

Pearson Edexcel International Advanced Level

Tuesday 2 June 2026

Afternoon (Time: 1 hour 45 minutes)

Paper

reference

WCH15/01A

Chemistry

International Advanced Level

UNIT 5: Transition Metals and Organic Nitrogen Chemistry
Question Paper

You must have:

Scientific calculator, Data Booklet, ruler and Answer Book (sent separately)

Turn over ►

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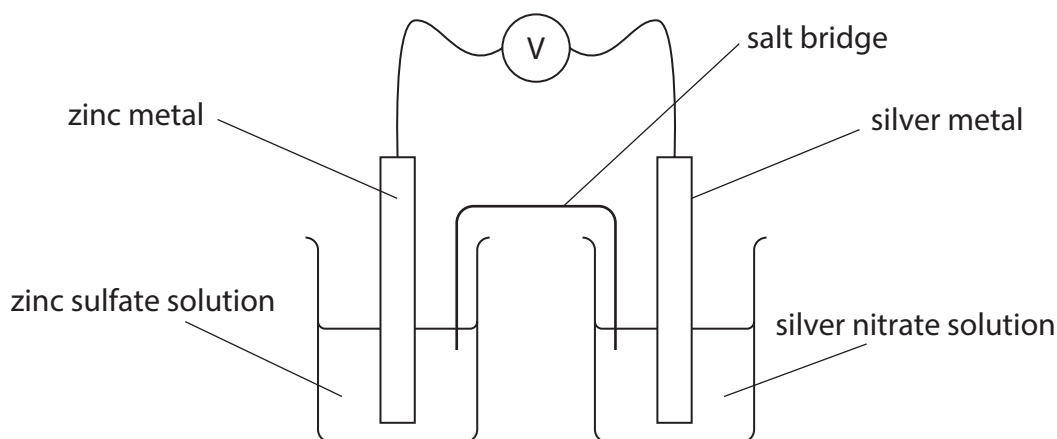
SECTION A

Answer ALL the questions in this section.

You should aim to spend no more than 20 minutes on this section.

For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 The diagram shows an electrochemical cell.

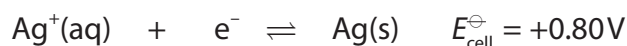
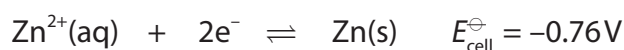


- 1 (a) Which would be the **best** way of making the salt bridge?

- A soak a filter paper in a 1 mol dm^{-3} solution of potassium chloride
- B soak a filter paper in a saturated solution of potassium chloride
- C soak a filter paper in a 1 mol dm^{-3} solution of potassium nitrate
- D soak a filter paper in a saturated solution of potassium nitrate

(1)

- 1 (b) The standard electrode potentials for this cell are shown.



What is the $E_{\text{cell}}^{\ominus}$ value?

- A +1.56V
- B -1.56V
- C +0.04V
- D -0.04V

(1)

1 (c) What happens in the cell reaction?

(1)

- A Ag(s) is an oxidising agent and $\text{Zn}^{2+}(\text{aq})$ is a reducing agent
- B $\text{Ag}^+(\text{aq})$ is a reducing agent and Zn(s) is an oxidising agent
- C $\text{Ag}^+(\text{aq})$ is an oxidising agent and Zn(s) is a reducing agent
- D Ag(s) is a reducing agent and $\text{Zn}^{2+}(\text{aq})$ is an oxidising agent

(Total for Question 1 = 3 marks)

2 What is $E_{\text{cell}}^\ominus$ directly proportional to?

- A the entropy change of the system, ΔS_{system}
- B the equilibrium constant, K
- C the total entropy change, ΔS_{total}
- D the entropy change of the surroundings, $\Delta S_{\text{surroundings}}$

(Total for Question 2 = 1 mark)

3 Ammonia (NH_3), butylamine ($\text{C}_4\text{H}_9\text{NH}_2$) and phenylamine ($\text{C}_6\text{H}_5\text{NH}_2$) form alkaline solutions in water.

What is the order of **increasing** pH of equimolar solutions?

- A $\text{C}_4\text{H}_9\text{NH}_2 < \text{NH}_3 < \text{C}_6\text{H}_5\text{NH}_2$
- B $\text{C}_6\text{H}_5\text{NH}_2 < \text{NH}_3 < \text{C}_4\text{H}_9\text{NH}_2$
- C $\text{C}_6\text{H}_5\text{NH}_2 < \text{C}_4\text{H}_9\text{NH}_2 < \text{NH}_3$
- D $\text{NH}_3 < \text{C}_4\text{H}_9\text{NH}_2 < \text{C}_6\text{H}_5\text{NH}_2$

(Total for Question 3 = 1 mark)

4 Which compound does **not** contain a planar centre?

- A $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
- B butylamine
- C ethanoyl chloride
- D benzene

(Total for Question 4 = 1 mark)

5 Four complex ions are shown.

Complex ion **1** $[\text{Zn}(\text{OH})_4]^{2-}$

Complex ion **2** $[\text{Fe}(\text{EDTA})]^-$

Complex ion **3** $[\text{CuCl}_4]^{2-}$

Complex ion **4** $[\text{Ni}(\text{NH}_3)_6]^{2+}$

5 (a) Which complex ions are coloured?

(1)

- A** **1, 2, 3 and 4**
- B** **3 and 4 only**
- C** **2, 3 and 4 only**
- D** **1, 3 and 4 only**

5 (b) Which complex ions contain a central metal ion in a +2 oxidation state?

(1)

- A** **1, 2, 3 and 4**
- B** **3 and 4 only**
- C** **2, 3 and 4 only**
- D** **1, 3 and 4 only**

5 (c) These complex ions may be formed from the corresponding aqua complex. Which are formed by ligand exchange?

(1)

- A** **1, 2, 3 and 4**
- B** **3 and 4 only**
- C** **2, 3 and 4 only**
- D** **1, 3 and 4 only**

5 (d) When the complex ions are formed from the corresponding aqua complex there is a change in the entropy of the system.

Which formation gives the greatest change in the entropy of the system?

(1)

- A** complex ion **1**
- B** complex ion **2**
- C** complex ion **3**
- D** complex ion **4**

(Total for Question 5 = 4 marks)

6 How many isomers have the molecular formula C_6H_4BrCl and contain a benzene ring?

- A 3
- B 4
- C 5
- D 6

(Total for Question 6 = 1 mark)

7 When propylamine is heated with bromoethane a mixture of products is formed.

Which compound could **not** be formed?

- A $CH_3CH_2CH_2NHC_2H_5$
- B $CH_3CH_2CH_2N(C_2H_5)_2$
- C $CH_3CH_2CH_2N^+(C_2H_5)_3$
- D $(CH_3CH_2CH_2)_2N^+(C_2H_5)_2$

(Total for Question 7 = 1 mark)

8 A section of a polymer is shown.



Which monomer or pair of monomers could form this polymer?

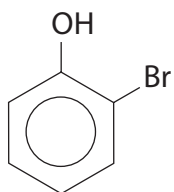
- A $\text{ClOC}(\text{CH}_2)_4\text{NH}_2$
- B $\text{HOOC}(\text{CH}_2)_6\text{NH}_2$
- C $\text{ClOC}(\text{CH}_2)_6\text{COCl}$ and $\text{H}_2\text{N}(\text{CH}_2)_4\text{NH}_2$
- D $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ and $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$

(Total for Question 8 = 1 mark)

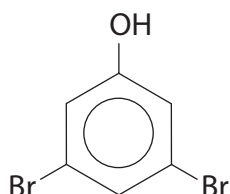
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9 What is the organic product when phenol reacts with **excess** bromine water?

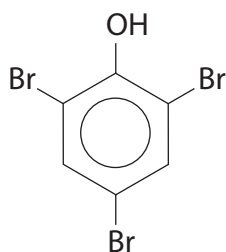
A



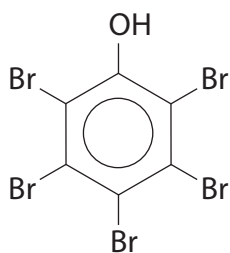
B



C



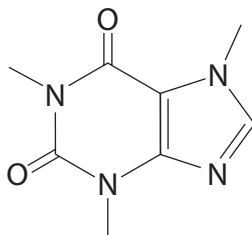
D



(Total for Question 9 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

10 The caffeine molecule has the structure shown.



10 (a) Which **one** of the following functional groups is present in caffeine?

(1)

- A primary amine
- B ketone
- C amide
- D aldehyde

10 (b) How many peaks are in the ^{13}C NMR spectrum of caffeine?

(1)

- A 5
- B 6
- C 7
- D 8

(Total for Question 10 = 2 marks)

11 Which technique provides the **best** evidence that the carbon-carbon bonds in benzene are all the same length?

- A X-ray diffraction
- B proton NMR spectroscopy
- C infrared spectroscopy
- D calorimetry

(Total for Question 11 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

12 Which is formed when benzene reacts with fuming sulfuric acid?

- A** $\text{C}_6\text{H}_5\text{SO}_3$
- B** $\text{C}_6\text{H}_5\text{SO}_3\text{H}$
- C** $\text{C}_6\text{H}_5\text{SO}_3\text{H}_2$
- D** $\text{C}_6\text{H}_5\text{SO}_4\text{H}$

(Total for Question 12 = 1 mark)

13 The infrared spectrum of a compound with the molecular formula $\text{C}_4\text{H}_8\text{O}_2$ has a peak in the range of $1740\text{--}1720\text{ cm}^{-1}$ and a broad peak above 3300 cm^{-1} .

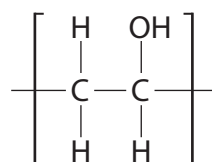
Which compound gives these peaks?

- A** $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CHO}$
- B** $\text{C}_3\text{H}_7\text{COOH}$
- C** $\text{C}_2\text{H}_5\text{COOCH}_3$
- D** $\text{CH}_3\text{COC}_2\text{H}_4\text{OH}$

(Total for Question 13 = 1 mark)

14 Poly(ethenol) is a water-soluble polymer used to make liquid detergent capsules and laundry bags.

The repeat unit of the polymer is shown.



Poly(ethenol) is soluble in water because it

- A** forms London forces with water molecules
- B** forms hydrogen bonds with water molecules
- C** is broken down when heated in water
- D** is broken down by the detergent

(Total for Question 14 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

15 This question is about chromium and its compounds.

(a) Electrode potential data for some chromium species are shown.

Electrode system	$E^\ominus/\text{V}$
$\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \rightleftharpoons \text{Cr}(\text{s})$	-0.74
$\text{Cr}^{3+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{Cr}^{2+}(\text{aq})$	
$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$	

15 (a) (i) Complete the table in the Answer Book using your Data Booklet.

(1)

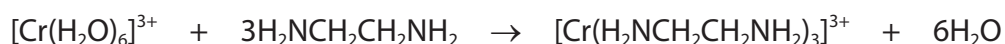
15 (a) (ii) Write the equation for the disproportionation of Cr^{3+} to Cr^{2+} and $\text{Cr}_2\text{O}_7^{2-}$.
State symbols are **not** required.

(2)

15 (a) (iii) Deduce, by calculating the $E^\ominus_{\text{cell}}$ value, whether or not this disproportionation reaction is feasible under standard conditions.

(2)

15 (b) An aqueous solution containing the chromium(III) complex ion, $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$, reacts with the bidentate ligand ethane-1,2-diamine, $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$, to produce a blue solution.



15 (b) (i) Explain, in terms of its structure, how ethane-1,2-diamine acts as a bidentate ligand.

(2)

- 15 (b) (ii) Complete the diagram in the Answer Book of the complex ion $[\text{Cr}(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_3]^{3+}$.

(2)

- 15 (c) A standard solution of potassium dichromate(VI), $\text{K}_2\text{Cr}_2\text{O}_7$, was used to determine the value of x in a sample of hydrated iron(II) sulfate, $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$.

In an experiment 5.81 g of hydrated iron(II) sulfate was transferred to a volumetric flask and made up to 250 cm^3 with distilled water.

A 25.0 cm^3 portion of this solution was acidified with sulfuric acid and titrated with 0.024 mol dm^{-3} potassium dichromate(VI).

The mean titre was 16.60 cm^3 .

The equation for the reaction is shown.



- 15 (c) (i) Suggest **two** reasons why an indicator is needed for this titration even though dichromate(VI) ions and chromium(III) ions are different colours.

(2)

- 15 (c) (ii) Calculate the value of x in the sample of hydrated iron(II) sulfate, $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$.

You **must** show your working.

[Data: Molar mass $\text{FeSO}_4 = 151.9\text{ g mol}^{-1}$]

(6)

(Total for Question 15 = 17 marks)



16 This question is about Grignard reagents and some products prepared using them. Grignard reagents are important in organic syntheses because they increase the length of carbon chains.

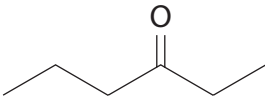
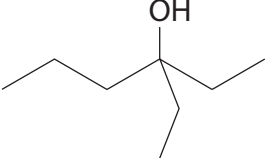
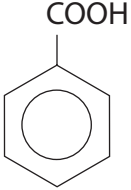
Grignard reagents have the general formula RMgX , where R is an alkyl or aryl group and X is a halogen, such as bromine.

16 (a) State the type of reagent that reacts with magnesium to form a Grignard reagent. Include the conditions for this reaction.

(2)

16 (b) (i) The table shows the structure of two products formed using Grignard reagents. Complete the table in the Answer Book.

(4)

	Structure of Grignard reagent	Structure of the other reagent	Structure of product	Name of product
Reaction 1				
Reaction 2				benzoic acid

16 (b) (ii) Benzoic acid is used as a preservative in many foods and drinks.

A carbonated drink contains benzoic acid with a concentration of $1.85 \times 10^{-3} \text{ mol dm}^{-3}$.

The acceptable daily limit of benzoic acid is 5 mg of benzoic acid per kg of body weight.

A can of drink contains 330 cm^3 of carbonated liquid.

Calculate the maximum number of cans of drink that a 60 kg person could consume and still be below the acceptable daily limit of benzoic acid.

(3)

(Total for Question 16 = 9 marks)

***17** Scandium and copper are both d-block elements, but only copper is a transition metal.

Explain any similarity and differences between the two metals.

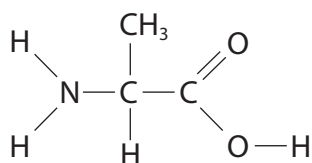
In your answer refer to:

- oxidation numbers
- coloured ions

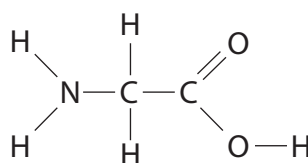
(6)

(Total for Question 17 = 6 marks)

18 The structures of two amino acids, alanine and glycine, are shown.



alanine (ala)



glycine (gly)

- 18 (a)** Suggest how the two amino acids could be distinguished using **low** resolution proton NMR spectroscopy.
Refer only to the number of peaks and their relative areas in your answer. (2)
- 18 (b)** In separate experiments, solutions of alanine and glycine had **no** effect on the plane of plane-polarised light.
Explain the result for each solution. (2)
- 18 (c) (i)** Give the name of alanine according to IUPAC rules. (1)
- 18 (c) (ii)** Draw the structure of alanine in a solution with a high pH. (1)
- 18 (d)** Explain why glycine has a high melting temperature, despite it being a relatively small molecule. (2)
- 18 (e)** Draw in the Answer Book the structure of the **tripeptide** formed when an alanine molecule bonds to two glycine molecules in the sequence gly–ala–gly. (2)

(Total for Question 18 = 10 marks)

19 7.80 g of an organic compound **X**, containing only carbon, hydrogen and oxygen, is burned in excess oxygen. When the products of combustion were cooled to room temperature, 5.01 g of water and 10 028 cm³ of carbon dioxide remained.

[Data: Molar volume of a gas = 24.0 dm³ mol⁻¹, molar mass of **X** = 168 g mol⁻¹]

19 (a) Calculate the molecular formula of **X**.
You **must** show your working.

(6)

19 (b) **X** burns with a very smoky flame.
X reacts with phosphorus(V) chloride to produce steamy fumes.
X does not react with sodium carbonate solution.

Draw a possible structure for **X** in the Answer Book, using this information and your answer to (a).

(2)

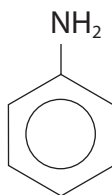
(Total for Question 19 = 8 marks)

TOTAL FOR SECTION B = 50 MARKS

SECTION C

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

20 Phenylamine is a colourless oily liquid with the structure shown.



Phenylamine was first isolated in 1826 when it was extracted from a blue dye called indigo, which is found in certain plants. It is used in the manufacture of dyes, drugs, explosives and plastics. Nowadays, phenylamine is produced synthetically.

20 (a) Phenylamine is prepared in a three-step process.

Procedure

Step 1 Benzene reacts with concentrated nitric acid, in the presence of the catalyst, concentrated sulfuric acid, to form nitrobenzene.

20 (a) (i) Draw the mechanism for this reaction in the Answer Book, using curly arrows. Include equations for the formation of the electrophile and the regeneration of the catalyst.

(5)

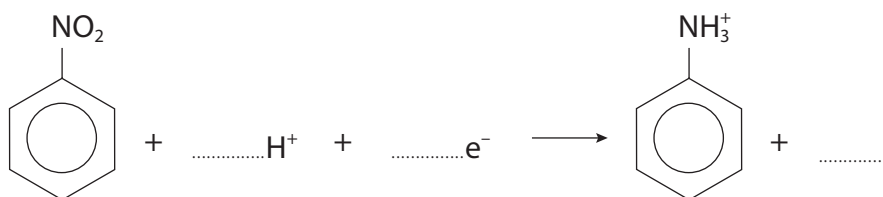
20 (a) (ii) Explain why the temperature for the reaction in Step 1 should not fall below 50 °C or rise above 60 °C.

(2)

20 (a) (iii) Step 2 The nitrobenzene is heated under reflux with tin and concentrated hydrochloric acid.

Write the balanced equation for this reaction in the Answer Book.

(1)



20 (a) (iv) Step 3 The NH_3^+ group is deprotonated.

Identify, by name or formula, a reagent needed for this deprotonation.

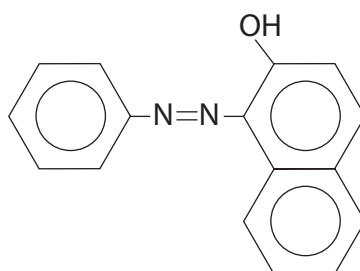
(1)

- 20 (a) (v)** In a preparation of phenylamine the yield for the conversion of benzene into nitrobenzene (Step **1**) was 43.0%.
The yield for the conversion of nitrobenzene into phenylamine (Step **2** and Step **3**) was 38.0%.

Calculate the mass of phenylamine produced if 5.00 cm^3 of benzene reacted.
[Data: Density of benzene = 0.879 g cm^{-3}]

(4)

- 20 (b)** Phenylamine can be used to form the azo dye, 2-naphthol aniline, which has the structure shown.



Phenylamine can be converted into a diazonium ion, and then into the azo dye, 2-naphthol aniline.

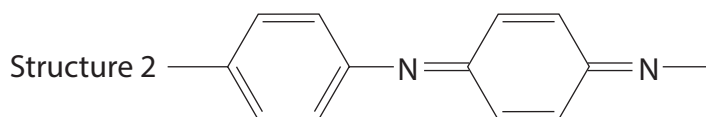
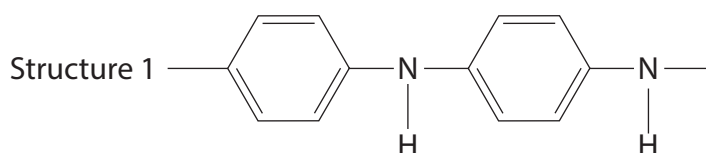
State the reagents and essential conditions for these two reactions.

Include the structure of the intermediate diazonium ion.

Detailed descriptions of the experimental procedures are **not** required.

(5)

- 20 (c)** Phenylamine forms a polymer, poly(phenylamine), which exists in several different structures. Two of these are shown.



Add curly arrows to the structures in the Answer Book to show how Structure 1 loses hydrogen to form Structure 2.

(2)

(Total for Question 20 = 20 marks)

TOTAL FOR SECTION C = 20 MARKS
TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname					Other names				
Centre Number					Candidate Number				

Pearson Edexcel International Advanced Level

Tuesday 2 June 2026

Afternoon (Time: 1 hour 45 minutes) **Paper reference** **WCH15/01A**

Chemistry
International Advanced Level
UNIT 5: Transition Metals and Organic Nitrogen Chemistry
Answer Book

You must have:
 Question paper (sent separately)
 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 90.
- The marks for **each** question are shown in brackets
 – *use this as a guide as to how much time to spend on each question.*
- In the question marked with an **asterisk (*)**, marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- 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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SECTION A

Answer ALL the questions in this section.

You should aim to spend no more than 20 minutes on this section.

For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(1)

1 (b)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(1)

1 (c)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(1)

(Total for Question 1 = 3 marks)

2

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(Total for Question 2 = 1 mark)



3☐ **A**☐ **B**☐ **C**☐ **D****(Total for Question 3 = 1 mark)****4**☐ **A**☐ **B**☐ **C**☐ **D****(Total for Question 4 = 1 mark)****5 (a)****(1)**☐ **A**☐ **B**☐ **C**☐ **D****5 (b)****(1)**☐ **A**☐ **B**☐ **C**☐ **D**

5 (c)

(1)

- ☐ A
☐ B
☐ C
☐ D

5 (d)

(1)

- ☐ A
☐ B
☐ C
☐ D

(Total for Question 5 = 4 marks)

6

- ☐ A
☐ B
☐ C
☐ D

(Total for Question 6 = 1 mark)

7

- ☐ A
☐ B
☐ C
☐ D

(Total for Question 7 = 1 mark)



8

☐ A☐ B☐ C☐ D

(Total for Question 8 = 1 mark)

9

☐ A☐ B☐ C☐ D

(Total for Question 9 = 1 mark)

10 (a)

(1)

☐ A☐ B☐ C☐ D

10 (b)

(1)

☐ A☐ B☐ C☐ D

(Total for Question 10 = 2 marks)



11

- ☐ A
☐ B
☐ C
☐ D

(Total for Question 11 = 1 mark)

12

- ☐ A
☐ B
☐ C
☐ D

(Total for Question 12 = 1 mark)

13

- ☐ A
☐ B
☐ C
☐ D

(Total for Question 13 = 1 mark)

14

- ☐ A
☐ B
☐ C
☐ D

(Total for Question 14 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS



DO NOT WRITE IN THIS AREA

SECTION B

Answer ALL the questions in the spaces provided.

15 (a) (i)

(1)

Electrode system	$E^{\ominus}/V$

15 (a) (ii)

(2)

15 (a) (iii)

(2)

.....

.....

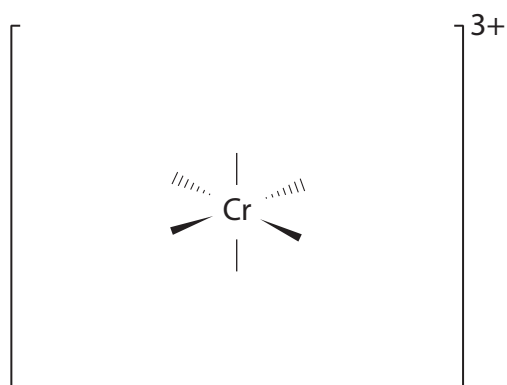
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15 (b) (i)

(2)

15 (b) (ii)

(2)



15 (c) (i)

(2)



DO NOT WRITE IN THIS AREA

15 (c) (ii)

(6)

(Total for Question 15 = 17 marks)



16 (a)

(2)

16 (b) (i)

(4)

	Structure of Grignard reagent	Structure of the other reagent	Structure of product	Name of product
Reaction 1				
Reaction 2				

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DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

16 (b) (ii)

(3)

(Total for Question 16 = 9 marks)



*17

(6)

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DO NOT WRITE IN THIS AREA



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Handwriting practice area with 20 horizontal dotted lines.

(Total for Question 17 = 6 marks)



18 (a)

(2)

18 (b)

(2)

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DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



18 (c) (i)

(1)

18 (c) (ii)

(1)

18 (d)

(2)

18 (e)

(2)

(Total for Question 18 = 10 marks)



19 (a)

(6)

19 (b)

(2)

(Total for Question 19 = 8 marks)

TOTAL FOR SECTION B = 50 MARKS

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DO NOT WRITE IN THIS AREA

SECTION C

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

20 (a) (i)

(5)



20 (a) (ii)

(2)

20 (a) (iii)

(1)

20 (a) (iv)

(1)



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20 (a) (v)

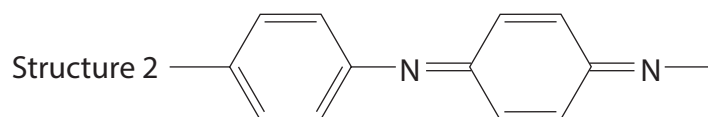
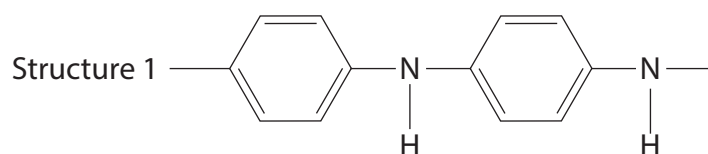
(4)



20 (b)

(5)

20 (c)



(2)

(Total for Question 20 = 20 marks)

TOTAL FOR SECTION C = 20 MARKS
TOTAL FOR PAPER = 90 MARKS

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The Periodic Table of Elements

1	2	3	4	5	6	7	0 (8)

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DO NOT WRITE IN THIS AREA

