AQA

A-level
CHEMISTRY

Paper 3

Wednesday 20 June 2018   Morning   Time allowed: 2 hours

Materials
For this paper you must have:
- the Periodic Table/Data Booklet, provided as an insert (enclosed)
- 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.
- Fill in the boxes at the top of the 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.
- 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 90.

Advice
- You are advised to spend about 70 minutes on **Section A** and 50 minutes on **Section B**.

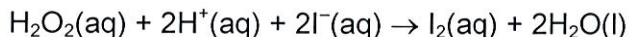| For Examiner's Use	
Question	Mark
1	
2	
3	
4	
Section B	
TOTAL	

7405/3

Section A

Answer **all** questions in this section.

0 1 Iodide ions are oxidised to iodine by hydrogen peroxide in acidic conditions.

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

The rate equation for this reaction can be written as

$$rate = k[H_2O_2]^a[I^-]^b[H^+]^c$$

In an experiment to determine the order with respect to $H^+(aq)$, a reaction mixture is made containing $H^+(aq)$ with a concentration of 0.500 mol dm^{-3}

A large excess of both H_2O_2 and I^- is used in this reaction mixture so that the rate equation can be simplified to

$$rate = k_1[H^+]^c$$

0 1 . 1 Explain why the use of a large excess of H_2O_2 and I^- means that the rate of reaction at a fixed temperature depends only on the concentration of $H^+(aq)$.

[2 marks]

• H_2O_2 and I^- concentrations are constant M1

• So they have no effect on the rate M2

0 1 . 2 Samples of the reaction mixture are removed at timed intervals and titrated with alkali to determine the concentration of $H^+(aq)$.

State and explain what must be done to each sample before it is titrated with alkali.
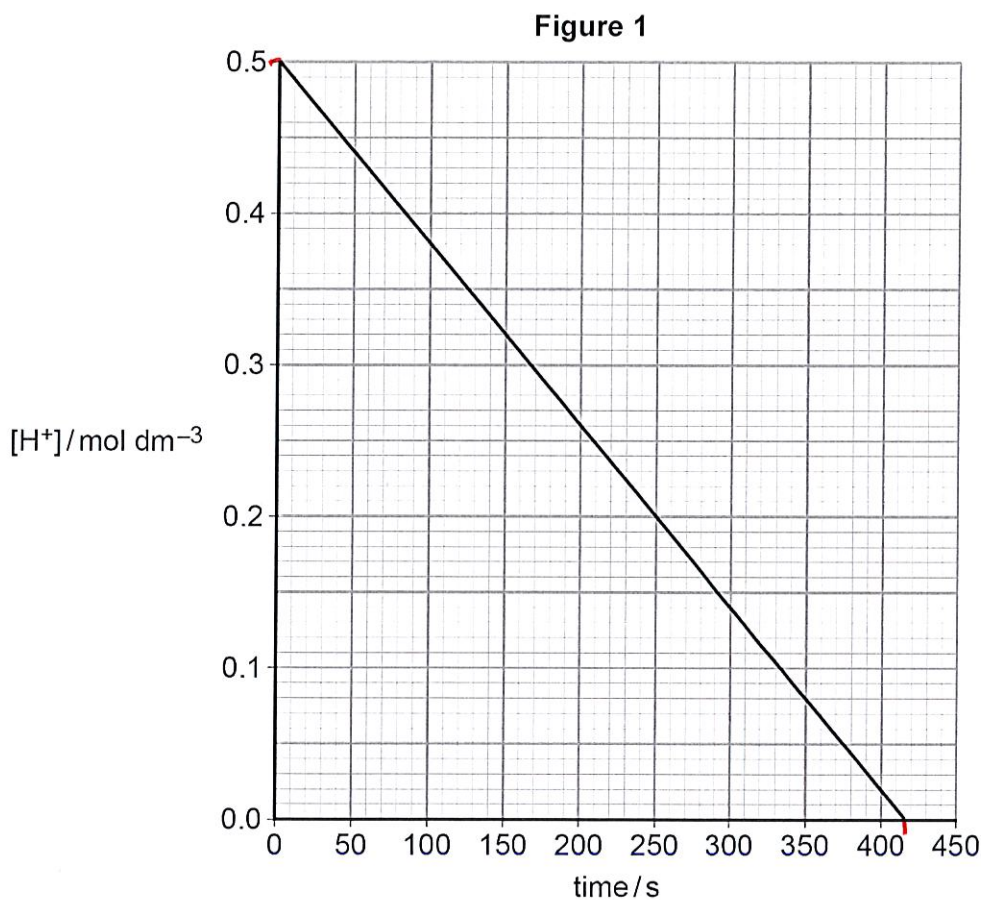
[2 marks]

• reaction must be stopped / quenched M1

• by dilution / cooling M2

0 1 . 3 A graph of the results is shown in **Figure 1**.

Figure 1

Explain how the graph shows that the order with respect to $H^+(aq)$ is zero.

[2 marks]

- decrease in concentration is proportional to time   M1
  or constant gradient

- as $[H^+]$ decreases   M2

0 1 . 4 Use the graph in **Figure 1** to calculate the value of k_1
Give the units of k_1

[3 marks]

gradient = k $\dfrac{0.5 - 0}{415 - 0}$ M1

k_1 ___1.20×10^{-3}___   M2

Units ___$mol\ dm^{-3}\ s^{-1}$___   M3

Turn over ▶

0 1 . 5 A second reaction mixture is made at the same temperature. The initial concentrations of $H^+(aq)$ and $I^-(aq)$ in this mixture are both 0.500 mol dm^{-3} There is a large excess of H_2O_2

In this reaction mixture, the rate depends only on the concentration of $I^-(aq)$.
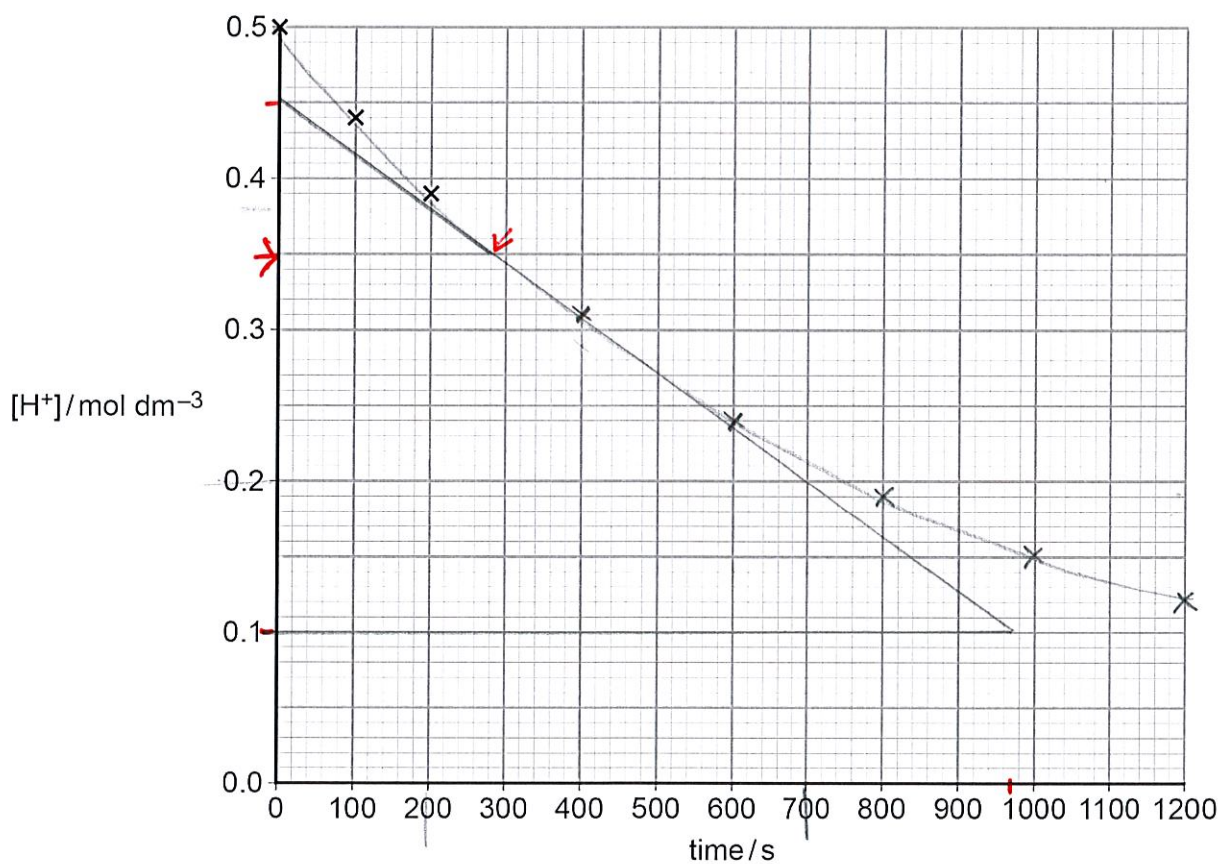
The results are shown in **Table 1**.

Table 1

Time / s	0	100	200	400	600	800	1000	1200
[H$^+$] / mol dm^{-3}	0.50	0.44	0.39	0.31	0.24	0.19	0.15	0.12

Plot these results on the grid in **Figure 2**. The first three points have been plotted.

[1 mark] ± half small square

Figure 2

0 1 . 6 Draw a line of best fit on the grid in **Figure 2**.

[1 mark] Smooth curve

| 0 | 1 | . | 7 | Calculate the rate of reaction when $[H^+] = 0.35$ mol dm^{-3}
Show your working using a suitable construction on the graph in **Figure 2**.

[2 marks]

Tangent to curve at 0.35 mol dm^{-3}

Gradient = rate

$$\frac{\Delta y}{\Delta x} = \frac{0.45 - 0.1}{970 - 0} = \frac{0.35}{970}$$

Rate _____ 3.60×10^{-4} _____ mol dm^{-3} s^{-1}

Question 1 continues on the next page

Turn over ▶

0 1 . 8 A general equation for a reaction is shown.

*LEVELLED
CHALLENGING*

$$A(aq) + B(aq) + C(aq) \rightarrow D(aq) + E(aq)$$
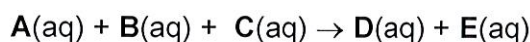
In aqueous solution, **A**, **B**, **C** and **D** are all colourless but **E** is dark blue.

*This is
the iodine
clock
reaction*

A reagent (**X**) is available that reacts rapidly with **E**. This means that, if a small amount of **X** is included in the initial reaction mixture, it will react with any **E** produced until all of the **X** has been used up.

Explain, giving brief experimental details, how you could use a series of experiments to determine the order of this reaction with respect to **A**. In each experiment you should obtain a measure of the initial rate of reaction.

[6 marks]

- Preparation
  - Measure known volumes of reagents A, B, C
  - measure known amount of X in a separate container
- Procedure
  - Mix all the reagents together and start stopwatch
  - time appearance of blue colour and record
  - repeat with different concentrations of A
  - keep the following the same
    - temperature
    - concentration of B + C
    - volume or amount of X
- Use of results
  - Calculate 1/time (as a measure of rate)
  - plot log (1/time) against log (concentration A)
  - calculate gradient of log plots to determine the rate

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0 2   The elements sodium to sulfur in Period 3 all react with oxygen to form oxides.

0 2 . 1   Give an equation and **two** observations made for the reaction that occurs when sodium is heated in oxygen.

[2 marks]

Equation $4Na + O_2 \rightarrow 2Na_2O$ M1

Observation 1   yellow flame / light

Observation 2   white solid / powder / smoke   ] M2

0 2 . 2   Give an equation and **one** observation made for the reaction that occurs when phosphorus is heated in oxygen.

[2 marks]

Equation $P_4 + 5O_2 \rightarrow P_4O_{10}$ M1

Observation   white flame / light OR white fumes / smoke / solid   M2

0 2 . 3   The melting points of the highest oxides of the elements sodium to sulfur are shown in **Table 2**.

Table 2

	Highest oxide of					
	sodium	magnesium	aluminium	silicon	phosphorus	sulfur
Melting point/K	1548	3125	2345	1883	573	290

Explain the increase in melting point from <u>sodium oxide to magnesium oxide</u>.

[2 marks]

• Stronger ionic bond
or stronger attraction between Mg^{2+} and O^{2-} ions   M1

• Due to greater charge on Mg^{2+}
or greater charge density on Mg^{2+} M2

0 2 . 4 Explain why the melting point of the oxide of silicon is much higher than that of the highest oxide of phosphorus.

[3 marks]

• SiO_2 is macromolecular   M1

• P_4O_{10} is a simple molecule   M2

• Covalent bonds between all atoms in SiO_2 M3 are much stronger than the weak intermolecular forces (forces between molecules in P_4O_{10}

0 2 . 5 A sample of the highest oxide of phosphorus was prepared in a laboratory.

Describe a method for determining the melting point of the sample.
State how the result obtained could be used to evaluate its purity.

[3 marks]

• Place sample of oxide in a melting point apparatus   M1

• Heat gently / slowly / gradually (near melting point)   M2

• Lower melting point / range of melting points indicates impurities   M3

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Turn over ▶

0 3 Cyclohexene (boiling point = 83 °C) can be prepared by the dehydration of cyclohexanol (boiling point = 161 °C) using concentrated phosphoric acid.
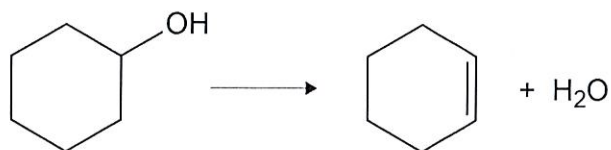
A student prepared cyclohexene by placing 10 cm³ of cyclohexanol (density = 0.96 g cm⁻³) into a round-bottomed flask.
3 cm³ of concentrated phosphoric acid were then carefully added to the flask.
The student added a few anti-bumping granules and set up the apparatus shown in **Figure 3**.

Figure 3
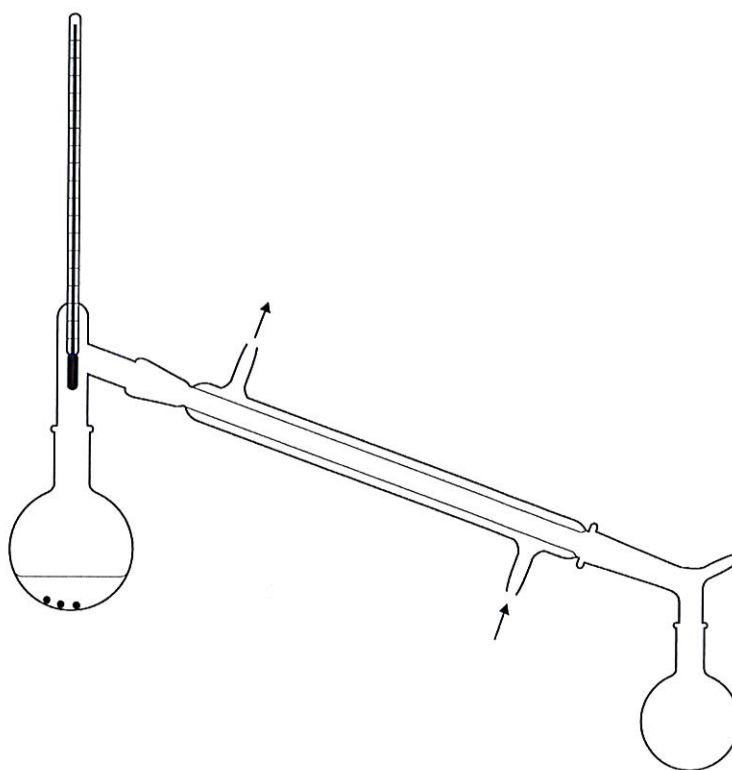
- The student heated the mixture and collected the liquid that distilled at temperatures below 100 °C
- The distillate was poured into a separating funnel and washed by shaking with sodium carbonate solution.
- Periodically, the separating funnel was inverted and the tap opened.
- The aqueous layer was discarded and the final organic product was dried using anhydrous calcium chloride.
- After the product was dried, the drying agent was removed by filtration under reduced pressure.

0 3 . 1 The student collected 5.97 g of cyclohexene in the experiment.

Calculate the percentage yield of cyclohexene.

[3 marks]

$d = \frac{m}{V}$

$m \ C_6H_{11}OH = 10 \times 0.96 = 9.6g$

$n \ C_6H_{11}OH = 9.6/100 = 0.096 \quad \therefore \ n \ C_6H_{10} = 0.096$ M1

max $m \ C_6H_{10} = 0.096 \times 82 = 7.87g$ M2

% yield $= \frac{5.97}{7.87} \times 100$

Alternative method using moles

Percentage yield ___75.9___ % M3

(Range: 75.8 - 76)

0 3 . 2 Describe a test-tube reaction, on the product, to show that the cyclohexanol had been dehydrated.
State what you would observe.

[2 marks]

• add bromine water M1

• decolourised / turns colourless M2

0 3 . 3 Suggest why sodium carbonate solution was used to wash the distillate.

[1 mark]

• neutralise / react with (phosphoric) acid

0 3 . 4 Explain why it is important to open the tap of the separating funnel periodically.

[1 mark]

• avoid pressure build up / release pressure / release CO_2 or gas

Question 3 continues on the next page

Turn over ▶

0 3 . 5 Give a property of anhydrous calcium chloride, other than its ability to absorb water, that makes it suitable as a drying agent in this preparation.
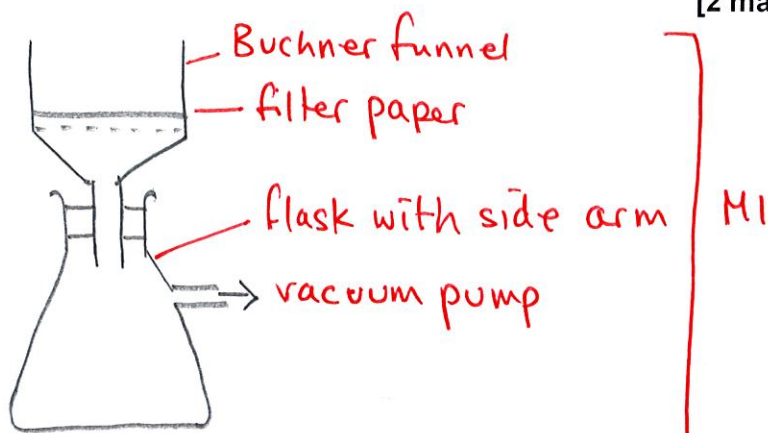
[1 mark]

does not dissolve in cyclohexene or react with cyclohexene

0 3 . 6 Describe the apparatus used to remove the drying agent by filtration under reduced pressure. Your description of the apparatus can be either a labelled diagram **or** a description in words.

[2 marks]

*Diagram!
(recommended)*

— Buchner funnel
— filter paper
— flask with side arm | M1
→ vacuum pump

M2 = apparatus works – flow through – air-tight – vacuum pump

Description:
- *Buchner funnel containing filter paper* — M1
- *Side-arm flask attached to vacuum pump* — M2

0 3 . 7 A sample of cyclohexene has been contaminated with cyclohexanol. The cyclohexene can be separated from the cyclohexanol by column chromatography. Silica gel is used as the stationary phase and hexane as the mobile phase.

Explain why cyclohexene has a shorter retention time than cyclohexanol.

[2 marks]

- cyclohexene is less polar than cyclohexanol   M1

- cyclohexene has a greater affinity for the   M2
  mobile phase/hexane
or cyclohexanol has a greater affinity for the
  stationary phase/silica gel

0 3 . 8 Explain how an infrared spectrum would confirm that the cyclohexene obtained from the chromatography column did **not** contain any cyclohexanol.

[1 mark]

both needed for mark [No peak in region 3230-3550 cm⁻¹
due to O-H bond (in alcohol/cyclohexanol)

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Turn over for the next question

M1: Axes
y = Temp
x = time
sensible scales

M2: Plots points
± half small
square

M3: Two lines of
best fit

M4: Extrapolation
to 4th minute

Temperature /°C

Time / mins
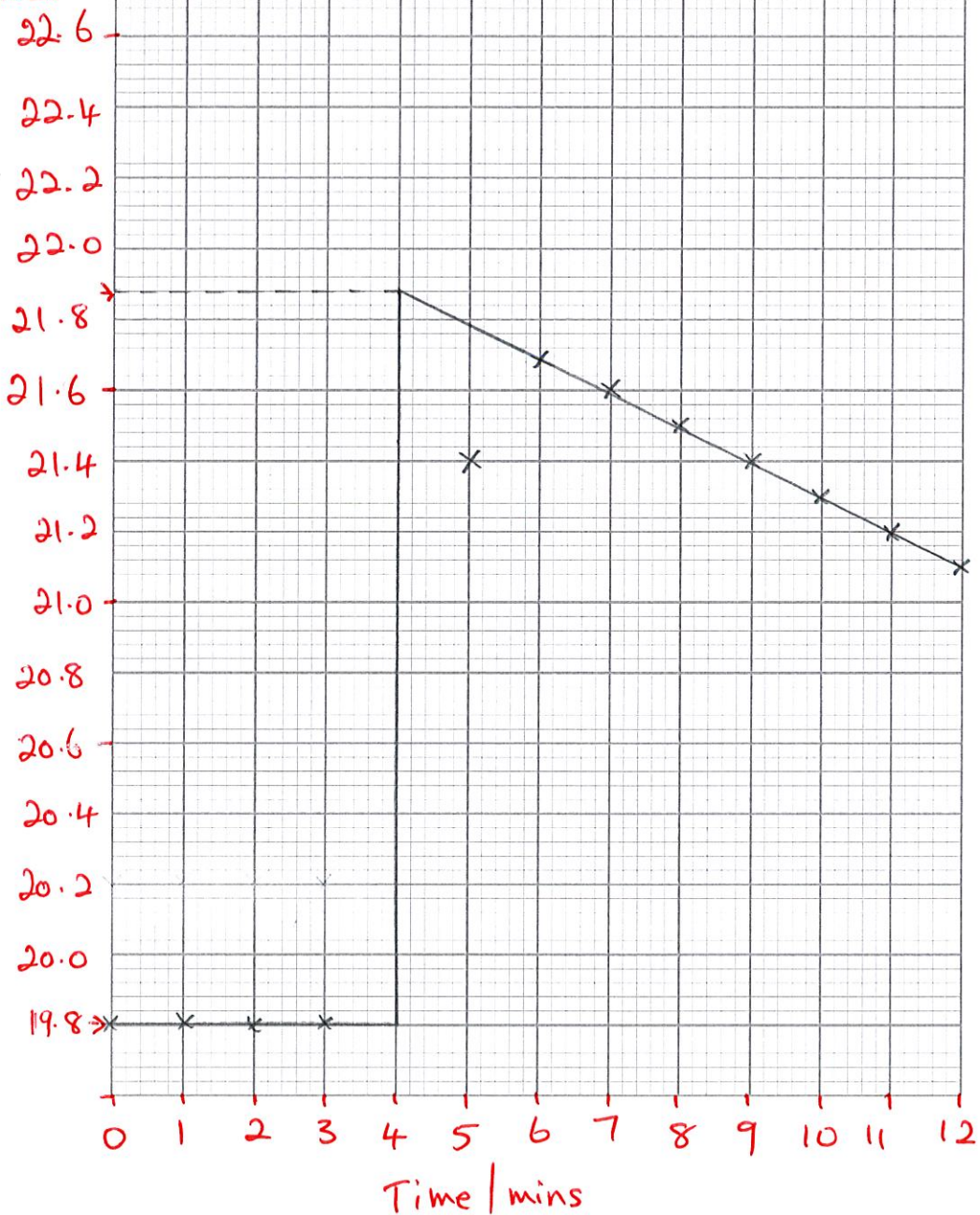
0 4 A student carried out an experiment to find the temperature rise for a reaction between hydrochloric acid and sodium hydroxide solution.

- The student used a measuring cylinder to place 50 cm³ of 0.400 mol dm⁻³ hydrochloric acid into a glass beaker.
- The student recorded the temperature at one-minute intervals for three minutes.
- At the fourth minute the student added 50 cm³ of 0.400 mol dm⁻³ sodium hydroxide solution and stirred to mix the solutions, but did not record the temperature.
- The student recorded the temperature at one-minute intervals for a further eight minutes.

The results are shown in **Table 3**.

Table 3

Time / min	0	1	2	3	4	5	6	7	8	9	10	11	12
Temperature / °C	19.8	19.8	19.8	19.8		21.4	21.7	21.6	21.5	21.4	21.3	21.2	21.1

0 4 . 1 Plot a graph of temperature against time on the grid opposite.
Use your graph to find the temperature rise, ΔT, at the fourth minute.
Show your working on the graph by drawing suitable lines of best fit.

[5 marks]

$\Delta T = 21.9 - 19.8$

MS

ΔT ___2.1___ °C

0 4 . 2 The uncertainty in each of the temperature readings from the thermometer used in this experiment was ±0.1°C

Calculate the percentage uncertainty in the value for the temperature rise.

Two readings **[1 mark]**

$\dfrac{0.2}{2.1} \times 100$

Percentage uncertainty ___9.5%___

0 4 . 3 Suggest a change to the experiment that would minimise heat loss.

[1 mark]

replace glass beaker with polystyrene cup or insulate glass beaker or use a lid

0 4 . 4 Suggest and explain another change to the experiment that would decrease the percentage uncertainty in the use of the same thermometer.

[2 marks]

- Increase the temperature change — M1
- by increasing the concentration of the — M2
  acid/alkali

0 4 . 5 A second student completed an experiment to determine the enthalpy of neutralisation for the reaction between ethanedioic acid solution (HOOCCOOH) and potassium hydroxide solution.

The student added 25 cm³ of 0.80 mol dm⁻³ ethanedioic acid solution to 75 cm³ of 0.60 mol dm⁻³ potassium hydroxide solution.
The temperature increased by 3.2 °C

Give an equation for the reaction between ethanedioic acid solution and potassium hydroxide solution.
Calculate the enthalpy change (ΔH) per mole of water formed in this reaction.
Assume that the specific heat capacity of the reaction mixture is $4.2\,J\,K^{-1}\,g^{-1}$
Assume that the density of the reaction mixture is $1.00\,g\,cm^{-3}$

[5 marks]

Equation $HOOCCOOH + 2KOH \rightarrow K_2(OOCCOO) + 2H_2O$

$q = mc\Delta T$
$= 100 \times 4.2 \times 3.2$
$= 1344\,J \Rightarrow 1.344\,kJ$

$n\ HOOCCOOH = 0.8 \times 25 \times 10^{-3} = 0.020$ limiting
$n\ KOH = 0.6 \times 75 \times 10^{-3} = 0.045$ excess

$\therefore n\ H_2O = 0.040$

$\Delta H = \dfrac{q}{n}$

$= \dfrac{1.344}{0.04}$

ΔH -33.6 kJ mol⁻¹
(of H_2O)

0 4 . 6 In a similar experiment to that in Question **04.5**, the enthalpy of neutralisation for the reaction between sulfuric acid and potassium hydroxide solution was found to be -57.0 kJ mol^{-1} per mole of water formed.

Suggest an explanation for the difference between this value and your answer to Question **04.5**.
(If you were unable to obtain an answer to Question **04.5** you should assume a value of -28.5 kJ mol^{-1}. This is **not** the correct answer.)

[2 marks]

- HOOCCOOH is a weak acid / not fully dissociated
or H_2SO_4 is a strong acid / fully dissociated

- more energy needed to break bonds / complete dissociation / dissociation is endothermic
or less energy needed for dissociation H_2SO_4

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Turn over for Section B
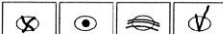
Section B

Answer **all** questions in this section.

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 | 5 | Which can be both an empirical and molecular formula of a stable compound?

[1 mark]

A CH_2O ⬤   H⟍C=O
                        H⟋
B P_4O_{10} ◯   not emprical

C NH_2 ◯

D CH_3 ◯
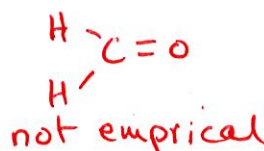
0 6 Which diagram shows the correct bonding and correct bond polarity in a molecule of oxygen difluoride?

[1 mark]

A
δ^- F $\qquad$ F δ^-
O
δ^+
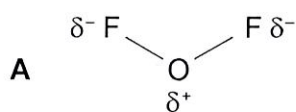
Coralent bonds form not dative
F more electronegative than O

B
δ^+ F $\qquad$ F δ^+
O
δ^-

C
δ^- F $\qquad$ F δ^-
O
δ^+

D
δ^+ F $\qquad$ F δ^+
O
δ^-
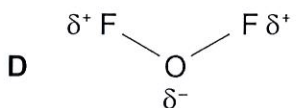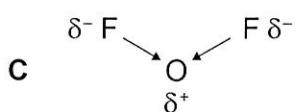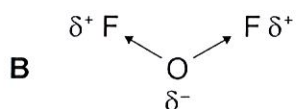
Turn over for the next question

Turn over ▶

In the early twentieth century the apparatus shown in the diagram was used to investigate atomic structure. When He^{2+} particles were fired at a thin sheet of gold, most of the particles were detected at point **P**.
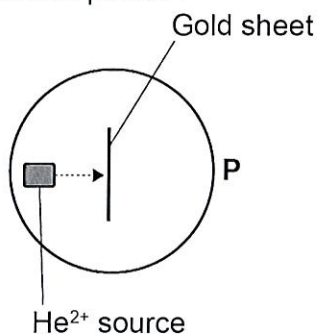
0 7 What conclusion can be drawn from the detection of He^{2+} particles at point **P**?

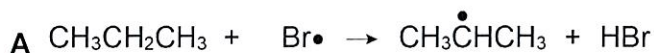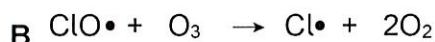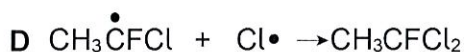**[1 mark]**

A Gold atoms contain electrons. ○

B Gold atoms contain protons. ○

C Gold atoms contain neutrons. ○

D Gold atoms are mainly empty space. ●

When He^{2+} particles were fired at a thin sheet of gold, about 1 in 8000 of the particles were detected at point **Q**.
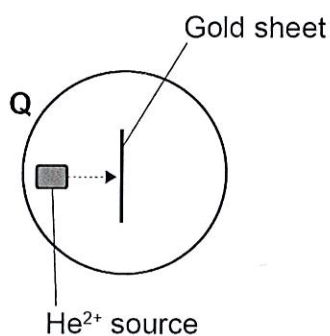
0 8 What conclusion can be drawn from the detection of He^{2+} particles at point **Q**?

[1 mark]

A Gold atoms have a small, positive nucleus. ●

B Gold atoms have electrons in orbitals. ○

C Gold consists of ions in a sea of delocalised electrons. ○

D Gold atoms have more protons than He^{2+} particles. ○

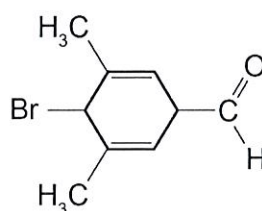**0 9** Which equation represents a <u>termination</u> step?

[1 mark]

A $CH_3CH_2CH_3 + Br• \rightarrow CH_3\overset{•}{C}HCH_3 + HBr$ ⊖

B $ClO• + O_3 \rightarrow Cl• + 2O_2$ ⊖

C $RO• + CH_2 = CH_2 \rightarrow ROCH_2\overset{•}{C}H_2$ ⊖

D $CH_3\overset{•}{C}FCl + Cl• \rightarrow CH_3CFCl_2$ ⦿ *2 free radicals*

1 0 Which statement is correct about the molecule shown?

[1 mark]

A It reacts with HBr in an electrophilic substitution reaction. ⊖
addition

B It reacts with $NaBH_4$ in a nucleophilic addition-elimination reaction. ⊖
nucleophilic addition

C It reacts with ethanolic KOH in an elimination reaction. ⊖

D It reacts with KCN in a nucleophilic substitution reaction. ⦿

1 1 Which statement is correct about both 2-methylbutan-1-ol and 2-methylbutan-2-ol?

[1 mark]

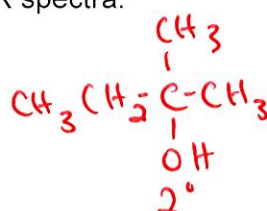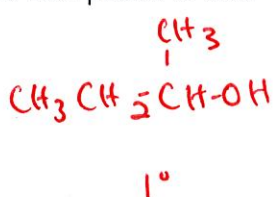A They can be formed by alkaline hydrolysis of esters. ⦿

B They can be oxidised by reaction with acidified potassium dichromate(VI). ⊖

C They can be formed by hydration of 2-methylbut-2-ene. ⊖

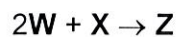D They have four peaks in their ^{13}C NMR spectra. ⊖

CH3
CH3 CH2 CH-OH
1°

CH3
CH3 CH2 C-CH3
OH
2°

Turn over ▶

1 2 Solutions of two compounds, **W** and **X**, react together in the presence of a soluble catalyst, **Y**, as shown in the equation

$$2W + X \rightarrow Z$$

When the concentrations of **W**, **X** and **Y** are all doubled, the rate of reaction increases by a factor of four.

Which is a possible rate equation for this reaction?

[1 mark]

A *rate* = $k\,[W]^2\,[X]$ ☐ *over all 3rd order*

B *rate* = $k\,[W]^2\,[Y]$ ☐ *over all 3rd order*

C *rate* = $k\,[X]\,[Y]$ ● *over all 2nd order*

D *rate* = $k\,[X]\,[Z]$ ☐ *Z is a product*

1 3 A series of experiments was carried out to find the order of reaction with respect to reactant **X**. In these experiments, only the concentration of **X** was changed.

Which graph would show that the reaction is <u>second-order with respect to **X**</u>?

[1 mark]

rate of reaction

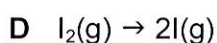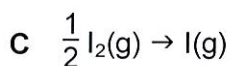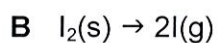concentration of **X**
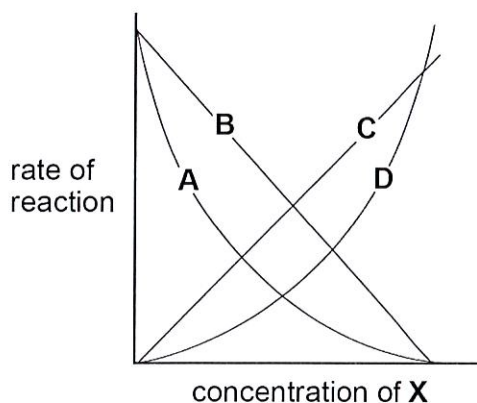
A ☐

B ☐

C ☐

D ●

1 4 Which equation represents the process that occurs when the standard enthalpy of atomisation of iodine is measured?

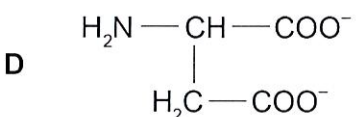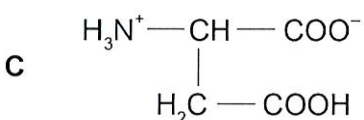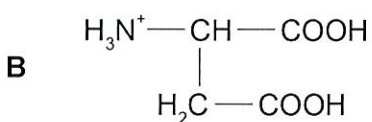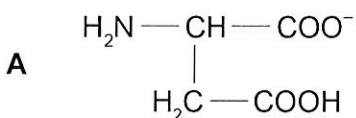*one mole gaseous atoms from element in standard state* **[1 mark]**

A $\frac{1}{2} I_2(s) \rightarrow I(g)$ ▣

B $I_2(s) \rightarrow 2I(g)$ ☐

C $\frac{1}{2} I_2(g) \rightarrow I(g)$ ☐

D $I_2(g) \rightarrow 2I(g)$ ☐

1 5 Which structure is formed by aspartic acid in solution at pH 12?

[1 mark]

A $H_2N — CH — COO^-$
       $|$
       $H_2C — COOH$ ☐

B $H_3N^+ — CH — COOH$
       $|$
       $H_2C — COOH$ ☐

C $H_3N^+ — CH — COO^-$
       $|$
       $H_2C — COOH$ ☐

D $H_2N — CH — COO^-$
       $|$
       $H_2C — COO^-$ ▣

Turn over for the next question

Turn over ▶

1 6 How many peaks are there in the ^{13}C NMR spectrum of 1,4-dimethylbenzene?
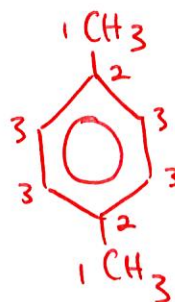
[1 mark]

A 8 ⬭

B 4 ⬭

C 3 ●

D 2 ⬭

[handwritten benzene structure with labels: 1 CH₃, 2, 3, 3, 3, 3, 2, 1 CH₃]

1 7 Which of these Period 3 elements has the highest melting point?

[1 mark]

A Aluminium ● *metallic*

B Phosphorus ⬭ ⎤

C Sodium ⬭ ⎬ *simple molecules*

D Sulfur ⬭ ⎦

1 8 Chlorine reacts with cold, dilute, aqueous sodium hydroxide.

Which is a complete list of the products?

[1 mark]

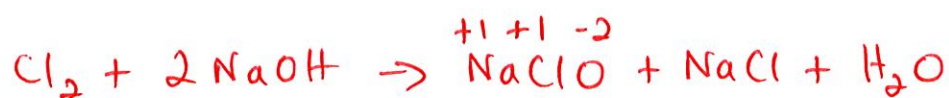A Sodium chloride, sodium chlorate(I) and water ●

B Sodium chlorate(I) and water ⬭

C Sodium chloride, sodium chlorate(V) and water ⬭

D Sodium chloride and sodium chlorate(I) ⬭

[handwritten equation]

$$Cl_2 + 2NaOH \rightarrow \overset{+1\ +1\ -2}{NaClO} + NaCl + H_2O$$

1 9 Which products are formed when magnesium reacts with steam?

[1 mark]

A Magnesium hydroxide and hydrogen ⭕

B Magnesium hydroxide and oxygen ⭕

C Magnesium oxide and hydrogen 🔴

D Magnesium oxide and oxygen ⭕

$$Mg\,(s) + H_2O\,(g) \rightarrow MgO\,(s) + H_2\,(g)$$

2 0 Which observation would confirm that ammonia gas is released when solid ammonium chloride is warmed with solid calcium hydroxide?

[1 mark]

A Damp blue litmus paper turns red when touched onto the solid mixture. ⭕

B Damp red litmus paper turns blue when touched onto the solid mixture. ⭕

C Damp blue litmus paper turns red when held just above the solid mixture. ⭕

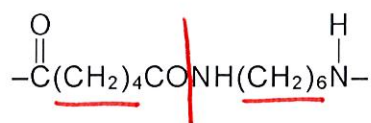D Damp red litmus paper turns blue when held just above the solid mixture. 🔴 $NH_3\,(g)$ alkali

Turn over for the next question

Turn over ▶

2 1 The repeating unit of a polymer is shown.

$$-\overset{O}{\underset{}{C}}(CH_2)_4CONH(CH_2)_6\overset{H}{\underset{}{N}}-$$

Which monomer or pair of monomers could be used to make this polymer?

[1 mark]

A $ClOC(CH_2)_4NH_2$ only

B $ClOC(CH_2)_4COCl$ only

C $ClOC(CH_2)_4COCl$ and $H_2N(CH_2)_6NH_2$ ●

D $ClOC(CH_2)_6COCl$ and $H_2N(CH_2)_4NH_2$

2 2 The structure of part of a polyester chain is shown.
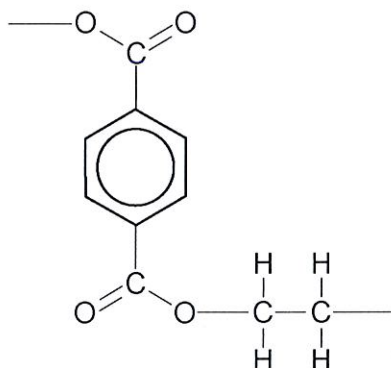
Which statement correctly explains why plastics made from this polyester only soften at high temperatures?

[1 mark]

A Hydrogen bonds and van der Waals' forces exist between polyester chains.   *no H bonded to N, O, F*

B Permanent dipole-dipole forces and van der Waals' forces exist between polyester chains. ●
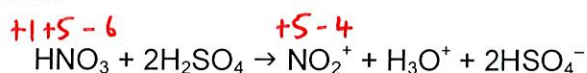
C The carbon-carbon bonds in the chain are strong.

D The carbon-oxygen bonds in the chain are strong.

2 3 The nitration of benzene uses a nitrating mixture of concentrated nitric acid and concentrated sulfuric acid.

+1 +5 −6   +5 −4
$$HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$$

Which statement is correct?

[1 mark]

A HNO_3 acts as a base.   ⬤

B HNO_3 acts as a catalyst.   ▢   no regenerated

H_2SO_4

C HNO_3 acts as an electrophile.   ▢ NO_2^+ electrophile

D HNO_3 acts as a reducing agent.   ▢   no change in oxidation state

2 4 Aqueous solutions of ammonia, ethylamine and phenylamine are prepared. Each solution has the same concentration.

Which is the correct order for the pH values of these solutions?

[1 mark]

A ammonia > ethylamine > phenylamine   ▢

B ammonia > phenylamine > ethylamine   ▢

C ethylamine > ammonia > phenylamine   ⬤

D ethylamine > phenylamine > ammonia   ▢

2 5 Which element forms an ionic oxide that reacts with strong alkalis?

[1 mark]

A Aluminium   ⬤   aluminium oxide is ionic + amphoteric

B Magnesium   ▢

C Sodium   ▢

D Sulfur   ▢   Sulphur oxides are molecular

Turn over ▶

2 6 Which statement is correct about this reaction?

$$[Co(NH_3)_6]^{2+} + 3H_2NCH_2CH_2NH_2 \rightarrow [Co(H_2NCH_2CH_2NH_2)_3]^{2+} + 6NH_3$$
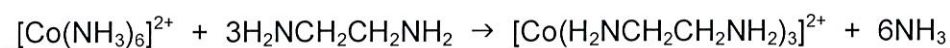
[1 mark]

A The co-ordination number of cobalt decreases. ○ Same

B The enthalpy change is large and positive. ○ no information given

C The entropy change is large and positive. ● 4 → 6 molecules

D The shape of the complex changes from octahedral. ○ Same

2 7 Which complex exists as <u>optical</u> isomers?

[1 mark]

A $[Ag(NH_3)_2]^+$ ○

B $[Co(C_2O_4)_3]^{4-}$ ●

C $[Cu(EDTA)]^{2-}$ ○

D $[Cu(NH_3)_4(H_2O)_2]^{2+}$ ○ forms geometric isomers cis/trans

2 8 How many structural isomers with the molecular formula $C_5H_{10}O$ react with Tollens' reagent?

[1 mark]

A 3 ○

B 4 ●

C 5 ○
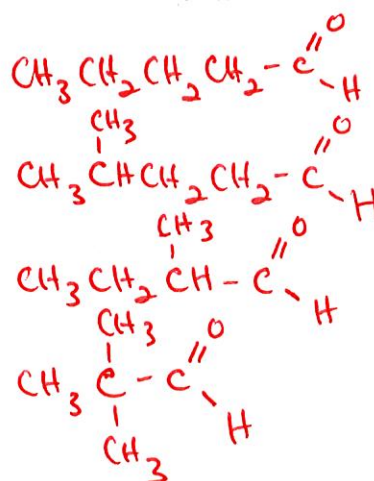
D 6 ○

CH₃CH₂CH₂CH₂—C(=O)H

CH₃CHCH₂CH₂—C(=O)H with CH₃ branch

CH₃CH₂CH—C(=O)H with CH₃ branch

CH₃C—C(=O)H with CH₃ branches

2 9 Which ion **cannot** catalyse the reaction between iodide (I^-) and peroxodisulfate ($S_2O_8^{2-}$)?

Use the data below to help you answer this question.

[1 mark]

Half-equation	$E^{\ominus}/V$
$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-}$	+2.01
$Co^{3+} + e^- \rightarrow Co^{2+}$	+1.82
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.77
$I_2 + 2e^- \rightarrow 2I^-$	+0.54
$Cr^{3+} + e^- \rightarrow Cr^{2+}$	−0.41

A Co^{2+} ⬭

B Cr^{2+} ⬤

C Fe^{2+} ⬭

D Fe^{3+} ⬭

3 0 Which species has a shape that is influenced by the presence of <u>one or more lone pairs</u> of electrons around the central atom?

[1 mark]

A $AlCl_3$ ⬭

B ClF_3 ⬤   Only 3 bonding pairs so 2 lone pairs

C IF_6^+ ⬭

D PCl_6^- ⬭

F—Cl—F
|
F

Turn over for the next question

Turn over ▶

3 **1**   Some 1.0 mol dm^{-3} solutions were mixed using equal volumes of each solution.

Which pair of solutions would give the greatest mass of solid?

[1 mark]

A $Ba(OH)_2$ and $MgCl_2$ → $BaCl_2 (aq) + Mg(OH)_2 (s)$ ◯

B $Ba(OH)_2$ and $MgSO_4$ → $BaSO_4 (s) + Mg(OH)_2 (s)$ ⬤

C $Ba(OH)_2$ and 2NaCl → $BaCl_2 (aq) + 2NaOH (aq)$ ◯

D $Ba(OH)_2$ and Na_2SO_4 → $BaSO_4 (s) + 2NaOH (aq)$ ◯

3 **2**   Which indicator should be used in a titration to find the concentration of a solution of methylamine using 0.010 mol dm^{-3} hydrochloric acid?
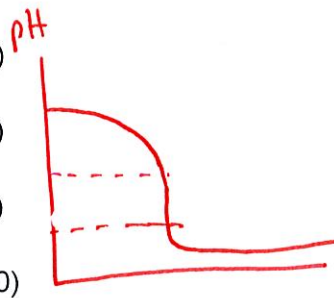
weak base   strong acid

[1 mark]

A Thymol blue   (pH range 1.2–2.8)   ◯

B Bromophenol blue   (pH range 3.0–4.6)   ⬤

C Phenol red   (pH range 6.8–8.4)   ◯

D Phenolphthalein   (pH range 8.3–10.0)   ◯

3 **3**   Lattice enthalpy values can be obtained from Born–Haber cycles and by calculations based on a perfect ionic model.

Which compound shows the greatest percentage difference between these two values?

[1 mark]

A CsF   ◯

B CsI   ◯
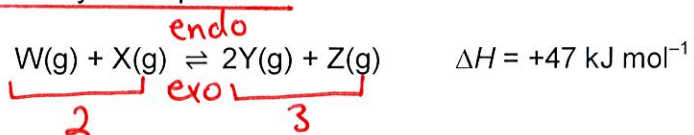
C LiF   ◯

D LiI   ⬤   Small cation – high charge density
large anion – polarisation

3 4 For this reaction at equilibrium, which combination of temperature and pressure would give the greatest equilibrium yield of products?

endo

$$W(g) + X(g) \rightleftharpoons 2Y(g) + Z(g) \qquad \Delta H = +47 \text{ kJ mol}^{-1}$$

exo

2   3

[1 mark]

A High pressure and high temperature ⬭

B High pressure and low temperature ⬭

C Low pressure and high temperature ⬤

D Low pressure and low temperature ⬭

30

END OF QUESTIONS

There are no questions printed on this page

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