Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	

CENTRE NUMBER							CANDIDATE NUMBER					

3366684619

CHEMISTRY **9701/34**

Paper 3 Advanced Practical Skills 2 **May/June 2018**

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Give details of the practical session and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Use of a Data Booklet is unnecessary.

Qualitative Analysis Notes are printed on pages 10 and 11.
A copy of the Periodic Table is printed on page 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Session
Laboratory

For Examiner's Use	
1	
2	
Total	

This document consists of **12** printed pages.

CAMBRIDGE International Examinations

[Turn over

Quantitative Analysis

Read through the whole method before starting any practical work. Where appropriate, prepare a table for your results in the space provided.

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

1 Glucose, $C_6H_{12}O_6$, is a sugar that can act as a reducing agent. You will investigate how an increase in temperature affects the rate of the redox reaction between glucose and acidified potassium manganate(VII).

FB 1 is 0.010 mol dm^{-3} acidified potassium manganate(VII), $KMnO_4$.
FB 2 is 1.0 mol dm^{-3} sulfuric acid, H_2SO_4.
FB 3 is an aqueous solution containing 32.8 g dm^{-3} glucose, $C_6H_{12}O_6$.
distilled water

You will measure the time it takes for the purple colour to disappear. Your table of results on page **4** should include the rate of reaction for each experiment.

(a) Method

Experiment 1

- Fill the burette with **FB 1**.
- Add 10.00 cm^3 of **FB 1** into the 250 cm^3 beaker.
- Use the 50 cm^3 measuring cylinder to transfer 50.0 cm^3 of **FB 2** into the beaker containing **FB 1**.
- Use the same measuring cylinder to transfer 50.0 cm^3 of distilled water into the same beaker.
- Place the beaker on the tripod and heat its contents to between 65 °C and 70 °C.
- While the solution in the beaker is heating pour 25.0 cm^3 of **FB 3** into the 25 cm^3 measuring cylinder.
- When the temperature of the contents of the beaker has reached between 65 °C and 70 °C, remove the Bunsen burner and **carefully** place the hot beaker onto the white tile.
- Record the temperature of the solution in the beaker.
- Add the 25.0 cm^3 of **FB 3** and **immediately** start timing.
- Stir the contents of the beaker once and stop timing as soon as the solution turns colourless. Record the time to the nearest second.
- Record the temperature of the solution as soon as it is colourless.
- Calculate and record the average temperature of the reaction mixture to one decimal place.
- Empty, rinse and dry the beaker so it is ready for use in **Experiment 2**.

Experiment 2

- Add 10.00 cm^3 of **FB 1** into the 250 cm^3 beaker.
- Use the 50 cm^3 measuring cylinder to transfer 50.0 cm^3 of **FB 2** into the beaker containing **FB 1**.
- Use the same measuring cylinder to transfer 50.0 cm^3 of distilled water into the same beaker.
- Place the beaker on the tripod and heat its contents to between 30 °C and 35 °C.
- While the solution in the beaker is heating pour 25.0 cm^3 of **FB 3** into the 25 cm^3 measuring cylinder.
- When the temperature of the contents of the beaker has reached between 30 °C and 35 °C, remove the Bunsen burner and **carefully** place the hot beaker onto the white tile.
- Record the temperature of the solution in the beaker.
- Add the 25.0 cm^3 of **FB 3** and **immediately** start timing.
- Stir the contents of the beaker once and stop timing as soon as the solution turns colourless. Record the time to the nearest second.
- Record the temperature of the solution as soon as it is colourless.
- Calculate and record the average temperature of the reaction mixture to one decimal place.
- Empty, rinse and dry the beaker so it is ready for use in **Experiment 3**.

Experiments 3, 4 and 5

- Repeat the method for **Experiment 2** at three different temperatures.
- Keep the temperature of the contents of the beaker between room temperature and 70 °C.
- Record all your results in your table.

Results

The rate of reaction can be calculated as shown.

$$\text{rate} = \frac{1000}{\text{reaction time}}$$

Calculate the rate of reaction for each experiment and include this in your table.

I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

(b) Plot a graph of rate (*y*-axis) against average temperature (*x*-axis) on the grid opposite. Select a scale on the *x*-axis to include an average temperature of 15.0 °C. Label any points you consider anomalous.

Draw a line of best fit and extrapolate it to 15.0 °C. [4]

(c) **Use your graph** to calculate the **time** to the nearest second that the reaction would have taken if the average temperature had been 52.5 °C.
Show **on the grid** how you obtained your answer.

time = ... s [2]

(d) Explain, by referring to your graph or your table of results, how the rate of reaction is affected by an increase in temperature.

....

....

.... [2]

I	
II	
III	
IV	

(e) (i) Calculate the concentration of glucose in **FB 3** in $mol\,dm^{-3}$.

concentration of glucose in **FB 3** = ... $mol\,dm^{-3}$ [1]

(ii) Under certain conditions, 1.0 mole of acidified potassium manganate(VII), $KMnO_4$, can oxidise 2.5 moles of glucose.

Calculate the volume of $0.010\,mol\,dm^{-3}$ acidified $KMnO_4$ that would react with **all** the glucose present in $25.0\,cm^3$ of **FB 3**.

[3]

(iii) The formula of glucose can be written as $CHO(CHOH)_4CH_2OH$.

Suggest the formula of an organic product of the oxidation of glucose.

.... [1]

(f) (i) Calculate the maximum percentage error in the reaction time recorded for **Experiment 1**. Assume the error of the timer is ±1 s.

maximum percentage error in **Experiment 1** = ... % [1]

(ii) You have carried out experiments at five different temperatures.

Identify an experiment, if any, you should have repeated. Give a reason for your answer.

....

....

.... [1]

(g) Suggest **two** ways to improve the accuracy of the results for this investigation.

1 ....

....

2 ....

....

[2]

[Total: 25]

Qualitative Analysis

Where reagents are selected for use in a test, the **name** or **correct formula** of the element or compound must be given.

At each stage of any test you are to record details of the following:

- colour changes seen;
- the formation of any precipitate and its solubility in an excess of the reagent added;
- the formation of any gas and its identification by a suitable test.

You should indicate clearly at what stage in a test a change occurs.

If any solution is warmed, a **boiling tube** must be used.

Rinse and reuse test-tubes and boiling tubes where possible.

No additional tests for ions present should be attempted.

2 Sandell's solution reacts in a similar way to Fehling's reagent.
You will need to heat Sandell's solution in a hot water bath when using it in tests.

Half fill the 250 cm^3 beaker with water and place it on the tripod and gauze. Heat the water until it is boiling then turn off the Bunsen burner. This will be your hot water bath.

(a) **FB 4**, **FB 5** and **FB 6** are all solutions of carbohydrates.
- Sugars and starch are carbohydrates.
- Some sugars contain an aldehyde group so act as reducing agents.
- Other sugars do not contain an aldehyde group.

(i) For each test use a 1 cm depth of the solution in a test-tube. Record all your observations in the table.

test	*observations*		
	FB 4	**FB 5**	**FB 6**
Add 2 or 3 drops of aqueous iodine.			
Add 2 or 3 drops of acidified potassium manganate(VII) and **allow to stand for two minutes.**			
Add a 3 cm depth of Sandell's solution and place the tube in the hot water bath for two minutes.			

[3]

(ii) Circle the carbohydrate that could be starch.

FB 4 **FB 5** **FB 6**

Circle the carbohydrate that contains an aldehyde group.

FB 4 **FB 5** **FB 6**

[1]

(iii) Suggest a different test, other than using Fehling's reagent, that could be carried out to identify the presence of an aldehyde group. State the reagent(s) you would use and the expected observation if the result were positive.

Do not carry out your test.

reagent(s) ....

observation ....

[1]

(b) (i) **FB 7** and **FB 8** are two of the components of Sandell's solution. Each contains one cation and one anion. Two of the ions are listed in the Qualitative Analysis Notes.

For each test use a 1 cm depth of solution in a test-tube. Record all your observations in the table.

test	*observations*	
	FB 7	**FB 8**
Add a few drops of aqueous silver nitrate.		
Add a few drops of aqueous barium nitrate or aqueous barium chloride, then		
add dilute nitric acid.		
Add a few drops of aqueous iodine.		
Add a 1 cm depth of aqueous iron(II) sulfate.		
Add a 1 cm depth of **FB 8**.		

[6]

(ii) Identify the ions in **FB 7** and **FB 8**. If you are unable to identify any of the ions, write 'unknown'.

FB 7 cation .... anion ....

FB 8 cation .... anion ....

[2]

(iii) Write an ionic equation for any reaction in **(i)** that produced a precipitate.
Include state symbols.

.... [2]

[Total: 15]

Qualitative Analysis Notes

1 Reactions of aqueous cations

ion	*reaction with*	
	$NaOH(aq)$	$NH_3(aq)$
aluminium, $Al^{3+}(aq)$	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, $NH_4^{+}(aq)$	no ppt. ammonia produced on heating	–
barium, $Ba^{2+}(aq)$	faint white ppt. is nearly always observed unless reagents are pure	no ppt.
calcium, $Ca^{2+}(aq)$	white ppt. with high $[Ca^{2+}(aq)]$	no ppt.
chromium(III), $Cr^{3+}(aq)$	grey-green ppt. soluble in excess	grey-green ppt. insoluble in excess
copper(II), $Cu^{2+}(aq)$	pale blue ppt. insoluble in excess	blue ppt. soluble in excess giving dark blue solution
iron(II), $Fe^{2+}(aq)$	green ppt. turning brown on contact with air insoluble in excess	green ppt. turning brown on contact with air insoluble in excess
iron(III), $Fe^{3+}(aq)$	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
magnesium, $Mg^{2+}(aq)$	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), $Mn^{2+}(aq)$	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess
zinc, $Zn^{2+}(aq)$	white ppt. soluble in excess	white ppt. soluble in excess

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chloride, $Cl^-(aq)$	gives white ppt. with $Ag^+(aq)$ (soluble in $NH_3(aq)$)
bromide, $Br^-(aq)$	gives cream ppt. with $Ag^+(aq)$ (partially soluble in $NH_3(aq)$)
iodide, $I^-(aq)$	gives yellow ppt. with $Ag^+(aq)$ (insoluble in $NH_3(aq)$)
nitrate, $NO_3^-(aq)$	NH_3 liberated on heating with $OH^-(aq)$ and Al foil
nitrite, $NO_2^-(aq)$	NH_3 liberated on heating with $OH^-(aq)$ and Al foil
sulfate, $SO_4^{2-}(aq)$	gives white ppt. with $Ba^{2+}(aq)$ (insoluble in excess dilute strong acids)
sulfite, $SO_3^{2-}(aq)$	gives white ppt. with $Ba^{2+}(aq)$ (soluble in excess dilute strong acids)

3 Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint

The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
							1 H hydrogen 1.0										2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0											5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3											13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.4	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –