education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

SUBJECT GUIDELINES

PHYSICAL SCIENCE

NQF level 3

September 2007

PHYSICAL SCIENCE – LEVEL 3

CONTENTS

INTRODUCTION

A. What is Physical Science?

Physical Science focuses on investigating physical and chemical phenomena through scientific enquiry. By applying scientific models, theories and laws, it seeks to explain and predict events in our physical environment. This subject also deals with society's desire to understand how the physical environment works, how to benefit from it and how to care for it responsibly.

B. Why is Physical Science important in this programme?

Physical science plays an increasingly important role in the lives of all South Africans due to its influence on scientific, technological and engineering development, which underpins our country's economic growth and the social well-being.

Physical Science focuses on the scientific knowledge and principles used in the vast engineering and related technology context. The engineering subjects focus on the equipment, design and related communication applications, systems and processes used. This subject cuts across all engineering fields and the chemical industry, as all fields use both chemistry and physics.

The Physical Science curriculum must ensure increased access to scientific knowledge, scientific literacy and access to higher education in the context of engineering.

C. The link between Physical Science Learning Outcomes and the Critical and Developmental Outcomes

The Physical Science Learning Outcomes were adapted from the Critical and Developmental Outcomes and the relationships are indicated as follows:

- The practical assignments and all content represent Critical Outcomes 1 to 5 by focussing on process skills, scientific reasoning, critical thinking, problem solving and working effectively with others and individually. The activities are also reflected in Developmental Outcome 1.
- All content in the Subject Outcomes represent Critical Outcomes 4 and 5 by focussing on constructing, understanding and applying scientific knowledge. The content is also reflected in Developmental Outcomes 1 and 4.
- Subject Outcome 7 specifically represents Critical Outcomes 1, 3, 4, 6 and 7 as students show the ability to see the world as a set of interrelated systems by understanding the interrelationship between science, technology, society, ethics and the environment. The Subject Outcome is also reflected in Developmental Outcomes 2 and 3.

D. Factors that contribute to achieving Physical Science Learning Outcomes

Physical Science, as a subject, should:

- Enhance understanding of chemistry and physics in such a way that the understanding of these two bodies of knowledge complements each other.
- Give students the opportunity to work in A scientific manner to understand and deal with the natural and physical world in which they live and study.
- Stimulate students' curiosity, deepening their interest and allow them to reflect on the natural and physical world in which they study and live.
- Develop useful skills and attitudes that will prepare students for real-life situations.
- Develop insights and respect for different scientific perspectives and sensitivity to cultural beliefs and practices in society.
- Enhance understanding that the technological applications of the physical sciences should be used responsibly towards social, human, environmental and economic development both in South Africa and globally.

Progression in Physical Science is reflected in the differentiation of the problem-solving situations as they increasingly use less routine problem-solving skills and more higher order problem-solving skills. Increasing the problem-solving concepts need not increase the complexity of the problem.

Progression in the content of Physical Science is reflected in the increase in quantity and depth of understanding of the applied principles of the core content to develop a well-organised knowledge base.

Progression in the increased ability to analyse and evaluate the impact of science and technology on the environment and socio-economic development is reflected where knowledge of Physical Science is applied in everyday situations and industry.

1 DURATION AND TUITION TIME

This is a one-year instructional programme comprising approximately 200 teaching and learning hours, including a practical component. The subject may be offered on a part-time basis provided all of the assessment requirements are adhered to.

Students with special education needs (LSEN) must be catered for in a way that addresses barriers to learning, such as material with bigger font, access to class rooms and venue for practical sessions.

2 SUBJECT LEVEL FOCUS

Describe, analyse and apply scientific and technological knowledge, the nature of science and its relationship to technology, society and the environment.

Range of scientific and technological knowledge includes mechanics, waves, electricity and magnetism, matter and materials, chemical changes and chemical systems in the industry.

Associated Assessment Criteria:

- Process skills, scientific reasoning and strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday contexts are used by the student.
- Scientific and technological knowledge are stated, analysed and applied in scientific and technological contexts.
- Impact of scientific knowledge on the quality of human, environmental and socio-economic development is identified and analysed.

3 ASSESSMENT REQUIREMENTS

The aim in this subject is the preparation of a student with a range of skills, supplemented by a broad knowledge base, a positive attitude and values that will ultimately serve the student to become an economical active, responsible and a participating member of society.

Achievement in this subject will be assessed internally, with various assessment tools measuring different skills, knowledge and values, as well as externally for maintaining standard.

The assessment consists of two components:

- formative assessment (site-based assessment) during the year that is internally set and assessed and externally moderated and reflected in a Portfolio of Evidence (PoE); and
- summative assessment at the end of the year that will be externally set, internally marked and externally moderated.

The assessment programme can be summarised as follows:

<table>
<tr><th colspan="4">PROGRAMME OF ASSESSMENT
(400 marks)</th></tr>
<tr><th colspan="2">INTERNAL SITE-BASED ASSESSMENT
(completed during the year)

50% (100 marks)
-presented in Portfolio of Evidence</th><th colspan="2">SUMMATIVE ASSESSMENT
(completed at the end of the year)

50% (100 marks)</th></tr>
<tr><td>Tasks</td><td>Value</td><td>Tasks</td><td>Value</td></tr>
<tr><td>• 1 mark consisting of 2 control tests.
• 1 exam (mid-year).
• 1 mark consisting 2 assignment – research tasks
• ISAT
• 1 mark consisting of 4 practical tasks</td><td>10
20
20
10
40
100</td><td>• Theoretical examination consisting of 2 papers:
Paper 1
Paper 2</td><td>
200
200
400÷4</td></tr>
</table>

3.1 Internal assessment (50 percent)

All internal assessments must be finalised by a qualified Physical Science educator or an assessor with at least a competent assessor

3.1.1 Theoretical Component

The theoretical component will form 50 percent of the internal assessment.

The number and type of theoretical tasks are paced in the year programme as follows:

Tasks	Term 1	Term 2	Term 3	Term 4
• 2 control tests each of 45 min	Test 1		Test 2	
• 1 mid year examination consisting of 1 paper of 1.5 hours		Exam		
• 2 research assignments that are industry related	Project		Project	

- **Some examples of assignments include, but are not limited to:**

	SO	Suggested Assignment or Reasearch Task
Physics (Select any 1)	• 2.4 • 2.5 • 3.2 • 4.1 • 4.2	• Inertia and its applications in real life and industry. • Research the mechanical advantage of an inclined plane by pulling an object up a ramp instead of lifting it vertically. Give examples where this principle is applied in industry or every day life. • Research one of the following lens applications and give examples in industry or every day life: corrective lenses, lenses in telescopes or lenses in microscopes. • Research the different applications of electromagnets in industry – refer to at least two different applications. • Research the different types of capacitors in industry and their applications – refer to at least two different applications.
Chemistry (Compulsory)	• 7	• Identify and critically evaluate the impact of air pollution, hazardous gases, methods of preventing pollution in industries and other.

- **Required skills for assignment or research tasks include, but are not limited to:**

Assignments should indicate the relationship of science content, related industry and the impact on the environment.

- **Criteria for assignment or research tasks include, but are not limited to:**
  - Plan and conduct a scientific investigation to collect data using appropriate resources.
  - Communicate and present collected information and conclusions with relevant scientific references; presented in a practical report or presentation.

3.1.2 Practical Component

The practical component will form 50 percent of the internal assessment.

Practical investigation and performance tasks are set equally on chemistry and physics.

These tasks are based on the theory and require a comprehensive understanding of the content and integration of skills, values and attitudes.

A suggested year pacer is the following:

Tasks	Term 1	Term 2	Term 3	Term 4
• 2 practical tasks based on physics	Prac	Prac		
• 2 practical tasks based on chemistry		Prac	Prac	
• ISAT				ISAT

- **Some examples of practical assessment tasks and assignments include, but are not limited to:**

	SO	Suggested Practical Task
Physics (any 2)	• 2.2 • 2.4 • 4.3	• Proof that 3 non-parallel forces are in equilibrium using a "force board" and three hanging mass pieces. • Investigate the relationship between mass and acceleration. (Newton 2nd Law) • Investigate the relationship between potential difference and electrical current at constant temperature in a electrical circuit. (Ohm's Law).
Chemistry (any 2)	• 5.1 • 5.2 • 5.4	• Investigate if a spring or elastic obeys Hooke's Law. • Research and classify materials as polar or non-polar with reference to water; also classify solvents as polar or non-polar. • Investigate the relationship between volume and pressure at constant temperature. (Boyle's Law)

- **Definition of the term "Structured Environment"**

"Structured environment" for the purposes of assessment refers to
- a laboratory
- or classroom simulated as a laboratory
- or a class that is adapted for group work, clear escape route, space for apparatus set up and where chemicals and water can be used.

- **Assessing practical tasks and ISET**

Students will be assessed on seven skill areas, using a rubric-grid, during each practical. The seven skill areas are:
1. Group work skills
2. Write up skills – the layout of practical report
3. Manipulative or procedural Skill – the way that the experiment is performed.
4. Observation and measuring skills
5. Recording skills – display of measurements
6. Interpretation of recording – mathematical manipulation
7. Interpretation of results and conclusion

Skill areas 1 and 3 will be assessed during practical sessions.

- **Required skills for practical assessments tasks include, but are not limited to:**

Assignments should indicate the relationship of science content, related industry and the impact on the environment.

Conducting a practical task in a structured environment will involve some of the following skills all written in a practical report:
- plan and conduct a scientific investigation to collect data systematically with regard to accuracy and reliability: collect, assemble and use appropriate apparatus, make and record observations, take and record measurements in tables. Different types of resources to be used.
- seek patterns and trends in the information collected and link it to existing scientific knowledge to help draw conclusions: analyse data using graphs, calculations etc., interpret results formulate and test hypothesis. Represent patterns and trends in different forms to draw conclusions and formulate simple generalisations.
- communicate and present collected information and conclusions with relevant scientific arguments: synthesise, evaluate and give conclusions. Present in a practical report or presentation.

All practical reports should have the following headings:

HEADING	DESCRIPTION
Aim or hypothesis	• This clearly states what the experiment is about and the problem that you want to solve or investigate. • The final result or conclusion of the practical has to be reflecting the aim.
Apparatus	• A labeled diagram of the experimental set up or apparatus/ reactants listed.
Method	• How the experiment was performed in point form.

Observation	• What you have noticed, using your senses. Ticker tape dots spacing, bulbs brighter; colour changes, bubbles, smell and sound.
Results recorded	• A table has to be used to record the data (measurements or observations) • In the table the heading must state the variable and its unit- it must be informative. • No units must be written with the recordings. • Experiments have to be repeated to verify the previous results; if it differs a second repeat has to done in order to find the correct results. This will give you 3 sets of readings, all noted in the table.
Interpretation of Results	A graph is used to interpret the data in the table. The graph must have a title. Appropriate axes must be used – the axes must be labeled and with the correct scale. Look at the results in the table to see if there are any patterns or anything that supports or refutes the investigative question. Calculations needed to manipulate the data or for explanations has to shown. Explain, if possible, the result.
Conclusion	Mention if the data and interpretations answered the investigative question. The following questions should also be answered in the conclusion: • Did the results/data support the hypothesis? • Can (and if, what) predictions be made from the results/data? • What sources of error could have influenced the result? • Should (and if, what) safety / hygienic measures be taken?

- **Evidence of practical assessments**

All evidence pertaining to evaluation of practical work must be reflected in the students' Portfolio of Evidence (PoE). The tools and instruments constructed and used for the purpose of conducting such assessments must be clear from evidence contained in the PoE.

The following information must be contained in the PoE
- index;
- all continuous assessment tasks and the evaluation of each task;
- declaration of own work done by the student.

For the Portfolio of Evidence to be regarded as valid evidence an officially assigned supervisor must sign it off.

3.1.3 Processing of internal assessment mark for the year

Calculation of a year mark consisting of the internal assessment tasks as indicated in the table below is suggested:

	Tasks	Total marks	Value
Questionnaire	• 2 control tests:	2 x 50 = 100	10
	• 1 mid year examination consisting of 1 paper	100	20
Research	• 2 assignments – research tasks: 1 based on physics and 1 on chemical content; • both related to industry	2 x 20 = 40	20
Practical (hands on skills)	• 2 physics practical tasks	2 x 25 = 50	40
	• 2 chemistry practical tasks	2 x 25 = 50	
	• ISAT	1x20	10
	Total for Site Based-Assessment		100

3.1.4 Moderation of internal assessment mark

Internal assessment is subjected to both internal and external moderation procedures as contained in the *National Examinations Policy for FET College Programmes*.

3.2 External assessment (50 percent)

A national examination is conducted annually in October or November by means of two papers set externally and marked and moderated internally.

External assessment details are set out in the *Assessment Guidelines: Physical Science* (Level 3).

4 WEIGHTED VALUES OF THE TOPICS

TOPICS/TOPICS	WEIGHTED VALUE
Paper 1	
1. Measurements	5%
2. Mechanics	40%
3. Waves, sound and light	20%
4. Electricity and magnetism	35%
Paper 2	
5. Matter and materials	45%
6. Chemical change	45%
7. Chemical systems and industry	10%
TOTAL	**100**

5 CALCULATION OF FINAL MARK

Internal assessment:	Student's mark/100 x 50 = a mark out of 50	(a)
Examination mark:	Student's mark/100 x 50 = a mark out of 50	(b)
Final mark:	**(a) + (b) = a mark out of 100**	

All marks are systematically processed and accurately recorded to be available as hard copy evidence for, amongst others, purposes of moderation and verification.

6 PASS REQUIREMENTS

The student must obtain at least fifty (50) percent in ICASS and fifty (50) percent in the examination

7 SUBJECT AND LEARNING OUTCOMES

On completion of Physical Science Level 3 the student should have covered the following topics:

Topic 1: Measurements
Topic 2: Mechanics
Topic 3: Waves, Sound and Light
Topic 4: Electricity and Magnetism
Topic 5: Matter and Materials
Topic 6: Chemical change
Topic 7: Chemical systems and industry

7.1 Topic 1: Measurements

7.1.1 Subject Outcome: Identify and apply the metric system.

Learning Outcome:

- Identify and use SI symbols and units correctly as applied in this level.
- Measure length, volume (including cm^3, dm^3), volt & ampere, time, mass and weight.

7.1.2 Subject Outcome 2: Conduct scientific investigations to collect, represent and interpret data.

Learning Outcome:

- Plan and conduct a scientific investigation to collect data systematically with regard to accuracy, reliability and the need to control variables.
- Seek patterns and trends in the information collected and link it to existing scientific knowledge to help draw conclusions.
- Present collected information and conclusions with relevant scientific arguments.

7.2 Topic 2: Mechanics

7.2.1 Subject Outcome 1: State, explain and interpret principles of horizontal motion.

Learning Outcome:

- Analyse and calculate more complex problems (e.g. spot a speed trap or pedestrian and slow down after seconds; two vehicles with different types of motion one try to catch other) using linear equations of motion.

  Range: Linear equations of motion are $v_f = v_i + a\,\Delta t$, $s = v_i\,\Delta t + \frac{1}{2} a\Delta t^2$, $v_f^2 = v_i^2 + 2as$
- Analyse and interpret graphs of motion: types of motion, direction of motion and turning point.

  Range: Graphs of motion include displacement-time, velocity-time and acceleration-time graphs.
- Calculate and interpret gradient of s-t (to determine velocity) and v-t graphs (to determine acceleration).
- Calculate area of v-t graphs to find displacement and distance.

7.2.2. Subject Outcome 2: Describe, analyse and apply principles of concurrent forces.

Learning Outcome:

- Identify force as a vector.
- Construct vector diagrams of two forces to determine the relationship between the resultant and angle between forces (range 0^0 -180^0).
- Determine the resultant of two forces acting simultaneously on a body.
- Determine components of a force by calculation or by construction.
- Describe an object in equilibrium.
- Draw a labeled force diagram (free-body diagram) and vector diagram of 3 non-parallel forces in equilibrium and find unknown force by construction or mathematically.

  Range: Systems to include mass in suspension on ropes/cables, mass on an inclined plane, object with frictional force acting on it.
- Define, identify and calculate the equilibrant of a system.

7.2.3 Subject Outcome 3: Describe, analyse and apply principles of non-concurrent forces.

Learning Outcome:

- Distinguish between applied forces: concurrent and non concurrent forces; parallel and non-parallel non concurrent forces.
- State and apply the two conditions for equilibrium with parallel forces.
- Identify and draw a labelled force diagram of parallel forces to solve problems using the centre gravity.
- Identify and draw a labelled force diagram of non- parallel forces to solve problems.

7.2.4 Subject Outcome 4: State, explain, analyse and apply principles of Newton's 1^{st} and 2^{nd} laws of motion.

Learning Outcome:

- Identify if forces applied on mass are balanced or not; and determine the nett force.
- Define inertia and give examples.
- Define Newton's 1^{st} law of motion and relate to examples.
- Define and apply Newton's 2^{nd} law of motion.
- Plan and conduct a scientific investigation to investigate the proportionality between mass and acceleration.
- Solve problems using Newton's 2^{nd} law on one and more than one mass system for horizontal and vertical motion.

7.2.5 Subject Outcome 5: Describe, analyse and apply principles of simple machines and mechanical advantage.

Learning Outcome:

- Describe, identify and calculate the mechanical advantage of an inclined plane
- Identify and describe the mechanical advantage of screws and give examples.

7.3 Topic 3: Waves, sound and light

7.3.1 Subject Outcome 1: Describe, analyse and apply principles of longitudinal waves in every day life.

Learning Outcome:

- Describe the production and propagation of longitudinal waves in various media.
- Give examples of longitudinal waves and differentiate between sound and radio waves.
- Describe and calculate wave speed, wavelength, frequency, amplitude.
- Differentiate between intensity and loudness; pitch and tone.
- Describe the effects of interference and reflection in sound and give examples.
- Identify and describe resonance in musical instruments and structures (building and bridges).

7.3.2 Subject Outcome 2: Identify and critically evaluate the impact of geometrical optics on the human development.

Learning Outcome:

- Draw diagrams showing the type and size and distance of image formed and focal point by at least two rays using converging (convex) and diverging (concave) lenses.
- Apply knowledge of convergence and divergence lenses to spectacles in the correction of lens defects of the eye and identify the use of these lenses in telescopes (SALT), microscopes and cameras.

7.4 Topic 4: Electricity and Magnetism

7.4.1 Subject Outcome 1: State, analyse and apply principles of static electricity (electrostatics).

Learning Outcome:

- Define and solve problems using Coulombs Law.
- Identify and calculate the force between charges.
- Identify and draw the electric field around single charges, groups of charges and a Faraday case.
- Calculate electric field around a charge and between parallel plates.
- Define and apply electrical potential energy and electrical potential.
- Define capacitance and apply the principle to the parallel plate capacitor.
- Identify and apply the relation between charge, potential difference and capacitance.
- Describe, identify and apply the capacitor as a circuit device.

7.4.2 Subject Outcome 2: State, analyse and apply principles in electromagnetism.

Learning Outcome:

- Identify and draw diagrams of the magnetic field associated with current in long straight current carrying conductor and in a solenoid.
- Identify and describe the use of magnetic field and its application in electromagnets.
- Describe the effect on charged particles in motion by a magnetic field.
- Describe and apply electromagnetic induction in current induced by changing magnetic field, dynamos and transformers.

7.4.3 Subject Outcome 3: State, analyse and apply principles in electric circuits.

Learning Outcome:

- Define and apply Ohm's Law.
- Determine the proportionality between current and potential difference (Ohm's Law).
- Distinguish between resistance, equivalent resistance and internal resistance.
- Identify symbols used for electrical circuit:

  Range: Symbols include cell, battery of cells (in series and parallel), Voltmeter, Ammeter, Galvanometer, switch, fuse, earth and different types of resistors: globe, fixed resistor, rheostat and capacitor.
- Analyse and solve problems in electrical circuits calculating pd, emf, resistance in series and parallel networks.
- Describe the purpose of a Wheatstone bridge.

7.5 Topic 5: Matter and Materials

7.5.1 Subject Outcome 1: State and apply mechanical properties of matter.

Learning Outcome:

- Describe mechanical properties of solids.
  Range of mechanical properties is applied hardness, tensile strength, elasticity, plasticity, fracture and creep (descriptive), ductility and brittleness and brittleness.
- Differentiate between stress and strain, compression stress and shear stress.
- Define, investigate and interpret Hooke's Law.

7.5.2 Subject Outcome 2: State, analyse and apply principles of atomic combinations: molecular structure.

Learning Outcome:

- Use group properties of the Periodic Table to find the number of valence electrons and valency number of and element.
- Use and draw Lewis diagrams and octet rule to explain chemical bonds.
- Define electro negativity of atoms and apply it to explain the polarity of chemical bonds.
- Calculate oxidation number of atoms in molecules to explain their relative richness in electrons.
- Identify and molecular shapes and give molecular examples for the shapes.
  Range: Molecular shapes are linear, angular, pyramidal, tetrahedrall.
- Identify polar and non-polar substances.

7.5.3 Subject Outcome 3: State, analyse and explain change of state due to molecular forces

Learning Outcome:

- Describe and distinguish between intermolecular bonding and intra-molecular forces
- Identify the types of intra-molecular forces: hydrogen and van der Waals' forces and illustrate with examples.
- Explain the physical state of matter with reference to intra-molecular forces and illustrate with examples.
- Use boiling point of group- 5, 6, 7 hydrides to differentiate between the strength of hydrogen and van der Waals' forces and the effect of mass on the boiling point.

7.5.4 Subject Outcome 4: Describe, analyse and apply properties of gases theory.

Learning Outcome:

- Define the properties of gases and state the kinetic- molecular theory.
- Define and list the properties of an ideal gas.
- Describe and distinguish between the term atmospheric pressure and gauge pressure.
- Identify and apply the relationship between volume and pressure at constant temperature (Boyle's Law).
- Identify and apply the relationship between volume and temperature at constant pressure (Charles's Law).
- Identify and apply the relationship between pressure and temperature at constant volume.
- Do calculations on the combined gas laws and ideal gas equation.

7.5.5 Subject Outcome 5: Describe, analyse and apply principles heat and thermal properties of solids and liquids.

Learning Outcome:

- Describe and apply expansion of solids (refer to linear, area and volume expansion).
- Describe and apply expansion of liquids and viscosity.
- Define and calculate latent heat.
- Describe and differentiate between vapour pressure and boiling point.
- Describe evaporation as a cooling process and factors that have an effect (surface area, temperature, volatile liquids, air currents and air pressure).

7.6 Topic 6: Chemical Change

7.6.1 Subject Outcome 1: Identify, analyse and apply energy changes.

Learning Outcome:

- Identify, draw and apply exothermic and endothermic reactions, activation energy and enthalpy.

7.6.2 Subject Outcome 2: Describe, analyse and apply quantitative aspects of change.

Learning Outcome:

- Write chemical equations down recognise reactants and products, conservation of mass and matter (atoms), conservation of energy.
- Balance chemical equations.
- Define mole and calculate molar volume of gases.
- Identify volume relationships in gaseous reactions.

7.6.3 Subject Outcome 3: Identify and apply types of chemical reactions.

Learning Outcome:

- Identify and write down combination, decomposition and displacement reactions with reference to industrial gases (7):

  Range: Combination reactions are metal + O_2, non-metal + O_2, metal + non-metal, metal oxide + H_2O, non-metal oxide + H_2O. Decomposition reactions are metal oxides, carbonates, nitrates, chlorates and H_2O_2 decomposing in heat.Single-displacement reactions are halogen + halide, metallic salt + salt, metal + acid, metal + H_2O –activity series).

7.7 Topic 7: Chemical systems and industry

7.7.1 Subject outcome 1: Identify and critically evaluate the impact of scientific knowledge on the atmosphere and the quality of human, environmental and socio-economic development.

Learning outcome:

- Identify industrial gases (e.g. CO_2, O_2, H_2, CH_4, N_2, NH_3, acetylene): the chemical properties and uses.
- Identify examples of gases emitted by industries rated as hazardous (NO, NO_2, SO_2, H_2S etc) and explain the reason for the gases status.
- Identify and describe air pollution and methods of prevention in industries and elsewhere.

8 RESOURCE NEEDS FOR THE TEACHING OF PHYSICAL SCIENCE - LEVEL 3

8.1 Human Resources

The lecturer should be proficient in physics as well as chemistry. The lecturer must be familiar with the engineering and industrial context applicable to Physical Sciences, and the OBE teaching and assessment principles.

A laboratory assistant may be needed if this is justified according to the number of students and classes.

Physical Resources

The subject requires a venue with a working area to accommodate the performance of demonstrations and practical tasks, which includes physics as well as chemistry.

Care should be taken in handling chemicals and electricity.

The number of students per practical is only dependant on the human resources available and the venue size.

Other Resources

Learning and training material needed are the following:

- Lecturers will need general teachjing materials
- Students will each need textbooks or guidelines
- Each student will need a portfolio file and the necessary paper
- Each classroom will need wall charts (in particular the Periodic Table), a board ruler and pair of compasses, and any other equipment and materials that the lecturers considers necessary

Equipment necessary for demonstrations and also needed for practical tasks performed by students, specifically for Physics and Chemistry are the following:

Physics	
Measurement vectors	• Force board , pulleys, mass pieces & string • Balance springs 3 x 10 N, 20 N, 50 N
Mechanics/motion	• Air track & accessories • Air blower Or • Track, 2x trolleys, pulley, ticker timer, carbon disks and tape • Stop watch • Power supply
Waves	• Slinky spring • Light kit • Oscilloscope
Electricity Electrostatics	• Magnets, iron filings & small compasses • Circuit board Worcester + accessories, batteries • Resistors, rheostat sliding • Voltmeter, ammeter • Leads croc-croc clips • Bridge rectifier, wheat stone bridge • Capacitance sub box, diode tube , electrolytic capacitor • Induction coil, dynamo model or electromagnetic kit • Electronics kit or UNILAB alpha electronics kit

Chemistry	
	• Boyles Law apparatus & hand pump • Joule meter/ mains input or watt measurer • Thermometer
	• Retort stand, clamps & boss head • Crucible tongs • Test tube brushes • Safety goggles • Filter paper • Paper towel & dispenser • Disposable plastic syringes • Rubber tubing • Rubber stoppers for flasks& test tubes • Cork borer • Wash bottle • spatula
	• Apparatus trolley • conductivity of liquids apparatus • balance for measuring mass • digital balance
	• polystyrene spheres, and/or • atom molecular set • crystal model set

<table>
<tr><td>Glassware</td><td colspan="2">• Beaker squat 50 cc, 100 cc , 250 cc, 1000cc
• Erlenmeyer flask 250 cc
• Volumetric flask 50cc,100 cc, 250 cc, 1000 cc
• Test tubes
• Funnel
• Watch glass
• Pipette
• Burette
• Measuring cylinders 25 ml, 50ml, 250ml
• Water trough
• Mortar & pestle
• Medicine droppers
• Bottle dropper
• Reagent bottles</td></tr>
<tr><td>Chemicals</td><td>• acetic acid
• ammonia sol 25%
• ammonium nitrate
• ammonium chloride
• barium chloride
• bromothymol blue
• carbon
• calcium hydroxide
• calcium carbonate marble
• calcium powder
• calcium metal
• cobalt chloride
• copper sulphate
• copper metal turnings
• hydrochloric acid 32%
• iodine crystal
• iron sulphide
• steel wool
• iron(iii)chloride
• lead nitrate
• litmus paper</td><td>• litmus solution
• magnesium ribbon
• magnesium sulphate (Epson salts)
• methyl orange
• phenolphthalein
• potassium bromide or sodium bromide
• potassium chloride or sodium chloride
• potassium iodide or sodium iodide
• potassium hydroxide
• potassium permanganate
• propanoic acid
• sodium carbonate
• sodium bicarbonate
• sodium dichromate
• sulphur powder
• sulphuric acid
• universal indicator
• xylene
• zinc granular
• zinc carbonate</td></tr>
</table>