

Year 12 Chemistry

NCEA Level 2

Technician's Manual

For all Practical Activities in:

Internal Workbook: AS 2.1, 2.2 and 2.7

External Workbook: AS 2.4, 2.5 and 2.6



Graeme Abbott
Bev Cooper



CONTENTS

General Safety Notes..... overleaf

INTERNAL WORKBOOK

Chemistry 2.2: Identifying Ions (Section 1)

Practical Precipitates (<i>workbook page 11</i>).....	1
A Complex Experiment (<i>workbook page 14</i>).....	1
Identifying Ions (<i>workbook page 18</i>).....	2
Into the Unknown! (<i>workbook page 23</i>).....	2
Keep Flowing! (<i>workbook page 24</i>).....	3
Hard Water (<i>workbook page 27</i>).....	3

Chemistry 2.1: Quantitative Analysis (Section 2)

Let's Get Reacting (<i>workbook page 36</i>).....	4
Counting the Number of Particles Using Mass (<i>workbook page 40</i>).....	4
A Mole is a Chemist's Best Friend (<i>workbook page 46</i>).....	5
More Moles (<i>workbook page 49</i>).....	5
Preparation of a Standard Sodium Carbonate Solution (<i>workbook page 63</i>).....	6
Standardisation of Hydrochloric Acid Solution (<i>workbook page 65</i>).....	6
Standardisation of Sodium Hydroxide Solution (<i>workbook page 67</i>).....	6
Analysis of Vinegar (<i>workbook page 69</i>).....	7
Analysis of Household Ammonia (<i>workbook page 71</i>).....	7
Analysis of an Aspirin Tablet (<i>workbook page 73</i>).....	7

Chemistry 2.7: Oxidation-Reduction Reactions (Section 3)

Oxygen as an Oxidant/Oxidising Agent/Oxidiser (<i>workbook page 88</i>).....	8
Reduction of Metal Oxides (<i>workbook page 90</i>).....	8
Electron Transfer in Oxidation and Reduction (<i>workbook page 94</i>).....	9
Growing Metal Crystals (<i>workbook page 97</i>).....	9
More Oxidants (<i>workbook page 105</i>).....	10

EXTERNAL WORKBOOK

Chemistry 2.4: Bonding, Structure, Properties and Energy Changes (Section 1)

Forces Between Particles (<i>workbook page 27</i>).....	11
Electrical Conductivity (<i>workbook page 30</i>).....	11
Polar Molecules (<i>workbook page 54</i>).....	12
Water Solubility (<i>workbook page 55</i>).....	12
Exothermic and Endothermic Reactions (<i>workbook page 63</i>).....	12
Heat Output of Fuels (<i>workbook page 70</i>).....	13

Chemistry 2.5: Selected Organic Compounds (Section 2)

Properties of Alkanes (<i>workbook page 112</i>).....	14
Candle Wax Analysis (<i>workbook page 118</i>).....	14
Teacher Demonstration: Formation of Alkenes from Alkanes (<i>workbook page 120</i>).....	15
Alkenes vs Alkanes (<i>workbook page 123</i>).....	15
Teacher Demonstration: Production of Ethene from Ethanol (<i>workbook page 130</i>).....	16
Properties of Alkynes (<i>workbook page 138</i>).....	16
Properties of Amines (<i>workbook page 147</i>).....	17
Oxidation of Alcohols (<i>workbook page 154</i>).....	17

Chemistry 2.6: Chemical Reactivity (Section 3)

Teacher Demonstration: A Clock Reaction (<i>workbook page 182</i>).....	18
Teacher Demonstration: Elephant Toothpaste! (<i>workbook page 186</i>).....	18
Teacher Demonstration: Chemical Equilibrium Practical (<i>workbook page 204</i>).....	19
Equilibrium Systems (<i>workbook page 212</i>).....	19
Equilibrium – Another Example! (<i>workbook page 216</i>).....	20
Acidity of Household Substances (<i>workbook page 233</i>).....	20
The Strengths of Acids and Bases (<i>workbook page 236</i>).....	20
Reaction Rates of Strong and Weak Acids (<i>workbook page 238</i>).....	21

General Safety Notes for These Workbooks

- Your immediate reference concerning practical activities carried out in school laboratories is the 'Code of Practice for School Exempt Laboratories' which has been developed by the *New Zealand Association of Science Educators (NZASE)*. This document is freely downloadable from the Internet.
- Many chemical substances can be potentially hazardous to human health if they are ingested, come into skin or eye contact, are inhaled or are flammable.

Specific safety notes are provided for some substances required for practicals in this workbook. However, in general, two simple practices that should be implemented when running practical sessions with students are:

1. Students should wear **safety glasses** in most circumstances, when carrying out a practical activity.
2. Students should not consume **food** or **drinks** in the laboratory.

INTERNAL WORKBOOK

Section 1: Chemistry 2.2 (AS91162)

Identifying Ions

Practical Precipitates *(workbook page 11)*

Chemicals:

- dilute solution of sodium hydroxide
- dilute solution of magnesium sulfate
- dilute solution of sodium carbonate
- dilute solution of copper sulfate
- dilute solution of copper nitrate
- dilute solution of lead nitrate
- dilute solution of potassium iodide
- dilute solution of iron(II) sulfate
- dilute solution of iron(III) nitrate
- dilute solution of sodium sulfate
- dilute solution of barium chloride
- dilute solution of potassium sulfate
- dilute solution of calcium chloride
- dilute solution of silver nitrate

Equipment:

- test tubes
- safety glasses

- Safety Notes:**
- *Sodium hydroxide solution is corrosive.*
 - *Lead nitrate is harmful if inhaled or swallowed and is a cumulative poison.*
 - *Iron(II) sulfate and iron(III) nitrate are irritants to the eyes and skin. Iron(III) nitrate is an irritant to the respiratory system.*
 - *Barium chloride is harmful if inhaled or swallowed.*
 - *Wear safety glasses during this practical.*

A Complex Experiment *(workbook page 14)*

Chemicals:

- 2 mol L⁻¹ solution of sodium hydroxide
- 2 mol L⁻¹ solution of ammonia
- 0.1 mol L⁻¹ iron(III) nitrate solution
- 0.1 mol L⁻¹ lead nitrate
- 0.1 mol L⁻¹ zinc nitrate
- 0.1 mol L⁻¹ aluminium nitrate
- 0.1 mol L⁻¹ copper nitrate
- 0.01 mol L⁻¹ silver nitrate solution

Equipment:

- safety glasses

- Safety Notes:**
- *Sodium hydroxide is corrosive.*
 - *Ammonia solution is irritating to the skin and respiratory system. Avoid breathing the vapour.*
 - *Wear safety glasses during this practical.*

Identifying Ions (workbook page 18)

Chemicals:

- 2 mol L⁻¹ solution of sodium hydroxide
- 2 mol L⁻¹ solution of hydrochloric acid
- 2 mol L⁻¹ solution of ammonia
- 1 mol L⁻¹ solution of sodium sulfate
- 0.1 mol L⁻¹ solution of iron(II) sulfate
- 0.1 mol L⁻¹ solution of copper sulfate
- 0.1 mol L⁻¹ solution of sodium chloride
- 0.1 mol L⁻¹ solution of potassium thiocyanate
- 0.1 mol L⁻¹ solution of magnesium nitrate
- 0.1 mol L⁻¹ solution of iron(III) nitrate
- 0.1 mol L⁻¹ solution of sodium carbonate
- 0.1 mol L⁻¹ solution of barium chloride
- 0.1 mol L⁻¹ solution of aluminium nitrate
- limewater (saturated calcium hydroxide solution)
- 0.01 mol L⁻¹ silver nitrate solution
- litmus paper

Safety Notes:

- Sodium hydroxide and hydrochloric acid solutions are corrosive.
- Ammonia solution is irritating to the skin and respiratory system. Avoid breathing the vapour.
- Copper sulfate can cause eye damage and is harmful if swallowed.
- Potassium thiocyanate is harmful by skin contact and if swallowed. Solid is harmful by inhalation.
- Barium chloride is harmful if swallowed. Solid is harmful by inhalation.
- Calcium hydroxide is irritating to the eyes, skin and respiratory system.
- Silver nitrate is corrosive and causes burns.
- Wear safety glasses during this practical.

Equipment:

- test tubes
- eye droppers
- safety glasses

Into the Unknown! (workbook page 23)

Chemicals:

- 2 mol L⁻¹ solution of sodium hydroxide
- 2 mol L⁻¹ solution of hydrochloric acid
- 2 mol L⁻¹ solution of ammonia
- 0.1 mol L⁻¹ solution of barium chloride
- 0.1 mol L⁻¹ solution of potassium thiocyanate
- 0.01 mol L⁻¹ silver nitrate solution
- five unknown solutions labelled A, B, C, D and E

Safety Notes:

- Sodium hydroxide and hydrochloric acid solutions are corrosive.
- Barium chloride solution is harmful if swallowed.
- Silver nitrate is corrosive and causes burns.
- Wear safety glasses during this practical.

Equipment:

- test tubes
- eye droppers
- safety glasses

Keep Flowing! (workbook page 24)

Chemicals:

- nine bottles randomly labelled 'A' to 'I' containing the following solutions:
 - 1 mol L⁻¹ sodium hydroxide
 - 0.1 mol L⁻¹ iron(III) chloride
 - 0.1 mol L⁻¹ sodium chloride
 - 0.1 mol L⁻¹ sodium carbonate
 - 0.1 mol L⁻¹ copper sulfate
 - 0.1 mol L⁻¹ iron(II) sulfate
 - 0.1 mol L⁻¹ silver nitrate
 - 1 mol L⁻¹ hydrochloric acid
 - 0.1 mol L⁻¹ ammonium chloride

- Safety Notes:**
- Sodium hydroxide and hydrochloric acid are corrosive.
 - Iron(III) chloride and iron(II) sulfate are irritants to the eyes and skin.
 - Sodium carbonate is harmful to the eyes.
 - Copper sulfate can cause eye damage and is harmful if swallowed.
 - Silver nitrate is corrosive and causes burns.
 - Wear safety glasses during this practical.

Equipment:

- coloured paper and a plastic bag or spotting tiles
- eye droppers
- test tube
- Bunsen burner
- safety glasses

Hard Water (workbook page 27)

Chemicals:

- sodium carbonate solution
- four samples of water:
 - rainwater
 - water taken from a river running through limestone country
 - town water supply
 - salt water

Equipment:

- test tubes with rubber stoppers
- soap solution
- 10 mL measuring cylinder
- filter funnel
- filter paper
- 250 mL beaker
- safety glasses

Note: Add some Ca²⁺ and Mg²⁺ ions to a water sample.

Safety Note: • Sodium carbonate is harmful to the eyes.

Section 2: Chemistry 2.1 (AS91161)

Quantitative Analysis

Let's Get Reacting (workbook page 36)

Chemicals:

- copper foil
- magnesium ribbon
- calcium
- granulated zinc
- iron nail
- dilute sulfuric acid solution
- copper sulfate solution
- concentrated hydrochloric acid
- concentrated nitric acid
- concentrated ammonia solution
- limewater

Equipment:

- Bunsen burner
- crucible tongs
- test tubes
- sandpaper
- safety glasses

- Safety Notes:**
- *Magnesium metal is highly flammable. When burning, produces great heat and light.*
 - *Concentrated hydrochloric and nitric acids are corrosive. They cause burns and irritate the respiratory system.*
 - *Concentrated ammonia solution is corrosive. It causes burns and is an irritant to the eyes, skin and respiratory system.*
 - *Copper sulfate is harmful if swallowed or in contact with the eyes.*
 - *Calcium metal produces a highly flammable gas when in contact with water.*
 - *Wear safety glasses during this practical.*

Counting the Number of Particles Using Mass (workbook page 40)

Equipment:

- balance (preferably electronic)
- 400 mL beaker
- handful of marbles
- handful of nails (or old 2 cent pieces, etc.)

A Mole is a Chemist's Best Friend *(workbook page 46)*

Chemicals:

- aluminium, Al
- glucose, C₆H₁₂O₆
- copper sulfate 5-hydrate, CuSO₄·5H₂O
- oxalic acid 2-hydrate, H₂C₂O₄·2H₂O
- potassium dichromate, K₂Cr₂O₇
- potassium permanganate, KMnO₄
- sodium hydrogen carbonate, NaHCO₃
- sodium sulfate, Na₂SO₄
- sulphur, S₈
- steel wool, Fe
- granulated zinc, Zn

Equipment:

- small plastic container with lid or ziplock plastic bag
- 2-dp balance
- safety glasses

- Safety Notes:**
- *Copper sulfate is harmful by inhalation and if swallowed. Risk of serious damage to eyes.*
 - *Oxalic acid is harmful in contact with skin and if swallowed.*
 - *Potassium dichromate is irritating to the eyes, respiratory system and skin. May cause sensitisation by skin contact.*
 - *Potassium permanganate may cause fire when in contact with combustible material. Harmful if swallowed.*
 - *Do not breathe sulfur dust and avoid contact with eyes.*
 - *Wear safety glasses during this practical.*

More Moles *(workbook page 49)*

Chemicals:

- sample of sodium chloride
- sample of aluminium sheet
- sample of sulfur
- sample of copper sulfate 5-hydrate
- sample of zinc granules
- sample of lead sheet (or pellets)
- sample of copper sheet (or granules)
- sample of magnesium ribbon
- sample of sucrose
- sample of brass

Equipment:

- balance
- spatula
- 100 mL beaker
- plastic sample containers
- 50 mL measuring cylinder
- ruler
- pen
- calculator
- safety glasses

- Safety Notes:**
- *Do not breathe sulfur dust and avoid contact with eyes.*
 - *Copper sulfate is harmful by inhalation and if swallowed. Risk of serious damage to eyes.*
 - *Wear safety glasses during this practical.*

Preparation of a Standard Sodium Carbonate Solution *(workbook page 63)*

Chemicals:

- small sample bottle of anhydrous sodium carbonate (Na_2CO_3)
- distilled or de-ionised water

Equipment:

- 250 mL standard flask (volumetric flask)
- wash bottle
- balance
- 250 mL beaker
- stirring rod
- filter funnel
- measuring cylinder
- safety glasses

- Safety Notes:**
- *Anhydrous sodium carbonate is an irritant to eyes.*
 - *Wear safety glasses during this practical.*

Standardisation of Hydrochloric Acid Solution *(workbook page 65)*

Chemicals:

- standard sodium carbonate solution
- distilled or de-ionised water
- hydrochloric acid solution (approx. 0.1 mol L^{-1})
- methyl orange indicator

Equipment:

- 10 mL transfer pipette
- pipette filler
- 50 mL burette
- 3 x 100 mL conical flasks
- wash bottle

Standardisation of Sodium Hydroxide Solution *(workbook page 67)*

Chemicals:

- standard hydrochloric acid solution (approx. 0.1 mol L^{-1})
- solid sodium hydroxide
- phenolphthalein indicator

Equipment:

- 20 mL pipette
- 50 mL burette
- 3 x 100 mL conical flasks
- wash bottle
- 250 mL beaker
- 250 mL storage container
- safety glasses

- Safety Notes:**
- *Sodium hydroxide is very corrosive and can cause severe burns.*
 - *Phenolphthalein solution is highly flammable.*
 - *Wear safety glasses during this practical.*

Analysis of Vinegar *(workbook page 69)*

Chemicals:

- vinegar
- standard sodium hydroxide solution
- distilled or deionised water
- phenolphthalein indicator

Equipment:

- 10 mL pipette
- 25 mL pipette
- 50 mL burette
- 100 mL standard flask
- 3 x 100 mL conical flasks
- wash bottle

Note: *As this titration involves a weak acid with a strong base, care has to be taken over the choice of indicator. Phenolphthalein is a suitable indicator in this case.*

Analysis of Household Ammonia *(workbook page 71)*

Chemicals:

- household ammonia solution
- standardised hydrochloric acid solution
- methyl orange indicator

Equipment:

- 5 mL transfer pipette (or 10 mL graduated pipette)
- 20 mL pipette
- pipette filler
- 50 mL burette
- 250 mL standard flask
- wash bottle
- 3 x 100 mL conical flasks
- safety glasses

Note: *As this titration involves a weak base with a strong acid, care has to be taken over the choice of indicator. Methyl orange is a suitable indicator in this case.*

Safety Notes:

- *Commercial ammonia solution is an irritant to the eyes, respiratory system and skin. **Do not pipette this solution by mouth** – use a safety pipette filler.*
- *Wear safety glasses during this practical.*

Analysis of an Aspirin Tablet *(workbook page 73)*

Chemicals:

- aspirin (not the soluble variety)
- standard sodium hydroxide solution
- ethanol for solvent
- phenolphthalein solution

Equipment:

- 2 x 100 mL conical flasks
- 50 mL burette
- wash bottle
- beaker to hold flask
- measuring cylinder

Safety Note:

- *Phenolphthalein solution and ethanol are flammable.*

Section 3: Chemistry 2.7 (AS91167)

Oxidation-Reduction Reactions

Oxygen as an Oxidant/Oxidising Agent/Oxidiser (workbook page 88)

Chemicals:

- copper foil
- iron nail
- magnesium ribbon
- 0.1 mol L⁻¹ mercury(II) nitrate solution (or mercury(II) chloride)
- zinc foil
- aluminium foil
- charcoal powder
- sulfur
- 2 mol L⁻¹ sulfuric acid

Equipment:

- tongs
- burner
- bottle top
- test tube
- cotton buds
- safety glasses

- Safety Notes:**
- *Mercury(II) nitrate (or chloride) solids are toxic by inhalation, skin contact and if swallowed. Danger of cumulative effects. These substances should only be handled by a teacher.*
 - *Avoid breathing sulfur dust and avoid contact with the eyes. Avoid breathing the gas given off (sulfur dioxide) when sulfur burns.*
 - *Sulfuric acid solution is corrosive.*
 - *Wear safety glasses during this practical.*

Reduction of Metal Oxides (workbook page 90)

Chemicals:

- copper(II) oxide (CuO)
 - zinc oxide (ZnO)
 - lead oxide (Pb₃O₄)
 - charcoal powder
 - magnesium powder
 - zinc powder
 - concentrated nitric acid
 - dilute sulfuric acid
- some of the above are mixed as follows:
- A: copper(II) oxide + charcoal (carbon)
- B: copper(II) oxide + zinc
- C: zinc oxide + magnesium
- D: lead oxide (Pb₃O₄) + charcoal (carbon)

Equipment:

- dry pyrex test tubes
- test tube holder
- Bunsen burner
- spatulas
- safety glasses

- Safety Notes:**
- *Copper(II) oxide is harmful if inhaled or swallowed. Do not breathe the dust.*
 - *Lead oxide (Pb₃O₄) is harmful if inhaled or swallowed. A cumulative poison.*
 - *Concentrated nitric acid is dangerous. It will damage your eyes, your skin and your clothes.*
 - *Wear safety glasses during this practical.*

Electron Transfer in Oxidation and Reduction *(workbook page 94)*

Chemicals:

- magnesium ribbon
- iron wool
- zinc
- dilute sulfuric acid (1 mol L⁻¹)
- copper sulfate solution (0.1 mol L⁻¹)
- sodium hydroxide solution (2 mol L⁻¹)

Equipment:

- test tubes
- Bunsen burner

- Safety Notes:**
- *Sulfuric acid and sodium hydroxide solutions are corrosive.*
 - *Copper sulfate crystals are harmful by inhalation or if swallowed and can cause serious damage to eyes.*
 - *Wear safety glasses during this practical.*

Growing Metal Crystals *(workbook page 97)*

Chemicals:

- 40 mL distilled or deionised water
- 0.5 g agar
- approximately 0.3 g of tin(II) chloride
- approximately 0.3 g of lead nitrate
- approximately 0.3 g of copper(II) sulfate
- approximately 0.3 g of silver nitrate
- 4 cm x 1 cm strip of clean zinc sheet

Equipment:

- Petri dish
- 250 mL beaker
- Bunsen burner
- tripod and gauze
- glass stirring rod

- Safety Notes:**
- *Tin(II) chloride and copper(II) sulfate can irritate the eyes and skin.*
 - *Lead nitrate is harmful by inhalation and if swallowed. Danger of cumulative effects.*
 - *Silver nitrate causes burns and stains skin and clothing.*
 - *Wear safety glasses during this practical.*

More Oxidants (*workbook page 105*)**Chemicals:**

- 2 mol L⁻¹ solution of sodium hydroxide
- 2 mol L⁻¹ solution of hydrochloric acid
- 2 mol L⁻¹ solution of sulfuric acid
- 2 mol L⁻¹ solution of hydrogen peroxide
- chlorine water
- 0.02 mol L⁻¹ potassium permanganate solution
- 0.1 mol L⁻¹ solution of potassium dichromate
- 0.1 mol L⁻¹ solution of barium nitrate
- 0.1 mol L⁻¹ solution of potassium thiocyanate
- 0.1 mol L⁻¹ solution of sodium sulfate
- 0.1 mol L⁻¹ solution of iron(III) chloride
- 0.1 mol L⁻¹ solution of potassium (or sodium) iodide
- 0.1 mol L⁻¹ solution of iron(II) sulfate (freshly made)
- 0.1 mol L⁻¹ solution of sodium hydrogen sulfite (fresh)
- 0.01 mol L⁻¹ silver nitrate
- starch solution

Equipment:

- test tubes
- droppers
- safety glasses

Safety Notes:

- *All acid and sodium hydroxide solutions are corrosive.*
- *Hydrogen peroxide is irritating to the eyes, skin and respiratory system.*
- *Chlorine water is irritating to the eyes, skin and respiratory system. Toxic by inhalation.*
- *Potassium permanganate is harmful if swallowed. Contact with combustible material may cause fire.*
- *Potassium dichromate is an irritant to eyes, respiratory system and skin. May cause sensitisation by skin contact.*
- *Barium chloride is harmful by inhalation and if swallowed.*
- *Potassium thiocyanate is harmful by inhalation, by skin contact and if swallowed.*
- *Iron(II) sulfate and iron(III) chloride are irritants to eyes and skin.*
- *Wear safety glasses during this practical.*

EXTERNAL WORKBOOK

Section 1: Chemistry 2.4 (AS91164)

Bonding, Structure, Properties and Energy Changes

Forces Between Particles (workbook page 27)

Chemicals:

- sodium chloride (NaCl)
- silica (SiO₂)
- iodine (I₂)
- charcoal (C)
- 1,4-dichlorobenzene (C₆H₄Cl₂)
- potassium iodide (KI)
- wax
- sulfur (S₈)

Equipment:

- about 20 small blocks
- 'Blu-tack' or plasticene
- large tin lid
- Bunsen burner
- tripod and gauze
- safety glasses

- Safety Notes:**
- Solid iodine burns the skin and irritates the eyes. Iodine vapour is harmful to the eyes and respiratory system.
 - Do not breathe sulfur dust and avoid contact with eyes.
 - Wear safety glasses during this practical.

Electrical Conductivity (workbook page 30)

Chemicals:

- sodium chloride (NaCl)
- distilled or deionised water
- tap water
- propanone (acetone) (CH₃COCH₃)
- sucrose (C₁₂H₂₂O₁₁)
- 1,4-dichlorobenzene (C₆H₄Cl₂)
- wax
- aluminium foil (Al)
- lead (Pb)
- anhydrous calcium chloride (CaCl₂)

Equipment:

- crucibles
- conductivity tester
- beakers
- Bunsen burner
- tripod and gauze
- safety glasses

- Safety Notes:**
- Acetone is highly flammable, causes severe corneal damage and the vapour is irritating if inhaled. Use a fume cupboard.
 - Do not breathe calcium chloride dust and avoid contact with eyes.
 - Wear safety glasses during this practical.

Polar Molecules *(workbook page 54)*

Chemicals:

- ethanol (C₂H₅OH)
- cyclohexane (C₆H₁₂)
- water (H₂O)

Equipment:

- Burettes
- plastic rod or strip of plastic tubing (a plastic ball point pen is often suitable)
- beakers
- safety glasses

- Safety Notes:**
- *Ethanol and cyclohexane are highly flammable.*
 - *Wear safety glasses during this practical.*

Water Solubility *(workbook page 55)*

Chemicals:

- water
- cyclohexane
- sodium chloride
- potassium iodide
- copper sulfate
- naphthalene
- iodine
- ethanol

- Safety Notes:**
- *Cyclohexane is highly flammable.*
 - *Copper sulfate is harmful by inhalation and if swallowed, and can cause serious damage to eyes.*
 - *Naphthalene is harmful by inhalation, skin contact and if swallowed.*
 - *Iodine is an irritant to skin and eyes and may cause burns.*
 - *Ethanol is highly flammable.*

Exothermic and Endothermic Reactions *(workbook page 63)*

Chemicals:

- 1 mol L⁻¹ of hydrochloric acid
- 1 mol L⁻¹ of sodium hydroxide
- 1 mol L⁻¹ of copper(II) sulfate;
- magnesium turnings
- anhydrous copper(II) sulfate
- ammonium chloride
- concentrated sulfuric acid
- sodium thiosulfate

Equipment:

- test tubes
- spatula
- 10 mL measuring cylinder
- thermometer (−10°C to +110°C)
- safety glasses

- Safety Notes:**
- *Concentrated sulfuric acid is extremely corrosive and can cause very bad blistering of skin. When diluting sulfuric acid, always add the acid slowly to cold water. If you spill any acid, dilute it with lots of water and wipe it up immediately.*
 - *Sodium hydroxide and hydrochloric acid are corrosive.*
 - *Copper sulfate is toxic. Anhydrous form can cause serious damage to eyes.*
 - *Wear safety glasses during this practical.*

Heat Output of Fuels *(workbook page 70)*

Chemicals:

- methanol
- ethanol
- propan-1-ol

Equipment:

- spirit burner
- candle
- matches
- steel can (e.g. 420 g baked bean tin)
- balance
- 250 mL measuring cylinder
- -10 to 110°C thermometer
- retort stand and clamp
- safety glasses

- Safety Notes:**
- *Methanol, ethanol and propan-1-ol are toxic and highly flammable. Avoid skin contact and do not breathe their vapours.*
 - *Do not attempt to refill the spirit burner near a naked flame.*
 - *Wear safety glasses during this practical.*

Section 2: Chemistry 2.5 (AS91165)

Selected Organic Compounds

Properties of Alkanes *(workbook page 112)*

Chemicals:

- solid hydrocarbon (e.g. candle)
- liquid hydrocarbon (e.g. kerosene or mineral turpentine)
- gaseous hydrocarbon (e.g. 'gas pak' can or natural gas)

Equipment:

- conductivity apparatus
- evaporating dish
- disposable test tube
- bung
- candle
- matches
- beaker
- safety glasses

- Safety Notes:**
- *Liquid and gaseous hydrocarbons are flammable. Ensure that stock bottles are kept well away from naked flames.*
 - *Wear safety glasses during this practical.*

Candle Wax Analysis *(workbook page 118)*

Chemicals:

- 20 g of candle wax

Equipment:

- boiling tube
- 250 mL beaker
- Bunsen burner
- tripod and gauze
- thermometer
- paper towel
- safety glasses

- Safety Note:**
- *Hot candle wax (paraffin) can cause burns when in contact with skin.*

Teacher Demonstration: Formation of Alkenes from Alkanes (*workbook page 120*)**Chemicals:**

- paraffin oil
- iron wool
- bromine water (diluted to a pale orange colour)
- potassium permanganate solution (acidified with dilute sulfuric acid and diluted to a pale pink colour)

Equipment:

- glass wool
- retort stand and clamp
- pyrex test tube fitted with a bung and delivery tubing
- 3 x test tubes with bungs
- 250 mL beaker
- Bunsen burner
- safety glasses

- Safety Notes:**
- *Glass wool is a skin irritant and can cut you.*
 - *Hot paraffin oil can burn the skin.*
 - *Gases produced in this practical are flammable. Make sure that all connections are well sealed and have a fire extinguisher available.*
 - *Do not leave the end of the delivery tubing in water once you have stopped heating. This is done to prevent 'suck-back' into the hot test tube.*
 - *Bromine water causes burns and is an irritant to eyes and the respiratory system.*
 - *Potassium permanganate is harmful if swallowed.*
 - *Wear safety glasses during this practical.*

Alkenes vs Alkanes (*workbook page 123*)**Chemicals:**

- cyclohexane (or mineral turpentine as a source of alkanes)
- cyclohexene
- bromine water (1 mL bromine/100 mL water)
- 0.02 mol L⁻¹ potassium permanganate solution
- litmus paper

Equipment:

- molecular models
- test tubes and stoppers
- 250 mL beaker
- safety glasses

- Safety Notes:**
- *Cyclohexane is highly flammable and explosive when mixed with oxidising substances.*
 - *Cyclohexene is flammable and harmful if swallowed. Vapour from the liquid irritates the eyes, skin and respiratory system.*
 - *Bromine water causes burns and is an irritant to the eyes and the respiratory system.*
 - *Potassium permanganate is harmful if swallowed.*
 - *Wear safety glasses during this practical.*

Teacher Demonstration: Production of Ethene from Ethanol *(workbook page 130)*

Chemicals:

- ethanol
- alumina (aluminium oxide) or porcelain chips
- bromine water (diluted to a pale orange colour)

Equipment:

- glass wool
- retort stand and clamp
- pyrex test tube fitted with a bung and delivery tubing
- 2 x test tubes with bungs
- 250 mL beaker
- Bunsen burner
- safety glasses

- Safety Notes:**
- *Glass wool is a skin irritant and can cut you.*
 - *The gas produced in this practical is flammable. Make sure that all connections are well sealed and have a fire extinguisher available.*
 - *Do not leave the end of the delivery tubing in water once you have stopped heating. This is done to prevent 'suck-back' into the hot test tube.*
 - *Bromine water causes burns and is an irritant to eyes and respiratory system.*
 - *Wear safety glasses during this practical.*

Properties of Alkynes *(workbook page 138)*

Chemicals:

- calcium carbide
- bromine water
- 0.001 mol L⁻¹ potassium permanganate solution (acidified with sulfuric acid)

Equipment:

- boiling tube fitted with a 2-hole stopper and eye dropper
- delivery tubing
- 3 x test tubes and stoppers
- sand
- 50 mL beaker
- safety glasses

- Safety Notes:**
- *Calcium carbide on contact with water releases a highly flammable gas.*
 - *Bromine water causes burns and is an irritant to eyes and respiratory system.*
 - *Potassium permanganate is harmful if swallowed.*
 - *Wear safety glasses during this practical.*

Properties of Amines (workbook page 147)

Chemicals:

- 30% aqueous solution of aminomethane
- 30% aqueous solution of aminoethane
- 1 mol L⁻¹ copper sulfate solution
- concentrated hydrochloric acid
- concentrated ammonia solution

Equipment:

- test tubes
- droppers
- glass rod
- red and blue litmus paper
- universal indicator paper
- safety glasses

- Safety Notes:**
- *Aminomethane and aminoethane are harmful to eyes, respiratory system and skin. Avoid breathing the vapour.*
 - *Concentrated hydrochloric acids and ammonia solutions are corrosive. They cause burns and irritate the eyes, skin and respiratory system.*
 - *Wear safety glasses during this practical.*

Oxidation of Alcohols (workbook page 154)

Chemicals:

- ethanol
- methanol
- butan-1-ol
- 0.1 mol L⁻¹ potassium dichromate solution
- dilute sulfuric acid solution

Equipment:

- test tubes
- 250 mL beaker
- eye droppers
- Bunsen burner
- tripod stand and gauze

- Safety Notes:**
- *Methanol is highly flammable, toxic by inhalation, toxic if swallowed, damaging if splashed in the eyes and can be absorbed through the skin.*
 - *Ethanol is highly flammable.*
 - *Butan-1-ol is flammable and harmful by inhalation.*
 - *Wear safety glasses during this practical.*

Section 3: Chemistry 2.6 (AS91166)

Chemical Reactivity

Teacher Demonstration: A Clock Reaction *(workbook page 182)*

Chemicals:

- 1% starch solution
- 0.002 mol L⁻¹ copper sulfate solution
- Solution X: freshly prepared 5 g of potassium iodide and 0.009 g of sodium thiosulfate dissolved in 100 mL of water
- Solution Y: freshly prepared 0.54 g of sodium persulfate dissolved in 100 mL of water

Equipment:

- 50 mL measuring cylinders
- 50 mL beakers
- boiling tubes
- watch showing seconds
- **safety glasses**

- Safety Notes:**
- *Solid copper sulfate is harmful if inhaled or swallowed. Risk of serious damage to eyes.*
 - *Sodium persulfate is a strong oxidant. It is a severe irritant of the eyes, skin and respiratory system.*
 - *Ensure **safety glasses** are worn during this practical.*

Teacher Demonstration: Elephant Toothpaste! *(workbook page 186)*

Chemicals:

- 100 mL of 100 volume hydrogen peroxide solution (or its equivalent)
- dishwashing liquid
- approximately 1 cm³ of chopped or ground liver
- approximately 0.5 g sample of lead(IV) oxide (lead dioxide, PbO₂)
- approximately 0.5 g sample of manganese(IV) oxide (manganese dioxide, MnO₂)
- approximately 0.5 g sample of iron(III) oxide (Fe₂O₃)
- approximately 0.5 g sample of copper(II) oxide (CuO)
- approximately 0.5 g sample of zinc oxide ZnO
- approximately 0.5 g sample of potassium iodide (KI)

Equipment:

- several 250 mL glass measuring cylinders (one for each catalyst used)
- clock or stopwatch with a second hand
- large tray or plastic sheet to catch any foam spillage over the top of the cylinders
- wooden splint and burner
- **safety glasses**

- Safety Notes:**
- *100 volume hydrogen peroxide is an extremely powerful oxidant. Skin contact can cause extremely painful burns.*
 - *Do not consume any of the substances produced in this practical!*
 - *Wear safety glasses during this practical.*

Teacher Demonstration: Chemical Equilibrium Practical *(workbook page 204)*

Chemicals:

- iron(III) nitrate solution (0.1 mol L⁻¹)
- potassium thiocyanate solution (0.02 mol L⁻¹)
- potassium thiocyanate solid
- sodium fluoride solid
- potassium nitrate solution

Equipment:

- Petri dishes
- overhead projector
- safety glasses

- Safety Notes:**
- *Iron(III) nitrate is an irritant to the eyes, skin and respiratory system.*
 - *Potassium thiocyanate is harmful by inhalation, contact with skin and if swallowed.*
 - *Sodium fluoride is toxic by inhalation, skin contact and if swallowed.*
 - *Wear safety glasses during this practical.*

Equilibrium Systems *(workbook page 212)*

Chemicals:

- 0.1 mol L⁻¹ solution of potassium chromate
- 0.1 mol L⁻¹ solution of potassium dichromate
- 1 mol L⁻¹ solution of hydrochloric acid
- 1 mol L⁻¹ solution of sodium hydroxide
- 1 mol L⁻¹ solution of copper sulfate
- concentrated hydrochloric acid
- 2 mol L⁻¹ sulfuric acid
- 0.2 mol L⁻¹ cobalt chloride solution

Equipment:

- test tubes
- beaker
- burner
- spatula
- safety glasses

- Safety Notes:**
- *Potassium chromate and potassium dichromate are irritants to the eyes, skin and respiratory system and are harmful if swallowed. May cause sensitisation by skin contact. May cause cancer.*
 - *Dilute hydrochloric acid and sodium hydroxide solutions are corrosive.*
 - *Concentrated hydrochloric acid causes burns and is an irritant to the respiratory system.*
 - *Copper sulfate solution is harmful if swallowed. Risk of serious damage to eyes.*
 - *Cobalt chloride is harmful if swallowed.*
 - *Wear safety glasses during this practical.*

Equilibrium – Another Example! *(workbook page 216)*

Chemicals:

- 1 mol L⁻¹ hydrochloric acid solution
- 2 mol L⁻¹ sodium hydroxide solution
- phenolphthalein solution
- solid ammonium chloride
- 0.1 mol L⁻¹ magnesium sulfate solution

Equipment:

- boiling tubes
- test tubes
- burner
- spatula

- Safety Notes:**
- *Sodium hydroxide and hydrochloric acid solutions are corrosive.*
 - *Phenolphthalein is highly flammable. Keep away from sources of ignition.*
 - *Ammonium chloride and magnesium sulfate are harmful if swallowed and are irritating to the eyes.*
 - *Wear safety glasses during this practical.*

Acidity of Household Substances *(workbook page 233)*

Chemicals:

- Some means of testing pH (such as an electronic pH meter, universal indicator solution or paper, pH paper, etc.)
- distilled (or deionised) water
- tap water
- sea water (or sample of salt water)
- vinegar
- ammonia solution
- battery acid
- soda water (or lemonade)
- caustic soda (sodium hydroxide)

Equipment:

- safety glasses
- gloves

- Safety Notes:**
- *Battery acid (sulfuric acid) and caustic soda (sodium hydroxide) pellets are corrosive substances which cause severe burns. **Wear safety glasses and gloves when handling them.***

The Strengths of Acids and Bases *(workbook page 236)*

Chemicals:

- 0.1 mol L⁻¹ solution of hydrochloric acid
- 0.1 mol L⁻¹ solution of ethanoic acid
- 0.1 mol L⁻¹ solution of nitric acid
- 0.1 mol L⁻¹ solution of sodium hydroxide
- 0.1 mol L⁻¹ solution of ammonia solution
- pH meter (or pH indicator paper)

- Safety Notes:**
- *All solutions listed, although very dilute, are still corrosive.*
 - *Wear safety glasses during this practical.*

Reaction Rates of Strong and Weak Acids (*workbook page 238*)**Chemicals:**

- hydrochloric acid in the following concentrations: 6 mol L⁻¹
2 mol L⁻¹
1 mol L⁻¹
0.1 mol L⁻¹
- ethanoic acid in the following concentrations: 6 mol L⁻¹
2 mol L⁻¹
1 mol L⁻¹
- calcium carbonate (marble chips)
- magnesium ribbon
- universal indicator paper

Equipment:

- test tubes

Safety Notes:

- *All acid solutions listed are corrosive and can cause burns. They should be handled with care.*
- *Wear safety glasses during this practical.*