SEC SYLLABUS (2014)

PHYSICS SEC 24

SYLLABUS

Physics SEC 24	Available in September (Paper I and Paper IIB only)
Syllabus	Paper 1 (2 hrs) + Paper 2 (2 hrs) + laboratory reports

Introduction

The syllabus is designed to develop the candidates' understanding of the nature of scientific ideas and activity through the acquisition of a systematic body of scientific knowledge and an appreciation of its power and limitations. The scientific method is to be presented as a method of inquiry in a way that stimulates curiosity and interest. As far as possible, an investigative approach should be followed. Every opportunity should be taken to expose the students to the applications of Physics to technology and environmental issues. Wherever possible the subject content should be presented within a contemporary context relevant to the lives of students and within a historical context which illustrates how the scientific ideas were developed and the scientists who developed them.

Aims

- To emphasize the importance of the process of scientific investigation as a means of solving problems in every day life;
- To contribute to the pupils' general education by helping to make sense of the physical environment through scientific inquiry;
- To provide the basis for further study of the subject;
- To develop experimental and investigative abilities;
- To develop the skills necessary to find solutions to scientific problems;
- To understand that scientific ideas are developed within a contemporary and historical context.
- To develop positive attitudes towards Physics, Science and the environment.

Course Objectives

As a result of following a course in Physics, candidates should acquire:

Knowledge and understanding

- recall facts and ideas;
- show an understanding of facts, terminology, principles and concepts;
- use units correctly;
- demonstrate an understanding of the application of Physics in everyday life;
- understand that scientific concepts are developed within a contemporary and historical context;
- recognise the importance of the work of key scientists;
- understand the outcomes of the applications of science.

Application of knowledge through problem solving

- use Physics principles and concepts to describe and explain everyday situations;
- interpret data presented in tables, diagrams or graphs;
- carry out relevant calculations;
- apply principles and concepts to unfamiliar situations.

Experimental skills

- plan and carry out investigations;
- use safe and accurate practical techniques;
- record data accurately;
- interpret data and draw conclusions;
- communicate the data in a clear and accurate manner.

Positive attitudes

- recognise alternative points of views;
- evaluate the implications of science and how it affects the quality of one's life, that of others and the quality of the environment;
- use their knowledge and understanding to make informed choices.

Assessment

Content The examination will consist of two written papers of two hours' duration each and an assessment of practical work. The questions will be set in English and must be answered in English.

Paper I Consists of a written paper, comprising about 10 compulsory short questions to be answered in the spaces provided in the examination booklet, and a practical component. This paper is to be taken by ALL candidates registered for the examination.

Paper IIA/Paper IIB There will be two versions of Paper II; Paper IIA or Paper IIB.

Questions in Paper IIA will be more difficult than those in Paper I. Questions in Paper IIB will be less difficult than those in Paper I.

Registration Candidates will be required to indicate on the registration form which option in Paper II (A or B) they wish to sit for. No change in the choice of paper will be allowed after the registration period.

Supplementary In the September Supplementary session, only Paper I and Paper IIB will be offered.

Test questions Paper IIA or Paper IIB will consist of five compulsory questions, two of which will test experimental skills.

The papers will cover the whole syllabus and will test the candidates' abilities according to the following scheme:

Ability	Paper I	Paper IIA or Paper IIB	% Mark
Knowledge and Understanding	15%	20%	35%
Problem Solving	15%	15%	30%
Design and Planning of experiments	10%	10%	20%
Practical Assessment	15%	-	15%
Approximate % of total mark	55%	45%	100%

Questions requiring the application of knowledge will normally refer to common situations and any calculations required will be simple and direct. When reference is made to particular situations or apparata which might be unfamiliar to candidates, sufficient details will be given to explain the context.

Mathematical content The use of non-programmable electronic calculators with arithmetical (four rules, squares, square root, log) and simple trigonometrical functions (sin, cos, tan, and their inverses in degrees) is recommended.

Units Standard notation and SI units will be used. When one quantity is divided by another, the solidus will be used, e.g. m/s but the notation ms^{-1} will also be accepted. The acceleration of free fall, g, which will be given in the question paper, will be taken as 10 m/s^2.

Practical Work

Aims

Through practical work candidates should be able to carry out experimental and investigative work in which they plan procedures, use precise and systematic ways of making measurements and observations, analyze and evaluate evidence and relate this to scientific knowledge and understanding.

Learning Outcomes

A candidate must be able to:

- recall, understand, use and apply the scientific knowledge set out in the syllabus;
- communicate scientific observations, ideas and arguments using a range of scientific and technical vocabulary and appropriate scientific and mathematical conventions;
- evaluate relevant scientific information and make informed judgements about it.

Marks

- 15% of the total marks for this examination are allotted to the practical experience of the candidates. This will be assessed by the schools during the candidates' course of study.
- The mark of the practical work is to be based on the average mark of:
  EITHER
  The best 15 experiments carried out.
  OR
  The best 13 experiments and a longer investigation which will be given 2 marks out of the 15 marks.

Examples of investigations are included in Appendix 3.

Private Candidates

- Private candidates who left school before 1994 will not be expected to present their laboratory report books. Their mark will be obtained by pro-rating of the written papers.
- Candidates who studied the subject at school and are re-sitting the subject may carry forward the practical report mark from a previous session.
- Candidates who have never studied the subject at school but have covered the coursework privately will be expected to present their coursework to the MATSEC Board by the date indicated by the Board. Candidates may be asked to attend an oral examination about their practical work.

Examples of Practical Work

In order to ensure that experiments involving a variety of skills are assigned and assessed it is recommended that candidates present at least two experiments for each themes 1-6. Experiments which are considered important are marked in the text.

A number of types of activity may be used such as:

- Skill development [e.g. The use of circuits for measuring current and voltage].
- Open-ended enquiry [e.g. What affects the sag of a bridge?]
- Testing a given prediction [e.g. Electromagnets with more coils are stronger].
- Verifying a law [e.g. The relationship between force and acceleration, Newton's second law of motion].

Simple experiments with data loggers are also recommended.

The investigations may be chosen from any area of the syllabus.

Assessment of Practical Work

In assessing one would look for evidence of:

Planning

- A simple safe procedure has been planned.
- A prediction has been made and a fair test planned.
- Appropriate equipment has been selected.
- Scientific knowledge and understanding has been used to plan a procedure.
- A suitable range of measurements has been chosen.

Observation

- Equipment has been used safely to obtain measurements.
- Appropriate measurements have been taken.
- The measurements have been recorded clearly and accurately in tables.
- The measurements are sufficient, appear to be accurate and repeated.

Analysis

- The student has explained what has been found out.
- A graph has been drawn to present the findings where applicable.
- A trend has been identified.
- Numerical methods have been used to process the evidence.
- A conclusion is drawn and linked to scientific knowledge.
- Explanation of how results match or do not match the original prediction.

Evaluation

- Relevant comment about the procedure and evidence obtained.
- The accuracy of the results and any sources of error are discussed.
- The suitability of procedures are evaluated.

Communicating results

- Report written in an acceptable format.
- Use of technical vocabulary.
- Proper format in presentation of results including tabulation, graphs, etc.
- Ability to justify conclusions reached verbally and during class discussions.

Marking Criteria

Criteria for Experiments	Marks
Actual conduct of experiment including handling of apparatus.	5
Format of experiment report to include date, title of experiment, aim and procedure.	2
Clear, neat fully-labelled diagram of apparatus.	2
Results obtained by observations in the form of a table and graph with labelled axes if applicable.	2
Discussion of precautions undertaken to ensure accuracy in the results observed.	2
Discussion of results obtained in view of the aim of the experiment/investigation.	2
	15

Criteria for Investigation	Marks
Planning of investigation and determining a hypothesis.	3
Choosing and setting up of apparatus.	3
Carrying out the investigation.	3
Results obtained.	3
Discussion of results including precautions taken.	3
	15

Moderation of Practical Work

Moderation

- Laboratory Report books are to be available at the candidates' schools for moderation by the Markers' Panel.
- The Markers' Panel will look for evidence that the candidates have actually carried out practical work and were capable of:
  (a) following verbal and written instructions;
  (b) planning and organizing practical work;
  (c) handling laboratory apparatus;
  (d) carrying out and recording observations and measurements, and
  (e) processing experimental data and drawing conclusions from them.

Notes for Teachers

Organisation

- Laboratory books should be grouped by class.
- When more than one laboratory book is presented by a student, these should be bound together in some way.
- A sheet listing the experiments presented and the marks assigned should be attached inside the laboratory book. The experiments presented should be clearly marked.

Experiments

- The experiments presented should be representative of the different sections of the syllabus. At least two experiments from each theme 1 to 6 should be presented.
- The experiments should be corrected and a mark (out of 15) given, based on the marking criteria presented previously.
- Standard experimental analysis involving tables, graphs, gradients and statements of precautions taken should be evident in at least some of the experiments presented.

Investigations

- The investigations should be longer experiments designed and carried out by the students (group work is allowed).

Demonstrations

- The experiments presented whenever possible should be the work of the student. Reports of demonstrations while valid in their own right, should not be considered when choosing the best 13/15 experiments, except where valid reasons, such as the apparatus involved is very expensive, are provided.
  Even for a valid reason not more than 5 reports of demonstrations should be presented.
- When demonstrations are carried out with apparatus which is very expensive such as data loggers then, if possible, students can carry out the experiments in small groups and take it in turns to take different sets of readings by varying one variable at a time. Then each group can present their readings to the whole class and graph plotting and discussion carried out on an individual basis.

Candidates may be called for an interview regarding their work.

Results

Grades Awarded

Candidates sitting for Paper I and Paper IIA may qualify for Grades 1, 2 , 3, 4 or 5. The results of candidates who do not obtain at least a Grade 5 shall remain Unclassified (U).

Candidates sitting for Paper I and Paper IIB may qualify for Grades 4, 5, 6 or 7. The results of candidates who do not obtain at least a Grade 7 shall remain Unclassified (U).

Coursework Moderation Evaluation Sheets

School______________________ **Date of Moderation**____________

AREA	Insufficient	Satisfactory	Good
Experiments show variety of skills.			
Work presented is up to SEC standard.			
Experiments are spread across most of the syllabus.			
Report contain evidence of student's authentic work.			
Reports do not contain dictated, downloaded or copied material.			
At least 15 experiments are presented by most students.			
Diagrams are well drawn and labelled.			
Observations & measurements are well recorded.			
Analyses include graphs/quantitative work.			
Reports contain precautions about observations and measurement.			
Student make their own conclusions.			
Marks awarded are fair.			
Other Comments:			

Moderation of Investigations

Examples of investigations by students should be kept in the school so that moderators visiting the schools can evaluate the investigations being carried out.

Teachers need to give students feedback about the investigations and give a mark out of 15 based on the criteria for investigations given.

Moderators visiting schools will prepare an evaluation sheet for presentations:

School______________________ **Date of Moderation**____________

AREA	Insufficient	Satisfactory	Good
Investigations are creative and have been actually carried out by students (or groups of students).			
A hypothesis has been made and recorded.			
The appropriate apparatus has been chosen and the investigation adequately planned and carried out.			
Results have been recorded and presented in tabular or graph format.			
The results have been analysed and conclusions about relationships which emerge from the data drawn.			
Other comments:			

Grade descriptors

Grade 1	Grade 5	Grade 7
Knowledge and Understanding		
▪ recall and show understanding of a wide range of scientific facts, principles, concepts and practical techniques across all the Physics syllabus; ▪ use consistently the correct scientific vocabulary and units; ▪ use consistently scientific or mathematical conventions as used in Physics; ▪ consistently apply Physics principles in everyday situations; ▪ show a very good understanding of the development of principles by key scientists within a historical context; ▪ demonstrate a very good understanding of how scientific theories can be changed by new evidence and identify areas of uncertainity in Physics.	▪ recall and show understanding of a range of scientific facts, principles, concepts and practical techniques across parts of the Physics syllabus; ▪ use the correct scientific vocabulary in a number of cases but not consistently; ▪ use scientific or mathematical conventions in most of the instances; ▪ apply Physics principles in some everyday situations; ▪ show a good understanding of the development of principles by key scientists within a historical context; ▪ demonstrate a good understanding of how scientific theories can be changed by new evidence and identify areas of uncertainity in Physics.	▪ recall and show understanding of a limited range of scientific facts, principles, concepts and practical techniques across parts of the Physics syllabus; ▪ use the correct scientific vocabulary in a very few cases; ▪ use scientific or mathematical conventions in few cases; ▪ apply Physics principles in only a few everyday situations; ▪ show a very limited understanding of the development of prinicples by key scientists within a historical context; ▪ demonstrate a very limited understanding of how scientific theories can be changed by new evidence and identify only some areas of uncertainity in Physics.
Application of Knowledge through Problem Solving		
▪ link the different areas of the syllabus in a meaningful way; ▪ give a very good interpretation of data presented; ▪ carry out most calculations in an accurate manner; ▪ use knowledge of Physics processes and concepts in both familiar and unfamiliar situations.	▪ use and apply scientific knowledge and understanding in some general contexts; ▪ give a good interpretation of data presented; ▪ carry out a number of calculations in an accurate manner; ▪ use knowledge of Physics processes and concepts in familiar situations and apply them to unfamiliar situations with limitations.	▪ use and apply scientific knowledge and understanding in a few general contexts; ▪ give a very limited interpretation of data presented; ▪ carry out only a very few calculations in an accurate manner; ▪ use a very limited knowledge of Physics processes and concepts in familar situations.
Experimental Skills		
▪ plan and carry out experiments related to all areas of the syllabus; ▪ make clear and very good systematic observations in experiments; ▪ use safe and accurate practical techniques; ▪ record and represent data accurately using a variety of methods; ▪ interpret graphs in terms of patterns, trends, anomalous observations and salient features; ▪ recognise limitations in the evidence; ▪ draw conclusions based on scientific knowledge and understanding; ▪ suggest improvements to collect more reliable data; ▪ communicate the data in a clear and accurate manner.	▪ plan and carry out experiments related to a number of areas in the syllabus; ▪ make good systematic observations in experiments; ▪ use safe and good practical techniques; ▪ record and represent data using a variety of methods; ▪ interpret graphs including best straight line graphs, in terms of patterns, trends, anomalous observations and salient features; ▪ suggest improvements that would enable them to collect more reliable data; ▪ communicate the data in a clear manner.	▪ plan and carry out experiments related to a few areas of the syllabus; ▪ make only simple systematic observations in experiments; ▪ use safe and good practical techniques; ▪ record and represent data; ▪ interpret straight line graphs in simple terms; ▪ appreciate that improvements in their experiments and repeated readings would enable them to collect more reliable data; ▪ communicate the data in an appropriate manner.
Positive Attitudes		
▪ synthesise their knowlege of science and evaluate how it affects the quality of life; ▪ use their knowledge and understanding of science to make informed choices.	▪ use their knowledge of science to understand how it affects the quality of life; ▪ use their knowledge and understanding of science in everyday life situations.	▪ understand that science can affect the quality of life; ▪ understand the importance of science in everyday life.

The Themes

The syllabus is organised around eight themes:

- On the Move
- Balancing Forces
- The Nature of Waves
- Staying Cool
- Electricity in the Home
- Magnets and Motors
- Radiation and its Uses
- The Earth and the Universe

The Structure

Each theme starts off with:

- A description of the topic.
- A set of questions that can be asked to arouse interest.
- The Learning Programme.
- A set of links to the Internet.

This page is then followed by a number of learning outcomes which the students are expected to have achieved by the end of each theme.

The Learning Programme

The sections of the Learning Programme are divided into three columns:

- The actual Learning Outcomes which students are expected to have achieved at the end of each theme.
- Suggested Teaching Activities which include experiments, investigations and role play which can be carried out with students.
- Historical and STS (Science, Technology, Society) connections which link the learning outcomes to their historical background and to the way in which physical laws and applications are being used for the benefit of society.

The written examination will assess the achievement of the learning outcomes.

The suggested Teaching Activities, Historical and STS connections are only suggestions and teachers are free to use their own activities and examples from everyday life.

The Symbols

A number of symbols have been used to describe the kind of activity, whether investigation or role play, whether historical connection or STS.

Experiment or Investigation.

This investigation is expected.

Drama and other activities.

Building a model.

Historical Connections.

Science, Technology, Society (STS) Connections.

ICT links.

Theme 1: On the Move

Describing the unit

Moving objects such as cars and trucks on roads or a ball thrown upwards always follow particular patterns of motion. This is so because they obey laws of motion. There are also laws which govern the way objects behave when they crash into each other.

This topic is aimed at helping students understand forces and motion. Forces can result from different sources and can produce different kinds of effects. Some forces do not produce motion, others cause an object to move, some may even cause rotation. There are different forms of motion, the simplest form being linear motion. Yet even this can sometimes be complicated to describe. What happens to a car or truck when it moves in a particular direction depends on whether or not forces are acting on it, and the resultant effect of these combined forces. Newton's laws of motion are very useful to help us predict what can happen. In order to understand why objects move, one must talk about energy which can neither be created nor destroyed. There are different sources of energy however we tend to depend too much on non-renewable sources. These are becoming scarce and so we have to find ways of how to use energy more wisely.

Have you ever thought about the following:

1. What does the speedometer of a car measure?
2. Why a car accelerates?
3. Why it is easier to walk on horizontal ground than up a hill?
4. Why a seatbelt can extend when a car crashes?
5. Why eggs in containers are not broken during transportation?
6. What do we mean by power?
7. How we can we use energy efficiently?
8. From where do we get energy?

Learning Programme:

- Measuring motion and changes in (velocity, acceleration).
- Equations of Linear Motion.
- Motion in situations of zero resultant force (Newton's first Law).
- Motion under the effect of a resultant force (Newton's second Law).
- Effects of forces in pairs (Newton's third Law).
- Momentum as a property of a moving object.
- Principle of conservation of momentum applied to colliding objects.
- Energy, Work and Power.
- Sources of Energy: renewable and non-renewable.

Internet Links

Some information about Isaac Newton.
http://www.newton.cam.ac.uk/newtlife.html
Some information about Isaac Newton.
http://www.newton.cam.ac.uk/newton.html
Information about scientists.
http://www.yesnet.yk.ca/schools/projects/renaissance/scientists.html
Online simulations of mechanics
http://www.edumedia-sciences.com/m185_l2-newton-s-laws.html
Educational resources on mechanics.
http://www.emints.org/ethemes/resources/S00000559.shtml

Learning Outcomes Candidates should be able to:	**Suggested Teaching Activities**	**Historical and STS connections**
1.1 Calculate speed using Average speed = Distance travelled/time taken.	Calculate the speed of a student while walking or running.	
1.2 Sketch and interpret distance-time graphs, and calculate velocity from the graphs.	☑ Investigate the motion of a body (using air track, data loggers or other suitable apparatus).	
1.3 Understand acceleration as a change in velocity and calculate its value using: Acceleration = Change in velocity /Change in time. *(Use of the equation is limited to situations where the direction of the velocity does not change.)*		
1.4 Sketch and interpret speed-time graphs and calculate the distance and acceleration from the graphs.		Use everyday examples of cars, trucks, athletes etc. to provide context to graphs.
1.5 Understand the significance of braking and thinking distance, and appreciate that Stopping distance = Thinking distance + Braking distance.		Driver's reaction time while braking and the importance of speed limits.
1.6 Use the equations of motion: $v = u + at$, $v^2 = u^2 + 2as$, $s = (u+v)t/2$, $s = ut + ½ at^2$.		
1.7 Understand that objects falling freely have the same acceleration provided there are no opposing forces.	☑ Carry out an investigation to find the acceleration of freefall by timing a falling object.	Galileo Galilei and falling bodies.

1.8. Understand that there is no change in motion (at rest or uniform motion) when there is no resultant force acting on an object – Newton's First Law.		Isaac Newton and the laws of motion. How people/things plunge forward when a driver in a vehicle brakes suddenly.
1.9 Understand that a resultant (unbalanced) force leads to a change in motion (acceleration) in the direction of the force – Newton's Second Law. Use the equation: Resultant (Unbalanced) Force = mass x acceleration.	☑ Investigate how the resultant force acting on an object causes acceleration. ☑ Investigate how by keeping the resultant force constant, the acceleration of an object is affected by varying its mass.	
1.10 Understand how forces occur in pairs and the properties of these forces – Newton's Third Law.		
1.11 Understand that moving objects possess momentum which is equal to the product of the mass of the object and its velocity and use the equation: Momentum = mass x velocity State the units for momentum as kg m/s.		
1.12 State, understand and use the concept of conservation of momentum in situations involving collisions between two objects and explosions.	☑ Investigate the conservation of momentum for different collisions (objects sticking together, objects moving separately, explosion) using air track, data loggers or other suitable apparatus.	Collisions of billiard balls. Recoil when a gun is fired.
1.13 Use the equation: Resultant (Unbalanced) Force = Change in momentum/Change in time.		Car safety; crumple zones, airbags and seatbelts.

		Using soft material for packing. Safety helmets. The importance of flexing feet/arms when jumping or catching objects.
1.14 Be able to understand that the longer the time of impact, the smaller is the force of impact and apply it to practical situations.		
1.15 Understand the concept of energy as the ability to do work.		
1.16 Know that energy is measured in joules.		James Prescott Joule and his work on energy.
1.17 Calculate work using the equation: Work = force x distance moved in the direction of the force.		
1.18 Understand the significance of the principle of conservation of energy.		
1.19 Give examples of energy in different states, its conversion and conservation.	Construct simple models that show energy conversion.	
1.20 Draw and explain energy flow diagrams through steady state systems.		
1.21 Understand that gravitational potential energy and kinetic energy are two examples of mechanical energy and calculate their value using: Gravitational potential energy = Work done in raising a mass against its weight = mass x acceleration due to gravity x height, and Kinetic energy = ½ x mass x $(\text{velocity})^2$.	Compare potential and kinetic energy changes of falling bodies.	

1.22 Understand the significance of power and calculate it using: Power = work done / time taken State the unit of power as the watt.	Calculate the work and power needed to go up a flight of stairs.	
1.23 Understand the meaning of efficiency and be able to calculate its value using: Efficiency = Useful energy output / Total energy input. Efficiency may be expressed as a percentage.		
1.24 Understand the efficient use of energy in the context of the home, heating and cooling of buildings.	Investigate the use of energy at home.	Energy efficient home appliances.
1.25 Understand the meaning of renewable and non-renewable forms of energy.	Visit an institution/ location which makes use of renewable sources of energy.	
1.26 Give examples of and classify sources of energy as renewable and non-renewable.		
1.27 State the advantages and disadvantages of fossil fuels, nuclear, wind, hydroelectric, solar and biomass sources of energy.		World energy source; fossil fuels and other energy sources.
1.28 Understand the importance of using energy resources efficiently especially with respect to their running costs and resulting pollution.		Practical ways of using renewable sources of energy at home.

Theme 2: Balancing Forces

Describing the unit

Forces are all around us. We may not see them, but we surely feel them when they act on us. Forces are present between any two masses, even if they are not touching. Forces are also present when two or more objects are in contact with each other. Forces never occur on their own but exist in pairs. When not balanced, they can make things go faster, slower or round in a circle. This topic focuses on the properties of forces and their measurement. It also includes related issues such as turning forces (moments).

This topic also looks at pressure as a force acting on a particular area and its practical applications such as hydraulic brakes. It also involves atmospheric pressure, how it acts as well how it changes with altitude.

Have you ever thought about the following:

1. Why do we fall to Earth and not the other way round?
2. Why does the moon go round the Earth, and the Earth round the Sun?
3. Why do we place handles on doors on the opposite side of the hinges?
4. Why do we use a teaspoon to open a tin of coffee?
5. Why do we use a long spanner to undo a tight nut?
6. How do drivers remove fuel from a car tank by using a pipe?
7. Why does it hurt more if a woman with a stiletto heel rather than one wearing shoes with a flat base area steps on you?
8. Why do you manage to stop a car from moving when you push the brakes?
9. How do hydraulic lifters manage to lift such heavy loads?

Learning Programme:

- The nature and properties of forces.
- Identification of Newton's pairs of forces.
- Action of a force applied to a helical spring.
- Action of a force at a distance from a fulcrum.
- Bodies in equilibrium and the motion which results.
- The moment of a force.
- Pressure exerted by a force acting on an area.
- The properties of atmospheric pressure.

Internet Links

http://www.phschool.com/science/cpsurf/mechanics/1_2lear.html - link to online animations of motion situations.
http://www.science-house.org/learn/Physics/goal2.html - website with links to resources.
http://www.sasinschool.com/global/cpdemos/physicsWR.html - offers links to many Physics resources on forces and motion.
http://www.glenbrook.k12.il.us/gbssci/phys/Class/newtlaws/u2l2b.html - classroom tutorials available.
http://sciencespot.net/Pages/kdzphysics.html - offers links to resources on the topic of forces.
http://www.darvill.clara.net/enforcemot/forces.htm - notes and practical examples on forces.
http://scienceworld.wolfram.com/physics/Pressure.html - website with definitions and notes on pressure.

Learning Outcomes Candidates should be able to:	**Suggested Teaching Activities**	**Historical and STS connections**
2.1 Describe situations where different types of forces such as weight (gravitational force), tension, contact forces and frictional forces occur.	Investigate what factors affect the friction between two surfaces.	. Historical development on gravitation – Kepler, Copernicus & Newton. Hovercraft. Lubricating to reduce friction.
2.2 Draw the forces acting on an object and understand that each force acts in one direction.		
2.3 State that a force is measured in Newtons and is measured by a Newton meter.	Use a Newton meter to measure the force needed to lift different objects.	
2.4 Distinguish between mass and weight of an object. Use the equation: Weight = mass x acceleration due to gravity.		
2.5 Understand the distinction between vector and scalar quantities (in a qualitative manner only) and be able to classify basic quantities in Physics such as: distance, displacement, speed, velocity, mass, weight, acceleration, momentum and pressure as being vector or scalar.		
2.6 Describe the behaviour of a helical spring when subjected to an increasing force. State and use Hooke's law to solve simple problems. Understand the meaning of elastic limit.	☑ Experimental investigation of the relationship between force and extension of a helical spring.	Robert Hooke. Discuss why the concrete and steel structure used in high buildings enables them to retain their original shape in wind and to withstand wind loads.

2.7 Understand that the turning effect of a force depends on the size of the force and the perpendicular distance from the pivot to the line of action of the force.		Archimedes and levers. Practical applications of levers e.g. spanner, door/window handles, wheelbarrow etc
2.8 Relate turning effect of a force to the moment of a force.		
2.9 Be able to use the equation: Moment = Force x perpendicular distance from the pivot to the line of action of the force. Make use of appropriate units for moment (Nm).	Investigate what happens when a door is closed by pushing it at different distances from the hinges.	Tower cranes.
2.10 State and understand the principle of moments.	☑ Carry out an experiment to demonstrate the principle of moments.	
2.11 Be familiar with the two conditions for equilibrium of a body.		
2.12 Be able to solve simple problems where bodies in equilibrium are supported by one pivot.		
2.13 Understand that the weight of an object acts at its centre of gravity (centre of mass).	Use the principle of moments to find the weight of a ruler.	The importance of centre of gravity and stability for different sports such as gymnastics and martial arts. Stability of racing cars, large ships (cruise liners), etc. Incorporating stability in design of household goods.
2.14 State that the standard unit of pressure is the Pascal (N/m^2).		Blaise Pascal and his work on pressure.

2.15 Use the equation Pressure = Force/Area and describe situations where pressure is inversely proportional to area.		Practical applications where the surface area affects the pressure e.g. studs in football shoes, high heeled shoes, knives, pins, wall foundations, washers, skis, wide tyres in heavy vehicles etc.
2.16 Relate the pressure beneath a liquid surface to depth and to density and use the equation Pressure = vertical height x density x acceleration due to gravity.		Deep sea diving vessels and scuba divers.
2.17 Understand that liquids transmit pressure in all directions enabling force to be magnified and apply the equation of pressure to simple hydraulic machines.	Demonstrating the siphon effect.	Discuss applications of simple hydraulic machines.
2.18 Understand that the atmosphere exerts a pressure and that this decreases to zero with increase in height above the Earth's surface.		Applications of atmospheric pressure: drinking from a straw, vacuum cleaner, rubber sucker, syringe etc.
2.19 Describe qualitatively how the pressure of a fixed mass of gas is affected by changes in its temperature and volume.		

Theme 3: The Nature of Waves

Describing the unit

Wave behaviour explains many phenomena, both natural and artificial, for all waves have properties in common. A basic vocabulary for describing waves is introduced first. Reflection, refraction and diffraction of water serve as models for the behaviour of light and sound throughout the topic. Waves are a means of carrying energy and information from one place to another. The topic also explores the electromagnetic spectrum, giving examples of properties and contemporary uses of different waves.

Have you ever thought about the following:

1. How do we see things?
2. Why do some people need glasses to see things clearly?
3. How do we see details in very small things?
4. How are rainbows formed?
5. Is the image of your face in a plane mirror what other people see when they look directly at your face?
6. Why are the words Ambulance and Fire Engine are written laterally inverted on the front of vehicles?
7. Why does a pool filled with water appear much shallower than its actual depth?
8. How is sound produced?
9. Why can an earthquake below the sea bed cause a tsunami?
10. How do ultrasound waves enable us to scan organs inside the body more safely than other forms of waves like X-rays?
11. Why are X-rays used in medicine?
12. How do we receive TV channels from satellites?
13. How is news transmitted from one part of the earth to another?
14. Why do we hear sound when under water?
15. Why do we see lightning flashes before we hear the thunder?
16. How are sonars on ships used to measure sea depth?

Learning Programme:

- Meaning of wave motion and how waves transfer energy from one place to another without transfer of the medium.
- Distinguish between transverse and longitudinal waves using examples.
- Meaning of terms: frequency, wavelength, wave velocity; amplitude; periodic time; oscillation and wavefront.
- Wave equation: $v = f.\lambda$
- Relationship between frequency of wave source and the wavelength.
- Sound production from a vibrating source.
- Speeds of light and sound compared.
- Approximate range of audible frequencies.
- Ultrasound and its use to scan body organs without undesirable effects.
- Relationship between pitch and frequency and also between loudness and amplitude.
- Reflection of water waves in a ripple tank compared to reflection of light in a plane mirror, and compared to reflection of sound waves in echoes.
- Characteristics of image formed in a plane mirror.
- Refraction of water waves in a ripple tank compared to refraction of light in a glass block.
- Total internal reflection and its use in optic fibres.
- Dispersion of white light by a prism.
- Electromagnetic spectrum: its properties and uses.
- Action of a converging lens and a diverging lens on a beam of light falling on it: focus and focal length.
- Formation of real and virtual images by a converging lens using ray diagrams; describing properties of images produced.
- Uses of lenses in simple cameras, projectors, magnifying glass and to correct eyesight (no detailed explanations expected).
- Diffraction of water waves in a ripple tank, using a single gap only.

Internet Links

Waves – simulations
http://www.cbu.edu/~jvarrian/applets/waves1/lontra_g.htm
http://www.matter.org.uk/schools/Content/Seismology/longitudinaltransverse.html
http://members.aol.com/nicholashl/waves/movingwaves.html
Sound propagation – basic phenomena (Detailed notes on various properties of sound)
http://hyperphysics.phy-astr.gsu.edu/hbase/sound/sprop.html#c1
Reflection, Refraction and Diffraction of light
http://www.physicslab.co.uk/ripple.htm
Diffraction of waves
http://www.nfos.org/degree/opt11/module_02a1.html
http://www.control.co.kr/java1/masong/oneslit.html
http://www.launc.tased.edu.au/online/sciences/physics/diffrac.html
Electromagnetic Spectrum
http://hyperphysics.phy-astr.gsu.edu/hbase/ems1.html
Electromagnetic radiation propagation
http://www.phy.ntnu.edu.tw/ntnujava/index.php?topic=35.0
A good source of animations on all parts of em spectrum, waves etc.
http://www.scienceman.com/physics/pgs/3007_emr.html
Ray diagrams for thin converging lens applet
http://www.phy.ntnu.edu.tw/ntnujava/index.php?PHPSESSID=87f5042a3746fa687a15f6083b3ef037&topic=48.msg297#msg297
Newton's Spectrum experiment
http://micro.magnet.fsu.edu/primer/java/scienceopticsu/newton/index.html
Fibre optics
http://www.howstuffworks.com/fiber-optic1.htm
Wave and Particle theories of light – Newton vs Huygens Theories
http://en.wikipedia.org/wiki/Wave-particle_duality#Huygens_and_Newton
How a TV infra red remote control works
http://electronics.howstuffworks.com/inside-rc.htm

Learning Outcomes Candidates should be able to:	**Suggested Teaching Activities**	**Historical and STS connections**
3.1 Describe what is meant by wave motion as shown by vibrations in ropes, springs, tuning forks and water waves	Practical demonstrations using slinky spring, rope etc.	
3.2 Qualitatively describe features of waves including wavelength, amplitude, frequency and speed, periodic time and wavefront.	Use of CRO to demonstrate frequency, amplitude and wavelength.	
3.3 Identify waves as carriers of energy from one location to another, for instance in a slinky spring or a water wave. Use of the ripple tank is expected.	☑ Use the slinky spring and the ripple tank to demonstrate the propagation of waves.	Describe the energy transformations required in producing a wave in a mobile phone, radio or television.
3.4 Explain that mechanical waves require a medium to travel.	Bell-jar experiment.	
3.5 Distinguish between transverse and longitudinal waves and give suitable examples. Define and apply the following terms to the wave model: displacement, amplitude, periodic time, compression, rarefaction, crest and trough.	Demonstrate the relationship between particle motion and the direction of energy propagation in transverse and longitudinal waves using the slinky spring. Computer simulations of transverse and longitudinal waves.	
3.6 Recall that the frequency of the waves, in hertz (Hz) is the number of waves per second that are produced by the source or that pass through any particular point.		
3.7 Recall and use the equation: Periodic time = 1/frequency. Solve problems by applying the equation to a range of situations.		

3.8 Recall that the wavelength of waves is the distance between the same point on two adjacent disturbances.		
3.9 Present and analyze information from displacement-time graphs for transverse waves.		
3.10 Appreciate the difference between speed of sound and speed of light.		
3.11 Know that ultrasound consists of high frequency longitudinal waves which have a frequency greater than 20 kHz.	Show sample abdominal scans e.g. of unborn baby.	Dog's whistle. Dolphins. Use of ultrasound in lieu of X-rays as a safer way of human body scanning. Bats. Echo sounding in ships.
3.12 Recall and use the equation: $v = f\lambda$ in simple problems.		
3.13 Draw and interpret wave diagrams to show a) reflection of plane water waves b) narrow beams of sound and c) light from a plane mirror.	☑ a) Use the ripple tank to show reflection of water waves and b) a mirror to show reflection of light waves.	Why do scientists think that light and sound are waves?
3.14 Define incident ray and reflected ray for reflection of waves. Use the law: angle of incidence = angle of reflection.		
3.15 Use a plane mirror to show the formation and characteristics of the image produced.		
3.16 Associate refraction with a change in wave speed.	Use the ripple tank and an immersed plate to demonstrate refraction of	

Use the definition of refractive index η in terms of speed. $\eta = \frac{\text{Speed of light in air}}{\text{speed of light in medium}}$	waves and (b) use a parallel sided transparent block to demonstrate refraction of light waves.	
3.17 Use the terms angle of incidence and angle of refraction.		
3.18 Associate refraction of light with apparent depth of water: $\eta = \frac{\text{real depth}}{\text{apparent depth}}$		
3.19 Demonstrate the effect of refraction of light in water when an object in water is viewed from vertically above. Knowledge of ray diagrams is expected.		Understand why a pool filled with water appears shallower.
3.20 Explain the term critical angle and total internal reflection.		Fibre optics. Road reflectors, Binoculars and the periscope.
3.21 Use a semicircular glass block to demonstrate that the direction of the emergent ray depends upon the angle of incidence in the glass block.		
3.22 Describe the action of a thin converging lens and a thin diverging lens on a beam of light and recall the meaning of principal focus and focal length.		Invention of telescope and microscope.
3.23 Know how to draw ray diagrams to illustrate the formation of real and virtual images by a converging lens. The knowledge of $1/f = 1/v + 1/u$ is not expected.	☑ Investigate the formation of images for various object positions for a converging lens.	Photographic camera, magnifying lens and projector.
3.24 Calculate the magnification of the lens as the ratio of image and object height and/or distances from the lens: $M = \frac{\text{height of image}}{\text{height of object}}$ and/or $M = \frac{\text{Image distance}}{\text{Object distance}}$		A substantial percentage of the price tag of a photographic camera or a video camera is the zooming power of the lens.

3.25 Give a qualitative account of the dispersion of light as illustrated by the action on light of a glass prism.	Set up a prism to produce a simple spectrum of white light.	Formation of rainbows. Newton's experiments with prisms and the spectrum.
3.26 Appreciate that light is part of the electromagnetic spectrum of radiations which travel at the same velocity.		
3.27 Identify the component radiations making up the electromagnetic spectrum, in order of increasing wavelength (decreasing frequency). Typical values of frequency and wavelength are not expected.	Computer simulations.	
3.28 Recall some of the properties and uses of the above types of radiations.		Treatment of Cancer, Scan for bone fractures, detecting counterfeit banknotes, human vision, TV remote controls, microwave ovens, radio communication and other applications.
3.29 Describe how waves can spread out at a narrow gap and recall that this is called diffraction.	☑ Use the ripple tank to demonstrate and interpret diagrams showing wave diffraction through a single gap.	Structure of breakwater.

Theme 4: Staying Cool

Describing the unit

This topic tries to explain the meaning of heat energy and how heat energy moves from warm regions to cooler ones. It describes the three methods of heat transfer: conduction, convection and radiation. It also aims to explain the different rates of conduction in different materials with practical applications. It helps students to distinguish between materials which heat up quickly and those which heat up slowly leading to the meaning of specific heat capacity. Students will understand the factors which affect the rate of absorption or emission of heat energy from a surface. They can then apply the above principles to explain how to keep warm in winter and cool in summer – both physically and in our home and work environments.

Have you ever thought about the following:

1. How do we keep warm in winter and stay cool in summer?
2. Why do we cook food on the top shelf when it needs cooking at a higher temperature?
3. Why do we wear dark uniforms in winter and light ones in summer?
4. Why do fire-fighters and astronauts wear reflective clothes?
5. Why do we feel cooler near the seaside, in summer?
6. Why are young or very old patients covered with aluminium foil while undergoing long surgical operations?
7. Why do we cover a turkey in aluminium foil when cooking it in the oven?
8. Why are houses in hot countries painted white?
9. Why are car radiators painted black?
10. Why are cavity walls and double glazing used in our homes?
11. How do solar panels manage to harness heat energy from the sun to save us so much in electricity bills?
12. Why do elephants have big ears?
13. Why does water in a glass take much longer to dry up than the same volume of water spilled on the floor?
14. Why do you feel hot and sticky on a humid day?
15. Why does sand feel hot at midday but cold at night in summer?
16. Why does sea water feel warm at night in summer?

Learning Programme:

- Density and its measurement.
- Three methods of heat transfer: conduction, convection and radiation.
- Good and bad conductors of heat and their practical applications.
- Good and bad emitters and good and bad absorbers of heat energy with practical examples.
- The use of glass to trap heat radiation e.g. in solar panels.
- Specific heat capacity.
- Expansion.
- Evaporation.
- Ways of keeping our homes warm in winter and cool in summer.

Internet Links

Conduction, convection and radiation (General notes and some simulations)
http://sol.sci.uop.edu/~jfalward/heattransfer/heattransfer.html (first part only)
http://coolcosmos.ipac.caltech.edu/cosmic_classroom/light_lessons/thermal/transfer.html
http://www.bbc.co.uk/schools/gcsebitesize/physics/energy/energytransferrev6.shtml
http://www.quia.com/servlets/quia.activities.common.ActivityPlayer?AP_rand=336078764&AP_activityType=14&AP_urlId=62554&AP_continuePlay=true&id=62554
http://www.school-for-champions.com/science/heat_transfer.htm
http://www.vtaide.com/png/heat2.htm
http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heatra.html#c2
http://www.physchem.co.za/Heat/Transfer.htm

Animation: conduction:
http://www.scienceonline.co.uk/energy/conduction2.html
http://www.gcse.com/energy/conduction2.htm

The Physics of cooking:
http://www.geocities.com/yummyphysics/

Activities and experiments:
http://coolcosmos.ipac.caltech.edu/cosmic_classroom/light_lessons/thermal/activities.html
http://www.scienceonline.co.uk/energy/green_roofs.html
http://www.miamisci.org/af/sln/mummy/coolingthetomb.html
http://drifters.doe.gov/moving-water/moving-water.html
http://www.jc-solarhomes.com/CLASS/7%20HeatLoss.htm

Learning Outcomes Candidates should be able to:	Suggested Teaching Activities	Historical and STS connections
4.1 Describe qualitatively the molecular structure of solids, liquids and gases and the motion of their particles.	Use role play to simulate the arrangement of atoms in solids, liquids and gases.	John Dalton and the Kinetic Theory of matter.
4.2 State and use the equation: Density = mass/ volume. State units for density: Kg/m^3 and g/cm^3.	☑ Describe an experiment to determine the density of a liquid and of a regularly or irregularly shaped solid and make the necessary calculations.	
4.3 Use of density to explain floating and sinking.		
4.4 Appreciate that the hotter a substance is, the more energy its particles have resulting in expansion. (Unusual expansion of water is not required).		
4.5 Recall that the unit of energy is the Joule (J) and the unit of temperature as deg. Celsius (^oC).		James Prescott Joule and his work on energy.
4.6 Relate a rise in the temperature of a body to an increase in internal energy.		The miners' Safety Davy lamp designed by Humphrey Davy.
4.7 Describe evaporation in terms of the escape of the more energetic molecules from the surface of a liquid.	Use role play to simulate the movement of atoms when evaporation takes place.	
4.8 Relate evaporation to cooling.		Demonstration that rapid evaporation causes cooling leading to a discussion about air conditioning and refrigeration.

4.9 Describe how to measure the specific heat capacity of a liquid or a metal using an electric heater of known power or joulemeter.		
4.10 Use the equation: Energy transfer = mass x specific heat capacity x temperature change ($\Delta Q = m \, . \, c. \, \Delta \theta$).		
4.11 State that the unit of specific heat capacity is J / (kg ^{o}C).		
4.12 Know that a temperature difference may cause energy transfer called heat.		
4.13 Know the meaning of the term conduction and insulation.		
4.14 Give examples of good and bad conductors of heat.	☑ Use different materials to enable students to distinguish between good and bad conductors of heat.	Discuss how air can be used in different situations to stop heat energy from being lost or gained in a house e.g. double cavity walls, water heaters, double glazing, ovens etc.
4.15 Understand that convection currents in fluids are caused by a difference in density due to expansion which is caused by heat energy.	Demonstrate convection currents in fluids.	The Montgolfier brothers invention of the first hot air balloon. Describe the role of convection currents in heating rooms, in sea and land breezes.
4.16 Understand that all objects which are warmer than the surroundings radiate heat energy (infra-red radiation) in the form of waves.	Investigate the temperature difference between air inside a closed glass container and the air just outside it while the container is in the sun.	Identify and explain some of the everyday applications of heat radiation including the 'Greenhouse effect'.
4.17 Understand the different rates of emission and absorption of heat energy of matt black and silver.	☑ Investigate the difference between good and bad absorbers of heat energy using different coloured materials.	**Find a solution:** You are near the beach and you buy a large bottle containing a cold soft drink. You can make use of the following available

	☑ Investigate the difference between good and bad emitters of heat energy using different coloured materials.	materials: thick beach towel; roll of aluminium foil; black paper. Describe how you would use any of the materials available and set it up to keep the liquid cold for as long as possible. Investigation: Try and find out ways of having energy efficient houses in Malta. Choose one aspect and focus your investigation on it. Take a look at how traditional Maltese houses such as farmhouses were built. (Double insulation / quarry and building site / small sized openings facing usual wind direction, loggia openings facing South to maximise natural light and warmth in Winter. Global warming. Greenhouses used to produce all kinds of vegetables available all the year round. Solar water heater.

Theme 5: Electricity in the Home

Describing the unit

Our homes provide comforts that frequently we take for granted. At home you can turn on the light or a heater at the flick of a switch. You may easily take a snack from the fridge and cook it in the microwave as you watch your favourite TV serial. Without electricity most of these appliances would not work and our lives would be completely different.

In this topic we shall explore how electricity was discovered when the effect of rubbing materials together was noticed. An understanding of the static electricity formed in these instances may give students a better insight about certain phenomena that take place around our homes but also enable them to consider particular applications.

This topic provides the opportunity to discuss what electricity is and how it can be measured through different circuits. It gives students the opportunity to explore different sources of electricity and investigate the relationship between voltage and current in resistors and filament lamps. Students shall also be given the opportunity to investigate components that are influenced by changes in light and temperature. This topic enables the students to appreciate how electrical energy is generated, how this is used in our houses and how its cost can be calculated. The topic also considers why electricity can be dangerous and ways to use it in a safe way.

Have you ever thought about the following:

1. Why do television screens and computer monitors become so dusty?
2. Why when after combing your hair, placing the plastic comb near a very thin stream of water will make the stream bend to the side?
3. How is a spark is produced?
4. Which is the safest place to seek shelter in a thunderstorm?
5. Why is it better to use a vacuum cleaner rather than a broom to clean a carpet?
6. Why do you get an electric shock when you touch the body of a car when you come out of the car?
7. Why are many contacts in high quality electronic systems gold-plated?
8. Why does an electrician have to wear shoes with thick rubber soles at work?
9. How do the lights in street lighting remain on when one bulb is broken?
10. How do you wire up a three pin plug?
11. What happens when you blow a fuse?
12. How much does it cost to charge a mobile phone in one year?

Learning Programme:

- Measuring charge.
- There are forces acting between charged objects.
- Difference between conductors and insulators.
- Measuring and describing current and potential difference.
- Ways of producing electricity.
- The resistance of materials depends on particular factors.
- The change of resistance of electrical devices is used in a variety of applications.
- The potential difference, current and resistance in a circuit are related.
- The behaviour of potential difference, current and resistance differs through different circuits.
- House wiring.
- Risks and hazards associated with electricity. Safety measures.

Internet Links

Balloons and Static electricity - Charging by rubbing and forces between charges.
http://phet-web.colorado.edu/web-pages/simulations-base.html

Current construction Kit- Constructing Series and Parallel circuits
http://phet-web.colorado.edu/web-pages/simulations-base.html -

Ohm's Law
http://www.walter-fendt.de/ph14e/ohmslaw.htm

Series and Parallel circuit simulations
http://www.walter-fendt.de/ph14e/combres.htm

A.C. circuit
http://www.walter-fendt.de/ph14e/accircuit.htm

Learning Outcomes Candidates should be able to:	**Suggested Teaching Activities**	**Historical and STS connections**
5.1 Describe how positive and negative charges are produced.	Describe simple experiments to show the production of electrical charge.	
5.2 Know that like charges repel and unlike charges attract.	Demonstration of forces between charges.	
5.3 Distinguish between electric conductors, insulators and semiconductors in terms of conductivity. Give suitable examples of conductors, insulators and semiconductors.		Examples of conductors, insulators and semiconductors ▪ PVC insulating wire ▪ Lightning conductor ▪ Diode as an application of semi conducting material.
5.4 Explain that conductors contain loosely bound electrons while insulators contain strongly bound electrons.		
5.5 Explain that an electric current (measured in amperes) is the rate of flow of charge.	Use an ammeter and voltmeter. Digital meters or current and voltage sensors may be used.	Sources of electrical energy: mains, simple cells, batteries.
5.6 Use the equation: Current, $I = Q/t$. Know that charge is measured in Coulombs.		
5.7 Know that a cell connected to a closed circuit uses up its chemical energy to push charge through the circuit. This chemical energy appears finally as other forms of energy.		
5.8 Use the equations: Energy, $E = Q.V$ and $E = I.V.t$		

5.9 State that resistance is measured in ohms.	Use a variable resistance to control current.	Volume controls in radios and dimmer switches.
5.10 State that Resistance = Voltage/Current; Ohm's Law and the equation V = I.R	☑ Describe an experiment to determine the resistance using a voltmeter and ammeter appropriately connected in the circuit.	
5.11 Relate the resistance of a wire to its length, diameter, type of material and temperature.	☑ Investigate the factors affecting resistance in a wire.	Filament of lighting bulb, heating elements, suitable wires for different appliances.
5.12 Be familiar with the circuit symbols shown in the 'Table of symbols' (Appendix 1)and circuit diagrams containing these symbols.	☑ Construct a circuit using different components.	
5.13 Be able to draw circuit diagrams showing how an ammeter and/or a voltmeter can be connected appropriately to measure current and voltage respectively.		
5.14 State how the resistance of an LDR changes with light level and how the resistance of a thermistor changes with temperature.	Investigate properties of an LDR. Investigate the properties of a thermistor using a digital meter and a thermometer or temperature sensor.	Electrical thermometers and circuits lighting automatically.
5.15 Interpret V-I graphs for an ohmic metal conductor, filament lamp, and thermistor.	☑ Describe experiments by which V-I graphs for an ohmic metal conductor kept at constant temperature and a filament lamp can be drawn.	

5.16 Understand that the current at every point in a series circuit is the same.	☑ Investigate how current, voltage and resistance vary in a series circuit, Computers may be used.	House lighting and Christmas tree lights.
5.17 Understand that the sum of the p.d.s across the components in a series circuit is equal to the total p.d. across the supply.		
5.18 Calculate the combined resistance of two or more resistors in series.		
5.19 Understand that the current from the source is the sum of the current in the separate branches of a parallel circuit.	Investigate how current and voltage vary in a parallel circuit. Computer simulations may be used.	
5.20 Understand that the voltage is the same across components in parallel.		
5.21 Calculate the combined resistance of two resistors in parallel, using the equation $1/R_T=1/R_1+1/R_2$		
5.22 Understand that an alternating current changes direction.	Demonstrate a.c. rectification using an oscilloscope. Demonstrate half wave rectification only.	Discuss the ideas behind the 'War of currents' era; Edison's d.c. against Tesla's a.c.
5.23 Understand the function of live, neutral and the earth wires in domestic mains.	Wiring a plug using the colour codes.	Three pin plug and connecting circuit to the appliance.
5.24 Understand that the live wire has to be insulated from the earth and neutral wires.		
5.25 Use the equation for Power, P=I.V.		

5.26 Understand why fuses have various ratings.	Fuse rating in a plug for a given current.	The fuse box. Using MCBs (minature circuit breakers). Construction details not required.
5.27 Give simple explanations of the safety measures used at home: how fuses, earthing and circuit breakers prevent the risk of fire and electrocution.		Radio, lampshades etc.
5.28 Understand why double insulated appliances do not need an earth wire while appliances with a metal case need to be earthed.		
5.29 Recognise dangerous practices in the use of mains electricity.		Old frayed wires, wrong use of multi plugs and water in sockets.
5.30 Use the equation for Energy, E = P.t in Joules and Kilowatt hours.		
5.31 Know that the amount of energy transferred from the mains is measured in Kilowatt-hours called units.		Discuss the social and environmental issues associated with the generation of electricity in Malta.
5.32 Calculate the cost of electrical energy given the power, time and the cost per unit.	Ways of reducing your electricity bill.	Electrical meters and electricity bills. Ring main power circuit. Recognize the main features of domestic circuits. (Drawing of circuits not required). Know why domestic supplies are connected in parallel. A visit to the power station may be carried out.

Theme 6: Magnets and Motors

Describing the unit

A magnet may seem to be an ordinary piece of metal or ceramic but it is actually surrounded by an invisible magnetic field that makes it affect any magnetic material that is within reach. The Earth itself has its own magnetic field that enables the use of plotting compasses for navigation and travel in general.

The similarity between certain effects given by magnets and electric charges led a number of scientists, almost 200 years ago, to look for some connection between magnetism and electricity. Along this theme, some of these connections shall be explored and their application taken into consideration. One of these is the electric motor: a convenient source of motive power since it is clean, silent, starts instantly and can be built large enough to drive a train and small enough to fit a wrist watch. Another application is the use of transformers that find their use in the many appliances we find in our homes and along the transmission lines in our national grid.

Have you ever thought about the following:

1. How can you make a magnet?
2. Why does a compass needle point towards the north pole?
3. What makes the auroras happen?
4. Why do magnets attract certain materials but not others?
5. How is your personal information stored on an automatic cash-card?
6. How does the school's electric bell work?
7. How are magnets used in scrap yards switched on and off?
8. How does a loudspeaker vibrate?

Learning Programme:

- Describing magnets.
- Forces acting between two magnetic poles.
- Magnetising and demagnetising.
- The magnetic field formed around a magnet, a current in a straight wire and solenoid.
- The Earth's magnetic field.
- Varying the strength of an electromagnet.
- Applications of electromagnetism.
- The effect of a conductor carrying a current in a magnetic field.
- Knowledge of Fleming's left hand rule.
- Faraday's Law. Electromagnetic induction.
- Lenz's law.
- The principle of operation of a basic iron-cored transformer.

Internet Links

http://micro.magnet.fsu.edu/electromag/java - An index to interactive Java tutorials that have been developed to help students understand topics in electricity and magnetism
http://www.walter-fendt.de/ph14e/mfbar.htm - Magnetic field of a bar magnet.
http://www.walter-fendt.de/ph14e/mfwire.htm - Magnetic fields of a straight current-carrying conductor.
http://phet.colorado.edu/new/simulations/sims.php?sim=Faradays_Electromagnetic_Lab – Various simulations.
http://www.walter-fendt.de/ph14e/lorentzforce.htm - A current-carrying conductor in a magnetic field.
http://www.walter-fendt.de/ph14e/electricmotor.htm - DC motor.
http://phet.colorado.edu/sims/faraday-mx/faraday-mx.swf - Faraday's Law.

Learning Outcomes Candidates should be able to:	**Suggested Teaching Activities**	**Historical and STS connections**
6.1 Explain that magnetic poles exist in pairs.	Simple investigation to demonstrate these properties.	Ancient Greeks and Chinese discovered the lodestone, a natural magnetic material.
6.2 Demonstrate how a magnetic material is different from a non-magnetic material.	☑ Simple demonstrations to show forces between magnetic poles. Computer simulations may also be used.	Common applications of magnets: ▪ Cupboard doors; ▪ Fridge doors.
6.3 Distinguish between the properties of iron and steel as magnetic materials.		
6.4 State the forces between: ▪ Like poles; ▪ Unlike poles; ▪ Magnetic and non-magnetic materials.	Computer simulations may be used.	
6.5 Describe how magnetism can be induced using the stroking method and the electrical method.		
6.6 Describe how demagnetisation can be achieved using hammering, heating and the electrical method.		Storing magnetic tapes or disks safely. Storing c.ds and d.v.ds.
6.7 Describe the pattern and direction of the field formed by: ▪ Bar magnets; ▪ A current in a straight wire; ▪ A solenoid (Using the Right hand grip rule).		

6.8 Describe simple experiments to identify pattern and direction of field lines on: ▪ A bar magnet; ▪ A straight wire carrying a current; ▪ A solenoid.	Experiments and investigations are recommended.	Hans Christian Oersted, learned that a current flowing through a wire would move a compass needle.
6.9 Relate the strength of the field lines to the pattern of the magnetic flux lines.		
6.10 Understand that the Earth has its own magnetic field and that the magnetic north pole and geographical North Pole are not on the same place on the Earth.		The plotting compass and its uses. The Auroras.
6.11 Understand that the strength of a solenoid can be changed by varying: ▪ the number of turns; ▪ the size of current flow and ▪ by introducing an iron core.		Maglev trains.
6.12 Investigate how changing the current or number of turns may vary the strength of the field of the solenoid.		
6.13 Describe simple applications where the magnetic effect of an electric current is used.		The electromagnetic relay, the circuit breaker, the electric bell, loudspeaker, the electromagnetic door lock and electromagnets for lifting.
6.14 Describe an experiment to show that a force acts on a conductor carrying a current across a magnetic field, including the effect of reversing the current and the direction of the field.	Investigate a straight current-carrying wire in a magnetic field.	
6.15 Give the relative directions of force, field, and current. Knowledge/use of Fleming's Left Hand Rule is expected.		
6.16 Understand that a current - carrying conductor placed parallel to a magnetic field has no force acting on it.		

6.17 State that a current-carrying coil in a magnetic field experiences a turning effect and this turning effect is increased by increasing the number of turns on the coil.	☑ Investigate how increasing the number of turns in a current-carrying coil affects the turning effect.	
6.18 Relate this turning effect to the action of an electric motor. Details of construction are not required.		Uses of the electric motor: Electric driller and toys.
6.19 Faraday's law: The e.m.f. induced in a conductor is directly proportional to the rate at which the magnetic field lines are cut by the conductor.		Michael Faraday and electromagnetic induction.
6.20 Describe an experiment to show that a changing magnetic field can induce an e.m.f. in a circuit. Knowledge/use of Fleming's Right Hand rule is not expected.		The moving-coil microphone.
6.21 Lenz's law: Understand that the direction of the induced e.m.f. opposes the change causing it and relate this phenomenon to conservation of energy.	Demonstrate eddy current damping.	Metal detectors, emergency brakes. Heinrich Lenz and his study on electromagnetic induction.
6.22 Describe the construction and the principle of operation of a basic iron-cored transformer. For transformer: Power input = Power output.		Transformers in domestic use: mobile chargers, CD players, laptops etc.
6.23 Use the equations: $(V_p/V_s) = (N_p/N_s)$ and $(V_p.I_p) = (V_s.I_s)$ for an ideal transformer.		The national grid system.

Theme 7: Radiation and its Uses

Describing the unit

Radioactivity is usually associated with its negative effects such as the explosion of the atom bomb in Nagasaki and Hiroshima and the nuclear accident in Chernobyl. Media reports of these events show how radioactivity killed humans, animals and plants and caused serious repercussions on the environment. However, in reality natural radioactivity occurs all around us and nowadays, radioactivity has many important applications including treating malignant tumors, domestic smoke alarms, sterilisation of medical equipment, preserving food and dating materials. This topic introduces students to radioactivity; the different types of radiation and their properties and how they are used to help us in our everyday lives. This topic can also be used to discuss the uses and misuses of science and the political and social consequences of using radiation.

Have you ever thought about the following:

1. What is an atom made up of?
2. Why does radioactivity destroy cancerous cells?
3. Why did radiation kill so many people in Nagasaki and Hiroshima?
4. Why did the nuclear accident in Chernobyl change the surrounding environment?
5. Can we eat irradiated food?
6. How can we find out how old the remains found in Ghar Dalam are?
7. Why do some watches shine in the dark?
8. What makes the 'Northern Lights'?

Learning Programme:

- An atom is made up of a positively charged nucleus and negatively charged electron. It may contain neutrons.
- Some nuclei are unstable and give out radiation to get rid of excess energy.
- There are three different types of radiation and they have different properties.
- The activity of a radioactive source can be measured and used in practical situations.
- Radioactivity has many applications in everyday life.

Internet Links

http://www.philrutherford.com/radiation_kids.html
http://studio.invisiblethreads.com/portfolios/peds
http://kids.niehs.nih.gov/uranium.htm

Chernobyl:
http://news.bbc.co.uk/2/shared/spl/hi/guides/456900/456957/html/nn2pages

Learning Outcomes Candidates should be able to:	**Suggested Teaching Activities**	**Historical and STS connections**
7.1 Describe the structure of an atom in terms of protons, neutrons and electrons and describe particular nuclei in the format: $^{A}_{Z}X$	Role play may be used to demonstrate the structure of the atom.	Discuss the discovery of radioactivity and the nucleus and the experiments carried out by Becquerel, Marie Curie, Rutherford and Bohr.
7.2 Define isotopes as atoms that have the same proton number but different nucleon number.		
7.3 Use the terms proton number and nucleon number to explain the structure of isotopes.		
7.4 Recall that some nuclei are unstable and give out radiation to get rid of excess energy. Such nuclei are said to be radioactive.	Role play can also be used to demonstrate the emission of radioactivity.	
7.5 State that the three main types of radiation are α, β, and γ radiation.		Discuss the hazardous effects of radiation and the serious implications on human beings and the environment.
7.6 Recognise the properties of the different types of radiation and their ability to penetrate and ionise. Use of the cloud chamber is not expected.	A demonstration of the penetrating powers of radioactivity using a GM tube and counter can be used. Computer simulations may be used.	Discuss the consequences of nuclear warfare, using Nagasaki and Hiroshima as examples, and the nuclear accident at Chernobyl. Use documentaries and films to show the nuclear accident at Chernobyl.

7.7 Describe the uses of radioactivity for example in irradiating food to make it last longer, thickness control of paper and leakage detection of underground pipes.		
7.8 Describe uses of radioactivity in medical applications for both diagnosis and treatment of patients and in the sterilization of equipment.		Discuss the importance of radiation in medical applications and whether the benefits of radiation outweigh the risks.
7.9 Explain what is meant by background radiation and its origin from Earth and Space.		
7.10 Define half-life as the time taken for half the atoms of a radioactive substance to decay.	Use blocks to demonstrate radioactive decay.	
7.11 Use the concept of half-life to carry out simple calculations using tabular and graphical data.	Use principles of carbon dating to calculate the age of a tree, the time which has elapsed on a dead corpse and how old our Earth is.	Use historical evidence to demonstrate dating of materials such as fossils found in Ghar Dalam and the paintings of Caravaggio in St. John's Co-Cathedral.
7.12 Describe the ways in which radioactive materials need to be handled, used and stored.		Discuss how ideas about radiation have changed with time. Describe how ionizing radiation causes tissue damage and possible mutations.

Theme 8: The Earth and the Universe

Describing the unit

Planet Earth is our home. What makes our Earth unique? It forms part of the solar system. This is made up of the Sun and everything that moves around it including the planets, their moons, and space objects such as comets. There are also vast bands of drifting rocks called asteroid bands. Scientists and astronomers have made it possible for people to find out more about the planets and other bodies. Man has launched missions to the Moon and launched missions to explore Mars. Very soon it might be possible to travel in space with the current possibilities of space travel becoming more accessible to ordinary citizens.

The unit aims to highlight the historical development of ideas with regards to astrophysics from the work of the first scientists such as Copernicus, Gallileo and Newton to Hubble. Knowledge of our Universe is important since space research illustrates the social and economic development of scientific research and the developments made in space exploration.

Have you ever thought about the following:

1. Why do we have night and day?
2. Why do we have seasons?
3. Why is the Earth so unique?
4. Why is the Sun so important?
5. Why can we sometimes see an eclipse in the sky?
6. What do other planets look like?
7. Is there life on other planets?
8. What lies beyond our galaxy?
9. What would it be like to live in space?
10. How do satellites transmit information to the Earth?
11. Why do we see stars only at night?

Learning Programme:

- The earth spins upon itself once a day to give night and day.
- The Earth orbits the Sun once in 365 days.
- The moon orbits the Earth and the planets orbit the Sun because of gravitational force.
- Satellites can be used for different purposes such as communication and monitoring of the Earth.
- Planets in our solar system have different characteristics.
- The difference between planets, stars and galaxies.
- Conditions for living in space.
- Space Exploration and its benefits.
- The historical development of ideas about the Earth and the Universe.

Internet Links

http://www.space.gc.ca/asc/eng/virtual_visit.asp
http://www.esa.int/esaKIDSen/Newwaystospace.html
http//www.nasa.gov/audience/forkids/home/index.html

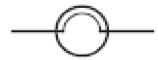
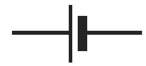
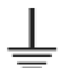
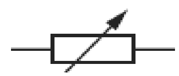
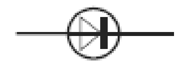
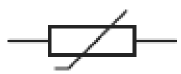
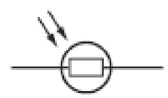
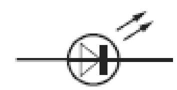
Basic Astronomy:	http://starchild.gsfc.nasa.gov/docs/StarChild/StarChild.html
General Astronomy:	http://www.enchantedlearning.com/subjects/astronomy
Solar System:	http://www.solarviews.com/eng/homepage.htm
The Moon:	http://www.pbs.org/wgbh/nova/tothemoon/
Mars landing:	http://www.nasa.si.edu/research/ceps/etp/mars/viking.html
Hubble Space Telescope:	http://hubblewite.org./gallery

Learning Outcomes Candidates should be able to:	**Suggested Teaching Activities**	**Historical and STS connections**
8.1 Describe how we have day and night on earth due to the spinning of the Earth.	Use a model of the earth and the sun using a football and an orange to show daylight and darkness.	Discuss the historical ideas about the sun and the Earth and their movements using Ptolemy, Copernicus and Gallileo.
8.2 Know that the Earth takes about 365 days to orbit the sun.		
8.3 Explain how the periodical journey of the Earth and its tilt give rise to seasons.		Discuss the effects of global warming on the seasons.
8.4 Explain the role of gravity both on Earth as well as in space to keep objects orbiting around each other.	Use the Internet to show how moon and planets stay in orbit.	Galileo and gravity. Experiments from the Tower of Pisa.
8.5 Understand the force of gravity as the force of attraction between objects and that this force of attraction increases with mass and decreases with distance.	Build a gravity model.	Newton and the law of gravity.
8.6 Use the force of gravity to describe how (i) the moon and (ii) satellites orbit the Earth.	Connect with satellites to show position of the school.	
8.7 Describe the definition of a planet as being a celestial body that: ▪ is in orbit around the sun; ▪ has a nearly round shape; ▪ has cleared the neighbourhood around its orbit.		Discuss the uniqueness of life on Earth. Discuss the statistical probability of life on other planets.
8.8 Name the eight major planets of the Solar system.	Prepare a travel brochure inviting people to visit the different planets in the solar system.	Use documentaries and films to show travel of Man and Man landing on the Moon.

8.9 Recognise that Pluto is a "dwarf planet" because it has not cleared the neighbourhood around its orbit.		
8.10 Describe our solar system as part of the Milky Way galaxy which is a small part of the Universe.	🛠 Build a model of the solar system.	👁 Multimedia presentation of photos from Mars.
8.11 State that distances in space are measured in "light years" and that one light year is the distance that light travels in one year.		
8.12 Name the instruments which can be used to observe the sky (telescopes and radio telescopes).		🏛 Discuss the instruments which the first scientists used to observe the sky before the Hubble Space telescope was invented.
8.13 Identify a few of the social and economic benefits of space explorations.		👁 Discuss the social and economic benefits of space travel. Illustrate the many technological spin offs which are a result of space research.
8.14 Recognise that there are still many unanswered questions about our Universe.		👁 Discuss the Big Bang theory.

Appendix 1

Table of symbols

a. c. supply		**filament lamp**		**voltmeter**	
ammeter		**cell**		**battery**	
d. c. supply		**junction**		**switch**	
earth		**galvanometer**		**fuse**	
fixed resistor		**variable resistor**		**diode**	
thermistor		**Light Dependent Resistor**		**Light Emitting Diode**	

Mathematical Notations

Students should be able to:

- recognise and use expressions in decimal and standard form (scientific) notations;
- recognise and use prefixes indicating multiplication by 10^{-6}, 10^{-3}, 10^{3}, 10^{6};
- make evaluations of numerical expressions and use such approximations to check calculations;
- change the subject of an equation;
- solve simple algebraic equations.

Appendix 2
SI Units and Symbols

Physical Quantity	Symbol	S.I. Unit	S.I. Unit
length	l	metre	m
area	A	square metre	m^2
volume	V	cubic metre	m^3
mass	m	kilogram	kg
density	ρ	kilogram per metre cubed	kg/m^3
time	t	second	s
periodic time	T	second	s
frequency	f	hertz [per second]	Hz
Wavelength	λ	metre	m

work	W	joule [newton metre]	J
energy	E	joule	J
power	P	watt [joule per second]	W or J/s
Potential Energy	PE	joule	J
Kinetic Energy	KE	joule	J
heat energy	Q	joule	J
temperature	θ	degree Celsius	°C
specific heat capacity	c	joule per kilogram degree Celsius	J/kg°C

force	F	newton [kg m/s^2]	N
weight	W	newton	N
moment of a force	M	newton metre	Nm
pressure	P	pascal [N/m^2]	Pa
distance	s	metres	m
speed	S	metre per second	m/s
initial velocity	u	metre per second	m/s
final velocity	v	metre per second	m/s
acceleration	a	metre per second squared	m/s^2
acc. due to gravity	g	metre per second squared	m/s^2
momentum	p	kilogram metre per second	kg m/s

electric charge	Q	coulomb	C
electric current	I	ampere	A
electromotive force **emf**	E	volt [joule per coulomb]	V
potential difference **pd**	V	volt [joule per coulomb]	V
voltage	V	volt [joule per coulomb]	V
resistance	R	ohms	Ω
electrical energy	W	joule	J

Appendix 3

Practical Investigation

Aim

To investigate relationship between physical dimensions of resistance wire and their electrical resistance.

Apparatus

20 cm length of 36 swg resistance wire like constantan
voltmeter
ammeter
variable resistor
switch
connecting wires with crocodile clips at both ends

Information about swg

The size of a wire is the measure of its diameter. For convenience, the different wires are numbered in order of decreasing size, the number being known as the gauge, or gage; the higher the gauge the smaller the diameter. For example 36 swg is a wire with thickness 0.127 mm while 24 swg has a thickness of 0.511mm.

Starting the Investigation

Your investigation should start by connecting up the apparatus given to find the resistance of the 20 cm length of resistance wire in ohms.

The Investigation

You are expected to ask the teacher for any additional materials you would need for the following investigations.
You are to conduct two different investigations:

1. Is there a relationship between the thickness of a resistance wire and its electrical resistance? (in simple terms, does the thickness of a wire affect its electrical resistance?)
2. Is there a relationship between the length of a wire and the electrical resistance? (in simple terms, does the length of a wire affect its electrical resistance?)

You are expected to describe the methods you used in each case and to include any results in a table or in the form of a graph. Mention any precautions taken.

You can also note down your forecast of any relationship which you think may exist before conducting the actual investigations.

Practical Investigation

Aim

To investigate how high a ball bounces when dropped from different heights and on to different surfaces.

Apparatus

Different balls, e.g. basketball, football, softball.
Different surfaces on which to drop the ball, e.g. wood, tile, carpet.
Different heights from which to drop the ball.

Information needed

To investigate the relationship between drop and bounce heights, students need to devise a comprehensive plan which should include decisions about the number and types of balls (e.g., basketball, softball, power ball) to use, the number of trials, the heights from which the ball should be dropped, the methods for measuring heights of bounces, the type of surface (e.g., wood, tile, carpet) on which the balls will be dropped, and the methods for reporting results.

The Investigation

You are expected to ask the teacher for any additional information you would need for the following investigations.
You are to conduct different investigations

1. How high will a ball bounce on its first bounce when dropped from a height?
2. Does this ball bounce change when a different ball is used?
3. If you change the drop height how does the ball bounce change?
4. Can you predict the first bounce height if you know the drop height?

You are expected to describe the methods you used in each case and to include any results in a table or in the form of a graph. Mention any precautions taken.

You can also note down your forecast of any relationship which you think may exist before conducting the actual investigations.

Appendix 4: SEC Physics

Candidates of SEC Physics are required to fill in this form and attach it to the first page of their practical report book. If additional practical books are presented the form should be attached to the first book.

Candidate's Name ______________________ School ____________________________

Name of 12 experiments, two from each theme 1-6, presented		Marks	Page No
1.1			
1.2			
2.1			
2.2			
3.1			
3.2			
4.1			
4.2			
5.1			
5.2			
6.1			
6.2			
Name of the remaining 2/3 experiments presented		**Marks**	**Page No**
	Total number of marks:		
	Total number of experiments presented:		
	Average mark for the experiments presented:		
	Average mark to the nearest whole number:		

On the above list mark with a * the experiment presented as an investigation.