OXFORD

INTERNATIONAL
AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

# INTERNATIONAL A-LEVEL

# CHEMISTRY (9620)

## Unit 5: Practical and synoptic

Time allowed: 1 hour 25 minutes

**Materials**

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

**Instructions**

- Use black ink or black ball-point pen. Use pencil for drawing only.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

**Information**

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.

| For Examiner's Use | |
|---|---|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4–33 | |
| **TOTAL** | |

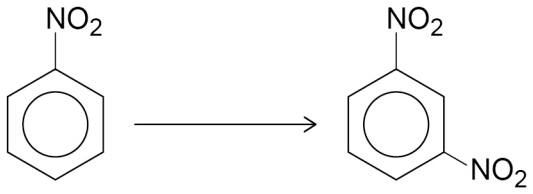
*Do not write outside the box*

## Section A

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

**0 1** This question is about the preparation of 1,3-dinitrobenzene from nitrobenzene.

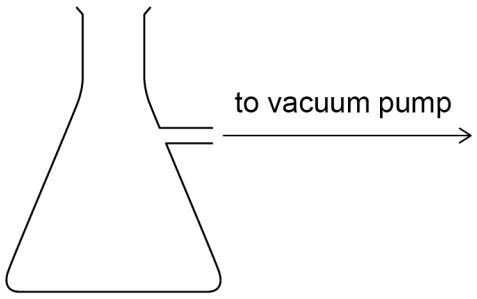
Nitrobenzene is heated with concentrated nitric acid and concentrated sulfuric acid.




**0 1 . 1** During the reaction, 1,3-dinitrobenzene forms as a solid.
This solid is collected by filtration under reduced pressure.

Complete the diagram to show the apparatus you would use to collect the solid under reduced pressure.

**[2 marks]**




**0 1 . 2** Give a reason why the solid is washed with water after filtration.

**[1 mark]**

*Do not write outside the box*

**0 1 . 3** Suggest **two** possible reasons why the yield in this preparation of 1,3-dinitrobenzene is less than 100%

**[2 marks]**

Reason 1 _____

Reason 2 _____

**0 1 . 4** The sample is dried.

Describe how to measure the melting point of the dry sample.

**[2 marks]**

_____

_____

_____

_____

**0 1 . 5** A data book value for the melting point of 1,3-dinitrobenzene is 90 °C

State **two** ways that the measured melting point will differ from the data book value if the 1,3-dinitrobenzene is impure.

**[2 marks]**

1 _____

_____

2 _____

_____

**9**

**Turn over for the next question**

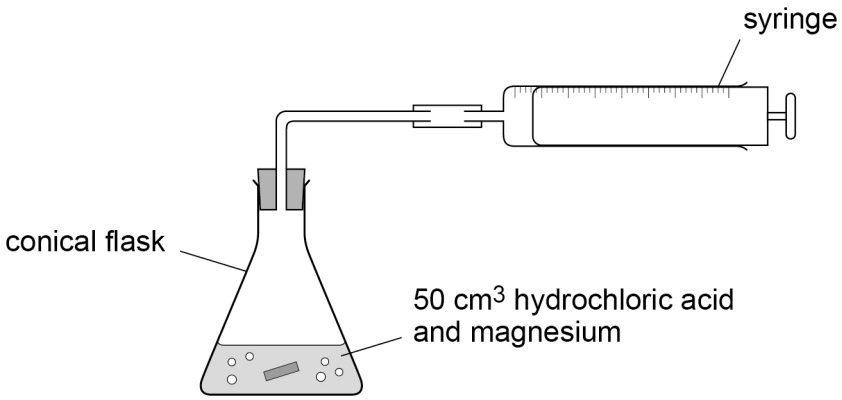
*Do not write outside the box*

**0 2** This question is about rates of reaction.

A student does an experiment to find the rate of reaction between magnesium ribbon and dilute hydrochloric acid using a continuous monitoring method.

The apparatus is shown in **Figure 1**.

**Figure 1**




Method

- 50 $cm^3$ of hydrochloric acid are placed in a conical flask.
- A piece of magnesium ribbon is cleaned by rubbing with sandpaper.
- The magnesium is added to the acid, the bung is put into the flask and a timer is started.
- The total volume of gas collected in the gas syringe is recorded every 10 seconds.

**0 2 . 1** Suggest a reason why the magnesium ribbon is cleaned by rubbing with sandpaper.

**[1 mark]**

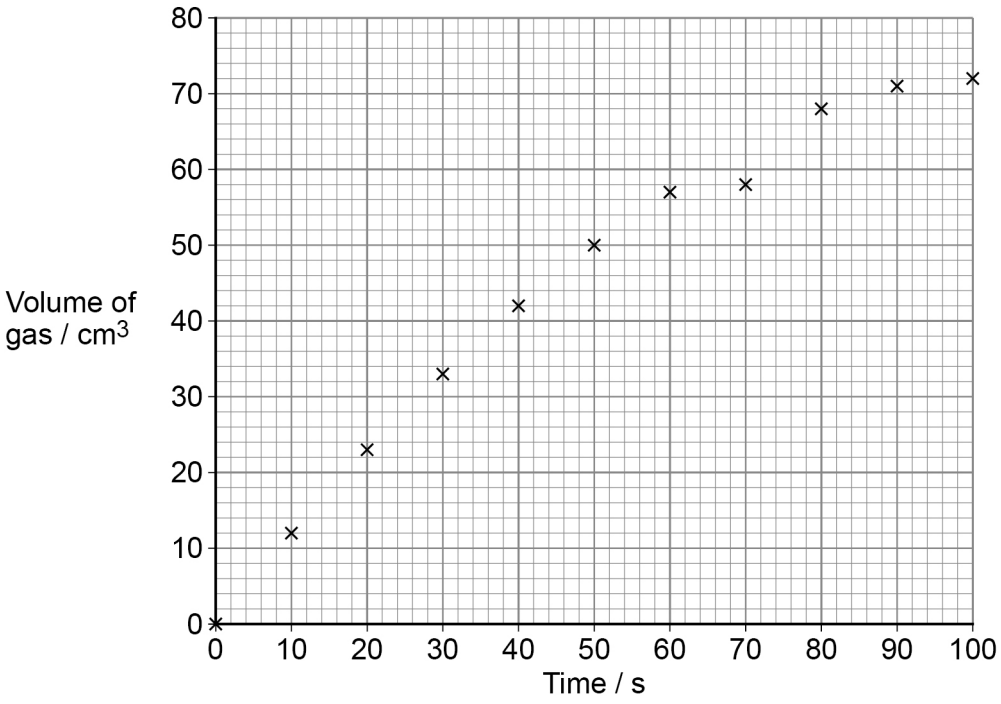
**0 2 . 2** Give a reason why the bung is put into the flask as quickly as possible after the magnesium ribbon is added to the acid.

**[1 mark]**

*Do not write outside the box*

**Figure 2** shows the results of the experiment.

**Figure 2**




**0 2 . 3** Draw a suitable line to complete the graph in **Figure 2**.

**[1 mark]**

**0 2 . 4** Draw a tangent on the graph at $t = 0$ on **Figure 2**.

Use the tangent to calculate the initial rate of reaction.

Give the units of the initial rate of reaction.

**[3 marks]**

Initial rate of reaction _____

Units _____

*Do not write outside the box*

**0 2 . 5** During the experiment, the temperature of the mixture in the conical flask increased.

Predict how the increase in temperature affects the shape of the graph.

Suggest how the temperature increase can be minimised.

**[2 marks]**

Effect on shape of graph _____

_____

_____

How temperature increase can be minimised _____

_____

_____

**0 2 . 6** The acid concentration used in the experiment was 1.0 mol $dm^{-3}$

Suggest why an acid concentration of 3.0 mol $dm^{-3}$ was **not** used.
Do **not** include safety in your answer.

**[1 mark]**

_____

_____

_____

*Do not write outside the box*

A different reaction is studied using continuous monitoring.

Iodine reacts slowly with propanone in the presence of an acid catalyst.

$$CH_3COCH_3 + I_2 \longrightarrow CH_3COCH_2I + HI$$

Method

- 20.0 $cm^3$ of an acidified iodine solution are placed in a beaker.
- Some aqueous propanone is added and a timer is started.
- Every 20 seconds, 0.50 $cm^3$ of the reaction mixture is removed, added to a large volume of cold sodium hydrogencarbonate solution, and the amount of iodine is determined.

The change in the amount of iodine over time is used to determine the rate of reaction.

**0 2 . 7** Explain why each 0.50 $cm^3$ sample is added to a large volume of cold sodium hydrogencarbonate solution.

**[2 marks]**

The rate of reaction between iodine and propanone is measured in a series of experiments (**A**, **B**, **C** and **D**) to find the order of the reaction.

**Table 1** shows the volumes used in each experiment.

**Table 1**

| **Experiment** | **A** | **B** | **C** | **D** |
|---|---|---|---|---|
| Volume of acidified iodine solution / $cm^3$ | 20.0 | 20.0 | 20.0 | 20.0 |
| Volume of 1.00 mol $dm^{-3}$ aqueous propanone / $cm^3$ | 50.0 | 40.0 | 30.0 | 20.0 |
| Volume of distilled water / $cm^3$ | 0.0 | 10.0 | 20.0 | 30.0 |

*Do not write outside the box*

**0 2 . 8** Explain why different volumes of water are added in experiments **A** to **D**.

**[2 marks]**

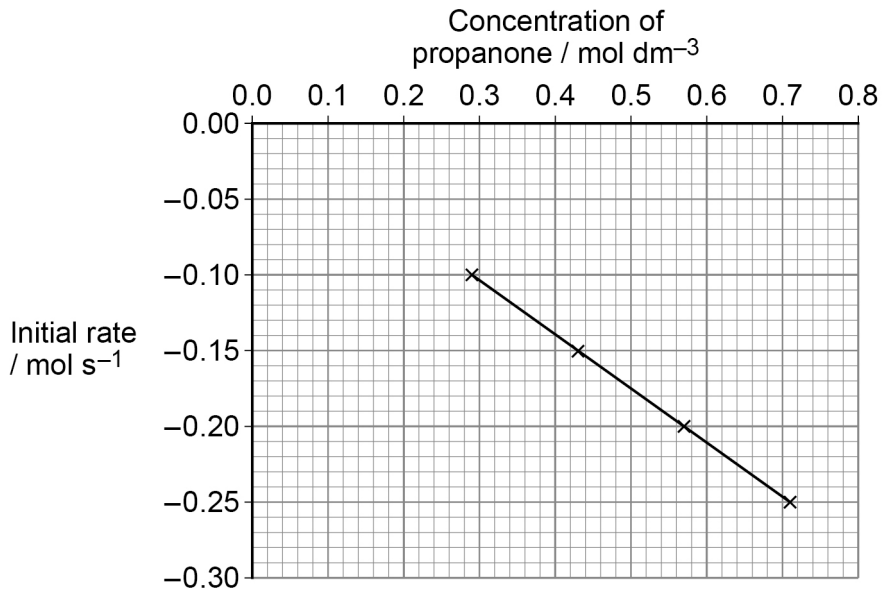
**0 2 . 9** **Figure 3** shows a graph of the results of experiments **A** to **D**.

Use **Figure 3** to deduce the order of reaction with respect to propanone.

Justify your answer.

**[2 marks]**

**Figure 3**




Order _____

Justification _____

15

*Do not write outside the box*

**0 3** This question is about halide ions.

In a test for a halide ion, a solution is acidified before silver nitrate solution is added.

**0 3 . 1** Explain why the solution is acidified.

**[1 mark]**

**0 3 . 2** Identify an acid that can be used to acidify the solution.

**[1 mark]**

**0 3 . 3** State what is observed when silver nitrate solution is added to sodium chloride solution.

**[1 mark]**

**0 3 . 4** Solid **Y** is a sodium halide. Concentrated sulfuric acid is added to a sample of solid **Y**. An orange-brown gas is given off.

Identify the halide ion in **Y**.

Write an equation for the reaction of concentrated sulfuric acid with **Y** to produce the orange-brown gas.

State the role of sulfuric acid in this reaction.

**[3 marks]**

Halide ion in **Y** _____

Equation _____

Role of sulfuric acid _____

**6**

*Do not write outside the box*

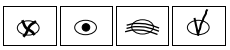
## Section B

Each question is followed by four responses, **A**, **B**, **C** and **D**.

For each question select the best response.

Only **one** answer per question is allowed.
For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD 

WRONG METHODS 

If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

You may do your working in the blank space around each question but this will not be marked. Do **not** use additional sheets for this working.

**0 4** Which is the definition of mass number?

**[1 mark]**

**A** Average mass of an atom of an isotope compared to the mass of an atom of $^{12}C$ ⬭

**B** Total number of protons and electrons in an atom ⬭

**C** Average mass of an atom of an element compared to $\frac{1}{12}$ of the mass of an atom of $^{12}C$ ⬭

**D** Total number of protons and neutrons in an atom ⬭

**0 5** Which of these elements has the highest first ionisation energy?

**[1 mark]**

**A** Helium ⬭

**B** Hydrogen ⬭

**C** Krypton ⬭

**D** Potassium ⬭

*Do not write outside the box*

**0 6** What is the formula of chromium(III) sulfate?

**[1 mark]**

**A** $CrSO_4$ ⬭

**B** $Cr_2SO_4$ ⬭

**C** $Cr_2(SO_4)_3$ ⬭

**D** $Cr_3(SO_4)_2$ ⬭

**0 7** Which row is correct for solid magnesium chloride?

**[1 mark]**

| | Crystal structure | Bonding | Electrical conductivity | |
|---|---|---|---|---|
| **A** | macromolecular | van der Waals | poor | ⬭ |
| **B** | giant | ionic | good | ⬭ |
| **C** | ionic | ionic | poor | ⬭ |
| **D** | metallic | metallic | good | ⬭ |

**0 8** Some mean bond enthalpies are given.

| **Bond** | **N–N** | **N≡N** | **H–H** | **N–H** |
|---|---|---|---|---|
| **Bond enthalpy / kJ mol$^{-1}$** | 163 | 943 | 436 | 391 |

These bond enthalpies are used to calculate the enthalpy change for this reaction.

$$N_2(g) + 2\,H_2(g) \rightarrow H_2N{-}NH_2(g)$$

What is the value of the enthalpy change, in kJ mol$^{-1}$, for this reaction?

**[1 mark]**

**A** +88 ⬭

**B** –88 ⬭

**C** –348 ⬭

**D** –692 ⬭

**Turn over ►**

*Do not write outside the box*

**0 9** What is the electron configuration of a $Co^{2+}$ ion?

**[1 mark]**

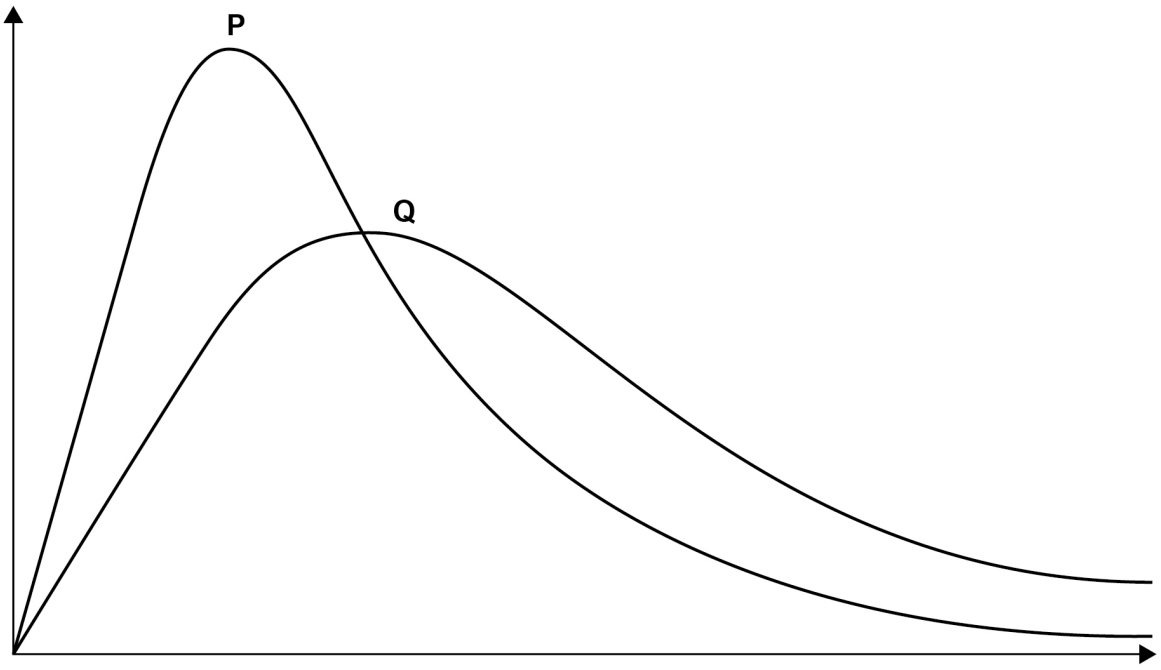
**A** $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^7\,4s^2$ ⬭

**B** $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\,4s^2$ ⬭

**C** $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^7$ ⬭

**D** $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^6$ ⬭

**1 0** The diagram shows the Maxwell–Boltzmann distribution of molecular energies for 1 mole of gas under different conditions.




Which statement is correct?

**[1 mark]**

**A** The number of molecules is plotted on the *x*-axis. ⬭

**B** Curve **P** is at a higher temperature than curve **Q**. ⬭

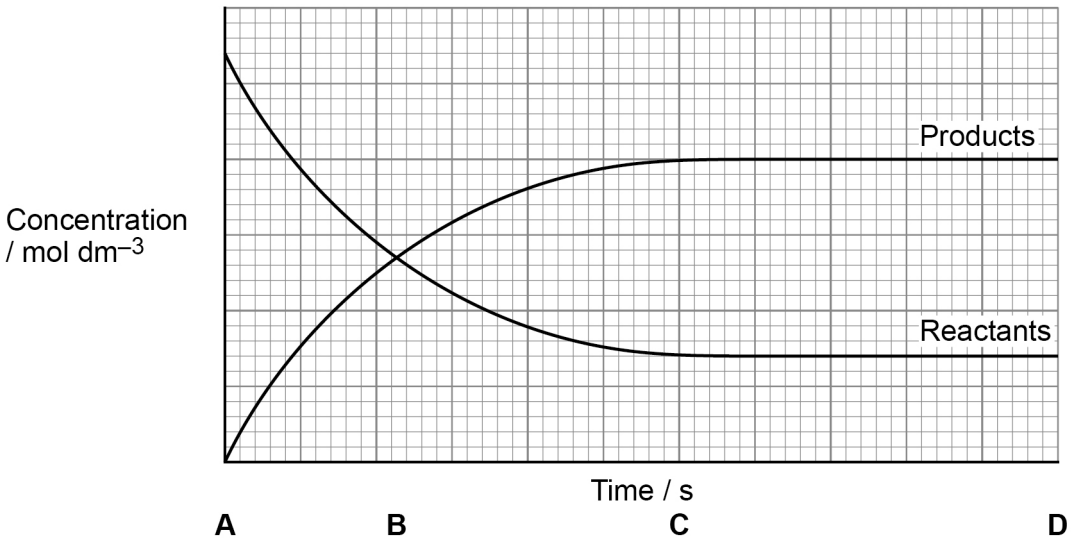
**C** The area under each curve is the same. ⬭

**D** The most probable energy of the molecules represented by curve **P** is higher than that for curve **Q**. ⬭

*Do not write outside the box*

**1 1** The graph shows changes in concentration during a reversible reaction.

$$P(g) + Q(g) \rightleftharpoons R(g) + S(g)$$




At which time is equilibrium reached?

**[1 mark]**

**A** ⬭

**B** ⬭

**C** ⬭

**D** ⬭

**1 2** The electron configurations of four atoms are shown.

Which is the strongest oxidising agent?

**[1 mark]**

**A** $1s^2\ 2s^2\ 2p^5$ ⬭

**B** $1s^2\ 2s^2\ 2p^6\ 3s^1$ ⬭

**C** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ ⬭

**D** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$ ⬭

*Do not write outside the box*

**1 3** Which row shows the electrode equations for a lithium cell when it is being used?

**[1 mark]**

| | Positive electrode | Negative electrode |
|---|---|---|
| **A** | $Li \rightarrow Li^+ + e^-$ | $Li^+ + CoO_2 + e^- \rightarrow Li^+[CoO_2]^-$ |
| **B** | $Li^+ + e^- \rightarrow Li$ | $Li^+[CoO_2]^- \rightarrow Li^+ + CoO_2 + e^-$ |
| **C** | $Li^+ + CoO_2 + e^- \rightarrow Li^+[CoO_2]^-$ | $Li \rightarrow Li^+ + e^-$ |
| **D** | $Li^+[CoO_2]^- \rightarrow Li^+ + CoO_2 + e^-$ | $Li^+ + e^- \rightarrow Li$ |

**A** ⬭

**B** ⬭

**C** ⬭

**D** ⬭

**1 4** In which equation is the first species acting as an acid?

**[1 mark]**

**A** $CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$ ⬭

**B** $HNO_3 + H_2SO_4 \rightarrow H_2NO_3^+ + HSO_4^-$ ⬭

**C** $H_2O + NH_4^+ \rightarrow H_3O^+ + NH_3$ ⬭

**D** $[Fe(H_2O)_6]^{2+} + H_2O \rightarrow [Fe(H_2O)_5(OH)]^+ + H_3O^+$ ⬭

**1 5** What is the pH of a $2.0 \times 10^{-1}$ mol $dm^{-3}$ sodium hydroxide solution at 25 °C?

$K_w = 1.0 \times 10^{-14}$ $mol^2$ $dm^{-6}$ at 25 °C

**[1 mark]**

**A** 13.30 ⬭

**B** 13.70 ⬭

**C** 14.30 ⬭

**D** 14.70 ⬭

*Do not write outside the box*

**1 6** A weak acid has $K_a = 4.30 \times 10^{-6}$ mol dm$^{-3}$ at 25 °C

What is the p$K_a$ of this acid at 25 °C?

**[1 mark]**

**A** –5.37 ⬭

**B** –4.37 ⬭

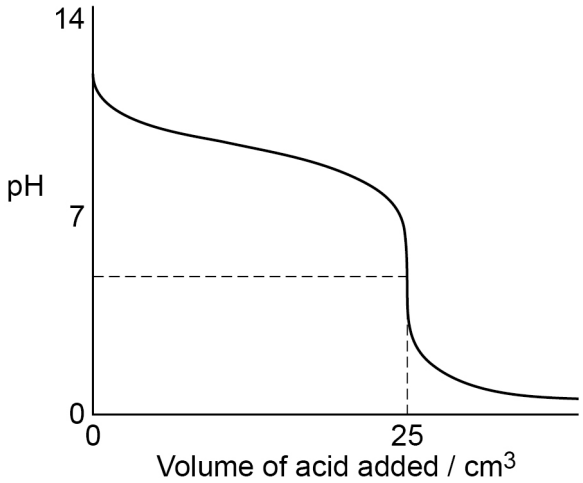
**C** 4.37 ⬭

**D** 5.37 ⬭

**1 7** A titration was done with 1.0 mol dm$^{-3}$ acid solution and 1.0 mol dm$^{-3}$ alkali solution.

Which titration would produce the pH curve shown?

**[1 mark]**




**A** Adding hydrochloric acid to ammonia solution. ⬭

**B** Adding hydrochloric acid to sodium hydroxide solution. ⬭

**C** Adding ethanoic acid to ammonia solution. ⬭

**D** Adding ethanoic acid to sodium hydroxide solution. ⬭

*Do not write outside the box*

**1 8** Which shows the oxides of Period 3 elements in order of increasing melting point?

**[1 mark]**

**A** $SiO_2 < P_4O_{10} < SO_2$ ⬭

**B** $SO_2 < SiO_2 < P_4O_{10}$ ⬭

**C** $SO_2 < P_4O_{10} < SiO_2$ ⬭

**D** $P_4O_{10} < SO_2 < SiO_2$ ⬭

**1 9** An unknown oxide, **X**, is added to a test tube of water and the mixture is stirred. When some universal indicator is added, the mixture turns green.

Which of these could be oxide **X**?

**[1 mark]**

**A** $Na_2O$ ⬭

**B** $MgO$ ⬭

**C** $Al_2O_3$ ⬭

**D** $P_4O_{10}$ ⬭

**2 0** Which row is correct for these complexes?

**[1 mark]**

| | Complex | Co-ordination number | Shape | |
|---|---|---|---|---|
| **A** | $Pt(NH_3)_2Cl_2$ | 2 | tetrahedral | ⬭ |
| **B** | $CuCl_4^{2-}$ | 4 | square planar | ⬭ |
| **C** | $[Co(C_2O_4)_3]^{4-}$ | 3 | octahedral | ⬭ |
| **D** | $[Cu(NH_3)_4(H_2O)_2]^{2+}$ | 6 | octahedral | ⬭ |

*Do not write outside the box*

**2 1** Which complex does **not** show stereoisomerism?

**[1 mark]**

**A** $[Pt(NH_3)_2Cl_2]$ ⬭

**B** $[Cr(H_2O)_4Cl_2]^+$ ⬭

**C** $[Fe(NH_2CH_2CH_2NH_2)_3]^{2+}$ ⬭

**D** $[Cu(H_2O)_4(C_2O_4)]$ ⬭

**2 2** Which equation represents the process that occurs when the first electron affinity of fluorine is measured?

**[1 mark]**

**A** $F^-(g) \rightarrow F(g) + e^-$ ⬭

**B** $F(g) + e^- \rightarrow F^-(g)$ ⬭

**C** $F_2(g) + 2e^- \rightarrow 2F^-(g)$ ⬭

**D** $F(g) \rightarrow F^+(g) + e^-$ ⬭

**2 3** Dilute sodium hydroxide is added to a solution containing the complex ion **P**.

As the sodium hydroxide solution is added, a precipitate forms. This precipitate dissolves when excess sodium hydroxide solution is added.

What is the formula of **P**?

**[1 mark]**

**A** $[Cu(H_2O)_6]^{2+}$ ⬭

**B** $[Fe(H_2O)_6]^{2+}$ ⬭

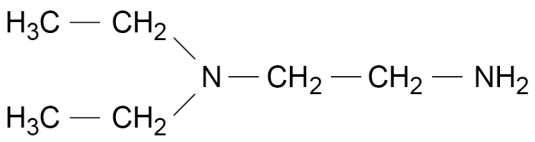
**C** $[Al(H_2O)_6]^{3+}$ ⬭

**D** $[Fe(H_2O)_6]^{3+}$ ⬭

*Do not write outside the box*

**2 4** What is the integration ratio for peaks in the $^1H$ NMR spectrum of this amine?

**[1 mark]**



**A** 3 : 3 : 2 : 2 : 2 : 2 : 2 ⬭

**B** 3 : 2 : 1 : 1 : 1 ⬭

**C** 3 : 2 : 1 : 1 ⬭

**D** 3 : 2 : 2 : 1 ⬭

**2 5** What is the approximate C–O–C bond angle in epoxyethane?

**[1 mark]**

**A** 60° ⬭

**B** 105° ⬭

**C** 109° ⬭

**D** 120° ⬭

**2 6** Which compound is formed when epoxyethane reacts with methanol?

**[1 mark]**

**A** $CH_3CH_2CH_2OH$ ⬭

**B** $CH_3OCH_2CH_2OH$ ⬭

**C** $CH_3CH_2OCH_2CH_2OH$ ⬭

**D** $CH_3OCH_2CH_2CH_2OH$ ⬭

*Do not write outside the box*

**2 7** Why is ethanoic anhydride used instead of ethanoyl chloride in the manufacture of aspirin?

**[1 mark]**

**A** Ethanoic anhydride is more easily hydrolysed by water. ⬭

**B** Ethanoyl chloride produces hydrogen chloride as a waste product. ⬭

**C** Ethanoyl chloride reacts more slowly. ⬭

**D** Ethanoic anhydride is a stronger acylating agent. ⬭

**2 8** Benzene reacts with concentrated sulfuric acid to form benzenesulfonic acid.

Which statement is correct?

**[1 mark]**

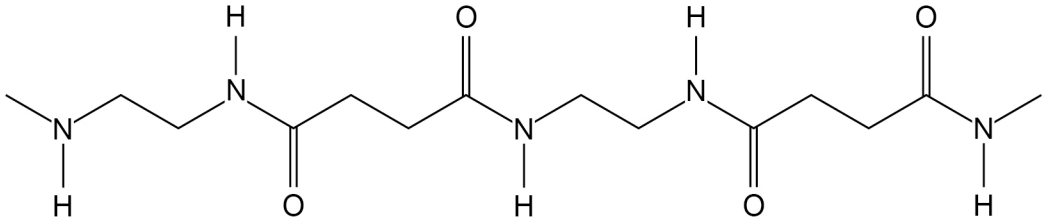
**A** Aluminium chloride is used as a catalyst. ⬭

**B** Benzene is protonated by the sulfuric acid. ⬭

**C** The electrophile has the molecular formula $SO_3$ ⬭

**D** Benzenesulfonic acid has the molecular formula $C_6H_5SO_3$ ⬭

**2 9** A section of a polymer is shown.



Which statement is correct?

**[1 mark]**

**A** The section shown has four repeating units. ⬭

**B** The polymer is non-biodegradable. ⬭

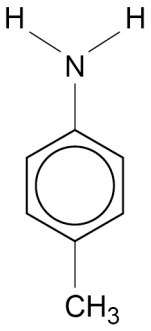
**C** The strongest forces between the polymer chains are hydrogen bonds. ⬭

**D** The monomer ethanedioic acid could be used to make the polymer. ⬭

*Do not write outside the box*

**3 0** Which statement about 4-methylphenylamine is correct?

**[1 mark]**



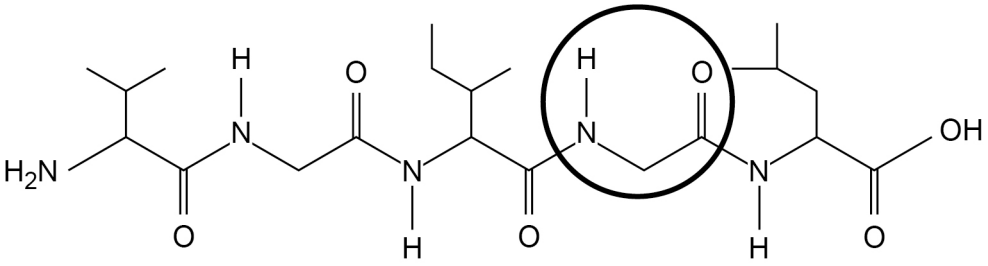

**A** It is a weaker base than ammonia. ⬭

**B** It can be prepared by reduction of a nitrile. ⬭

**C** There are four peaks in its $^{13}C$ NMR spectrum. ⬭

**D** Its infrared spectrum has an absorption between 2220 and 2260 $cm^{-1}$ ⬭

**3 1** The diagram shows a peptide.




Which statement is correct?

**[1 mark]**

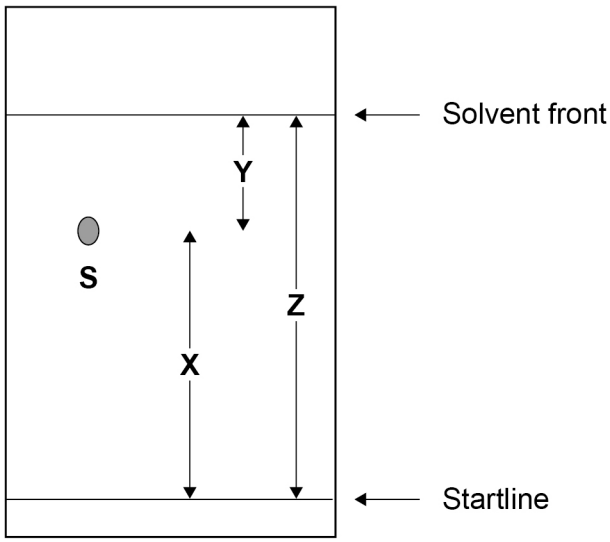
**A** The peptide is made from five different amino acids. ⬭

**B** The complete hydrolysis of the peptide produces four different amino acids. ⬭

**C** The complete hydrolysis of the peptide allows the sequence of amino acids to be determined. ⬭

**D** The circle on the diagram shows a peptide link. ⬭

**3 2** A thin-layer chromatogram of substance **S** is shown.




Which calculation shows the $R_f$ value of substance **S**?

**[1 mark]**

**A** X ÷ Y ⬭

**B** X ÷ Z ⬭

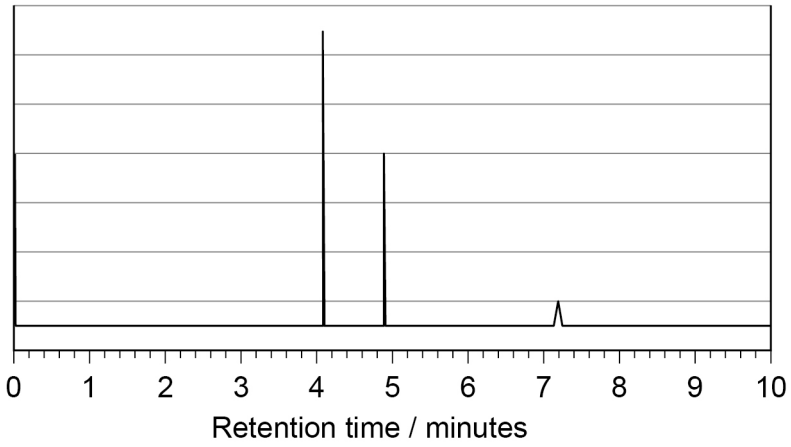
**C** Y ÷ Z ⬭

**D** Z ÷ X ⬭

**Turn over for the next question**

*Do not write outside the box*

**3 3** A mixture of organic compounds is analysed by gas chromatography (GC).
The GC trace is shown.




The retention times for some compounds using the same GC apparatus are given.

| Compound | Retention time / min |
|---|---|
| 2-methylnitrobenzene | 4.1 |
| 3-methylnitrobenzene | 4.4 |
| 4-methylnitrobenzene | 4.9 |
| 1-methyl-2,4-dinitrobenzene | 7.2 |

Which statement is correct?

**[1 mark]**

**A** 1-Methyl-2,4-dinitrobenzene travels through the column fastest. ⬭

**B** The length of the column does not affect the retention times. ⬭

**C** 3-Methylnitrobenzene is not detected in the mixture. ⬭

**D** The nature of the stationary phase does not affect the retention times. ⬭

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**END OF QUESTIONS**

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