SALTERS ADVANCED CHEMISTRY

A2

TECHNICIANS MANUAL

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We also thank *CLEAPSS* for the excellent safety information, which has been used in the production of both the Technicians' and Students' Safety Sheets.

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Chris Peel
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Quantities in Requirements

The quantities given in the requirements are per student or group of students.

The bulk quantities given for preparing solutions may need to be adjusted to the needs of individual establishments, depending on the number of students or groups of students per experiment

Suppliers

Some information on suppliers for particular items is given in the Advance Warning and Technicians Sheets. This information however may go out of date. Updated information on suppliers can be found on the Salters website at, www.york.ac.uk/org/seg/salters/chemistry or, www.salterschem.org.uk.
Also on this site is a direct link to a discussion forum for Salters technicians, with simple instructions on how to register.

Technician and Student Safety Sheets

The technician and student safety sheets, have been compiled using the current *CLEAPSS* safety information. They include details of the hazard classification and specific risks associated with each chemical. They also deal with practical safety issues relating to the activity. Some *CLEAPSS Hazcard* references are given, particularly in the Students Safety Sheets. Some immediate first aid measures for eye and skin contact are included, but further information on first aid is available on the *CLEAPSS Hazcards*.

The safety sheets are not risk assessments in themselves, but they provide a guide towards a risk assessment for the specific activity. The degree of risk posed by any hazard depends on local procedures and conditions, for example laboratory size, number of students etc., and must incorporate local safety rules, guidelines and any updated safety information.
Whilst every effort has been made to ensure the information contained in this manual is correct, the authors cannot be held responsible for errors and omissions or held liable for any loss or damage, however arising. The final assessment of risk therefore, is the responsibility of individual schools and colleges.

Further information on safety matters can be obtained from the following sources.

- *CLEAPSS*. School Science Service, Brunel University, Uxbridge. As well as *Hazcards, CLEAPPS* provide information and advice on all aspects of science in schools and colleges. The benefits of membership far outweigh any costs.
- *Topics in Safety*, 3rd edition. Association for Science Education
- *Safeguards in the School Laboratory*, 10th edition. ASE, 1996
- *Safety Reprints*. ASE, 1996
- *Safety in Science Education*. DfEE, HMSO, 1996
- *Hazardous Chemicals: A Manual for Science Education*. SSERC Ltd, 1997
- Chemical suppliers' catalogues and Safety Data Sheets

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WHAT'S IN A MEDICINE

Advance warning

Activity	Item(s)	Quantities per expt.	Essential or Optional	
WM2	Oil of wintergreen	2 g	E	Available from chemists shops, or from chemical suppliers as methyl salicylate e.g. Aldrich, **Cat. No. M8050-4**
	Silica coated TLC plates	1 per expt	E	With fluorescent dye if UV light is to be used for detection The plates are sensitised ~ 260 nm so a UV lamp in that range is required

Notes

Chemicals required for WM

Chemical	Concs.	Quantities per group
2-hydroxybenzoic acid (salicylic acid)	 Sat. solution in ethanol	10 g Few drops
2-Methylpropan-2-ol		Few drops
Aspirin (acetyl salicylic acid)		1 crystal
Aspirin tablets		3
Butan-1-ol		Few drops
Butan-2-ol		Few drops
Chromatography solvent;- cyclohexane ethyl ethanoate conc. ethanoic acid		 20 cm^3 10 cm^3 1 drop
Conc. hydrochloric acid		Few drops
Ethanoic acid	2M Conc.	20 cm^3 10 cm^3
Ethanoic anhydride		10 cm^3
Ethanol		75 cm^3
Iron(III) chloride		Few g
Methanol		5 cm^3
Neutral iron(III) chloride		Few drops
Oil of wintergreen (methyl salicylate)		2 g
Phenol	Sat. solution in water	20 cm^3
Phenolphthalein indicator		Few drops
Potassium dichromate(VI)	0.1M	2 cm^3
Potassium manganate(VII)	0.2M	50 cm^3
Propan-1-ol		Few drops
Sodium carbonate	0.5M	200 cm^3
Sodium hydroxide	0.100M 2M	100 cm^3 25 cm^3
Sulphuric acid	2M Conc.	5 cm^3 Few drops

Notes

WM2 EXTRACTION OF SALICYLIC ACID

Requirements

50 cm^3 pear shaped flask and condenser	For reflux
Semi-micro burner	Or heating mantle
Anti bump granules	
25 cm^3 measuring cylinder	
10 cm^3 measuring cylinder	
100 cm^3 beaker	2
400 cm^3 beaker	Or bigger, for ice bath
Ice	
pH paper and charts	
Glass rod	
Dropping pipette	
Apparatus for vacuum filtration	e.g. Büchner flask and funnel and filter pump
Watch glass	
TLC plate	Dried in an oven at 105^{o} C for 15 minutes
Beaker	To hold TLC plate for chromatography
Melting point tubes	For spotting TLC plate
Cling film	Or watch glass to cover chromatography beaker
UV light	To view TLC plate, or a few crystals of iodine
Chromatography solvent	To cover the bottom of the beaker. – cyclohexane, ethyl ethanoate, concentrated ethanoic acid. (200:100:1)
Oil of wintergreen	2 cm^3
Ethanol	A few drops
Saturated solution of salicylic acid in ethanol	A few drops for TLC 'standard'. The conc. of the solution is not critical, as long as there is enough to give a spot on the TLC plate
Sodium hydroxide 2M	25 cm^3
Concentrated hydrochloric acid	A few drops

WM2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing oil of wintergreen	 Harmful  Harmful to environment	Harmful if swallowed. May cause eye irritation. Causes moderate skin irritation	 Wear eye protection  Wear protective gloves
Dispensing concentrated hydrochloric acid	 Corrosive	Causes burns. The vapour is very irritating to the respiratory system	 Wear safety goggles  Wear protective gloves. Use in a fume cupboard.
Preparation of 2M sodium hydroxide	**Solid & 2M soln.**  Corrosive	Solid and solution cause severe burns and are particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring.
Preparation of a solution of salicylic acid in ethanol & dispensing ethanol	**Salicylic acid**  Harmful **Ethanol**  Highly flammable	Harmful by inhalation, in contact with skin and if swallowed. Irritating to eyes respiratory system and skin. Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection.  Wear protective gloves. Avoid skin contact Avoid inhaling fumes or dust. Use in a fume cupboard and away from sources of ignition.
Preparation of chromatography solvent	**Cyclohexane**  Highly flammable  Harmful to environment	Risk of fire.	 Wear eye protection Keep away from sources of ignition.
	Ethyl ethanoate	Risk of vapour catching fire. May be irritating to eyes and respiratory system	 Wear eye protection Keep away from sources of ignition. Use in a well ventillated area
	Highly flammable **Conc. ethanoic acid**  Corrosive	Causes severe burns. Very irritating to the respiratory system.	 Wear eye protection  Wear protective gloves. Use in a fume cupboard. Avoid inhaling fumes.

WM3 INVESTIGATING THE CHEMISTRY OF THE -OH GROUP IN VARIOUS ENVIRONMENTS

Requirements

Small quantities (approx. 20 cm^3) of:	
ethanol	Labelled A
phenol	A saturated solution in water labelled B
ethanoic acid 2M	Labelled C
2-hydroxybenzoic acid solid	Labelled D
Glacial ethanoic acid	A few cm^3
Universal indicator solution and chart	
Iron(III) chloride	A few grams
Potassium dichromate(VI) solution 0.1M	2 cm^3- Dissolve 3 g of the salt in dist water. Make up to 100 cm^3 with dist. water
Methanol	5 cm^3
Concentrated sulphuric acid	A few cm^3
Sulphuric acid 2M	5 cm^3- Add 112 cm^3 of the concentrated acid slowly to 600 cm^3 dist. water. Make up to 1 dm^3 with dist. water
Sodium carbonate solution approx 0.5M	200 cm^3- Dissolve 53 g of the salt in dist. water. Make up to 1 dm^3 with dist. water
Test tubes	10
100 cm^3 beaker	8
A range of alcohols: propan-1ol butan-1ol butan-2-ol 2-methylpropan-2-ol	A few drops of each 2-Methylpropan-2-ol has a m.p. of 25.5 °C so if it is stored in a cold place it will need time to thaw
Source of hot water	
Spatula	
Dropping pipette	6

Notes

WM3 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing ethanol and universal indicator soln. (contains ethanol)	**Ethanol**  Highly flammable	Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.
Dispensing phenol	 Toxic	Toxic in contact with skin and if swallowed. Causes burns. Prolonged contact with skin may result in dermatitis. Vapour may irritate the respiratory system.	 Wear eye protection  Wear protective gloves. Avoid breathing fumes. Glycerol (propane-1,2,3-triol) can be used to treat burns
Dispensing concentrated ethanoic acid and making 2M ethanoic acid	**Conc. ethanoic acid**  Corrosive **2M ethanoic acid**  Irritant	Causes severe burns. Very irritating to the respiratory system. The vapour is flammable.	 Wear eye protection  Wear protective gloves. Use and dilute in a fume cupboard. Avoid inhaling fumes. Avoid sources of ignition near the vapour of the concentrated acid
Dispensing 2-hydroxybenzoic acid (salicylic acid)	**Salicylic acid**  Harmful	Harmful by inhalation, in contact with skin and if swallowed. Irritating to eyes respiratory system and skin.	 Wear eye protection.  Wear protective gloves. Avoid skin contact Avoid inhaling fumes or dust.
Dispensing solid iron(III) chloride	**Solid**  Irritant	Irritating to eyes and skin.	 Wear eye protection  Wear protective gloves. Avoid skin contact
Preparing 0.1M solution of potassium dichromate(VI)	**Solid and soln**  Toxic  Irritant  Harmful to environment	Chromates are suspected carcinogens. Irritating to eyes, respiratory system and skin.	 Wear eye protection.  Wear protective gloves. Avoid all skin contact. Any spillages should be washed off at once
Dispensing methanol	Highly flammable  Toxic	Methanol is toxic by inhalation, if swallowed and by skin absorption. Risk of fire.	 Wear eye protection  Wear protective gloves. Avoid inhaling fume. Use in a fume cupboard and away from sources of ignition.

Cont...

Operation	Hazard	Risks	Control measures
Dispensing concentrated sulphuric acid and making 2M sulphuric acid	**Conc. Sulphuric acid**  Corrosive **2M sulphuric acid**  Corrosive	The concentrated acid causes severe burns and has an affinity for water. Hence it is extremely dangerous to eyes, and can cause blindness if entering the eye. The act of diluting produces much heat, and if control measures are not taken the mixture can boil causing dangerous splashes.	 A full face shield should be worn.  Gloves should be worn. The conc. acid should be added very slowly to the distilled water, with constant stirring, cooling the beaker in a large vessel of cold water. **Never add water conc. to acid**
Preparation of 0.5M sodium carbonate solution	**Solid**  Irritant	Irritating to eyes skin and respiratory system.	 Wear eye protection  Wear protective gloves. Avoid inhaling dust
Dispensing butan-1-ol	Flammable  Harmful	The vapour is harmful by inhalation and may cause headaches and dizziness and can irritate the eyes and skin. Risk of fire	 Wear eye protection  Wear protective gloves. Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.
Dispensing Propan-1-ol & propan-2-ol	 Highly flammable  Harmful	Serious risk of damage to eyes. Vapours may cause drowsiness or dizziness. Risk of fire.	 Wear eye protection  Wear protective gloves. Avoid inhaling vapour. Use away from sources of ignition.
Dispensing 2-methylpropan-2-ol	Highly flammable  Harmful	Can catch fire very easily. Harmful by inhalation. The vapour may cause dizziness and headaches and can irritate the eyes and skin.	 Wear eye protection.  Wear protective gloves. Dispense in a fume cupboard. Avoid inhaling vapour. Keep away from any sources of ignition.

Notes

WM5.1 A PREPARATION OF ASPIRIN

Requirements

100 cm^3 conical flask	
10 cm^3 measuring cylinders	2
Stirring rod	
Apparatus for vacuum filtration	Eg Büchner flask and funnel, and filter pump
2-Hydroxybenzoic acid (salicylic acid)	2 g
Glacial ethanoic acid	4 cm^3
Ethanoic anhydride	4 cm^3
Concentrated sulphuric acid	5 drops
Dropping pipette	
Test tubes	4
Water bath containing crushed ice	
Aspirin (acetylsalicylic acid)	1 crystal
Access to balance	
Source of hot water	
Neutral iron(III) chloride	1 cm^3- Dissolve 1.4 g of the salt in dist. water. Make up to 100 cm^3 with dist. water. Add dilute (1M) ammonium hydroxide slowly until the first faint precipitate remains

Notes

WM5.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing 2-hydroxybenzoic acid (salicylic acid)	**Salicylic acid**  Harmful	Harmful by inhalation, in contact with skin and if swallowed. Irritating to eyes respiratory system and skin.	 Wear eye protection.  Wear protective gloves. Avoid skin contact Avoid inhaling fumes or dust.
Dispensing ethanoic anhydride	 Corrosive	Causes burns with blistering and peeling. Contact with eyes may cause delayed damage. Extremely irritating vapour. Can catch fire if heated. Reacts violently with water	 Wear eye protection  Wear protective gloves. Use only in a fume cupboard. Avoid breathing vapour. Do not put waste down drain undiluted.
Dispensing concentrated sulphuric acid	**Conc. Sulphuric acid**  Corrosive	The concentrated acid causes severe burns and has an affinity for water. Hence it is extremely dangerous to eyes and can cause blindness if entering the eye.	 A full face shield should be worn.  Gloves should be worn.
Dispensing concentrated ethanoic acid	**Conc. ethanoic acid**  Corrosive	Causes severe burns. Very irritating to the respiratory system. The vapour is flammable.	 Wear eye protection  Wear protective gloves. Use in a fume cupboard. Avoid inhaling fumes. Avoid sources of ignition near the vapour of the concentrated acid
Dispensing aspirin (acetyl salicylic acid)	 **Harmful**	Harmful if swallowed. Irritating to eyes, skin and respiratory system	 Wear eye protection  Wear protective gloves.
Preparing neutral iron(III) chloride	**Solid**  Irritant 1M ammonia Low hazard	Irritating to eyes and skin.	 Wear eye protection  Wear protective gloves. Avoid skin contact

Notes

WM6 AN ASPIRIN ASSAY

Requirements

Aspirin tablets (300 mg)	3
Mortar and pestle	
Spatula	
Specimen tubes	3
100 cm^3 conical flask	3
10 cm^3 measuring cylinder	
Burette and funnel	
White tile	
Phenolphthalein indicator	
Ethanol 95%	50 cm^3
Sodium hydroxide 0.100M (Accurate for titration)	100 cm^3- Dissolve 4 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Access to balance	

Notes

WM6 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing 95% ethanol and phenolphthalein indicator solution (contains ethanol)	**Ethanol**  Highly flammable	Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.
Preparing 0.1M sodium hydroxide solution	**Solid**  Corrosive	Solid causes severe burns and is particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring.

Notes

Notes on "What's in a medicine"

DESIGNER POLYMERS

Advance warning

The following items are needed for activities in this unit and may not be already in your school or college and might take a little time to obtain

Activity	Item(s)	Quantities per expt.	Essential or Optional	
DP 2.1	Decanedioyl dichloride 5% solution in cyclohexane 1,6-Diaminohexane 5% in 0.5M sodium carbonate	1 cm^3 1 cm^3	E E	
DP 2.2	Nylon 6,6 granules	2 g	E	Must be nylon-6,6 **NOT** (nylon-6)

Notes

Chemicals required for DP

Chemical	Concs.	Quantities per group
1, 6-Diaminohexane	5% in 0.5M sodium carbonate	1 cm^3
Decanedioyl dichloride	5% in cyclohexane	1 cm^3
Nylon-6,6 granules		2 g
Sodium hydrogen carbonate	Sat. solution	20 cm^3
Sodium hydroxide	2M	5 cm^3
Sulphuric acid	30%	35 cm^3

Notes

DP2.1 MAKING NYLON

Requirements

5 cm^3 beaker	
Decanedioyl dichloride solution	1 cm^3- 5 % solution in cyclohexane
1, 6-Diaminohexane solution	1 cm^3- 5 % solution in 0.5M sodium carbonate solution. To make 0.5M sodium carbonate, dissolve 5.3 g of the anhydrous solid in dist. water. Make up to 100 cm^3 with dist. water
Glass rod	
Tweezers	
Disposable gloves	

Notes

DP2.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparation of 5% solution of decanedioyl dichloride	**Decanedioyl dichloride**  Corrosive  Highly flammable	Causes severe burns. It has an offensive odour which is very irritating to the respiratory system. Vapour can catch fire.	 Wear eye protection  Wear protective gloves. Use in a fume cupboard away from sources of ignition
	Cyclohexane  Highly flammable  Harmful to environment	Risk of fire	 Wear eye protection. Keep away from sources of ignition
Preparation of 5% solution of 1,6-diaminohexane	**1,6-Diaminohexane**  Irritant	Irritating to eyes. Unpleasant fumes.	 Wear eye protection Use in a fume cupboard
	Solid sodium carbonate  Irritant	Irritating to eyes skin and respiratory system.	 Wear eye protection  Wear protective gloves. Avoid inhaling dust

Notes

DP2.2 TAKING NYLON APART

Requirements

Nylon-6,6 granules	2 g
100 cm^3 round bottom flask fitted with a reflux condenser	Quickfit reflux apparatus
Sulphuric acid 30%	35 cm^3- Add 300 cm^3 of the conc. acid slowly with stirring and cooling to 500 cm^3 dist. water. Make up to 1 dm^3 with dist. water
Anti-bump granules	
250 cm^3 conical flasks	2
Melting point apparatus and tubes	For use up to 150 ^oC
Vacuum filtration apparatus	Büchner flask, funnel and paper and pump
Saturated sodium hydrogen carbonate solution	20 cm^3
Sodium hydroxide solution 2M	5 cm^3- Dissolve 8 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
100 cm^3 measuring cylinder	
Ice	
Electric heating mantle	
250 cm^3 beaker	2
10 cm^3 measuring cylinder	
Watch glass	
Spatula	
pH paper and chart	
Access to balance	

Notes

DP2.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparation of a solution of 30% sulphuric acid	**Concentrated sulphuric acid**  Corrosive **30% sulphuric acid**  Corrosive	Causes severe burns. The concentrated acid has an affinity for water. Hence it is extremely dangerous to eyes, and can cause blindness if entering the eye. The act of diluting produces much heat and if control measures are not taken the mixture can boil causing dangerous splashes.	 Wear a full-face shield.  Gloves should be worn. The conc. acid should be added very slowly to the distilled water, with constant stirring, cooling the beaker in a large vessel of cold water. **Never add water to the conc. acid**
Preparation of 2M sodium hydroxide	**Solid sodium hydroxide**  Corrosive **2M sodium hydroxide**  Corrosive	The solid causes severe burns and is particularly dangerous to eyes Gets very hot when added to water. Causes burns and particularly dangerous to eyes	 Wear goggles or face-shield  Wear protective gloves Add the solid to the water slowly with constant stirring to dissipate the heat produced If any solid or solution enters the eye, immediately flush with copious amounts of water from a hose connected to a tap. Continue to irrigate for 10 minutes and seek medical advice.

Notes

Notes on "Designer Polymers"

ENGINEERING PROTEINS

Advance warning

The following items needed for activities in this unit may not be already in your school or college and might take a little time to obtain

Activity	Item(s)	Quantities per expt.	Essential or Optional	
EP2.2	'Canderel' tablets (aspartame) Aspartic acid & phenylalanine	1-3 Small amounts for chromato-graphy	E	
EP2.5	Spearmint chewing gum Caraway seeds	$^1/_2$ piece 20	E E	
EP2.7	Plastic coated wire 'Minit' molecular model peg type a: Ref 0293 (white) to 0300 (green) depending on colour 21 cm red plastic tubes: Ref 0289	1 metre 30 8	E E E	E.g 30 x 0.25 mm stranded, available from RS Components Ltd, PO Box 99, Corby, Northants, NN17 4RS Tel: 01536 201201 Available from Cochranes of Oxford, Leafield, Witney, Oxon, OX8 5NY Tel: 01993 878641. or from Aldrich Chemical Co. **Cat No. Z,12,720-5 (white)** **Z15,981-6 (green)** Available from Cochranes or Aldrich **Cat No. Z15,960-3**
EP6.1	Clinistix™ or Diastix ™ glucose test strips	5-10	E	Available from chemist shops
EP6.4	Potassium peroxodisulphate(VI) ($K_2S_2O_8$)	0.1 g	E	

Notes

Chemicals required for EP

Chemical	Conc.	Quantity per group
Aminoethanoic acid (glycine)		2 g
Aspartame		1>3 tablets
Aspartic acid	0.01M	Few cm^3
Butan-1-ol		20 cm^3
Butylamine		2 cm^3
Concentrated ethanoic acid		4 cm^3
Copper(II) sulphate solution	0.1M	2 cm^3
Ethanoyl chloride		2 cm^3
Glucose	0.02M	100 cm^3
Glucose test strips		~10
Hydrochloric acid	0.01M 4M 2M 1M	2 cm^3 25 cm^3 25 cm^3 30 cm^3
Hydrogen peroxide	5 vol.	25 cm^3
Ninhydrin solution	0.5% in butan-1-ol	Spray bottle
Phenylalanine	0.01M	Few cm^3
Potassium iodide	1M	15 cm^3
Potassium peroxodisulphate(VI)	0.0400M	10 cm^3
Samples of any sugars		Few grams
Sodium hydroxide	2M 1M 0.01M	10 cm^3 Few cm^3 2 cm^3
Sodium thiosulphate	0.0100M	10 cm^3
Starch	1%	5 cm^3
Universal indicator paper		Few pieces
Yeast suspension	1.25%	20 cm^3

Notes

EP2.1 INVESTIGATING AMINES AND AMINO ACIDS

Requirements

Universal indicator paper & chart	
Butylamine	2 cm^3
Ethanoyl chloride (acetyl chloride)	2 cm^3
Aminoethanoic acid (glycine)	2 g
Concentrated hydrochloric acid	A few drops
Sodium hydroxide solution 2M	10 cm^3- Dissolve 80 g of the solid slowly in 600 cm^3 dist. water. Make up to 1 dm^3 with dist. water
Hydrochloric acid 0.01M	2 cm^3- Make up 0.1M by adding 8.6 cm^3 of the conc. acid to dist. water. Make up to 1 dm^3 with dist. water, then take 10 cm^3 of the 0.1M acid and dilute to 100 cm^3 with dist. water
Sodium hydroxide solution 0.01M	2 cm^3- Make 0.1M by dissolving 4 g of the solid in dist. water. Make up to 1 dm^3 with dist. water, then take 10 cm^3 of the 0.1M solution and make it up to 100 cm^3 with dist. water
Copper(II) sulphate solution 0.1M	2 cm^3- Dissolve 2.5 g of the hydrated salt in dist. water. Make up to 100 cm^3 with dist. water
Dropping pipettes	6
Test tubes	10
Spatula	
Protective gloves	

Notes

EP2.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing butylamine	 Highly flammable  Irritant	Vapour will easily catch fire. Irritating to eyes, respiratory system and skin.	 Wear eye protection.  Wear protective gloves. avoid skin contact. Use in a fume cupboard away from sources of ignition. Avoid breathing vapour
Dispensing concentrated hydrochloric acid and making 0.01M hydrochloric acid	**Concentrated acid**  Corrosive	Causes burns. The vapour is very irritating to the respiratory system	 Wear safety goggles  Wear protective gloves. Dilute adding the acid slowly to water in a fume cupboard.
Preparing solutions of sodium hydroxide	**Solid**  Corrosive **2M solution**  Corrosive	The solid causes severe burns and is particularly dangerous to eyes Gets very hot when added to water. Causes burns and particularly dangerous to eyes	 Wear goggles or face-shield  Wear protective gloves Add the solid to the water slowly with constant stirring to dissipate the heat produced If any solid or solution enters the eye, immediately flush with copious amounts of water from a hose connected to a tap. Continue to irrigate for 10 minutes and seek medical advice.
Preparing a 0.1M solution of copper(II) sulphate	**Solid**  Harmful  Harmful to environment	Harmful if swallowed. The solid may be irritating to eyes and skin and has been known to sensitise the skin.	 Wear eye protection  Wear protective gloves.
Dispensing ethanoyl chloride	 Corrosive  Highly flammable	Causes severe burns. It has an offensive odour which is very irritating to the respiratory system. Vapour can easily catch fire. Dangerous violent reaction with water producing choking fumes of hydrogen chloride	 Wear eye protection  Wear protective gloves. Avoid skin contact and breathing vapour. Use in a fume cupboard away from sources of ignition. **DO NOT PUT UNDILUTED WASTE DOWN SINKS**

Notes

EP2.2 WHAT'S IN ASPARTAME?

Requirements

Aspartame	1-3 tablets. e.g. 'Canderel'
Hydrochloric acid 4M	25 cm^3- Add 344 cm^3 of the conc. acid to 600 cm^3 dist. water. Make up to 1 dm^3 with dist. water
Hydrochloric acid 2M	25 cm^3- Dilute some of the 4M acid by half
Hydrochloric acid 1M	25 cm^3- Dilute some of the 2M acid by half
Butan-1-ol	20 cm^3
Glacial ethanoic acid	4 cm^3
Aspartic acid solution 0.01M	A few cm^3 for chromatography- Dissolve 1.33 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Phenylalanine solution 0.01M	A few cm^3 for chromatography- Dissolve 1.65 g of the acid in dist. water. Make up to 1 dm^3 with dist. water
Ninhydrin reagent 0.5%	Dissolve 0.5 g of ninhydrin in butan-1-ol. Make up to 100 cm^3 with butan-1-ol, and pour into a spray bottle
Pestle and mortar	
Separating funnel	
25 cm^3 measuring cylinder	
10 cm^3 measuring cylinder	
Apparatus for reflux	e.g. jointed glassware kits
Anti-bump granules	
250 cm^3 beaker	
Hair dryer	
Apparatus for paper chromatography	e.g. Chromatography paper, tall jars or beakers with lids, capillary tubes

EP2.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dilution of concentrated hydrochloric acid to make 4M, 2M, & 1M	**Conc acid**  Corrosive **4M, 2M,1M hydrochloric acid**  Irritant	Concentrated hydrochloric acid is corrosive and the fumes irritate the eyes and respiratory system	 Wear a face shield.  Dispense the concentrated acid in a fume cupboard. Dilute the conc. acid in a fume cupboard by adding the **acid to water** Take great care when opening bottles of the conc. acid on hot days
Dispensing butan-1-ol	 Flammable  Harmful	Harmful by inhalation. Vapour may cause headaches and dizziness and can irritate eyes and skin	 Wear eye protection  Wear protective gloves Dispense in a fume cupboard. Keep away from sources of ignition
Dispensing concentrated ethanoic acid	 Corrosive  Irritant  Flammable	The concentrated acid causes severe burns. The vapour is very irritating to eyes and the respiratory system. The vapour is flammable above 40°C	 Wear safety goggles  Wear protective gloves. Avoid skin contact and breathing vapour. Use in a fume cupboard
Preparing and dispensing ninhydrin reagent	**Ninhydrin solid**  **Harmful** **Ninhydrin reagent and butan-1-ol**  Harmful  Highly flammable	The ninhydrin solid and solution,are harmful in contact with skin and if swallowed. They are irritating to eyes, skin and respiratory system. Contact with the skin produces a violet stain, which can persist for several days. The butan-1-ol is harmful by inhalation. Vapour may cause headaches and dizziness and can irritate eyes and skin	 Wear eye protection  Wear protective gloves. Use, dissolve, and dispense all ninhydin solid and solution and butan-l-ol in a fume cupboard and away from naked flames. If it comes into contact with skin, wash with lots of soap and water Use spray only in a fume cupboard

Notes

EP2.5 A TESTING SMELL

Requirements

Spearmint chewing gum	A half of a piece
Caraway seeds	Approx 20
Boiling tubes wrapped in foil to obscure contents	3
Stoppers for boiling tubes	3- Use cotton wool as rubber bungs can retain the odour
Pestle and mortar	

Notes

EP6.1 TESTING FOR GLUCOSE

Requirements

Glucose test strips	10- e.g. 'Clinistix'™. Available from chemist shops
Glucose solution 0.02M	100 cm^3- Dissolve 3.62 g of the sugar in dist. water. Make up to 1 dm^3 with dist. water
Small beakers (50 cm^3)	5
Boiling tubes	5
Thermometer 0-110 ^oC	
pH paper and charts	Or pH meter, electrode and buffer solutions
Hydrochloric acid 1M	A few cm^3- Add 8.6 cm^3 of the conc. acid to dist. water. Make up to 100 cm^3 with dist. water
Sodium hydroxide solution 1M	A few cm^3- Dissolve 4 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Solutions or solid samples of other sugars	A few cm^3 or grams

Notes

EP6.1 Technicians Safety Sheet

Operation	*Hazard*	Risks	Control measures
Dilution of concentrated hydrochloric acid to make 1M acid	**Conc acid**  Corrosive **1M hydrochloric acid**  Irritant	Concentrated hydrochloric acid is corrosive and the fumes irritate the eyes and respiratory system	 Wear a face shield.  Dispense the concentrated acid in a fume cupboard. Dilute the conc. acid in a fume cupboard by adding the **acid to water** Take great care when opening bottles of the conc. acid on hot days
Preparation of 1M sodium hydroxide	**Solid & 1M soln.**  Corrosive	Solid and solution cause severe burns and are particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring.

Notes

EP6.3 THE EFFECT OF ENZYME AND SUBSTRATE CONCENTRATIONS ON THE RATE OF A REACTION

Requirements

Burette	
Trough or bowl	
Boiling tube with bung and delivery tube	To enable gas produced in the boiling tube to be collected in an inverted burette, as in the diagram in students 'Activities'
5 cm^3 graduated pipette and filler	
10 cm^3 measuring cylinder	
Hydrogen peroxide 5 vol.	25 cm^3- Dilute from 100 vol. Or from fresh 20vol.
Yeast suspension	20 cm^3- Mix 2 g dried yeast with 160 cm^3 dist. water, and aerate for several hours
100 cm^3 beaker	
Stopwatch	

Notes

EP6.3 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dilution of 100vol. or 20vol. hydrogen peroxide	**100 & 20 vol.**  Corrosive	Causes burns. Irritating to eyes and skin. Dangerous if swallowed	 Wear eye protection  Wear protective gloves.

Notes

EP6.4 USING THE IODINE CLOCK METHOD TO FIND THE ORDER OF A REACTION

Requirements

0-110 ^{o}C thermometer	
Boiling tubes	5
Test tubes	5
Burettes or graduated pipettes to deliver 1 cm^3, 2 cm^3, 5 cm^3	5- If burettes are used, sets of five can be arranged around the lab and shared
Potassium iodide solution 1.00M	15 cm^3- Dissolve 166.01 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Potassium peroxodisulphate(VI) ($K_2S_2O_8$) 0.0400M (accurate)	10 cm^3- Dissolve 10.81 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Sodium thiosulphate ($Na_2S_2O_3$) 0.0100M (accurate)	10 cm^3- Dissolve 2.48 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Fresh starch solution	5 cm^3- Make a paste with 1 g of starch and cold dist. water. Boil approx. 70 cm^3 dist. water and add to the paste stirring constantly. Boil the solution for 1 minute. Cool, make up to 100 cm^3 with dist. water
Stop watch	

Notes

EP6.4 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparation of 0.0400M solution of potassium peroxodisulphate (VI)	**Solid**  Oxidiser  Irritant **Solution**  Harmful	Contact with combustible material may cause fire. Irritating to eyes, skin and respiratory system. Harmful if swallowed	 Wear eye protection  Wear protective gloves. Avoid skin contact. Do not breathe dust.

Notes

Notes on "Engineering Proteins"

THE STEEL STORY

Advance warning

The following items needed for activities in this unit may not be already in your school or college and might take some time to obtain

Activity	Item(s)	Quantities per expt	Essential or Optional	
SS1.1	Potassium iodate(VII) (periodate) KIO_4 Colorimeter	0.5 g 1	E E	
SS1.2	Spinach/spinach beet or rhubarb leaves	15 g (5 g if using rhubarb leaves)	E	
SS5.1	Ammonium vanadate(V) (metavanadate) NH_4VO_3	0.25 g	E	
SS5.2	Potassium sodium 2,3-dihydroxybutanedioate (potassium sodium tartrate or Rochelle salt) Cobalt(II) chloride	2.5 g 0.25 g	E E	
SS5.3	Nickel(II) chloride Ethylenediaminetetraacetic acid disodium salt (Na_2H_2edta)	1 g 0.5 g	E E	

Notes

Chemicals required for SS

Chemical	Concs.	Quantities per group
Ammonia solution	Conc. 2M	5 cm^3 20 cm^3
Ammonium vanadate(V)		0.25 g
Cobalt(II) chloride		0.25 g
Copper strips		1
Copper(II) sulphate	1M	150 cm^3
EDTA di sodium salt	0.1M	5 cm^3
Hydrochloric acid	Conc. 2M	2 cm^3 2 cm^3
Hydrogen peroxide	20 vol	20 cm^3
Iron filings		1 g
Iron nails		3
Iron(II) ammonium sulphate	0.1M	2 cm^3
Iron(II) sulphate	1M	50 cm^3
Iron(III) chloride	1M	4 cm^3
Mild steel strips		3
Nickel chloride		1 g
Nitric(V) acid	2M	100 cm^3
Phosphoric(V) acid		10 cm^3
Potassium bromide	1M	50 cm^3
Potassium chloride	1M	50 cm^3
Potassium hexacyanoferrate(III)	For ferroxyl	0.5g
Potassium iodate(VII) (periodate)	5%	10 cm^3
Potassium iodide	1M 0.05 M	50 cm^3 2 cm^3
Potassium nitrate(V)	Sat. solution	50 cm^3
Potassium manganate(VII)	 0.01M 0.02M	Few grams 150 cm^3 10 cm^3
Potassium sodium 2,3-dihydroxybutanedioate (tartrate) or Rochelle salt		2.5 g
Sodium chloride	For ferroxyl	5 g
Sodium hydroxide	2M	215 cm^3
Sodium sulphite		1 g
Sodium thiosulphate	0.1M	2 cm^3
Sulphuric acid	Conc. 1M	5 cm^3 350 cm^3
Zinc foil		Small piece
Zinc powder		1>2 g
Zinc strips		1
Zinc sulphate	1M	70 cm^3

SS1.1 HOW MUCH MANGANESE IS THERE IN A PAPER CLIP?

Requirements

Paper clip	
Wire cutters or strong scissors	
250 cm^3 beaker	
Watch glass	To cover beaker
10 cm^3 measuring cylinder	
100 cm^3 measuring cylinder	
100 cm^3 graduated flask and stopper	
Small funnel	
Colorimeter	With appropriate filter
Thin walled matched test tubes for colorimeter	Or cuvettes
Additional glassware as required-e.g. 10 cm^3 pipettes 100 cm^3 conical flask 100 cm^3 beaker 1 dm^3 graduated flask	
Nitric acid 2M	100 cm^3-Slowly add 128 cm^3 of the conc. acid to 600 cm^3 of dist. water. Make up to 1 dm^3 with dist. water.
Sulphuric acid 1M	100 cm^3- Slowly add 56 cm^3 of the conc. acid, stirring constantly, to 600 cm^3 dist. water. Make up to 1 dm^3 with dist. water
Potassium iodate(VII) solution (KIO_4) (potassium periodate) 5%	10 cm^3-dissolve 5 g of the solid in 100 cm^3 of 2M nitric acid
Solid potassium manganate(VII)	Few grams
Phosphoric(V) acid-(orthophosphoric acid)	10 cm^3
Spatula, stirring rod	
Access to balance	

SS1.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dilution of concentrated nitric acid to 2M	**Conc nitric acid**  Corrosive  Oxidiser **2M nitric acid**  Corrosive	Concentrated nitric acid fumes are an irritant to the respiratory system. The fumes are of nitrogen dioxide, which is toxic. The fumes and the liquid are corrosive to skin, eyes and the linings of the respiratory system.	 A full face shield should be worn. Pour out, and dilute in a fume cupboard, adding the concentrated acid slowly to distilled water.  Gloves should be worn. Spillages on the skin should be washed with lots of soap and water, but may still cause the skin to turn brown and peel off.
Dilution of concentrated sulphuric acid to 1M	**Conc. Sulphuric acid**  Corrosive **1M sulphuric acid**  Irritant	The concentrated acid causes severe burns and has an affinity for water. Hence it is extremely dangerous to eyes, and can cause blindness if entering the eye. The act of diluting produces much heat and if control measures are not taken the mixture can boil causing dangerous splashes.	 A full face shield should be worn.  Gloves should be worn. The conc. acid should be added very slowly to the distilled water, with constant stirring, cooling the beaker in a large vessel of cold water. **Never add water to the conc. acid**
Preparation of a 5% solution of potassium iodate(VII)	**Solid**  Harmful  Irritant  Oxidiser	Do not breathe the dust. It is harmful and an irritant. It is an oxidiser and can cause a fire if mixed with combustible materials	 Safety goggles must be worn. Handle the solid with care. Store oxidisers away from combustible materials and in particular, away from flammables.  Gloves may be necessary, especially for those with sensitive skin.
Dispensing solid potassium manganate (VII)	**Solid**  Harmful  Irritant  Oxidiser  Harmful to environment	Do not breathe the dust. It is harmful and an irritant. It is an oxidiser and can cause fire or explosions, if mixed with combustible materials. The solid will stain skin and clothing if it comes into contact with them	 Safety goggles must be worn. Handle the solid with care. Store oxidisers away from combustible materials and in particular, away from flammables.  Gloves may be necessary, especially for those with sensitive skin.
Dispensing phosphoric (V) acid	 Corrosive	Corrosive to skin	 Safety goggles must be worn  Gloves may be worn. Pour out with care.

SS1.2 A REDOX TITRATION

Requirements

Spinach, spinach beet, or rhubarb leaves	15 g (5 g if using rhubarb leaves)
Scissors	
250 cm^3 beaker	
Sulphuric acid 1M	300 cm^3- Add 56 cm^3 of the conc. acid slowly to dist. water with stirring. Make up to 1 dm^3 with dist. water.
100 cm^3 measuring cylinder	
Apparatus for vacuum filtration	
100 cm^3 volumetric flask	
10 cm^3 pipette and filler	
250 cm^3 conical flask	3
0-100 ^oC thermometer	
Burette and funnel	
White tile	
Potassium manganate(VII) solution, 0.01M	150 cm^3- Dissolve 1.58 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Access to balance	

Notes

SS1.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dilution of concentrated sulphuric to 1M	**Conc. Sulphuric acid**  Corrosive **1M sulphuric acid**  Irritant	The concentrated acid causes severe burns and has an affinity for water. Hence it is extremely dangerous to eyes, and can cause blindness if entering the eye. The act of diluting produces much heat and if control measures are not taken the mixture can boil causing dangerous splashes.	 A full face shield should be worn.  Gloves should be worn. The conc. acid should be added very slowly to the distilled water, with constant stirring, cooling the beaker in a large vessel of cold water. **Never add water to conc.acid**
Preparing potassium manganate(VII) solution 0.010M	Solid  Oxidiser  Harmful  Harmful to environment	Contact with combustible material can cause fire. Harmful if entering the eyes and if swallowed The solution at this concentration is not harmful but contact with eyes should be avoided, and if in contact with skin will stain it brown.	 Eye protection must be worn  Wear protective gloves when handling the solid.
Preparing and disposing of rhubarb leaves	 Toxic	Toxic if swallowed because of the high oxalate content	 Wear eye protection Wash hands thoroughly after handling

Notes

SS3.1 A SIMPLE REDOX REACTION

Requirements

Test tubes or small beakers	3
Strips of zinc and copper	Long enough to reach into the test tubes or beakers
Copper(II) sulphate solution 1M	20 cm^3- Dissolve 250 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Zinc(II) sulphate solution 1M	20 cm^3- Dissolve 287 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
0-110 ^oC thermometer	
Small filter funnels and paper	
Spatula	
Zinc powder	1 g
Tweezers	

Keep unused solutions for SS3.2 and SS3.3

Notes

SS3.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparing 1M copper(II) sulphate	**Solid & IM soln.**  Harmful  Harmful to environment	Harmful if swallowed. The solid may be irritating to eyes and skin and has been known to sensitise the skin.	 Wear eye protection  Wear protective gloves.
Dispensing zinc powder	 Flammable	Risk of fire. Contact with water liberates a flammable gas (hydrogen) . Moist zinc dust can ignite spontaneously	 Wear eye protection. Keep dry

Notes

SS3.2 SIMPLE ELECTROCHEMICAL CELLS

Requirements

Connecting leads with croc-clips	2
Iron nail	1, 4 inches long
Strip of copper	Long enough to fit into 100 cm^3 beaker
Strip of zinc	Long enough to fit into 100 cm^3 beaker
Strip of filter paper soaked in saturated potassium nitrate(V) solution	Long enough to reach from one beaker to another with the ends in the solutions
Copper(II) sulphate solution 1M	50 cm^3- Prepare as for SS3.1
Zinc(II) sulphate solution 1M	50 cm^3- Prepare as for SS3.1
Iron(II) sulphate solution 1M	50 cm^3- Dissolve 278 g of the solid in 600 cm^3 dist. water. Add 50 cm^3 2M sulphuric acid, make up to 1 dm^3 with dist. water
Piece of emery paper	To clean electrodes
100 cm^3 beakers	4
High resistance voltmeter	E.g. digital voltmeter

Notes

SS3.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparing 1M copper(II) sulphate	**Solid & IM soln.**  Harmful  Harmful to environment	Harmful if swallowed. The solid may be irritating to eyes and skin and has been known to sensitise the skin.	 Wear eye protection  Wear protective gloves.
Preparing 1M iron(II) sulphate solution	**Solid**  Harmful **Solution**  Harmful	Harmful if swallowed. May be irritating to eyes and skin	 Wear eye protection
Preparing a saturated solution of potassium nitrate(V) (for salt bridges)	 Oxidiser	Risk of fire with combustible materials.	 Wear eye protection Keep away from combustible materials

Notes

SS3.3 MORE ELECTROCHEMICAL CELLS

Requirements

100 cm^3 beaker	4
Connecting leads and croc-clips	3
3 volt DC power supply	
Clean graphite electrodes	2
Electrode holder	
Filter paper strips soaked in saturated potassium nitrate(V) solution	For a salt bridge as in SS3.2
Copper(II) sulphate solution 1M	50 cm^3- Prepare as in SS3.1
Copper strip	To fit into 100 cm^3 beakers
Emery paper	
Potassium iodide solution 1M	50 cm^3- Dissolve 166 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Potassium bromide solution 1M	50 cm^3- Dissolve 119 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Potassium chloride solution 1M	50 cm^3- Dissolve 75 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
High resistance voltmeter	E.g. Digital voltmeter

Notes

SS3.3 Technicians Safety Sheet

Chlorine and bromine are produced in Part 1 of this activity and are toxic and corrosive gases. Avoid inhaling any fumes. Do not let the electrolysis run for more than 1-2 minutes

Operation	Hazard	Risks	Control measures
Preparing 1M copper(II) sulphate	**Solid & IM soln**.  Harmful  Harmful to environment	Harmful if swallowed. The solid may be irritating to eyes and skin and has been known to sensitise the skin.	 Wear eye protection  Wear protective gloves.
Preparing a saturated solution of potassium nitrate(V) (for salt bridges)	 Oxidiser	Risk of fire with combustible materials.	 Wear eye protection Keep away from combustible materials
Preparing solutions of potassium iodide, bromide and chloride	Low hazard	Minimal risks, but would be harmful if ingested in quantity	 Wear eye protection

Notes

SS3.4 HOW DOES STEEL RUST?

Requirements

Test tubes	4
Watch glasses	1 small, 1 large
Cotton wool	
Petri dishes	3
Iron filings	1 g
Iron nails	3
Emery paper	To clean nail and steel sheet
Ethanol	To clean nail and steel sheet
Piece of steel sheet	16 cm^2
Zinc strip	1- Narrow strip to wrap around nail
Copper strip	1- Narrow strip to wrap around nail
Hydrochloric acid 2M	2 cm^3- Add 17.2 cm^3 of the conc. acid to dist. water. Make up to 100 cm^3 with dist. water
Sodium hydroxide solution 2M	3 cm^3- Dissolve 8 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Ferroxyl indicator solution	50 cm^3- Make up fresh. Dissolve 20 g sodium chloride and 2 g potassium hexacyanoferrate(III) in dist. water. Add 20 cm^3 of a 0.1% solution of phenolphthalein indicator, make up to 1 dm^3 with dist. water
Agar or gelatin	6 g- Optional
Dropping pipette	
Tweezers	
Spatula	

SS3.4 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing ethanol	**Ethanol**  Highly flammable	Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.
Dilution of concentrated hydrochloric acid to make 2M	**Conc. acid**  Corrosive **2M hydrochloric acid**  Irritant	Concentrated hydrochloric acid is corrosive and the fumes irritate the eyes and respiratory system	 Wear a face shield.  Dispense the concentrated acid in a fume cupboard. Dilute the conc. acid in a fume cupboard by adding the **acid to water** Take great care when opening bottles of the conc. acid on hot days
Preparing a solution of 2M sodium hydroxide	**Solid**  Corrosive **2M solution**  Corrosive	The solid causes severe burns and is particularly dangerous to eyes Gets very hot when added to water. Causes burns and particularly dangerous to eyes	 Wear goggles or face-shield  Wear protective gloves Add the solid to the water slowly with constant stirring to dissipate the heat produced
Preparation of ferroxyl indicator Phenolphthalein indicator solution (contains ethanol)	**Potassium hexacyano-ferrate(III)** Low Hazard **Phenolphthalein indicator**  Highly flammable	Irritating to eyes and harmful when ingested in quantity	 Wear eye protection  Gloves may be worn

Notes

SS5.1 INVESTIGATING THE OXIDATION STATES OF VANADIUM

Requirements

100 cm^3 conical flask with cotton wool plug	
Test tubes	5
Ammonium vanadate(V), (ammonium metavanadate) NH_4VO_3	0.25 g
Zinc powder	1-2 g or a few small pieces of granulated zinc
Filter funnel & paper	
Concentrated sulphuric acid	5 cm^3
Dropping pipette	
Sulphuric acid 1M	25 cm^3- Add 56 cm^3 of the conc. acid slowly with constant stirring to 600 cm^3 of dist. water. Make up to 1 dm^3 with dist. water
Potassium manganate(VII) solution 0.02M	10 cm^3- Dissolve 3.16 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Sodium sulphite Na_2SO_3	1 g
Iron(II) ammonium sulphate solution 0.1M	2 cm^3- Prepare fresh. Dissolve 3.92 g of the solid in 1M sulphuric acid. Make up to 100 cm^3 with 1M sulphuric acid
Potassium iodide solution 0.05M	2 cm^3- Dissolve 1.66 g of the salt in dist. water. Make up to 200 cm^3 with dist. water
Sodium thiosulphate ($Na_2S_2O_3$) solution 0.1M	2 cm^3- Dissolve 2.48 g of the solid in dist. water. Make up to100 cm^3 with dist. water
Spatula	
25 cm^3 measuring cylinder	
Stirring rod	
Boiling tube	

Notes

SS5.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing ammonium vanadate(V)	 Toxic	Very toxic if swallowed and in contact with skin	 Wear eye protection  Wear protective gloves. Avoid skin contact and inhaling dust.
Dilution of concentrated sulphuric acid to make 1M	**Conc. Sulphuric acid**  Corrosive **1M sulphuric acid**  Irritant	The concentrated acid causes severe burns and has an affinity for water. Hence it is extremely dangerous to eyes, and can cause blindness if entering the eye. The act of diluting produces much heat and if control measures are not taken the mixture can boil causing dangerous splashes.	 A full face shield should be worn.  Gloves should be worn. The conc. acid should be added very slowly to the distilled water, with constant stirring, cooling the beaker in a large vessel of cold water. **Never add water to concentrated acid**
Dispensing zinc powder	 Flammable	Risk of fire. Contact with water liberates a flammable gas. (hydrogen)	 Wear eye protection. Keep away from sources of ignition. Keep dry
Preparation of a 0.02M solution of potassium manganate(VII)	**Solid**  Oxidiser  Harmful  Harmful to environment	Contact with combustible material can cause fire. Harmful if entering the eyes and if swallowed The solution at this concentration is not harmful but contact with eyes should be avoided, and if in contact with skin will stain it brown.	 Eye protection must be worn  Wear protective gloves when handling the solid.
Dispensing sodium sulphite	 Harmful	Harmful if swallowed. Contact with acid liberates toxic gas. (sulphur dioxide)	 Eye protection must be worn
Preparing solutions of potassium iodide, iron(II) ammonium sulphate, sodium thiosulphate	Minimal hazards		 Eye protection must be worn

Notes

SS5.2 HOW DO TRANSITION METAL IONS ACT AS CATALYSTS?

Requirements

Potassium sodium 2,3-dihydroxybutanedioate (potassium sodium tartrate or Rochelle salt)	2.5 g
250 cm^3 beaker	
25 cm^3 measuring cylinder	
0-110 ^oC thermometer	
Hydrogen peroxide solution 20vol.	20 cm^3
100 cm^3 beaker	
Cobalt(II) chloride (hydrate)	0.25 g
Test tubes	
Stirring rod	
Spatula	
Ice bath	

Notes

SS5.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing 20vol. hydrogen peroxide	 Irritant	Irritating to eyes and skin	 Wear eye protection  Wear protective gloves. Avoid skin contact
Dispensing cobalt(II) chloride	 Toxic  Harmful to environment	Toxic if swallowed. May cause skin sensitisation	 Wear eye protection.  Wear protective gloves. Avoid skin contact

Notes

SS5.3 LOOKING AT SOME TRANSITION METAL COMPLEXES

Requirements

Test tubes	5
Boiling tube	
Nickel(II) chloride	1 g
Concentrated hydrochloric acid	2 cm^3
Sodium hydroxide 2M	20 cm^3- Slowly dissolve 80 g of the solid in 600 cm^3 of dist. water. Make up to 1 dm^3 with dist. water
Concentrated ammonia solution	5 cm^3
EDTA di-sodium salt solution 0.1M	5 cm^3- Dissolve 3.7 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Copper(II) sulphate solution 1M	4 cm^3- Dissolve 24.9 g of the hydrated solid in dist. Water. Make up to 100 cm^3 with dist. Water
Ammonia solution 2M	20 cm^3- In a fume cupboard add 115 cm^3 of 880 ammonia to dist. water. Make up to 1 dm^3 with dist. water
Iron(II) sulphate solution 1M	4 cm^3- Dissolve 27.8 g of the solid in about 65 cm^3 of 1 M sulphuric acid. Make up to 100 cm^3 with 1 M sulphuric acid
Iron(III) chloride solution 1M	4 cm^3- Dissolve 27 g of the solid in about 65 cm^3 of 1M hydrochloric acid. Make up to 100 cm^3 with 1M hydrochloric acid
Spatula	
Dropping pipette	2

Notes

SS5.3 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing solid nickel(II) chloride	 Harmful	May cause sensitisation by skin contact. The dust is a category 3 carcinogen.	 Wear safety goggles  Wear protective gloves. Avoid skin contact and inhaling the dust
Dispensing concentrated hydrochloric acid	 Corrosive	Causes burns. The vapour is very irritating to the respiratory system	 Wear safety goggles  Wear protective gloves. Dispense in a fume cupboard.
Preparing 2M sodium hydroxide	**Solid & 2M soln.**  Corrosive	Solid and solution cause severe burns and are particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring
Dispensing the concentrated ammonia solution and preparation of 2M ammonia solution	**Concentrated ammonia**  Corrosive  Harmful to environment	The concentrated ammonia causes burns in contact with skin and is dangerous to eyes. The vapour is irritating to eyes. Pressure can build up in sealed containers	 Goggles must be worn  Wear protective gloves to avoid skin contact Dispense, and carry out dilutions in a fume cupboard. Open containers of the concentrated ammonia with care particularly on hot days, using a safety screen or face shield.
Preparing 1M copper(II) sulphate	**Solid & IM soln**.  Harmful  Harmful to environment	Harmful if swallowed. The solid may be irritating to eyes and skin and has been known to sensitise the skin.	 Wear eye protection  Wear protective gloves.
Preparing 1M iron(II) sulphate solution	**Solid & solution**  Harmful	Harmful if swallowed. May be irritating to eyes and skin	 Wear eye protection
Preparing a 1 M solution of iron(III) chloride	**Solid**  Irritant	Irritating to eyes and skin	 Wear eye protection  Wear protective gloves. Avoid skin contact

Notes

Notes on "The Steel Story"

ASPECTS OF AGRICULTURE

Advance warning

The following items needed for activities in this unit may not already be in your school or college and might take a little time to obtain

Activity	Item(s)	Quantities per expt	Essential or Optional	
AA2.3	Samples of sand, quartz, talc, mica, clay and unexpanded vermiculite	Small amounts of each	E	
AA2.4	Strong cation exchange resin (in hydrogen form) Strong anion exchange resin	5 g 5 g	E E	Examples are given in the technicians preparation notes but any cheap strong acid and strong OH resins will do E.g. Aldrich **Cat. Nos. 10322(H+) & 50198(OH-)**
AA2.5	Samples of soil or soil-based compost	50 g	O	
AA3.1	Boric acid Devarda's alloy	0.1 g 0.5 g	O O	

Notes

Chemicals required for AA

Chemical	Concs.	Quantities per group
Aluminium sulphate	0.1M	5 cm^3
Boric acid	1%	5 cm^3
Calcium hydroxide	0.0100M	240 cm^3
Cyclohexane		4 cm^3
Devarda's alloy		0.5 g
Dilute solutions of salts containing coloured positive ions and others containing coloured negative ions	Dilute so that the colour is faint (e.g. 0.05 M)	5 cm^3
Iodine		2 crystals
Magnesium oxide		0.5 g
pH indicator (e.g. 1:1 mixture of Methyl Red & Bromocresol Green)	0.1% in ethanol	Few drops
Phenolphthalein indicator		Few drops
Potassium chloride	2M	200 cm^3
Potassium iodide	0.2M	35 cm^3
Potassium peroxodisulphate(VI)	0.01M	35 cm^3
Samples of; quartz, sand, talc, mica, unexpanded vermiculite, clay		Small amounts to look at
Sodium chloride	0.05M	5 cm^3 3 g
Sodium hydroxide	0.100M	50 cm^3
Sodium thiosulphate	0.01M	20 cm^3
Starch	1%	10 cm^3
Sulphuric acid	0.00500M	100 cm^3

Notes

AA2.1 HOW DOES TEMPERATURE AFFECT RATE OF REACTION?

Requirements

0 - 110 ^{o}C thermometer	
Boiling tubes	5
Test tubes	5
Burette or graduated pipette to deliver 1 cm^3, 2 cm^3, 5 cm^3	5- If burettes are used, sets of 5 can be arranged around the lab and shared
Potassium iodide solution 0.2M	25 cm^3- Dissolve 33.2 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Potassium peroxodisulphate(VI) solution 0.01M ($K_2S_2O_8$)	35 cm^3- Dissolve 2.7 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Sodium thiosulphate solution 0.01M	20 cm^3- Dissolve 2.48 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Fresh starch solution	10 cm^3- Make a paste with 1 g of starch and cold dist. water. Boil approx. 70 cm^3 dist. water. Add to the paste stirring constantly, boil for 1 min. Cool and make up to 100 cm^3 with dist. water
Stop watch	
250 cm^3 beaker	

Notes

AA2.1 Technician Safety Sheet

Operation	Hazard	Risks	Control measures
Preparation of 0.01M solution of potassium peroxodisulphate(VI)	**Solid**  Oxidiser  Irritant **Solution**  Harmful	Contact with combustible material may cause fire. Irritating to eyes, skin and respiratory system. Harmful if swallowed	 Wear eye protection  Wear protective gloves. Avoid skin contact. Do not breathe dust.

Notes

AA2.3 STRUCTURE AND PROPERTIES

Requirements

Hand lens	
Samples of -: quartz	
sand	
talc	
mica	
unexpanded vermiculite	
clay	
Test tubes	4
Aluminium sulphate solution 0.1M	5 cm^3- Dissolve 6.3 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Tin lid	

Notes

AA2.3 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparation of 0.1M solution of aluminium sulphate	Low hazard	Only harmful if ingested in quantity	 Wear eye protection

Notes

AA2.4 INVESTIGATING ION EXCHANGE

Requirements

250 cm^3 conical flask	
Ion exchange resins	5 g of each cation and anion resins, e.g- Strong cation H^+, strong anion OH^- as in advance warning. 0.5 g of the cation resin must be dry
10 cm^3 measuring cylinder	
50 cm^3 measuring cylinder	
Test tubes and bungs	8
Burette and funnel	
White tile	
Universal indicator solution and chart	
Sodium hydroxide 0.100M (accurate for titration)	50 cm^3- Dissolve 4 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Sodium chloride	3 g
Sodium chloride solution 0.05M	5 cm^3- Dissolve 2.9 g of the solid in dist. water. Make up to 100 cm^3 with dist. water to give a 0.5M solution. Dilute 10 cm^3 of the 0.5M solution to 100 cm^3 with dist. water to make 0.05M
Spatula	
Phenolphthalein indicator	
Dilute solutions with coloured cations, e.g copper(II) sulphate	5 cm^3 of each- Very dilute (approx 0.05M) so that the colours can be seen but not too intense
Dilute solutions with coloured anions, e.g potassium manganate(VII)	5 cm^3 of each- Very dilute (approx 0.05M) as with the coloured cations
Access to balance	

Notes

AA2.4 Technicians Safety Sheet

Ion exchange resins swell when wet. Do not pack tightly into glass containers for fear of shattering the glass.
Do not throw used resins away. They can be re-generated by passing 4M hydrochloric acid through the acid resin and 4M sodium hydroxide through the OH resin then washing them both with dist. water

Operation	Hazard	Risks	Control measures
Preparing 0.1M sodium hydroxide	**Solid**  Corrosive	Solid causes severe burns and is particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring
Dispensing universal indicator soln. (contains ethanol)	**Ethanol**  Highly flammable	Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.
Dispensing phenolphthalein indicator solution (contains ethanol)	**Ethanol**  Highly flammable	Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.
Preparing copper(II) sulphate	**Solid**  Harmful  Harmful to environment	Harmful if swallowed. The solid may be irritating to eyes and skin and has been known to sensitise the skin.	 Wear eye protection  Wear protective gloves.
Preparation of a solution of potassium manganate(VII)	Solid  Oxidiser  Harmful  Harmful to environment	Contact with combustible material can cause fire. Harmful if entering the eyes and if swallowed The solution at this concentration is not harmful but contact with eyes should be avoided, and if in contact with skin will stain it brown.	 Eye protection must be worn  Wear protective gloves when handling the solid.
Preparing 4M sodium hydroxide	**Solid & 4M soln.**  Corrosive	Solid and solution cause severe burns and are particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring
Dilution of concentrated hydrochloric acid to make 4M	**Conc acid**  Corrosive **4M acid**  Irritant	Concentrated hydrochloric acid is corrosive and the fumes irritate the eyes and respiratory system	 Wear a face shield.  Dispense the concentrated acid in a fume cupboard. Dilute the conc. acid in a fume cupboard by adding the **acid to water** Take great care when opening bottles of the conc. acid on hot days

AA2.5 THE pH, BUFFERING CAPACITY, AND LIME REQUIREMENT OF SOIL (OPTIONAL EXTENSION)

Requirements for pH measurement

Oven dry soil	20 g- Dry in an oven at 105 ^{o}C overnight
pH meter and electrode	
Buffer solutions	To calibrate electrode
100 cm^3 beaker	
50 cm^3 measuring cylinder	
Stirring rod	

Requirements for buffering capacity measurement

Oven dry soil	4 x 2 g portions
Oven dry clay	Optional- 4 x 2 g portions
Oven dry sand	Optional- 4 x 2 g portions
100 cm^3 beakers	8
5 cm^3 or 10 cm^3 graduated pipette and filler	
Calcium hydroxide 0.0100M (accurate)	20 cm^3 for each soil sample- Dissolve 0.74 g of the solid in dist. water, make up to 1 dm^3 with dist. water

Notes

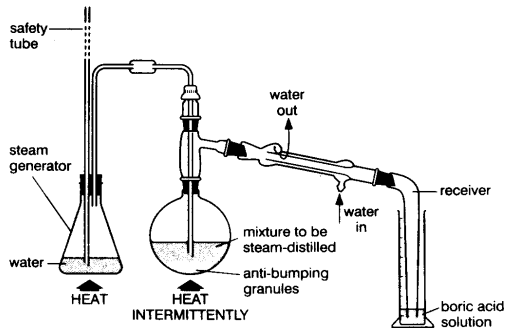
AA2.5 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparation of buffer solutions	 Irritant	Check hazcards for chemicals contained in chosen recipes	 Wear eye protection  Wear protective gloves
Preparation of 0.0100 M calcium hydroxide solution	**Solid**  Irritant	May irritate eyes, skin and lungs	 Wear eye protection  Wear protective gloves

Notes

AA3.1 WHAT IS THE NITROGEN CONTENT OF SOILS? (OPTIONAL EXTENSION)

Requirements

Apparatus for steam distillation	
Filter funnel and paper	
50 cm^3 measuring cylinder	
Burette and funnel	
Stoppered bottle	250 cm^3 capacity
Conical flasks and stoppers	2
Oven dried soil	30 g- Dry in an oven at 110 ^oC overnight. Do not heat with a bunsen or have the oven too high
Potassium chloride solution 2M	200 cm^3- Dissolve 149 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Sulphuric acid 0.00500M (accurate)	100cm^3-Dilute 5 cm^3 of 1M sulphuric acid to 1 dm^3 with dist. water
pH indicator- range 5-6	e.g. methyl red or a mixture of 1:1 methyl red and bromocresol green (100 mg in 100 cm^3 ethanol)
Boric acid 1%	5 cm^3
Magnesium oxide	0.5 g
Devada's alloy	0.5 g
100 cm^3 volumetric flask	
10 cm^3 pipette	
25 cm^3 pipette	
Pipette filler	

AA3.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dilution of concentrated sulphuric acid to make 0.005M solution	**Conc. Sulphuric acid**  Corrosive	The concentrated acid causes severe burns and has an affinity for water. Hence it is extremely dangerous to eyes, and can cause blindness if entering the eye. The act of diluting produces much heat and if control measures are not taken the mixture can boil causing dangerous splashes.	 A full face shield should be worn.  Gloves should be worn. The conc. acid should be added very slowly to the distilled water, with constant stirring, cooling the beaker in a large vessel of cold water. **Never add water to concentrated acid**
Dispensing and preparing indicator soln. (contains ethanol)	**Ethanol**  Highly flammable	Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition. ***Check Hazcard 32 for chosen indicator***

Notes

AA4.2 PARTITION EQUILIBRIUM

Requirements

Iodine crystals	2 small crystals
Tweezers	
Test tubes and bungs	3
Dropping pipette	
Cyclohexane	4 cm^3
Potassium iodide solution 0.2M	10 cm^3- Dissolve 3.32 g of the solid in dist. water. Make up to 100 cm^3 with dist water
Access to colorimeter	If required
Cuvettes for colorimeter	

Notes

AA4.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing solid iodine	**Solid**  Harmful  Harmful to environment	Harmful if breathed in or by contact with skin. Causes burns to skin if left for some time. The vapour is particularly dangerous to eyes.	 Safety goggles should be worn.  Gloves should be worn. Dispense in a fume cupboard
Dispensing cyclohexane	 Highly flammable  Harmful to environment	Risk of fire.	 Wear eye protection Keep away from sources of ignition.

Place residues into the correct wastes containers and not down sinks

Notes

Notes on "Aspects of Agriculture"

COLOUR BY DESIGN

Advance warning

The following items needed for activities in this unit may not be already in your school or college and might take a little time to obtain

Activity	Item(s)	Quantities per expt	Essential or Optional	
CD1	Ammonium vanadate(V) (metavanadate) NH_4VO_3	0.1 g	E	
	Dry ice		O	Can use a CO_2 cylinder or CO_2 generator
CD5	Cyclohexane	2 cm^3	E	
	Cyclohexene	2 cm^3	E	
	Methyl benzoate	2.5 cm^3	E	
CD6	Phenylamine	1.5 cm^3	E	
	Ethyl-4-aminobenzoate (benzocaine)	2 g	E	
	Methylphenol (cresol; any isomer)	A few crystals	E	
	Naphthalen-2-ol (ß-naphthol)	A few crystals	E	
CD7.1	Untreated white cotton	10 g	E	Bandage is a good source
	Durazol Red 2B	0.2 g	E	Available from Aldrich Chemical Co., or from, Kemtex Educational Supplies, Unit 2, Building 6, Tameside Business Centre, Windmill Lane, Denton, Manchester, M34 3QS Tel: 0161 320 6505
	Procion Red MX-5B	0.3 g	E	
CD7.2	White cotton, polyester and nylon or a multi-fibre strip	Small pieces to dye	E	Multi-fibre strips available from; Society of Dyers and Colourists, Perkin House, PO Box 244, 82 Gratton Road, Bradford, West Yorks,BD1 2JB tel; 01274 725138
	Acid Blue 40	0.4 g	E	Available from Aldrich or Kemtex
	Direct Red 23	0.2 g	E	
	Disperse Yellow 7	0.1 g	E	

Chemicals required for CD

Chemical	Concs.	Quantities per group
Acidified ammonium vanadate(V)	1%	10 cm^3
Alkaline glucose	2%	100 cm^3
Ammonia solution	Conc. 2M	2 cm^3 5 cm^3
Bromine in cyclohexane	Sat. solt.	3 cm^3
Bromine water	Sat. solt.	6 cm^3
Butan-1-ol		~20 cm^3
Chromium(III) chloride Potassium dichromate(VI) Screened Methyl Orange	Any conc. to see colour	10 cm^3 of each
Cyclohexane		5 cm^3
Cyclohexene		2 cm^3
Durazol Red 2B	0.08%	250 cm^3
Dye mixture,- Acid Blue 40, Direct Red 23, Disperse Yellow 7, citric acid		Very small amounts of each
Ethyl 4-aminobenzoate (benzocaine)		2 g
Hydrochloric acid	1M	10 cm^3
Indicators : Methylene Blue, phenolphthalein, universal, fluorescein		Few drops of each
Lead nitrate(V)	0.5M	5 cm^3
Methyl benzoate		2.5 cm^3
Methylbenzene		2 cm^3
Nitric(V) acid	Conc.	2 cm^3
Phenol, cresol, napthalen-2-ol		Few crystals of each
Phenylamine		1.5 cm^3
Potassium chromate(VI)	0.5M	2 cm^3
Potassium hexacyanoferrate(II)	0.005M	1 cm^3
Potassium iodide 0.5 M		0.5 g 1 cm^3
Potassium manganate(VII)	0.02M	3 cm^3 0.5 g
Potassium or ammonium thiocyanate	0.1M	1 cm^3
Procion Red MX 5B	0.15%	200 cm^3
Sodium carbonate	1M	1 cm^3 0.05 g
Sodium chloride		13 g
Sodium hydroxide	1M 2M	2 cm^3 10 cm^3
Sodium metabisulphite	1M	5 cm^3
Sodium nitrite		2 g
Solutions containing copper(II), nickel(II) and iron(III) ions	0.005M	20 cm^3 of the copper solution and 2 cm^3 each of others
Sulphuric acid	Conc. 1M	7 cm^3 25 cm^3
Zinc granules		Few g
Zinc oxide		0.5 g

CD1 CHANGING COLOURS CHEMICALLY

Requirements

250 cm^3 stoppered bottle	
100 cm^3 measuring cylinder	
Alkaline solution of glucose	100 cm^3- Dissolve 10 g of sodium hydroxide in 500 cm^3 dist. water, add 10 g glucose, dissolve. The solution should be clear but rapidly deteriorates to yellow/brown, so it must be freshly prepared on day of use
Methylene Blue indicator	A few drops
Phenolphthalein & fluorescein indicators	Optional
Boiling tubes & bungs	5
Acidified solution of ammonium vanadate(V) (ammonium metavanadate NH_4VO_3)	10 cm^3- Dissolve 0.5 g of the solid in 50 cm^3 1M sulphuric acid. Slowly add 10 cm^3 conc. sulphuric acid with stirring to obtain a clear yellow solution
Granulated zinc	A few grams
Sodium hydroxide 1M	2 cm^3- Dissolve 4 g of the solid in dist water. Make up to 100 cm^3 with dist. water
Dropping pipettes	8
Zinc oxide	0.5 g
Lead nitrate(V) (ground to a powder)	0.5 g
Potassium iodide (ground to a powder)	0.5 g
Lead nitrate(V) solution 0.5M	3 cm^3- Dissolve 16.5 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Potassium iodide 0.5M	1cm^3- Dissolve 8.3 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Sodium carbonate solution 1M	1 cm^3- Dissolve 10.6 g of the anhydrous solid in dist. water. Make up to 100 cm^3 with dist. water
Ammonia 2M	5 cm^3- In a fume cupboard add 11 cm^3 conc. ammonia to dist. water. Make up to 100 cm^3 with dist. water

Potassium (or ammonium) thiocyanate solution 0.1M	1 cm^3- Dissolve 1 g of the potassium salt (or 0.76 g of the ammonium salt) in the dist. water. Make up to 100 cm^3 with dist. water
Potassium hexacyanoferrate(II) solution 0.005M	1 cm^3- Dissolve 1 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Potassium chromate(VI) solution 0.5M	2 cm^3- Dissolve 9.7 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Dilute solutions (approx. 0.1M) containing the following ions:- copper(II) nickel(II) iron(III)	1 - 2 cm^3 of each
Sulphuric acid 1M	1 cm^3 – Add 5.6 cm^3 of the conc. acid slowly with constant stirring to dist. water. Make up to 100 cm^3 with dist. water
Microscope & slides and cover slips	
Universal indicator solution & chart	
Small lump of solid carbon dioxide	Or CO_2 cylinder or generator
250 cm^3 beaker	
Spatula	

Notes

CD1 Technicians Safety Sheet

Wear heavy gloves when handling dry ice

Operation	Hazard	Risks	Control measures
Preparation of alkaline glucose solution & 1M sodium hydroxide soln.	**Sodium hydroxide solid & 1M soln**.  Corrosive	Solid and solution cause severe burns and are particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring
Preparation & dispensing all indicator solution (contains ethanol)	**Ethanol**  Highly flammable	Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.
Preparation of acidified ammonium vanadate(V) solution Preparing 1 M sulphuric acid	**Solid and solution**  Toxic See later in table	Very toxic if swallowed and in contact with skin	 Wear eye protection  Wear protective gloves. Avoid skin contact. Avoid inhaling dust

Cont…

Operation	Hazard	Risks	Control measures
Grinding and dispensing solid lead(V) nitrate and preparing 0.5M solution	**Solid & soln**.  Toxic Solid  Oxidiser  Harmful to environment	Harmful by ingestion and inhalation of dust. Danger of cumulative effects. May cause damage to unborn child.	 Wear eye protection.  Wear protective gloves. Avoid inhaling dust.
Preparation of 0.5M sodium carbonate solution	**Solid**  Irritant	Irritating to eyes skin and respiratory system.	 Wear eye protection  Wear protective gloves. Avoid inhaling dust
Preparation of 2M ammonia solution	**Concentrated ammonia**  Corrosive  Harmful to environment	The concentrated ammonia causes burns in contact with skin and is dangerous to eyes. The vapour is irritating to eyes. Pressure can build up in sealed containers	 Goggles must be worn  Wear protective gloves to avoid skin contact Dispense, and carry out dilutions in a fume cupboard. Open containers of the concentrated ammonia with care particularly on hot days, using a safety screen or face shield.
Preparation of 0.1M potassium or ammonium thiocyanate	 Harmful	Harmful by inhalation, if swallowed and in contact with skin. Contact with acids produces a very toxic gas	 Wear eye protection  Wear protective gloves. Avoid skin contact and breathing dust. Keep away from all acids
Preparing a 0.5M solution of potassium chromate(VI)	**Solid and soln**  Very toxic  Irritant  Harmful to environment	Chromates are suspected carcinogens. Irritating to eyes, respiratory system and skin.	 Wear eye protection.  Wear protective gloves. Avoid all skin contact. Any spillages should be washed off at once
Preparation of a solution of nickel(II) salt	**Solid**  Harmful	May cause sensitisation by skin contact. The dust is a category 3 carcinogen.	 Wear safety goggles  Wear protective gloves. Avoid skin contact and inhaling the dust
Preparing a solution of copper(II) salt	**Solid & soln.**  Harmful  Harmful to environment	Harmful if swallowed. The solid may be irritating to eyes and skin and has been known to sensitise the skin.	 Wear eye protection  Wear protective gloves.

Operation	Hazard	Risks	Control measures
Preparing a solution of iron(III) salt	**Solid**  Irritant	Irritating to eyes and skin	 Wear eye protection  Wear protective gloves. Avoid skin contact
Dilution of concentrated sulphuric acid to make 1M	**Conc. Sulphuric acid**  Corrosive **1M sulphuric acid**  Irritant	The concentrated acid causes severe burns and has an affinity for water. Hence it is extremely dangerous to eyes, and can cause blindness if entering the eye. The act of diluting produces much heat and if control measures are not taken the mixture can boil causing dangerous splashes.	 A full-face shield should be worn.  Gloves should be worn. The conc. acid should be added very slowly to the distilled water, with constant stirring, cooling the beaker in a large vessel of cold water. **Never add water to concentrated acid**

Notes

CD3 SEEING COLOURS

Requirements

Hand held direct vision spectroscope	Or diffraction grating
Test tubes	6
White light source or sunlight	An ordinary light bulb can be used but it must be in a shaded holder
Aqueous solutions of a range of coloured compounds, e.g. copper(II) sulphate chromium(III) chloride potassium dichromate(VI) screened Methyl Orange	10 cm^3 of each
Brightly coloured surfaces	E.g. books, folders, etc.

Notes

CD3 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparing a solution of copper(II) sulphate	**Solid & soln**.  Harmful  Harmful to environment	Harmful if swallowed. The solid may be irritating to eyes and skin and has been known to sensitise the skin.	 Wear eye protection  Wear protective gloves.
Preparing a solution of chromium(III) chloride	**Solid and soln**  Irritant	Irritating to eyes and skin. Harmful by ingestion. If the solution is greater than 0.5M it is also an irritant	 Wear eye protection
Preparing a solution of potassium dichromate(VI)	**Solid and soln**  Toxic  Irritant	Chromates are suspected carcinogens. Irritating to eyes, respiratory system and skin.	 Wear eye protection.  Wear protective gloves. Avoid all skin contact. Any spillages should be washed off at once
Preparing & dispensing screened Methyl Orange indicator solution (contains ethanol)	**Ethanol**  Highly flammable	Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.

Notes

CD5 COMPARING HYDROCARBONS

Requirements

Test tubes & bungs	10
Boiling tube	
Dropping pipettes	
Cyclohexane	2 cm^3
Cyclohexene	2 cm^3
Methylbenzene	2 cm^3
Bromine in cyclohexane	3 cm^3- Shake a few drops of bromine with hexane in a fume cupboard. DO NOT STORE. Make up fresh
Stirring rod	
Concentrated ammonia solution	2 cm^3
Bromine water	6 cm^3- Stir bromine with dist. water in a fume cupboard until saturated. Store in dark bottles
Concentrated sulphuric acid	7 cm^3 (fresh)
Concentrated nitric(V) acid	2 cm^3
Sulphuric acid 1M	20 cm^3- Add 56 cm^3 of the conc. acid slowly with stirring to 600 cm^3 dist. water. Make up to 1 dm^3 with dist. water
Potassium manganate(VII) solution 0.02M	3 cm^3- Dissolve 3.16 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Potassium manganate(VII)	0.5 g
Sodium carbonate	0.05 g
Sodium disulphite(IV) (metabisulphite) 1M	5 cm^3- Dissolve 19 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
250 cm^3 beaker	
10 cm^3 measuring cylinder	
100 cm^3 conical flask	
0-110 ^oC thermometer	
Crushed ice	50 g

Methyl benzoate	2.5 cm^3
Spatula	

CD5 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing cyclohexane & cyclohexene	 Highly flammable  Harmful to environment	Risk of fire.	 Wear eye protection Keep away from sources of ignition.
Dispensing methylbenzene	 Highly flammable  Harmful	Vapour/air mixtures are explosive. Harmful by inhalation which may cause dizziness and headaches. Vapour is irritating to eyes and mucous membranes	 Wear eye protection  Wear protective gloves. Dispense in a fume cupboard. Keep away from sources of ignition. Avoid inhaling vapour.
Preparation of bromine water & bromine in cyclohexane Cyclohexane	**Bromine**  Corrosive  Very toxic  Harmful to environment **Bromine water**  Corrosive  Very toxic See above	The liquid causes severe burns to eyes and skin. The vapour is very toxic if breathed in. Saturated bromine solution causes severe burns to eyes and skin. The vapour is very toxic if breathed in.	 Wear protective goggles  Wear RUBBER gloves. Use and make solution in a fume cupboard. Do not breathe vapour. **WHEREVER BROMINE IS USED, HAVE A 500 cm^3 BOTTLE OF 1M (25%) SODIUM THIOSULPHATE TO HAND TO TREAT SPILLAGES**
Dispensing concentrated ammonia	**Concentrated ammonia**  Corrosive  Harmful to environment	The concentrated ammonia causes burns in contact with skin and is dangerous to eyes. The vapour is irritating to eyes. Pressure can build up in sealed containers	 Goggles must be worn  Wear protective gloves to avoid skin contact Dispense in a fume cupboard. Open containers of the concentrated ammonia with care particularly on hot days, using a safety screen or face shield.

Cont…

Operation	Hazard	Risks	Control measures
Dispensing concentrated nitric acid	 Corrosive  Oxidiser	Causes severe burns. Skin will turn yellow then peel. Vapour is dangerous to eyes and respiratory system. Contact with combustible material may cause fire.	 Wear eye protection  Wear protective gloves. Dispense in a fume cupboard. Keep away from combustible material
Dispensing concentrated sulphuric acid & dilution of concentrated sulphuric acid to make 1M	**Conc. Sulphuric acid**  Corrosive **1M sulphuric acid**  Irritant	The concentrated acid causes severe burns and has an affinity for water. Hence it is extremely dangerous to eyes, and can cause blindness if entering the eye. The act of diluting produces much heat and if control measures are not taken the mixture can boil causing dangerous splashes.	 A full face shield should be worn.  Gloves should be worn. The conc. acid should be added very slowly to the distilled water, with constant stirring, cooling the beaker in a large vessel of cold water. **Never add water to concentrated acid**
Dispensing solid potassium manganate(VII) & preparation of a 0.02 M solution	**Solid**  Oxidiser  Harmful  Harmful to environment	Contact with combustible material can cause fire. Harmful if entering the eyes and if swallowed The solution at this concentration is not harmful but contact with eyes should be avoided, and if in contact with skin will stain it brown.	 Eye protection must be worn  Wear protective gloves when handling the solid.
Dispensing sodium carbonate solution	 Irritant	Irritating to eyes skin and respiratory system.	 Wear eye protection
Preparing a 1M solution of sodium disulphite(IV) (metabisulphite)	 Harmful	Harmful if swallowed.	 Wear eye protection
Dispensing methyl benzoate	 Harmful	Harmful by inhalation, if swallowed and in contact with skin	 Eye protection must be worn  Wear protective gloves

Notes

CD6 MAKING AZO DYES

Requirements

Boiling tubes	3
Test tubes & bungs	3
Thin polythene gloves	
10 cm^3 measuring cylinder	
Phenylamine	1.5 cm^3
Ethyl 4-aminobenzoate (benzocaine)	2 g
Hydrochloric acid 1M	10 cm^3- Add 8.6 cm^3 of the conc. acid to dist. water. Make up to 100 cm^3 with dist. water
250 cm^3 beaker	
Ice/salt mixture	Enough to half fill 250 cm^3 beaker
0-110 ^oC thermometer	
Sodium nitrite (nitrate(III))	2 g
Stirring rod	
Starch / iodide paper	
Sodium hydroxide solution 2M	6 cm^3- Dissolve 8 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Phenol	A few crystals
Methylphenol (cresol)	A few crystals
Naphthalen-2-ol	A few crystals
Spatula	
Dropping pipettes	2
Access to balance	

Notes

CD6 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing phenylamine (aniline)	 Toxic  Harmful to environment	Toxic by inhalation, through contact with skin and if swallowed. Danger of serious damage to health by prolonged exposure. Possible risks of irreversible effects. A category 3 carcinogen. Prolonged contact may cause dermatitis. Very toxic to the aquatic environment.	 Eye protection must be worn  Wear protective gloves to avoid skin contact. Dispense in a fume cupboard. Avoid breathing vapour
Dispensing ethyl 4-amino-benzoate (benzocaine)	 Harmful	Harmful in contact with skin and if swallowed. It may irritate the skin	 Eye protection must be worn  Wear protective gloves to avoid skin contact.
Dilution of concentrated hydrochloric acid to make 1M acid	**Conc acid**  Corrosive **1M acid**  Irritant	Concentrated hydrochloric acid is corrosive and the fumes irritate the eyes and respiratory system	 Wear a face shield.  Dispense the concentrated acid in a fume cupboard. Dilute the conc. acid in a fume cupboard by adding the **acid to water** Take great care when opening bottles of the conc. acid on hot days
Dispensing sodium nitrite (nitrate(III))	 Toxic  Oxidiser  Harmful to environment	Toxic if swallowed Contact with combustible material may cause fire. Very toxic to aquatic organisms	 Eye protection must be worn Keep away from combustible material
Preparing 2M sodium hydroxide	**Solid & 2M soln.**  Corrosive	Solid and solution cause severe burns and are particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring
Dispensing phenol and methylphenol	 Toxic  Corrosive	Toxic in contact with skin and if swallowed. Causes burns. Prolonged contact with skin may result in dermatitis. Vapour may irritate the respiratory system.	 Wear eye protection  Wear protective gloves. Avoid breathing fumes. Glycerol (propane-1,2,3-triol) can be used to treat burns
Dispensing napthalen-2-ol	 Harmful	Harmful by inhalation and if swallowed. Old samples may contain a dangerous impurity.	 Wear eye protection. Dispense in a fume cupboard. Use new stock with a purity above 99%
Clearing away prepared azo dyes	 Toxic  Harmful to environment	Toxic by inhalation, through contact with skin and if swallowed. Danger of serious damage to health by prolonged exposure. Category 3 carcinogens. Prolonged contact may cause dermatitis. Very toxic to the aquatic environment.	 Eye protection must be worn  Wear protective gloves to avoid all skin contact. Dispose of promptly by flushing down the sink **with lots of water and detergent**

CD7.1 DYEING WITH A DIRECT DYE AND A REACTIVE DYE

Requirements

Untreated white cotton	2 pieces about 5 g each. Bandage is a good source of untreated cotton
Rubber gloves	
400 cm^3 beaker	2
Procion Red MX5B solution	200 cm^3- Dissolve 1.5 g of the dye in dist. water. Make up to 1 dm^3 with dist. water
Durazol Red 2B solution	250 cm^3- Dissolve 0.8 g of the dye in dist. water. Make up to 1 dm^3 with dist. water
Sodium chloride	13 g
Sodium carbonate	0.5 g
Stirring rods	2
Tongs	
Washing powder	
Beaker	To use as a chromatography tank
Strip of chromatography paper	To fit the size of beaker used
100 cm^3 measuring cylinder	
Melting point tubes	For spotting chromatography paper
Spatula	
250 cm^3 beaker	
Access to balance	

Notes

CD7.1 Technicians Safety Sheet

Procion dyes are reactive chemicals and cases of allergy have occurred among people who handle them on a regular basis. (Procion Yellow, in particular, has caused problems, so it is important not to substitute the recommended Procion dye.) Avoid generating and breathing the dust, mist or droplets during handling. If symptoms of hay fever or asthma develop, seek medical advice

Operation	Hazard	Risks	Control measures
Weighing and dissolving Procion Red MX5B & Durazol Red 2B dyes	 Irritant	Irritating to skin, eyes and respiratory system. **The solids are particularly hazardous,** and can cause allergic reactions	 Eye protection must be worn.  Protective gloves must be worn. The solid must be weighed and dissolved in a fume cupboard.
Dispensing sodium carbonate	 Irritant	Irritating to eyes and respiratory system	 Eye protection must be worn  Avoid skin contact Avoid breathing dust
Dispensing washing powder	 Irritant	Irritating to eyes and respiratory system Some washing powders can cause sensitive reactions in contact with skin	 Eye protection must be worn  Avoid skin contact Avoid breathing dust

Notes

CD7.2 DIFFERENT DYES FOR DIFFERENT FIBRES

Requirements

Rubber gloves	
400 cm^3 beaker	
Stirring rod	
100 cm^3 measuring cylinder	
10 cm^3 measuring cylinder	
Tongs	
Dye mixture	10 cm^3- Dissolve the following quantities of dyes in 140 cm^3 dist. water;- Acid Blue 40 0.4 g Direct Red 23 0.2 g Disperse Yellow 7 0.1 g Citric acid- 0.015 g to 0.02 g
Samples of white cotton, polyester, nylon	20 cm^2 pieces of each, or multi-fibre strips
Apparatus for paper chromatography	
Chromatography paper	
Melting point tubes	For spotting
Chromatography solvent	Quantity depends on apps. used.- Solvent is 95% butan-1-ol, 5% dist. water

Notes

CD7.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparation of dye mixture	**Solid dyes**  Irritant  Harmful	Irritating to eyes skin and respiratory system. May act as sensitisers	 Wear eye protection  Wear protective gloves. Avoid skin contact with solids and solutions. Avoid breathing dust.
Preparation of butan-1-ol chromatography solvent	**Butan-1-ol**   Harmful	The vapour is harmful by inhalation and may cause headaches and dizziness and can irritate the eyes and skin. Risk of fire	 Wear eye protection  Wear protective gloves. Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.

Notes

Notes on "Colour by Design"

THE OCEANS

Advance warning

The following items needed for activities in this unit may not already be in your school or college and might take a little time to obtain

Activity	Item(s)	Quantities per expt.	Essential or Optional	
O1.2	Anhydrous iron(III) chloride	33 g	E	
O3.1	Apparatus for measuring the enthalpy change of vaporisation of water as in the diagram in the techs notes O3.1 page 153		O	To make electric heater; 1. Clean both wires with emery paper 2. Clean the copper wire by dipping into orthophosphoric acid 3. Coat with a thin layer of solder 4. Clean the nichrome wire with orthophosphoric acid in the same way and coat with solder (May need a bit more solder than on copper) 5. Clamp the two wires so that the coated parts overlap and heat with the soldering iron to allow the soldered surfaces to bind together

Notes

Chemicals required for O

Chemical	Concs.	Quantities per group
Ammonia solution	0.5M	25 cm^3
Ammonium chloride	0.5M	25 cm^3
Anhydrous calcium chloride		25 g
Anhydrous iron(III) chloride		33 g
Anhydrous sodium chloride		14 g
Candle wax		2 g
Copper(II) sulphate	Sat. solution	4 cm^3
Ethanoic acid	0.1M 0.03M 0.01M 0.003M 0.001M 0.5M	50 cm^3 50 cm^3 50 cm^3 50 cm^3 50 cm^3 75 cm^3
Glucose		2 g
Hexane		12 cm^3
Hydrochloric acid	0.1M 0.03M 0.01M 0.003M 0.001M 0.5M	50 cm^3 50 cm^3 50 cm^3 50 cm^3 50 cm^3 15 cm^3
Methanoic acid	0.5M	25 cm^3
Methylbenzene		100 cm^3
Nitric(V) acid	0.0001M	50 cm^3
Potassium (or sodium) ethanoate	0.5M	75 cm^3
Potassium (or sodium) methanoate	0.5M	25 cm^3
Potassium hydroxide	0.5M	15 cm^3
Propanone		12 cm^3

Notes

O1.1 WHAT IS THE RELATIONSHIP BETWEEN A SOLVENT AND THE SUBSTANCES THAT DISSOLVE IN IT?

Requirements

Anhydrous sodium chloride	2 g in a stoppered specimen tube
Anhydrous calcium chloride	2 g in a stoppered specimen tube
Glucose or sucrose	2 g in a stoppered specimen tube
Candle wax	2 g Granules or grated wax
Test tubes	3
Hexane	12 cm^3
Propanone	12 cm^3

Notes

O1.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing anhydrous calcium chloride	 Irritant	Irritating to eyes, skin and respiratory system	 Wear eye protection  Wear protective gloves. Avoid inhaling dust
Dispensing hexane	 Highly flammable  Harmful  Harmful to environment	Harmful to health by prolonged exposure. Risk of fire	 Wear eye protection  Wear protective gloves. Dispense in a fume cupboard. Keep away from sources of ignition.
Dispensing propanone	 Highly flammable  Irritant	Serious risk of liquid and vapour catching fire. Can cause severe eye damage. The liquid will degrease skin. The vapour can be harmful with prolonged exposure	 Wear eye protection  Wear protective gloves. Use and dispense well away from naked flames in a well ventilated area or fume cupboard

Notes

O1.2 WHAT CHANGES OCCUR WHEN AN IONIC SOLID DISSOLVES?

Requirements

Anhydrous sodium chloride	12 g in a stoppered specimen tube
Anhydrous calcium chloride	23 g in a stoppered specimen tube
Anhydrous iron(III) chloride	33 g in a stoppered specimen tube. Aluminium sulphate can be used as a less messy alternative
Polystyrene cup	Or a plastic or insulated beaker
0-110 ^{o}C thermometer	
50 cm^3 measuring cylinder	
Burettes and funnels	2
Bungs to fit burette	2
Weighing bottles and stoppers	3
Spatula	3
Access to balance	
Protective gloves	

Notes

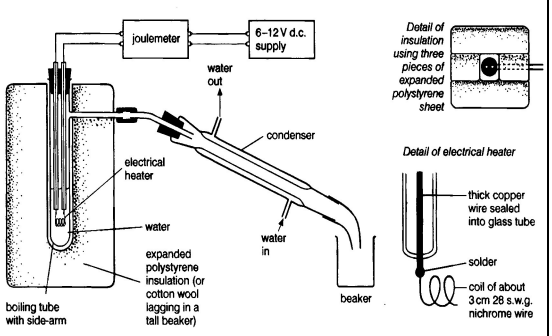
O1.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dispensing anhydrous calcium chloride	 Irritant	Irritating to eyes, skin and respiratory system	 Wear eye protection  Wear protective gloves. Avoid inhaling dust
Dispensing anhydrous iron(III) chloride	 Irritant	Irritating to eyes skin and respiratory system	 Wear eye protection  Wear protective gloves. Avoid inhaling dust

Notes

O3.1 THE ENTHALPY CHANGE OF VAPORISATION OF WATER (OPTIONAL)

Requirements

Electric heating coil and apparatus for boiling and condensing water as in the diagram	 *(See notes in advance warning for construction of heating coil)* Alternatively a thermos flask can be used fitted with a 2 hole bung into which is placed a 12 volt immersion heater and a delivery tube with a bung or quickfit adapter to fit a condenser
Joulemeter	Use a 10 amp shunt with the Unilab Joulemeter
Small beakers	2 or specimen tubes
12V dc power supply	
Connecting leads	4
Access to balance	

The experiment should be started using hot water as it takes a long time for the 12V immersion heater to boil the water from cold

Notes

O 3.2 WHAT CRYSTALS FORM WHEN A SOLUTION IS COOLED?

Requirements

Copper(II) sulphate, a saturated solution	4 cm^3
250 cm^3 beaker	
Test tubes	2
Crushed ice	
Table salt	A spoonful
-10 ^oC- 110 ^oC thermometer	
Spatula	

Notes

O 3.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparing a saturated solution of copper(II) sulphate	**Solid & soln.**  Harmful  Harmful to environment	Harmful if swallowed. The solid may be irritating to eyes and skin and has been known to sensitise the skin.	 Wear eye protection  Wear protective gloves.

Notes

O 4.1 FINDING OUT MORE ABOUT WEAK ACIDS

Requirements

pH meter and electrode	
100 cm^3 beakers	12
Buffer solutions	To calibrate electrode
Solutions of hydrochloric acid of the following concentrations 0.1M 0.03M 0.01M 0.003M 0.001M	50 cm^3 of each- Make up 0.1M by adding 8.6 cm^3 of the conc. acid to dist. water. Make up to 1 dm^3 with dist. water. Dilute portions of the 0.1M acid for the other concentrations
Solutions of ethanoic acid, the same concentrations as hydrochloric acid	50 cm^3 of each- Make up 0.1M by adding 5.7 cm^3 of the glacial acid to dist. water. Make up to 1 dm^3 with dist. water. Dilute portions of the 0.1M acid for the other concentrations

Notes

O4.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dilution of concentrated hydrochloric acid to make dilute solutions	**Conc acid**  Corrosive **2M acid**  Irritant	Concentrated hydrochloric acid is corrosive and the fumes irritate the eyes and respiratory system	 Wear a face shield.  Dispense the concentrated acid in a fume cupboard. Dilute the conc. acid in a fume cupboard by adding the **acid to water** Take great care when opening bottles of the conc. acid on hot days
Dilution of concentrated ethanoic acid to make dilute solutions	**Conc. ethanoic acid**  Corrosive **2M ethanoic acid**  Irritant	Causes severe burns. Very irritating to the respiratory system. The vapour is flammable.	 Wear eye protection  Wear protective gloves. Use and dilute in a fume cupboard. Avoid inhaling fumes. Avoid sources of ignition near the vapour of the concentrated acid

Notes

O4.2 INVESTIGATING SOME BUFFER SOLUTIONS

Requirements

Ethanoic acid 0.5M	75 cm^3- Add 28.5 cm^3 of the glacial acid to dist. water. Make up to 1dm^3 with dist. water
Potassium (or sodium) ethanoate solution 0.5M	75 cm^3- Dissolve 49 g (41 g of anhydrous sodium salt) of the solid in dist. water. Make up to 1 dm^3 with dist. water.
Methanoic acid solution 0.5M	25 cm^3- Add 25.5 cm^3 of the concentrated (90%) acid to dist. water. Make up to 1 dm^3 with dist. water
Potassium (or sodium) methanoate solution 0.5M	25 cm^3- Dissolve 42 g (44 g of the sodium salt) of the solid in dist. water. Make up to 1 dm^3 with dist. water.
Ammonium chloride solution 0.5M	25 cm^3- Dissolve 26.7 g of the solid in dist. water. Make up to 1 dm^3 with dist. water
Ammonia solution 0.5M	25 cm^3- Add 28.5 cm^3 of 880 ammonia to dist. water. Make up to 1 dm^3 with dist. water
Hydrochloric acid 0.5M	15 cm^3- Add 43 cm^3 of the conc. acid to dist. water. Make up to 1 dm^3 with dist. water
Potassium hydroxide solution 0.5M	15 cm^3- Dissolve 28 g of the solid in dist. water. Make up to 1 dm^3 with dist. water.
25 cm^3 measuring cylinder	
10 cm^3 measuring cylinder	
100 cm^3 beakers	7
pH meter and electrode	
Buffer solutions	To calibrate the electrode
Stirring rod	
Nitric acid 1 x 10^{-4}M	50 cm^3- Make up 0.1M by adding 6.4 cm^3 of the conc. acid to dist. water. Make up to 1 dm^3 with dist. water. Take 1 cm^3 of the 0.1M acid, dilute to 1 dm^3 to make 0.0001M acid

O4.2 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Dilution of concentrated ethanoic acid to make 0.5M acid	**Conc. ethanoic acid**  Corrosive	Causes severe burns. Very irritating to the respiratory system. The vapour is flammable.	 Wear eye protection  Wear protective gloves. Use and dilute in a fume cupboard. Avoid inhaling fumes. Avoid sources of ignition near the vapour of the concentrated acid
Dilution of concentrated methanoic acid to make 0.5M acid	**Conc. methanoic acid**  Corrosive	Causes severe burns. Very irritating to the respiratory system. The vapour is flammable.	 Wear eye protection  Wear protective gloves. Use and dilute in a fume cupboard. Avoid inhaling fumes. Avoid sources of ignition near the vapour of the concentrated acid
Preparation of 0.5M solution of ammonium chloride	**Solid**  Harmful	Harmful if swallowed. Irritating to eyes	 Wear eye protection
Diluting concentrated ammonia to make 0.5M solution	**Concentrated ammonia**  Corrosive  Harmful to environment	The concentrated ammonia causes burns in contact with skin and is dangerous to eyes. The vapour is irritating to eyes. Pressure can build up in sealed containers	 Goggles must be worn  Wear protective gloves to avoid skin contact Dispense in a fume cupboard. Open containers of the concentrated ammonia with care particularly on hot days, using a safety screen or face shield.
Dilution of concentrated hydrochloric acid to make 0.5M acid	**Conc acid**  Corrosive	Concentrated hydrochloric acid is corrosive and the fumes irritate the eyes and respiratory system	 Wear a face shield.  Dispense the concentrated acid in a fume cupboard. Dilute the conc. acid in a fume cupboard by adding the **acid to water.** Take great care when opening bottles of the conc. acid on hot days
Preparing 0.5 M solution of potassium or sodium hydroxide	**Solid & 0.5 M solution**  Corrosive	Solid and solution cause severe burns and are particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring
Dilution of concentrated nitric acid to make dilute solutions	**Concentrated acid**  Corrosive  Oxidiser	Causes severe burns. Skin will turn yellow then peel. Vapour is dangerous to eyes and respiratory system. Contact with combustible material may cause fire	 Wear eye protection  Wear protective gloves. Dispense in a fume cupboard. Keep away from combustible material

Notes on "Oceans"

MEDICINES BY DESIGN

Advance warning

The following items needed for activities in this unit may not be already in your school or college and might take a little time to obtain

Activity	Item(s)	Quantities per expt.	Essential or Optional	
MD5.1	6-Aminopenicillanic acid (6APA)	1 g	E	Available from; GlaxoSmithKline, New Frontier Science Park North, 3rd Avenue, Harlow, Essex, CM19 5AW Tel; 01279 627565 ***They will supply free of charge and collect any unused for disposal. They recommend using fresh each year.*** Also available from; Aldrich Chemical Co. **Cat. No. A7090-9**
	Bacillus subtilis living culture		E	Available from; Philip Harris Education, Novara House, Excelsior Road, Ashby Park, Ashby de la Zouch, Leicestershire, LE65 1NG or from; Blades Biological, Cowden, Eden Bridge, Kent, TN8 7DX Tel; 01342850242
	Nutrient agar		E	
	Nutrient broth		E	
	Access to incubator		E	
	Access to autoclave or pressure cooker for sterilisation		E	
	Autoclavable bags or roasting bags		E	
	Disposable sterile syringes		E	
	Sterile plastic petri dishes with lids		O	

Notes

Chemicals required for MD

Chemical	Concs.	Quantities per group
2-methylpropan-2-ol		3 drops
6-aminopenicillanic acid (6-APA)		1 g
Bacillus subtillis		Living culture
Benzoyl chloide		0.5 cm^3
Ethyl ethanoate		15 cm^3
Fehlings solution 1		2 cm^3
Fehlings solution 2		2 cm^3
Hydrochloric acid	1M	10 cm^3
Nutrient agar		80 cm^3
Nutrient broth tablets		2
Potassium dichromate(VI)	0.1M	2 cm^3
Propan-1-ol		3 drops
Propan-2-ol		3 drops
Propanal		3 drops
Propanone		6 cm^3
Sodium benzoate		Few g
Sodium hydrogencarbonate	Sat. solution	25 cm^3
Sodium hydroxide	1M	5 cm^3
Sulphuric acid	2M	10 cm^3

Notes

MD1.1 ALDEHYDES AND KETONES

Requirements

Potassium dichromate(VI) 0.1M	2 cm^3- Dissolve 2.94 g of the solid in dist. water. Make up to 100 cm^3 with dist. water
Sulphuric acid 2M	10 cm^3- Add 11 cm^3 of the concentrated acid slowly with constant stirring to dist. water. Make up to 100 cm^3 with dist. water
Propan-1-ol	3 drops
Propan-2-ol	3 drops
Propanal	3 drops
2-Methylpropan-2-ol	3 drops
Propanone	3 drops
Test tubes	6
Angled glass tube with rubber bung	To fit test tubes
250 cm^3 beaker	For cold water bath
400 cm^3 beaker	For hot water bath
Fehlings solution 1	2 cm^3
Fehlings solution 2	2 cm^3
Dropping pipette	5

Notes

MD1.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Preparing a 0.1M solution of potassium dichromate(VI)	**Solid and soln**  Toxic  Irritant  Harmful to environment	Dichromates are suspected carcinogens. Irritating to eyes, respiratory system and skin.	 Wear eye protection.  Wear protective gloves. Avoid all skin contact. Any spillages should be washed off at once
Preparing 2M sulphuric acid	**Conc. acid**  Corrosive **2M sulphuric acid**  Corrosive	Causes severe burns. The concentrated acid has an affinity for water. Hence it is extremely dangerous to eyes, and can cause blindness if entering the eye. The act of diluting produces much heat and if control measures are not taken the mixture can boil causing dangerous splashes.	 Wear a full-face shield.  Gloves should be worn. The conc. acid should be added very slowly to the distilled water, with constant stirring, cooling the beaker in a large vessel of cold water. **Never add water to the conc. acid**
Dispensing propan-1-ol propan-2-ol & 2-methylpropan-2-ol	 Highly flammable  Harmful & irritant	Serious risk of damage to eyes. Vapours may cause drowsiness or dizziness. Risk of fire.	 Wear eye protection  Wear protective gloves. Dispense in a fume cupboard. Avoid inhaling vapour. Use away from sources of ignition.
Dispensing propanal	 Highly flammable  Irritant	Risk of vapour catching fire. Irritating to eyes, respiratory system and skin	 Wear eye protection  Wear protective gloves. Dispense in a fume cupboard. Avoid inhaling vapour. Use away from sources of ignition.
Dispensing propanone	 Highly flammable  Irritant	Serious risk of liquid and vapour catching fire. Can cause severe eye damage. The liquid will degrease skin. The vapour can be harmful with prolonged exposure	 Wear eye protection  Wear protective gloves. Use and dispense well away from naked flames in a well ventilated area or fume cupboard
Dispensing Fehlings 1 (contains copper sulphate)	 Harmful  Harmful to environment	Harmful if swallowed	 Wear eye protection
Dispensing Fehlings 2 (contains sodium hydroxide)	 Corrosive	Causes severe burns and is particularly dangerous to eyes	 Wear eye protection

MD5.1 MAKING AND TESTING A PENICILLIN

Sterile Technique

Full details of sterile technique are given in *CLEAPSS Laboratory Handbook* Section *15.2*

Basic rules to observe when handling bacterial cultures

1. Wash down the work area with a suitable disinfectant before and after use.
2. Wear gloves and lab. coat at all times.
3. Wash your hands well in hot soapy water before and after use. Make sure that skin cuts are protected with effective waterproof dressings. Do not touch your face or other parts of your body when using.
4. Do not open containers any wider and do not keep them open any longer than is absolutely necessary.
5. Transfer micro-organisms as quickly as possible.
6. Do not breathe or cough over a Petri dish when the lid is raised.
7. Plates should be sealed with small pieces of adhesive tape along the diameter (see Figure 2 on p. 333 Students Activity sheets), and not around the circumference. The plates should remain sealed during subsequent examinations.
8. All cultures, plates, syringes and contaminated apparatus should be sterilised before disposal or before being returned to stock.

Advanced preparation

The preparation of the broth culture of *Bacillus subtilis* takes 24 hours, so this must be started the day before the practical session. The agar plates should be poured immediately before the practical session if possible.

Making up the agar plates

Requirements

Bacillus subtilis	Living culture on agar
Nutrient broth tablets	
Screw cap bottles	30 cm^3 capacity
Inoculating loop	
Access to incubator	
Disposable sterile syringes	
Access to pressure cooker	Or autoclave
Autoclavable plastic bags	Or roasting bags
Sterile Petri dishes with lids	4- If glass ones are used they must be sterilised first
Sterilised nutrient agar	80 cm^3- Make up according to the instructions on the bottle

1. First make a sub-culture of *Bacillus subtilis* in a sterile nutrient broth as follows. Put two nutrient broth tablets and 15 cm^3 dist. water into a 30 cm^3 screw cap bottle. Put the cap on loosely and sterilise in a pressure cooker or autoclave for 30 min. Allow to cool.
Sterilise an inoculating loop in a Bunsen flame until red hot and allow to cool. Draw the sterile loop across the surface of the *Bacillus subtilis* culture on the agar slope, so that a very small amount of the culture is taken up on the loop. Transfer to the sterile nutrient broth. Flame the neck of the bottle to resterilise, by passing it briefly through a flame. Replace the cap and stand the bottle in an incubator set at 25 ^oC-28 ^oC for 24 hours. Sterilise the inoculating loop in a flame. Shake the tube from time to time during the incubation period

N.B.
The neck of the culture bottle must be flamed if the cap is removed at any time. The cap should not be placed on the bench.

2. Using a sterile syringe, transfer 2 cm^3 of the broth culture into 20 cm^3 sterilised dist. water in a screw cap bottle. (Each group needs 4 cm^3 of the diluted *Bacillus subtilis* broth culture.)

3. Make up the nutrient agar solution according to the directions given, and sterilise in a pressure cooker or autoclave for 30 min. This can be done in bulk or in a number of small bottles. (Agar only dissolves in water above 95 ^oC. It is best to let the agar soak in dist. water first for about 15 mins. and then heat on a water bath. *Do not add solid agar to boiling water.*)
Allow the agar solution to cool to about 48 ^oC before pouring. If the solution is too hot, it will kill the bacteria. If it cools below 40 ^oC, it will solidify. It is a good idea to have a water bath at about 45 ^oC to keep the bottles of agar solution at the right temperature for pouring.

4. Using a sterile syringe, place 1 cm^3 of the diluted *Bacillus subtilis* broth culture into each sterile Petri dish on a level surface. Add 20 cm^3 sterilised nutrient agar solution to each and mix by swirling gently. (Alternatively it may be more convenient to mix the *Bacillus subtilis* broth culture with the nutrient agar in bottles before pouring.) Cover the plates and leave to set. Put the containers from the agar immediately into a bowl of hot water.

N.B.
The *Bacillus subtilis* is incorporated in the agar in this way to give a uniform distribution of bacteria. This makes it much easier to see any inhibition.

Notes

MD 5.1

Requirements

100 cm^3 well-stoppered bottle	Or conical flask
6-aminopenicillanic acid (6-APA)	1.0 g- Fresh.- It can be stored for a few months in a refrigerator, but fresh should be obtained each year and old stocks should be returned to supplier for free disposal. (See advance warning)
25 cm^3 measuring cylinders	2
10 cm^3 measuring cylinder	
Sodium hydroxide solution 1M	5 cm^3- Dissolve 4 g of the solid in dist. water. Make up to 100 cm^3 with dist. water.
Dropping pipettes	
Benzoyl chloride	0.5 cm^3
Propanone	5 cm^3
Test tubes	
100 cm^3 beakers	2
Ethyl ethanoate	15 cm^3
Glass rod	
pH meter and electrodes	Or universal indicator paper
Agar plates impregnated with *Bacillus subtilis*	4- See advance prep
Cork borer (5-7 mm)	
Ethanol	For sterilisation
Beaker of disinfectant	
Hydrochloric acid 1M	10 cm^3- Add 8.6 cm^3 of the conc. acid to dist. water. Make up to 100 cm^3 with dist. water
Saturated sodium hydrogen carbonate solution	25 cm^3
50 cm^3 separating funnel	

Spatula	
Adhesive tape	
6-APA solution	Few drops- Dissolve 0.13 g of the solid in a solution of 0.15 g sodium hydrogencarbonate in 250 cm^3 dist. water; take 10 cm^3 of this and dilute to 100 cm^3 with dist water
Sodium benzoate solution	Few drops- Dissolve 0.13 g of the solid in 250 cm^3 dist. water; take 10 cm^3 of this and dilute to 100 cm^3 with dist. water

MD5.1 Technicians Safety Sheet

Operation	Hazard	Risks	Control measures
Handling cultures of microorganisms & nutrient	 Biohazard	Danger of contamination from pathogens from the environment	 Wear eye protection  Wear protective gloves Observe sterile technique as given at beginning of this expt. and as in *CLEAPSS Handbook* section 15.2
Dispensing 6-APA & preparing solution	 Irritant	6-APA can act as a sensitiser by inhalation and skin contact	 Wear eye protection  Wear protective gloves to avoid skin contact. Dispense and prepare solution in a fume cupboard to avoid inhaling dust
Preparing 1M sodium hydroxide	**Solid & 1M soln.**  Corrosive	Solid and solution cause severe burns and are particularly dangerous to eyes. The solid gets hot when added to water	 Wear safety goggles  Wear protective gloves. Add solid slowly to water with constant stirring
Dispensing benzoyl chloride	 Corrosive	Causes severe burns. It has an offensive odour which is very irritating to eyes and respiratory system	 Wear eye protection  Wear protective gloves to avoid skin contact. Dispense in a fume cupboard to avoid inhaling fumes
Dispensing propanone	 Highly flammable  Irritant	Serious risk of liquid and vapour catching fire. Can cause severe eye damage. The liquid will degrease skin. The vapour can be harmful with prolonged exposure	 Wear eye protection  Wear protective gloves. Use and dispense well away from naked flames in a well ventilated area or fume cupboard

Dispensing ethyl ethanoate	 Highly flammable  Irritant	Risk of vapour catching fire. Irritating to eyes. Vapour can cause dizziness or drowsiness. May cause skin dryness	 Wear safety goggles  Wear protective gloves.
Dispensing ethanol	 Highly flammable	Breathing the vapour has a narcotic effect. Risk of fire.	 Wear eye protection Avoid inhaling fumes. Use in a fume cupboard and away from sources of ignition.
Dilution of concentrated hydrochloric acid to make 1M acid	**Conc acid**  Corrosive **1M acid**  Irritant	Concentrated hydrochloric acid is corrosive and the fumes irritate the eyes and respiratory system	 Wear a face shield.  Dispense the concentrated acid in a fume cupboard. Dilute the conc. acid in a fume cupboard by adding the **acid to water.** Take care when opening bottles on hot days

Notes

Notes on "Medicines by Design"