AQA

A-level
CHEMISTRY
Paper 3

Wednesday 19 June 2019   Morning   Time allowed: 2 hours

Materials
For this paper you must have:
* the Periodic Table/Data Sheet, 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 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.
* 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
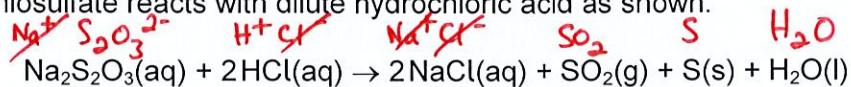* You are advised to spend about 70 minutes on **Section A** and 50 minutes on **Section B**.

Section A

Answer **all** questions in this section.

0 1 Sodium thiosulfate reacts with dilute hydrochloric acid as shown.

$$\overset{Na^+ \ S_2O_3{}^{2-}}{Na_2S_2O_3(aq)} + \overset{H^+ \ Cl^-}{2HCl(aq)} \rightarrow \overset{Na^+ Cl^-}{2NaCl(aq)} + \overset{SO_2}{SO_2(g)} + \overset{S}{S(s)} + \overset{H_2O}{H_2O(l)}$$

0 1 . 1 Give the simplest ionic equation for this reaction.

[1 mark]

$$S_2O_3{}^{2-} + H^+ \rightarrow SO_2 + S + H_2O$$

0 1 . 2 The gas SO_2 is a pollutant.

State the property of SO_2 that causes pollution when it enters rivers.

Give an equation to show the reaction of SO_2 with water.

[2 marks]

Property   _acidic_

Equation $SO_2 + H_2O \rightarrow H_2SO_3$

0 1 . 3 Draw a diagram to show the shape of a molecule of H_2O
Include any lone pairs of electrons.

State the H–O–H bond angle.

Explain this shape and bond angle.

[4 marks]

Diagram

[Diagram: Lewis structure of water molecule showing central O with two lone pairs (dots on top) bonded to two H atoms in a bent shape]

Bond angle ___105°___ (range 104–105°) ___

Explanation ___

· lone pairs repel more than bonding pairs
· so bond angle reduced from 109.5°

Question 1 continues on the next page

Turn over ▶

0 1 . 4   The initial rate of the reaction between sodium thiosulfate and hydrochloric acid can be monitored by measuring the time taken for a fixed amount of sulfur to be produced.

Describe an experiment to investigate the effect of temperature on the initial rate of this reaction.

Include

- a brief outline of your method
- how you will measure the time taken for a fixed amount of sulfur to be formed
- how you will present your results in graphical form
- a sketch of the graph that you would expect.

LEVELLED

[6 marks]

Method

- Measure volume sodium thiosulphate at room temperature and place in a conical flask
- Place flask on a black cross
- Add volume of acid to flask
- Record time taken for the cross to be no longer seen
- Repeat using reagents at different temperatures eg. 30°C and 40°C using a water bath
- keep concentration and volume of reagents the same
- Use the same cross each time

Results and graph

- Calculate 1/t to give the rate of reaction
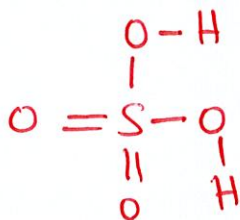- Plot 1/t against T
- Graph:
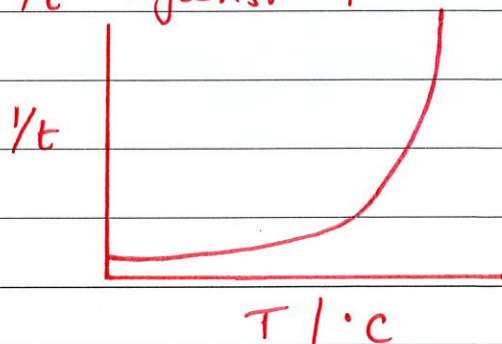
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13

Turn over ▶

0 2 This question is about sulfuric acid and its salts.

0 2 . 1 Draw the displayed formula of a molecule of H_2SO_4

[1 mark]

$$O = S - O$$

(displayed formula showing central S with O=S double bond on left, two O–H groups, and one O double bonded below)

0 2 . 2 In aqueous solution, sulfuric acid acts as a strong acid. The H_2SO_4 dissociates to form HSO_4^- ions and H^+ ions.

The HSO_4^- ions act as a weak acid and dissociate to form SO_4^{2-} ions and H^+ ions.

Give an equation to show each stage in the dissociation of sulfuric acid in aqueous solution.

Include appropriate arrows in your equations.

[2 marks]

Equation 1 $\quad H_2SO_4 \rightarrow H^+ + HSO_4^-$

Equation 2 $\quad HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$
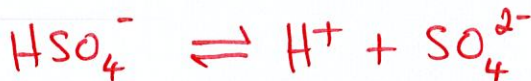
0 2 . 3 A student is required to make 250 cm³ of an aqueous solution that contains an accurately measured mass of sodium hydrogensulfate ($NaHSO_4$).

Describe the <u>method</u> that the student should use <u>to make this solution</u>.

[4 marks]

- Weigh required mass $NaHSO_4$ in a weighing bottle
- Re-weigh bottle to calculate exact mass by taking the difference

M1

- Transfer $NaHSO_4$ to a beaker, add distilled water and mix to <u>dissolve</u>

M2

- Transfer solution to 250 cm³ volumetric flask
- Rinse beaker with distilled water and transfer washings to the flask

M3

- Make up to mark with distilled water
- Stopper flask and invert several times to (thoroughly) mix

M4

Extra space

Question 2 continues on the next page

Turn over ▶

0 2 . 4 A solution that contains 605 mg of $NaHSO_4$ in 100 cm³ of solution has a pH of 1.72
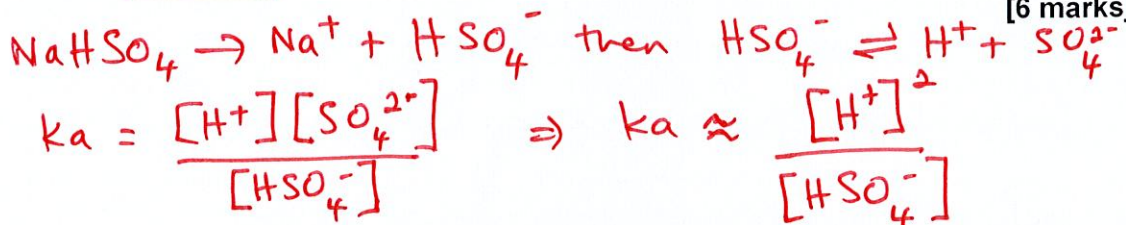
Alternative method in mark scheme

Calculate the value of K_a for the hydrogensulfate ion (HSO_4^-) that is behaving as a weak acid.

Give your answer to three significant figures.

State the units of K_a

[6 marks]

$$NaHSO_4 \rightarrow Na^+ + HSO_4^- \quad \text{then} \quad HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$$

$$ka = \frac{[H^+][SO_4^{2-}]}{[HSO_4^-]} \quad \Rightarrow \quad ka \approx \frac{[H^+]^2}{[HSO_4^-]}$$ M3

$$[H^+] = 10^{-1.72} = 0.01905 \text{ mol dm}^{-3}$$ M1

$n = \frac{m}{Mr}$

$$n \, NaHSO_4 = \frac{605 \times 10^{-3}}{120.1} = 5.037 \times 10^{-3}$$ M2

$$\therefore n \, HSO_4^- = 5.037 \times 10^{-3}$$

$c = \frac{n}{V}$

$$c \, HSO_4^- = \frac{5.037 \times 10^{-3}}{100 \times 10^{-3}} = 0.05037 \text{ mol dm}^{-3}$$

$$ka = \frac{(0.01905)^2}{0.05037} \quad \frac{(mol\,dm^{-3})^2}{mol\,dm^{-3}}$$ M3

K_a __7.20×10^{-3}__   Units __$mol \, dm^{-3}$__   M4+M5

(allow $7.15 - 7.26 \times 10^{-3}$)

0 2 . 5 Some sodium sulfate is dissolved in a sample of the solution from question **02.4**.

Na_2SO_4

Explain why this increases the pH of the solution.

[2 marks]

· Addition of SO_4^{2-} ions shifts equilibrium to left to reduce increase in SO_4^{2-} ions   M1

· so $[H^+]$ decreases   M2

15

Turn over for the next question

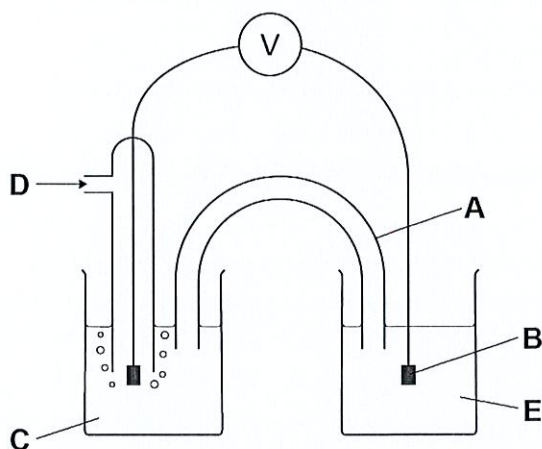DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Turn over ▶

0 3   **Figure 1** represents the cell used to measure the standard electrode potential for the Fe^{3+}/Fe^{2+} electrode.

Figure 1

0 3 . 1   Name the piece of apparatus labelled **A**.

[1 mark]

Salt bridge

0 3 . 2   State the purpose of **A**.

[1 mark]

Completes the circuit (by allowing ions to flow)

0 3 . 3   Name the substance used as electrode **B** in **Figure 1**.

[1 mark]

platinum

| 0 3 . 4 | Complete **Table 1** to identify **C**, **D** and **E** from **Figure 1**.
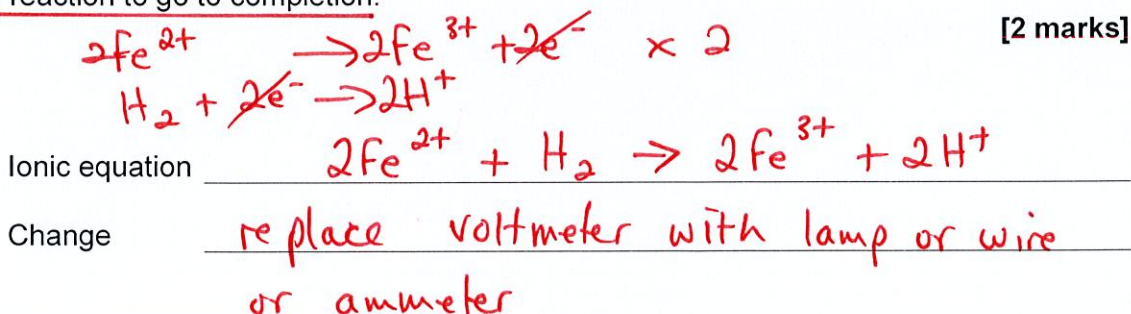Include the essential conditions for each. |

[4 marks]

Table 1

	Identity	Conditions
C	HCl	1 mol dm^{-3} 298K
D	H$_2$	100 kPa 298K
E	FeCl$_2$ and FeCl$_3$	1 mol dm^{-3} 298K

| 0 3 . 5 | The standard electrode potential, $E^{\ominus}$, for the Fe^{3+}/Fe^{2+} electrode is +0.77 V |

Give the <u>ionic equation</u> for the overall reaction in the cell in **Figure 1**.

<u>State the change</u> that needs to be made to the apparatus in **Figure 1** to allow the cell reaction to go to completion.

[2 marks]

$$2Fe^{2+} \rightarrow 2Fe^{3+} + 2e^- \quad \times 2$$
$$H_2 + 2e^- \rightarrow 2H^+$$

Ionic equation $2Fe^{2+} + H_2 \rightarrow 2Fe^{3+} + 2H^+$

Change   replace voltmeter with lamp or wire
or ammeter

Question 3 continues on the next page

Turn over ▶

0 3 . 6 A student sets up a cell as shown in the cell representation.

$$Zn(s)|Zn^{2+}(aq)||Cu^{2+}(aq)|Cu(s)$$

The student measures the cell EMF, E_{cell}, with several different concentrations of Cu^{2+} ions and Zn^{2+} ions.
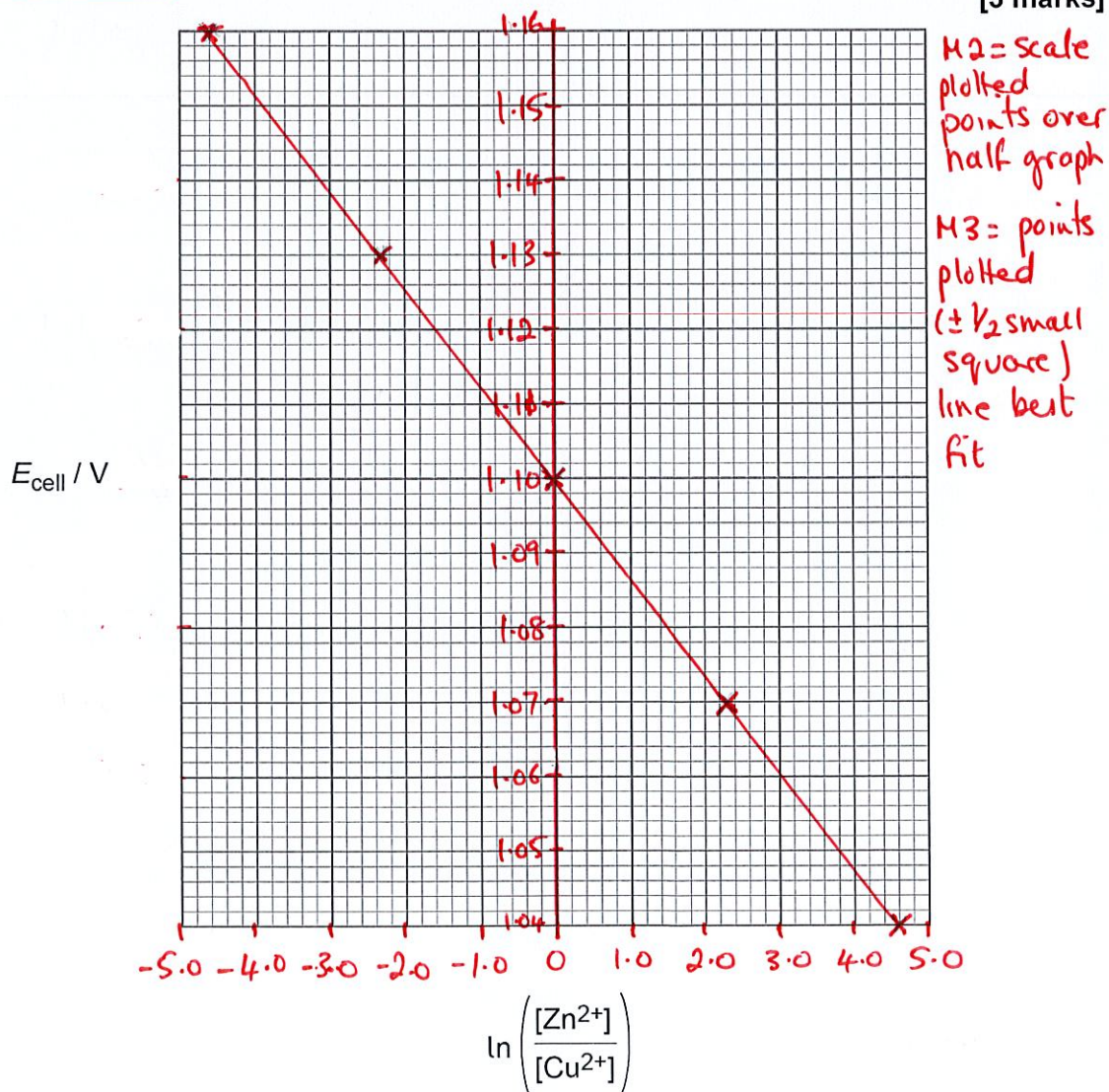
The results are shown in **Table 2**.

Table 2

Experiment	$[Zn^{2+}]$ / mol dm^{-3}	$[Cu^{2+}]$ / mol dm^{-3}	$\ln\left(\dfrac{[Zn^{2+}]}{[Cu^{2+}]}\right)$	E_{cell} / V
1	0.010	1.0	−4.61	1.16
2	0.10	1.0	−2.30	1.13
3	1.0	1.0	0.00	1.10
4	1.0	0.10	2.30	1.07
5	1.0	0.010	4.61	1.04

Complete **Table 2** to show the value missing from experiment **4**.

Plot a graph of E_{cell} against $\ln([Zn^{2+}]/[Cu^{2+}])$ on the grid.

[3 marks]

0 3 . 7 This equation shows how E_{cell} varies with concentration for this reaction.

$$E_{cell} = (-4.3 \times 10^{-5} \times T) \ln\left(\frac{[Zn^{2+}]}{[Cu^{2+}]}\right) + E^{\ominus}_{cell}$$

← gradient

← y-intercept

This equation is in the form of the equation for a straight line, y = mx + c

Calculate the gradient of your plotted line on the graph in question **03.6**.
You must show your working.

Use your gradient to calculate the temperature, T, at which the measurements of E_{cell} were taken.
(If you were unable to calculate a gradient you should use the value −0.016 V
This is **not** the correct value.)

[3 marks]

gradient = $-4.3 \times 10^{-5} \times T$

gradient = $\frac{(1.16 - 1.04)}{(-4.61 - 4.61)}$ = $\frac{0.12}{-9.22}$

Gradient ___−0.013___ V

$T = \frac{gradient}{-4.3 \times 10^{-5}}$ = $\frac{-0.013}{-4.3 \times 10^{-5}}$

T ___302___ K

0 3 . 8 In experiment **2** in **Table 2** the electrode potential of the Cu^{2+}/Cu electrode is +0.33 V

Use data from **Table 2** in question **03.6** to calculate the electrode potential for the Zn^{2+}/Zn electrode in experiment **2**.

Give one reason why your calculated value is different from the standard electrode potential for Zn^{2+}/Zn electrode.

[2 marks]

$E_{cell} = E^{\ominus}_{R} - E^{\ominus}_{L}$
  Cu^{2+}/Cu Zn^{2+}/Zn

$1.13 = 0.33 - E^{\ominus}(Zn^{2+}/Zn)$

Electrode potential ___−0.80___ V

Reason ___Temperature is not standard conditions___

17

Turn over ▶

0 4 Ethanal reacts with potassium cyanide, followed by dilute acid, to form 2-hydroxypropanenitrile.

0 4 . 1 Name the mechanism for the reaction between potassium cyanide and ethanal.

[1 mark]

nucleophilic addition

0 4 . 2 The 2-hydroxypropanenitrile formed by the reaction in question **04.1** is a mixture of equal amounts of two isomers.

State the name of this type of mixture.

Explain how the structure of ethanal leads to the formation of two isomers.

Draw 3D representations of the two isomers to show the relationship between them.

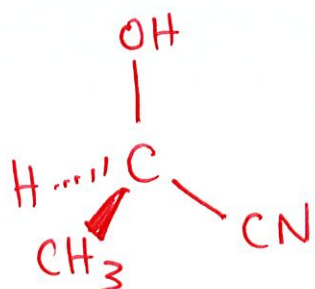[5 marks]

Name ___racemic (mixture) / racemate___ M1

Explanation ___planar c=o___ M2

___allows equal chance of attack from both___ M3

___sides by the nucleophile___

3D representations
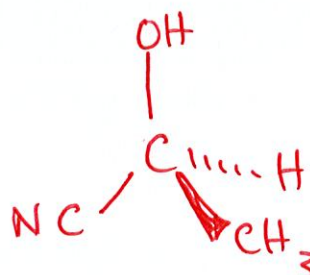
M4 +M5

0 4 . 3 2-Hydroxypropanenitrile can be used in the synthesis of the monomer, acrylonitrile, $CH_2=CHCN$

Suggest a suitable reagent and conditions for the conversion of 2-hydroxypropanenitrile into acrylonitrile.

[2 marks]
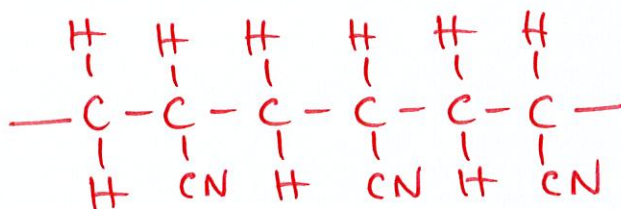
Reagent   conc. H_2SO_4 or conc. H_3PO_4

Conditions   heat or hot or reflux

0 4 . 4 Draw a section of the polymer polyacrylonitrile, showing three repeating units.

[1 mark]

Turn over for the next question

9

Turn over ▶

0 5 The percentage by mass of iron in a steel wire is determined by a student.

The student

- reacts 680 mg of the wire with an excess of sulfuric acid, so that all of the iron in the wire forms $Fe^{2+}(aq)$
- makes up the volume of the $Fe^{2+}(aq)$ solution to exactly 100 cm^3
- takes 25.0 cm^3 portions of the $Fe^{2+}(aq)$ solution
- titrates each portion with 0.0200 mol dm^{-3} potassium manganate(VII) solution.

0 5 . 1 Give the equation for the reaction between iron and sulfuric acid.

[1 mark]

$$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$$

0 5 . 2 The titration results are shown in **Table 3**.

Table 3

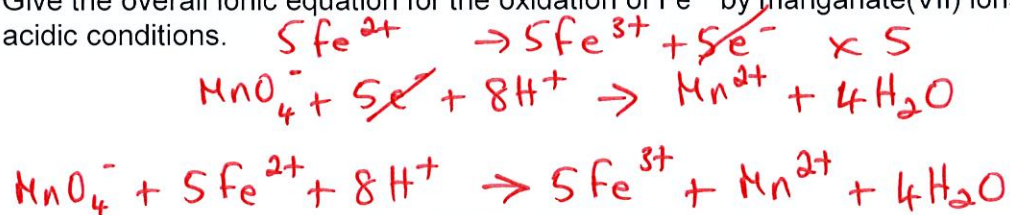|	1	2	3
Final volume / cm^3	22.90	45.60	22.60
Initial volume / cm^3	0.00	22.90	0.00
Titre / cm^3	22.90	22.70	22.60

Calculate the mean titre.

[1 mark]

$$\frac{22.7 + 22.6}{2}$$

Mean titre ___22.65___ cm^3

0 5 . 3 Give the overall ionic equation for the oxidation of Fe^{2+} by manganate(VII) ions, in acidic conditions.

$$5Fe^{2+} \rightarrow 5Fe^{3+} + 5e^- \quad \times 5$$

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

[1 mark]

$$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$$

0 5 . 4 State the colour change seen at the end point of the titration.

[1 mark]

colourless to pale pink

0 5 . 5 Name the piece of apparatus used for these stages of the method.

[1 mark]

Taking the 25.0 cm³ portions   *(volumetric) pipette*

Adding the
potassium manganate(VII) solution   *burette*

0 5 . 6 The balance used to weigh the 680 mg of iron wire has an uncertainty of ±0.005 g

A container was weighed and its mass was subtracted from the total mass of the container and wire.

Calculate the percentage uncertainty in using the balance.

[1 mark]

Two readings taken so total uncertainty × 2

$$\frac{0.01}{680 \times 10^{-3}} \times 100$$

% uncertainty   *1.47*

6

Turn over ▶

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	6

Which amount of sodium hydroxide would react exactly with 7.5 g of a diprotic acid, H_2A (M_r = 150)?

$$H_2X + 2NaOH \rightarrow Na_2X + 2H_2O$$

[1 mark]

$n = CV$

A 50 cm^3 of 0.05 mol dm^{-3} NaOH(aq) 0.0025 ⬭

B 100 cm^3 of 0.50 mol dm^{-3} NaOH(aq) 0.05 ⬤

C 100 cm^3 of 1.0 mol dm^{-3} NaOH(aq) 0.10 ⬭

D 100 cm^3 of 2.0 mol dm^{-3} NaOH(aq) 0.20 ⬭

$$n = \frac{m}{M_r} \qquad \frac{7.5}{150} = 0.05 \text{ mol acid so need } 0.10 \text{ mol NaOH}$$

0 7   Lead(II) nitrate and potassium iodide react according to the equation

$$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$$
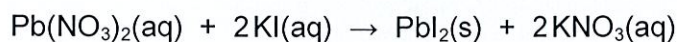
In an experiment, 25.0 cm³ of a 0.100 mol dm⁻³ solution of each compound are mixed together.

Which amount, in mol, of lead(II) iodide is formed?

[1 mark]

A 1.25×10^{-3}

B 2.50×10^{-3}

C 1.25×10^{-2}

D 2.50×10^{-2}

Handwritten working:

$n = cV$
$= 0.1 \times 25 \times 10^{-3}$
$= 2.5 \times 10^{-3} \equiv n\ KI\ (in\ xs)$

$n\ Pb(NO_3)_2 = \dfrac{2.5 \times 10^{-3}}{2} = 1.25 \times 10^{-3}$ (limiting)

so $n\ PbI_2 = 1.25 \times 10^{-3}$

(Option A marked)

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0 8   Nitrogen dioxide is produced from ammonia and air as shown in these equations

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g) \qquad \Delta H = -909 \text{ kJ mol}^{-1}$$

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g) \qquad \Delta H = -115 \text{ kJ mol}^{-1}$$

What is the enthalpy change (in kJ mol⁻¹) for the following reaction?

$$4NH_3(g) + 7O_2(g) \rightarrow 4NO_2(g) + 6H_2O(g)$$
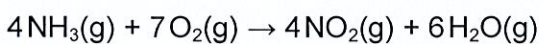
[1 mark]

A   −679

B   −794

C   −1024

D   −1139

Handwritten working:

$-909 \searrow$ $\uparrow 2 \times -115$

$4NO + 6H_2O$

$\Delta H_r = \Delta H_1 + \Delta H_2$
$= -909 + (2 \times -115)$
$= -1139$

(Option D marked)

Turn over ▶

0 9

Which change leads to a higher concentration of SO_3 in this equilibrium mixture?

$$2SO_2(g) + O_2(g) \underset{endo}{\overset{exo}{\rightleftharpoons}} 2SO_3(g) \qquad \Delta H = -188 \text{ kJ mol}^{-1}$$

4   2

[1 mark]

A higher concentration of O_2 shift to HS   ⬤

B higher temperature   shift to LHS   ◯

C lower pressure   shift to LHS   ◯

D use of a catalyst   no change   ◯

1 0

The results of an investigation of the reaction between **P** and **Q** are shown in this table.

Experiment	Initial [P] / mol dm^{-3}	Initial [Q] / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	0.200	0.500	0.400
2	0.600	To be calculated	0.800

The rate equation is: $rate = k \, [P] \, [Q]^2$

What is the initial concentration of **Q** in experiment 2?

$$k = \frac{rate}{[P][Q]^2}$$

[1 mark]

A 0.167

eqt 1: $k = \dfrac{0.4}{(0.2)(0.5)^2} = 8$ ◯

B 0.333   ◯

eqt 2: $[Q]^2 = \dfrac{rate}{k[P]}$

C 0.408   ⬤

D 0.612   ◯

$$= \frac{0.8}{8 \times 0.6} = 0.167$$

$$[Q] = 0.408$$

1 1 The equation for the reaction between sulfur dioxide and oxygen is shown.

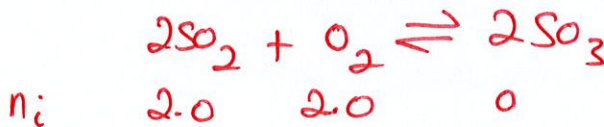$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$
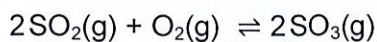
In an experiment, 2.00 mol of sulfur dioxide are mixed with 2.00 mol of oxygen. The total amount of the three gases at equilibrium is 3.40 mol

What is the mole fraction of sulfur trioxide in the equilibrium mixture?

[1 mark]

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

A 0.176 n_i 2.0 2.0 0

B 0.353 n_{eqm} $2-2x$ $2-x$ $2x = 3.40$ ●

C 0.600 $4 - x = 3.4$

D 1.200 $x = 0.6$

mol fraction $= \dfrac{\text{moles gas}}{\text{total moles}} = \dfrac{1.2}{3.4}$

1 2 Nitrogen reacts with hydrogen in this exothermic reaction

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
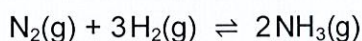
Which change increases the equilibrium yield of ammonia but has **no** effect on the value of the equilibrium constant K_p?

[1 mark]

A Add a catalyst *no effect on yield*

B Increase the partial pressure of nitrogen *increases yield / no effect on K_p* ●

C Decrease the temperature *increases yield and K_p*
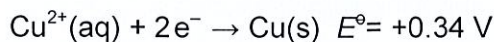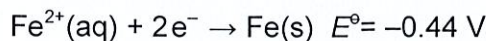
D Decrease the total pressure *no effect on yield*

Turn over ▶

1 3 The $E^\ominus$ values for two electrodes are shown.

$$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s) \quad E^\ominus = -0.44 \text{ V}$$

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s) \quad E^\ominus = +0.34 \text{ V}$$

What is the EMF of the cell $Fe(s)|Fe^{2+}(aq)||Cu^{2+}(aq)|Cu(s)$?

[1 mark]

A +0.78 V

B +0.10 V

C −0.10 V

D −0.78 V

[Handwritten working:]
$$\dot{E}_{cell}^\ominus = E_R^\ominus - E_L^\ominus$$
red   ox
$-e^-$ $+e^-$
$Cu^{2+}|Cu$ $Fe^{2+}|Fe$
$$= 0.34 - (-0.44)$$
$$= +0.78$$

1 4 Which atom has the greatest first ionisation energy?

[1 mark]

A H

B He

C Li

D Ne

[Handwritten working:]
1st ionisation energy
- decreases down groups
- increases across periods

1 5 What is the correct observation when barium metal is added to an excess of water?

[1 mark]

[Handwritten working:] $Ba(s) + H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g)$

A Forms a colourless solution only

B Forms a colourless solution and effervesces

C Forms a white precipitate only

D Forms a white precipitate and effervesces

[Handwritten working:]
Solubility
group 2
hydroxides
increases
down group

1 6   An aqueous solution of a salt gives a white precipitate when mixed with aqueous silver nitrate and when mixed with dilute sulfuric acid.

→ AgCl (s)   → BaSO$_4$ (s)

Which could be the formula of the salt?

[1 mark]

A $BaCl_2$ ●

B $(NH_4)_2SO_4$ ○

C KCl ○

D $Sr(NO_3)_2$ ○

1 7   Which statement is **not** correct about the trends in properties of the hydrogen halides from HCl to HI ?

[1 mark]

A   The boiling points decrease.   ●

increase

B   The bond dissociation energy of H–X decreases. T   ○

C   The polarity of the H–X bond decreases. T   ○

D   They are more easily oxidised in aqueous solutions. T   ○

1 8   What is observed when concentrated hydrochloric acid is added to an aqueous solution of $CuSO_4$ until no further change occurs?

[1 mark]

A   A colourless gas is evolved and a precipitate forms.   ○

B   A colourless gas is evolved and no precipitate forms.   ○

C   A precipitate forms that dissolves in an excess of concentrated hydrochloric acid.   ○

D   The solution changes colour and no precipitate forms.   ●

$$[Cu(H_2O)_6]^{2+}(aq) + 4Cl^-(aq) \rightarrow [CuCl_4]^{2-}(aq) + 6H_2O(l)$$
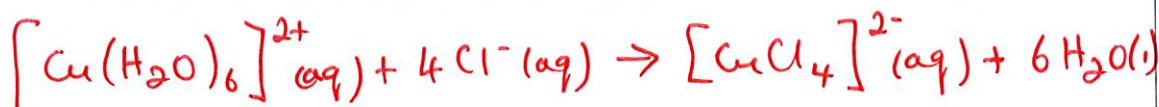
Turn over ▶

1 9 What is the most suitable reagent for detecting the presence of carbonate ions in the presence of an excess of sulfate ions?

[1 mark]

A dilute NaOH(aq)

B dilute H_2SO_4(aq) $CO_3^{2-} + 2H^+ \rightarrow CO_2 + 2H_2O$ ⬤

C $BaCl_2$(aq)

D NaCl(aq)

2 0 Methylbenzene reacts with a mixture of concentrated nitric acid and concentrated sulfuric acid.

What is the name of the mechanism for this reaction?

[1 mark]

A Electrophilic addition

B Electrophilic substitution   ⬤

C Nucleophilic addition

D Nucleophilic substitution

| 2 | 1 |

A possible synthesis of a compound found in jasmine flower oil is shown.

[handwritten annotations in red below the structures: Free-radical substitution; nucleophilic substitution; nucleophilic addition-elimination]
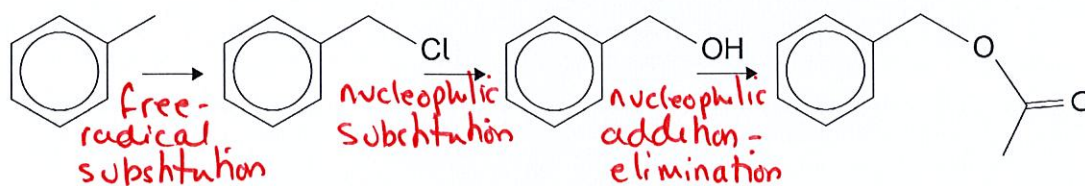
Which mechanism is **not** used in this synthesis?

[1 mark]

A Electrophilic substitution

B Nucleophilic substitution

C Free-radical substitution

D Nucleophilic addition-elimination

| 2 | 2 |

Which compound is formed when 1-phenylethanol reacts with acidified potassium dichromate(VI)?

[1 mark]

A $C_6H_5CH_2CH_2OH$

B $C_6H_5CH_2CHO$

C $C_6H_5COCH_3$

D $C_6H_5CH_2COOH$

[handwritten in red: structure showing CH₃–C(OH)(H)–phenyl + [O] → CH₃–C(=O)–phenyl + H₂O]
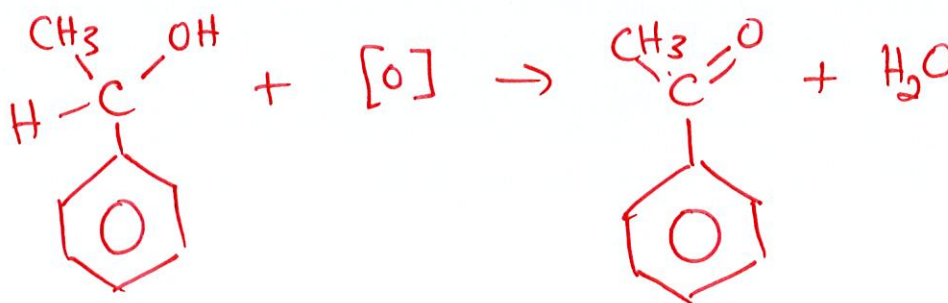
Turn over ▶

2 3   Three reagents are added separately to four organic compounds.

Which row shows the correct observations?

[1 mark]

		Sodium hydrogen carbonate	Acidified potassium dichromate(VI)	Tollens' reagent
A	Propan-1-ol	effervescence ✗	orange solution turns green ✓	no visible change ✗
B	Propanal	no visible change ✓	orange solution turns green ✓	silver mirror ✓
C	Propanone	no visible change ✓	no visible change ✓	silver mirror ✗
D	Propanoic acid	effervescence ✓	no visible change ✓	silver mirror ✗

2 4   Which compound is formed by acid hydrolysis of phenylmethyl ethanoate?

[1 mark]

A $C_6H_5CH_2OH$

B C_6H_5CHO

C $C_6H_5COCH_3$

D C_6H_5COOH

CH₃−C=O, O−CH₂−⟨O⟩
↓ +H₂O
CH₃COOH + ⟨O⟩−CH₂OH
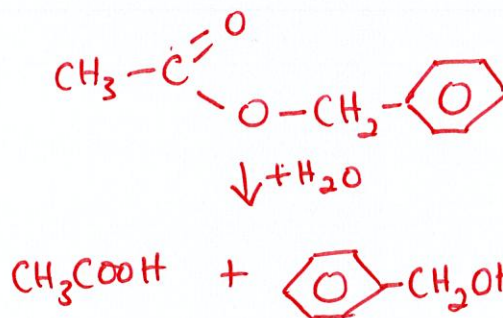
2 5   A student is required to dry a liquid sample of pentanoic acid.

Which drying agent is suitable?

[1 mark]

A Calcium oxide   − base would react

B Calcium sulfate

C Potassium hydroxide ⎤
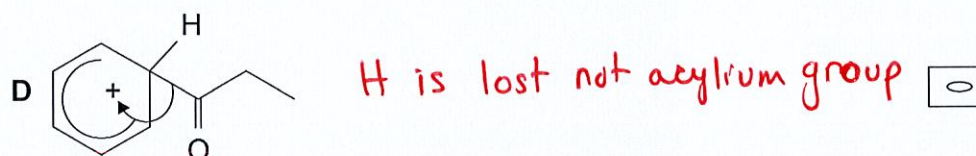   bases would react
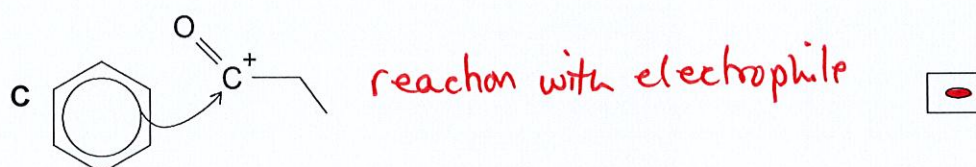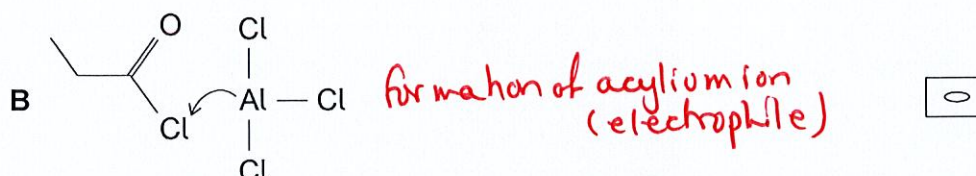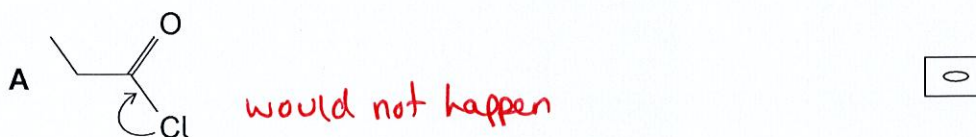D Potassium carbonate ⎦

2 6 The reaction between propanoyl chloride and benzene is an example of <u>acylation</u>.

Which is a <u>correct representation</u> of part of the <u>mechanism of this reaction</u>?
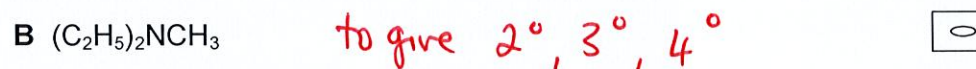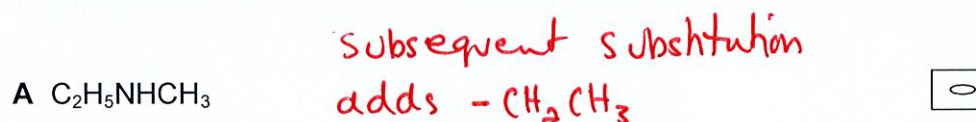
[1 mark]

A   *would not happen*   ☐

B   *formation of acylium ion (electrophile)*   ☐

C   *reaction with electrophile*   ◉

D   *H is lost not acylium group*   ☐

2 7 <u>Methylamine</u> reacts with <u>bromoethane</u> by <u>substitution</u> to produce a <u>mixture</u> of products.

Which compound is **not** a possible product of this reaction?

[1 mark]

Subsequent substitution adds $-CH_2CH_3$ to give $2°, 3°, 4°$

A $C_2H_5NHCH_3$ ☐

B $(C_2H_5)_2NCH_3$ ☐

C $[(C_2H_5)_3NCH_3]^+ Br^-$ ☐

D $[(C_2H_5)_2N(CH_3)_2]^+ Br^-$ ◉

Turn over ▶

2 8 Which polymer has hydrogen bonding between its chains?

[1 mark]

A Kevlar *polyamide* ⬤
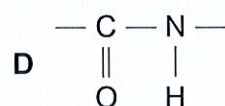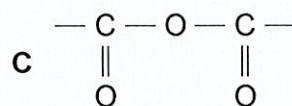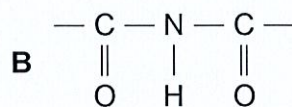
B Polythene ⬭
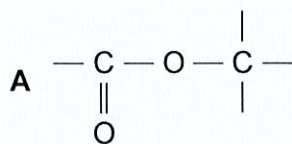
] *addition polymers*

C PVC ⬭

D Terylene *polyester* ⬭

2 9 Which structure shows part of a peptide link in a protein?

[1 mark]

A
$$-C-O-C-$$
with $=O$ on first C
⬭

B
$$-C-N-C-$$
with $=O$, $-H$, $=O$
⬭

C
$$-C-O-C-$$
with $=O$ and $=O$
⬭

D
$$-C-N-$$
with $=O$ and $-H$
⬤

IB/G/Jun19/7405/3

3 0 Two strands of DNA are linked together by hydrogen bonding between bases on each strand.

Which row shows the number of hydrogen bonds between the pair of bases?

Use the Data Booklet to help you answer this question.

[1 mark]

	Base 1	Base 2	Number of hydrogen bonds
A	adenine	guanine	2
B	cytosine	thymine	2
C	guanine	cytosine	3
D	adenine	thymine	3

(handwritten: wrong pairing) — next to rows A and B

A ○
B ○
C ● (selected)
D ○

(handwritten: (2 for tea) with arrow pointing to thymine in row D)

3 1 Which is **not** responsible for conduction of electricity?

[1 mark]

A The sodium ions in molten sodium chloride ○

B The electrons between layers of carbon atoms in graphite ○

C The bonding electrons in a metal ○

D The lone pair electrons on water molecules ● (selected)

Turn over ▶

3 2 In the UK industrial ethanol is now produced by the direct hydration of ethene. This process has largely replaced the fermentation method.

Which is a likely reason for this change of method?

[1 mark]

A The direct hydration route produces purer ethanol. ⬤

B The direct hydration route employs milder conditions. F ○

C The direct hydration route does NOT use a catalyst. F ○

D The direct hydration route produces ethanol by a slower reaction. F ○

3 3 Which alkene reacts with hydrogen bromide to give 2-bromo-3-methylbutane as the major product?
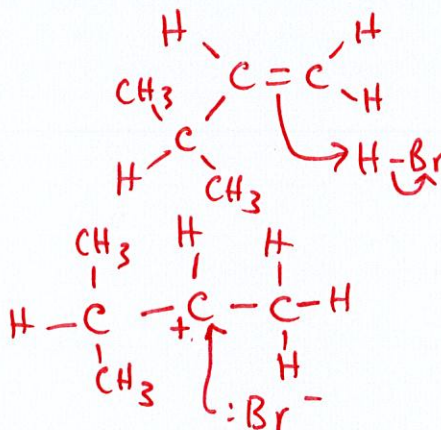
[1 mark]

A $(CH_3)_2C=CHCH_3$ ○

B $CH_3CH_2CH=CHCH_3$ ○

C $CH_3CH_2C(CH_3)=CH_2$ ○

D $(CH_3)_2CHCH=CH_2$ ⬤

3 4 Which compound can be purified by forming a hot aqueous solution that recrystallises on cooling?

[1 mark]

A Cyclohexene *Immiscible* ○

B Ethanoic acid *liquid at RT* ○

C Phenylamine *immiscible* ○

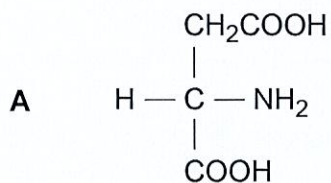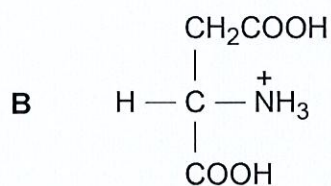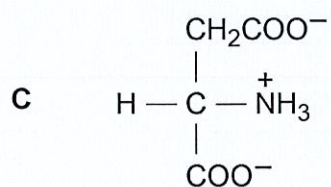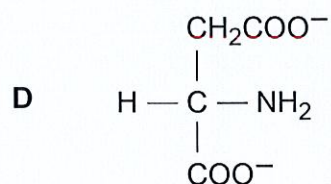D Benzoic acid *solid at RT dissolves in water* ⬤

3 5   Use the Data Booklet to help you answer this question

basic

Which is the main aspartic acid species present in an aqueous solution at pH = 14?

[1 mark]

A
CH_2COOH
$H-C-NH_2$
$COOH$
⬭

B
CH_2COOH
$H-C-\overset{+}{N}H_3$
$COOH$
⬭

C
CH_2COO^-
$H-C-\overset{+}{N}H_3$
COO^-
⬭

D
CH_2COO^-
$H-C-NH_2$
COO^-
🔴

30

END OF QUESTIONS