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METHODS FOR THE COLLECTION AND ANALYSIS OF WATER SAMPLES
FOR A GEOCHEMICAL CYCLING STUDY

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PREFACE

The methods contained in this manual are those developed and used in an ITE Project on Geochemical Cycling in an Upland Grassland Ecosystem (ITE Project No. 594). A general introduction to the project is available as Bangor Research Station Occasional Paper No. 4.

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METHOD SHEET 1

Cleaning and Preparation of Glassware and Sample Bottles

A. New Bottles and Glassware

1. Any obvious dirt or grease should be wiped off under the tap.
2. Immerse in a 2% (v/v) solution of DECON 90 in hot tap water for 2 - 3 hours.
3. Rinse off DECON solution with tap water and a single rinse with distilled water.
4. Continue with 7. below, as for "used items".

B. Previously Used Bottles and Glassware

5. Empty surplus solutions down the sink and rinse once or twice with distilled water.
6. Remove any felt pen labelling with acetone.
7. Items may then be immersed in the tanks containing 5% (v/v) Hydrochloric acid or left to stand filled with acid for at least 12 hours, preferably 24 hours. Protective clothing should be worn for this operation, i.e. gloves, lab. coat and safety glasses. Pipettes may be immersed in acid in the pipette washing cylinder, and small items of glassware may be placed in a bucket rather than the tanks.
8. Remove from acid bath and rinse four times with distilled water.
9. Place items in the Belling glass fronted drying cabinet at 40 - 50°C (low setting). This temperature is suitable for the plastic bottles. Plastic items may also be air dried on the bench, covered with tissue. Volumetric glassware should not be dried in a hot oven.
10. Clean dry glassware and bottles should be placed in their appropriate labelled cupboards, boxes

and drawers.

Sample bottles should be stored with caps in place.

Notes

- (i) It is desirable to wash all the filtration glassware in DECON prior to acid washing as this will remove any organic surface film on the glass.
- (ii) The 2l. collecting bottles for rainfall and lysimeter samples and the soil solution sample jars should be soaked in DECON before proceeding with step 7 and onwards.
- (iii) Great care must be taken to rinse the rainfall funnel assemblies thoroughly following the DECON and acid soaks to prevent sample contamination.

METHOD SHEET 2

Collection of Stream Water Samples

1. Ensure that the sample bottle is clean and labelled correctly, (i.e.: site and ref. number) and that weather conditions and approximate time of sampling for the day have been recorded.
2. Sample sites are marked by a pair of red and white painted posts on either bank. Take the sample from the centre of the stream in line with posts and in moving water. Samples should be taken below the surface, at a depth of 5 - 10 cm. depending on the stream depth.
3. Approximately half fill the bottle, shake and then discard the water downstream of the sampling point, rinsing the inside of the cap at the same time. Fill the bottle again and screw on the cap.
4. Fill and rinse the 125 ml bottle for pH and HCO_3 twice with stream water, rinsing the inside of the cap at the same time.
5. Submerge the 125 ml bottle and fill it, taking care to exclude air from the sample. This is best achieved by screwing on the cap underwater. Where the stream flow has been piped or where there is a shallow depth of water, fill the bottle to capacity using the cap.
6. Empty the 500 ml sample bottle, and fill to capacity with sample water as in 5. above
7. Return samples to the laboratory as soon as possible, and store in the dark at 4°C .
(See note V overleaf)

Notes

- (i) If it is necessary to stand in the stream to collect the sample, wade in from the downstream side. Wait one or two minutes for any disturbed bottom sediment to settle and the flow pattern to establish itself before taking the sample. Collect the sample as far upstream and to one side of yourself as possible, to prevent contamination from footwear. When collecting a series of samples along the length of a single stream, it is good practice to sample at the lowest site first and then to progress up the stream.
- (ii) Avoid sampling in pools, by accumulated leaf debris, dead animals, aerated rapidly flowing water or in back-eddies.
- (iii) If a site has become obviously contaminated, sample at least 10 m upstream, or, if this is not possible 60-100 m downstream. Make a note of the problem and attempt to remove the contaminant if possible.
- (iv) When sampling in shallow water take care to avoid disturbing fine bottom sediment either with your foot or the action of submerging the bottle. If any obvious particulate contamination e.g. twigs insects, leaves etc., enters the bottle discard the sample and refill.
- (v) Try to keep samples out of direct sunlight when in transit and when possible store in a dark cool place until refrigeration is possible.

METHOD SHEET 3A

Standardisation of EIL 3050 pH Meter

1. Connect the combination pH electrode to the input socket on the bottom of the meter and remove the protective cap from the electrode bulb. Rinse the electrode with distilled water. Switch the meter to the ON position.
2. Immerse the electrode in pH = 7 buffer solution (BDH).
3. Measure the temperature of the buffer solution with a thermometer and set the TEMPERATURE^{°C} control to the value.
4. Allow the electrode to stabilize (1 minute approx.).
5. Adjust the STANDARDIZE control so that the readout shows the value of the pH7 buffer solution, i.e. 7.00.
6. Remove the electrode from the buffer solution and rinse with distilled water.
7. Immerse the electrode in pH = 4.001 buffer solution. Measure the temperature of this solution with a thermometer and adjust the TEMPERATURE^{°C} control to the value.
8. Allow sufficient time for the electrode to stabilize and then adjust the SLOPE control (with a screwdriver) to give 4.00 on the readout.
9. Rinse the electrode with distilled water, and check the pH = 7.00 buffer solution (usually the instrument holds its calibration). The instrument is now ready to use - see sheet 3B, for freshwater samples.

Notes

- (i) After use leave the electrode in distilled water without the end cap unless it is to be taken into the field, when the rubber end cap should be

replaced.

- (ii) The calibration of the meter should be checked after every ten samples.
- (iii) The meter should be run from the mains supply, using the adaptor for laboratory measurements.

METHOD SHEET 3B

Laboratory Measurement of Stream Water Sample pH

1. Calibrate the EIL 3050 pH meter as described in Sheet 3A.
2. Remove the cap from the 125 ml. sample bottle and discard approx. 10 - 20 ml. of water (to allow for the volume of the pH probe). Check the temperature of the sample with a thermometer and adjust the TEMPERATURE °C control accordingly.
3. Drop in a magnetic follower and place the bottle on the magnetic stirrer. Insert the pH electrode, taking care not to damage the electrode bulb.
4. Stir sample vigorously for 60 seconds.
5. Switch off the stirrer and allow the reading to stabilize for a further 60 seconds.
6. Record the reading displayed on the meter.

Notes

- (i) Allow the samples plenty of time to equilibrate to room temperature after storage in the incubator, before making measurements.
- (ii) The precision of the measurement is improved if the stirring and stabilization times are carefully adhered to.
- (iii) pH electrode should be rinsed with distilled water between each measurement.
- (iv) Check the meter calibration every ten samples.
- (v) Method is based on that of Sutcliffe, D. W. and Carrick, T. R., 1973, Freshwater Biol, 3, 437-462.

METHOD SHEET 3C

Laboratory Measurement of pH of Rainfall Soil Solution
and Lysimeter Drainage Water Samples

1. Calibrate the EIL 3050 pH meter as in Sheet 3A.
2. Decant approx. 50 ml. of sample into a plastic beaker (75 ml) and check the sample temperature with a thermometer. Adjust the TEMPERATURE °C control accordingly.
3. Drop in a magnetic follower and stir for 60 seconds
4. Switch off the stirrer and allow the reading to stabilize for a further 60 seconds.
5. Record the displayed readings.

Notes

- (i) Soil Solution samples are stored at 4°C, they should be allowed to equilibrate to room temperature before attempting measurements. Rainfall and lysimeter water are usually left at room temperature so pH can be measured directly.

METHOD SHEET 4A

Vacuum Filtration of 500 ml. Stream Water Samples

1. Soak 47 mm. Sartorius membrane filters (0.45 μm pore size) in distilled water over night in a covered 250 ml. beaker.
2. Place filters on a circle of Whatman No. 1 filter paper, cover with another circle and dry at 40 - 50°C in the drying cabinet. When dry place in the desiccator.
3. Weigh filters and place in individually numbered polythene bags.
4. Shake sample bottle well to resuspend and mix particulate matter and pour out exactly 500 ml. into a measuring cylinder (500 ml).
5. Assemble filtration apparatus by connecting buchner flask to the vacuum line (tap closed) and inserting the glass filter support and silicone rubber bung into the flask neck.
6. Dip a dry weighed filter paper into distilled water in a petri dish and place wet filter onto the support. Carefully, clamp the reservoir onto the filter support taking care not to crease the filter disc.
7. Open vacuum tap and pour approx 100 ml of sample into the reservoir. Continue adding sample to maintain a volume of 100 - 200 ml. in the reservoir until filtration is complete. If the filtration rate becomes very slow, replace with new filter and continue procedure, until all the sample has been filtered.
8. Discard the remaining sample in the bottle, rinse with a small volume (c. 25-50 ml) of distilled water and allow to drain.

9. When filtration is completed close the vacuum tap and bleed air into the flask. Disconnect the flask from the vacuum line. Dismantle the reservoir and remove the filter disc and place on a labelled circle of Whatman No. 1 filter paper. Transfer the filtrate to a labelled 250 ml sample bottle for analysis at Merlewood. A further subsample (c. 60 ml) should be transferred into a plastic screw top tub for cation analyses (Bangor). Discard any remaining sample. Store both samples in the incubator at 4°C. Filters should be oven dried for 1 - 2 days at 40 - 50°C and then placed in a desiccator to cool. Weigh the filters and store in individually numbered bags.
10. Rinse the measuring cylinder, flask, filter support and reservoir twice in distilled water and allow to drain. Repeat 4 - 10 for the next sample.

Notes

- (i) All glassware should have been cleaned as described in Method Sheet 1.
- (ii) Filters must only be handled using the white blunt ended plastic forceps, DO NOT TOUCH WITH FINGERS, as this not only contaminates the filter, but oils from the skin can prevent wetting of the filter and thus impede filtration.
- (iii) Several filter discs may be needed for samples containing large amounts of fine particulate material. The individual numbering of filter discs will therefore not correspond to the sample number. A careful record of the filter numbers used for each sample must be made.

(iv) Occasionally, particulate material may adhere to the sides of the filter reservoir during filtration. When this happens, agitate the filter unit to maintain the material in solution. If material is still adhering to the reservoir after filtration, this should be wiped off with tissue and the reservoir rinsed with plenty of distilled water.

METHOD SHEET 4B

Vacuum Filtration of Lysimeter, Soil Solution, Snow
Melt Water and Rainfall Samples

1. Soak 47 mm Sartorius membrane filters (0.45 um pore size) in distilled water overnight in a covered 250 ml beaker.
2. Assemble the filtration apparatus by connecting the buchner flask to the vacuum line (tap closed) and inserting the glass filter support and silicone rubber bung into the flask neck.
3. Remove a filter disc from the beaker using white plastic forceps, and allow excess water to drain off. Place the moist filter onto the filter support. Carefully clamp the reservoir onto the filter support, ensuring that the filter is not creased.
4. Shake the sample bottle well to resuspend and mix any particulate matter.
5. Open the vacuum tap and pour c. 100 ml of sample into the reservoir. Continue to add sample to maintain this volume in the reservoir until c.500 ml of sample has been filtered. The remaining sample can be discarded.
6. When filtration is complete, close the vacuum tap and bleed air into the flask. Disconnect the flask from the vacuum line. Dismantle the reservoir and discard the filter. Transfer c. 250 ml to a labelled 250 ml bottle for analysis at Merlewood and a further 60 ml (approx.) into a plastic tub or vial for cation analyses (Bangor). Store both samples at 4°C.

Notes

See notes (i), (ii) and (iv), METHOD SHEET 4A

METHOD SHEET 5

Determination of Alkalinity in Stream Water Samples

Reagents

(i) 0.01 N Hydrochloric Acid

Make up 50 ml of 0.1 N Hydrochloric acid from a BDH CVS standard HCl ampoule. Take 20 ml of 0.1 N HCl and dilute to 200 ml to give 0.01 N acid. Store the 0.1 N acid in a polypropylene bottle in the 'fridge'. The 0.01 N acid may also be kept in the cool for about two weeks.

(ii) Indicator solution

"BDH 4.5 Indicator"

Procedure

Transfer, by pipette, 100 ml of sample from a 125 ml sample bottle to a conical flask. Add 8 - 10 drops of indicator. Slowly run in the acid from a 10 ml burette swirling the flask continuously. Add the acid until the colour of the solution assumes a pale pink flush or until the measured pH reaches the chosen end point value (4.5)

Calculation

Titrant of normality 'n' contains 'n' meq of acid in each ml, so that each ml of standard acid used in the titration corresponds to n meq of alkalinity in the sample volume V (ml). If v ml of acid are used in the titration, the alkalinity of the sample in meq l⁻¹ is:

$$\frac{n \times 1000}{V} \quad v$$

When n = 0.01 and V = 100 ml, then the alkalinity of the sample is 0.1 v meq l⁻¹.

Notes

- (i) The standard acid maybe checked against a standard 0.0200 N carbonate solution. This is made up from 1.059 g of pure anhydrous Na_2CO_3 dried overnight at 110°C and dissolved in distilled water and diluted to 1000 ml exactly.

METHOD SHEET 6

Determination of Sodium in Water Samples

Standards

Using the BDH Sodium nitrate standard solution for AAS (1000 mg/1 Na), take 10 ml and make up to 100 ml with distilled water to give a stock solution, of 100 mg/1 Na.

Standard Range

ml Stock Solution	Total Volume	mg/1 Na
1	100	1
2	100	2
5	100	5
10	100	10

Method

Measure filtered water samples directly using the flame photometer (Method Sheet 8) against the Na standards using the Na filter. Plot a calibration curve of standard concentration vs. instrument readout to obtain actual concentrations of Na in the samples.

Alternatively, use the computer program AACAL to obtain the concentrations of Na in the samples from the instrument calibration data.

METHOD SHEET 7

Determination of Potassium in Water Samples

Using the BDH Potassium nitrate standard solution for AAS (1000 mg/1 K), take 10 ml and make up to 100 ml with distilled water to give a stock solution of 100 mg/1 K.

Standard Range

ml Stock Solution	Total Volume	mg/1 K
1	100	1
2	100	2
5	100	5
10	100	10

Method

Measure filtered water samples directly using the flame photometer (Method Sheet 8) against the K standards using the K filter. Plot a calibration curve of standard concentration vs. instrument readout to obtain actual concentrations of K in the samples.

Alternatively, use the computer program AACAL to obtain the concentrations of K in the sample from the instrument calibration data.

METHOD SHEET 8

Operation of the EEL Flame Photometer

1. Check all the connections, i.e. compressed air gas electricity and waste drainage.
2. Turn on the gas and ignite.
3. Turn on the compressed air and slowly adjust the pressure to 10 p.s.i.
4. Adjust the gas control so that the central blue flame breaks up into a number of cones.
5. Switch on the mains, and then switch on the galvanometer bulb.
6. Insert the required filter into the slot to the left of the lens.
7. Set the flame photometer to zero against a blank solution; by adjusting the SET ZERO knob.
8. Using the top working standard set the instrument to read 100 using the OFF SENSITIVITY knob on the front. Further adjustments of this and the SET ZERO knobs will probably be needed until the readings have stabilised at 100 and 0 respectively.
9. Use the intermediate standards to plot a calibration curve of concentration vs. instrument readout.
10. Aspirate the sample solutions and record the readout. Dilute any solutions that are too concentrated using distilled water.
11. Check the calibration of the instrument after every ten samples using the blank and appropriate standard.
12. At the end of the batch of analyses, aspirate distilled water for several minutes, shut down the instrument by switching off the gas first.

METHOD SHEET 9

Determination of Calcium in Water Samples

Standards

Using the BDH Calcium nitrate standard solution, for AAS (1000 mg/1 Ca) take 5 ml and dilute to 500 ml with distilled water to give a stock solution of 10 mg/1 Ca.

Standard Range

Volume of Stock Solution	Volume of La solution	Final Volume	Concentration of Standard
15	50	100	1.5
10	50	100	1.0
5	50	100	0.5
0	50	100	0.0

Instrument Parameters

Wavelength 422.7 nm
Slit 0.7 nm
Flame Air-Acetylene, Oxidising (lean blue)
Quoted Sensitivity 4 ppm standard = 0.20 abs units

Method

Dilute filtered samples in the ratio 1:1 with 0.5% w/v Lanthanum Chloride in approx. 0.5 M HCl. Estimate Ca using the Perkin-Elmer 280 AAS using the conditions and standards given above.

METHOD SHEET 10

Determination of Magnesium in Water Samples

Standards

Using the BDH Magnesium nitrate standard solution for AAS (1000 mg/1 Mg) take 5 ml and dilute to 500 ml with distilled water to give a stock solution of 10 mg/1 Mg.

Standard Range

Volume of Stock Solution	Volume of La Solution	Final Volume	Concentration of Standard
15	50	100	1.5
10	50	100	1.0
5	50	100	0.5
0	50	100	0.0

Instrument Parameters

Wavelength 285.2 nm
Slit 0.7 nm
Flame Air-Acetylene, Oxidising (lean blue flame)
Quoted Sensitivity 0.3 ppm = 0.19 abs units

Method

Dilute filtered water samples in the ratio 1:1 with 0.5% w/v Lanthanum chloride solution in approx 0.5 M HCl. Estimate Mg using the Perkin-Elmer 280 AAS using the standards and conditions given above.

METHOD SHEET 11

Preparation of 0.5% w/v Lanthanum Chloride Solution for
Ca and Mg Analysis

To prepare 1 l of 0.5% w/v La solution, take 50 ml of BDH 10% w/v La solution and dilute to 1000 ml with 0.5 M Hydrochloric acid.

Dilute samples and standards 1:1 with 0.5% w/v La solution before analysis for Ca and Mg by AAS.

APPENDIX I

Dilutions and Strengths of Various Lab. Reagents

Molarity of Concentrated Acid	Vol. Conc. Acid Per Litre (ml).	Molarity of dilute Acid
HCl 11.3 M	89	1 M
	442.5	5 M
	44.3	0.5 M
HNO ₃ 16 M	63	1 M
	31.3	0.5 M
NH ₃ 14.3 M	71	1 M
HAc 17.2M	58	1 M

APPENDIX II

Units

Four main systems of units for concentrations per unit volume (usually litre) are in common use.

1. By weight (strictly mass): e.g. mg/l and ng/l. The equivalences of these units, numerically and excluding very saline water, are given below:

$$\text{mg/l} \equiv \text{ng/ml} \equiv \text{g/m}^3 \equiv \text{ppm}$$

$$\text{ng/l} \equiv \text{ng/ml} \equiv \text{mg/m}^3 \equiv \text{ppb}$$

/l and /m³ can be written l⁻¹ and m⁻³

2. By chemical equivalents: e.g. milli-equivalent meq l⁻¹ and micro equivalent (µeq/l). Multiplication by the appropriate equivalent weight gives the concentration in the corresponding weight unit. Equivalent weight is normally equal to the atomic weight (or its sum in radicals), divided by the charge, see Table I, it may, however depend upon the particular reaction considered and so tends to be less used in general chemistry. The system is chiefly used for the major ions and allows cations and anions to be summed and compared with each other and with conductivity. It is also applicable to various operationally defined quantities (e.g. alkalinity, oxidizability) with a variable or unknown molecular basis. Table II gives simple conversion factors from mg/l - meq/l and mg/l - m.mol/l for most of the common elements and radicals.
3. By molarity: e.g. m.mol l⁻¹ (=mM), µ mol l⁻¹ (= µM). This is the most rational system of units and facilitates calculations involving theoretical (stoichiometric) ratios between components. It is not strictly applicable to constituents associated with varying molecular composition (e.g. alkalinity).
4. By atoms: e.g. µg - at l⁻¹. Multiplication by

TABLE I

Atomic Weights and Equivalent Weights of
some Common Elements and Ionic Species

Component	Atm. Wt.	Equivalent Weight
H	1	1
C	12.0	
N	14.0	
O	16.0	
P	31.0	
Na	23.0	23.0
Mg	24.3	12.16
Si	28.1	
S	32.1	
Cl	35.5	35.5
K	39.1	39.1
Ca	40.1	20.04
Mn	54.9	Mn ²⁺ 27.5
Fe	55.9	Fe ²⁺ 27.9
Cu	63.5	
Zn	65.4	
Ionic Molecular Wt.		
OH ⁻	17.0	17.0
CO ₃ ²⁻	60.0	30.0
HCO ₃ ⁻	61.0	61.0
SO ₄ ²⁻	96.1	48.0

TABLE II

Conversion Factors.

$$\text{mg/l} \times F_1 = \text{meq/l}; \text{mg/l} \times F_2 = \text{m.mol/l}$$

		F ₁	F ₂
Aluminium	(Al ³⁺)	0.11119	0.03715
Ammonium	(NH ₄ ⁺)	0.05544	0.05544
Bicarbonate	(HCO ₃ ⁻)	0.01639	0.01639
Calcium	(Ca ²⁺)	0.04990	0.02495
Carbonate	(CO ₃ ²⁻)	0.03333	0.01666
Chloride	(Cl ⁻)	0.02821	0.02821
Hydrogen	(H ⁺)	0.99209	0.99209
Hydroxide	(OH ⁻)	0.05880	0.05880
Iron	(Fe ²⁺)	0.03581	0.01791
Iron	(Fe ³⁺)	0.05372	0.01791
Magnesium	(Mg ²⁺)	0.08226	0.04113
Manganese	(Mn ²⁺)	0.03640	0.01820
Nitrate	(NO ₃ ⁻)	0.01613	0.01613
Nitrite	(NO ₂ ⁻)	0.02174	0.02174
Phosphate	(PO ₄ ³⁻)	0.03159	0.01053
Phosphate	(HPO ₄ ²⁻)	0.02084	0.01042
Phosphate	(H ₂ PO ₄ ⁻)	0.01031	0.01031
Potassium	(K ⁺)	0.02557	0.02557
Silica	(SiO ₂)	-	0.01664
Sodium	(Na ⁺)	0.04350	0.04350
Sulphate	(SO ₄ ²⁻)	0.02082	0.01041

the atomic weight gives the concentration in weight units. It is useful in assessing stoichiometric ratios of specific elements e.g. N and P and is mainly used in oceanography.

References

Mackereth et al 1978, Water Analysis, F. B. A. Sci.
Publ. No. 36.

Hem, J. D. 1970, Study and Interpretation of chemical characteristics of Natural Water. 2nd., Ed., U.S.G.S.
Wat. Supply Paper No.

APPENDIX III

Synopsis of Methods used by the Chemical Section,
Merlewood for the analysis of Water Samples
for Project 594

<u>Component</u>	<u>Method</u>
Fe	Flame atomic absorption
Mn	Flame atomic absorption
Al	Flame atomic absorption
PO ₄	Molybdenum blue with SnCl ₂ as reducing agent - Auto analyser.
NO ₃ /NO ₂	Reduction of NO ₃ to NO ₂ with hydrazine sulphate, followed by colorimetric detrmn of NO ₂ using sulphanilic acid and naphthylamine sulphuric acid - Auto Analyser.
Cl	Auto - Analyser, using mercury thiocyanate colorimetric method
SO ₄	Auto - Analyser, BaCl ₂ turbidimetric method.
Si	Auto - Analyser, Molybdenum blue colorimetric method.
T.O.C.	T.O.C. analyser (commercial instrument.)

For details of methods, see: Allen et al 1974
Chemical Analysis of Ecological Materials,
Blackwell Scientific Publications.

APPENDIX IV

Equipment and Chemicals

This list is intended purely as a guide to the equipment used in this work and does not constitute an endorsement of the products by the Institute of Terrestrial Ecology.

Article

Supplier

500 ml narrow mouth
polypropylene bottles

"Azlon" - Scientific Suppliers Co.,
Scientific House,
Vine Hill,
London. EC1

125 ml narrow
polypropylene bottles.

" "

All glass filtration apparatus
47 mm, Cat. No: XX15 04700

Millipore U.K. Ltd.,
Abbey Road,
Park Royal,
London. NW10

Cellulose acetate membrane
filters, Cat. No: SM 11106
0.45 μ m pore size, 47 mm
diameter

V.A. Howe & Co. Ltd.,
88 Peterborough Road,
London. SW6

Model 3050, portable digital
pH meter with plastic bodied
combination electrode
(EIL Part No. 1180 400).

EIL
Chertsey,
Surrey,
England

Model 280 Atomic Absorption
Spectrophotometer.

Perking Elmer Ltd.,
Beaconsfield,
Buckingham.

White nylon forceps

A. Gallenkamp & Co. Ltd.

Silicon rubber bungs

Jencons (Scientific) Ltd.,
Mark Road,
Hemel Hempstead.

Chemicals

Hydrochloric Acid Analar Grade

Concentrated Volumetric Solution hydrochloric acid, 0.1 N

Standard solutions for A.A.S.

Sodium Nitrate,
Calcium Nitrate,
Potassium Nitrate,
Magnesium Nitrate,
Lanthanum Chloride (10% w/v)

Buffer solutions, pH 4.0 (phthalate)
pH 7.0 (phosphate)

DECON 90

All chemicals supplied by BDH Chemicals Limited,
Shaw Road,
Speke,
Liverpool.