

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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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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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, $\text{BaCl}_2(\text{aq})$.

(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)

(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**



- (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.

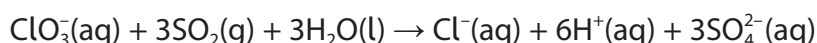
Method 1 – Precipitation

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.



- (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)

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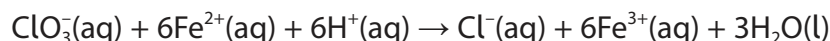
Method 2 – Titration

Step 1 Mix a sample of potassium chlorate(V) solution with an acidified solution containing iron(II) sulfate, FeSO₄

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.



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

(1)

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

(5)

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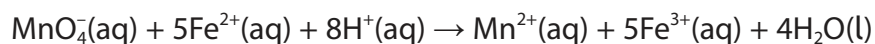
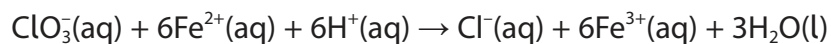
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- (f) In Method 2, 50.0 cm³ of potassium chlorate(V) was mixed with 150 cm³ of 0.0750 mol dm⁻³ of iron(II) sulfate. The iron (II) sulfate was in excess.

The whole of this solution required 9.25 cm³ of 0.050 mol dm⁻³ of potassium manganate(VII) to completely react.

The equations for the reactions are



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

(6)

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(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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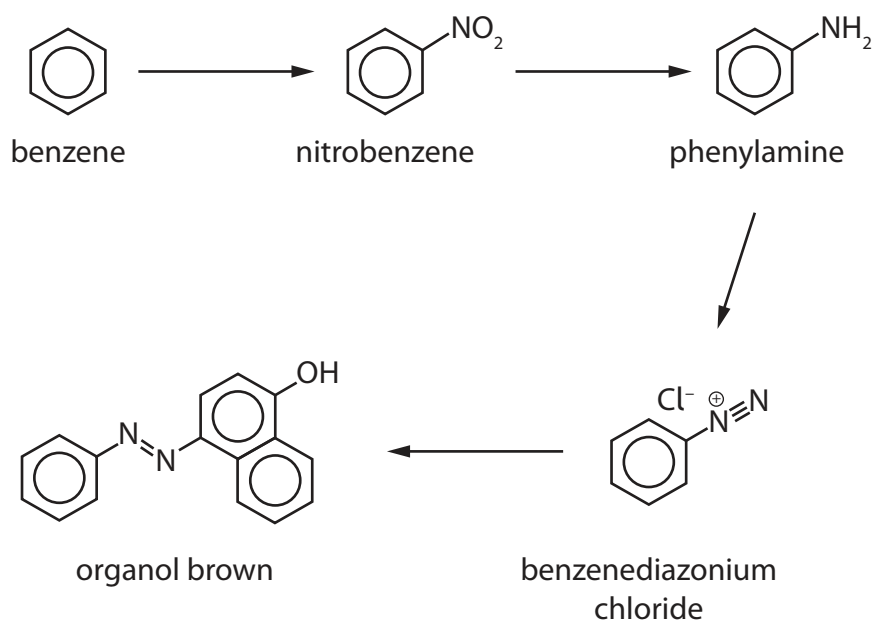
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(Total for Question 2 = 20 marks)



- 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 $55^\circ C$ 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)



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

(3)

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(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)

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

Phenylamine reacts with nitrous acid at a temperature between $0^\circ C$ and $10^\circ C$ 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)

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

(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)

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

(1)

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

(2)

- (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)



(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)

(Total for Question 3 = 16 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

1 2 3 4 5 6 7 0 (8) (18)

1.0
H
hydrogen
1

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

| | | | | | | | | | | | | | | | | | |
|--------------------------------------|--------------------------------------|--|--|--------------------------------------|---|---------------------------------------|---------------------------------------|---|---|--|---|--------------------------------------|--------------------------------------|--------------------------------------|---------------------------------------|--------------------------------------|------------------------------------|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
| 6.9 Li lithium 3 | 9.0 Be beryllium 4 | 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 | 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 | 4.0 He helium 2 |
| 23.0 Na sodium 11 | 24.3 Mg magnesium 12 | 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 | 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 | 87.6 Sr strontium 38 | 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 | 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 | 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 | 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 | [227] 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 | | | | | | |

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

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|-----------------------------------|--|-------------------------------------|---------------------------------------|---------------------------------------|--------------------------------------|---|---|--------------------------------------|--|---------------------------------------|---|
| 140 Ce cerium 58 | 141 Pr praseodymium 59 | 144 Nd neodymium 60 | 150 Sm samarium 62 | 152 Eu europium 63 | 157 Gd gadolinium 64 | 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 | [242] Pu plutonium 94 | [243] Am americium 95 | [247] Cm curium 96 | [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

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