Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

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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P 5 1 5 7 9 A 0 1 2 0

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 cm^3 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)**

(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)

.... $+ SO_2 + 2H_2O \rightarrow$ .... $+ SO_4^{2-} +$ .... H^+

(Total for Question 1 = 10 marks)

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

$$CH_3COCH_3(aq) + I_2(aq) \rightarrow CH_3COCH_2I(aq) + H^+(aq) + I^-(aq)$$

The change of iodine concentration with time was investigated.

Procedure

Step **1** 50.0 cm^3 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 cm^3 of a solution of 1.00 mol dm^{-3} propanone and 25.0 cm^3 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 cm^3 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 mol dm^{-3} sodium thiosulfate solution. The titre was 18.50 cm^3.

The equation for the reaction of iodine with thiosulfate ions is

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

Calculate the concentration of iodine after 70 s.

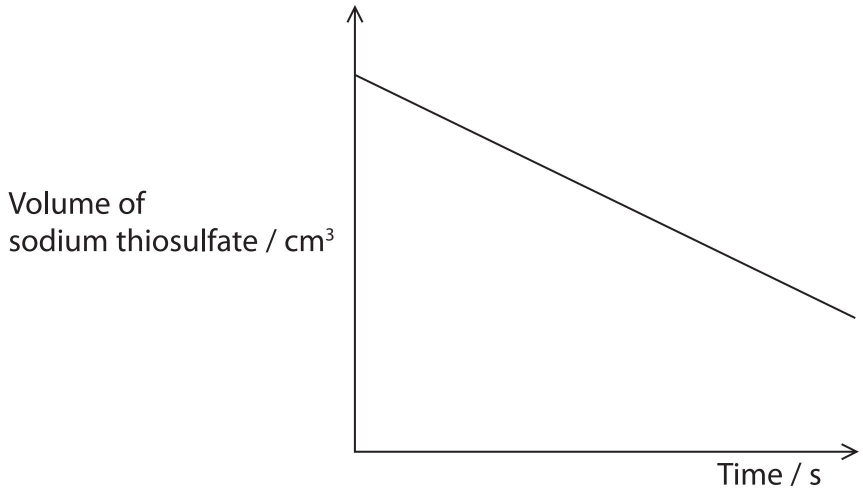
Hence calculate the mean rate of change of iodine concentration in the first 70 s of the reaction. Include units with your answer.

(4)

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

$$rate = k[CH_3COCH_3][H^+]$$

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)

....

....

....

....

....

(iv) The experiment was repeated in which the only change was using 25 cm^3 of 0.500 mol dm^{-3} propanone in Step **2** instead of 25 cm^3 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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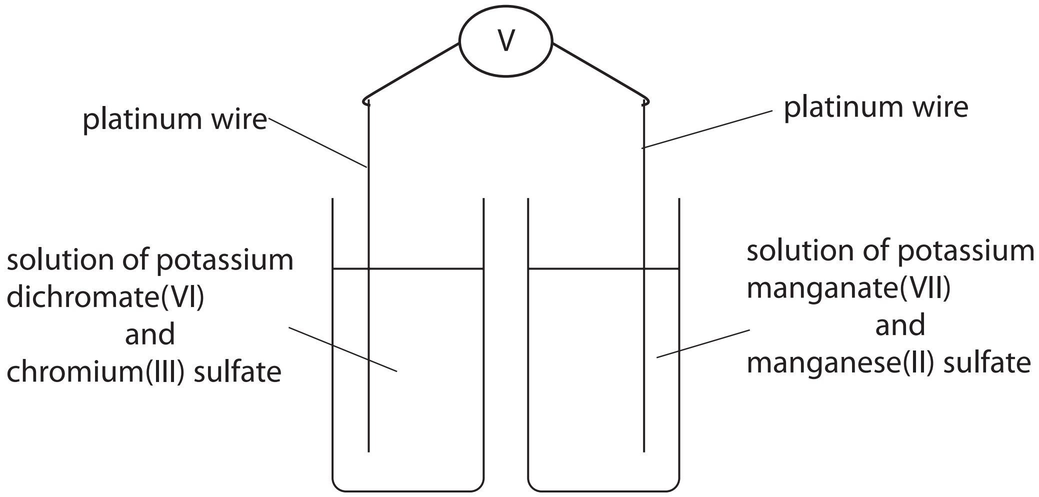
....

(Total for Question 2 = 15 marks)

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 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)

....

....

....

....

(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
$S_2O_8^{2-}(aq) + 2e^- \rightarrow 2SO_4^{2-}(aq)$	+2.01

Aqueous sodium peroxodisulfate, $Na_2S_2O_8$, is a colourless solution containing $S_2O_8^{2-}(aq)$ 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)

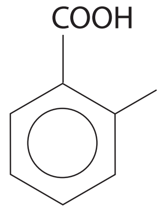
....

....

....

(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)

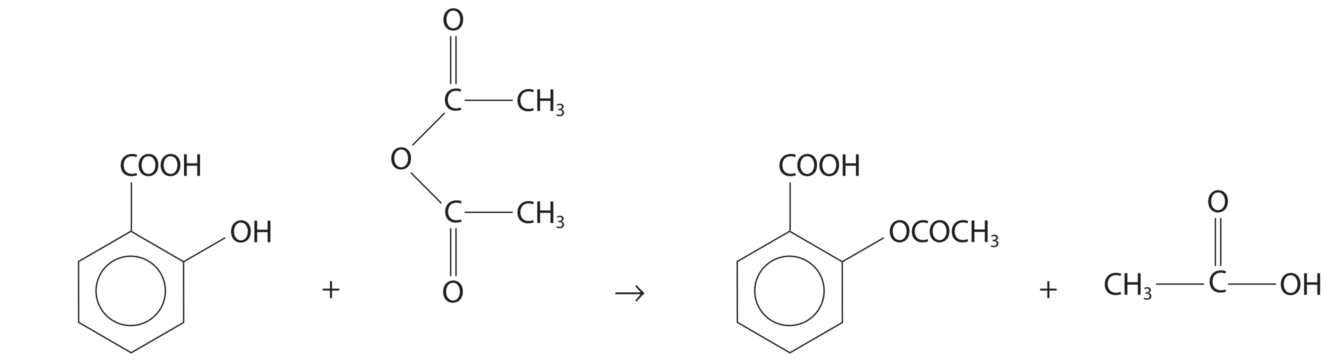
....

....

....

....

(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 cm^3 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 cm^3 of water down the condenser. This hydrolyses excess ethanoic anhydride.

Step **4** When the vigorous reaction has ended, pour the mixture into 40 cm^3 of cold water in a 100 cm^3 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)

....

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

(2)

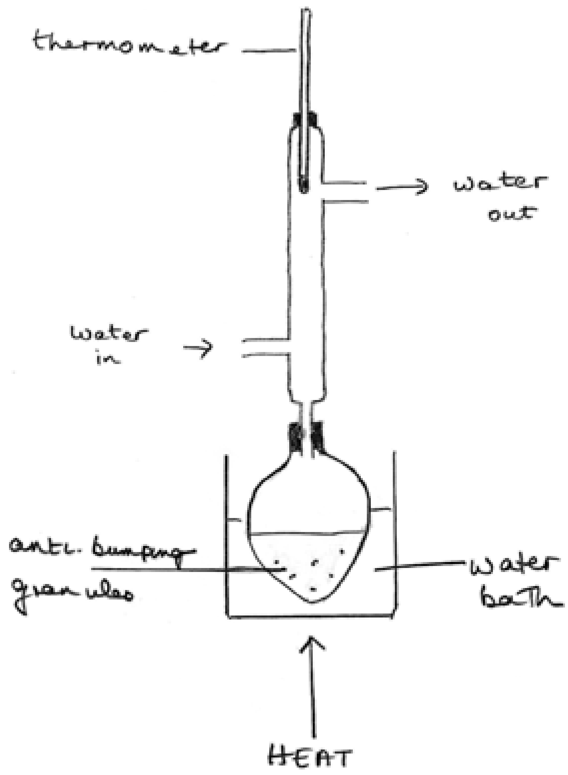
(iii) Show by calculation that the ethanoic anhydride used in Step **1** was in excess.

(1)

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

(2)

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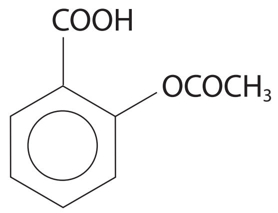
(vi) Draw a labelled diagram of the funnel and flask used for filtration in Step **5** of the procedure, and state how reduced pressure is achieved.

(3)

How to achieve reduced pressure: ....

....

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



aspirin

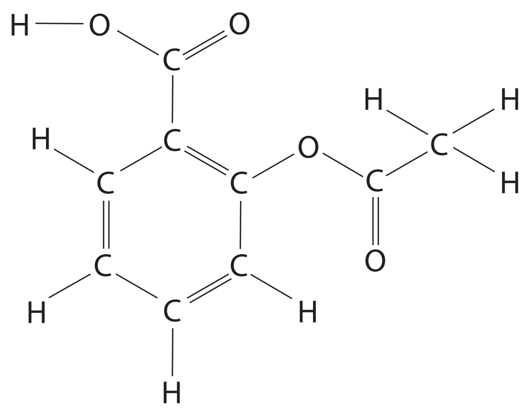
The mass spectrum of aspirin includes a major peak at *m*/*e* = 92. Suggest the molecular formula of the fragment which produces this peak.

(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

Key

relative atomic mass **atomic symbol** name atomic (proton) number

1.0 **H** hydrogen 1

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (8) (18)
																	4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	95.9 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La*** lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111							

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

Series															
* Lanthanide series	140 **Ce** cerium 58	141 **Pr** praseodymium 59	144 **Nd** neodymium 60	[147] **Pm** promethium 61	150 **Sm** samarium 62	152 **Eu** europium 63	157 **Gd** gadolinium 64	159 **Tb** terbium 65	163 **Dy** dysprosium 66	165 **Ho** holmium 67	167 **Er** erbium 68	169 **Tm** thulium 69	173 **Yb** ytterbium 70	175 **Lu** lutetium 71
* Actinide series	232 **Th** thorium 90	[231] **Pa** protactinium 91	238 **U** uranium 92	[237] **Np** neptunium 93	[242] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[245] **Bk** berkelium 97	[251] **Cf** californium 98	[254] **Es** einsteinium 99	[253] **Fm** fermium 100	[256] **Md** mendelevium 101	[254] **No** nobelium 102	[257] **Lr** lawrencium 103