<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>1 (a)</td><td>titration / <u>volumetric</u> analysis</td><td></td><td>1</td></tr>
<tr><td>(b)</td><td>C (25 cm^3 pipette)</td><td></td><td>1</td></tr>
<tr><td>(c)</td><td>M1 (before) – yellow

M2 (after) - orange</td><td>

accept pink / red and combinations with orange
Allow 1 mark if correct colours reversed</td><td>2</td></tr>
<tr><td>(d)</td><td><table><tr><td>after adding acid</td><td>23.60</td></tr><tr><td>before adding acid</td><td>2.75</td></tr><tr><td>volume added</td><td>20.85</td></tr></table>
M1 23.60
M2 2.75
M3 20.85</td><td>If readings are correct but in the wrong order, award 1 mark for M1 and M2

M3 CQ on (M1 – M2)</td><td>3</td></tr>
<tr><td>(e) (i)</td><td><table><tr><td>22.90</td><td>22.60</td><td>22.45</td><td>22.55</td></tr><tr><td></td><td>✓</td><td>✓</td><td>✓</td></tr></table></td><td></td><td>1</td></tr>
<tr><td>(ii)</td><td>M1 (22.60 + 22.45 + 22.55) ÷ 3

M2 22.53 (cm^3)</td><td>Correct final answer with no working scores (2)
Accept 22.53 with 3 recurring

If no results ticked in (i), then only use of two or three concordant titres can score in (ii)

If only one result ticked, then no marks can be scored in (ii)
Otherwise, both marks CQ on ticked results in (e)(i)

Answer with zero as 2nd dp does not need trailing zero</td><td>2</td></tr>
</table>

		Answers obtained by averaging other titre values do require answers to 2 dp	

Question number				Answer	Notes	Marks
2	a	(i)	M1	more accurate	Accept more precise / gives an exact value	1
		(ii)	M1	(thermal) insulator /poor conductor/keeps heat in/ reduces heat loss	Accepts traps heat	1
		(iii)	M1	stirring/mixing/swirling	Ignore name of apparatus used	1
		(iv)	M1	temperature goes down/stops rising/stays constant	Accept measure pH/when pH = 7/when pH is less than 7 Reject changing to any pH value > 7 Accept use of any indicator (named example or just indicator) Ignore colour changes	1
	b		M1	19.4		1
			M2	23.1		1
			M3	3.7	CQ on temperatures recorded Penalise negative sign	1
					Penalise second decimal place values, except zeroes, for M1 and M2 M1 and M2 both correct but wrong way around scores 1	

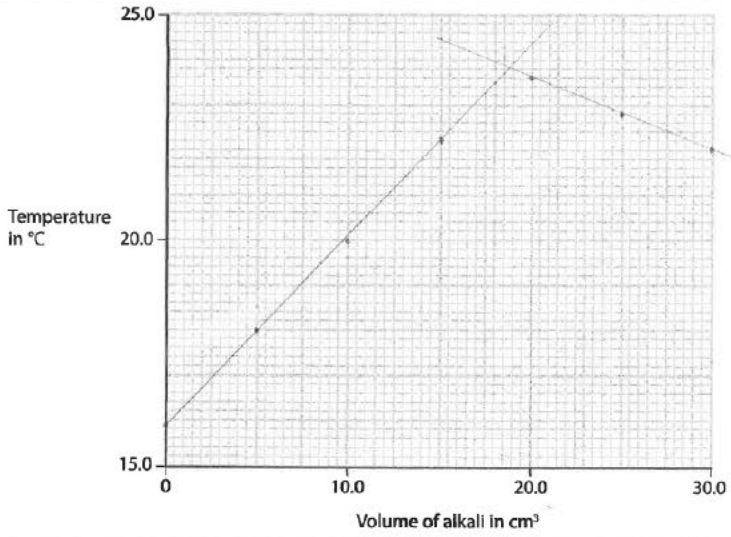
Question number				Answer	Notes	Marks
2	c	(i)	M1 M2	9 points plotted correctly to nearest gridline	Deduct 1 for each error If points not visible beneath line, assume them to be on line	2
			M3	straight line of best fit through first 5 points		1
			M4	straight line of best fit through last 4 points		1
					If lines do not cross or are joined by curve or straight line, only M3 or M4 can be awarded	
		(ii)	M1	volume of acid CQ on where lines cross	Accept answer ± 0.5 to minimum of 1 dp	1
			M2	maximum temperature CQ on where lines cross	Accept answer ± 0.1 to minimum of 1 dp	1
					Do not award either mark if lines do not intersect Apply dp penalty once only Award 1 mark if both values correct but recorded in wrong places	
	d		M1	55 (× 4.2 × 5.5)		1
			M2	1270.5	Accept any value between 1270 and 1271 Accept 1300 M2 CQ on M1 If vol used is 25, answer is 577.5 Accept any value between 577 and 578 accept 580 If vol used is 30, answer is 693 Accept 690 Ignore signs	1
					Correct final answer without working scores 2 marks	

Question number				Answer	Notes	Marks
2	e	(i)	M1	1.5 × 0.025		1
			M2	0.0375	Correct final answer scores 2 marks 37.5 scores M2 only	1
		(ii)	M1	1800 ÷ 0.0375 /1800 ÷ answer to (e)(i)	Accept correct use of 1.8 in place of 1800	1
			M2	48 (kJ/mol)	M2 CQ on M1 provided 1800 or 1.8 used correctly If 37.5 in (a)(i) then answer is 0.048 (kJ/mol) Correct final answer scores 2 marks Ignore answer in J/mol Ignore signs	1
						Total 19 marks

Question number			Answer	Notes	Marks
3	(a)		M1 23.60 M2 2.25 M3 21.35	Award 1 mark for both M1 and M2 correct but in wrong order Penalise missing zero in 2nd dp once only CQ on M1 and M2	3
	(b)	(i)	ticks in columns 3 and 4		1
		(ii)	M1 $\frac{23.50 + 23.0}{2}$ M2 23.6(0) (cm^3)	If no results ticked in (i), then only use of concordant titres can score in (ii) If only one result ticked, then no marks can be scored in (ii) Otherwise, both marks CQ on ticked results Answers with zero as 2nd dp do not need trailing zero Answers obtained by averaging other titre values do require 2nd dp Correct final answer with no working scores (2)	2
	(c)	(i)	M1 $\frac{0.107 \quad 25.0}{1000}$ M2 0.00268 (mol)	If no division by 1000, only M2 can be scored Accept 2 or more significant figures	2
		(ii)	(2 × 0.00268 =) 0.00535 (mol)	CQ on (c)(i)	1
		(iii)	M1 $\frac{0.00535}{0.02285}$ M2 0.234 (mol/dm^3)	CQ on (c)(ii) Accept 2 or more significant figures	2

Question number			Answer	Notes	Marks
3	(d)	(i)	white precipitate	Ignore names and formulae Apply list principle for incorrect observations such as bubbles	1
		(ii)	barium sulfate	Accept $BaSO_4$ If both name and formula given, mark name only	1
				Total for Question 3	**13**

Question number				Answer	Notes	Marks
4	a		M1	concentration	Ignore from the same bottle	1
			M2	temperature / same temperature as acid		1
					Accept in either order Ignore references to volume	
	b		M1	19.4	Award 1 for both temperatures	1
			M2	16.9	correct but in wrong order	1
			M3	(+)2.5	CQ on temperatures recorded Penalise negative sign	1
	c	i		cross in box D (The volume of acid used was 50.0 cm^3 instead of 25.0 cm^3)		1
		ii		cross in box D (The alkali was added in 10.0 cm^3 portions but were recorded as 5.0 cm^3 portions)		1
	d		M1	all points plotted correctly to nearest gridline	Deduct 1 for each error If points not visible beneath line, assume them to be on the line	2
			M2			
			M3	<u>straight</u> line of best fit through first 4 points	Lines must be drawn with a ruler	1
			M4	<u>straight</u> line of best fit through last 3 points	Penalise freehand once only ECF on incorrectly plotted points	1



If first line drawn to (23.6,20.0), do not award M3
If lines do not cross or are joined by curve or straight line, only one of M3 and M4 can be awarded

Question number				Answer	Notes	Marks
4	e		M1	volume of alkali CQ on where lines cross	Accept answer to nearest gridline to min 1 dp	1
			M2	maximum temperature CQ on where lines cross	Accept answer to nearest gridline to min 1 dp	1
					Penalise missing dp once only If both values correct but in wrong order, award 1/2 0/2 if lines do not cross	
	f	i	M1	0.650×0.025		1
			M2	0.01625 / 0.0163	16.25 scores 1/2 Accept 0.016 and 0.0162	1
		ii	M1	0.0325	CQ on fi	1
		iii	M1	$\frac{0.0325 \times 1000}{0.500}$	CQ on fii	1
			M2	65 (cm^3)	If M1 wrong because ×1000 missing, then award M2 by ECF	1
					Penalise failure to use 1000 once only in i and iii Do not penalise rounding of intermediate answers and consequent final answer eg 65.2	
					If final answer obtained by use of $\frac{V_1M_1}{n_1} = \frac{V_2M_2}{n_2}$ both marks may be awarded in iii	
TOTAL						**18**