**M1.**(a) water level above the start line

**and**

start line drawn in ink

*allow water level too high*

**1**

*water level*

food colours would dissolve into water

**or**

*start line*

the ink would 'run' on the paper

**1**

(b) (distance moved by **A**) 2.8cm **and** 8.2 cm (distance moved by solvent)

*allow values in range 2.7 – 2.9 cm and 8.1 – 8.3 cm*

**1**

$\frac{2.8}{8.2}$

**1**

0.34

*allow 0.33 or 0.35*

*allow ecf from incorrect measurement to final answer for **2** marks if given to 2 significant figures*

*accept 0.34 without working shown for **3** marks*

**1**

(c) 6.6 cm

*allow values between 6.48 and 6.64 cm*

**1**

(d) solvent moves through paper

**1**

different dyes have different solubilities in solvent

**1**

and different attractions for the paper

**1**

and so are carried different distances

**1**

(e) calcium ions

*allow $Ca^{2+}$*

**1**

sodium ions

*allow $Na^{+}$*

**1**

(f) two different colours

**or**

$Ca^{2+}$ / one is orange-red and $Na^{+}$ / the other is yellow

*allow brick red for $Ca^{2+}$ and / or orange for $Na^{+}$*

*allow incorrect colours if consistent with answer to **7.5***

**1**

(so) colours mix

**or**

(so) one colour masks the other

**1**

(g) (Student **A** was incorrect)

because sodium compounds are white not green

**or**

because sodium carbonate is soluble

**1**

so can't contain sodium ions

**1**

(Student **B** was incorrect)

because adding acid to carbonate produces carbon dioxide

**1**

so must contain carbonate not chloride ions

**1**

**[18]**

**M2.** (a) limewater **or** calcium hydroxide solution

**1**

(reacts with carbon dioxide and) turns cloudy / milky

*linked to first point*

*if no other mark awarded 'puts out lighted splint' gains **1** mark*

**1**

(b) (i) any **two** from:

- same volume / amount of the acids
- concentration of the acids
- temperature
- same surface area / size / mass / amount of calcium carbonate
- same measuring equipment

**2**

(ii) any **three** from:

- (after about 4 minutes) the sulfuric acid stops reacting **or** nitric acid continues to react

  *accept more $CO_2$ with nitric acid at any time after 4 minutes*
- (initially) the reaction with sulfuric acid is faster
- (the reaction stops) because calcium sulfate is a solid

  *allow sulfuric acid produces a solid*
- (the reaction continues) because calcium nitrate is soluble / in solution / aqueous

  *allow nitric acid produces an (aqueous) solution*
- because the calcium sulfate prevents the sulfuric acid reacting with the calcium carbonate
- (the rate is faster) because sulfuric acid contains two hydrogens

**3**

**[7]**

**M3.** (a) (i) (bubble gas produced through) limewater

*incorrect tests = zero*

**1**

(limewater) goes cloudy / milky

**1**

(ii) *ignore yes or no*

red flame indicates that calcium / lithium ions present

*allow aluminium has no flame colour*

**or**

Ca/Mg also produce a (white) precipitate with NaOH

**1**

the (white) precipitate formed in test 3 **or** by adding sodium hydroxide solution would dissolve (in excess) if aluminium ions were present

**1**

(iii) *ignore yes or no*

because a white precipitate is formed in test 4 **or** by adding silver nitrate

**1**

but chloride ions are in hydrochloric acid

**1**

(b) (i) mass spectrometry

*allow MS*

**or**

atomic absorption spectroscopy

*allow AAS*

*spectrometry / spectroscopy alone is insufficient*

**1**

(ii) can detect a small(er) amount of the substance

*allow can detect small(er) changes*

*allow small(er) sample sizes*

*ignore references to precision / accuracy*

**1**

**[8]**

**M4.** (a) (i) test: limewater

*accept calcium hydroxide solution*

**1**

result: 'goes' cloudy

*accept white **or** milky*

*do **not** accept misty **or** chalky test must be correct before result mark can be considered*

**1**

(ii) $2\ NaHCO_3 + H_2SO_4 \rightarrow$

$Na_2SO_4 + (2)\ H_2O + (2)\ CO_2$

**1**

correctly balanced

**1**

(b) (i) $H^+ + OH^-$

**1**

$\rightarrow H_2O$

deduct **one** mark if incorrectly balanced

*accept $H_3O^+$ instead of $H^+$ then $2H_2O$ needed for balance*

**1**

(ii) pH increases

*accept numerical indication*

**1**

(c) addition of sulphuric acid

**1**

correct use of an indicator

*accept idea of forming a neutral solution*

**1**

crystallisation (of neutral solution)

*accept description using evaporation*

**1**

**[10]**