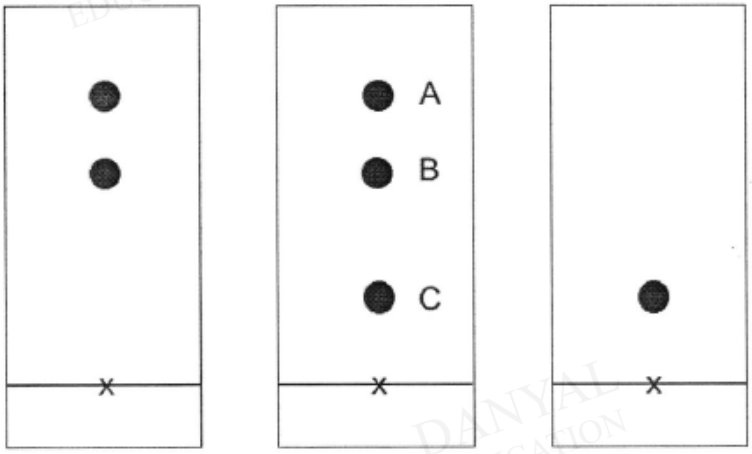
O Level Pure Chemistry Structured

Separation Techniques Test 1.0

Q1

The conversion of the alcohol and carboxylic acid into this ester can be monitored using paper chromatography.

A small sample of the reacting mixture was extracted at three separate time intervals and run through the chromatography process. The three chromatograms below show the mixture before the reaction (t = 0 hours), during the reaction (t = 1 hour) and after a long period of time (t = 5 hours).



(i) Suggest the identities of the three dots **A**, **B** and **C** on the chromatogram at t = 1 hour, and explain why there are three dots on the chromatogram at this time, compared to t = 0 hours and t = 5 hours.

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.....

.....

.....[2]

(ii) Make a conclusion about dot **C** based on the results shown in the chromatogram.

.....

.....[1]

Q2

B8 Aspirin is a medicine that is used as a painkiller. It is made from salicylic acid.

(a) A student makes a sample of aspirin. He thinks it contains some impurities.

(i) The student tests the melting point of his sample of aspirin.

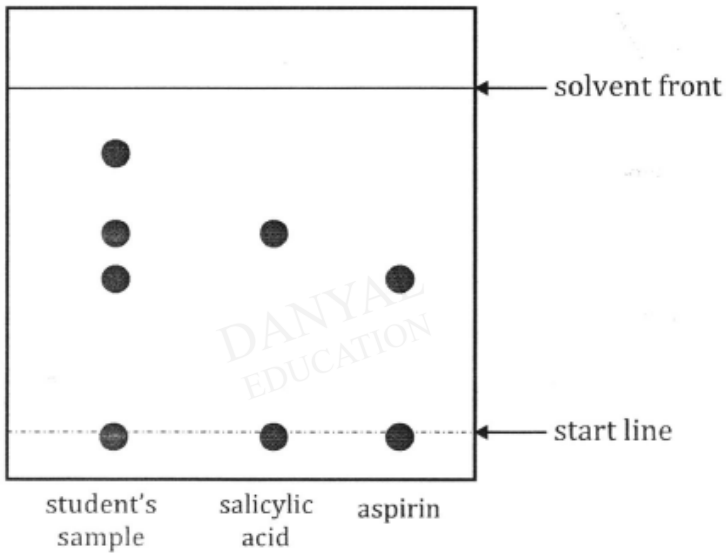
Explain how he can use the result of the test to find out whether his sample contains impurities.

.....

.....

[2]

(ii) The student uses chromatography to produce a chromatogram.
He uses his own aspirin and pure samples of aspirin and salicylic acid.
The diagram shows his chromatogram.



Is the student's sample of aspirin pure? Explain your answer.

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.....

.....

[2]

(iii) In another chromatography using pure samples of aspirin and salicylic acid, the solvent was allowed to travel 9 cm from the start line.

Table 8.1

Substance	aspirin	salicylic acid
R_f values	0.56	0.654

Using the R_f values provided in Table 8.1, calculate the distance travelled by aspirin.

[1]

Q3

A mixture consists of two miscible liquids, methylbenzene (boiling point 111 °C) and cyclohexane (boiling point 81 °C). The mixture is separated using fractional distillation as shown in Fig. 3.1.

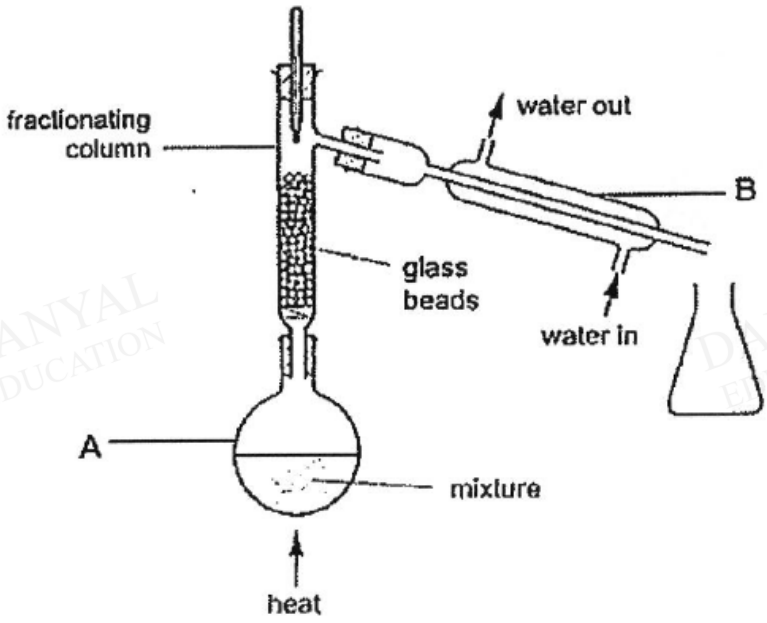


Fig. 3.1

(a) Name the processes involving the change of state that occur in the pieces of apparatus labelled **A** and **B** when the mixture is being separated.

A: ..... B: ..... [2]

(b) The following statements attempt to describe the distillation process. Place a tick (✓) in the correct box to indicate if the statement is true or false.

		true	false
(i)	At 81 °C, there is no vapour of methylbenzene present in the fractionating column.		
(ii)	At 81 °C, only the vapour of cyclohexane enters the condenser.		
(iii)	When the first few drops of liquid are collected, the thermometer reading stays constant at 81 °C.		

[2]

(c) There is at least one false statement in part **(b)**. Choose one false statement and explain why the statement is false.

Choice of false statement: .....

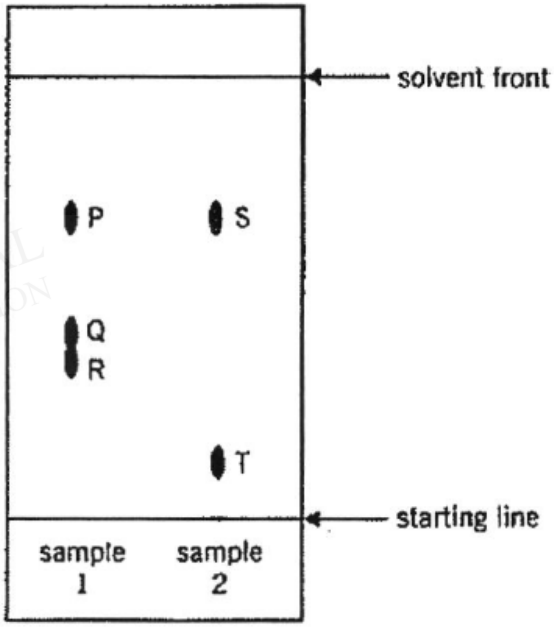
Explanation: .....

.....

.....[2]

Q4

Amino acids are simple organic compounds formed when proteins are digested. Two samples are analysed for the presence of amino acids using paper chromatography. After a locating agent is sprayed on the chromatogram, the following results are obtained.



(a) Suggest how the amino acids **Q** and **R** can be better separated on this chromatogram.

.....[1]

The table below shows the R_f values of five common amino acids using the same solvent.

amino acid	R_f value
arginine	0.21
threonine	0.35
cysteine	0.42
methionine	0.54
phenylalanine	0.67

(b) Using data from the table, compare and contrast the chromatography results of sample 1 and sample 2.

.....

.....

.....[4]

(e) Suggest why a locating agent is used.

.....[1]

Q5

Esters such as propyl butanoate are often used to manufacture perfumes.

A bottle of propyl butanoate was opened in a room. Some of the propyl butanoate evaporates and diffuses into the room.

(a) Suggest another use for esters such as propyl butanoate.

(b) What is meant by the term '*diffusion*'?

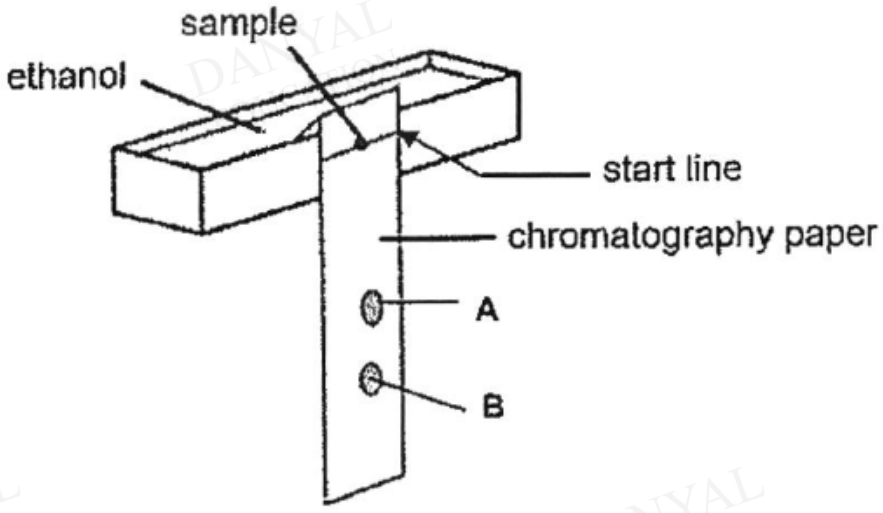
(c) The bottle of propyl butanoate is moved into a colder room.

Explain, in terms of kinetic particle theory, why this results in a decrease in the rate of diffusion.

(d) A bottle of perfume contains a mixture of colourless esters A and B.

A student used the descending method of paper chromatography to separate the esters A and B. It is known that ester B is more soluble than ester A in ethanol.

(i)



(ii) Explain how can the student make the spots visible.

(iii) Suggest how can the student determine the identity of the esters A and B.

(iv) Explain why does the R_f values of esters A and B change when ethanol is replaced by water as the solvent.

Answers

Separation Techniques Test 1.0

Q1

(i)	At t = 3h, the reaction is not yet complete, [1] so **A** and **B** represent the alcohol and carboxylic acid reactants, while the **C** represents the ester product. [1]	**[2]**
(ii)	Dot C has a larger mass / is heavier / less soluble in the solvent compared to dots A and B / Dot C is pure / has the lowest Rf value	**[1]**

Q2

(a) (i) If his sample is pure, the melting point should be a fixed temperature. [1]
If his sample is not pure, the aspirin should melt over a range of temperatures. [1]
or
Look up the melting point of aspirin. [1]
If the melting points are the same, the sample is pure. / Impure aspirin would have a different (lower) melting point. [1] [2]

(ii) Sample is not pure. (no mark)
Sample contains **two** impurities. [1]
The impurities are salicylic acid and an unidentified/unknown substance. [1]

(iii) $0.56 \times 9 =$ **5.04 cm** [1]

Q3

(a)	A: boiling / evaporation [1] B: condensation [1]	
(b)	**(i)** **(ii)** **(iii)**	false true true *For (b)(i) to (b)(iii):* *3 correct answers – [2]* *1-2 correct answers – [1]*
(c)	Choice of false statement: (i) At 81 °C, <u>both liquids are able to vapourise</u> [1 mk pt] and enter the fractionating column as <u>evaporation occurs at all temperatures</u>. [1 mk pt] There is however, a <u>greater amount of cyclohexane vapour</u> [1 mk pt] compared to methylbenzene vapour. *3 mk pts – [2]* *1-2 mk pts – [1]*	

Q4

(a)	Let the chromatography run for a longer period of time // Use a different solvent [1]
(b)	Both samples contain phenylalanine (spot P and S). [1] Only sample 1 contains threonine (spot Q) [1] and cysteine (spot R). [1] Sample 2 contains an unknown substance (spot T). [1]
(c)	Amino acids are colourless // not visible on the chromatogram. [1]

Q5

(a) Suggest another use for esters such as propyl butanoate.

They can be used as **organic solvents** / used to **manufacture food flavourings**. [1]

(b) What is meant by the term '*diffusion*'?

It is the random **movement of particles from a region of higher concentration to a region of lower concentration** until a dynamic equilibrium is achieved. [1]

(c) The bottle of propyl butanoate is moved into a colder room.

Explain, in terms of kinetic particle theory, why this results in a decrease in the rate of diffusion.

As the temperature decreases, the gas **particles lose kinetic energy**. [1]
They **move slower** and therefore the rate of diffusion decreases. [1]

(ii) Explain how can the student make the spots visible.

A **locating agent can be applied / sprayed** onto the chromatogram. [1]

(iii) Suggest how can the student determine the identity of the esters A and B.

Compare the R_f values with known esters / **compare length of distance travelled** of the spots with **known esters** that are on the same chromatogram. [1]

(iv) Explain why does the R_f values of esters A and B change when ethanol is replaced by water as the solvent.

The **solubility of esters A and B is different in water** as compared to ethanol. [1]