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_2SO_4 = conc × vol = 0.00271

allow ecf from 8.4

1

Ratio H_2SO_4:NaOH is 1:2

or

Moles NaOH = Moles H_2SO_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 cm^3 and 32 cm^3

accept smaller ranges as long as no lower than 20 cm^3 and no higher than 32 cm^3

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

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 and 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]

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)

white fumes / smoke / solid (1)
allow white 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

white precipitate / solid (formed)
allow white barium sulfate / $BaSO_4$
ignore barium sulfate / $BaSO_4$ alone

1

(b) (i) fully / completely ionised / dissociated
or hydrogen ions fully dissociated

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 × 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 × 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*

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) green precipitate / solid

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

white precipitate / solid

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^-

accept hydrochloric acid reacts with silver nitrate

*do **not** accept chlorine*

1

[7]