Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Wednesday 22 January 2025

Afternoon (Time: 1 hour 20 minutes)

Paper reference **WCH16/01**

Chemistry

International Advanced Level

UNIT 6: Practical Skills in Chemistry II

You must have:
Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 7 8 4 6 0 A 0 1 1 6

Pearson

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

1 This question is about experiments involving chromium ions or compounds containing chromium.

(a) A small amount of chromium(III) sulfate was dissolved in deionised water, forming a solution containing a complex ion.

(i) Give the colour of the solution formed.

(1)

.....

(ii) State the formula of the complex ion.

(1)

.....

(b) Sodium hydroxide solution was added slowly to the complex ion solution until a solid, **Q**, formed.
The solid was then separated by filtering under reduced pressure.

(i) State the formula of **Q**.

(1)

.....

(ii) Draw a labelled diagram of the apparatus used to filter under reduced pressure.

(3)

(iii) Give **two** advantages of filtering under reduced pressure compared to gravity filtration.

(2)

(c) A sample of solid **Q** was added to manganese(IV) oxide and excess sulfuric acid. A redox reaction occurred forming a mixture containing dichromate(VI) ions, $Cr_2O_7^{2-}(aq)$.

$$3MnO_2(s) + 4H^+(aq) + 2\mathbf{Q}(s) \rightarrow 3Mn^{2+}(aq) + Cr_2O_7^{2-}(aq) + 5H_2O(l)$$

Describe what you would see in this reaction.

(2)

(d) Excess sodium hydroxide solution was added to a second sample of solid **Q**, forming a green solution.

(i) Give the formula of the complex ion that forms the green colour.

(1)

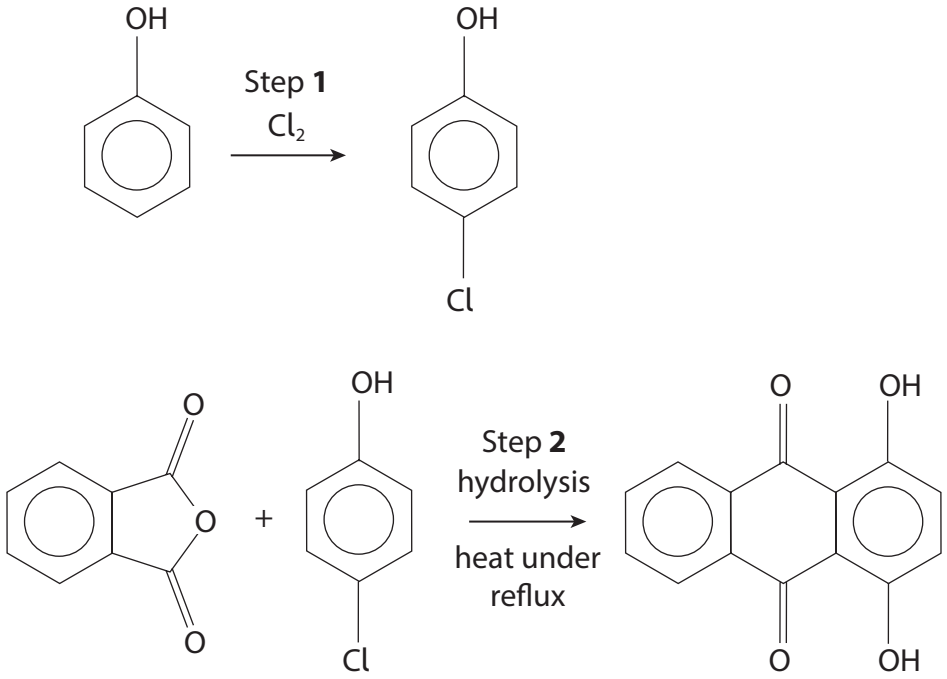
(ii) Name the type of reaction that has taken place.

(1)

(Total for Question 1 = 12 marks)

2 This question is about synthetic dyes.

The compound 4-chlorophenol is used in the synthesis of a dye, called solvent orange 86.



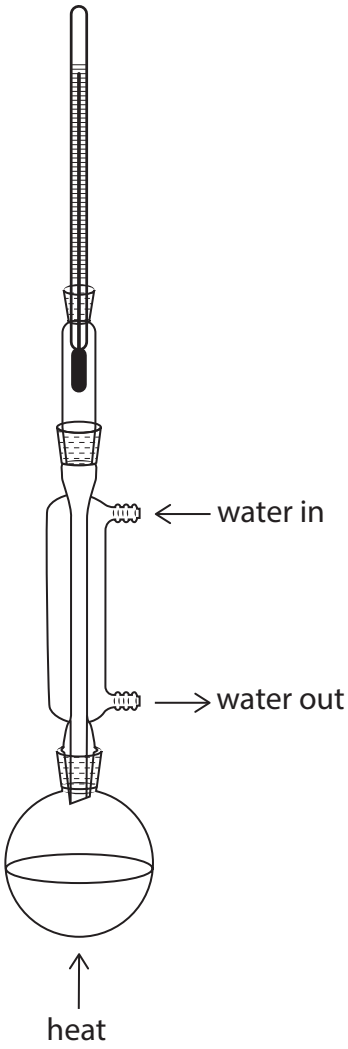
solvent orange 86

(a) A student suggested using iron as a catalyst in Step **1**.

Explain why it is not needed in the reaction with phenol, even though chlorination of other aryl compounds, such as benzene, require this catalyst.

(2)

(b) The student suggested using the apparatus shown to carry out the heating under reflux in Step **2**. There are **two** mistakes with this set-up.



Identify the two mistakes, in each case describing the problem that would occur due to this error.

You should assume the apparatus is supported using appropriate clamps.

(2)

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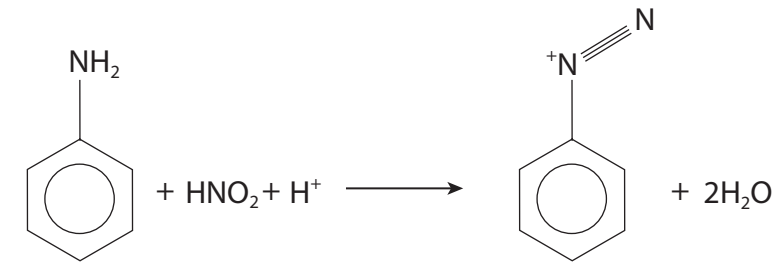
(c) Diazonium ions can react to form azo dyes. The ions are formed as shown.

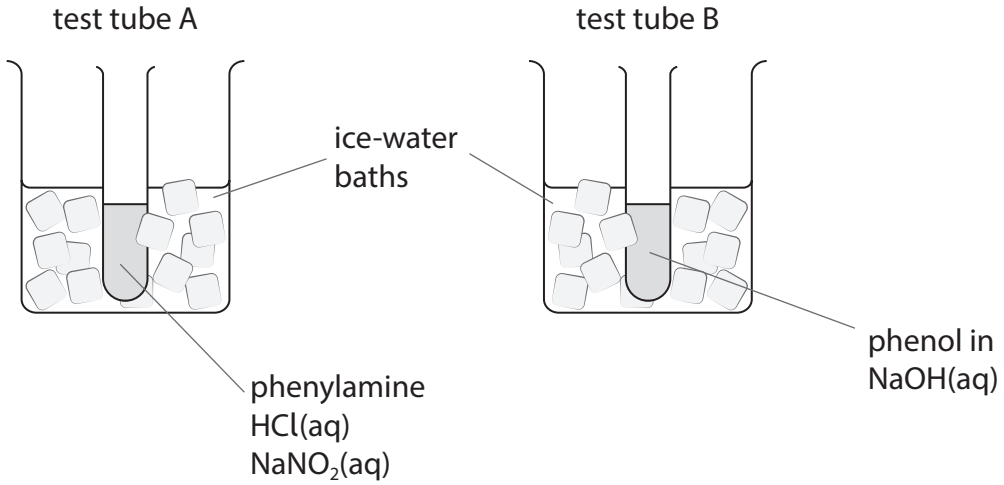


phenylamine diazonium ion

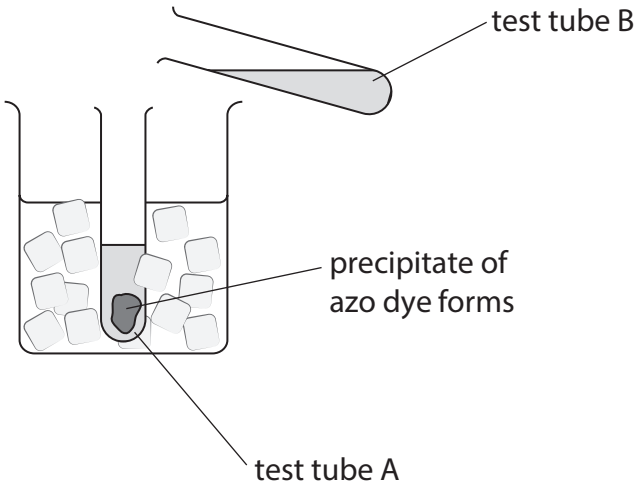
The diazonium ions then react with phenol in alkaline solution to form the azo dye.

Procedure

Step **1** Two test tubes containing the reactants are left to stand in ice-water baths for five minutes as shown.



Step **2** The contents of test tube B are carefully poured into test tube A.



Step **3** The impure azo dye is separated by filtering under reduced pressure.

Step **4** The impure azo dye is recrystallised using ethanol as the solvent.

Step **5** The purified sample of azo dye is dried.

(i) Give the systematic name of HNO_2.

(1)

(ii) State why the HNO_2 is formed when required in test tube A, rather than bought from a chemical supplier.

(1)

(iii) Explain why the test tubes in Step **1** are left in an ice-water bath for five minutes.

(2)

(iv) Explain why a student carrying out Step **4** was told to ensure they used the **minimum** amount of **hot** ethanol to dissolve the azo dye.

(3)

(v) State how the purified azo dye could be dried in Step **5**.

(1)

.....

(d) The hazard symbols present on the reagent bottle containing phenylamine are shown.

State three precautions, other than wearing safety glasses and a laboratory coat, chemists should take when using phenylamine. In each case give a reason for your answer.

(3)

Precaution 1

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Reason

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.....

Precaution 2

.....

Reason

.....

.....

Precaution 3

.....

Reason

.....

.....

(Total for Question 2 = 15 marks)

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3 Compound **X** is a colourless, viscous liquid used in the manufacture of fragrances and resins.

Molecules of **X** contain the elements carbon, hydrogen and oxygen only and have **one** functional group.

(a) Qualitative tests on **X** show that it

- burns in air with a very smoky flame
- forms an orange precipitate with 2,4-dinitrophenylhydrazine (Brady's reagent)
- does **not** form a red precipitate when warmed with Fehling's solution
- forms a yellow precipitate when warmed with iodine in sodium hydroxide solution.

Explain what can be deduced about the structure of **X** from **each** of these findings.

(4)

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(b) Complete combustion of 4.70 g of **X** produces 13.80 g of carbon dioxide and 2.82 g of water.

Determine the empirical formula of **X**.

(4)

(c) The molecular formula of **X** is the same as its empirical formula.
Use this information, and your answers to (a) and (b), to deduce the structure of **X**.

(1)

(Total for Question 3 = 9 marks)

4 Phenolphthalein is an indicator used in acid-base titrations. It can be represented by the simplified formula H_2In. When mixed with an excess of hydroxide ions it reacts rapidly, forming a pink solution, due to the ion In^{2-}.

The pink colour then fades as the colourless ion $InOH^{3-}$ forms.

$$\underset{\text{pink}}{In^{2-}(aq)} + OH^-(aq) \rightarrow \underset{\text{colourless}}{InOH^{3-}(aq)}$$

(a) A student carried out an experiment to find the order of this reaction with respect to In^{2-}.

A solution of phenolphthalein was mixed with a large excess of potassium hydroxide solution.
The resulting solution contains In^{2-} of concentration 0.00500 mol dm^{-3}.

The concentration of In^{2-} was measured over a time period of 300 seconds.

Time /s	Concentration of In^{2-} / mol dm^{-3}
0	0.00500
30	0.00380
60	0.00280
120	0.00150
150	0.00110
210	0.00060
270	0.00030
300	0.00020

(i) Give the name of the most suitable technique to monitor the concentration of In^{2-} during the reaction.

(1)

.....

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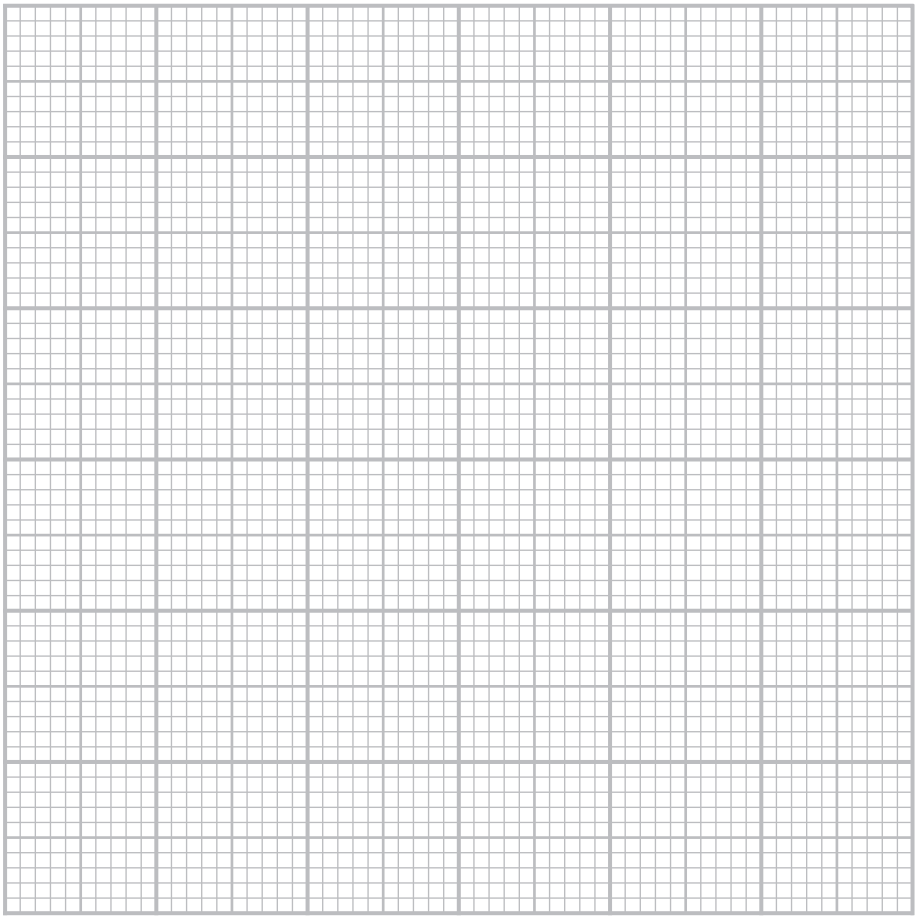
(ii) Plot a graph of the concentration of In^{2-} against time.

(3)



(iii) Determine **two** successive half-lives for the concentration of In^{2-}.
You must show your working on the graph.

(2)

First half-life .....

Second half-life .....

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(iv) Deduce the order with respect to In^{2-}.

Justify your answer.

(2)

(v) Explain why the results of this experiment do not allow the overall order of the reaction to be determined.

(2)

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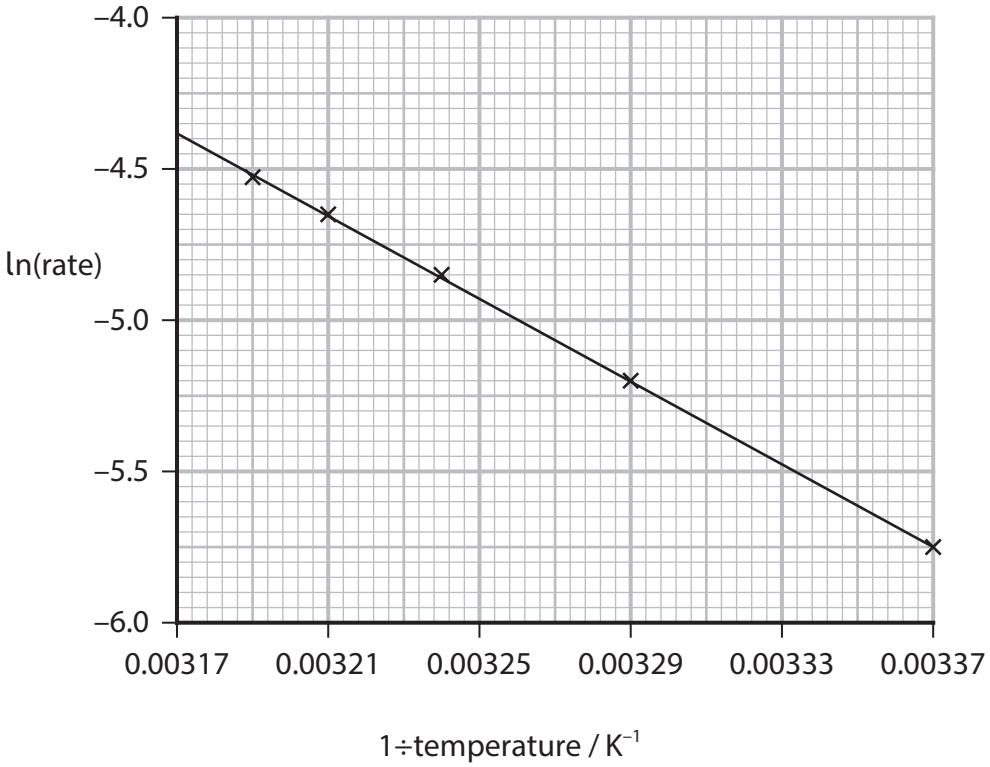
(b) Another student carried out an experiment to find the activation energy of the reaction between In^{2-} and hydroxide ions.

A graph of ln(rate) against 1÷temperature was plotted using the data obtained.



(i) Calculate the activation energy for the reaction, using the gradient of the graph and the Arrhenius equation shown.

Give your answer to an appropriate number of significant figures, including a sign and units.

$$\ln k = -\frac{E_a}{R} \times \frac{1}{T} + \ln(\text{collision factor}) \qquad R = 8.31\,\text{J mol}^{-1}\,\text{K}^{-1}$$

(3)

(ii) A value for ln(collision factor) of –4.4, given to two significant figures, was suggested by the student.

State whether or not you agree with this value. Justify your answer.

(1)

.....

.....

.....

.....

(Total for Question 4 = 14 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									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	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(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

* 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