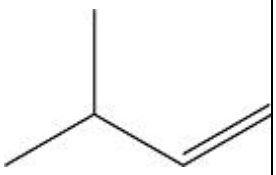
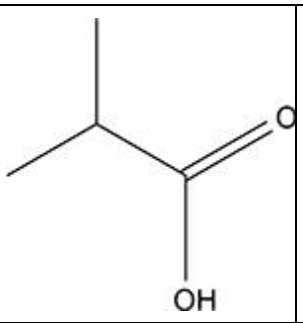
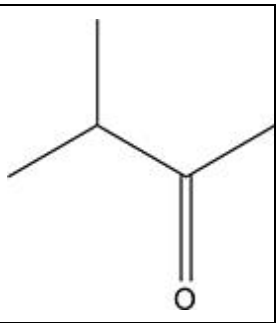
Q1.

This question is about the analysis of organic compounds.

(a) The table below shows the results of chemical tests on three organic compounds.

Complete the empty boxes in the table.

Chemical test			
Add bromine water	orange to colourless		no visible change
	no visible change	bubbles of gas	no visible change
Warm with Fehling's solution	no visible change	no visible change	

(3)

(b) 0.500 g of a hydrocarbon is analysed.
The hydrocarbon contains 0.450 g of carbon.

Calculate the empirical formula of this hydrocarbon.

Empirical formula _____

(3)

(Total 6 marks)

Q2.

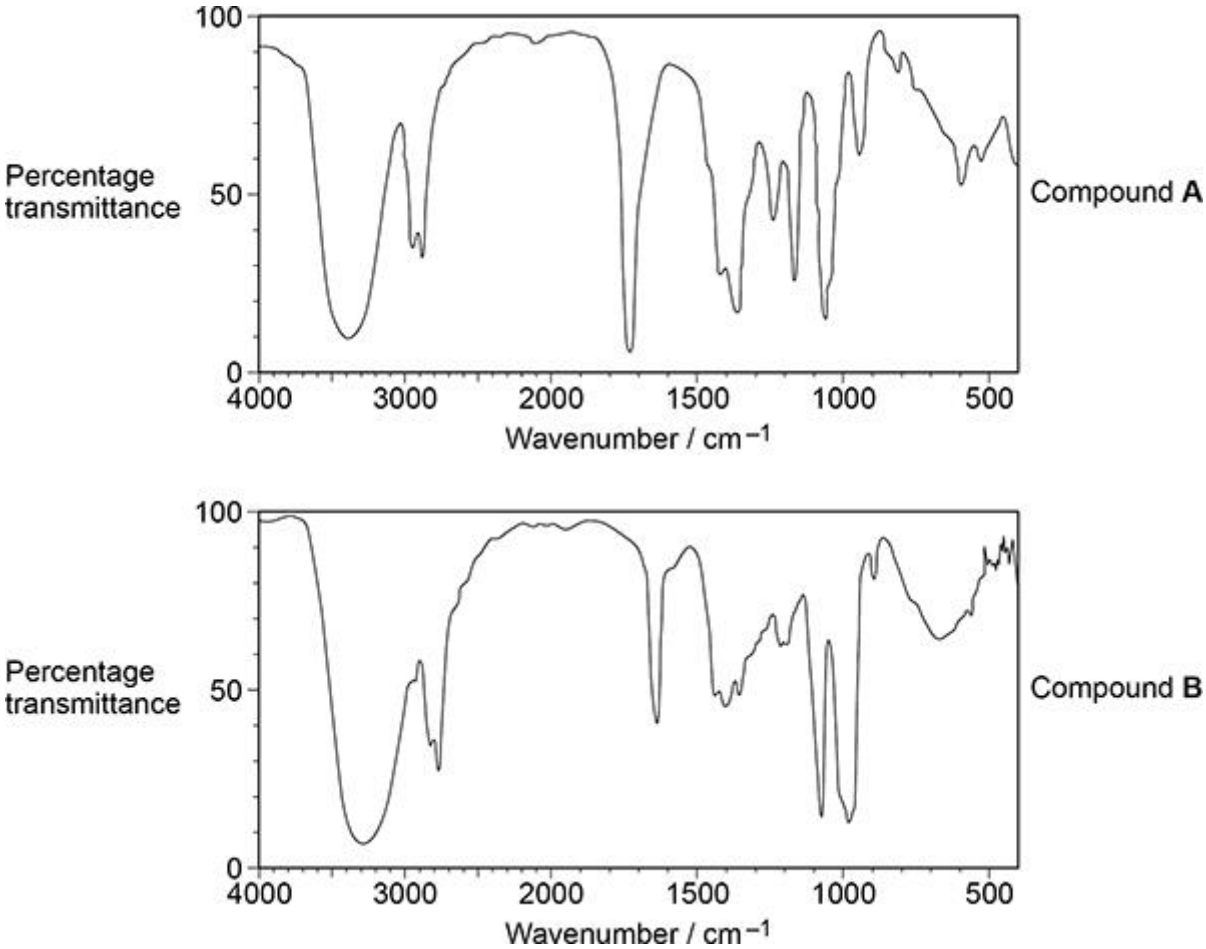
This question is about infrared spectroscopy.

(a) Compounds **A** and **B** both have the molecular formula $C_4H_8O_2$

Figure 1 shows the infrared spectra of compounds **A** and **B**.

Use the infrared spectra to deduce a possible structural formula for compound **A** and a possible structural formula for compound **B**.

Figure 1



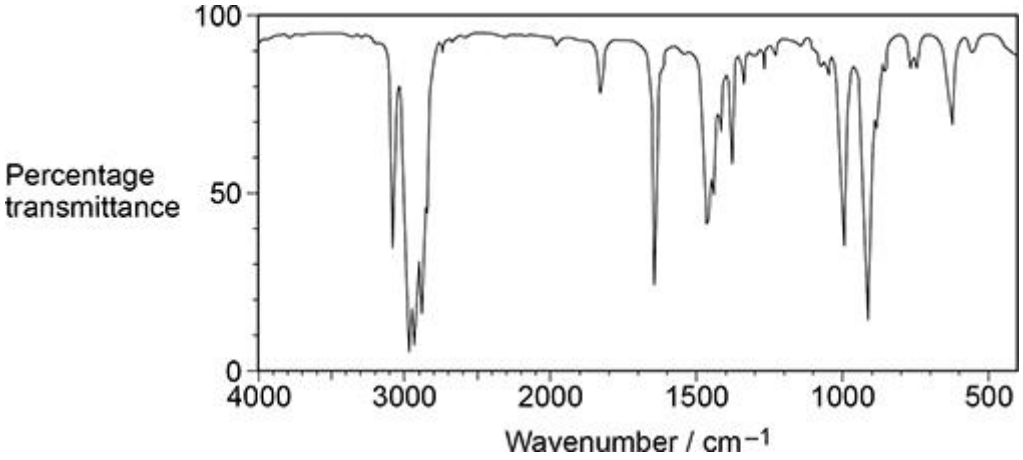
Possible structural formula of **A**

Possible structural formula of **B**

(2)

(b) **Figure 2** shows the infrared spectrum of either pent-1-ene or 2-methylbut-2-ene.

Figure 2



Outline how to use the infrared spectrum to determine whether the compound is pent-1-ene or 2-methylbut-2-ene.

_____

_____

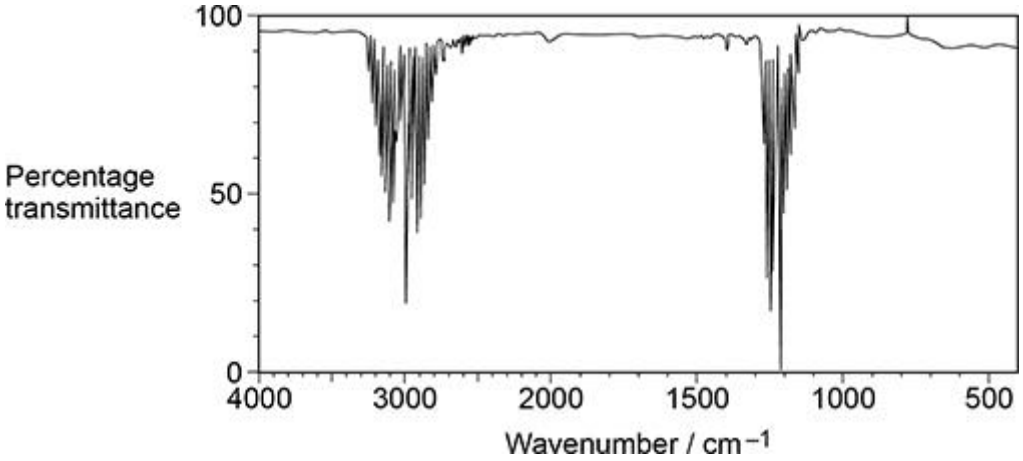
_____

_____

(2)

(c) **Figure 3** shows the infrared spectrum of methane.

Figure 3



Use information from **Figure 3** to explain why methane acts as a greenhouse gas.

_____

_____

_____

_____

(1)

(Total 5 marks)

Q3.

This question is about simple test-tube reactions to identify organic liquids.

(a) Silver nitrate solution can be used to distinguish between propanoyl chloride and 1-chloropropane.

Give the observations you would expect when a few drops of silver nitrate solution are added to separate samples of propanoyl chloride and 1-chloropropane.

Observation with propanoyl chloride _____

_____

Observation with 1-chloropropane _____

_____

(2)

(b) Three unlabelled bottles are known to contain either propan-1-ol, propanal, or propanone.

A sample of each liquid is warmed with a few drops of Fehling's solution.

Identify the liquid that reacts with Fehling's solution and give the expected observation.

Suggest a further simple test-tube reaction that can be used to distinguish between the remaining two liquids.

Give the expected observation with the liquid that reacts.

Liquid that reacts with Fehling's solution _____

Observation _____

_____

Further test _____

_____

Observation _____

_____

(3)

(Total 5 marks)

Q4.

This question is about the analysis of organic compounds.

For each pair of compounds in parts (a) and (b), give a reagent (or combination of reagents) that could be added separately to each compound in a single reaction to distinguish between them.

State what is observed in each case.

(a) $CH_3CH_2CH_2CHO$ and $CH_3CH_2CH(OH)CH_3$

Reagent(s) _____

Observation with $CH_3CH_2CH_2CHO$ _____

_____

Observation with $CH_3CH_2CH(OH)CH_3$ _____

_____

(3)

(b) Cyclohexane and cyclohexene

Reagent(s) _____

Observation with cyclohexane _____

_____

Observation with cyclohexene _____

_____

(3)

(c) The table below gives the precise relative molecular masses (M_r) of some organic compounds measured using high resolution mass spectrometry.

Molecular formula	C_5H_{12}	C_5H_{10}	C_6H_6
M_r	72.1416	70.1260	to be calculated

Use these data to find the relative atomic masses (A_r) of hydrogen and carbon. Give your answers to 4 decimal places.

Use these calculated A_r values to find the relative molecular mass (M_r) of C_6H_6 Give your answer to 4 decimal places.

A_r of hydrogen _____

A_r of carbon _____

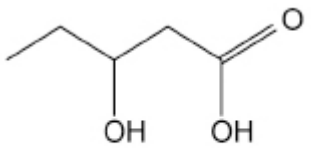
M_r of C_6H_6 _____

(3)

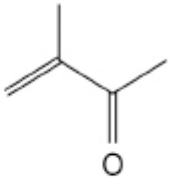
(Total 9 marks)

Q5.

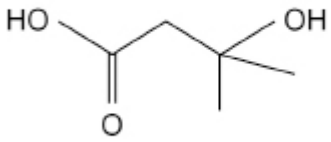
A student plans a series of chemical tests to confirm the identities of four organic liquids.



Liquid **J**



Liquid **K**



Liquid **L**

Liquid **M**

This is the student's method.

To separate test tubes containing samples of each liquid:

Test 1 add potassium dichromate(VI) solution and warm gently

Test 2 add Fehling's solution and cool in iced water

Test 3 add sodium hydrogencarbonate solution and test any gas produced with a lighted splint

Test 4 add bromine water and shake at room temperature.

(a) Identify the missing reagent needed in **Test 1**.

_____

(1)

(b) In addition to the missing reagent in **Test 1**, there is a mistake in the method for **two** of the other tests.

State the **two** mistakes.

Suggest how each of the mistakes should be corrected.

Mistake 1 _____

Suggestion _____

_____

Mistake 2 _____

Suggestion _____

_____

(2)

(c) The missing reagent is added and the mistakes are corrected.

Identify the liquid(s), **J**, **K**, **L** and **M**, that would react in each test.

State the expected observation for each reaction.

Liquid(s) that react in **Test 1** _____

Expected observation _____

_____

Liquid(s) that react in **Test 2** _____

Expected observation _____

_____

Liquid(s) that react in **Test 3** _____

Expected observation _____

_____

Liquid(s) that react in **Test 4** _____

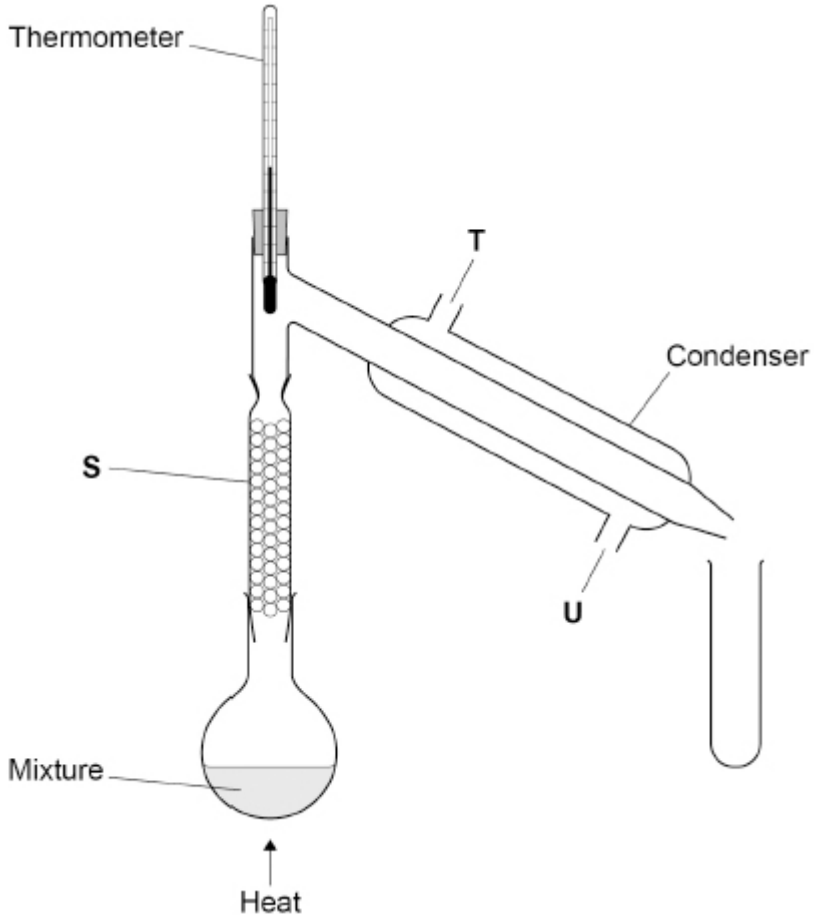
Expected observation _____

(8)

(d) The figure below shows the apparatus that is used to separate a mixture of liquids **K** and **M** using fractional distillation.

Suggest labels that should be added to positions **S**, **T** and **U** in the figure.

Explain why fractional distillation is preferred to simple distillation to separate liquids **K** and **M**.



Label **S** _____

Label **T** _____

Label **U** _____

Explanation _____

_____

(3)

(Total 14 marks)

Q6.

A student has samples of these four compounds but does not know which is which:

- butanoic acid
- 2-methylpropanal
- 2-methylpropanoic acid
- 2-methylpropan-1-ol

Step 1: Two of these compounds can be identified by simple chemical tests.

Step 2: The other two compounds, that contain the same functional group as each other, can then be distinguished using a spectroscopic technique.

Describe how these two steps could be used to identify which compound is which.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(Total 6 marks)