Physical Science Grade 10 Teachers' Guide - Siyavula WebBook

By:

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Online:
< http://cnx.org/content/col11342/1.1/ >

C O N N E X I O N S

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Collection structure revised: August 10, 2011
PDF generated: August 10, 2011
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Table of Contents

1 TG Physical Science - Overview 1
2 TG Physical Science - Blog Posts 17
3 TG Physical Science - Chapter Contexts 21
4 TG Physical Science - Solutions 33
5 On the Web, Everyone can be a Scientist 35
6 FullMarks User Guide 39
7 Rich Media 43
Index 48
Attributions 49

Chapter 1

TG Physical Science - Overview[1]

1.1 Overview

Dear educator, welcome to the force of educators that make a difference by unlocking the marvels of the Physical Sciences to learners. What a privilege you have to guide the learners in becoming critical thinkers!

To improve curriculum implementation and to meet the vision for our nation, the National Curriculum Statement Grades R - 12 (NCS) was revised, changed and is replaced by a national policy document developed for each subject. All Physical Sciences educators in the country have to use the National Curriculum and Assessment Policy Statement for Physical Sciences. This policy document replaces all old Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines in Grades R - 12. These changed curriculum and assessment requirements come into effect in January 2012. As a Physical Sciences educator for Grade 10, you need to have a sound understanding of the National Curriculum and Assessment Policy Statement for Physical Sciences.

This teachers' guide is divided into two main parts:

- **Part 1** deals with the policy document; and
- **Part 2** with the learners' textbook.

Part 1

The National Curriculum and Assessment Policy Statement for Physical Sciences has four sections:

Section 1: Curriculum overview

Section 2: Physical Sciences

Section 3: Physical Sciences Content (Grades 10 - 12)

Section 4: Assessment

This part will assist you in getting to grips with the objectives and requirements laid down for the Physical Sciences at national level, and how to implement the prescribed policy document.

Part 2

The Grade 10 Physical Sciences textbook is divided into Chemistry and Physics. Each chapter in the textbook addresses prescribed content, concepts and skills. The range of activities includes practical activities, experiments, and informal and formal assessment tasks.

1.2 Curriculum Overview

From the beginning of January 2012, all learning and teaching in public and independent schools in South Africa is laid down in the National Curriculum and Assessment Policy Statements (January 2012) (CAPS)

[1] This content is available online at <http://cnx.org/content/m40362/1.1/>.

document. National Curriculum and Assessment Policy Statements were developed for each subject and replace all previous policy statements including:

- National Senior Certificate: a qualification at Level 4 on the National Qualifications Framework (NQF);
- An addendum to the policy document, the National Senior Certificate: a qualification at Level 4 on the National Qualifications Framework (NQF), regarding learners with special needs, published in the Government Gazette, No. 29466 of 11 December 2006;
- The Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines for Grades R - 9 and Grades 10 - 12.

The following sections in this document set out the expected norms and standards and minimum outcomes, as well as processes and procedures for the assessment of learner achievement in public and independent schools.

The national agenda and how the curriculum can serve this agenda:

(a) The knowledge, skills and values worth learning for learners in South Africa are clearly set out in the National Curriculum and Assessment Policy Statement for Physical Sciences. The content links to the environment of the learners and is presented within local context, with awareness of global trends.

(b) The National Curriculum Statement Grades R - 12 undertakes to:

- equip all learners, irrespective of their socio-economic background, race, gender, physical ability or intellectual ability, with the knowledge, skills and values necessary for self-fulfilment to participate meaningfully in society as citizens of a free country;
- provide access to higher education;
- facilitate the transition of learners from education institutions to the workplace; and
- provide employers with a sufficient profile of a learner's competencies.

(c) The key principles (fuller described in the document) of the National Curriculum Statement for Grades R - 12 are:

- social transformation: making sure that the educational differences of the past are put right, by providing equal educational opportunities to all;
- active and critical learning: encouraging an active and critical approach to learning, not only rote learning of given facts;
- high knowledge and high skills: specified minimum standards of knowledge and skills are set to be achieved at each grade;
- progression: content and context of each grade shows progression from simple to complex;
- human rights, inclusivity, environmental and social justice: being sensitive to issues such as poverty, inequality, race, gender, language, age, disability and other factors;
- valuing indigenous knowledge systems: acknowledging the rich history and heritage of this country; and
- credibility, quality and efficiency: providing an education that is comparable in quality, breadth and depth to those of other countries.

(d) The aims as listed in the National Curriculum Statement Grades R - 12 interpret the kind of citizen the education systems tries to develop. It aims to produce learners that are able to:

- identify and solve problems and make decisions using critical and creative thinking;
- work effectively as individuals and with others as members of a team;
- organise and manage themselves and their activities responsibly and effectively;
- collect, analyse, organise and critically evaluate information;
- communicate effectively using visual, symbolic and/or language skills in various modes;

- use science and technology effectively and critically showing responsibility towards the environment and the health of others; and
- demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.

(e) Inclusivity is one of the key principles of the National Curriculum Statement Grades R - 12 and should become a central part of the organisation, planning and teaching at each school.

Educators need to:

- have a sound understanding of how to recognise and address barriers to learning;
- know how to plan for diversity;
- address barriers in the classroom;
- use various curriculum differentiation strategies[2];
- address barriers to learning using the support structures within the community; District-Based Support Teams, Institutional-Level Support Teams, parents and Special Schools as Resource Centres.

1.2.1 Physical Sciences

As economic growth is stimulated by innovation and research which is embedded in the Physical Sciences, this subject plays an increasingly important role to meet the country's needs. The nature of the Physical Sciences and the needs of the country are reflected in the curriculum. The specific aims direct the classroom activities that intend to develop higher order cognitive skills of learners, needed for higher education.

The nature of the Physical Sciences is to:

- investigate physical and chemical phenomena through scientific inquiry, application of scientific models, theories and laws in order to explain and predict events in the physical environment;
- deal with society's need to understand how the physical environment works in order to benefit from it and responsibly care for it;
- use all scientific and technological knowledge, including Indigenous Knowledge Systems (IKS) to address challenges facing society.

The specific aims of Physical Sciences

The specific aims provide guidelines on how to prepare learners to meet the challenges of society and the future during teaching, learning and assessment. The Specific Aims of the Physical Sciences (CAPS document, stated below) are aligned to the three Learning Outcomes (NCS document) with which you are familiar. Developing language skills as such is not a specific aim for the Physical Sciences, but we know that cognitive skills are rooted in language; therefore language support is crucial for success in this subject.

The specific aims for the Physical Sciences are:

- **Specific aim 1:** to promote knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships to technology, society and the environment.
- **Specific aim 2:** to equip learners with investigating skills relating to physical and chemical phenomena. These skills are: classifying, communicating, measuring, designing an investigation, drawing and evaluating conclusions, formulating models, hypothesising, identifying and controlling variables, inferring, observing and comparing, interpreting, predicting, problem solving and reflective skills.
- **Specific aim 3:** to prepare learners for future learning (including academic courses in Higher Education), specialist learning, employment, citizenship, holistic development, socio-economic development, and environmental management. Learners choosing Physical Sciences as a subject in Grades 10 - 12, including those with barriers to learning, can have improved access to professional career paths related to applied science courses and vocational career paths.

[2] Consult the Department of Basic Education's Guidelines for Inclusive Teaching and Learning (2010)

Within each of these aims, specific skills or competences have been identified. It is not advisable to try to assess each of the skills separately, nor is it possible to report on individual skills separately. However, well designed assessments must show evidence that, by the end of the year, all of the skills have been assessed at a grade-appropriate level. Study the next section that deals with assessment.

Developing language skills: reading and writing

As a Physical Sciences educator you need to engage in the teaching of language. This is particularly important for learners for whom the Language of Learning and Teaching (LoLT) is not their home language. It is important to provide learners with opportunities to develop and improve their language skills in the context of learning Physical Sciences. It will therefore be critical to afford learners opportunities to read scientific texts, to write reports, paragraphs and short essays as part of the assessment, especially (but not only) in the informal assessments for learning.

Six main knowledge areas inform the Physical Sciences. These are:

- Matter and Materials
- Chemical Systems
- Chemical Change
- Mechanics
- Waves, Sound and Light
- Electricity and Magnetism

1.2.1.1 Time Allocation of the Physical Sciences in the Curriculum

The teaching time for Physical Sciences is 4 hours per week, with 40 weeks in total per grade. The time allocated for the teaching of content, concepts and skills includes the practical work. These are an integral part of the teaching and learning process.

Grade	**No. of Weeks Allocated**	**Content, Concepts & Skills (Weeks)**	**Formal Assessment**
10	40	30	10
11	40	30	10
12	40	28	12

Table 1.1

1.2.1.2 Topics and Content to be Dealt with in Grade 10

(Consult the National Curriculum and Assessment Policy Statement for Physical Sciences for an overview of Grades 10 - 12)

Topic	**Content**
Mechanics	Introduction to vectors & scalars; motion in one dimension (reference frame, position, displacement and distance, average speed, average velocity, acceleration, instantaneous velocity, instantaneous speed, description of motion in words, diagrams, graphs and equations).Energy (gravitational potential energy, kinetic energy, mechanical energy, conservation of mechanical energy (in the absence of dissipative forces). • 30 hours
Waves, Sound & Light	Transverse pulses on a string or spring (pulse, amplitude superposition of pulses); transverse waves (wavelength, frequency, amplitude, period, wave speed, longitudinal waves (on a spring, wavelength, frequency, amplitude, period, wave speed, sound waves); sound (pitch, loudness, quality (tone),ultrasound); electromagnetic radiation (dual (particle/wave); nature of electromagnetic (EM) radiation, nature of EM radiation, EM spectrum, nature of EM as particle – energy of a photon related to frequency and wavelength). • 16 hours

continued on next page

Electricity & Magnetism	Magnetism (magnetic field of permanent magnets, poles of permanent magnets, attraction and repulsion, magnetic field lines, earth's magnetic field, compass); electrostatics (two kinds of charge, force exerted by charges on each other (descriptive), attraction between charged and uncharged objects (polarisation), charge conservation, charge quantization); electric circuits (emf, potential difference (pd), current, measurement of voltage (pd) and current, resistance, resistors in parallel). • 14 hours
Matter & Materials	Revise matter and classification (materials; heterogeneous and homogeneous mixtures; pure substances; names and formulas; metals and nonmetals; electrical and thermal conductors and insulators; magnetic and non magnetic materials); states of matter and the kinetic molecular theory; atomic structure (models of the atom; atomic mass and diameter; protons, neutrons and electrons; isotopes; energy quantization and electron configuration); periodic table (position of the elements; similarities in chemical properties in groups, electron configuration in groups); chemical bonding (covalent bonding; ionic bonding; metallic bonding); particles substances are made of (atoms and compounds; molecular substances and ionic substances). • 28 hours

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Chemical Systems	Hydrosphere • 8 hours
Chemical Change	Physical and chemical change (separation by physical means; separation by chemical means; conservation of atoms and mass; law of constant composition; conservation of energy); representing chemical change (balanced chemical equations); reactions in aqueous solution (ions in aqueous solutions; ion interaction; electrolytes; conductivity; precipitation; chemical reaction types); stoichiometry (mole concept). • 24 hours

Table 1.2

1.2.1.3 An Overview of Practical Work

Educators now have clarity regarding the role and assessment of practical work. This document specifies that practical work must be integrated with theory to strengthen the concepts being taught. Practical work can be: simple practical demonstrations; an experiment or practical investigation. In Section 3 practical activities are outlined alongside the content, concepts and skills column. The table below lists prescribed practical activities for formal assessment as well as recommended practical activities for informal assessment in Grade 10.

Term	**Prescribed Practical Activities for Formal Assessment**	**Recommended Practical Activities for Informal Assessment**
Term 1	**Experiment 1 (Chemistry)**:Heating and cooling curve of water.	**Practical Demonstration (Physics):** Use a ripple tank to demonstrate constructive and destructive interference of two pulses **or** **Experiment (Chemistry):** Flame tests to identify some metal cations and metals.
		continued on next page

Term 2	**Experiment 2 (Physics):** Electric circuits with resistors in series and parallel – measuring potential difference and current.	**Investigation (Physics):** Pattern and direction of the magneticfield around a bar magnet **or** **Experiment (Chemistry):** Prove the conservation of matter experimentally.
Term 3	**Project: Chemistry:** Purification and quality of water. **or** **Physics:** Acceleration.	**Experiment (Physics):** Roll a trolley down an inclined plane with a ticker tape attached to it, and use the data to plot a position vs. time graph **or** **Experiment (Chemistry):** Reaction types: precipitation, gas forming, acid-base and redox reactions.
Term 4		**Experiment (Chemistry):** Test water samples for carbonates, chlorides, nitrates, nitrites, pH, and look at water samples under the microscope.

Table 1.3

Weighting of topics [40 week programme]:

	Grade 10	**Time**
	%	**Hours**
Mechanics	18.75	30
Waves, Sound & Light	10.00	16
Electricity & Magnetism	8.75	14
Matter & Materials	17.50	28
Chemical Change	15.00	24
Chemical Systems	5.00	8
Teaching Time (Theory and Practical Work)	75.00	120
Time for Examinations and Control Tests	25	40

Table 1.4

Total time = 40 hours/term x 4 terms = 160 hours per year

1.2.2 Physical Sciences Content (Grade 10)

This section of the CAPS document provides a complete plan for: time, topics, content, concepts and skills, practical activities, resource material and guidelines for educators. You need to consult this section of the document regularly to check whether your classroom activities fall within the requirements and objectives of the prescribed curriculum. Use the condensed work schedule below which is aligned with Section 3 and the learner's book as a pacesetter to check your progress.

1.2.2.1 Work Schedule

Term 1: 36 Hours or 9 Weeks			
Chemistry (Matter & Materials)			
Weeks	**Topics**	**Practical Activities**	**Assessment**
Week 1 (4h)	Revise matter & classification (from Grade 9).The material(s) of which an object is composed. **Mixtures:** heterogeneous and homogeneous, pure substances: elements and compounds, names and formulae of substances. Metals, metalloids and non-metals, electrical conductors, semiconductors and insulators, thermal conductors and insulators, magnetic and non magnetic materials.States of matter and the kinetic molecular theory.Three states of matter, Kinetic Molecular Theory.	**Prescribed experiment for formal assessment:** Start with ice in a glass beaker and use a thermometer to read the temperature every 10 seconds when you determine the heating curve of water. Do the same with the cooling curve of water starting at the boiling point. Give your results on a graph.	**Recommended Formal Assessment:** 1. Control Test **Recommended Informal Assessment:** 1. At least two problem-solving exercises as homework and/or class work (every day, if possible cover all cognitive levels). 2. **One** practical activity per term. 3. At least **one** informal test per term.

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Week 2 (4h)	**The atom:** basic building block of all matter (atomic structure).Models of the atom, atomic mass and diameter, structure of the atom: protons, neutrons and electrons, isotopes, electron configuration.		
Week 3 (4h)	**Periodic table** (position of the elements; similarities in electron configuration and chemical properties amongst elements in groups 1, 2, 17 and 18).	**Recommended experiment for informal assessment:** Flame tests to identify some metalcations and metals.	
Week 4 & 5 (8h)	**Chemical bonding** (covalent bonding; ionic bonding; metallic bonding).		
Week 6 (4h)	**Transverse pulses on a string or spring** (pulse, amplitude superposition of pulses).	**Recommended experiment for informal assessment:** Use a ripple tank to demonstrate constructive and destructive interference of two pulses.	
Week 7 (2h)	**Transverse waves** (wavelength, frequency, amplitude, period, wave speed).		
Week 7 (cont.)(2h)	**Longitudinal waves** (on a spring, wavelength, frequency, amplitude, period, wave speed, sound waves).		

continued on next page

Week 8 (2h)(2h)	**Longitudinal waves** (continue).Sound (pitch, loudness, quality (tone), ultrasound).		
Week 9 (4h)	Electromagnetic radiation (dual (particle/wave), nature of electromagnetic (EM) radiation, nature of EM radiation, EM spectrum, nature of EM as particle – energy of a photon related to frequency and wavelength).		

Table 1.5

Term 2: 30 Hours or 7,5 Weeks			
Chemistry (Matter & Materials)			
Weeks	**Topics**	**Practical Activities**	**Assessment**
Week 1&2 (8h)	**Particles substances are made of** (atoms and compounds; molecular substances and ionic substance form due to bonding).		
Chemistry (Chemical Change)			
Week 3 (4h)	**Physical and chemical change** (separation by physical means; separation by chemical means; conservation of atoms and mass; law of constant composition; conservation of energy).	Recommended experiment for informal assessment:Prove the law of conservation of matter by • reacting lead(II) nitrate with sodium iodide; • reacting sodium hydroxide with hydrochloric acid; • reacting Cal-C-Vita tablet with water.	
Week 4 (4h)	**Representing chemical change** (balanced chemical equations).		
Physics (Electricity & Magnetism)			
Week 5 (2h)	**Magnetism** (magnetic field of permanent magnets, poles of permanent magnets, attraction and repulsion, magnetic field lines, earth's magnetic field, compass).	**Recommended Practical Activities Informal Assessment Investigation (Physics):**Pattern and direction of the magneticfield around a bar magnet.	**Formal Assessment** 1. Prescribed experiment in Physics on electric circuits. 2. Mid-year examinationsRecommended Informal Assessment: 1. At least two problem-solving exercises as homework and/or class work (every day, if possible cover all cognitive levels). 2. **One** practical activity per term. 3. At least **one** informal test per term.

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Week 5 (cont.)2h)Week 6 (2h)	**Electrostatics** (two kinds of charge, force exerted by charges on each other (descriptive), attraction between charged and uncharged objects (polarisation), charge conservation, charge quantization).		
Week 6(cont.) (2h) Week 7 (4h) Week 8 (2h)	**Electric circuits** (emf, potential difference (pd), current, measurement of voltage (pd) and current, resistance, resistors in parallel).	Prescribed experiment for formal assessment (Physics):Electric circuits with resistors in series and parallel – measuring potential difference and current.	
Week 8 &9	Mid year examination.		

Table 1.6

Term 3: 36 hours or 9 weeks			
Chemistry (Chemical Change)			
Weeks	**Topics**	**Practical Activities**	**Assessment**
Week 1 & 2 (8h)	**Reactions in aqueous solutions** (ions in aqueous solutions; ion interaction; electrolytes; conductivity; precipitation; chemical reaction types).	**Recommended experiment for informal assessment:** Test water samples for carbonates, chlorides, nitrates, nitrites, pH and look at water samples under the microscope.	**Formal Assessment:Recommended Project For Chemistry:** 1. Purification and quality of waterorRecommended project-Physics: 1. Acceleration.
continued on next page			

Week 3 & 4 (8h)	**Stoichiometry** (mole concept).		
Physics (Mechanics)			
Week 5 (4h)	**Introduction to vectors & scalars.**		2. Control test **Informal Assessment:** 1. At least two problem-solving exercises as homework and/or class work (every day, if possible cover all cognitive levels). 2. **One** practical activity per term. 3. At least **one** informal test per term.
Week 6 & 7 (8h)	**Motion in one dimension** (reference frame, position, displacement and distance, average speed, average velocity, acceleration.		
Week 8 & 9 (8h)	Instantaneous speed and velocity and the equations of motion.	**Recommended experiment for informal assessment:** Roll a trolley down an inclined plane with a ticker tape attached to it and use the data to plot a position vs. time graph.	

Table 1.7

Term 4: 16 hours or 4 weeks			
Physics (Mechanics)			
Weeks	**Topics**	**Practical Activities**	**Assessment**
Week 1 & 2 (8h)	**Energy** (gravitational potential energy, kinetic energy, mechanical energy, conservation of mechanical energy (in the absence of dissipative forces)).		**Formal Assessment:** Final examinations.
			continued on next page

Chemistry (Chemical Systems)			
Week 3 & 4 (8h)	**Thehydrosphere**.		**Informal Assessment:** 1. At least two problem-solving exercises as homework and/or class work (every day, if possible cover all cognitive levels). 2. **One** practical activity per term. 3. At least **one** informal test per term.
Week 5 up to end of term	**Revision and formal assessment.**		

Table 1.8

Chapter 2

TG Physical Science - Blog Posts[1]

2.1 Blog Posts

2.1.1 General Blogs

Educator's Monthly - Education News and Resources

- "We eat, breathe and live education! "
- "Perhaps the most remarkable yet overlooked aspect of the South African teaching community is its enthusiastic, passionate spirit. Every day, thousands of talented, hard-working educators gain new insight from their work and come up with brilliant, inventive and exciting ideas. Educator's Monthly aims to bring educators closer and help them share knowledge and resources.
- Our aim is twofold ...
- To keep South African educators updated and informed.
- To give educators the opportunity to express their views and cultivate their interests."
- http://www.teachersmonthly.com

Head Thoughts – Personal Reflections of a School Headmaster

- blog by Arthur Preston
- "Arthur is currently the headmaster of a growing independent school in Worcester, in the Western Cape province of South Africa. His approach to primary education is progressive and is leading the school through an era of new development and change."
- http://headthoughts.co.za/

Reflections of a Science Teacher - Scientist, Educator, Life-Long Learner

- blog by Sandra McCarron
- "After 18 years as an Environmental Consultant, I began teaching high school science and love it. My writings here reflect some of my thoughts about teaching, as they occur. I look forward to conversations with other thoughtful teachers."
- http://sanmccarron.blogspot.com/

The Naked Scientists - Science Radio and Naked Science Podcasts

- " "The Naked Scientists" are a media-savvy group of physicians and researchers from Cambridge University who use radio, live lectures, and the Internet to strip science down to its bare essentials, and promote it to the general public. Their award winning BBC weekly radio programme, The Naked Scientists, reaches a potential audience of 6 million listeners across the east of England, and also has an international following on the web."

[1] This content is available online at <http://cnx.org/content/m40364/1.1/>.

- http://www.thenakedscientists.com/

2.1.2 Chemistry Blogs

Chemical Heritage Foundation – We Tell the Story of Chemistry

- "The Chemical Heritage Foundation (CHF) fosters an understanding of chemistry's impact on society. An independent, nonprofit organization, CHF maintains major collections of instruments, fine art, photographs, papers, and books. We host conferences and lectures, support research, offer fellowships, and produce educational materials. Our museum and public programs explore subjects ranging from alchemy to nanotechnology."
- http://www.chemheritage.org/

ChemBark – A Blog About Chemistry and Chemical Research

- blog maintained by Paul Bracher
- "The scope of this blog is the world of chemistry and chemical research. Common subjects of discussion include ideas, experiments, data, publications, writing, education, current events, lab safety, scientific policy, academic politics, history, and trivia."
- http://blog.chembark.com/

Chemistry World Blog

- "This blog provides a forum for news, opinions and discussion about the chemical sciences. Chemistry World is the monthly magazine of the UK's Royal Society of Chemistry."
- http://www.rscweb.org/blogs/cw/

Chemistry Blog

- "A brand new site for chemists and the home of the international chemistry societies' electronic network. The site provides interesting features and useful services for the chemistry community. The information you find has been made available by various national chemistry societies for dissemination on a single site. Currently around 30 such societies are providing varying levels of information."
- http://www.chemistryblog.net/

Master Organic Chemistry

- blog by James A. Ashenhurst
- "I'm James. I've been an organic chemist for ten years. I love organic chemistry and I want to put the image of organic chemistry as a horror movie to rest (or at least make it less scary and more campy). The main goal for this site is that it be a place for conversation between students and educators. I also hope that it will be useful and valuable for students of organic chemistry."
- http://masterorganicchemistry.com/

About.com Chemistry

- This website is full of great chemistry information, including Chem 101, science projects, elements, plus many interesting articles, including a daily "This Day in Science History"
- http://chemistry.about.com/

2.1.3 Physics Blogs

dotphysics

- blog by Rhett Allain
- "This blog is about physics. Not crazy hard physics, but nice physics. You know, like physics you would take home to your mom. I try to aim most of the posts at the physics level an advanced high school student could understand."
- http://scienceblogs.com/dotphysics/

Think Thank Thunk – Dealing with the Fear of Being a Boring Teacher

- blog by Shawn Cornally
- "I am Mr. Cornally. I desperately want to be a good teacher. I teach Physics, Calculus, Programming, Geology, and Bioethics. Warning: I have problem with using colons. I proof read, albeit poorly."
- http://101studiostreet.com/wordpress/

Chapter 3

TG Physical Science - Chapter Contexts[1]

3.1 Overview of Chapters

3.1.1 Units

This chapter explains the huge role measuring plays in the Physical Sciences and the importance of units. Examples given illustrate that experiment and observation becomes meaningful when expressed in a quantity and its particular unit. The SI unit system with its seven base SI units is introduced. Details are provided for the correct way to write units and their abbreviations. For example: the SI unit for length is meter (lower case) and the abbreviation is "m", while the volume of a liquid is measured in litre "ℓ". When a unit is named after a person, then the symbol is a capital letter. The 'newton' is the unit of force named after Sir Isaac Newton and its symbol is "N". When writing a combination of base SI units, place a dot ($\cdot$) between the base units used. Metres per second is correctly written as "$m \cdot s^{-1}$".

Currently learners are expected to round off correctly to 2 decimal places. The text in the learner's book illustrates the big difference to the answer when rounding off digits during a calculation. As an educator you often need to remind your learners only to round off the final answer. Learners also need to be able to write and translate data into the correct units and dimensions using scientific notation. To develop learners' skills to do conversions and calculations use the table of unit prefixes, conversion diagrams and worked examples.

3.2 Chemistry Overview

3.2.1 Matter and Materials

3.2.1.1 What are the Objects Around us Made of?

Learners will learn that all objects are made of matter, and that different objects are made of different types of matter or materials. These different properties will be explained by studying material's microscopic structure (the small parts that make up the material). We will explore the smallest building blocks of matter, atoms, their unique properties and how they interact and combine with other atoms.

Revision of concepts related to molecules, their molecular and empirical formulae, and models to represent compounds will assure that all learners have the necessary prior knowledge to understand new concepts.

3.2.1.2 Classification of Matter

To link to Grade 9, matter is classified according to its different properties. The diagram below summarises the sequence in which content, concepts and skills are developed in this chapter.

[1] This content is available online at <http://cnx.org/content/m40363/1.1/>.

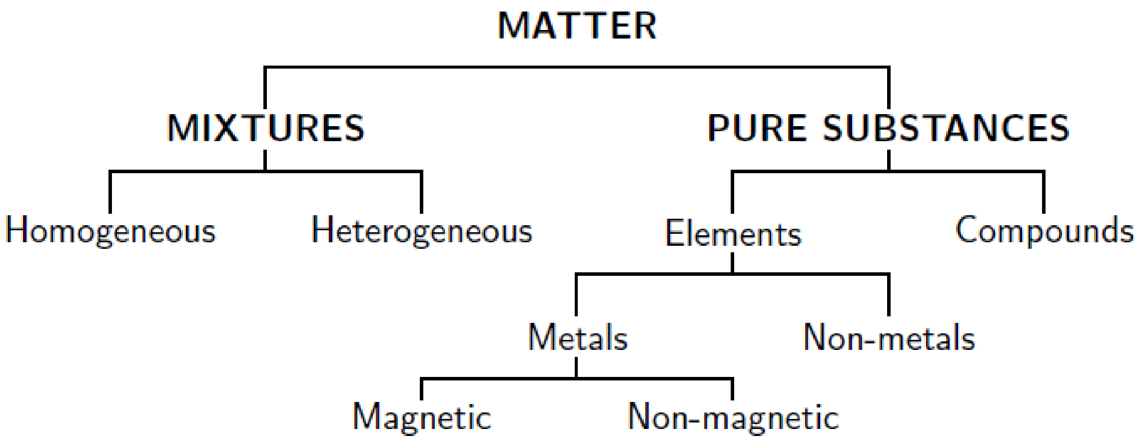


Figure 3.1

Diagram: the Classification of Matter

The terms: mixture, heterogeneous and homogeneous mixtures are defined and explained in a learner-friendly way. To clarify concepts and support understanding, a lot of interesting examples linked to everyday lifestyle are given. For example: a pizza is described as a heterogeneous mixture, as each slice of pizza will probably differ from the next one, because the toppings like cheese, tomato, mushrooms and peppers are not evenly distributed and are visible. Ways to separate mixtures is extended by explaining the dialysis process and how centrifugation is used to separate cells and plasma in blood.

In the section on pure substances, learners will learn about: elements, the periodic table of elements and compounds as well as to decide what the difference is between a mixture and a compound by using molecular models. The time spent on the guidelines provided for naming compounds and the exercise to consolidate understanding will be worthwhile! You ought to find that the learners will easily understand the text explaining the concepts: metals, semi-metal, non-metals, electrical conductors, semi-conductors and insulators, thermal conductors and insulators as well as magnetic and non-magnetic materials. The text also elaborates on where the specific properties of the listed materials are used in buildings, industrial and home environments as well as in animals and humans. Point out to the learners that as students of the Physical Sciences they need to understand how the physical environment works in order to benefit from it.

The learners need to engage in the three practical investigations listed in this chapter to strengthen their practical ability in a “hands on” way.

Investigate:

- The separation of a salt solution
- Electrical conductivity
- Magnetism

The detailed summary at the end of the chapter and the summary exercise provide a useful self-assessment checklist for the learner and the educator, to make sure that all aspects have been effectively addressed and learnt.

3.2.1.3 The Atom

In this section the idea that matter is made of very small particles (atoms) is developed further and learners are guided in understanding the microscopic nature of matter. Studying the atomic models illustrates that scientific knowledge changes over time as scientists acquire new information.

Studying the atomic models of Thomson, Rutherford and Bohr contribute to form a 'picture' of how an atom looks, based on evidence available at that stage. The concepts related to the structure of the atom: protons, neutrons and electrons, isotopes, atomic number and atomic mass are explained in a way that learners will understand. To consolidate learning, learners need to engage in studying the worked examples and do the exercises. By taking part in the suggested Group Discussion activities, learners have the opportunity to develop critical thinking skills and express themselves using the scientific language. The effective use of diagrams clarifies abstract concepts, such as energy quantisation and electron configuration. The text urges learners to understand electron configuration, as valence electrons of the atoms will determine how they react with each other.

3.2.1.4 The Periodic Table

The CAPS document requires that learners understand the arrangement of elements in increasing atomic number, and show how periodicity of the physical and chemical properties of the elements relates to electronic structure of the atoms in the periodic table. The content of this section in the learner book will enable learners to understand the underpinning concepts and to develop the skill to use the periodic table to extract data.

For example:

- the lower the ionisation energy, the more reactive the element will be
- how to predict the charge on cations and anions by using the periodic table

3.2.1.5 Atomic Combinations

This section explores the forming of new substances with new physical and chemical properties when different combinations of atoms and molecules join together. This process is called chemical bonding, one of the most important processes in chemistry. The type of bond formed depends on the elements involved. Three types of chemical bonding: covalent, ionic and metallic bonding are discussed.

Covalent bonds form when atoms of non-metals share electrons. Why and how atoms join is described and explained by using Lewis dot diagrams and Couper notation to represent the formed molecules. Names and formulae of several covalent compounds are presented.

Ionic bonds form when electrons are transferred. Ionic bonding takes place when the difference in electronegativity between the two atoms is more than1,7. The cations and anions that form attract each other with strong electrostatic forces. Details of how ionic compounds form is clarified with Lewis notation. When learners become familiar with the diagram of the crystal lattice arrangement in an ionic compound as NaCl they will be able to derive the properties of ionic compounds.

Metallic bonding is the electrostatic attraction between the positively charged atomic nuclei of metal atoms and the delocalised electrons in the metal. The unique properties of metals as a result of this arrangement are described in detail.

3.2.1.6 States of Matter and the Kinetic Molecular Theory (KMT)

Educators should not skip this section assuming that learners know the KMT because they have been exposed to it in previous grades. As an educator you should challenge the learners to move mentally between the three ways of thinking and talking about matter, as shown in the diagram above.

Use the learner's book to revise the following concepts:

The kinetic theory of matter states that:

- all matter is composed of particles which have a certain amount of energy, which allows them to move at different speeds depending on the temperature (energy);
- there are spaces between the particles and also attractive forces between particles when they come close together.

States of Matter

- Matter exists in one of three states: solid, liquid and gas.

- a solid has a fixed shape and volume;
- a liquid takes on the shape of the container that it is in;
- a gas completely fills the containers that it is in.

- Matter can change between these states by either adding heat or removing heat.
- Melting, boiling, freezing, condensation and sublimation are processes that take place when matter changes state.

In Grade 10 the learners should understand chemical bonds, intermolecular forces and the kinetic theory to assist them in explaining the macroscopic properties of matter, and why substances have different boiling points, densities and viscosities.

3.2.2 Chemical Systems

3.2.2.1 The Hydrosphere

The hydrosphere is made up of freshwater in rivers and lakes, the salt water of the oceans and estuaries, groundwater and water vapour. This section deals with how the hydrosphere interacts with other global systems. On exploring the hydrosphere, an investigation is proposed and guidance is given on how to choose the site, collect, and interpret the data. The very important function that water plays on our planet is highlighted, as well as threats to the hydrosphere. To cultivate an attitude of caring and responsibility towards the hydrosphere, learners are encouraged to engage in the proposed discussions on creative water conservation and investigations: how to build dams and to test the purity of water samples. As an educator you will appreciate the hints supplied for a project on water purification.

3.2.3 Chemical Change

3.2.3.1 Physical and Chemical Change

This section starts by distinguishing between physical and chemical changes of matter. Matter does not change during a physical change, it is the arrangement of molecules that change. Matter changes during chemical changes through decomposition and syntheses reactions. Physical and chemical changes are compared with respect to the arrangement of particles, conservation of mass, energy changes and reversibility. The role of intermolecular forces during phase changes (a physical change) is highlighted. Understanding of concepts is enhanced by examples which include diagrams, experiments and investigations.

3.2.3.2 Representing Chemical Change

As a Physical Sciences educator you will welcome this section as it will bridge the gap learners might have in conceptual understanding and skills to represent chemical change. The content revised includes: common chemical symbols, writing chemical formulae and balancing chemical equations by applying the law of conservation of mass. The four labels used to represent the state (phase) of compounds in the chemical equation are:

- (g) for gaseous compounds
- (l) for liquids
- (s) for solid compounds and
- (aq) for an aqueous (water) solution

Learners will develop the skills to balance chemical equations when they study and apply the steps discussed in the text. Learners need to do the proposed investigation and work through the examples and exercises to assess understanding and consolidate learning.

3.2.3.3 Reactions in Aqueous Solutions

Many reactions in chemistry and all reactions in living systems take place in water (or aqueous solutions). In almost all these reactions ions are present. We explore:

- ions in aqueous solutions;
- electrical conductivity; and
- the three main types of reactions that occur in aqueous solutions, namely precipitation, acid-base and redox reactions.

Ions in aqueous solutions

Learners need to understand why water is a polar molecule, to apply their knowledge in further discussions. It is this unique property that allows ionic compounds to dissolve in water. In plants and animals water is the carrier of these dissolved substances making life possible. The process of dissociation is thoroughly explained using words, a definition, image and an equation. The equation for the dissolution of sodium chloride is:

$\mathrm{NaCl}\,(s) \rightarrow Na^{+}\,(\mathrm{aq}) + Cl^{-}\,(\mathrm{aq})$

Electrolytes, ionisation and conductivity

Concepts are explored using: definitions, equations and experiments.

- Conductivity is a measure of the ability of water to conduct an electric current. The more ions in the solution, the higher its conductivity.
- An electrolyte is a material that increases the conductivity of water when dissolved in it. Electrolytes are divided into strong and weak electrolytes.
- A non-electrolyte is a material that does not increase the conductivity of water when dissolved in it. The substance that goes into a solution becomes surrounded by water molecules separate from each other, but no chemical bonds are broken. This is a physical change. In the oxygen the reaction is reversible because oxygen is only partially soluble in water and comes out of solution very easily.

$O_2\,(g) \rightarrow O_2\,(\mathrm{aq})$

Step by step guidance is given to understand precipitation reactions and to apply the knowledge when testing for the anions: chloride, bromide, iodide, sulphate and carbonate.

Acid-base and redox reactions also take place in aqueous solutions. When acids and bases react, water and a salt are formed. An example of this type of reaction is:

NaOH (aq) + HCl (aq) →NaCl (aq) + H2O (l)

Redox reactions involve the exchange of electrons. One ion loses electrons and becomes more positive, while the other ion gains electrons and becomes more negative. These reactions will be covered in more detail in Grade 11.

3.2.3.4 Quantitative Aspects of Chemical Change

As introduction to this topic, educators need to spend time on explanations, so that learners can acknowledge the very small size of atoms, molecules and ions. In the reaction between iron and sulphur, every iron (Fe) atom reacts with a single sulphur (S) atom to form one molecule of iron sulphide (FeS). But how will we know how many atoms of iron are in a small given sample of iron, and how much sulphur is needed to use up the iron? Is there a way to know what mass of iron sulphide will be produced? Concepts to be developed to answer these questions are: relative atomic mass, the mole, molar mass, Avogadro's constant and composition of substances. Learners need to understand and manipulate the equation below to calculate the number of moles, mass or molar mass of a substance.

$n = \frac{m}{M}$

When learners engage in the suggested group work: "Understanding moles, molecules and Avogadro's number" and the multiple exercises set on moles and empirical formulae and molar concentration of liquids, they will be able to do basic stoichiometric calculations to determine the theoretical yield of a product in a chemical reaction, when you start with a known mass of reactant.

3.3 Physics Overview

3.3.1 Vectors

Physics describes the world around us. In mechanics we study the motion of objects and the related concepts of force and energy. It takes two qualities: size and direction, to describe force and motion. A vector is such a quantity that has both magnitude and direction. Vectors are not Physics but vectors form a very important part of the mathematical description of Physics. In this section, learners will develop the understanding of the concepts of vectors. They need to master the use of vectors to enable them to describe physical phenomena (events).

The text will direct learners to:

- know and explain with examples the differences between vectors and scalars;
- define vectors in words, with equations, mathematical and graphical representations;
- express direction using different methods as: relative directions (right, left, up, down), compass directions (North, South, East, West) and bearing (in the direction 030);
- draw vectors;
- explore the properties of vectors like equal vectors and negative vectors;
- add, subtract and multiply with vectors;
- define the resultant vector in words, graphically and by calculation; and
- apply their understanding by doing the exercises.

3.3.1.1 Motion in One Dimension

This section explains how things move in a straight line or scientifically move in one dimension. Three ideas describe exactly how an object moves.

They are:

1. Position or displacement which tells us exactly where the object is;
2. Speed or velocity which tells us exactly how fast the object's position is changing or more familiarly, how fast the object is moving; and
3. Acceleration, which tells us exactly how fast the object's velocity is changing.

When studying motion, you need to know where you are, your position relative to a known reference point. The concept frame of reference, defined as a reference point combined with a set of directions (east, west, up down), is explained with illustrated examples. The illustrations on position are linked with learners' everyday experience, making it easy for them to describe position and to understand that position can be positive or negative, relative to a reference point. The displacement of an object is defined as its change in position, a vector quantity, mathematically described as Δx. In Mathematics and Science the symbol Δ (delta) indicates a change in a certain quantity. For example, if the initial position of a car is $x_i$and it moves to a final position of x_f, then the displacement is $x_f - -x_i$. Displacement is written as:

$\Delta x = x_f - x_i$

Each of the concepts: speed, average velocity, instantaneous velocity and acceleration that describe motion are developed in words; definitions are stated, and suitable examples are discussed using illustrations. Equations are also used to interpret motion and to solve problems. Graphs, another way of describing motion, is also introduced in this section. The three graphs of motion: position vs. time, velocity vs. time and acceleration vs. time are discussed and presented simultaneously, starting with a stationary object. Learners will benefit by the way in which the content is developed, showing that graphs are just another way of representing the same motions previously described in words and diagrams. The text guides learners to extract information about movement from graphs by calculating the gradient of a straight line and the area under a graph.

The multiple examples discussed will clarify concepts developed, and by doing the exercises learners can assess their understanding. This section ends with the equations of motion, another way to describe motion. The curriculum prescribes that learners must be able to solve problems set on motion at constant acceleration. The text familiarise learners with these equations, and provides ample examples and exercises of problems to solve, set on real life experiences.

3.3.1.2 Mechanical Energy

This section revises the concepts weight and mass, and explores the difference between mass and weight as an introduction to the energy concepts.

Gravitational potential energy is defined as the energy of an object due to its position above the surface of the Earth. In equation form gravitational potential energy is defined as:

$E_P = \mathrm{mgh}$

m = mass (measured in kg), g = gravitational acceleration ($9;\ 8m \cdot s^{-2}$) and h = perpendicular height from the reference point (measured in m).

Refer to the chapter on units. By showing that the units $\mathrm{kg} \cdot m \cdot s^{-2}$ are equal to J, and mixing units and energy calculations will assist learners to be more watchful when solving problems to convert given data to SI base quantities and units.

Kinetic energy is the energy an object has because of its motion. The kinetic energy of an object can be determined by using the equation:

$E_k = \frac{1}{2}\mathrm{mv}^2$

In words, mechanical energy is defined as the sum of the gravitational potential energy and the kinetic energy, and as an equation:

$E_M = E_P + E_K = \mathrm{mgh} + \frac{1}{2}\mathrm{mv}^2$

Both the laws of conservation of energy and conservation of mechanical energy are states. To solve problems the latter is applied in the form:

$$\mathrm{U}_{\mathrm{top}} = U_{\mathrm{bottom}}$$

$$\mathrm{E}_{P\mathrm{top}} + E_{K\mathrm{top}} = E_{P\mathrm{bottom}} + E_{K\mathrm{bottom}}$$

To assess their degree of understanding of the content and concepts, learners are advised to engage in studying the worked examples and do the set problems.

3.3.2 Waves and Sound and Electromagnetic Radiation

3.3.2.1 Transverse Pulses

Transverse pulses on a string or spring are discussed, but first the questions are asked: What is a medium? What is a pulse? The following terms related to transverse pulse are introduced, defined and explained: position of rest, pulse length, amplitude and pulse speed. When a transverse pulse moves through the medium, the particles in the medium only move up and down. This important concept is illustrated by a position vs. time graph. When learners engage in doing the investigation, drawing a velocity-time graph and studying the worked example, they will get to grips with the concepts. When two or more pulses pass through the same medium at the same time, it results in constructive or destructive interference. This phenomenon is explained by superposition, the addition of amplitudes of pulses.

3.3.2.2 Transverse Waves

A transverse wave is a wave where the movement of the particles of the medium is perpendicular to the direction of propagation of the wave. Concepts addressed include: wavelength, amplitude, frequency, period, crests, troughs, points in phase and points out of phase, the relationship between frequency and period, i.e. $f = \frac{1}{T}$ and $T = \frac{1}{f}$, the speed equation, $v = f\lambda$.

3.3.2.3 Longitudinal Waves

In a longitudinal wave, the particles in the medium move parallel to the direction in which the wave moves. It is explained how to generate a longitudinal wave in a spring. While transverse waves have peaks and troughs, longitudinal waves have compressions and rarefactions. A compression and a rarefaction is defined, explained and illustrated. Similar to the case of transverse waves, the concepts wavelength, frequency, amplitude, period and wave speed are developed for longitudinal waves. Graphs of particle position, displacement, velocity and acceleration as a function of time are presented. Problems set on the equation of wave speed for longitudinal waves, $v = f\lambda$, concludes this section.

3.3.2.4 Sound Waves

Sound is a longitudinal wave. The basic properties of sound are: pitch, loudness and tone. Illustrations are used to explain the difference between a low and a high pitch and a soft and a loud sound. The speed of sound depends on the medium the sound is travelling in. Sound travels faster in solids than in liquids, and faster in liquids than in gases. The speed of sound in air, at sea level, at a temperature of formula $21\,^{\circ}C$ and under normal atmospheric conditions, is $344m \cdot s^{-1}$. Frequencies from 20 to 20 000 Hz is audible to the human ear. Any sound with a frequency below 20 Hz is known as an infrasound and any sound with a frequency above 20 000 Hz is known as an ultrasound.

The use of ultrasound to create images is based on the reflection and transmission of a wave at a boundary. When an ultrasound wave travels inside an object that is made up of different materials such as the human body, each time it encounters a boundary, e.g. between bone and muscle, or muscle and fat, part of the wave is reflected and part of it is transmitted. The reflected rays are detected and used to construct an image of the object. Ultrasound in medicine can visualise muscle and soft tissue, making them useful for scanning the organs, and is commonly used during pregnancy. Ultrasound is a safe, non-invasive method of looking inside the human body.

3.3.2.5 Electromagnetic Radiation

In this section it is explained that some aspects of the behaviour of electromagnetic radiation can best be explained using a wave model, while other aspects can best be explained using a particle model. The educator can use the descriptions and diagrams in the text to explain:

- how electromagnetic waves are generated by accelerating charges;
- that an electric field oscillating in one plane produces a magnetic field oscillating in a plane at right angles to it, and so on; and
- how EM waves propagate through space, at a constant speed of $3x10^8 m \cdot s^{-1}$.

The colourful visual representation of the electromagnetic spectrum as a function of the frequency and wavelength also showing the use of each type of EM radiation, will assist learners to connect physical concepts to real life experiences. The penetrating ability of the different kinds of EM radiation,the dangers of gamma rays, X-rays and the damaging effect of ultra-violet radiation on skin and radiation from cell-phones are discussed.

The particle nature of EM radiation is stated and the concept photon is defined. The energy of a photon is calculated using the equation: E = hf where $h = 6,63 \times 10^{-}34J \cdot s$ is Planck's constant, f = frequency, and where $c = 3 \times 10^{8} m \cdot s^{-}1$is the speed of light in a vacuum. Learners can calculate the energy of an ultraviolet photon with a wavelength of 200 nm by using the equations given.

3.3.3 Electricity and Magnetism

3.3.3.1 Magnetism

Magnetism is a force exerted by magnetic objects without touching each other. A magnetic object is surrounded by a magnetic field, a region in space where a magnet or object made of magnetic material will experience a non-contact force. Electrons inside any object have magnetic fields associated with them. The way the electrons' magnetic fields line up with each other explains magnetic fields in ferromagnetic materials (e.g. iron), magnetisation, permanent magnets and polarity of magnets. These concepts are explored with descriptions, diagrams and investigations.

Magnets have a pair of opposite poles, north and south. Like poles of a magnet repel; unlike poles attract. It is not possible to isolate north and south poles - even if you split a magnet, you only produce two new magnets. The magnetic field line around a bar magnet can be visualised using iron filings and compass needles. Learners need to be reminded that the field is three dimensional, although illustrations depict the fields in 2D. To show the shape, size and direction of the magnetic fields different arrangements of bar magnets are investigated and illustrated.

The pattern of the Earth's magnetic field is as if there is an imaginary bar magnet inside the Earth. Since a magnetic compass needle (a north pole) is attracted to the south pole of a magnet, and magnetic field lines always point out from north to south, the earth's pole which is geographically North is magnetically actually a south pole. The Earth has two north poles and two south poles: geographic poles and magnetic poles. The geographic North Pole, which is the point through which the earth's rotation axis goes, is about $11,5^{\circ}$ away from the direction of the Magnetic North Pole (which is where a compass will point). Learners are made aware of the importance of the earth's magnetic field acting as a shield to stop electrically charged particles emitted by the sun from hitting the earth and us. Charged particles can damage and cause interference with telecommunications (such as cell phones).

Solar wind is the stream of charged particles (mainly protons and electrons) coming from the sun. These particles spiral in the earth's magnetic field towards the poles. If they collide with particles in the earth's atmosphere they sometimes cause red or green lights, or a glow in the sky which is called the aurora, seen at the north and south pole.

3.3.3.2 Electrostatics

Electrostatics is the study of electric charge which is static (not moving). Remind learners that all objects surrounding us (including people!) contain large amounts of electric charge. There are two types of electric charge: positive charge and negative charge. If the same amounts of negative and positive charge are brought together, they neutralise each other and there is no net charge; the object is neutral. However, if there is a little bit more of one type of charge than the other on the object, then the object is electrically charged. The concepts: positively charged (an electron deficient) and negatively charged (an excess of electrons) are explained mathematically and with illustrations

The unit in which charge is measured is coulomb (C). A coulomb is a very large charge. In electrostatics we often work with charge in microcoulombs ($1\mu\text{C} = 1 \times 10^{-6}C$) and nanocoulombs ($1\text{nC} = 1 \times 10^{-9}C$).

Objects may become charged by contact or when rubbed by other objects. Charge, like energy, cannot be created or destroyed - charge is conserved. When a ruler is rubbed with a cotton cloth, negative charge is transferred from the cloth to the ruler. The ruler is now negatively charged and the cloth is positively charged. If you count up all the positive and negative charges at the beginning and the end, there is still the same amount, i.e. total charge has been conserved!

An electrostatic force is exerted by charges on each other. The electrostatic force between:

- like charges are repulsive
- opposite (unlike) charges are attractive.

The closer together the charges are, the stronger the electrostatic force between them.

Perform the suggested experiment to test that like charges repel and unlike charges attract each other. The electrostatic force also determines the arrangement of charge on the surface of conductors, because charges can move inside a conductive material. On a spherical conductor the repulsive forces between the individual like charges cause them to spread uniformly over the surface of the sphere, however, for conductors with non-regular shapes, there is a concentration of charge near the point or points of the object.

Conductors and insulators: All the matter and materials on earth are made up of atoms. All atoms are electrically neutral i.e. they have the same amounts of negative and positive charge inside them. Some materials allow electrons to move relatively freely through them (e.g. most metals, the human body). These materials are called conductors. Other materials do not allow the charge carriers, the electrons, to move through them (e.g. plastic, glass). The electrons are bound to the atoms in the material. These materials are called non-conductors or insulators. There can be a force of attraction between a charged and an uncharged neutral insulator due to a phenomenon called polarisation. The latter is explained in terms of the movement of polarised molecules in insulators. Learners are also introduced to the electroscope, a very sensitive instrument which can be used to detect electric charge.

3.3.3.3 Electric Circuits

This section starts by revising concepts learners have dealt with in earlier grades such as: uses of electricity, closed circuits, representing electric circuits using symbols, how to connect resistors in series and in parallel, series and parallel circuits and alternative energy.

The text guides learners to gain a better understanding of potential difference. They need to know that charges will not move unless there is a force provided by the battery in the circuit. A parallel is drawn between the change in potential energy of an object in a gravitational field and electric potential difference. The amount of work done to move a charge from one point to another point equals the change in electric potential energy. Note: it is a difference between the value of potential energy at two points, therefore potential difference is measured between or across two points. Potential difference is defined as: the difference in electrical potential energy per unit charge between two points. The unit of potential difference is volt (V). 1 volt = 1 joule (energy)/1 coulomb (charge). Electrical potential difference is also called voltage.

The concepts of potential difference across resistors connected in parallel and in series in electric circuits are explored in depth. Diagrams show the points between which the potential difference is measured, how the voltmeter (an instrument that measures potential difference) is connected and the voltmeter readings obtained. The concept *emf* as the voltage measured across the terminals of a battery is developed in a similar way.

Current is defined as the amount of charges that move past a fixed point in a circuit in one second. Use the picture in the learners' book and description to explain to learners that the charges in the wires can only be pushed around the circuit by a battery. When one charge moves, the charges next to it also move. The current flowing can be calculated with the equation: $I = \frac{Q}{t}$, where I is the symbol for current measured in amperes (A) and Q the symbol for charge measures in coulomb (C). One ampere is one coulomb of charge moving in one second.

The current in series and parallel circuits are investigated first using the brightness of a light bulb as indication of the amount of current flowing, and then an ammeter is connected to measure the amount of current through a given circuit element.

Resistance slows down the flow of current in a circuit. On a microscopic level, resistance is caused when electrons moving through the conductor collide with the particles of which the conductor (metal) is made. When they collide, they transfer kinetic energy. The electrons therefore lose kinetic energy and slow down. This leads to resistance. The transferred energy causes the resistor to heat up. We use the symbol R to show resistance and it is measured in units called ohms with the symbol Ω. Ohm $= V \cdot A^{-1}$

An important effect of a resistor is that it converts electrical energy into other forms of heat energy. Light energy is a by-product of the heat that is produced.

Learners need to see the bigger picture and be able to explain why batteries go flat. In the battery, chemical potential energy (chemical reactions) is converted to electrical energy (which powers the electrons to move through the circuit). Because of the resistance of circuit elements, electrical energy is converted to heat and light. The battery goes flat when all its chemical potential energy has been converted into other forms of energy.

3.3.4 Safety in the Laboratory

It is very important for learners to know the general safety rules and guidelines for working in a laboratory, as a laboratory can be a dangerous place. The learners must also know the common hazard signs, and be able to identify them and know what they mean.

Chapter 4

TG Physical Science - Solutions[1]

4.1 Solutions

The solutions to the exercises can be found embedded throughout the textbooks on Connexions.

The Physical Science textbook can be accessed at http://siyavula.cnx.org/content/col11305/latest/[2]

[1] This content is available online at <http://cnx.org/content/m40367/1.1/>.

[2] *Siyavula textbooks: Grade 10 Physical Science [CAPS]* <http://cnx.org/content/col11305/latest/>

Chapter 5

On the Web, Everyone can be a Scientist[1]

5.1 On the Web, Everyone can be a Scientist

Did you know that you can fold protein molecules, hunt for new planets around distant suns or simulate how malaria spreads in Africa, all from an ordinary PC or laptop connected to the Internet? And you don't need to be a certified scientist to do this. In fact some of the most talented contributors are teenagers. The reason this is possible is that scientists are learning how to turn simple scientific tasks into competitive online games.

This is the story of how a simple idea of sharing scientific challenges on the Web turned into a global trend, called citizen cyberscience. And how you can be a scientist on the Web, too.

5.1.1 Looking for Little Green Men

A long time ago, in 1999, when the World Wide Web was barely ten years old and no one had heard of Google, Facebook or Twitter, a researcher at the University of California at Berkeley, David Anderson, launched an online project called SETI@home. SETI stands for Search for Extraterrestrial Intelligence. Looking for life in outer space.

Although this sounds like science fiction, it is a real and quite reasonable scientific project. The idea is simple enough. If there are aliens out there on other planets, and they are as smart or even smarter than us, then they almost certainly have invented the radio already. So if we listen very carefully for radio signals from outer space, we may pick up the faint signals of intelligent life.

Exactly what radio broadcasts aliens would produce is a matter of some debate. But the idea is that if they do, it would sound quite different from the normal hiss of background radio noise produced by stars and galaxies. So if you search long enough and hard enough, maybe you'll find a sign of life.

It was clear to David and his colleagues that the search was going to require a lot of computers. More than scientists could afford. So he wrote a simple computer program which broke the problem down into smaller parts, sending bits of radio data collected by a giant radio-telescope to volunteers around the world. The volunteers agreed to download a programme onto their home computers that would sift through the bit of data they received, looking for signals of life, and send back a short summary of the result to a central server in California.

The biggest surprise of this project was not that they discovered a message from outer space. In fact, after over a decade of searching, no sign of extraterrestrial life has been found, although there are still vast regions of space that have not been looked at. The biggest surprise was the number of people willing to help such an endeavour. Over a million people have downloaded the software, making the total computing power of SETI@home rival that of even the biggest supercomputers in the world.

[1]This content is available online at <http://cnx.org/content/m40353/1.1/>.

David was deeply impressed by the enthusiasm of people to help this project. And he realized that searching for aliens was probably not the only task that people would be willing to help with by using the spare time on their computers. So he set about building a software platform that would allow many other scientists to set up similar projects. You can read more about this platform, called BOINC, and the many different kinds of volunteer computing projects it supports today, at http://boinc.berkeley.edu/[2] .

There's something for everyone, from searching for new prime numbers (PrimeGrid) to simulating the future of the Earth's climate (ClimatePrediction.net). One of the projects, MalariaControl.net, involved researchers from the University of Cape Town as well as from universities in Mali and Senegal.

The other neat feature of BOINC is that it lets people who share a common interest in a scientific topic share their passion, and learn from each other. BOINC even supports teams – groups of people who put their computer power together, in a virtual way on the Web, to get a higher score than their rivals. So BOINC is a bit like Facebook and World of Warcraft combined – part social network, part online multiplayer game.

Here's a thought: spend some time searching around BOINC for a project you'd like to participate in, or tell your class about.

5.1.2 You are a Computer, too

Before computers were machines, they were people. Vast rooms full of hundreds of government employees used to calculate the sort of mathematical tables that a laptop can produce nowadays in a fraction of a second. They used to do those calculations laboriously, by hand. And because it was easy to make mistakes, a lot of the effort was involved in double-checking the work done by others.

Well, that was a long time ago. Since electronic computers emerged over 50 years ago, there has been no need to assemble large groups of humans to do boring, repetitive mathematical tasks. Silicon chips can solve those problems today far faster and more accurately. But there are still some mathematical problems where the human brain excels.

Volunteer computing is a good name for what BOINC does: it enables volunteers to contribute computing power of their PCs and laptops. But in recent years, a new trend has emerged in citizen cyberscience that is best described as volunteer thinking. Here the computers are replaced by brains, connected via the Web through an interface called eyes. Because for some complex problems – especially those that involve recognizing complex patterns or three-dimensional objects – the human brain is still a lot quicker and more accurate than a computer.

Volunteer thinking projects come in many shapes and sizes. For example, you can help to classify millions of images of distant galaxies (GalaxyZoo), or digitize hand-written information associated with museum archive data of various plant species (Herbaria@home). This is laborious work, which if left to experts would take years or decades to complete. But thanks to the Web, it's possible to distribute images so that hundreds of thousands of people can contribute to the search.

Not only is there strength in numbers, there is accuracy, too. Because by using a technique called validation – which does the same sort of double-checking that used to be done by humans making mathematical tables – it is possible to practically eliminate the effects of human error. This is true even though each volunteer may make quite a few mistakes. So projects like Planet Hunters have already helped astronomers pinpoint new planets circling distant stars. The game FoldIt invites people to compete in folding protein molecules via a simple mouse-driven interface. By finding the most likely way a protein will fold, volunteers can help understand illnesses like Alzheimer's disease, that depend on how proteins fold.

Volunteer thinking is exciting. But perhaps even more ambitious is the emerging idea of volunteer sensing: using your laptop or even your mobile phone to collect data – sounds, images, text you type in – from any point on the planet, helping scientists to create global networks of sensors that can pick up the first signs of an outbreak of a new disease (EpiCollect), or the initial tremors associated with an earthquake (QuakeCatcher.net), or the noise levels around a new airport (NoiseTube).

There are about a billion PCs and laptops on the planet, but already 5 billion mobile phones. The rapid advance of computing technology, where the power of a ten-year old PC can easily be packed into a

[2] http://boinc.berkeley.edu/

smart phone today, means that citizen cyberscience has a bright future in mobile phones. And this means that more and more of the world's population can be part of citizen cyberscience projects. Today there are probably a few million participants in a few hundred citizen cyberscience initiatives. But there will soon be seven billion brains on the planet. That is a lot of potential citizen cyberscientists.

You can explore much more about citizen cyberscience on the Web. There's a great list of all sorts of projects, with brief summaries of their objectives, at http://distributedcomputing.info/[3] . BBC Radio 4 produced a short series on citizen science http://www.bbc.co.uk/radio4/science/citizenscience.shtml[4] and you can subscribe to a newsletter about the latest trends in this field at http://scienceforcitizens.net/[5] . The Citizen Cyberscience Centre, www.citizencyberscience.net[6] which is sponsored by the South African Shuttleworth Foundation, is promoting citizen cyberscience in Africa and other developing regions.

[3] http://distributedcomputing.info/
[4] http://www.bbc.co.uk/radio4/science/citizenscience.shtml
[5] http://scienceforcitizens.net/
[6] http://www.citizencyberscience.net/

Chapter 6

FullMarks User Guide[1]

6.1 FullMarks User Guide

FullMarks can be accessed at: http://www.fullmarks.org.za/[2] .

Siyavula offers an open online assessment bank called FullMarks, for the sharing and accessing of curriculum-aligned test and exam questions with answers. This site enables educators to quickly set tests and exam papers, by selecting items from the library and adding them to their test. Educators can then download their separate test and memo which is ready for printing. FullMarks further offers educators the option of capturing their learners' marks in order to view a selection of diagnostic reports on their performance.

To begin, you need to a create a free account by clicking on "sign up now" on the landing page. There is one piece of administration you need to do to get started properly: when you log in for the first time, click on your name on the top right. It will take you to your personal settings. You need to select Shuttleworth Foundation as your metadata organisation to see the curriculum topics.

[1] This content is available online at <http://cnx.org/content/m40356/1.1/>.
[2] http://www.fullmarks.org.za/

6.1.1 What Can I do in FullMarks?

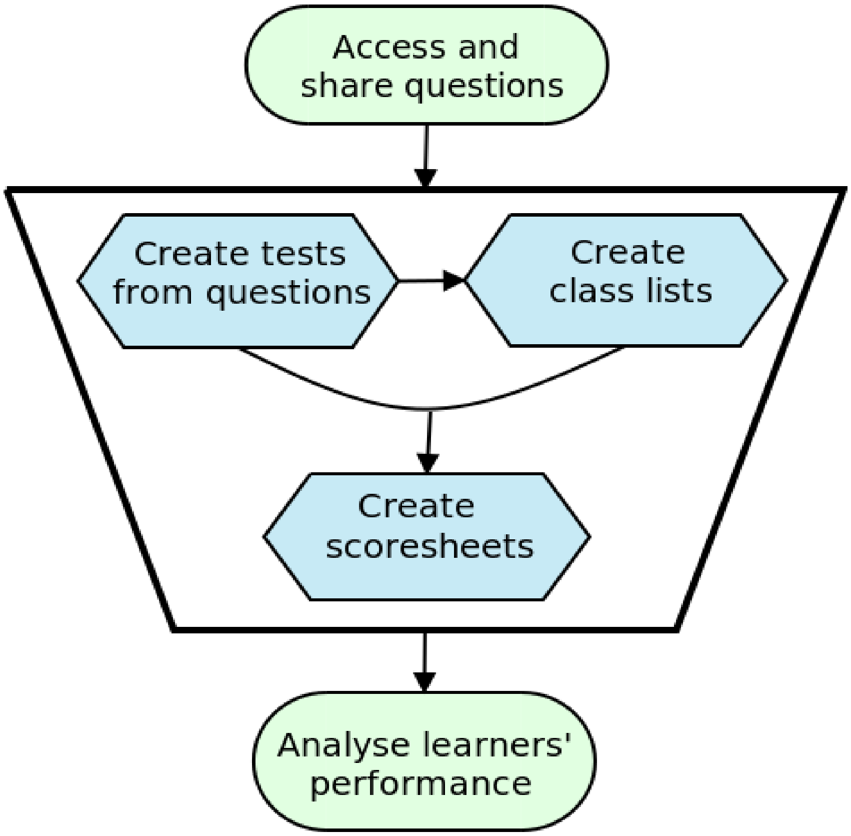


Figure 6.1

6.1.2 How do I do Each of These?

6.1.2.1 Access and Share Questions

Sharing questions: use either the online editor or OpenOffice template which can be downloaded from the website (Browse questions → Contribute questions → Import questions). Take your test/worksheet/other question source. Break it up into the smallest sized individual questions that make sense, and use the template style guide to style your page according to question/answer. Upload these questions or type them up in the online editor (Browse questions → Contribute questions → Add questions). Do not include overall question numbering but do include sub numbering if needed (e.g. 1a, 2c, etc.). Insert the mark and time allocation, tag questions according to grade, subject i.e. a description of the question, and then select the topics from the topic tree . Finalise questions so that they can be used in tests and accessed by other FullMarks users.

Accessing questions: there are three ways to access questions in the database. Click on “Browse questions” → click on the arrow to the left of the grade, which opens out the subjects → keep clicking on the arrows to open the learning outcomes or, following the same process, instead of clicking on the arrow, click on the grade → now you can browse the full database of questions for all the subjects in that grade or, from the landing page, click on “Browse questions” → below the banner image click on “Find Questions” → search by topics, author (if you know a contributor), text or keywords e.g. Gr10 mathematics functions and graphs.

6.1.2.2 Create Tests from Questions

So, you have all these bits of tests (i.e. many questions!), but what you really want is the actual test. How do you do this? Well, you can simply click “add to test” on any question and then click on the “Tests” tab at the top right of the page, and follow the simple instructions. Alternatively you can create a test by starting with clicking on that same “Tests” tab, and add questions to your test that way. Once done, simply print off the PDF file of the questions and the file for the memo. Issue your test, collect them once complete, and mark them.

6.1.2.3 Create Class Lists

But now you are asking, how can I keep track of my classes? Is Johnny Brown in class A or B? Well, you can make a class list by clicking on the “Class lists” tab at the top right of the page, and either import a CSV file, or manually enter the relevant information for each class. Now you can issue tests to your classes, and have a class list for each class. And what about capturing their marks?

6.1.2.4 Create Scoresheets

For each test you can create a scoresheet. Select the “Tests” tab at the top right, click on “Marks” below the banner image, and select the test and follow the instructions to input their marks. You can then export these as a CSV file for use in spreadsheets.

6.1.2.5 Analyse Learners’ Performance

And finally, you can print out reports of class performance. Click on “Reports” at the top right of the page, which opens various reports you can view. There are reports to see class performance, learner performance, class performance per topic, class performance per question, learner strengths and weaknesses, and learner progress.

So now you know how FullMarks works, we encourage you to make use of its simple functionality, and let it help you save time setting tests and analysing learner marks!

Chapter 7

Rich Media[1]

7.1 Rich Media

7.1.1 General Resources

Science education is about more than physics, chemistry and mathematics... It's about learning to think and to solve problems, which are valuable skills that can be applied through all spheres of life. Teaching these skills to our next generation is crucial in the current global environment where methodologies, technology and tools are rapidly evolving. Education should benefit from these fast moving developments. In our simplified model there are three layers to how technology can significantly influence your teaching and teaching environment.

7.1.1.1 First Layer: Educator Collaboration

There are many tools that help educators collaborate more effectively. We know that communities of practice are powerful tools for the refinement of methodology, content and knowledge as well as superb for providing support to educators. One of the challenges facing community formation is the time and space to have sufficient meetings to build real communities and exchanging practices, content and learnings effectively. Technology allows us to streamline this very effectively by transcending space and time. It is now possible to collaborate over large distances (transcending space) and when it is most appropriate for each individual (transcending time) by working virtually (email, mobile, online etc.).

Our textbooks have been uploaded in their entirety to the Connexions website (http://cnx.org/lenses/fhsst[2]), making them easily accessible and adaptable, as they are under an open licence, stored in an open format, based on an open standard, on an open-source platform, for free, where everyone can produce their own books. Our textbooks are released under an open copyright license - CC-BY. This Creative Commons By Attribution Licence allows others to legally distribute, remix, tweak, and build upon our work, even commercially, as long as they credit us for the original creation. With them being available on the Connexions website and due to the open copyright licence, learners and educators are able to download, copy, share and distribute our books legally at no cost. It also gives educators the freedom to edit, adapt, translate and contextualise them, to better suit their teaching needs.

Connexions is a tool where individuals can share, but more importantly communities can form around the collaborative, online development of resources. Your community of educators can therefore:

- form an online workgroup around the textbook;
- make your own copy of the textbook;
- edit sections of your own copy;

[1]This content is available online at <http://cnx.org/content/m40357/1.1/>.
[2]http://cnx.org/lenses/fhsst

- add your own content into the book or replace existing content with your content;
- use other content that has been shared on the platform in your own book;
- create your own notes / textbook / course material as a community.

Educators often want to share assessment items as this helps reduce workload, increase variety and improve quality. Currently all the solutions to the exercises contained in the textbooks have been uploaded onto our free and open online assessment bank called FullMarks (http://www.fullmarks.org.za/[3]), with each exercise having a shortcode link to its solution on FullMarks. To access the solution simply go to http://www.siyavula.com[4] , enter the shortcode, and you will be redirected to the solution on FullMarks.

FullMarks is similar to Connexions but is focused on the sharing of assessment items. FullMarks contains a selection of test and exam questions with solutions, openly shared by educators. Educators can further search and browse the database by subject and grade and add relevant items to a test. The website automatically generates a test or exam paper with the corresponding memorandum for download.

By uploading all the end-of-chapter exercises and solutions to the open assessment bank, the larger community of educators in South Africa are provided with a wide selection of items to use in setting their tests and exams. More details about the use of FullMarks as a collaboration tool are included in the FullMarks section.

7.1.1.2 Second Layer: Classroom Engagement

In spite of the impressive array of rich media open educational resources available freely online, such as videos, simulations, exercises and presentations, only a small number of educators actively make use of them. Our investigations revealed that the overwhelming quantity, the predominant international context, and difficulty in correctly aligning them with the local curriculum level acts as deterrents. The opportunity here is that, if used correctly, they can make the classroom environment more engaging.

Presentations can be a first step to bringing material to life in ways that are more compelling than are possible with just a blackboard and chalk. There are opportunities to:

- create more graphical representations of the content;
- control timing of presented content more effectively;
- allow learners to relive the lesson later if constructed well;
- supplement the slides with notes for later use;
- embed key assessment items in advance to promote discussion; and
- embed other rich media like videos.

Videos have been shown to be potentially both engaging and effective. They provide opportunities to:

- present an alternative explanation;
- challenge misconceptions without challenging an individual in the class; and
- show an environment or experiment that cannot be replicated in the class which could be far away, too expensive or too dangerous.

Simulations are also very useful and can allow learners to:

- have increased freedom to explore, rather than reproducing a fixed experiment or process;
- explore expensive or dangerous environments more effectively; and
- overcome implicit misconceptions.

We realised the opportunity for embedding a selection of rich media resources such as presentations, simulations, videos and links into the online version of the FHSST books at the relevant sections. This will not only present them with a selection of locally relevant and curriculum aligned resources, but also position these resources within the appropriate grade and section. Links to these online resources are recorded in the print or PDF versions of the books, making them a tour-guide or credible pointer to the world of online rich media available.

[3]http://www.fullmarks.org.za/
[4]http://www.siyavula.com/

7.1.1.3 Third Layer: Beyond the Classroom

The internet has provided many opportunities for self-learning and participation which were never before possible. There are huge stand-alone archives of videos like the Khan Academy which cover most Mathematics for Grades 1 - 12 and Science topics required in FET. These videos, if not used in class, provide opportunities for the learners to:

- look up content themselves;
- get ahead of class;
- independently revise and consolidate their foundation; and
- explore a subject to see if they find it interesting.

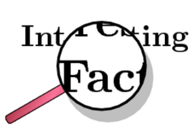
There are also many opportunities for learners to participate in science projects online as real participants. Not just simulations or tutorials but real science so that:

- learners gain an appreciation of how science is changing;
- safely and easily explore subjects that they would never have encountered before university;
- contribute to real science (real international cutting edge science programmes);
- have the possibility of making real discoveries even from their school computer laboratory; and
- find active role models in the world of science.

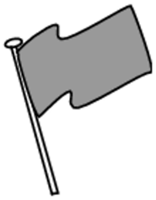
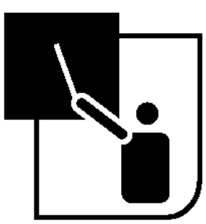
In our book we've embedded opportunities to help educators and learners take advantage of all these resources, without becoming overwhelmed at all the content that is available online.

7.1.2 Embedded Content

Throughout the books you will see the following icons:

Icon	Description
	**Aside:** Provides additional information about content covered in the chapters, as well as for extensions
	**An interesting fact:** These highlight interesting information relevant to a particular section of the chapter.

continued on next page

	Definition: This icon indicates a definition.
	Exercise: This indicates worked examples throughout the book.
	**Tip:** Helpful hints and tips appear throughout the book, highlighting important information, things to take note of, and areas where learners must exercise caution.
	**FullMarks:** This icon indicates that shortcodes for FullMarks are present. Enter the shortcode into http://www.siyavula.com[23], and you will be redirected to the solution on FullMarks, our free and open online assessment bank. FullMarks can be accessed at: http://www.fullmarks.org.za/[24]
	**Presentation:** This icon indicates that presentations are in the chapter. Enter the shortcode into http://www.siyavula.com[25], and you will be redirected to the presentation shared on SlideShare by educators. SlideShare can be accessed at: http://www.slideshare.net/[26]
	continued on next page

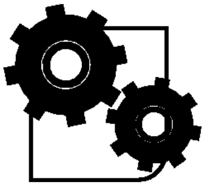
	**Simulation:** This icon indicates that simulations are present. Enter the shortcode into http://www.siyavula.com[27], and you will be redirected to the simulation online. An example is Phet Simulations. The website can be accessed at: http://phet.colorado.edu/[28]
	**Video:** This icon indicates that videos are present. Enter the shortcode into http://www.siyavula.com[29], and you will be redirected to the video online. An example is the Khan Academy videos. The website can be accessed at: http://www.khanacademy.org/[30]
	URL: This icon indicates that shortcodes are present in the chapter and can be entered into http://www.siyavula.com[31], where you will be redirected to the relevant website.

Table 7.1

[23]http://www.siyavula.com/
[24]http://www.fullmarks.org.za/
[25]http://www.siyavula.com/
[26]http://www.slideshare.net/
[27]http://www.siyavula.com/
[28]http://phet.colorado.edu/
[29]http://www.siyavula.com/
[30]http://www.khanacademy.org/
[31]http://www.siyavula.com/

Index of Keywords and Terms

Keywords are listed by the section with that keyword (page numbers are in parentheses). Keywords do not necessarily appear in the text of the page. They are merely associated with that section. *Ex.* apples, § 1.1 (1) **Terms** are referenced by the page they appear on. *Ex.* apples, 1

B Blogs, § 2(17)

C CAPS, § 1(1), § 2(17), § 3(21), § 4(33)
Citizen cyberscience, § 5(35)

F FullMarks, § 6(39)

G Grade 10, § 1(1), § 2(17), § 3(21), § 4(33)
Grade 10 Maths, § 5(35), § 6(39), § 7(43)

P Physical Science, § 1(1), § 2(17), § 3(21), § 4(33)

R Rich media, § 7(43)

S Siyavula, § 1(1), § 2(17), § 3(21), § 5(35), § 6(39), § 7(43)
Solutions, § 4(33)

T Teachers Guides, § 4(33)
Teachers' Guide, § 5(35), § 6(39)
Teachers' Guides, § 3(21), § 7(43)

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The Teachers' Guide for our Grade 10 Physical Science CAPS aligned WebBook.

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