Mark schemes

1. (a) (strong because) completely ionised (in aqueous solution)

> *ignore pH*
> *allow dissociated for ionised*
> *do **not** accept hydrogen is ionising*
> *do **not** accept H$^+$ are ionised*

1

(dilute because) small amount of acid per unit volume

> *ignore low concentration*

1

(b) 5.0

> *allow 5*

1

(c) (titre):
chooses titrations 3, 4, 5   1

average titre = 22.13 (cm^3)

allow average titre = 22.13(3…) (cm^3)
allow a correctly calculated average from an incorrect choice of titrations

      1

(calculation):
(moles NaOH =

$$\frac{22.13}{1000} \times 0.105 = 0.002324)$$

allow use of incorrect average titre from step 2

      1

(moles H_2SO_4 =
½ × 0.002324 =) 0.001162

allow use of incorrect number of moles from step 3

      1

(concentration =

$$\frac{0.001162}{25} \times 1000)$$

= 0.0465 (mol/dm^3)

allow use of incorrect number of moles from step 4

      1

alternative approach for step 3, step 4 and step 5

$$\frac{2}{1} = \frac{22.13 \times 0.105}{25.0 \times conc. H_2SO_4} \quad (1)$$

(concentration H_2SO_4 =)

$$\frac{22.13 \times 0.105}{25.0 \times 2}$$

= 0.0465 (mol/dm^3) (1)

*an answer of 0.046473 **or** 0.04648 correctly rounded to at least 2 sig figs scores marking points 3, 4 and 5*

*an answer of 0.092946 **or** 0.09296 **or** 0.185892 **or** 0.18592 correctly rounded to at least 2 sig figs scores marking points 3 and 5*

*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

(d) pipette measures a fixed volume (accurately)

      1

(but) burette measures variable volume

allow can measure drop by drop

      1

(e) $(\text{moles} =) \dfrac{30}{1000} \times 0.105$

or 0.00315 (mol)

or

(mass per dm^3 =) 0.105 × 40
or 4.2 (g)

1

$(\text{mass} = \dfrac{30}{1000} \times 0.105 \times 40)$

= 0.126 (g)

1

*an answer of 0.126 (g) scores **2** marks*

*an answer of 126(g) scores **1** mark*

*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[12]

2. (a) produces H^+ / hydrogen ions in aqueous solution

1

(but is) only partially / slightly ionised

1

(b) indicator changes colour

1

from blue to yellow
    allow from blue to green

1

(when) the acid and alkali are (exactly) neutralised
or
(when) no excess of either acid or alkali

1

(c) pipette measures one fixed volume (accurately)

1

(but) burette measures variable volumes (accurately)

1

(d) $\dfrac{12.10 + 12.15 + 12.15}{3}$

1

(mean titre =) 12.13(3) (cm^3)

1

(moles NaOH = conc × vol) = 0.00255

1

(moles citric acid = $\dfrac{1}{3}$ moles NaOH) = 0.00085

1

(conc acid = moles / vol) = 0.0701 (mol / dm^3)

allow ecf from steps 1, 2, 3 and / or 4

*allow an answer of 0.0701 (mol / dm^3) without working for **1** mark only*

1

[12]

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

1

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

1

(b) H$^+$(aq) + OH$^-$(aq) → H$_2$O(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
$\dfrac{27.05 + 27.15 + 27.15}{3}$

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1

27.12 cm^3

1

(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) $\dfrac{20}{1000}$ × 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]

4.   (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]