Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Thursday 21 January 2021

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

Total Marks

Instructions

- Use **black** ink or 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.*
- Show all your working in calculations and include units where appropriate.

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.

Turn over ▶

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P 6 7 8 2 0 A 0 1 1 6

Pearson

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

1 A student carries out some tests on four aqueous solutions **A**, **B**, **C** and **D**.
One of the solutions is aqueous barium chloride, $BaCl_2(aq)$.

(a) The student is asked to add **A** to samples of **B**, **C** and **D** in separate test tubes, a **small** amount at a time, until there is no further change.

The container of solution **A** has a hazard label.

(i) Identify the hazard indicated by this label.

(1)

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(ii) Describe how you would add small amounts of **A** until there is no further change. Name the apparatus you would use.

(2)

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(b) (i) **B** is a blue solution. When **A** is added to **B**, the mixture first turns green and then gradually turns yellow.

Give the **formula** of the cation in **B**.

(1)

(ii) When **A** is added to **C,** vigorous effervescence occurs and the gas produced turns limewater cloudy.

Identify, by name or formula, the gas produced.

(1)

(iii) Suggest the identity, by name or formula, of the anion in **C**.

(1)

(iv) Identify **A** by name or formula. Justify your answer.

(2)

(v) When **A** is added to **D** no change is seen.
A small amount of this mixture is added to **B** and a white precipitate forms.

Suggest what can be deduced about solutions **B** and **D**.

(2)

Solution **B**

Solution **D**

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(vi) A concentrated solution of ammonia is added to **B**.
Initially a pale blue precipitate forms. When more ammonia is added, the precipitate dissolves forming a dark blue solution **F**.

Identify, by name or formula, the pale blue precipitate and the species responsible for the dark blue colour in **F**.

(2)

(vii) A solution of the sodium salt of EDTA, Na_4EDTA, is added to a sample of solution **F**. The solution turns pale blue.

Write an equation for the reaction.
State symbols are not required.

(2)

(Total for Question 1 = 14 marks)

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2 Students were told to determine the concentration of a solution of potassium chlorate(V), $KClO_3$. Two methods were used: precipitation and titration.

Method 1 – Precipitation

Step **1** Bubble excess sulfur dioxide, SO_2 , into 100 cm^3 of the potassium chlorate(V) solution.

Step **2** Boil the resulting mixture to remove excess SO_2 and then add silver nitrate solution until no more silver chloride precipitate forms.

Step **3** Filter, dry and weigh the precipitate.

The equation for the reaction in Step **1** is shown.

$$ClO_3^-(aq) + 3SO_2(g) + 3H_2O(l) \rightarrow Cl^-(aq) + 6H^+(aq) + 3SO_4^{2-}(aq)$$

(a) Identify the main hazard in Step **1**, giving a safety precaution that will reduce the risk.
Assume that safety spectacles and a laboratory coat were used.

(2)

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(b) The reaction in Step **2** produced 0.430 g of a white precipitate of silver chloride, AgCl.

Calculate the concentration of $KClO_3$ in the solution, in mol dm^{-3}, found using Method 1.
You **must** show your working.

(2)

(c) A student who used Method 1 obtained a value that was significantly larger than the actual concentration of the solution.

Explain **one** possible source of experimental error which might lead to this result.

(2)

Method 2 – Titration

Step **1** Mix a sample of potassium chlorate(V) solution with an acidified solution containing iron(II) sulfate, $FeSO_4$

Step **2** Remove the chloride ions produced in Step **1**.

Step **3** Determine the concentration of excess iron(II) ions by titrating the whole of the solution with a standard solution of potassium manganate(VII).

The equation for the reaction in Step **1** is shown.

$$ClO_3^-(aq) + 6Fe^{2+}(aq) + 6H^+(aq) \rightarrow Cl^-(aq) + 6Fe^{3+}(aq) + 3H_2O(l)$$

(d) Give the colour change observed in Step **1**.

(1)

(e) Describe how to carry out the titration in Step **3**. You should identify suitable apparatus and any additional chemicals required.

(5)

(f) In Method 2, 50.0 cm^3 of potassium chlorate(V) was mixed with 150 cm^3 of 0.0750 mol dm^{-3} of iron(II) sulfate. The iron (II) sulfate was in excess.

The whole of this solution required 9.25 cm^3 of 0.050 mol dm^{-3} of potassium manganate(VII) to completely react.

The equations for the reactions are

$$ClO_3^-(aq) + 6Fe^{2+}(aq) + 6H^+(aq) \rightarrow Cl^-(aq) + 6Fe^{3+}(aq) + 3H_2O(l)$$

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

Calculate the concentration, in mol dm^{-3}, of the potassium chlorate(V) solution. You **must** show your working.

(6)

(g) Explain the change, if any, to the value calculated in (f) if the chloride ions were not removed before the reaction in Step **3** of Method 2.

(2)

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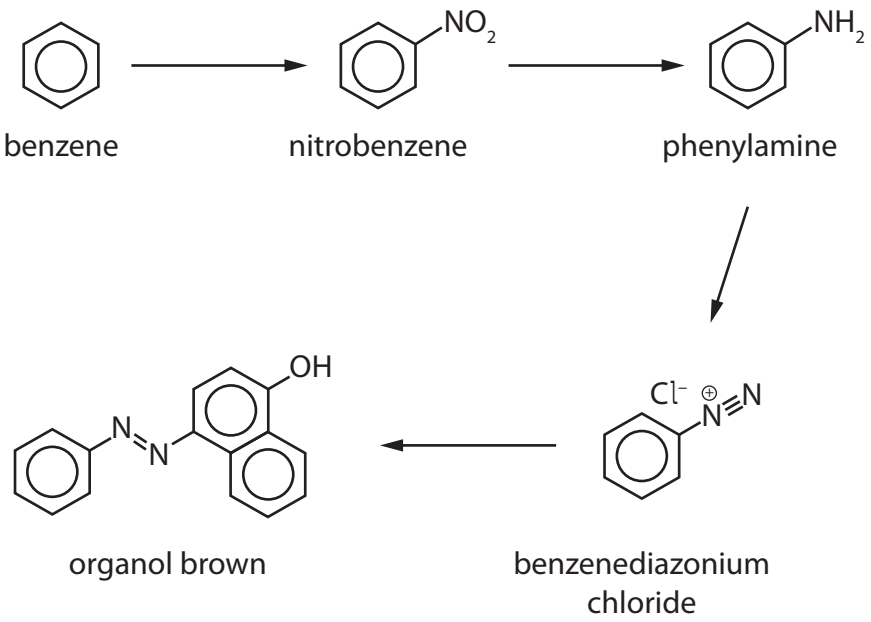
(Total for Question 2 = 20 marks)

3 Azo dyes, such as Organol Brown, can be made from benzene, C_6H_6, using the reaction scheme shown.

Due to the toxicity of benzene, the first step is never carried out in a school laboratory.



(a) In the preparation of nitrobenzene, benzene is added slowly to a mixture of concentrated nitric and sulfuric acids.

The mixture is warmed at 55°C under reflux for 45 minutes. The reaction mixture is stirred continuously.

(i) State why a reflux condenser is needed when the mixture is warmed.

(1)

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(ii) Draw a diagram of the apparatus used to warm under reflux in this experiment.

(3)

(iii) Suggest why the reaction mixture is stirred continuously.

(2)

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(b) The excess acid is removed from the reaction mixture. The layer containing nitrobenzene is separated and dried before being purified by distillation.

Identify a suitable drying agent.

(1)

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(c) Nitrobenzene is then reduced to phenylamine, $C_6H_5NH_2$.

Phenylamine reacts with nitrous acid at a temperature between 0°C and 10°C to form a diazonium compound.

(i) Nitrous acid is formed in the reaction mixture using sodium nitrite and hydrochloric acid.

State why nitrous acid is generated in the reaction mixture instead of being obtained from a chemical supplier.

(1)

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(ii) Explain why the temperature of the reaction between phenylamine and nitrous acid must be neither lower than 0°C nor higher than 10°C.

(2)

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(d) Reaction of the diazonium compound with an alkaline solution of naphthalene-1-ol produces the solid azo dye, Organol Brown. The solid is purified by recrystallisation.

Procedure

Step **1** The impure Organol Brown is dissolved in a minimum volume of hot solvent.

Step **2** The solution is filtered hot through a preheated funnel.

Step **3** The solution is cooled and filtered using a Buchner funnel.

Step **4** The solid is rinsed with a small amount of ice-cold solvent.

Step **5** The solid is dried in a desiccator.

(i) State why a **minimum** volume of hot solvent is used in Step **1**.

(1)

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(ii) Explain why a preheated funnel is used in Step **2**.

(1)

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(iii) Give a reason for each of the two filtrations in Steps **2** and **3**.

(2)

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(iv) Give a possible reason why it is preferable to dry the solid in a desiccator rather than in an oven in Step **5**.

(1)

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(e) The melting temperature of the recrystallised Organol Brown is measured to check its purity.

State what you would observe if the sample was pure.

(1)

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(Total for Question 3 = 16 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(13)	(14)	(15)	(16)	(17)	
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	(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

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
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

* Lanthanide series

* Actinide series