AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.3.4 USING CONCENTRATIONS OF SOLUTIONS IN MOL/DM3

SCORE	PERCENTAGE
/200	%

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Q1.

(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

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

(concentration H_2SO_4 =)
$\frac{22.13 \times 0.105}{25.0 \times 2}$

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

or 0.00315 (mol)

or

(mass per dm^3 =) 0.105 × 40

or 4.2 (g)

1

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

= 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]

Q2.

(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

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(c) pipette measures one fixed volume (accurately)

1

(but) burette measures variable volumes (accurately)

1

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

1

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

1

(moles NaOH = conc × vol) = 0.00255

1

(moles citric acid = $\frac{1}{3}$ 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]

Q3.

(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

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(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]

Q4.

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks)
There is a description of titrations that would allow a comparison to be made between the two solutions of hydrochloric acid.

Level 2 (3 – 4 marks)
There is a description of an experimental method including addition of acid to alkali which may include an indicator or colour change and may include a measurement of volume.

Level 1 (1 – 2 marks)
There is a simple description of using some of the apparatus.

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0 marks
No relevant content.

examples of chemistry points made in the response could include:
- acid in burette **or** flask
- alkali/sodium hydroxide **or** acid in burette **or** flask
- volume of acid **or** alkali measured using the pipette
- indicator in flask
- white tile under the flask
- slow addition
- swirling/mixing
- colour change of indicator
- burette volume measured

[6]

Q5.

(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*

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*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]

Q6.

(a) any **two** from:

- temperature (of the HCl)
- mass or length of the magnesium
- surface area of the magnesium
- volume of HCl

2

(b) (i) (a greater concentration has) more particles per unit volume

allow particles are closer together

1

therefore more collisions <u>per unit time</u> **or** more frequent collisions.

1

(ii) particles move faster

allow particles have more (kinetic) energy

1

therefore more collisions <u>per unit time</u> **or** more frequent collisions

1

collisions more energetic (therefore more collisions have energy greater than the activation energy) **or** more productive collisions

1

(c) (i) add (a few drops) of indicator to the acid in the conical flask

allow any named indicator

1

add NaOH (from the burette) until the indicator changes colour **or** add the NaOH dropwise

candidate does not have to state a colour change but penalise an incorrect colour change.

1

repeat the titration

1

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calculate the **average** volume of NaOH **or** repeat until concordant results are obtained

1

(ii) **moles of NaOH**

0.10 × 0.0272 = 0.00272 moles

*correct answer with or without working gains **3** marks*

1

Concentration of HCl

0.00272 / 0.005 = 0.544

allow ecf from mp1 to mp2

1

correct number of significant figures

1

[14]

Q7.

(a) (i) red

ignore pink

1

(ii) add silver nitrate (solution)

1

white precipitate

dependent on addition of silver nitrate

ignore addition of another acid

*if hydrochloric acid added max **1** mark*

1

(b) suitable named alkali / sodium hydroxide solution in burette

1

add alkali solution until (indicator) becomes pink / red

1

*if acid to acid titration described, first two marking points **not** available*

any **two** from:

- wash / rinse equipment
- add dropwise or slowly (near end point)
- swirl / mix
- read (meniscus) at eye level
- white background
- read start and final burette levels / calculate the volume needed
- repeat

2

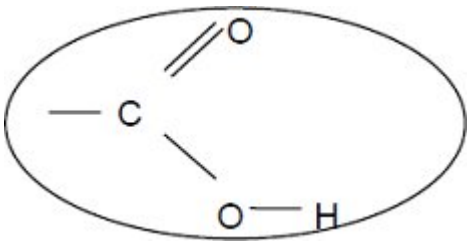
(c) does not ionise / dissociate completely

allow <u>for acids of the same concentration</u>, weak acids have a higher pH or fewer hydrogen ions

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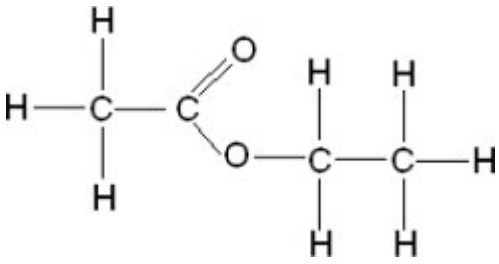
1

(d) (i) ring round COOH

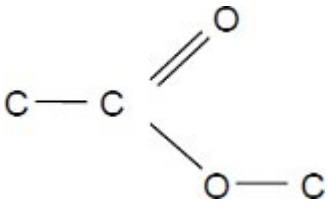


1

(ii)



*if not fully correct, allow **1** mark for correct ester group − minimum*



2

[11]

Q8.

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a simple description of using some of the equipment.

Level 2 (3-4 marks)
There is a description of an experimental method involving a measurement, **or** including addition of alkali to acid (or vice versa).

Level 3 (5-6 marks)
There is a description of a titration that would allow a successful result to be obtained.

Examples of chemistry points made in the response could include:

- acid in (conical) flask
- volume of acid measured using pipette
- indicator in (conical) flask

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- sodium hydroxide in burette
- white tile under flask
- slow addition
- swirling
- colour change
- volume of sodium hydroxide added

Extra information

- allow acid in the burette to be added to sodium hydroxide in the (conical) flask
- allow any specified indicator

colour change need not be specified

[6]

Q9.

(a) mixture is cooled / cooling

1

so ammonia / it condenses

or
so ammonia <u>turns into</u> a liquid (but nitrogen and hydrogen remain as gases)

1

(b) (i) exothermic reaction

accept reverse reaction is endothermic

or
equilibrium / reaction moves in the direction which raises the temperature

ignore answers based on rate or collisions

1

(ii) they / particles / molecules move faster **or** have more (kinetic) energy

allow atoms instead of particles
ignore particles move more / vibrate
*do **not** accept electrons (max1)*

1

any **one** from:

- particles / molecules collide more often / more frequently / more likely to collide
  ignore collide faster
  ignore more collisions
- more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy
  accept more successful collisions

1

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(iii) more molecules / particles / moles / volumes on LHS (of equation than RHS)

accept 4 molecules / particles / moles / volumes on LHS and 2 molecules / particles / moles / volumes on RHS

or

greater volume on LHS (than RHS)

or

equilibrium / reaction moves in the direction which reduces the pressure / volume

accept converse

1

(iv) cost

or

difficulty in containing such a high pressure

allow risk of explosion

ignore dangerous

1

(c) (i) 60

1

(ii) 2.4(2857….)

*correct answer gains **3** marks with or without working*

accept any answer that rounds to 2.4

ignore units

if answer is incorrect look for evidence of correct working to a

*maximum of **2** marks.*

moles of N_2 = 2/28 = (0.0714)

moles of ammonia = 2 × 0.0714 = (0.1428)

mass of ammonia = 0.1428 × 17 = (2.4276)

or

28 → 34

1g →34/28

2g →2.4… ….

3

(d) (i) 15

1

(ii) unreacted gases are recycled

allow unreacted gases are reused

1

rate (of production) is fast

accept production is continuous

ignore compromise between rate and yield

1

[14]

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Q10.

(a) (i) hydrogen ions

1

(ii) partially ionised

1

(b) (i) burette

1

(ii) indicator

1

(iii) colour change or turns pink

1

(c) 20.4(0)

*correct answer with or without working gains **2** marks*
if answer incorrect allow
$\frac{20.30 + 20.50 + 20.40}{3}$
*20.80 **or***
*for **1** mark*

2

(d) 50 (g)

*correct answer with or without working gains **2** marks*
*if answer incorrect allow evidence of 1.25 × 40 for **1** mark*

2

[9]

Q11.

(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

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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]

Q12.

(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

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(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 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 × 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

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[11]

Q13.

(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]

Q14.

(a) **must** be description of a titration no titration = no marks

NaOH in burette

*do **not** accept biuret etc*

1

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add NaOH until (indicator) changes colour

*if specific colour change mentioned, must be correct – colourless to pink / red **or** 'goes pink / red'*

*do **not** accept 'clear' for colourless*

1

note (burette) volume used **or** final reading

accept 'work out the volume'

1

one other point: eg repeat

accept:
*(white) tile **or** add dropwise / slowly **or** white background **or** swirling / mix **or** read meniscus at eye level **or** wash apparatus*

1

(b) 0.054

*for **2** marks*

*(0.1 × 13.5)/25 for **1** mark*

(c) don't know – insufficient evidence to decide

owtte

any sensible answer

or

depends on whether acid level is considered safe or unsafe

yes, safe – acid level low / weak acids / low compared with stomach acid

owtte

any sensible answer

2

no, unsafe – acid level (too) high / other substances or bacteria may be present / insufficient evidence to decide

owtte

any sensible answer

1

(d) (methyl orange) would have changed colour (well) before the end-point / pH7 / neutral

owtte

1

weak acid present

weak acid-strong base (titration)

allow methyl orange used for strong acid-weak base titration

1

[9]

Q15.

(a) yellow / yellow orange orange

1

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(b) (i) zinc carbonate

1

(ii) copper bromide

1

(iii) magnesium sulphate

1

(c) (white) precipitate / solid

*do **not** accept cloudy **or** milky*
*do **not** accept residue*
*green precipitate = **0***

1

[5]

Q16.

(a) (i) e.g. moles NaOH = moles of acid

or formula:

$0.2 \times \frac{45}{1000} = 0.009$

$15M_1 = 0.2 \times 45$

1

rounding to 0.01 loses mark

$= 0.009 \times \frac{1000}{15} = 0.6(M)$

$M_1 = 0.6(M)$

ecf for arithmetical error

*correct answer **2** marks*

1

(ii) 36

ecf – (a)(i) × 60
*correct answer **2** marks*
*0.6 × 60 gets **1** mark*
relative formula mass of ethanoic acid
*= 60 for **1** mark*
0.6 × incorrect molar mass gains second mark only

2

(b) (i) A = hydrogen / H_2

1

B = sodium hydroxide / NaOH **or**
sodium oxide / Na_2O

1

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(iii) C = ethyl ethanoate (acetate) /
$CH_3COOC_2H_5$ / $CH_3CO_2C_2H_5$

1

(iv) D = (concentrated) sulphuric acid /
H_2SO_4

*do **not** accept dilute sulphuric acid*

1

E = sodium ethanoate (acetate) / CH_3COONa / CH_3CO_2Na

1

[9]

Q17.

any series of chemical tests that work should be given credit

each mark is for test + result + inference

identifying all 4 substances unambiguously with no errors gains **5** marks

e.g.

- Flame test: yellow / orange
  $\Rightarrow Na^+ \Rightarrow$ sodium sulphate

  ignore incorrect flame test colours for other compounds

  1

- Add NaOH to remaining 3 samples:
  no (white) ppt / ammonia $\Rightarrow$

  no need to test for ammonia

  1

  $NH_4^+ \Rightarrow$ ammonium sulphate (white) ppt $\Rightarrow$ magnesium ions or aluminium ions

  1

- add excess NaOH to the 2 samples which gave a (white) ppt:
  ppt dissolves $\Rightarrow$ aluminium sulphate
  ppt insoluble $\Rightarrow$ magnesium sulphate

  2

or

- Add NaOH:

  no ppt: ammonia $\Rightarrow NH_4^+ \Rightarrow$ (1)
  ammonium sulphate
  the other one is sodium sulphate (1)

  (damp red) litmus goes blue*
  $\Rightarrow NH_3 \Rightarrow$ ammonium sulphate
  the other one is sodium sulphate

- Add excess NaOH to the 2 samples
  which gave the white ppt (1)
  ppt dissolves $\Rightarrow$ aluminium sulphate (1)
  ppt insoluble $\Rightarrow$ magnesium sulphate (1)

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(*) or UI/pH indicator goes blue/purple

[5]

Q18.

(a)

***must** be a description of a titration no titration = **0** marks*

Quality of written communication

*for correct sequencing of 2 of first 3 bullet points i.e. 1 + 2 **or** 2 + 3 **or** 1 + 3*

1

any **three** from:

- nitric acid in <u>burette</u>

  *do **not** accept biuret*
  can be inferred from 3rd point

- add nitric acid until <u>indicator</u> changes (colour)

  can be named acid-base indicator
  colour change does not have to be correct

- note (burette) volume used **or** final reading

- accuracy: e.g. repeat

  *accept white tile **or** dropwise near end **or** white background **or** swirling the flask **or** read meniscus at eye level*

3

(b) e.g. formula method:

$25 \times M_{NH3} = 0.25 \times 20$

1

$M_{NH3} = 0.2$

*correct answer alone = **2***

OR

moles NH_3 = moles HNO_3

$= \frac{20}{1000} \times 0.25 = 0.005$ moles (1)

concentration NH3

$= \frac{0.005 \times 1000}{25} = 0.2$ (1)

1

(c) sodium hydroxide **or** potassium hydroxide **or** lithium hydroxide **or** calcium hydroxide

ignore mention of alkali

1

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ammonia produced

accept gas produced turns (damp) (red) litmus blue (not blue litmus) ***or*** *<u>alkaline</u> gas produced*

any suitable named indicator e.g. UI with consequential marking white fumes / smoke with (concentrated) HCl

do ***not*** *accept white gas wrong test =* ***0*** *marks*

1

[8]

Q19.

(a) any four from:

- sulphuric acid measure by pipette
  or *diagram*
- potassium hydroxide in burette
  or *diagram*
- if solutions reversed, award
- note initial reading
- use of indicator
- note final reading **or** amount used

4

(b) $\frac{34 \times 2}{1000}$

1

= 0.068

1

(c) ½ or 0.5 moles H_2SO_4 react with 1 mole KOH

1

moles H_2SO_4 in 25.0 cm^3 = 0.068 × 0.5

1

∴ moles H_2SO_4 in 1 dm^3 = $\frac{0.068 \times 0.5 \times 1000}{25}$ = 1.36 mol/dm^3

1

[9]

Q20.

(a) hydrochloric acid in burette

1

indicator

1

note volume at end / neutralisation point

titre must be HC1

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1

(b) 1 mole HCl = 36.5g /36.5

1

$\therefore \frac{73}{36.5}$ = 2 moles / dm^3

2 for correct answer

1

(c) (i) $\frac{10 \times 2}{1000}$

allow e.c.f. ie their (b) × $\frac{10}{1000}$

2 for correct answer

1

= 0.02 moles

1

(ii) 0.02 × $\frac{1000}{25}$ = 0.8 mol / dm^3

1

allow e.c.f. ie their (c)(i) × $\frac{1000}{25}$

1

[9]

Q21.

(a) pipette / burette

1

(b) named indicator eg methyl orange / phenolphthalein

***not** universal*
*accept litmus but **not** litmus paper*

1

(c) $\frac{25 \times 0.4}{1000}$

2 for correct answer

1

= 0.01

1

(d) 1KOH ≡ 1 HCl

$\therefore$ 0.01 moles HCl in 35 cm^3

1

$\therefore \frac{0.01 \times 1000}{35}$ = 0.29

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2 for correct answer
0.3 = (1) (with correct working = (2))

1

[6]

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