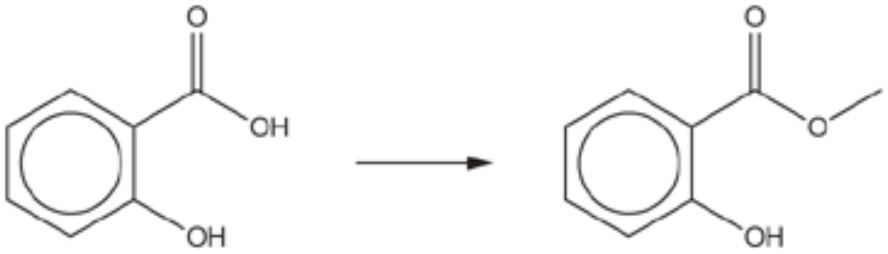
1. Oil of wintergreen is a liquid used in medicine to relieve muscle pain.

Compound **H** is a component in oil of wintergreen and can be synthesised from compound **G**, as shown below. The boiling point and density of compound **H** are stated.



Compound G **Compound H**

boiling point = 222 °C
density = 1.174 g cm^{-3}

A student prepares a sample of compound **H** by the method below.

Step 1	Reflux 8.97 g of compound **G** for 30 minutes with an excess of methanol in the presence of a small amount of sulfuric acid as a catalyst.
Step 2	Add an excess of aqueous sodium carbonate, Na_2CO_3(aq). Two layers are obtained.
Step 3	Purify the impure compound **H** that forms from the resulting mixture.

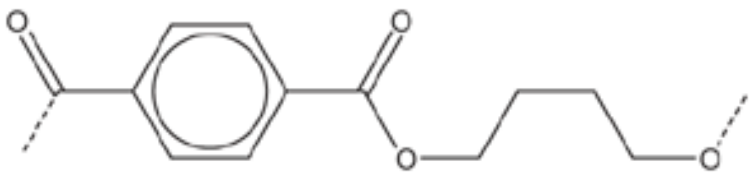
The student follows this method and obtains 5.32 g of pure compound **H**.

Why does the student use reflux in **Step 1**?

---

[1]

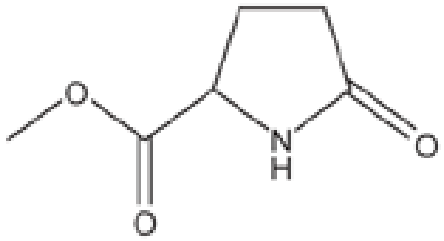
2(a). The repeat unit of a polyester is shown below.



Draw the structures of monomers required to form this polyester.

[2]

(b). The compound below contains an ester and an amide group.



Draw the structures of the organic products formed by the complete **alkaline** hydrolysis of this compound using NaOH(aq).

[4]

3(a). α-Amino acids have the general formula $RCH(NH_2)COOH$.

The R group in an α-amino acid contains C and H only.

This R group has a molar mass of 91 g mol^{-1}.

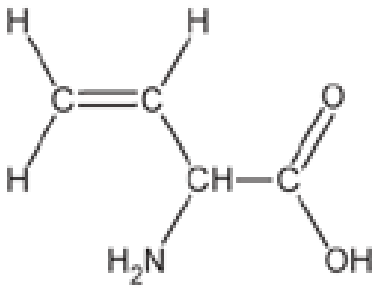
A polymer is formed from 500 molecules of this α-amino acid.

Determine the molar mass of this polymer.

Give your answer to the nearest whole number.

molar mass of polymer = ... g mol^{-1} **[3]**

(b). The amino acid below can form addition and condensation polymers.



Draw **2** repeat units of these polymers.
Display the sections linking the monomers together.

addition polymer (2 repeat units)

condensation polymer (2 repeat units)

[3]

4. 1,6-Diaminohexane, $H_2N(CH_2)_6NH_2$, reacts with hexanedioyl dichloride, $ClOC(CH_2)_4COCl$ to form a polyamide and one other product.

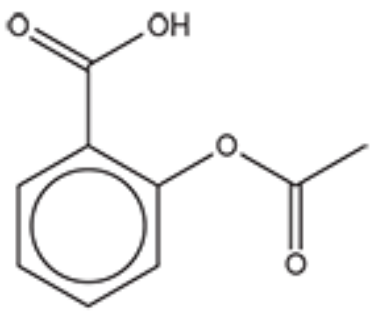
What is the other product formed in this reaction?

A HCl
B H_2O
C CO
D NH_3

Your answer ☐ **[1]**

5. Aspirin tablets are used for pain relief.

The structure of aspirin is shown below.



Aspirin

Aspirin reacts with hot NaOH(aq), under reflux.

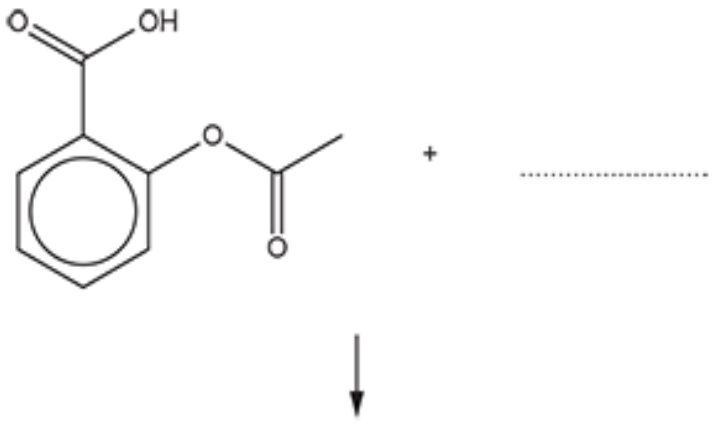
i. Draw a labelled diagram of suitable apparatus for reflux.

[2]

ii. In this reaction, 1 mol of aspirin reacts with 3 mol of hot NaOH(aq).

Complete the equation for the reaction of aspirin with an excess of hot NaOH(aq).

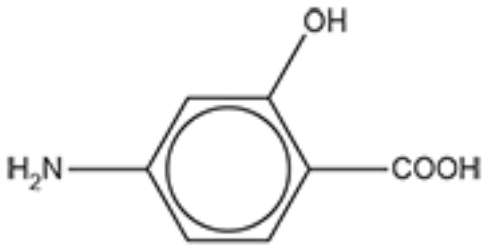
Show structures for organic compounds.



[3]

6. This question is about aromatic compounds containing the –COOH and –OH functional groups.

PAS, shown below, is an antibiotic used to treat several diseases including tuberculosis (TB).



PAS

i. A student predicts that PAS could polymerise to form a polymer containing **both** ester and amide linkages.

Draw a section of this polymer.

The section should contain **one** amide and **one** ester linkage, which should be displayed.

[3]

ii. For the treatment of TB, the maximum daily dosage of PAS that should be prescribed is 300 mg per kg of body mass.

A child weighs 20.0 kg.

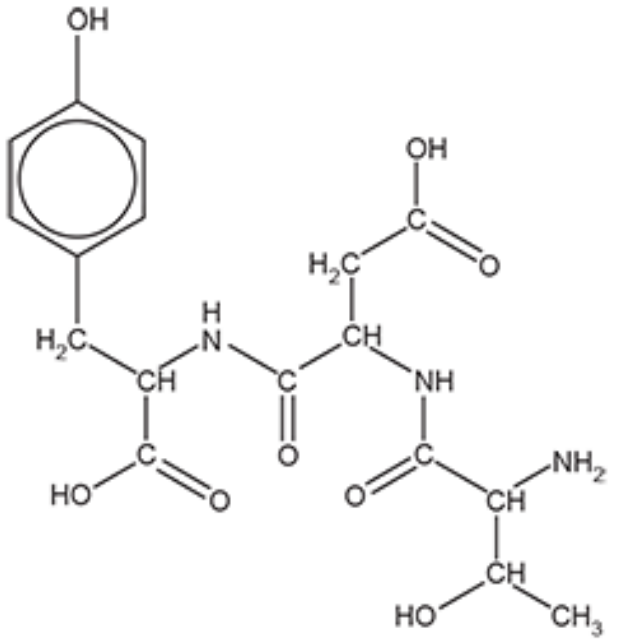
Calculate the number of PAS molecules in the maximum daily dosage of PAS for this child.

number of PAS molecules = ...

[3]

7. This question is about α-amino acids.

Three α-amino acids can react together to form compound **E**, shown below.



Compound E

i. How many optical isomers are possible for compound **E**?

---

[1]

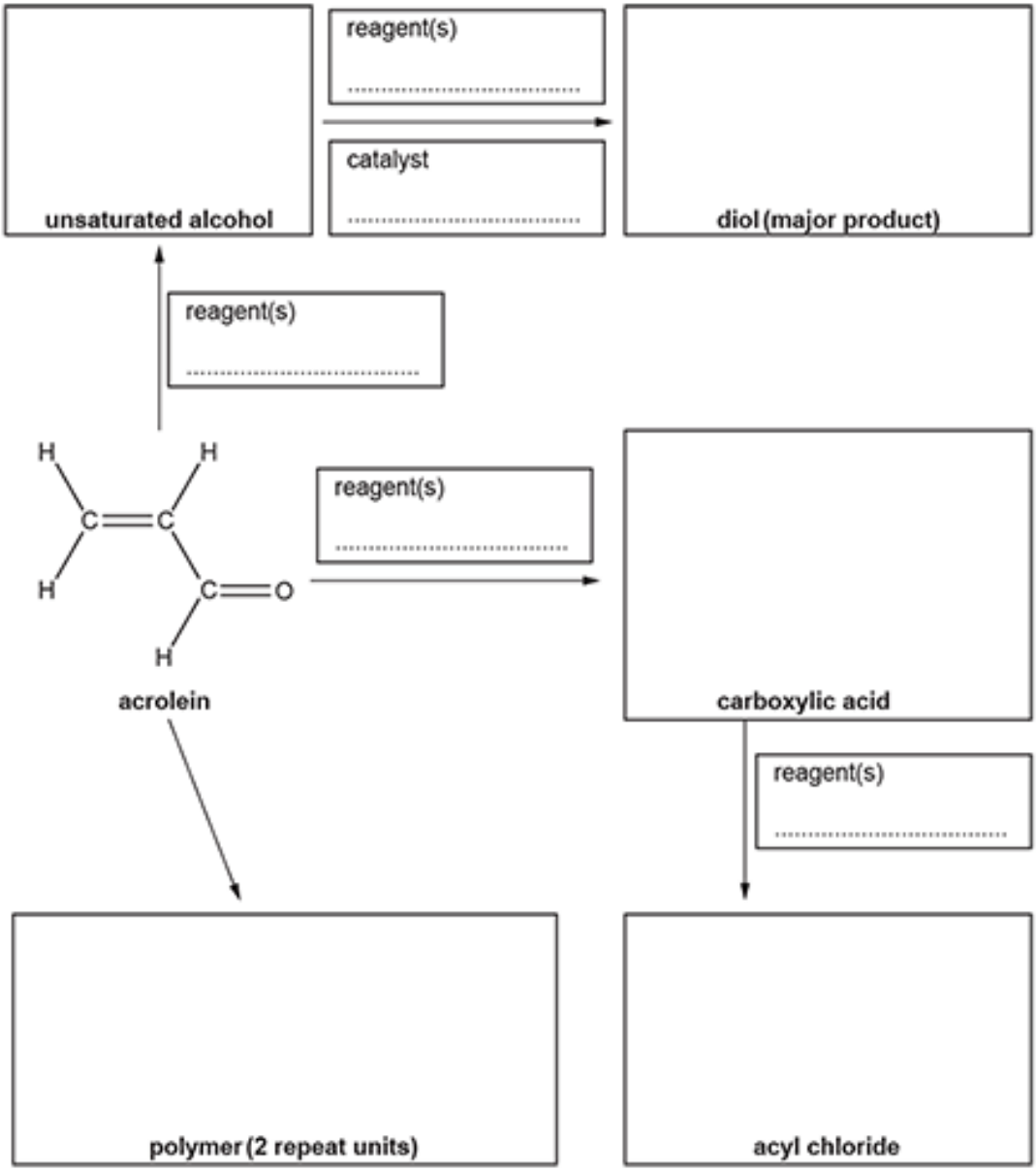
ii. A student hydrolyses compound **E** with dilute hydrochloric acid, HCl (aq).

Draw the structures of the organic products formed by this hydrolysis.

[4]

8. This question is about reactions of acrolein, $H_2C=CHCHO$.

Complete the flowchart by filling in each box.



[9]

9(a). This question is about polymers derived from carboxylic acid monomers.

i. Poly(pent-3-enoic acid) is an addition polymer.

Draw the structure of pent-3-enoic acid and **two** repeat units of this polymer.

Pent-3-enoic acid	
Two repeat units of poly(pent-3-enoic acid)	

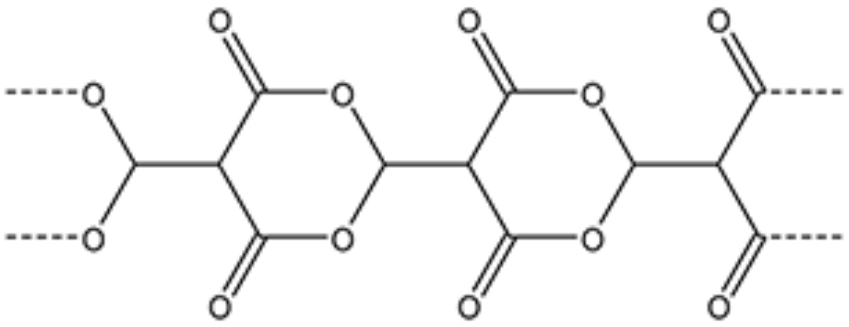
[2]

ii. Butanedicarboxylic acid and 1,4-dihydroxy-2-methylbenzene react to form a condensation polymer.

Draw **one** repeat unit of this condensation polymer.

[2]

iii. Three repeat units of a condensation polymer are shown below.



Draw the structure of the monomer required to form this polymer.

[1]

(b). This question is about compounds that contain the carboxylic acid functional group.

A polymer is formed from 400 molecules of 2-aminopropanoic acid.

i. Draw **one** repeat unit of this polymer.

[1]

ii. What is the relative molecular mass, M_r, of the polymer?

M_r = ... **[2]**

10. Butyl propanoate is hydrolysed by aqueous sodium hydroxide.

Which compound is one of the products of this hydrolysis?

A C_3H_7ONa
B $C_3H_5O_2Na$
C C_4H_9ONa
D $C_4H_7O_2Na$

Your answer ☐ **[1]**

END OF QUESTION PAPER