Mark schemes

Q1.

(a) (an acid which) is partially ionised

allow (an acid which) is partially dissociated

1

in aqueous solution

allow (when dissolved) in water

MP2 is dependent on the award of MP1

1

(b) pH increases

1

(because) the concentration of hydrogen ions decreases

1

(c) use a (volumetric) pipette to add the alkali

ignore beaker

1

any **two** from:

- into a conical flask
- add an indicator (to the alkali)
- take the initial burette reading
- use a white tile (under a conical flask)

allow named indicator

*do **not** accept add universal indicator*

2

(d)

$$\left(\text{volume of HCl} = \frac{0.0045}{0.15}\right)$$
$$= 0.030\ (\text{dm}^3)$$

1

(conversion 0.030 dm^3 =)
30 (cm^3)

allow correct conversion of an incorrectly determined volume in dm^3

1

alternative approach

$$\left(\text{concentration} = \frac{0.15}{1000} =\right)$$
0.00015 (mol/cm^3) (1)

$$\left(\text{volume} = \frac{0.0045}{0.00015} =\right)$$
30 (cm^3) (1)

allow correct use of an incorrectly determined concentration in mol/cm^3

(e) (calcium's) outer shell / electrons are further from the nucleus

allow converse arguments in terms of magnesium

allow energy level for shell

allow calcium has more shells

ignore calcium atoms are larger

1

(so) the outer electrons are less strongly attracted to the nucleus

allow (so) the outer electrons are more shielded from the nucleus

1

(so) positive ions are formed more easily

allow (so) electrons are more easily lost

1

[12]

Q2.

(a) (the acid is only) partially ionised (in aqueous solution)

1

(b) the mass of acid dissolved is doubled and the volume of the solution is halved

1

(c) methyl orange

1

from yellow to red / orange / pink

1

OR

phenolphthalein (1)

from pink to colourless (1)

OR

litmus (1)

from blue to red (1)

MP2 is dependent on the award of MP1

if no other marks awarded, allow ***1*** *mark for universal indicator turns from purple / blue to green / yellow / orange / red*

(d) OH^-

1

(e) (moles $Na_2CO_3 = \frac{25.0}{1000} \times 0.124$)

= 0.0031(0)

1

(moles HNO_3 = 2 × 0.0031(0)) = 0.0062(0) *allow correct use of an incorrectly determined number of moles of Na_2CO_3*

1

(concentration =) $\frac{0.0062(0)}{23.6} \times 1000$

allow correct use of an incorrectly determined number of moles of HNO_3

1

= 0.262711864

1

= 0.263 (mol/dm^3)

allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all the data in the question

1

alternative approach:

$\left(\text{ratio } \frac{\text{moles } HNO_3}{\text{moles } Na_2CO_3} = \right)$

allow inverted expression

$\frac{2}{1} = \frac{23.6 \times \text{concentration}}{25.0 \times 0.124}$ (2)

*allow **1** mark for the expression with an incorrect mole ratio*

(concentration =)

$\frac{2 \times 25.0 \times 0.124}{23.6}$ (1)

allow correct use of the expression with an incorrect mole ratio

= 0.262711864 (1)

= 0.263 (mol/dm^3) (1)

allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all the data in the question

(f) 3.16×10^{-3} (mol/dm^3)

1

(g) argon / Ar

1

[12]

Q3.

(a) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account. **3–4**

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear. **1–2**

No relevant content **0**

Indicative content

General principle

- pH depends on H^+ ion concentration
- the higher the concentration of H^+ ions the lower the pH

Strength

- the stronger an acid the greater the ionisation / dissociation (in aqueous solution)
- (so) the stronger the acid the lower the pH

Concentration

- the higher the concentration of an acid the more acid / solute in the same volume (of solution)
- (so) the higher the concentration of the acid the lower the pH

(b) the mean of titration numbers 2 to 5 values is calculated **1**

(because) 23.90 (cm^3) is an anomalous result

allow (because) 23.90 (cm^3) is not concordant

allow (because) 23.90 (cm^3) is too high a value

allow (because) the first titration is a rough value

*allow for **2** marks an answer of (because) the mean is taken of the values within 0.10 (cm^3)*

*allow for **2** marks an answer of (because) the mean is taken of the concordant values* **1**

allow identification of titration by titration number or volume

(c) (moles $Ba(OH)_2$ = $\frac{23.50}{1000}$ × 0.100) = 0.00235 **1**

(moles HCl = 0.00235 × 2 =) 0.00470

allow correct use of an incorrectly calculated number of moles of $Ba(OH)_2$ **1**

(concentration =) $0.00470 \times \frac{1000}{25.0}$

allow correct use of an incorrectly calculated number of moles of HCl

1

= 0.188 (mol/dm^3)

1

alternative approach:

$$\left(\text{ratio } \frac{\text{moles HCl}}{\text{moles Ba(OH)}_2} =\right)$$

allow inverted expression

$$\frac{2}{1} = \frac{25.0 \times \text{concentration}}{23.50 \times 0.100} \ (\mathbf{2})$$

*allow **1** mark for the expression with an incorrect mole ratio*

$$(\text{concentration} =) \ \frac{2 \times 23.50 \times 0.100}{25.00} \ (1)$$

allow correct use of the expression with an incorrect mole ratio

= 0.188 (mol/dm^3) (1)

(d) there are no ions that are free to move

allow there are no ions in solution

allow there are no ions free to carry the charge

1

(because) barium sulfate is solid / insoluble

1

(and) hydrogen ions have reacted with hydroxide ions to produce water

allow (and) water is a covalent / molecular substance

1

(e) the mixture (now) contains barium ions and hydroxide ions that are free to move

allow excess barium hydroxide solution contains ions

1

[14]