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Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Chemistry

Advanced

Unit 6: Chemistry Laboratory Skills II

Monday 14 May 2018 – Morning

Time: 1 hour 15 minutes

Paper Reference

WCH06/01

Candidates must have: Scientific calculator

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- Show all your working in calculations and include units where appropriate.

Turn over ►

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Pearson

Answer ALL the questions. Write your answers in the spaces provided.

1 A compound of a d-block element is dissolved in water to form a solution **X**.

A series of tests is carried out on separate 1 cm³ portions of solution **X**.

(a) Complete the table.

Test	Observation	Inference	
(i) Record the colour of solution X	Yellow-brown	The formula of the cation in solution X could be	(1)
(ii) To 1 cm ³ of solution X in a test tube, add sodium hydroxide solution, drop by drop, until no further change occurs	A brown precipitate forms which remains when sodium hydroxide is in excess	The formula of the precipitate is	(1)
(iii) To 1 cm ³ of solution X in a test tube, add potassium iodide solution	The colour of the mixture in the test tube becomes darker brown	The darker brown colour is due to the formation of	(1)
(iv) To 1 cm ³ of solution X in a test tube, add a few drops of nitric acid followed by	A white precipitate forms	Solution X contains chloride ions	(1)
(v) To 1 cm ³ of solution X in a test tube, add sodium carbonate solution	The solution of X is acidic	(1)

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- (b) Sulfur dioxide is passed through a sample of solution **X**. A redox reaction occurs in which the sulfur dioxide forms sulfate ions.

The solution **Y** which forms is no longer yellow-brown.

A series of tests is carried out on solution **Y**.

Complete the table.

Test	Observation	Inference
(i) To 1 cm ³ of solution Y in a test tube, add an excess of dilute aqueous ammonia	A precipitate is seen The colour of the precipitate is 	The formula of the precipitate is The formula of the cation in solution Y is
(ii) Leave the mixture to stand for a few minutes	The surface of the precipitate turns brown	The formula of the brown compound is

(3)

(1)

- (c) Complete the ionic equation for the reaction between the **cation** in solution **X** and sulfur dioxide to form solution **Y**. State symbols are not required.

(1)



(Total for Question 1 = 10 marks)

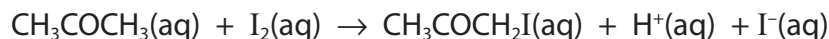
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- 2 The equation for the acid-catalysed reaction of iodine with propanone is



The change of iodine concentration with time was investigated.

Procedure

Step 1 50.0 cm³ of a solution of 0.0200 mol dm⁻³ iodine was measured into a conical flask. The flask was kept in a water bath maintained at room temperature throughout the experiment.

Step 2 25.0 cm³ of a solution of 1.00 mol dm⁻³ propanone and 25.0 cm³ of 1.00 mol dm⁻³ sulfuric acid were measured into a second conical flask.

Step 3 The mixture of propanone and acid was added to the iodine, a clock started and the conical flask shaken.

Step 4 After about one minute, a 10.0 cm³ sample of the reaction mixture was removed, using a pipette fitted with a pipette filler. The sample was run into a flask containing a solution which stopped the reaction.

Step 5 At approximately three-minute intervals, the procedure in Step 4 was repeated several times.

Step 6 Each sample of the mixture produced at the end of Step 4 was titrated with sodium thiosulfate solution of concentration 0.0100 mol dm⁻³.

- (a) Suggest a solution which could be used to stop the reaction in Step 4.

(1)

- (b) At what point in Step 4 should the time be recorded?

(1)

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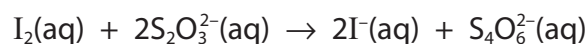


- (c) (i) Calculate the concentration, in mol dm^{-3} , of the iodine solution immediately after mixing with the acidified propanone at the start of the reaction.

(1)

- (ii) The iodine present in a 10.0 cm^3 sample of reaction mixture after reacting for seventy seconds was titrated with $0.0100 \text{ mol dm}^{-3}$ sodium thiosulfate solution. The titre was 18.50 cm^3 .

The equation for the reaction of iodine with thiosulfate ions is



Calculate the concentration of iodine after 70 s.

Hence calculate the mean rate of change of iodine concentration in the first 70 s of the reaction. Include units with your answer.

(4)

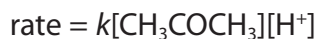
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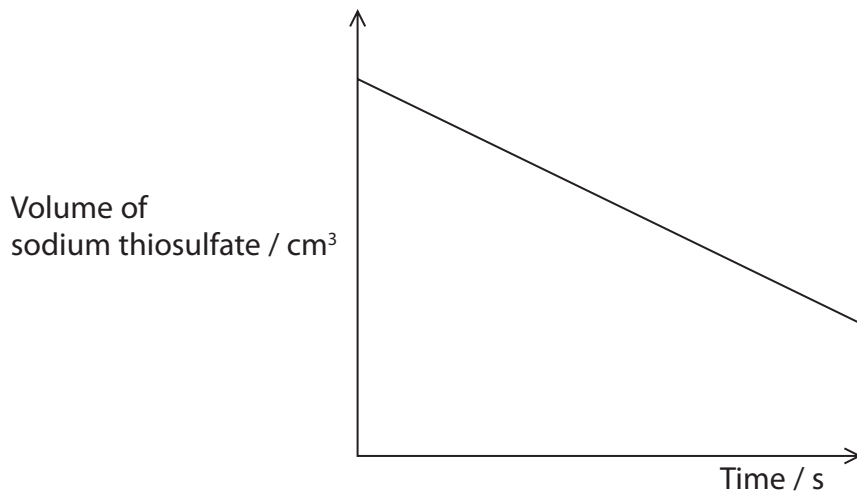
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(iii) Further experiments show that the rate equation for the reaction is



The diagram shows typical results of the original experiment. The volume of sodium thiosulfate is proportional to the concentration of iodine in the reaction mixture.



Use the rate equation to explain the appearance of the diagram.

(2)

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(iv) The experiment was repeated in which the only change was using 25 cm³ of 0.500 mol dm⁻³ propanone in Step 2 instead of 25 cm³ of 1.00 mol dm⁻³ propanone.

Add a line to the diagram in (c)(iii) to show the results which would be obtained in this repeat experiment.

(1)

(v) Explain, using the rate equation, any difference in the results of the repeat experiment.

(2)

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(d) The titration was carried out using an indicator. Name the indicator and state when it is added. Give all the colour changes involved.

(3)

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(Total for Question 2 = 15 marks)

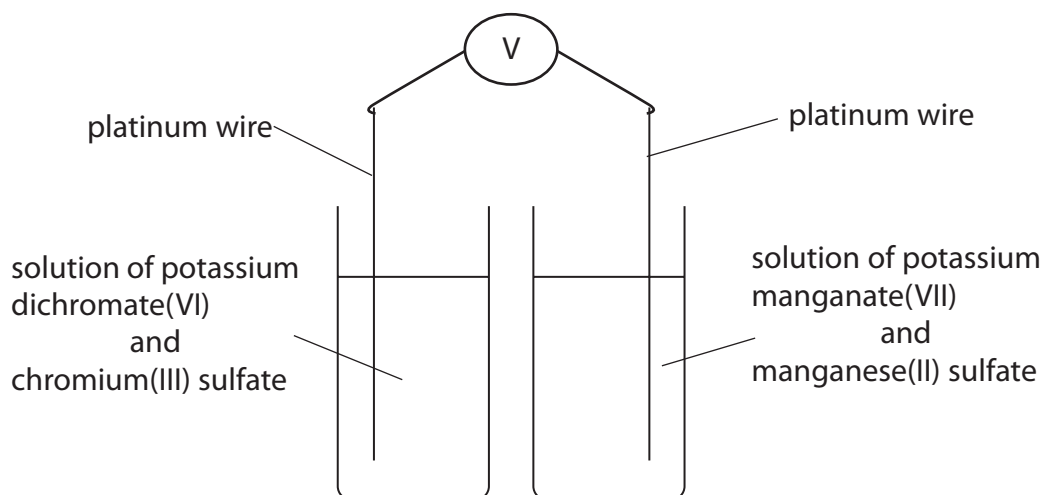
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- 3 A student set up a cell in an attempt to investigate whether potassium manganate(VII) is a stronger oxidising agent than potassium dichromate(VI).



The concentration of each of the solutions was $0.100 \text{ mol dm}^{-3}$.

- (a) What **compound** must be added to both beakers to allow redox reactions to occur? (1)

- (b) What must be added to the set-up to complete the cell? Name the item and any chemicals which are needed. (2)

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- (c) (i) The voltmeter showed that the right-hand half-cell contained the positive electrode.

Use this information to deduce whether potassium manganate(VII) is a stronger oxidising agent than potassium dichromate(VI). Explain how you made your deduction.

(2)

- (ii) Write the half-equation for the reaction which occurs in the right-hand half-cell when a current flows.

(1)

- (d) What colour change would be observed in the left-hand half-cell when a current has been flowing for some time?

(1)

- (e) What change, other than keeping the temperature at 298 K, would be needed to make the right-hand half-cell standard?

(1)



(f) The standard electrode potential of the right-hand half-cell, measured at 298 K, is +1.51 V.

The standard reduction potential of another system is given.

Electrode reaction	E^{\ominus} / V
$\text{S}_2\text{O}_8^{2-}(\text{aq}) + 2\text{e}^- \rightarrow 2\text{SO}_4^{2-}(\text{aq})$	+2.01

Aqueous sodium peroxodisulfate, $\text{Na}_2\text{S}_2\text{O}_8$, is a colourless solution containing $\text{S}_2\text{O}_8^{2-}(\text{aq})$ ions.

State all the observed colours and any colour changes that would be expected if a solution of sodium peroxodisulfate is added to

(i) potassium manganate(VII) solution.

(1)

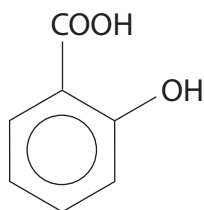
(ii) manganese(II) sulfate solution.

(1)

(Total for Question 3 = 10 marks)



- 4 Salicylic acid is the original name for a compound which can be obtained from the bark of willow trees. The systematic name for salicylic acid is 2-hydroxybenzoic acid.



- (a) Give a simple chemical test which is positive for 2-hydroxybenzoic acid but not for benzoic acid. State the reagent you would use and the expected result with 2-hydroxybenzoic acid.

(2)

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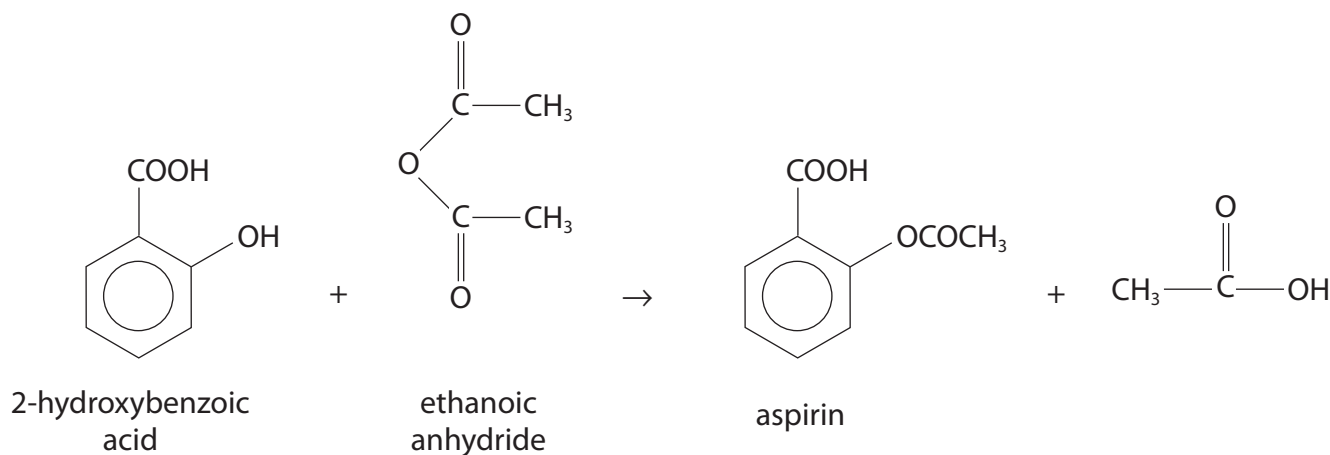
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(b) The compound known as aspirin can be prepared from 2-hydroxybenzoic acid.



Procedure

- Step 1** Transfer 2.00 g of 2-hydroxybenzoic acid into a dry, pear-shaped flask. Add 4.0 cm³ of ethanoic anhydride, followed by 5 drops of concentrated phosphoric acid.
- Step 2** Fit the flask with a reflux condenser and heat it on a hot water bath for about five minutes.
- Step 3** After allowing the reaction mixture to cool, add 2 cm³ of water down the condenser. This hydrolyses excess ethanoic anhydride.
- Step 4** When the vigorous reaction has ended, pour the mixture into 40 cm³ of cold water in a 100 cm³ beaker in an ice-water bath. Solid aspirin forms.
- Step 5** Filter the mixture under reduced pressure. Wash the solid aspirin with a little cold distilled water.
- Step 6** Recrystallise the product using distilled water and dry it.

Data

Density of ethanoic anhydride / g cm ⁻³	1.08
Molar mass of ethanoic anhydride / g mol ⁻¹	102
Molar mass of 2-hydroxybenzoic acid / g mol ⁻¹	138
Molar mass of aspirin / g mol ⁻¹	180



- (i) These are the hazard symbols for ethanoic anhydride.

Write the meaning of each symbol on the line provided.

(1)



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- (ii) Calculate the minimum mass, in grams, of ethanoic anhydride needed for the 2.00g of 2-hydroxybenzoic acid to react completely.

(2)

- (iii) Show by calculation that the ethanoic anhydride used in Step 1 was in excess.

(1)

- (iv) A student obtained 1.70g of aspirin from 2.00g of 2-hydroxybenzoic acid. Calculate the percentage yield.

(2)

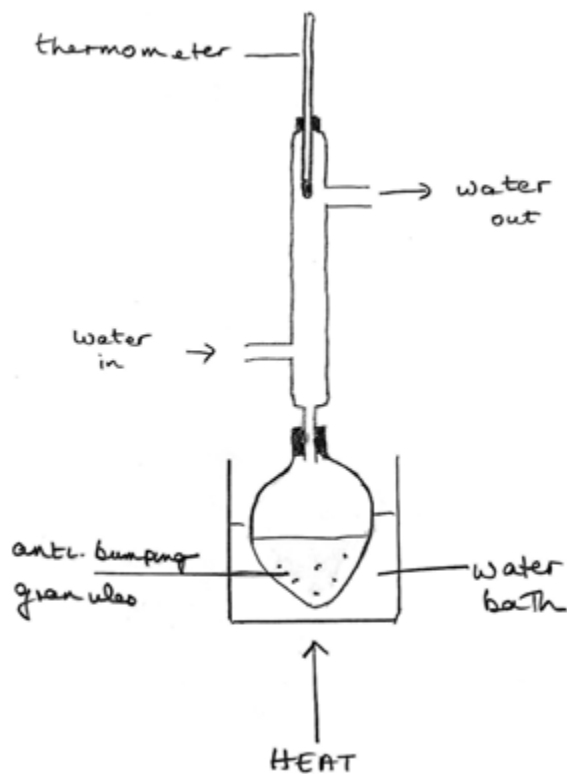
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- (v) A student drew a diagram of the apparatus for the reflux process. The diagram is shown below.



Identify **two** errors in the diagram and state how they should be corrected to make the apparatus workable. Assume that the apparatus is suitably clamped.

(2)

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(vi) Draw a labelled diagram of the funnel and flask used for filtration in Step 5 of the procedure, and state how reduced pressure is achieved.

(3)

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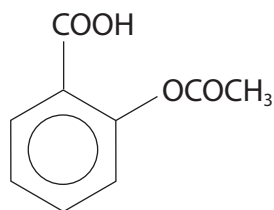
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How to achieve reduced pressure:

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(c) (i) The structure of aspirin is given again below.



aspirin

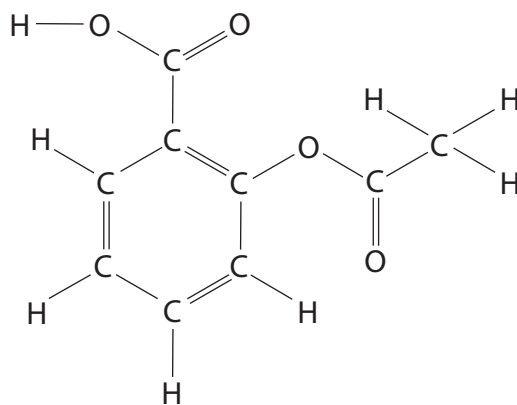
The mass spectrum of aspirin includes a major peak at $m/e = 92$. Suggest the molecular formula of the fragment which produces this peak.

(1)

(ii) The high resolution proton nmr spectrum of aspirin includes two singlet peaks.

On the formula below, which shows the structure of aspirin, circle the atoms which produced these singlet peaks.

(1)



(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 50 MARKS



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The Periodic Table of Elements

	1	2	Key										18							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)		
	relative atomic mass		atomic symbol																atomic (proton) number	
	atomic symbol		name																atomic (proton) number	
6.9	Li	9.0	45.0	47.9	50.9	52.0	54.9	55.8	58.9	58.7	63.5	65.4	10.8	12.0	14.0	16.0	19.0	4.0		
	lithium	beryllium	scandium	titanium	vanadium	chromium	manganese	iron	cobalt	nickel	copper	zinc	boron	carbon	nitrogen	oxygen	fluorine	helium		
3	3	4	21	22	23	24	25	26	27	28	29	30	5	6	7	8	9	2		
23.0	Na	24.3	88.9	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	27.0	28.1	31.0	32.1	35.5	20.2		
	sodium	magnesium	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	aluminium	silicon	phosphorus	sulfur	chlorine	neon		
11	11	12	39	40	41	42	43	44	45	46	47	48	13	14	15	16	17	10		
39.1	K	40.1	88.9	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	13	14	15	16	17	18		
	potassium	calcium	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	gallium	germanium	arsenic	selenium	bromine	argon		
19	19	20	39	40	41	42	43	44	45	46	47	48	31	32	33	34	35	36		
85.5	Rb	87.6	88.9	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	69.7	72.6	74.9	79.0	79.9	83.8		
	rubidium	strontium	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	indium	tin	antimony	tellurium	iodine	krypton		
37	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	36		
132.9	Cs	137.3	138.9	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6	114.8	118.7	121.8	127.6	126.9	131.3		
	caesium	barium	lanthanum	hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	thallium	lead	bismuth	polonium	astatine	xenon		
55	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	54		
[223]	Fr	[226]	[227]	[261]	[262]	[266]	[264]	[277]	[268]	[271]	[272]	[272]	81	82	83	84	85	[222]		
	francium	radium	actinium	rutherfordium	dubnium	seaborgium	bohrium	hassium	meitnerium	darmstadtium	roentgenium	roentgenium	thallium	lead	bismuth	polonium	astatine	radon		
87	87	88	89	104	105	106	107	108	109	110	111	111	81	82	83	84	85	86		

* Lanthanide series	
140	Ce
58	Pr
58	Ce
59	Pr
60	Nd
61	Pm
62	Sm
63	Eu
64	Gd
65	Tb
66	Dy
67	Ho
68	Er
69	Tm
70	Yb
71	Lu

* Actinide series	
232	Th
90	Th
91	Pa
92	U
93	Np
94	Pu
95	Am
96	Cm
97	Bk
98	Cf
99	Es
100	Fm
101	Md
102	No
103	Lr

Elements with atomic numbers 112-116 have been reported but not fully authenticated

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