Organic Synthesis

Question Paper 1

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Transition Metals & Organic Nitrogen Chemistry
Sub Topic	Organic Synthesis
Booklet	Question Paper 1

Time Allowed: **30 minutes**

Score: **/25**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 Dichromate(VI) ions, $Cr_2O_7^{2-}$ in dilute sulfuric acid, react with ethanol, CH_3CH_2OH, on warming to form chromium(III) ions and ethanal, CH_3CHO. The half equation for this oxidation of ethanol is

$$CH_3CH_2OH \longrightarrow CH_3CHO + 2H^+ + 2e^-$$

What is the mole ratio of dichromate(VI) ions to ethanol in this redox reaction?

- ☒ **A** 3:1
- ☒ **B** 2:3
- ☒ **C** 3:2
- ☒ **D** 1:3

(Total for Question 1 = 1 mark)

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2 The overall reaction between ethanoyl chloride and ethylamine to form N-ethyl ethanamide is best classified as

- ☒ **A** free radical substitution.
- ☒ **B** nucleophilic substitution.
- ☒ **C** free radical addition.
- ☒ **D** nucleophilic addition.

(Total for Question 2 = 1 mark)

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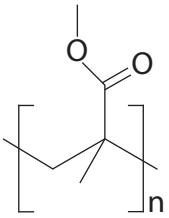
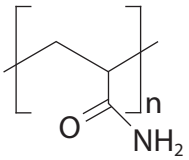
3 The formulae of four synthetic polymers, **W**, **X**, **Y** and **Z**, are given below.

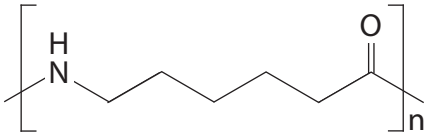
W Poly(methyl-2-methylpropenoate)



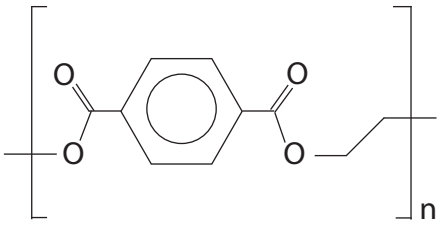
X Poly(propenamide)



Y Poly(amide 6)



Z Poly(ethylene terephthalate)



Which polymers are made by condensation polymerization reactions?

- ☒ **A** and **Z**
- ☒ **B** and **Y**
- ☒ **C** and **Z**
- ☒ **D** and **X**

(Total for Question 3 = 1 mark)

4 When recrystallization is used to purify a solid, which of the following statements is true?

☒ **A** Soluble impurities are removed by filtering the hot solution.

☒ **B** Insoluble impurities are removed by filtering the hot solution.

☒ **C** All impurities must be insoluble in the solvent used.

☒ **D** All impurities must be soluble in the solvent used.

(Total for Question 4 = 1 mark)

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5 The repeat unit of the polymer formed from ethane-1,2-diol and ethanedioic acid is

☒ **A** $-OCH_2CH_2OOCCO-$

☒ **B** $-OCH_2CH_2OCOOCO-$

☒ **C** $-OCH_2OOCCH_2CO-$

☒ **D** $-OCCH_2CH_2OOCO-$

(Total for Question 5 = 1 mark)

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6 Poly(ethenol) is an example of

☒ **A** an addition polymer that is soluble in water.

☒ **B** an addition polymer that is insoluble in water.

☒ **C** a condensation polymer that is soluble in water.

☒ **D** a condensation polymer that is insoluble in water.

(Total for Question 6 = 1 mark)

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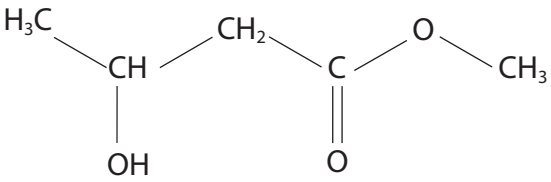
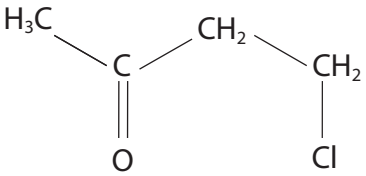
7 A compound gives an orange precipitate with 2,4-dinitrophenylhydrazine, Brady's reagent, but does **not** react with ammonia in the cold.
The compound could be

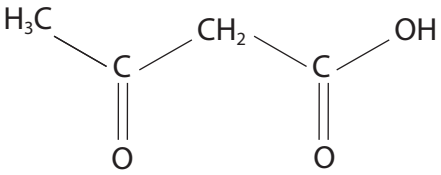
☒ **A**



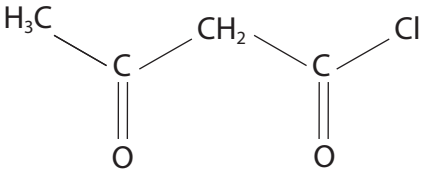
☒ **B**



☒ **C**

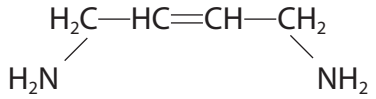
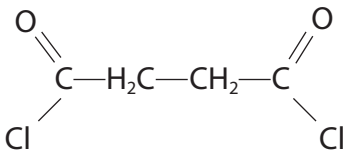
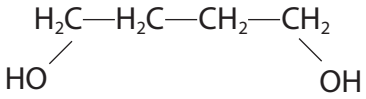


☒ **D**



(Total for Question 7 = 1 mark)

8 Three compounds are possible monomers in the formation of a polymer:

I	
II	
III	

Which of the following compounds could **not** react in the stated combination to form a polymer?

☒ **A** I alone

☒ **B** I in combination with II

☒ **C** II in combination with III

☒ **D** I in combination with III

(Total for Question 8 = 1 mark)

9 Pentan-3-one reacts with 2,4-dinitrophenylhydrazine to form a derivative which has a melting temperature of 156 °C.

A student attempted to synthesise pentan-3-one, and converted some of the product into the same derivative. The student's derivative melted gradually from 148 °C to 158 °C.

It is most likely that the student had synthesised

☒ **A** pure pentan-3-one.

☒ **B** impure pentan-3-one.

☒ **C** approximately equal amounts of two carbonyl derivatives, one with a melting temperature of 148 °C and the other with a melting temperature of 158 °C.

☒ **D** a compound that was not a ketone.

(Total for Question 9 = 1 mark)

10 The purification of organic compounds prepared in aqueous mixtures often involves solvent extraction. Desirable properties of the solvent used include that it is

☒ **A** fully miscible in water and has a high boiling temperature.

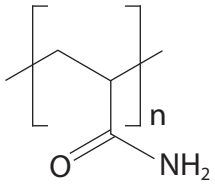
☒ **B** fully miscible in water and has a low boiling temperature.

☒ **C** immiscible in water and has a high boiling temperature.

☒ **D** immiscible in water and has a low boiling temperature.

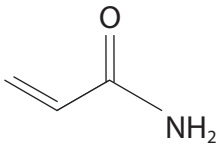
(Total for Question 10 = 1 mark)

11 The repeat unit of a polymer is shown below.

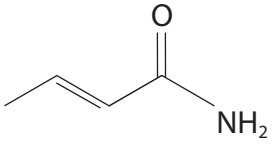


What is the structure of the monomer?

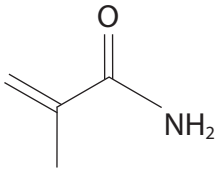
☒ **A**



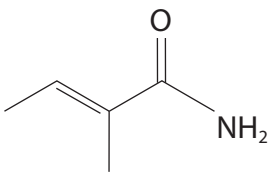
☒ **B**



☒ **C**

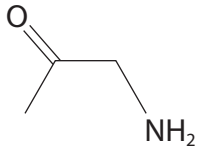


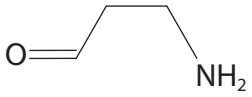
☒ **D**

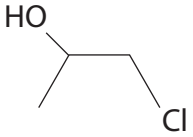


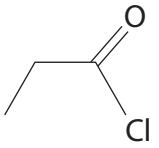
(Total for Question 11 = 1 mark)

12 An organic compound reacts with dilute sulfuric acid to form a colourless solution which produces a white solid on evaporation. It also gives a pale yellow solid on reaction with iodine in sodium hydroxide. The compound is

☒ **A** 

☒ **B** 

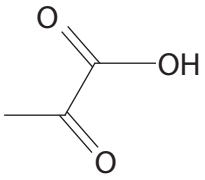
☒ **C** 

☒ **D** 

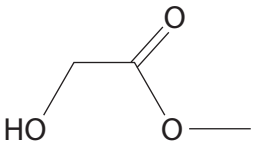
(Total for Question 12 = 1 mark)

13 An organic compound produces steamy fumes with phosphorus(V) chloride but does **not** react with 2,4-dinitrophenylhydrazine. The compound is

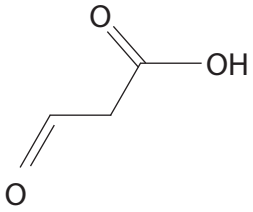
☒ **A**



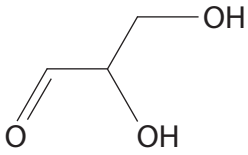
☒ **B**



☒ **C**



☒ **D**



(Total for Question 13 = 1 mark)

14 In the mass spectrum of an organic compound, the molecular ion occurs at *m/e* = 86.

Which of the following could be the **empirical formula** of the compound?

☒ **A** C_6H_{14}

☒ **B** $C_5H_{10}N$

☒ **C** $C_5H_{12}O$

☒ **D** C_5H_7F

(Total for Question 14 = 1 mark)

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15 The high resolution proton nmr spectrum of propan-1-ol, $CH_3CH_2CH_2OH$, contains four peaks. What is the splitting pattern of the four peaks?

[Where 1 represents a singlet, 2 represents a doublet, etc.]

☒ **A** 3

☒ **B** 3

☒ **C** 3

☒ **D** 3

(Total for Question 15 = 1 mark)

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16 Which of the following techniques would be the **least** effective as a control measure to reduce risk when heating a flammable liquid?

The use of

☒ **A** an electrical heater.

☒ **B** a fume cupboard.

☒ **C** a small quantity of the liquid.

☒ **D** a reflux condenser.

(Total for Question 16 = 1 mark)

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17 The mass spectrum of a compound, **Z**, has a peak at *m/e* = 43. Which of the following could **not** be **Z**?

☒ **A** $CH_3COCH_2CH_3$

☒ **B** $CH_3CH_2CH_2CHO$

☒ **C** $CH_3CH_2CH_2COCH_3$

☒ **D** $CH_3CH_2COCH_2CH_3$

(Total for Question 17 = 1 mark)

18 The low resolution proton nmr spectrum of a compound contains only two peaks. The compound could be

☒ **A** butan-1-ol

☒ **B** butan-2-ol

☒ **C** 2-methylpropan-1-ol

☒ **D** 2-methylpropan-2-ol

(Total for Question 18 = 1 mark)

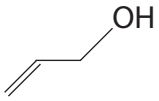
19 A compound, **G**, has the following properties:

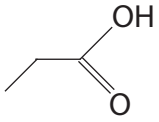
G reacts with phosphorus(V) chloride to form hydrogen chloride.

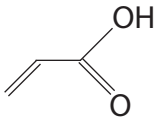
G reacts by addition with hydrogen in the presence of a nickel catalyst.

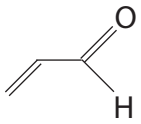
G reacts with sodium hydroxide to form an ionic solid.

Compound **G** could be

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(Total for Question 19 = 1 mark)

20 In the first stage of the synthesis of methyl 3-nitrobenzoate, methyl benzoate, $C_6H_5COOCH_3$, is prepared by the reaction of benzoic acid with methanol in the presence of concentrated sulfuric acid. When the reaction is complete, the sulfuric acid is neutralized by the addition of aqueous sodium carbonate. The simplest way of obtaining the impure methyl benzoate from this mixture will be

☒ **A** refluxing.

☒ **B** solvent extraction.

☒ **C** filtration.

☒ **D** recrystallization.

(Total for Question 20 = 1 mark)

21 What is the total number of peaks due to singly charged ions in the **complete** mass spectrum of chlorine, Cl_2?

☒ **A** Two

☒ **B** Three

☒ **C** Four

☒ **D** Five

(Total for Question 21 = 1 mark)

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22 The low resolution proton nmr spectrum of a compound contains two peaks. Which of the following compounds could **not** give this spectrum?

☒ **A** Propane

☒ **B** Butane

☒ **C** 2-methylpropane

☒ **D** 2,2-dimethylpropane

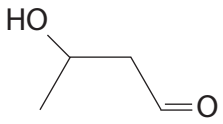
(Total for Question 22 = 1 mark)

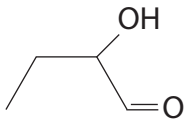
23 A compound, **P**, has the following properties:

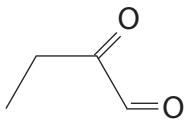
P forms a red precipitate when heated with Fehling's or Benedict's solution.

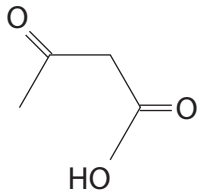
P forms a pale yellow precipitate when warmed with iodine dissolved in aqueous sodium hydroxide.

P could be

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(Total for Question 23 = 1 mark)

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24 10 cm^3 of a gaseous hydrocarbon was mixed with excess oxygen and ignited. The gas volumes were measured at room temperature and pressure before and after combustion and it was found that the total gas volume had contracted by 20 cm^3. Given that combustion was complete, the formula of the hydrocarbon was

☒ **A** C_4H_4

☒ **B** C_4H_6

☒ **C** C_4H_8

☒ **D** C_4H_{10}

(Total for Question 24 = 1 mark)

25 Steam distillation may be used in the purification of some compounds. The use of this technique depends on the compound

☒ **A** forming a single layer with water.

☒ **B** forming two layers with water.

☒ **C** having a lower boiling temperature than water.

☒ **D** being flammable.

(Total for Question 25 = 1 mark)