescribed Practical Activity (PPA) to find the effect of concentration on the rate of the reaction between hydrogen peroxide solution and an acidified solution of iodide ions.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow 2H_2O(\ell) + I_2(aq)$$

During the investigation, only the concentration of the iodide ions was changed.
Part of the student's results sheet for this PPA is shown.

Results

Experiment	Volume of KI(aq) /cm^3	Volume of H_2O /cm^3	Volume of H_2O_2(aq) /cm^3	Volume of H_2SO_4(aq) /cm^3	Volume of $Na_2S_2O_3$(aq) /cm^3	Rate /s^{-1}
1	*25*	*0*	*5*	*10*	*10*	*0·043*
2						
3						

(*a*) Describe how the concentration of the potassium iodide solution was changed during this series of experiments.

1

(*b*) Calculate the reaction time, in seconds, for the first experiment.

1

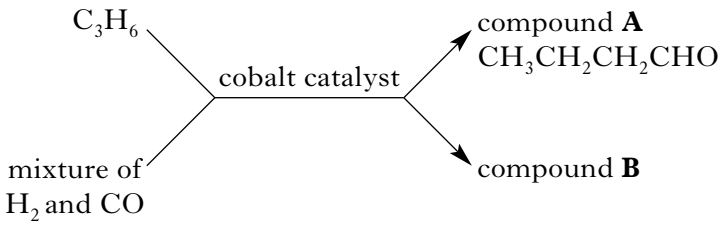
(2)

Marks

4. Using a cobalt catalyst, alkenes react with a mixture of hydrogen and carbon monoxide.

The products are two isomeric aldehydes.

Propene reacts with the mixture as shown.



(*a*) What name is given to a mixture of hydrogen and carbon monoxide?

1

(*b*) Draw a structural formula for compound **B**.

1

(*c*) (i) What would be observed if compound **A** was gently heated with Tollens' reagent?

1

(ii) How would the reaction mixture be heated?

1

(*d*) Aldehydes can also be formed by the reaction of some alcohols with copper(II) oxide.

Name the **type** of alcohol that would react with copper(II) oxide to form an aldehyde.

1

(5)

[Turn over

Marks

5. All the isotopes of technetium are radioactive.

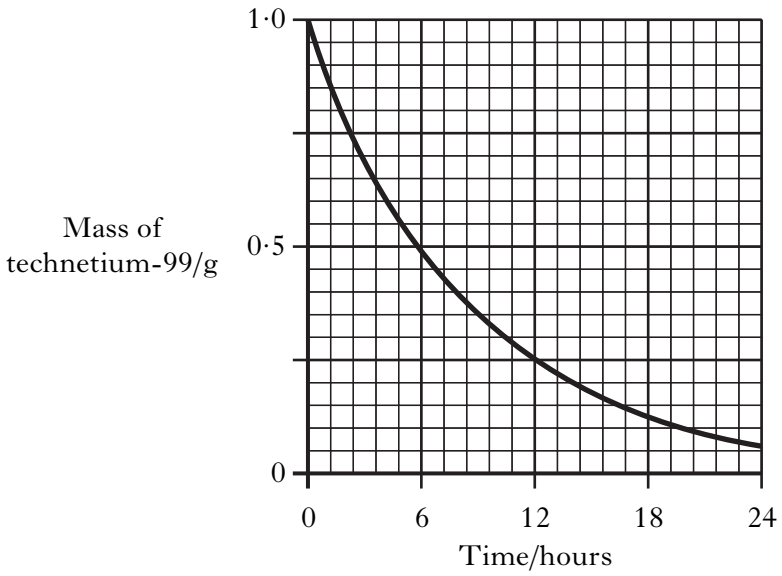
(*a*) Technetium-99 is produced as shown.

$$^{99}_{42}\text{Mo} \rightarrow {}^{99}_{43}\text{Tc} + \mathbf{X}$$

Identify **X**.

1

(*b*) The graph shows the decay curve for a 1·0 g sample of technetium-99.



(i) Draw a curve on the graph to show the variation of mass with time for a 0·5 g sample of technetium-99.
(An additional graph, if required, can be found on *Page twenty-eight*.) **1**

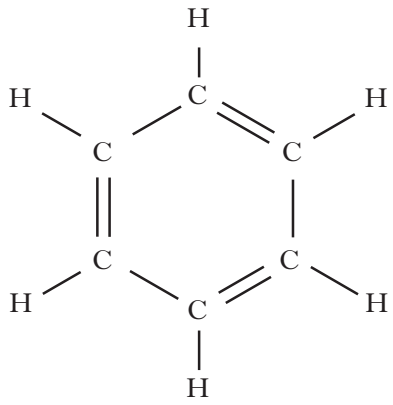
(ii) Technetium-99 is widely used in medicine to detect damage to heart tissue. It is a gamma-emitting radioisotope and is injected into the body.
Suggest **one** reason why technetium-99 can be safely used in this way.

1

(3)

6. In 1865, the German chemist Kekulé proposed a ring structure for benzene. This structure was based on alternating single and double bonds.

Marks



(*a*) (i) Describe a chemical test that would indicate that the above chemical structure for benzene is incorrect.

1

(ii) Briefly describe the correct structure for benzene.

1

(*b*) Benzene can be formed from cyclohexane.

$$C_6H_{12} \rightarrow C_6H_6 + 3H_2$$

What name is given to this type of reaction?

1

(*c*) Benzene is also added in very small amounts to some petrols.
Why is benzene added to petrol?

1

(4)

Marks

7. Hydrogen fluoride, HF, is used to manufacture hydrofluorocarbons.

Hydrofluorocarbons are now used as refrigerants instead of chlorofluorocarbons, CFCs.

(*a*) Why are CFCs no longer used?

1

(*b*) Hydrogen fluoride gas is manufactured by reacting calcium fluoride with concentrated sulphuric acid.

$$CaF_2 + H_2SO_4 \rightarrow CaSO_4 + 2HF$$

What volume of hydrogen fluoride gas is produced when 1·0 kg of calcium fluoride reacts completely with concentrated sulphuric acid?

(Take the molar volume of hydrogen fluoride gas to be 24 litres mol^{-1}.)

Show your working clearly.

2

(3)

Marks

8. Carbon monoxide can be produced in many ways.

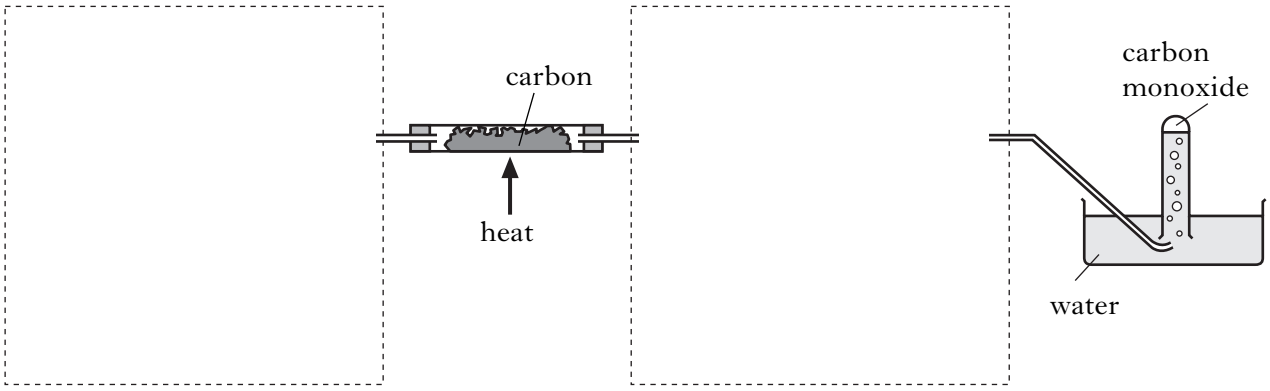
(*a*) One method involves the reaction of carbon with an oxide of boron.

$$B_2O_3 + C \rightarrow B_4C + CO$$

Balance this equation. **1**

(*b*) Carbon monoxide is also a product of the reaction of carbon dioxide with hot carbon. The carbon dioxide is made by the reaction of dilute hydrochloric acid with solid calcium carbonate.

Unreacted carbon dioxide is removed before the carbon monoxide is collected by displacement of water.



X **Y**

Complete the diagram to show how the carbon dioxide can be produced at **X** and how the unreacted carbon dioxide can be removed by bubbling it through a solution at **Y**.

Normal laboratory apparatus should be used in your answer and the chemicals used at **X** and **Y** should be labelled. **2**

(*c*) Why is carbon monoxide present in car exhaust fumes?

1

(4)

[Turn over

Marks

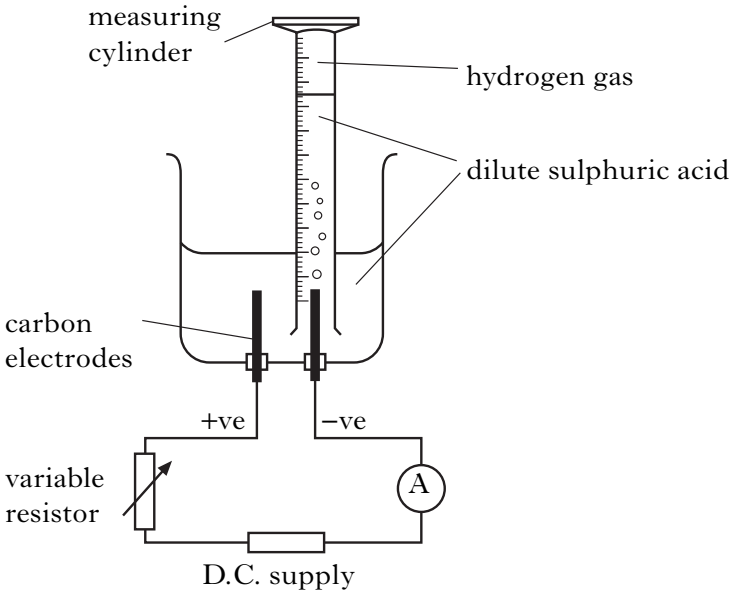
9. Hydrogen gas has a boiling point of –253 °C.

(*a*) Explain clearly why hydrogen is a gas at room temperature.

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

2

(*b*) Hydrogen gas can be prepared in the lab by the electrolysis of dilute sulphuric acid.



(i) Before collecting the gas in the measuring cylinder, it is usual to switch on the current and allow bubbles of gas to be produced for a few minutes. Why is this done?

1

Marks

9. (*b*) (continued)

(ii) The equation for the reaction at the negative electrode is:

$$2H^+(aq) \quad + \quad 2e^- \quad \rightarrow \quad H_2(g)$$

Calculate the mass of hydrogen gas, in grams, produced in 10 minutes when a current of 0·30 A was used.

Show your working clearly.

2

(*c*) The concentration of $H^+(aq)$ ions in the dilute sulphuric acid used in the experiment was 1×10^{-1} mol l^{-1}.

Calculate the concentration of $OH^-(aq)$ ions, in mol l^{-1}, in the dilute sulphuric acid.

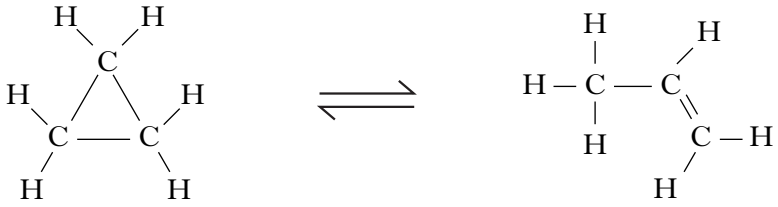
1

(6)

[Turn over

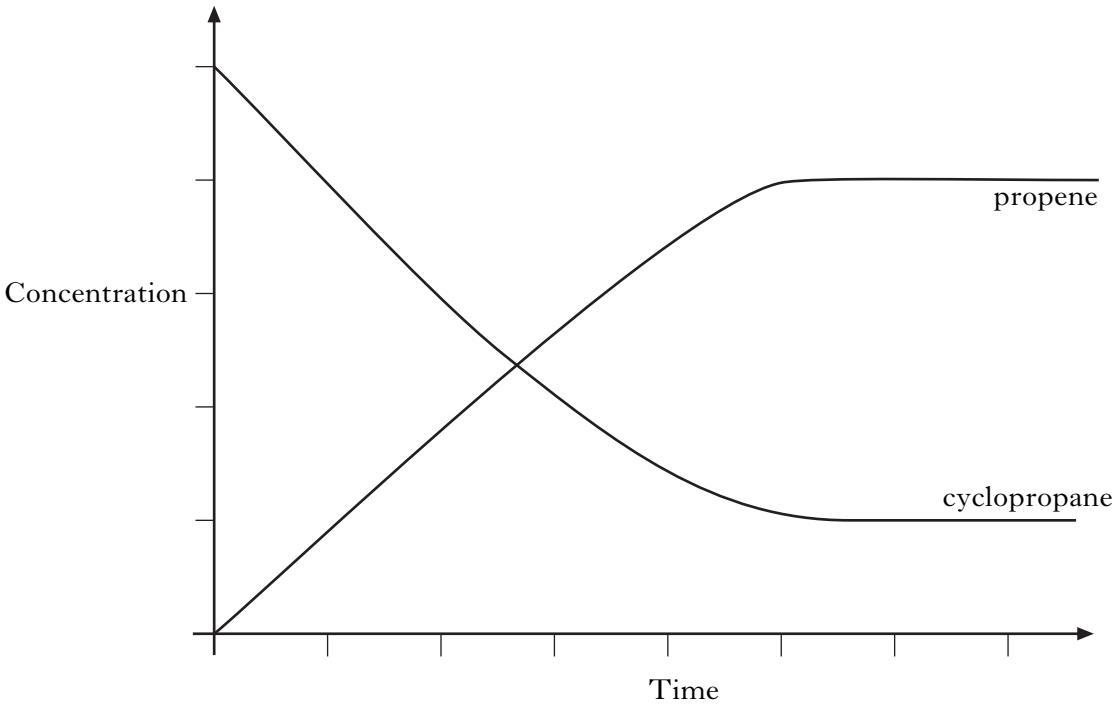
Marks

10. When cyclopropane gas is heated over a catalyst, it isomerises to form propene gas and an equilibrium is obtained.



cyclopropane propene

The graph shows the concentrations of cyclopropane and propene as equilibrium is established in the reaction.



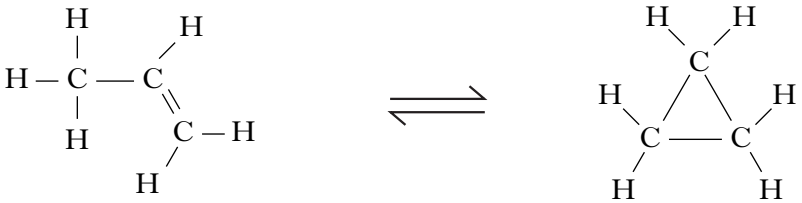
(*a*) Mark clearly on the graph the point at which equilibrium has just been reached. **1**

(*b*) Why does increasing the pressure have **no** effect on the position of this equilibrium? **1**

Marks

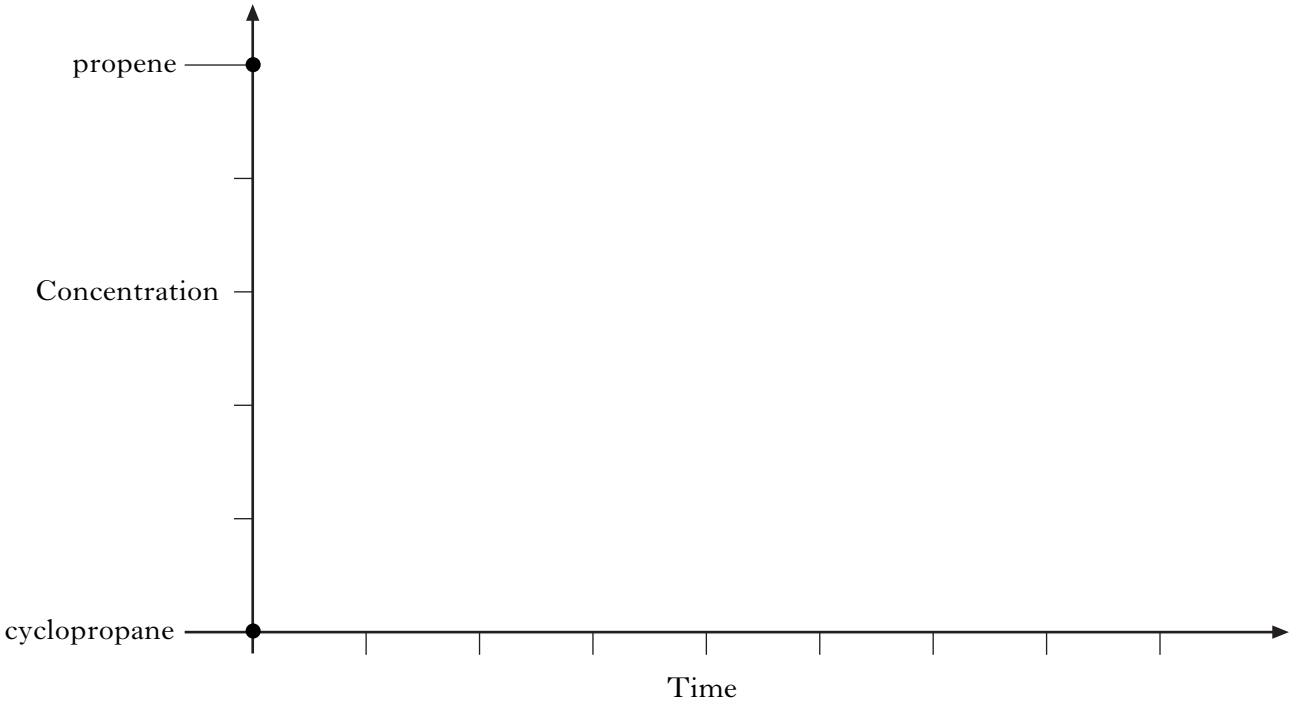
10. (continued)

(*c*) The equilibrium can also be achieved by starting with propene.



propene cyclopropane

Using the initial concentrations shown, sketch a graph to show how the concentrations of propene and cyclopropane change as equilibrium is reached for this reverse reaction.



1

(3)

[Turn over

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Marks

11. A student writes the following two statements. **Both are incorrect**.
In each case explain the mistake in the student's reasoning.

(*a*) Alcohols are alkaline because of their OH groups.

1

(*b*) Because of the iodine, potassium iodide will produce a blue/black colour in contact with starch.

1

(2)

Marks

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

This mixture contains quinone, $C_6H_4O_2$, a compound that is formed by the reaction of hydroquinone, $C_6H_4(OH)_2$, with hydrogen peroxide, H_2O_2. The reaction is catalysed by an enzyme called catalase.

(*a*) Most enzymes can catalyse only specific reactions, eg catalase cannot catalyse the hydrolysis of starch.

Give a reason for this.

1

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

$$C_6H_4(OH)_2(aq) + H_2O_2(aq) \rightarrow C_6H_4O_2(aq) + 2H_2O(\ell)$$

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

$$C_6H_4(OH)_2(aq) \rightarrow C_6H_4O_2(aq) + H_2(g) \qquad \Delta H = +177{\cdot}4\,kJ\ mol^{-1}$$

$$H_2(g) + O_2(g) \rightarrow H_2O_2(aq) \qquad \Delta H = -191{\cdot}2\,kJ\ mol^{-1}$$

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(g) \qquad \Delta H = -241{\cdot}8\,kJ\ mol^{-1}$$

$$H_2O(g) \rightarrow H_2O(\ell) \qquad \Delta H = -43{\cdot}8\,kJ\ mol^{-1}$$

Show your working clearly.

2

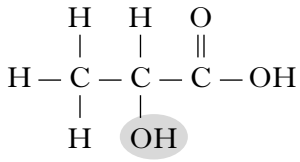
(3)

[Turn over

Marks

13. For many years, carbohydrates found in plants have been used to provide chemicals. Lactic acid can be produced by fermenting the carbohydrates in corn.

Lactic acid has the structure:



(*a*) Name the functional group in the shaded area.

1

(*b*) Lactic acid is used to make polylactic acid, a biodegradeable polymer that is widely used for food packaging.

(i) Name another biodegradeable polymer.

1

(ii) Polylactic acid can be manufactured by either a batch or a continuous process.

What is meant by a batch process?

1

(iii) The first stage in the polymerisation of lactic acid involves the condensation of two lactic acid molecules to form a cyclic structure called a lactone.

Draw a structural formula for the lactone formed when two molecules of lactic acid undergo condensation with each other.

1

(4)

Marks

14. Hydrogen peroxide decomposes as shown:

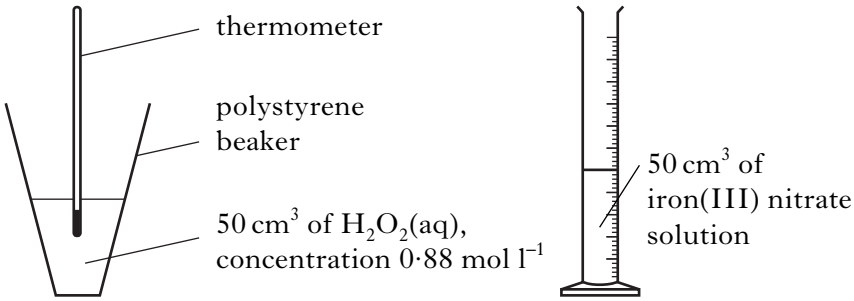
$$H_2O_2(aq) \rightarrow H_2O(\ell) + \tfrac{1}{2}O_2(g)$$

The reaction can be catalysed by iron(III) nitrate solution.

(*a*) What **type** of catalyst is iron(III) nitrate solution in this reaction?

1

(*b*) In order to calculate the enthalpy change for the decomposition of hydrogen peroxide, a student added iron(III) nitrate solution to hydrogen peroxide solution.



As a result of the reaction, the temperature of the solution in the polystyrene beaker increased by 16 °C.

(i) What is the effect of the catalyst on the enthalpy change (ΔH) for the reaction?

1

(ii) Use the experimental data to calculate the enthalpy change, in kJ mol^{-1}, for the decomposition of hydrogen peroxide.

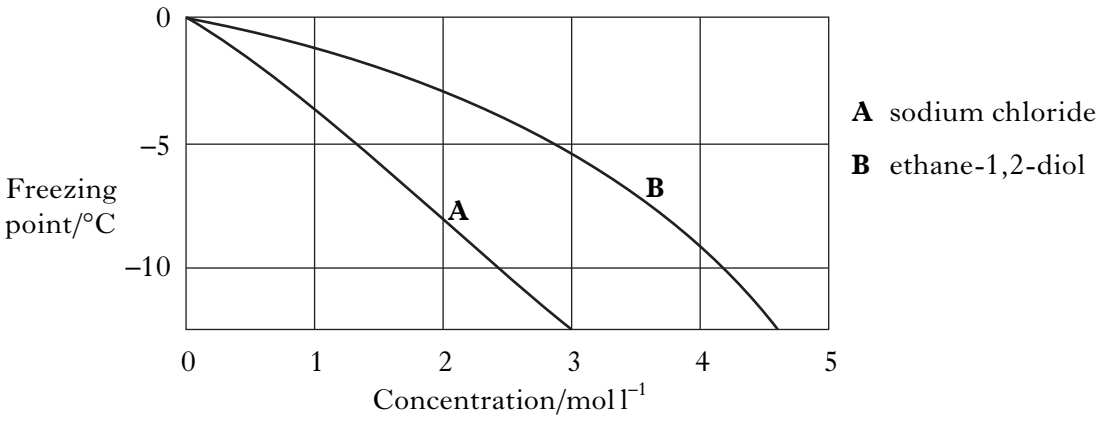
Show your working clearly.

3

(5)

Marks

15. (*a*) The graph shows how the freezing point changes with changing concentration for aqueous solutions of sodium chloride and ethane-1,2-diol.



(i) Draw a structural formula for ethane-1,2-diol.

1

(ii) Ethane-1,2-diol solution is used as an antifreeze in car radiators, yet from the graph it would appear that sodium chloride solution is more efficient.

Suggest why sodium chloride solution is **not** used as an antifreeze.

1

(*b*) Boiling points can be used to compare the strengths of the intermolecular forces in alkanes with the strengths of the intermolecular forces in diols.

Name the alkane that should be used to make a valid comparison between the strength of its intermolecular forces and those in ethane-1,2-diol.

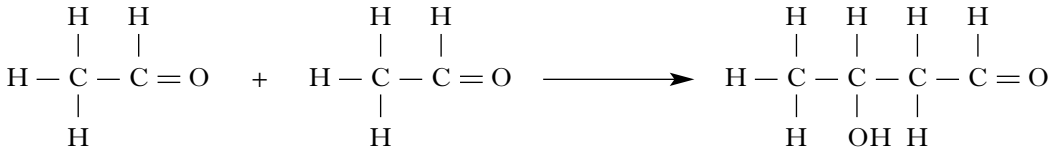
1

(3)

Marks

16. Aldehydes and ketones can take part in a reaction sometimes known as an aldol condensation.

The simplest aldol reaction involves two molecules of ethanal.



In the reaction, the carbon atom next to the carbonyl functional group of one molecule forms a bond with the carbonyl carbon atom of the second molecule.

(*a*) Draw a structural formula for the product formed when propanone is used instead of ethanal in this type of reaction.

1

(*b*) Name an aldehyde that would **not** take part in an aldol condensation.

1

(*c*) Apart from the structure of the reactants, suggest what is unusual about applying the term "condensation" to this particular type of reaction.

1

(3)

[Turn over

Marks

17. Oxalic acid is found in rhubarb. The number of moles of oxalic acid in a carton of rhubarb juice can be found by titrating samples of the juice with a solution of potassium permanganate, a powerful oxidising agent.

The equation for the overall reaction is:

$$5(COOH)_2(aq) + 6H^+(aq) + 2MnO_4^-(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(aq) + 8H_2O(\ell)$$

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

1

(*b*) Why is an indicator **not** required to detect the end-point of the titration?

1

(*c*) In an investigation using a 500 cm^3 carton of rhubarb juice, separate 25·0 cm^3 samples were measured out. Three samples were then titrated with 0·040 $mol\,l^{-1}$ potassium permanganate solution, giving the following results.

Titration	**Volume of potassium permanganate solution used/cm^3**
1	27·7
2	26·8
3	27·0

Average volume of potassium permanganate solution used = 26·9 cm^3.

(i) Why was the first titration result not included in calculating the average volume of potassium permanganate solution used?

1

Marks

17. (*c*) (continued)

(ii) Calculate the number of moles of oxalic acid in the 500 cm^3 carton of rhubarb juice.

Show your working clearly.

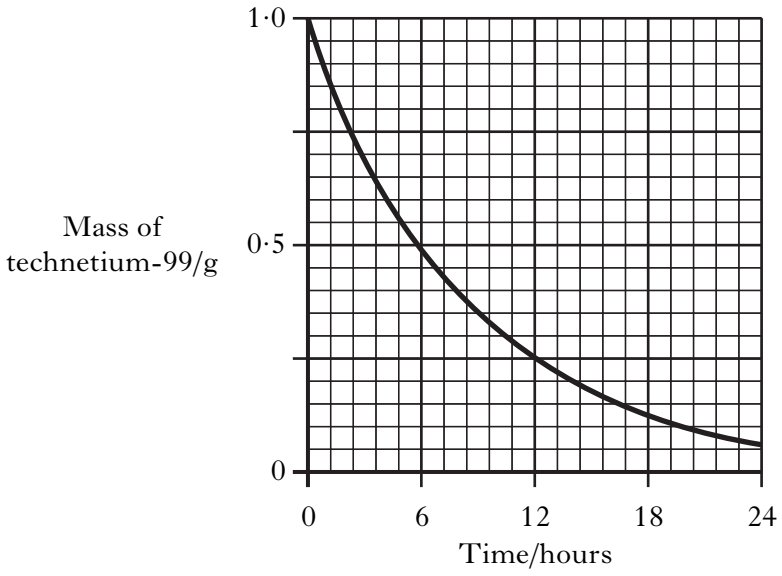
2

(5)

[*END OF QUESTION PAPER*]

SPACE FOR ANSWERS

ADDITIONAL GRAPH FOR QUESTION 5(*b*)(i)



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