1. Experiments were carried out on a sample of hydrated calcium nitrate crystals, $Ca(NO_3)_2.2H_2O$

(a) Describe how to carry out a flame test to show which cation is present in the sample.

Give the expected result of the test. (4)

(b) The calcium nitrate crystals were heated gently in a test tube. Fumes which looked like steam were given off.

Give the **name** of a substance that could be used to test for the presence of steam in the fumes. Describe the expected colour change for this test. (2)

(c) On further heating of the sample, a mixture of two gases was evolved. One of the gases was coloured, the other was colourless.

(i) Identify the coloured gas and give its colour. (2)

(ii) Identify the colourless gas. Give a test for the gas and its result. (2)

(d) A white solid remained after complete decomposition.

Complete the equation for this decomposition of the hydrated crystals. State symbols are not required. (2)

$Ca(NO_3)_2.2H_2O$ -->

(e) The white solid which remained in the test tube was allowed to cool to room temperature. Distilled water was added to it, and a solution formed.

(i) Give the **name** of the solution which forms when distilled water is added to the white solid. (1)

(ii) This solution is used in a common laboratory test for a gas. Identify this gas. (1)

(Total: 14 marks)

2. (a) A gaseous hydrocarbon **X** reacted with bromine to give a colourless product. At room temperature and pressure, 6.00 g of **X** occupied a volume of 5.14 dm^3.

Under these conditions, 1 mol of gas occupies 24.0 dm^3.
Show how all these pieces of information are used to identify **X**, and give its **displayed** formula. (3)

(b) A compound **Y** was prepared by reacting **X** with potassium manganate(VII) under suitable conditions. **Y** is a liquid at room temperature, and it is alcohol with two carbons.

(i) Describe a **chemical** test for hydrogen chloride, other than by using an indicator, and give the result of the test. (2)

(ii) Identify the **Y** by name and draw its displayed formulae (2)

(iii) What is the name and the structural formula of the organic product when Y reacts with ethanoic acid. (2)

(iv) Describe a **chemical** test to identify the organic molecule in (iii). (2)

(Total: 11 marks)

3. The inorganic compounds **A** and **B** contain the same Group 2 cation but different anions.

(a) Two tests were carried out on **A**. The observations made for each test are recorded in the table.

(i) Complete the statements in the inference column in the table by writing the names or formulae of the ions. (3)

Test	Observation	Inference
Dilute sulfuric acid was added to an aqueous solution of **A**	A white precipitate formed	Two possible **cations** in **A** are ....
A sample of **A** was heated in a test tube A glowing splint was held in the mouth of the test tube	A brown gas was evolved The splint relit	The **anion** in **A** is .....

(ii) There were two gases evolved when **A** was heated; a brown gas **C**, and a gas **D** which relit the glowing splint.

Identify the gases **C** and **D** by giving their name or formula. (2)

(iii) Name a test that could be used to distinguish between the two cations identified in (a)(i).

Include the expected result of the test for **both** cations. (3)

(b) A test was carried out on **B**. The observations made for the test are recorded in the table.

(i) Complete the statement in the inference column in the table by writing the **formula** of the anion.

Test	Observation	Inference
Concentrated sulfuric acid was added to a sample of solid **B** in a test tube	An orange-brown gas **E** was evolved	The **formula** of the anion in **B** is .....

(ii) Identify the orange-brown gas **E** by giving its name or formula. (1)

(iii) Two colourless acidic gases were also evolved in the test in (b)(i).

These gases were dissolved in water.
Aqueous silver nitrate and dilute nitric acid were added to the solution and a cream precipitate formed.

Give the name or formula of the gas identified by this method. (1)

(iv) Suggest the identity of the other acidic gas by giving its name or formula. (1)

(Total: 12 marks)

4. This question is about the preparation of crystals of hydrated sodium sulfate.
(a) You are provided with the following apparatus and materials to prepare a solution of sodium sulfate from sulfuric acid and aqueous sodium hydroxide:

- a burette, ready to use, filled with dilute sulfuric acid to the 0.00 cm^3 line
- an aqueous solution of sodium hydroxide
- methyl orange indicator
- access to other laboratory volumetric apparatus.

(i) Write the equation for the reaction when acid and alkali reacts to form the salt. Include state symbols. (2)

(ii) A preliminary (rough) titration shows that about 18 cm^3 of sulfuric acid is required to react with 25.0 cm^3 of the aqueous sodium hydroxide.

Describe how you would carry out a second titration to find the accurate volume of sulfuric acid that reacts with 25.0 cm^3 of the aqueous sodium hydroxide.

In your answer, you should include the colour change of the indicator at the end-point. (5)

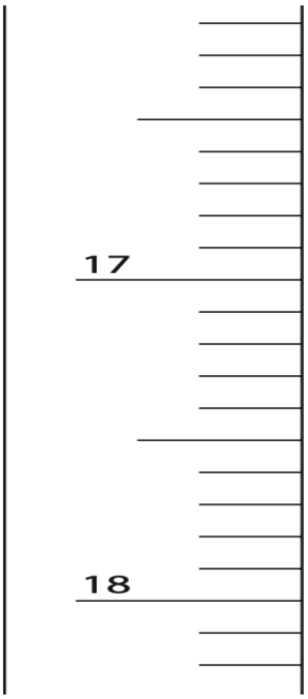
(iii) The results of three further titrations are shown in the table.

Titration number	Rough	1	2	3
Final burette reading / cm^3	18.2	17.90	35.55	17.65
Initial burette reading / cm^3	0.00	0.00	18.00	0.00
Titre / cm^3	18.2	17.90	17.55	17.65
Used in mean (✓)				

Calculate the mean titre.

Show which titres you have used in your calculation by putting a tick (✓) in the appropriate boxes in the table. (1)

(iv) On the diagram of part of a burette, show the level of dilute sulfuric acid when the final burette reading is recorded in **Titration 3**. (2)



(b) Using results from the table, briefly describe how to obtain a sample of pure crystals of hydrated sodium sulfate. (2)

(Total: 12 marks)

END OF TEST

5.