

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 phenolphthalein / 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

$$27.12 \text{ cm}^3$$

*accept 27.12 with no working shown for 2 marks*

1

*allow 27.1166 with no working shown for 2 marks*

(e) Moles  $\text{H}_2\text{SO}_4 = \text{conc} \times \text{vol} = 0.00271$

*allow ecf from 8.4*

1

Ratio  $\text{H}_2\text{SO}_4:\text{NaOH}$  is 1:2

**or**

$$\text{Moles NaOH} = \text{Moles H}_2\text{SO}_4 \times 2 = 0.00542$$

1

$$\text{Concentration NaOH} = \text{mol} / \text{vol} = 0.00542 / 0.025 = 0.2168$$

1

$$0.217 \text{ (mol / dm}^3\text{)}$$

*accept 0.217 with no working for 4 marks*

1

*accept 0.2168 with no working for 3 marks*

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

**or**

$$0.15 \times 40 \text{ g}$$

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<sup>3</sup> and 32 cm<sup>3</sup>

*accept smaller ranges as long as no lower than 20 cm<sup>3</sup> and no higher than 32 cm<sup>3</sup>*

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 =  $(2 \times 25 / 1000) = 0.05$  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<sup>+</sup>  
*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<sup>+</sup> 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:*

$$0.8 \times 60 = 48\text{g}$$

**or**

*evidence of dividing 48g (or ecf) by 4*

**or**

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

**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 /  $\text{BaCl}_2$  (solution)  
*do **not** accept  $\text{H}_2\text{SO}_4$  added*

**or** add barium nitrate /  $\text{Ba}(\text{NO}_3)_2$  (solution)  
*allow  $\text{Ba}^{2+}$  solution / aqueous added*

1

white precipitate / solid (formed)  
*allow white barium sulfate /  $\text{BaSO}_4$*   
*ignore barium sulfate /  $\text{BaSO}_4$  alone*

1

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

*accept has more ions than weaker acid / alkali of same concentration*

*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  $(0.05 \times 32) = (V \times 25)$  **or**  $0.05 \times 32 / 25$*

1

(reacts with)  $2 \times 0.0016$  **or**  $0.0032$  (mole  $NH_3$  in  $25\text{ cm}^3$ )

*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*

*$0.128 \times 17$  **or**  $0.13 \times 17$*

***or** their (b)(iii)  $\times 17$*

*or  $0.15 \times 17$  gains 1 mark*

2

[11]

M5. (a) (i) sodium hydroxide / NaOH (solution)  
*accept potassium hydroxide / KOH*  
*accept ammonia (solution) / NH<sub>3</sub>(aq) / NH<sub>4</sub>OH*  
*do not accept limewater / calcium hydroxide*  
*incorrect reagent*  
*or no reagent = 0 marks*

1

(pale) green precipitate / solid  
*allow iron(II) hydroxide / Fe(OH)<sub>2</sub> (formed)*  
*allow OH<sup>-</sup> / hydroxide solution gives a green precipitate for 1 mark*

1

(ii) (acidified) barium chloride / BaCl<sub>2</sub> barium nitrate / Ba(NO<sub>3</sub>)<sub>2</sub>  
*do not accept sulphuric acid*  
*incorrect reagent*  
*or no reagent = 0 marks*

1

white precipitate / solid  
*allow barium sulfate / BaSO<sub>4</sub> (formed)*  
*allow a solution of barium ions / Ba<sup>2+</sup> 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) /  $\text{Cl}^-$   
*accept hydrochloric acid reacts with silver nitrate*  
*do **not** accept chlorine*

1

[7]