Subject: CHEMISTRY

Code: 2813/03

Practical Exam

Session: June 2001

Mark Scheme

MAXIMUM MARK	**60**

Version for Publication

2813/03(A) Planning (June 2001)
Mark Scheme

Skill P (16 marks maximum)

1. ***Titration procedure*** *– **award maximum 6 marks** (from 8 available)*

Award six marking points only. Indicate the mark code next to each tick.
Use of an alkali other than sodium carbonate forfeits marks T3 and T4.

T1 Candidate realises that the HCl provided must be diluted before titration. [1]

T2 Uses a pipette and volumetric flask to dilute the HCl accurately. [1]
10 or 25 cm^3 → 250 cm^3 are examples of suitable dilutions
"Volumetric flask" may be listed under apparatus list in plan

T3 Uses a "known" solution of sodium carbonate for the titration. [1]
Award this mark for weighing [any mass of] solid and dissolving in water.

T4 Calculates the mass of alkali needed to make the known solution. [1]
Concentration must be justified relative to quantity of HCl used.
Calculation must explain the concentration of sodium carbonate chosen, which should be about [half] that of the [diluted] HCl.
NB: 0.10 mol dm^{-3} anhydrous sodium carbonate contains 2.65 g in 250 cm^3.
1.00 mol dm^{-3} sodium carbonate contains 10.6 g in 100 cm^3
No detail of how to make up this solution is needed for the mark.

T5 Outlines titration using a burette and a pipette [1]

T6 Obtains two consistent/concordant titres ***or*** "within 0.1 cm^3". [1]
Do not allow simply "repeat" or "accurate"

T7 Names a suitable indicator ***and*** quotes correct end colour. [1]
Methyl red goes pink/red if acid used in burette (or orange if alkali in burette)
Methyl orange orange/red/pink if acid in burette (or yellow if alkali in burette)
Screened methyl orange goes grey/light purple if acid is used in the burette
Bromophenol blue goes blue if alkali in burette (yellow for acid)

T8 Gives an intelligible specimen calculation of [HCl] from titration data
or explains the calculation, quoting all necessary formulae correctly. [1]
Candidates must convince Examiner that they know what they are doing!
Mole ratio (or equation) must be given as part of working
The calculation must allow for the dilution of HCl (if this was done)

2. ***Enthalpy procedure* – award maximum 6 marks** *(from 7 available)*

Mark six marking points only. Put the marking code next to each tick.

E1 Chooses three other suitable metals between Na and Pb in reactivity. [1]
Do not accept K, Ba or Cu.

E2 Uses known volume/mass of HCl ***and*** known mass of each metal. [1]
*[NB: Either reagent may be in excess **or** stoichiometric amounts may be used].*

E3 Shows a correct calculation to work out a suitable mass of any **one** metal. [1]
If 25.0 cm^3 of HCl (2.5 mol dm^{-3}) used → mass Mg = 0.76 g; mass Li = 0.44 g
If 25.0 cm^3 of HCl (2.0 mol dm^{-3}) used → mass Mg = 0.61 g; mass Li = 0.35 g
For 25.0 cm^3 of HCl (0.25 mol dm^{-3}) → mass Mg = 0.076 g; mass Li = 0.044 g
For 25.0 cm^3 of HCl (0.1 mol dm^{-3}) → mass Mg = 0.030 g; mass Li = 0.017 g
*Use A_r as integers **or** to one decimal place*
Only award this mark if working is shown with sufficient clarity

E4 Uses a suitable insulated container for the reactions
and measures the initial and maximum temperatures of the acid. [1]
Accept "calorimeter" or "plastic cup". Many will draw a diagram.
Do not accept "final (or change in) temperature" unless clearly explained.

E5 States **two** precautions (from four below) to improve accuracy of readings [1]
- *stirring during the experiment (a diagram with a stirrer implies this)*
- *powdering the metal **or** candidate removes corrosion on surface of metal*
- *plotting a cooling curve*
- *repeating readings and take average **or** until consistent*

E6 Quotes the "heat produced = mass of water *x* shc *x* temp rise" formula. [1]
Candidate must imply that the mass of water is numerically equal to the volume of HCl used. Specimen figures to illustrate calculation are acceptable.
Be certain that the candidate does not mean the mass of metal.

E7 Shows clearly how ΔH (in kJ mol^{-1}) is calculated from data obtained. [1]
***NB**: ΔH /kJ mol^{-1} = $^{heat\ produced}/_{1000 \times no\ of\ moles\ HCl\ used}$ (if metal used in excess)*
***or** ΔH /kJ mol^{-1} = $^{heat\ produced}/_{1000 \times no\ of\ moles\ Li\ used}$ (if acid is used in excess)*
Award this mark only if it is clear from candidate's account which is in excess.

3. ***Safety, Sources and QWC* – award maximum 4 marks** *(out of 5)*

Put a maximum of four ticks, with their marking codes.

S1 Refers to potentially explosive reaction of an alkali metal/Ba with an acid
or states the nature of the hazard of at least one very reactive metal. [1]

S2 States a **specific** safety precaution for reaction of an alkali metal with acid. [1]
Precaution must be specific to this reaction (eg use of long handled tongs) – not a routine safety precaution such as "wearing safety spectacles" etc.

S3 Uses two suitable secondary sources, quoting precise references. [1]
Minimum of two sources are required.
Specific internet references with at least a forward slash and/or book titles with chapter/pages/direct quotes are needed to score the mark.
No credit for book titles alone.

S4 Length of plan is between 500 and 1100 words
and candidates uses good spelling, punctuation and grammar. [1]
Poor chemical ICT skills may lose this mark.
QWC is marked subjectively. Plan should be well structured.

S5 Gives **two** different balanced equations correctly. [1]

Skill I (14 marks)

1. *Presentation and selection – 6 marks*

Labelled table of readings given, with each column/row labelled [1]
All readings must be in table. Minimum four rows/columns needed.
*Experiments may be numbered **or** labelled by volumes of NaOH.*

All temperature readings are shown to one (or two) decimal place(s). [1]
If initial temp is quoted only once, only second and sixth points score.

Five "set" readings: initial and final temperatures recorded, with unit. [1]
This mark is principally for doing the experiments described

Sixth (or 7th) reading carried out using between 30 and 40 cm^3 of NaOH ***and*** recorded, showing clearly the volume of NaOH used. [1]
Most candidates will probably go for 35 cm^3
This mark (and the next one) is forfeited if 10 cm^3 of X is not used.
The 30 – 40 cm^3 range changes depending on the supervisor's maximum.

Seventh reading suitably selected and recorded. [1]
Award only if reading is taken between 25 – 45 cm^3 NaOH (incl)
NB: this range changes if supervisor's maximum is at (say) 25 cm^3.
*The reading may be a repeat **or** an attempt to pin-point the maximum.*

Subtractions to work out the temperature rises are all correct. [1]

2. *Safety – 2 marks*

Simple safety comment made, such as wearing of spectacles. [1]

Precaution **explained** in terms of the corrosive nature of the acid or alkali. [1]
No mark just for "harmful" or "protects eye from splashes".

3. *Accuracy – 6 marks*

The volume of NaOH causing the maximum temperature rise is within 5 cm^3 of supervisor's volume of NaOH causing the maximum rise. [1]
This mark is assessed using the candidate's highest reading in the table.

For **every** temperature rise (out of the prescribed five) within 1.0°C (incl) of the supervisor's specimen results, award **one** mark. [5]

Skill A (16 marks)

(a) Axis scales are uniform and the plotted points are well spread [1]
The plotted points should embrace at least five large squares vertically
Graph must be fully on the squared paper.
*Either maximum temperature **or** temperature rise may be plotted.*

Plotting of five prescribed data points are correct. [1]
Crosses or dots must be within half of one small square of true position

Sixth and seventh data points plotted correctly on the graph. [1]

Best fit line/curve through first points, up to 30+ cm^3 [1]
No mark is awarded for joining the dots (unless the data genuinely fits)

Downward best fit line/curve after maximum temperature value [1]
The graphical maximum point must be within 5 cm^3 of supervisor's value
Be strict on poor graph drawing skills

(b) Equation for reaction: $\underline{2}NaOH + H_2SO_4 \rightarrow Na_2SO_4 + \underline{2}H_2O$ [1]
Allow correct multiples

(c) No of moles of sulphuric acid = 0.02 mol [1]

(d) Number of moles of NaOH = 2 x 0.020 = 0.040 mol [1]
Ecf. answer = 2 x moles of sulphuric acid is accepted.

(e) Maximum temperature **rise** is correctly read from the graph. [1]
Answer to 0.5°C is required. [It should be 14 – 15°C]
***If** the max temp has been plotted, candidate must subtract initial temp*
This mark is awarded for interpreting the graph, not for accuracy

Correct reading of volume of NaOH to neutralise acid [1]
Appropriate point on x-axis, corresponding to graphical maximum temp.
Answer must be correct to nearest cm^3.
If no graph is drawn give <u>one</u> mark if <u>both</u> of these answers are correct.

Correct working: $[NaOH] = {}^{0\ 04\ x\ 1000}/_{\text{vol of NaOH at "max"}}$ [1]
Correct answer for [NaOH] below scores this mark automatically

Answer for [NaOH] stated ***and*** to 2 or 3 sig. fig. (*unit not needed*) [1]
Concentration of NaOH should be approximately 1.2 mol dm^{-3}
A correctly calculated answer scores two marks.
Allow ecf from wrong answers to (d) and (e).

(f) Add 10 cm^3 on to the volume of NaOH needed for maximum temp. rise [1]
Volumes of alkali and acid must be added to obtain total <u>mass</u> of water

Heat produced in "maximum" experiment correctly calculated [1]
If candidate uses mass of water = volume of NaOH, allow ecf for 1 mark
Answer should be: heat produced = <u>42</u> x 4.2 x 14 = 2.47 kJ (approx)

ΔH correctly calculated from data (marked *ecf* from previous answer) [1]
$\Delta H = -{}^{2\ 47}/_{0\ 02} = -124$ *kJ per mol of acid*
Award this mark if previous answer (heat produced) is multiplied by 50

Negative sign ***and*** correct unit given to ΔH ***and*** 2 or 3 sig fig answer. [1]
This mark is <u>only</u> awarded if the calculation of ΔH is completely correct.

Skill E (14 marks, maximum)

(a) ***2 marks***

A Anomalous/reading(s) identified ***or*** explicit statement that there are none. [1]
Accept any sensible statement consistent with readings actually obtained.

B One reason for the anomalous reading ***or*** explains reason for saying "none". [1]
"Heat loss" is not acceptable: the reason must be a possible "one off".
Likely correct suggestions - incorrect use/reading of thermometer or cylinder
If more than one reason is given, mark the best one.
Allow most answers related to poor experimental technique for this mark.

(b) ***Award maximum of 7 marks*** *(out of the 11 marking points suggested)*

Marks are awarded for the ***best three*** *ideas discussed by the candidate.*

C There are heat losses from the calorimeter [1]
D Specific technical reason for losses:
there is conduction through its sides ***or*** convection out of top [1]
E Use better insulation ***or*** use a lid ***or*** use a bomb calorimeter [1]
F A brief description of a cooling curve, to compensate for heat losses. [1]

G Inaccuracy of measuring cylinder for measuring the solution of NaOH. [1]
Any statement to this effect scores the mark
H Use a burette instead. [1]

I Repeat readings ***or*** take extra readings with different volumes of W [1]
J Obtain consistent temperature rises/take average temperature
or fill in gaps between readings already taken. [1]
K This would improve the reliability of the data. [1]

L The initial temperature of the acid should also be measured. [1]
M The temperature of the acid may not be the same as that of the alkali. [1]

No marks awarded in this part for "using more accurate thermometers"
nor for answers related to washing of the plastic cup.

(c) ***Award 5 marks maximum*** *(from the 7 marking points available)*

N Use a titration method. [1]

O React with a named acid of known concentration [1]
Accept any stated concentration. Candidates may imply use of ***X*** *in this part.*
If the titrant quoted is ***not*** *an acid, award 3 marks maximum on part (c).*

P **W** should be diluted before the titration. [1]

Q Measure a known volume of one solution with a pipette. [1]

R Use the other solution in a burette
and obtain two consistent/accurate titres. [1]

S Use suitable named indicator. [1]

T Correct end-point colour (*depends on which solution is in the burette*). [1]

(d) ***3 marks maximum*** *(from the 6 marking points given below)*

U Candidate states that agreement of results is good. [1]
Award this mark only if candidate's result is very close to –133 kJ

V There is significant heat loss during the calorimetric experiment. [1]
This point can be awarded in part "d" as well as point C in "b" above

W The maximum temperature rise has not been determined precisely,
but it has been estimated from the pattern of data. [1]

X The exact volume of NaOH needed to neutralise the acid was not determined
accurately from the graph. [1]

Y Discussion of the reliability of candidate's own data: if the best-fit curve is close
to all the points on the graph, the data obtained are reliable. [1]

Z The density of H_2SO_4/Na_2SO_4 is assumed to be equal to that of pure water
or its specific heat capacity is not exactly the same as for pure water. [1]

Marking points not awarded in part "b" can score credit in parts "c" and "d"