M1.(a)   (sulfuric acid is) completely / fully ionised

1

In aqueous solution **or** when dissolved in water

1

(b) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

allow multiples

1 *mark for equation*

1 *mark for state symbols*

2

(c)   adds indicator, eg phenolpthalein / methyl orange / litmus added to the sodium hydroxide
(in the conical flask)

*do **not** accept universal indicator*

1

(adds the acid from a) burette

1

with swirling **or** dropwise towards the end point **or** until the indicator just changes colour

1

until the indicator changes from pink to colourless (for phenolphthalein) or yellow to red
(for methyl orange) or blue to red (for litmus)

1

(d)   titrations 3, 4 and 5
        or

$$\frac{27.05 + 27.15 + 27.15}{3}$$

1

27.12 cm^3

*accept 27.12 with no working shown for **2** marks*

1

*allow 27.1166 with no working shown for **2** marks*

(e)   Moles H$_2$SO$_4$ = conc × vol = 0.00271

allow ecf from 8.4

1

Ratio H$_2$SO$_4$:NaOH is 1:2
or
Moles NaOH = Moles H$_2$SO$_4$ × 2 = 0.00542

1

Concentration NaOH = mol / vol = 0.00542 / 0.025 = 0.2168

1

0.217 (mol / dm^3)

*accept 0.217 with no working for **4** marks*

1

*accept 0.2168 with no working for **3** marks*

(f) $\frac{20}{1000}$ ×   0.18 = no of moles

or

0.15 × 40 g

1

0.144 (g)

1

*accept 0.144g with no working for **2** marks*

[16]

M2.(a)   31

1

(b)   (i)   any **two** from:
- incorrect reading of thermometer / temperature
- incorrect measurement of volume of acid
- incorrect measurement of volume of alkali (burette).

2

(ii)   glass is a (heat) conductor **or** polystyrene is a (heat) insulator

*answer needs to convey idea that heat lost using glass **or** not lost using polystyrene*

accept answers based on greater thermal capacity of glass (such as "glass absorbs more heat than polystyrene")

1

(c)   (i)   temperature increases

1

(ii)   no reaction takes place **or** all acid used up **or** potassium hydroxide in excess

1

cool / colder potassium hydroxide absorbs energy **or** lowers temperature

ignore idea of heat energy being lost to surroundings

1

(iii)   take more readings

ignore just "repeat"

1

around the turning point **or** between 20 cm³ and 32 cm³

accept smaller ranges as long as no lower than 20 cm³ and no higher than 32 cm³

1

(d)   1.61 **or** 1.6(12903)

*correct answer with or without working scores **3***
*if answer incorrect, allow a maximum of **two** from:*
*moles nitric acid = (2 × 25 / 1000) = 0.05 for **1** mark*
*moles KOH = (moles nitric acid) = 0.05 for **1** mark*
concentration KOH = 0.05 / 0.031

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answer must be correctly rounded (1.62 is incorrect)

3

(e)   same amount of energy given out

1

which is used to heat a smaller total volume **or** mixture has lower thermal capacity **or**
number of moles reacting is the same
but the total volume / thermal capacity is less

*if no other marks awarded award **1** mark for idea of reacting faster*

1

[14]

M3.   (a)   Hydrogen / H⁺

ignore state symbols

ignore proton / H

1

(b)   *it = weak acid*

pH of weak acid is higher than the pH of a strong acid

allow converse for strong acids

allow correct numerical comparison

1

any **one** from:

allow converse for strong acids

• only partially dissociated (to form ions)

allow ionises less

• not as many hydrogen ions (in the solution)

allow fewer H⁺ released

1

(c)   (i)   (titration of) weak acid <u>and</u> strong base

1

(ii)   0.61

*correct answer with or without working gains **2** marks*

if the answer is incorrect:

moles of sodium hydroxide = (30.5 × 0.5)/1000 = 0.01525 moles

or

*(0.5 × 30.5/25) gains **1** mark*

2

(d)   12

*correct answer with or without working gains **2** marks or even*

with incorrect working.

if the answer is incorrect:

0.8 × 60 = 48g

or

evidence of dividing 48g (or ecf) by 4

or

$$\frac{0.8 \times 250}{1000} = \frac{0.8}{4} =$$
   0.8 × 0.25 = 0.2 mol

or

evidence of multiplying 0.2mol (or ecf) by 60

*would gain **1** mark*

2

[8]

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M4.   (a)   (i)   *incorrect test or no test = **0** mark*

          *testing the solution **or** using blue litmus = **0** mark*

      (test ammonia / gas with red) litmus

         accept any acid-base indicator with correct result

                                                            1

      (goes) blue

      OR

      (conc.) HCl (1)

      <u>white</u> fumes / smoke / solid (1)

         allow <u>white</u> gas / vapour

      OR

      (test ammonia / gas with) Universal Indicator (1)

      blue / purple (1)

                                                            1

      (ii)   *incorrect test or no test = **0** marks*

      add barium chloride / $BaCl_2$ (solution)

         *do **not** accept H_2SO_4 added*

      or add barium nitrate / $Ba(NO_3)_2$ (solution)

         allow Ba^{2+} solution / aqueous added

                                                            1

      <u>white</u> precipitate / solid (formed)

         allow white barium sulfate / $BaSO_4$

         ignore barium sulfate / $BaSO_4$ alone

                                                            1

   (b)   (i)   <u>fully</u> / <u>completely</u> ionised / dissociated

         or hydrogen ions fully <u>dissociated</u>

accept has more ions than weaker acid / alkali of <u>same concentration</u>

ignore strongly ionised

*do **not** accept ions are fully ionised*

*ignore concentrated **or** reference to concentrations of ions*

1

(ii) methyl orange

accept correct spelling only

accept any strong acid-weak base indicator

*do **not** allow phenolphthalein / litmus / universal indicator*

1

(iii) $32 \times 0.05/1000$ **or** 0.0016 (mole H_2SO_4)

*accept (0.05 x 32) = (V x 25) **or** 0.05 x 32 / 25*

1

(reacts with) 2×0.0016 **or** 0.0032 (mole NH_3 in 25 cm^3)

*accept dividing rhs by 2 **or** multiplying lhs by 2*

1

$(0.0032 \times 1000/25 =)$ 0.128

allow ecf from previous stage

*correct answer 0.128 **or** 0.13 with or without working gains all **3** marks*

1

(iv) 2.176 **or** 2.18

correct answer with or without working

or ecf from candidate's answer to (b)(iii)

or 2.55 if 0.15 moles used

if answer incorrect or no answer

*0.128 × 17 **or** 0.13 x 17*

***or** their (b)(iii) × 17*

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or 0.15 × 17 gains **1** mark

2

[11]

M5. (a) (i) sodium hydroxide / NaOH (solution)

        accept potassium hydroxide / KOH

        accept ammonia (solution) / $NH_3(aq)$ / NH_4OH

        *do **not** accept limewater / calcium hydroxide*

        incorrect reagent

        ***or** no reagent = **0** marks*

1

      (pale) <u>green</u> <u>precipitate</u> / <u>solid</u>

        allow iron(II) hydroxide / $Fe(OH)_2$ (formed)

        *allow OH^- / hydroxide solution gives a green precipitate for **1** mark*

1

    (ii) (acidified) barium chloride / $BaCl_2$ barium nitrate / $Ba(NO_3)_2$

        *do **not** accept sulphuric acid*

        incorrect reagent

        ***or** no reagent = **0** marks*

1

      <u>white</u> <u>precipitate</u> / <u>solid</u>

        allow barium sulfate / $BaSO_4$ (formed)

        *allow a solution of barium ions / Ba^{2+} gives a white precipitate for **1** mark*

1

  (b) (i)   *credit can not be obtained for incorrect reactions*

      carbonate (ions) give (white) ppt (with silver nitrate)

        owtte

1

      (nitric) acid reacts with / removes / displaces carbonate (ions)

        owtte

1

(ii)   hydrochloric acid is a chloride / contains chloride (ions) / Cl⁻

$\quad\quad$ *accept hydrochloric acid reacts with silver nitrate*

$\quad\quad$ *do **not** accept chlorine*

$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ **1**

$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ **[7]**