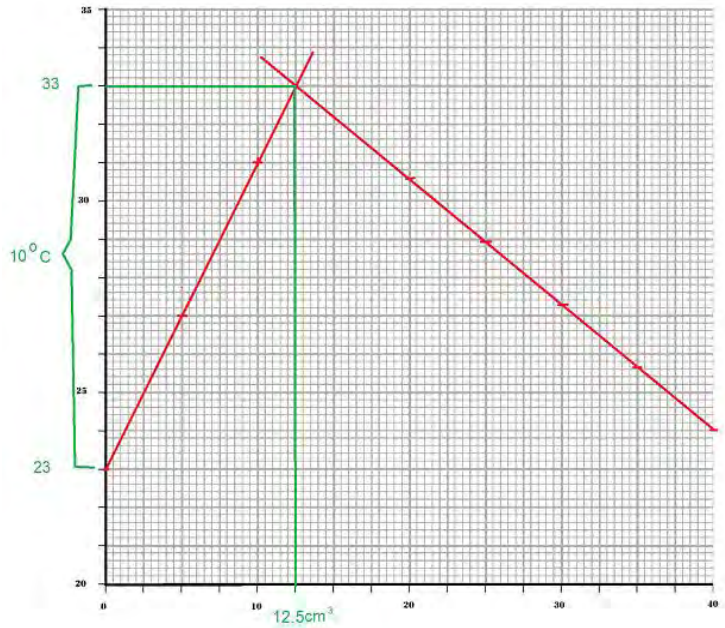
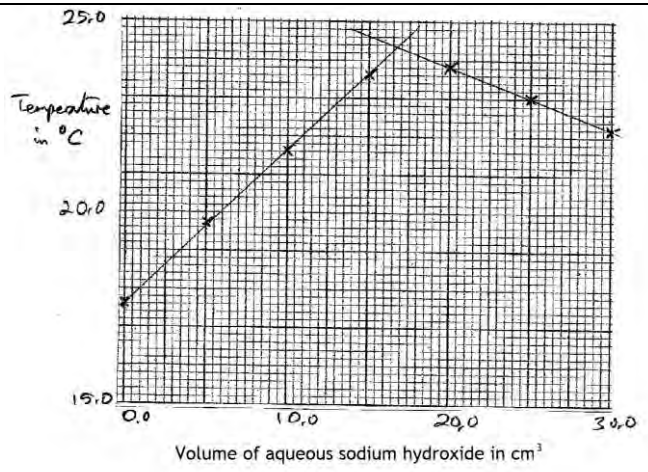
Question number	Answer	Notes	Marks
1 (a)			4
	M1 & M2 all points plotted correctly, to the nearest gridline	deduct one mark for each incorrectly plotted point	
	M3 best fit straight line through first 3 points drawn with the aid of a ruler	ALLOW M3 and M4 even if lines do not intersect	
	M4 best fit straight line through last 6 points drawn with the aid of a ruler		
(b) (i)	value correctly read (± 0.25 cm^3) to nearest gridline from candidate's graph (12.5 cm^3 if correctly drawn)	Do not award these marks if lines do not cross	1
(ii)	value correctly read (± 0.1°C) to nearest gridline from candidate's graph (10 °C if correctly drawn)		1

Question number	Answer	Notes	Marks
1 (c)	M1 (water) – to remove/flush out solution (X) M2 (solution Y) – to remove the water / avoid diluting solution Y	 ACCEPT so that the only liquid in the burette is solution Y IGNORE to remove impurities for both M1 and M2	2
(d)	solution Y is less concentrated (than solution X) OR solution (in Experiment 2) is less concentrated	IGNORE references to reactivity ALLOW weaker / less strong instead of less concentrated IGNORE refs to more/less acidic ACCEPT reverse argument	1

Question number	Answer	Notes	Marks
2 a	(polystyrene is an) insulator / prevents/reduces heat loss	Accept is a poor conductor (of heat) Accept keeps heat in Accept doesn't conduct (heat) as well (as glass) Ignore does not heat up Ignore references to accuracy/safety/breakages Reject to keep the temperature constant	1
b	M1 (after) 19.4(0) M2 (before) 15.9(0) M3 3.5(0)	If readings are correct but in the wrong order, award 1 mark for M1 and M2 M3 CQ on (M1 − M2)	3

c	i		M1+M2 all seven points plotted to nearest gridline Deduct 1 mark for each error M3 best fit straight line through first 4 points drawn with aid of a ruler M4 best fit straight line through last 3 points drawn with aid of a ruler No penalty if lines do not cross or if the two straight lines are joined by a curve values correctly read from candidate's graph Do not award these marks if lines do not cross or if curve drawn	4
	ii	M1 (temperature) M2 (volume)	temperature to ± 0.1 °C volume to ± 0.25 cm^3 If values correct but in wrong places allow 1/2	2

Question number	Answer	Notes	Marks
2 d	M1 mass = 47.7 (g)		
	M2 temperature change = 5.8 (°C)		
	M3 (47.7 × 4.2 × 5.8 =) 1200 (J)	Accept 1160, 1162, 1161.97, 1161.972 Reject 1161.9 M3 CQ on M1 and M2 answer correct to two or more sig fig Correct final answer with or without working scores 3 marks Accept answer in kJ if unit included Ignore sign	3

Question number	Answer	Notes	Marks
3 a	pipette		1
b	B (pink to colourless)		1
c	correct reference to one of these: • number of colours • end point/colour change (accept neutral point)	Examples: phenolphthalein has <u>only</u> two colours / only one colour change / negative statement eg does not have a range of colours / UI has several colours/more than one colour change sharp / definite / sudden / quick / not gradual / needs only one drop / converse for UI	1
d	M1 (after) 24.15 (only this answer) M2 (before) 2.30 (only this answer) M3 (added) 21.85	Award 1 mark for both burette readings correct but in wrong order CQ on after and before readings In M3, penalise answer not to 2 dp unless penalty already applied in M2	3

Question number	Answer	Notes	Marks
3 e i	ticks in columns 2 and 4		1
ii	M1 $\frac{26.30 + 26.40}{2}$	CQ on ticked results If no results ticked, award M1 only if columns 2 and 4 averaged If only one result ticked, no marks can be awarded in (e)	2
	M2 26.35	CQ on results averaged Answer must be to 2 dp M2 subsumes M1	

f		In part (f): • accept values in standard form, eg 4.5×10^{-3} • do not accept unevaluated fractions, eg 0.0045÷3 in (ii) • do not penalise too many sig figs • correct answer without working scores 2 marks in (i) and (iii) • penalise missing use of 1000 in (i) and (iii) once only	
i	M1 $\frac{0.18(0) \times 25(.0)}{1000}$		2
	M2 0.0045(0)	Award 1 mark for 4.5	
ii	(0.0045 ÷ 3 =) 0.0015(0)	CQ on answer to (i)	1
iii	M1 $\frac{0.0015 \times 1000}{28.3(0)}$	CQ on answer to (ii)	2
	M2 0.053(0)	Award 1 mark out of 2 for 0.000053 Award 1 mark out of 2 for 0.05 If correct final answer obtained by omission of 1000 in both (i) and (iii), award marks of 1,1, 2	
			Total 14 marks

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>4 (a)</td><td>
<table>
<tr><td>Titration number</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>Volume of $KMnO_4$ solution added / cm^3</td><td>22.80</td><td>22.10</td><td>22.50</td><td>22.20</td></tr>
<tr><td>Concordant titration results (✓)</td><td></td><td>✓</td><td></td><td>✓</td></tr>
</table>
</td><td></td><td>1</td></tr>
<tr><td>(b)</td><td>M1 - $\frac{22.1(0) + 22.2(0)}{2}$

M2 – 22.15 (cm^3)</td><td>CSQ on boxes ticked in (a)
If no results ticked, award M1 only if columns 2 and 4 averaged
If only one result ticked, no marks can be awarded in (b)

CSQ on results averaged, but the results must be taken from the table

Answer must be to 2dp

correct answer with no working scores 2</td><td>1

1</td></tr>
<tr><td>(c)</td><td>D (pipette)</td><td></td><td>1</td></tr>
</table>

Question number	Answer	Notes	Marks
4 (d) (i)	**M1** - $\frac{20(.00) \times 0.02(00)}{1000}$		1
	M2 - 4(.00) x 10^{-4} (mol)	0.4(00) scores 1	1
(ii)	5 x **M2** from (i) / 4(.00) x 10^{-4} x 5 / 2(.00) x 10^{-3}		1
(iii)	10 x answer to (ii) / 2(.00) x 10^{-2}		1
(iv)	answer to (iii) x 152 / (2(.00) x 10^{-2} x 152) = 3.04 (g)		1
(e) (i)	$m(H_2O)$ = (24.2 − 15.2) = 9(.0) (g)		1
(ii)	answer to (i) ÷ 18 / $n(H_2O)$ = (9.00 ÷ 18) = 0.5(0) (mol)		1
(iii)	$n(FeSO_4)$ = (15.2 ÷ 152) = 0.1(00) (mol)		1
(iv)	x = answer to (ii) ÷ answer to (iii) / 5	must be given as a whole number	1