

3 Half-fill the 250 cm<sup>3</sup> beaker with water and place it on a tripod and gauze. Heat the water until boiling then switch off your Bunsen burner. This will be your hot water bath for use in (b)(i). Start (a)(i) while the water is heating.

(a) **FA 4** is an aqueous solution containing three ions. One ion is **not** listed in the Qualitative analysis notes. **FA 5** is an aqueous solution containing two ions. The cation in **FA 5** is listed in the Qualitative analysis notes. The anions in both **FA 4** and **FA 5** contain sulfur.

(i) Carry out the following tests using a 1 cm depth of either **FA 4** or **FA 5** in a test-tube. Record your observations in Table 3.1.

**Table 3.1**

test	observations	
	FA 4	FA 5
<b>Test 1</b> Add aqueous sodium hydroxide.		
<b>Test 2</b> Add aqueous ammonia.		
<b>Test 3</b> Add aqueous sodium carbonate.		
<b>Test 4</b> Add aqueous barium chloride or aqueous barium nitrate.		
<b>Test 5</b> Add acidified aqueous potassium manganate(VII).		

[5]

(ii) From your observations in (a)(i), deduce the identities of the ions present in **FA 4** and **FA 5**. Give the formula of each ion in Table 3.2. If you are unable to identify an ion write 'unknown'.

**Table 3.2**

ions present	FA 4	FA 5
cations		
anions		

[3]

(b) (i) Both **FA 6** and **FA 7** are one of propan-1-ol, propan-2-ol, methanoic acid or ethanoic acid. You will carry out tests to investigate the identities of **FA 6** and **FA 7**. For each test use a 1 cm depth of **FA 6** or **FA 7** in a test-tube. Record your observations in Table 3.3.

**Table 3.3**

test	observations	
	FA 6	FA 7
<b>Test 1</b> Add a few drops of acidified aqueous potassium manganate(VII), then place the test-tube in the hot water bath.		
<b>Test 2</b> Add a 2 cm depth of aqueous iodine followed by drops of aqueous sodium hydroxide until the colour just disappears. If no reaction is visible, place the test-tube in the hot water bath.		
<b>Test 3</b> Add aqueous sodium carbonate.		

[3]

(ii) From your observations in (b)(i) deduce the identities of **FA 6** and **FA 7**. Give reasons for your answers.

**FA 6** is .....

reasons .....

.....

**FA 7** is .....

reasons .....

.....

[2]

(c) A student carrying out a similar set of tests identifies two unknown compounds to be ethanol and propanoic acid.

Write an equation for the reaction between these two compounds.

..... [1]

[Total: 14]

## Qualitative analysis notes

### 1 Reactions of cations

cation	reaction with	
	NaOH(aq)	NH <sub>3</sub> (aq)
aluminium, Al <sup>3+</sup> (aq)	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, NH <sub>4</sub> <sup>+</sup> (aq)	no ppt. ammonia produced on warming	–
barium, Ba <sup>2+</sup> (aq)	faint white ppt. is observed unless [Ba <sup>2+</sup> (aq)] is very low	no ppt.
calcium, Ca <sup>2+</sup> (aq)	white ppt. unless [Ca <sup>2+</sup> (aq)] is very low	no ppt.
chromium(III), Cr <sup>3+</sup> (aq)	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), Cu <sup>2+</sup> (aq)	pale blue ppt. insoluble in excess	pale blue ppt. soluble in excess giving dark blue solution
iron(II), Fe <sup>2+</sup> (aq)	green ppt. turning brown on contact with air insoluble in excess	green ppt. turning brown on contact with air insoluble in excess
iron(III), Fe <sup>3+</sup> (aq)	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
magnesium, Mg <sup>2+</sup> (aq)	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), Mn <sup>2+</sup> (aq)	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess
zinc, Zn <sup>2+</sup> (aq)	white ppt. soluble in excess	white ppt. soluble in excess

### 2 Reactions of anions

anion	reaction
carbonate, CO <sub>3</sub> <sup>2-</sup>	CO <sub>2</sub> liberated by dilute acids
chloride, Cl <sup>-</sup> (aq)	gives white ppt. with Ag <sup>+</sup> (aq) (soluble in NH <sub>3</sub> (aq))
bromide, Br <sup>-</sup> (aq)	gives cream/off-white ppt. with Ag <sup>+</sup> (aq) (partially soluble in NH <sub>3</sub> (aq))
iodide, I <sup>-</sup> (aq)	gives pale yellow ppt. with Ag <sup>+</sup> (aq) (insoluble in NH <sub>3</sub> (aq))
nitrate, NO <sub>3</sub> <sup>-</sup> (aq)	NH <sub>3</sub> liberated on heating with OH <sup>-</sup> (aq) and Al foil
nitrite, NO <sub>2</sub> <sup>-</sup> (aq)	NH <sub>3</sub> liberated on heating with OH <sup>-</sup> (aq) and Al foil; decolourises acidified aqueous KMnO <sub>4</sub>
sulfate, SO <sub>4</sub> <sup>2-</sup> (aq)	gives white ppt. with Ba <sup>2+</sup> (aq) (insoluble in excess dilute strong acids); gives white ppt. with high [Ca <sup>2+</sup> (aq)]
sulfite, SO <sub>3</sub> <sup>2-</sup> (aq)	gives white ppt. with Ba <sup>2+</sup> (aq) (soluble in excess dilute strong acids); decolourises acidified aqueous KMnO <sub>4</sub>
thiosulfate, S <sub>2</sub> O <sub>3</sub> <sup>2-</sup> (aq)	gives off-white/pale yellow ppt. slowly with H <sup>+</sup>

### 3 Tests for gases

gas	test and test result
ammonia, NH <sub>3</sub>	turns damp red litmus paper blue
carbon dioxide, CO <sub>2</sub>	gives a white ppt. with limewater
hydrogen, H <sub>2</sub>	'pops' with a lighted splint
oxygen, O <sub>2</sub>	relights a glowing splint