'WHAT'S IN A MEDICINE?' TEST

A copy of the WM Information Sheet is required for this test.

1 An ester **E** is used in food flavourings. Its structure is shown below.

a Give the systematic name for the ester E. (2 marks)

0

b This ester can be hydrolysed by heating under reflux with dilute hydrochloric acid. Draw a fully labelled diagram of the apparatus you would use in a laboratory to do this. (3 marks)

Ester E

- **c** Why is the reaction mixture heated *under reflux*, rather than just boiling the reagents together in a flask? (2 *marks*)
- d The two products formed on hydrolysis of the ester E are shown below.

$$CH_3 - C$$
 Compound **F** $CH_3 - OH$ Compound **G**

- i Name the functional group in compound F. (1 mark)
- ii Give the systematic name for compound F. (1 mark)
- iii Give the systematic name for compound G. (1 mark)
- e State the conditions needed to cause compound **F** and compound **G** to react together in the laboratory to form the ester **E**. (3 marks)
- **f** Compound **F** can be made by the oxidation of an alcohol.
 - i Give the name and full structural formula of the alcohol you would use to make compound **F** in this way. (2 marks)
 - **ii** Classify the alcohol that you have named in **i** as a primary, secondary or tertiary alcohol. Explain your answer. (2 *marks*)

[TOTAL: 17 MARKS]

2 Cannabis resin contains compounds called cannabinoids. Two compounds contained in fresh cannabis resin are shown below.



- **a** Describe, using diagrams, how you would carry out thin-layer chromatography to demonstrate that cannabis resin contains a *mixture* of compounds. (5 *marks*)
- **b** Samples of compounds **A** and **B** are isolated from the resin and purified. Various chemical tests are carried out on the compounds.
 - i Name **one** functional group (other than the benzene ring) that is present in **both** compounds **A** and **B**. (1 mark)

- ii State which of **A** and **B** would be the more acidic in aqueous solution. Explain your choice in terms of the relevant functional groups. (3 marks)
- iii What would be observed if **A** were added to aqueous sodium carbonate? Explain your answer. (2 marks)
- iv What would be observed if **B** were added to a neutral solution of iron(III) chloride? (1 mark)
- v An acidified solution of potassium dichromate(VI) is sometimes used for identifying compounds containing –OH groups. Would acidified potassium dichromate(VI) distinguish between the two compounds A and B? Briefly explain your answer. (2 marks)
- **c** Which spectroscopic technique would you use:
 - i to show that compounds A and B have different molar masses? (1 mark)
 - ii to show the presence of a C=O bond in compound A? (1 mark)

[TOTAL: 16 MARKS]

3 In 1936 the compound *pethidine*, a powerful painkiller, was synthesised by chance. The general structure of pethidine is shown below, where **X** represents a group of unknown structure.



The molecular formula of pethidine can, therefore, be written as $C_{12}H_{16}NX$.

- **a** The molecular ion peak in the mass spectrum of pethidine occurs at a mass of 247. $(A_r: H, 1; C, 12; N, 14; O, 16)$
 - i Find the relative formula mass of the group X. Show your working. (2 marks)
 - ii Show that this is consistent with **X** being $C_3H_5O_2$. (1 mark)
 - iii Two of the other peaks in the mass spectrum of pethidine occur at masses of 15 and 77. Suggest formulae for the ions giving rise to these two peaks. *(3 marks)*
- **b** When pethidine is hydrolysed with aqueous acid, a bond in the group **X** breaks and a mixture of two compounds is formed. One of these is ethanol.
 - i The infrared spectrum of ethanol is given below. Explain how it shows the presence of an alcohol. (2 marks)



The infrared absorption spectrum of ethanol

- **ii** You know that the formula of group **X** is $C_3H_5O_2$, and that when pethidine is hydrolysed ethanol is produced. Use this information to identify group **X** and write down the structural formula of pethidine. (3 marks)
- **c** Why might scientists, in search of new medicines, experiment by varying the nature of group **X** in pethidine? (2 marks)
- **d** Describe, using a flow diagram, the procedures that scientists use today to establish the safety of a new medicine. (3 marks)
- **e** Another alcohol **S** has the molecular formula C_3H_8O and is a secondary alcohol.
 - i Draw a full structural formula for compound S and write down its systematic name. (2 marks)
 - ii Compound S can be oxidised to compound T, which also has three carbon atoms in its molecule. Give the structural formula of compound T. (2 marks)
 - iii Name the functional group in compound T. (1 mark)
 - iv State the reagents and conditions needed to convert compound S into compound T. (3 marks)
 - \boldsymbol{v} Draw the structural formula and give the name of compound \boldsymbol{U} that is made by dehydrating compound $\boldsymbol{S}.$ (2 marks)
 - vi Choose from the list below the word that best describes this dehydration reaction of an alcohol. (1 mark)

condensation addition elimination hydrolysis

[TOTAL: 27 MARKS]

WM INFORMATION SHEET

Wavenumber/cm⁻¹ Bond Location Intensity С—Н 2850 - 2950 M–S alkanes alkenes, arenes 3000 - 3100 M-S *ca* 3300 alkynes S C = C1620 - 1680 Μ alkenes arenes several peaks variable in range 1450 - 1650 C = C2100 - 2260 alkynes Μ 1720 - 1740 1705 - 1725 S S C = 0aldehydes ketones carboxylic acids 1700 - 1725 S 1735 - 17501630 - 1700esters S Μ amides C-0 1050 - 1300S alcohols, ethers, esters C = Nnitriles 2200 - 2260 Μ 1000 - 1400S C—F fluoroalkanes C—CI 600 - 800 chloroalkanes S 500 - 600C—Br bromoalkanes S 0—H alcohols, phenols 3600 - 3640 S S (broad) *alcohols, phenols 3200 - 3600 *carboxylic acids 2500 - 3200 M (broad) N—H primary amines 3300 - 3500 M–S ca 3500 amides Μ

Table 1 Characteristic infrared absorptions in organic molecules

M = medium, S = strong

* = hydrogen-bonded