PHYSICAL SCIENCES

Grade 11

TERM 4

Content Booklet

TARGETED SUPPORT

Contents

A Message from the NECT

National Education Collaboration Trust (NEC)

Dear Teachers

This learning programme and training is provided by the National Education Collaboration Trust (NECT) on behalf of the Department of Basic Education (DBE)! We hope that this programme provides you with additional skills, methodologies and content knowledge that you can use to teach your learners more effectively.

What is NECT?

In 2012 our government launched the National Development Plan (NDP) as a way to eliminate poverty and reduce inequality by the year 2030. Improving education is an important goal in the NDP which states that 90% of learners will pass Maths, Science and languages with at least 50% by 2030. This is a very ambitious goal for the DBE to achieve on its own, so the NECT was established in 2015 to assist in improving education and to help the DBE reach the NDP goals.

The NECT has successfully brought together groups of relevant people so that we can work collaboratively to improve education. These groups include the teacher unions, businesses, religious groups, trusts, foundations and NGOs.

What are the Learning programmes?

One of the programmes that the NECT implements on behalf of the DBE is the 'District Development Programme'. This programme works directly with district officials, principals, teachers, parents and learners; you are all part of this programme!

The programme began in 2015 with a small group of schools called the Fresh Start Schools (FSS). Curriculum learning programmes were developed for Maths, Science and Language teachers in FSS who received training and support on their implementation. The FSS teachers remain part of the programme, and we encourage them to mentor and share their experience with other teachers.

The FSS helped the DBE trial the NECT learning programmes so that they could be improved and used by many more teachers. NECT has already begun this embedding process.

Everyone using the learning programmes comes from one of these groups; but you are now brought together in the spirit of collaboration that defines the manner in which the NECT works. Teachers with more experience using the learning programmes will deepen their knowledge and understanding, while some teachers will be experiencing the learning programmes for the first time.

Let's work together constructively in the spirit of collaboration so that
we can help South Africa eliminate poverty and improve education!
www.nect.org.za

PROGRAMME ORIENTATION

Programme Orientation

Welcome to the NECT Physical Sciences learning programme! This CAPS compliant programme consists of:

- A Content Booklet: Targeted Support
- A Resource Pack Booklet which consists of worksheets, a guide to formal experiments and/or investigations, formal assessment support.
- A DVD with a video of the formal experiments and/or investigation.
- A set of posters.

Overview and Approach of Programme

The FET Physical Sciences curriculum is long and complex. There are many quality textbooks and teachers' guides available for use. This programme does not aim to replace these resources, but rather, to supplement them in a manner that will assist teachers to deliver high quality Physical Sciences lessons.

Essentially, this programme aims to provide targeted support to teachers by doing the following:

1. Clarifying and explaining key concepts.
2. Clarifying and explaining possible misconceptions.
3. Providing worked examples of questions at an introductory level.
4. Providing worked examples of questions at a challenge level.
5. Providing the key teaching points to help learners deal with questions at challenge level.
6. Providing worksheet examples and corresponding marking guidelines for each topic.
7. Providing a Planner & Tracker that helps teachers to plan their lessons for a topic, and track their progress, pacing and curriculum coverage.
8. Providing videos of formal experiments and/or investigations, together with learners' worksheets and marking guidelines.
9. Providing guidance on how to structure formal assessment tasks.
10. Providing a 'bank' of questions and marking guidelines that may be used to structure formal assessment tasks.
11. Providing a set of posters with key information to display in the classroom.

Content Booklet: Targeted Support

1. The booklet starts with a ***contents page*** that lists all the topics for the term.
2. Every topic begins with a ***general introduction*** that states for how long the topic runs and the value of the topic in the final exam. It also gives a general idea of what is covered in the topic, and why this is important for our everyday lives.
3. This is followed by a ***list of requirements*** for the teacher and the learner. Try to ensure that you have all requirements on hand for the topic, and that your learners always have their requirements ready for each lesson. This is a simple classroom management practice that can improve your time-on-task and curriculum coverage significantly!
4. Next, you will see a ***sequential table*** that shows the prior knowledge required for this topic, the current knowledge and skills that will be covered, and how this topic will be built on in future years. Use this table to give learners an informal quiz to test their prior knowledge. If learners are clearly lacking in the knowledge and skills required, you may need to take a lesson to cover some of the essential content and skills. It is also useful to see what you are preparing learners for in the years to follow, by closely examining the 'looking forward' column.
5. This is followed by a ***glossary of terms***, together with an explanation of each term. It is a good idea to display these words and their definitions somewhere in the classroom, for the duration of the topic. It is also a good idea to allow learners some time to copy down these definitions into their books. You must teach the words and their meanings explicitly as and when you encounter these words in the topic.

   Once you have taught a new word or phrase, try to use it frequently in statements and questions. It takes the average person 20 – 25 authentic encounters with a new word to fully adopt it and make it their own.
6. Next, there are some very brief notes about the ***assessment*** of this topic. This just informs you of when the topic will be assessed, and of the kinds of questions that are usually asked. Assessment is dealt with in detail in the Assessment Section of the Resource Pack.
7. The next item is very useful and important. It is a table showing the ***breakdown of the topic and the targeted support offered.***

   This table lists the ***sub-topic***, the classroom ***time allocation*** for the sub-topic, and the ***CAPS page reference***.

   The table also clearly states the ***targeted support*** that is offered in this booklet. You will see that there are three main kinds of support offered:

   a. Key concepts are clarified and explained.
   b. Possible misconceptions are clarified and explained.
   c. Questions are modelled and practised at different levels (introductory level and challenge level).

8. After this introduction, the ***targeted support for each sub-topic*** commences. This generally follows the same routine:
   a. A key concept or key concepts are clarified and explained. It may be useful for you to work through this carefully with learners, and do any demonstrations that are included.
   b. Questions related to the key concepts are worked and explained.
      - These questions may be done at introductory level, at challenge level, or both.
      - It is important to expose learners to **challenge level questions**, as this is often how questions are presented in exams.
      - These questions also challenge learners to apply what they have learnt about key concepts. Learners are, essentially, challenged to think at a critical and analytical level when solving these problems.
      - Please note that when calculations are done at challenge level, the key teaching points are identified.
      - Make sure that you effectively share these key teaching points with learners, as this can make all the difference as to whether learners cope with challenge level questions or not.
   c. At key points in the topic, checkpoints are introduced.
      - These checkpoints involve asking learners questions to check that they understand everything to that point.
      - The checkpoints also refer to a worksheet activity that is included in the Worksheet Section of the Resource Pack.
      - Use checkpoints to ascertain whether more consolidation must be done, or if your learners are ready to move to the next key concept.

9. Every topic ends with a ***consolidation exercise*** in the Worksheet Section of the Resource Pack. This exercise is not scaffolded as a test, it is just a consolidation of everything covered in this programme for that topic.

10. Finally, a section on ***additional reading / viewing*** rounds off every topic. This is a series of web links related to the topic. Please visit these links to learn more about the topic, and to discover interesting video clips, tutorials and other items that you may want to share with your learners.

The Worksheet Section of the Resource Pack

1. The Worksheet Section has different worksheets and corresponding marking guidelines for each topic.
2. First, there is a ***practice worksheet***, with questions that learners must complete during the topic. These are referred to in the checkpoints.
3. Once learners have completed these calculations, it is important to mark their work, using the ***marking guidelines*** supplied. Either do this together as a whole class, or display copies of the marking guidelines around the classroom, in spaces where learners can go and mark their work for themselves.
4. It is important that learners see how marks are allocated in the marking guidelines, so that they fully understand how to answer questions in tests and exams.
5. At the end of each topic, there is a ***consolidation exercise*** and marking guidelines. This worksheet is a consolidation exercise of all the concepts covered in the topic. The consolidation exercise is NOT scaffolded and it is not designed to be used as a formal test. The level of the worksheet will be too high to be used as a test.
6. Again, it is important for learners to mark their work, and to understand how marks are allocated for each question.
7. Please remember that these worksheets do not replace textbook activities. Rather, they supplement and extend the activities that are offered in the textbook.

The Planner & Tracker

1. The Planner & Tracker is a useful tool that will help you to effectively plan your teaching programme to ensure that it is CAPS compliant.
2. The Planner & Tracker has a section for every approved textbook, so that regardless of the textbook that you use, you will be able to use this tool.
3. It also has space for you to record all lessons completed, which effectively allows you to monitor your curriculum coverage and pacing.
4. In addition, there is space for you to reflect on your progress and challenges at the end of each week.
5. At the end of the Planner & Tracker, you will find a series of resources that may be useful to you when teaching.
6. You will also find a sample formal assessment and marking guidelines.

The Formal Experiments and/or Investigations and DVD

1. The following experiments or investigations must be completed as part of the formal assessment programme:
   - **a.** Grade 10 Term 1: Heating and cooling curve of water
   - **b.** Grade 10 Term 2: Electric circuits with resistors in series and parallel – measuring potential difference and current
   - **c.** Grade 10 Term 3: Acceleration
   - **d.** Grade 11 Term 1: Verification of Newton's 2nd Law: Relationship between force and acceleration
   - **e.** Grade 11 Term 2: The effects of intermolecular forces on: BP, surface tension, solubility, rate of evaporation
   - **f.** Grade 12 Term 1: Preparation of esters
   - **g.** Grade 12 Term 2:
     1) Titration of oxalic acid against sodium hydroxide
     2) Conservation of linear momentum
   - **h.** Grade 12 Term 3:
     a) Determine the internal resistance of a battery
     b) Set up a series-parallel network with known resistor. Determine the equivalent resistance using an ammeter and a voltmeter and compare with the theoretical value.
2. Videos of all the listed experiments and investigations are supplied as part of this programme.
3. These videos should ideally be used as a teacher's guide. After watching the video, set up and complete the practical with your learners. However, if this is not possible, then try to show the video to your learners and allow them to record and analyse results on their own.
4. The videos should be used in conjunction with the experiment (or investigation) learners' worksheets. Learners should complete the observations and results section of the worksheet while watching the video, and then work on their own to analyse and interpret these as instructed by the questions that follow on the worksheet.

The Posters

1. Every FET Physical Sciences teacher will be given the following set of five posters to display in the classroom:
   - **a.** Periodic Table
   - **b.** Chemistry Data Sheet
   - **c.** Physics Data Sheet Part 1

   d. Physics Data Sheet Part 2
   e. Chemistry Half Reactions

2. **Please note that you will only be given these posters once**. It is important for you to make these posters as durable as possible. Do this by:
   a. Writing your name on all posters
   b. Laminating posters, or covering them in contact paper
3. Have a dedicated wall or notice board in your classroom for Physical Sciences, per grade:
   - Use this space to display the posters
   - Display definitions and laws
   - Display any additional relevant or interesting articles or illustrations
   - Try to make this an attractive and interesting space

The Assessment Section of the Resource Pack

1. A separate Assessment Section is provided for Grade 10, Grade 11 and Grade 12.
2. This section provides you with a 'bank' of sample assessment questions for each topic.
3. These are followed by the marking guidelines for all the different questions that details the allocation of marks.
4. The level of cognitive demand is indicated for each question (or part of a question) in the marking guidelines as [CL1] for cognitive level 1 etc.

Planning and Preparation

1. Get into the habit of planning every topic by using the following documents together:
   a. The Physical Sciences Planner & Tracker
   b. The Content Booklet: Targeted Support
   c. The Worksheet Section of the Resource Pack
   d. Your textbook
2. Planning should always be done well in advance. This gives you the opportunity to not only feel well-prepared but also to ask a colleague for help if any problems arise.
3. Follow these steps as you plan to teach a topic:
   a. **Turn to the relevant section in the Planner & Tracker for your textbook.**
      - Look through the breakdown of lessons for the topic.
      - In pencil, fill in the dates that you plan to teach each lesson. This will help with your sequencing.
   b. **Next, turn to the relevant section in your Textbook.**
      - Read through each key concept in the Textbook.
      - Complete as many examples as possible. This will also help in your teaching – you will remember more points to share with the learners if you have done all of the work yourself.
   c. **Finally, look at the topic in the Content Booklet: Targeted Support.**
      - Read through all the introduction points, including the table that shows the breakdown of lessons, and the targeted support offered.
      - Take note of the targeted support that is offered for each section.
      - Read through the whole topic in the Content Booklet: Targeted Support.
      - Complete all the examples in the Worksheets for the topic, including the Consolidation Exercise.
      - Make notes in your Planner & Tacker to show where you will include the targeted support teaching and activities. You may choose to replace some textbook activities with work from the targeted support programme, but, be careful not to leave anything out!
   d. **Document your lesson plans in the way that you feel most comfortable.**
      - You may like to write notes about your lesson plans in a notebook.
      - You may like to use a standardised template for lesson planning. (A template is provided at the end of this section).
      - Remember to make notes about where you will use the textbook activities, and where you will use the targeted support activities.

e. Ideally, Lesson Planning for a topic should include:

- Time to introduce the topic to learners.
- Time to establish the learners' prior knowledge.
- If required, time to address critical gaps in learners' prior knowledge.
- Introduction of terminology (glossary words).
- Time to introduce and teach each key concept.
- Time for learners to complete practice exercises for each key concept.
- Time to correct and remediate each key concept.
- Time for a consolidation exercise.

Note: Avoid giving learners an exercise to do that you haven't already completed yourself. This is useful for when the learners ask questions or get stuck on a question, you will be ready to assist them immediately instead of wasting time reading the question and working it out then.

Preparation and Organisation

1. Once you have completed your planning for a topic, you must make sure that you are properly prepared and organised to teach it.
2. Do this by completing all the steps listed in the planning section, including completing all the textbook and worksheet examples.
3. Have your lesson plans or teaching notes ready to work from.
4. Next, make sure that you have all resources required for the lesson.
5. Prepare your notice board for the topic, to give learners something visual to anchor their learning on, and to generate interest around the topic.
6. Print copies of the worksheets for all learners.

SAMPLE TEMPLATE FOR LESSON PREPARATION

PHYSICAL SCIENCES LESSON PLAN

School	
Teacher's name	
Grade	
Term	
Topic	
Date	
Lesson Duration	

1. CONCEPTS AND SKILLS TO BE ACHIEVED:

By the end of the lesson learners should know and be able to:

2. RESOURCES REQUIRED:

3. HOMEWORK REVIEW / REFLECTION:

Exercises to be reviewed and notes:

4. LESSON CONTENT / CONCEPT DEVELOPMENT

Explanation and examples to be done:

5. CLASSWORK ACTIVITY

Resource 1	
Page	
Exercise	
Resource 2	
Page	
Exercise	

Notes:

6. HOMEWORK ALLOCATION

Resource 1	
Page	
Exercise	
Resource 2	
Page	
Exercise	

7. LESSON REFLECTION:

What went well:
What could have gone better:

Examination Preparation

Note: It is important to start preparing learners for their exam from the beginning of the term.

1. Make sure that your learners know exactly when their Physical Science examination will be written.
2. Ask learners to take out their exercise books, and to mark off what must be studied.
3. Go through all their written work, and get them to tick off the work that they must study and practise.
    a. If learners are missing notes, they must copy the missing work from another learner.
    b. As you complete more work during the term that will be in the exam, tell learners to tick it off and to add it to their study plans.
4. If necessary, help learners to work out a study schedule.
    a. Estimate how long learners will need to study all the content required for the examination. This will differ from grade to grade, and from learner to learner.
    b. Be aware that some learners, even in the FET stage, have not yet developed these planning skills.
    c. Tell learners the number of hours that you think they need to study before the examination.
    d. Break this down into the number of hours they should study each week.
    e. Tell learners to think about their own lives and habits, and to work out when they have time to study, and when they study best.
    f. They must then use all of this information to work out their study and revision plan.

USEFUL REVISION RESOURCES

1. **Assessment Section of the Resource Pack**
    a. The Assessment Section that forms part of this series may be used as a very useful examination preparation tool.
    b. This section includes a 'bank' of questions for each topic at the different conceptual levels.
    c. If your province or district provides standardised tests and exams, use the questions in this booklet at revision and exam preparation for learners.

d. Remember to carefully explain the question structure and meaning, together with the mark allocation.

2. Vodacom e-school

a. If learners have a Vodacom number, they are eligible to use the Vodacom e-school as a free service, i.e. no data costs:
http://www.vodacom.co.za/vodacom/test-templates/eschool-two

b. This e-school includes Physical Science lessons as part of its curriculum.

c. Tell learners how to access this useful resource.

TOPIC 14:
Exploiting the Lithosphere

A Introduction

- This topic runs for 8 hours.
- For guidance on how to break this topic down into lessons, please consult the NECT Planner & Tracker.
- Exploiting the Lithosphere forms part of the content area Chemical Systems (Chemistry).
- Exploiting the Lithosphere is the only section in Chemical systems in grade 11 and it counts about 3,33% in the final Paper 2 (Chemistry) examination.

CLASSROOM REQUIREMENTS FOR THE TEACHER

1. Chalkboard.
2. Chalk.
3. Periodic Table.
4. Grade 11 Chemistry Examination Data Sheet.

Highly recommended:

5. Glass beaker, water bowl, test tubes, spatula, sodium chloride, sodium hydroxide, calcium hydroxide, sodium carbonate, ammonium hydroxide, dilute sulphuric acid, magnesium ribbon or rod, iron nails, galvanised iron nails, cotton wool, Vaseline, paint, oil, water, mass meter, tin rod, steel wool.

CLASSROOM REQUIREMENTS FOR THE LEARNER

1. An A4 3-Quire exercise book, for notes and exercises.
2. Scientific calculator – highly recommend Sharp or Casio.
3. Pen.
4. Grade 11 Chemistry Examination Data Sheet.

B Sequential Table

PRIOR KNOWLEDGE	CURRENT	LOOKING FORWARD
GRADE 10	**GRADE 11**	**GRADE 12**
• The Hydrosphere – the earth's water as liquid, ice and water vapour. • Identifying the hydrosphere, with the atmosphere, the lithosphere and the biosphere. • The effects of dam building on people and the environment. • Testing of water samples for the presence of various anions and pH. • The purification and quality of water.	• Lithosphere i.e. mining and energy resources. • The earth and its resources (How resources and minerals are scattered in the lithosphere and in what form they are found). • Brief history of mining and resource recovery in South Africa. • The recovery of precious resources, especially gold. • Major steps in mining and the environmental impact of mining and resource recovery. • The use of minerals and their corrosion. • The environmental impact of large scale use of fossil fuels.	• The chemical fertilizer industry.

C Glossary of Terms

TERM	DEFINITION
Lithosphere	The Earth's crust and upper mantle.
Mineral	A naturally occurring inorganic solid substance having a definite chemical composition and characteristic crystalline structure, colour, and hardness.
Non-renewable resource	A resource of economic value that cannot be readily replaced by natural means on a level equal to its consumption.
Renewable resource	A resource of economic value that can be readily replaced by natural means on a level equal to its consumption.
Ore	Rocks from which metals/minerals can be produced economically.
Smelting	To extract a metal from an ore by heating and melting.
Flux	Any substance added during the smelting of ores to promote fluidity, lower the melting points, and/or to remove impurities in the form of slag e.g. limestone is commonly used in smelting iron ores. Other materials used as fluxes are silica, dolomite, lime, borax, and fluorite.
Greenhouse gases	Gaseous compounds in the atmosphere that are capable of absorbing infrared radiation, thereby trapping and holding heat in the atmosphere e.g. carbon dioxide, water vapour, methane, nitrous oxide and CFC's.

D Assessment of this Topic

This topic is assessed through class tests and in the Term 4 examination (3,33%).

- Informal assessments of practical work or of projects may be done.
- The suggested practical work is as follows:
  - The corrosion of iron.
  - The effect of heat, water and acid on calcium carbonate.
  - The test for calcium carbonate.
  - Oxycleaners – their use to produce oxygen and/or to recover metal from its ore.
- Suggested projects and other investigations:
  - To investigate a mining industry not chosen by the teacher.
  - To relate elements of the Periodic Table to where they are found and how they are recovered from the lithosphere.

E Breakdown of Topic and Targeted Support Offered

- Please note that this booklet does not address the full topic – only targeted support related to common challenges is offered.
- For further guidance on full lesson planning, please consult CAPS, the NECT Planner & Tracker and the textbook.

TIME ALLOCATION	SUB-TOPIC	CAPS PAGE NUMBER	TARGETED SUPPORT OFFERED
8 hours	Mining and mineral processing: The choices are the following: Gold, iron, phosphate, coal, diamond, copper, platinum, zinc, chrome, asbestos and manganese mining industries	95-97	1. Key concepts and possible misconceptions are clarified and explained: a. Important knowledge concepts that require recall. b. The socio-economic and environmental impact of mining and the recovery of resources. This will enable the learners to formulate their own opinions. c. The writing and balancing of chemical reaction equations. d. The underlying chemical concepts are linked.

F Targeted Support per Sub-topic

1. 1. MINING AND MINERAL PROCESSING

INTRODUCTION TO THE TOPIC

The emphasis in this section is to understand the wider impacts of science, and concepts such as non-renewable resources, and the economic and social effects of exploiting these resources. The chemistry and chemical reactions are not as central, but useful revision can be done, especially on redox chemistry.

The section on Chemical Systems lends itself to the learners giving their own opinions, using higher order skills, such as analysis, synthesis and evaluation.

Learners should base their arguments and/or opinions on facts in order to engage critically with this content. There are often quantitative questions set in these contexts e.g. mass of ore required to produce the pure metal etc.

Because the CAPS syllabus gives latitude as to what to study, the three approved textbooks have slightly different approaches. However, they cover very similar material, as can be seen in the table below.

STUDY & MASTER PHYSICAL SCIENCES P 292 -323	PLATINUM SERIES PHYSICAL SCIENCES P270-292	OXFORD SUCCESSFUL PHYSICAL SCIENCES P293-321
History of mining and technological developments: • A brief history of the various stone, bronze ages and so on and the history of early mining in South Africa.	Mining and Mineral processing: • A brief history • The earth's crust as a source of materials • Recovering precious resources	The Earth's systems: • A brief history of the various stone, bronze ages and so on and the history of early mining in South Africa.
The Lithosphere: • The layers of the earth • The abundance of elements on the earth • Mining and mineral processing • (The rusting of iron, the limestone cycle and oxycleaners are all proposed experiments)	South Africa's mineral strengths: • Gold – introduction; mining and extraction • Iron (The rusting of iron is a proposed experiment) • Platinum Group Metals (PGMs) • Coal and other fossil fuels • Calcium carbonate (the limestone cycle is a proposed experiment)	The Lithosphere: • Minerals and Ores • Surveying and discovering resources • Mining Methods • Mining in South Africa

STUDY & MASTER PHYSICAL SCIENCES P 292 -323	PLATINUM SERIES PHYSICAL SCIENCES P270-292	OXFORD SUCCESSFUL PHYSICAL SCIENCES P293-321
Gold: • Gold mining history • The monetary value of gold • Gold mining in SA –its impact on labour • Mining and processing gold	Environmental impact of mining and mineral processing: • Gold • Phosphates • Coal and crude oil	Iron: • Iron ore reserves • Refining iron ore • Corrosion of iron (the rusting of iron is a proposed experiment)
• Environmental impact: • Mining • Use of fossil fuels • Greenhouse effect	• Oxy-cleaners (more environmentally friendly laundry cleaners)	Gold: • Characteristics and uses of gold • Importance of gold
		Extraction of gold in SA: • History of gold mining in SA • Mining (today) • Chemistry of mining (extraction of gold)
		Calcium Carbonate: • Limestone and lime (there are proposed experiments on limestone)
		Mining and the environment: • Environmental impact of mining • Impact of mining on our heritage sites • Fossil Fuels

CONCEPT EXPLANATION AND CLARIFICATION: ENERGY, THE EARTH AND ITS RESOURCES

The Earth's crust which forms part of the lithosphere, contains rock. **Rock** is a solid heterogeneous mixture of one or more minerals e.g. granite is a mixture of the minerals quartz, feldspar, and biotite. **A mineral** is a naturally occurring solid that has a crystalline structure and a definite chemical formula e.g. gibbsite is a mineral of aluminium with the formula $Al(OH)_3$. **An ore** is a rock that contains minerals in concentrations that are high enough for economical extraction e.g. bauxite is an aluminium ore. It is a mixture of various aluminium minerals and other materials such as silica and iron oxides.

Misconceptions: Many learners think that the abundance of a mineral or element (in elemental form or found in a compound) is the same as its ease of recovery. Also, many learners may think that the abundance of oxygen is the same as the abundance of O_2.

CONCEPT: THE HISTORY OF THE RECOVERY AND USE OF METALS (GOLD) IN SOUTH AFRICA

South Africa has a proud history of being able to exploit its mineral resources. This goes back to Mapungubwe in the 13th century. Alluvial gold was their main source of gold. Please also refer to any local or topical use of resources.

CONCEPT EXPLANATION AND CLARIFICATION: MINING AND RECOVERY OF METALS (GOLD)

Gold mining is very important in our economy and also has major environmental and social impacts on our society. You need to allow the learners to formulate their own opinions based on various sources of evidence as to how significant these economic and social impacts have been, and whether overall, they have been advantageous or not.

The chemistry of the extraction of gold is complicated, however learners need to know the simplified equations. They must also be able to apply redox chemistry concepts to these equations when required.

Misconceptions: Many learners are resistant to learning the equations and the names of the processes, but these types of questions are likely to arise in the Grade 12 final examination on this section – Chemical Systems (fertilisers) – so it is important for them to put in the required effort.

CONCEPT EXPLANATION AND CLARIFICATION: THE USE OF MINERALS AND THEIR CORROSION (IRON & $CaCO_3$)

All three recommended textbooks propose experiments here. The experiment involving the rusting of iron will enable learners to think about the design of an experiment and the use of controls and it is highly recommended that these experiments are either done by the learners or demonstrated to them.

CONCEPT EXPLANATION AND CLARIFICATION: THE ENVIRONMENTAL IMPACT OF OIL AND FOSSIL FUEL USE

Coal is South Africa's main fossil fuel and its use has major environmental impact especially in terms of greenhouse gases and the greenhouse effect.

INTRODUCTORY LEVEL QUESTIONS

a. These are the basic questions with recall of information and calculations that learners will be required to perform at this stage in the topic.

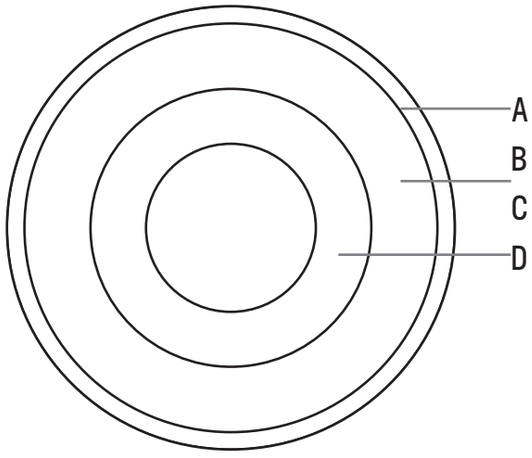
b. Their purpose is to remind the learners of the equations. However, as they have dealt with stoichiometric calculations before, this is treated as revision. It also enables the learners to practice these skills in context.

Learners are also required to recall and balance some reaction equations.

How to tackle these questions in the classroom:

- Work through these examples with learners.
- Explain each step of the calculation to the learners as you complete it on the chalkboard.
- Learners must copy down the questions and to answer them correctly in their workbooks.

1. a. Label the following diagram of a cross-section of the Earth:



b. Which layers make up the lithosphere?

Solution

This is a recall question, and the ability to recall facts is very important. Part b also identifies what makes up the lithosphere, which is the subject of this topic.

a. A – crust
B – mantle (upper mantle and lower mantle)
C – outer core
D – inner core

b. The lithosphere is made of the crust and the outer layer of the upper mantle.
You should explain that the lithosphere is the source of the materials we use, but it only extends a few hundred kilometres down, while the distance to the centre of the earth is about 6 700 km.

2. **a.** Explain the term "mineral".

b. Name or give the formula of the five most common elements in the lithosphere.

Solution

This is a recall question. Part b will require the learners to look up the data from their notes or textbooks.

a. A mineral is a naturally occurring, homogeneous inorganic solid substance having a definite chemical composition and characteristic crystalline structure, colour, and hardness.

Note that there are alternative similar explanations, depending upon which text book you use. However, the non-varying chemical composition and that it is found in crystals is important. Note that some of our precious resources are metals and not minerals.

b. Oxygen (O) (46%); silicon (Si) (27%); aluminium (Al) (8,0%); iron (Fe) (5,7%); calcium (Ca) (3,6%)

Note that the element oxygen O, found in many compounds, is at 46%, not just the O_2 molecule, which though abundant, is much rarer.

3. Mining has been common in South Africa. One of the earliest sites where gold was extracted and used was Mapungubwe in about the 13 century.

a. Was gold mined as gold ore or as gold nuggets at Mapungubwe?

b. What is the meant by the term "alluvial gold"?

c. Give three reasons why gold has been used as a precious metal for so long.

Solution

This question introduces some independent reasoning by relating the technologies available at a time period to the ability to extract the metal. Part c requires the learners to relate chemical properties to economic issues.

a. Gold nuggets (mainly from alluvial gold) were used. It is very difficult to extract gold from its ore.

b. Alluvial gold is gold found in water sources and rivers.

c. Gold is unreactive (so it is stable and can be traded, kept for a long time, will not rust); is attractive; is rare and has been found in nature for thousands of years (any three.)

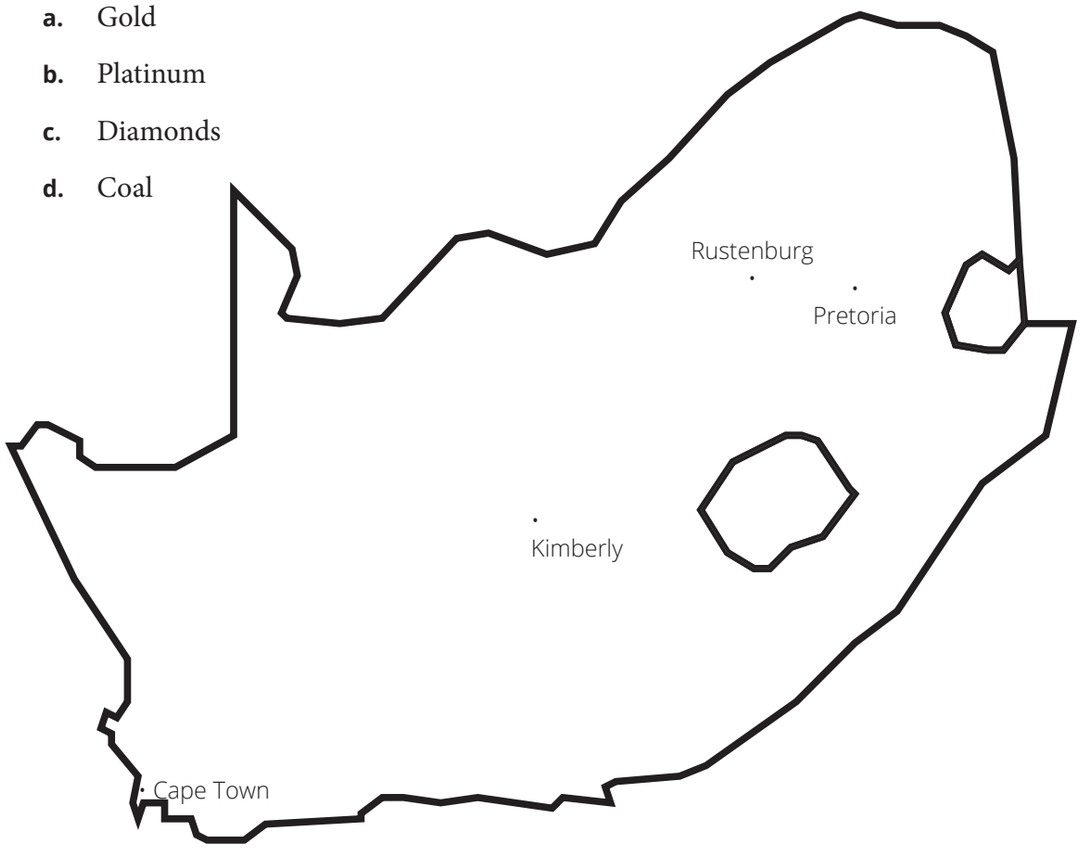
4. Below you are given a rough sketch map of South Africa. Label some of major sites where the following are found:

a. Gold

b. Platinum

c. Diamonds

d. Coal



Sourced from: http://www.vectorportal.com/Maps/Africa/VECTOR-MAP-OF-SOUTH-AFRICA/2482.aspx#

Solution

This question requires the learners to look up the information from their notes or text books. It emphasises the distribution of minerals around the country.

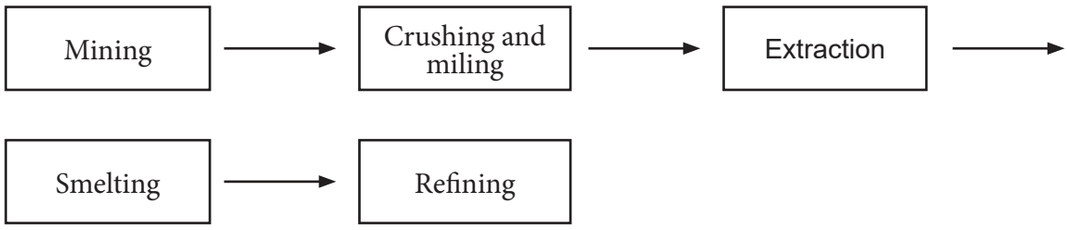
a. Gold is found mainly around Johannesburg in the Witwatersrand region, but there are reefs in Mpumalanga, the Free State and the Northwest (near Klerksdorp).

b. Platinum is found mainly near Rustenburg, west of Pretoria.

c. Diamonds are very wide spread. The most famous is near Kimberly and the Orange river basin where their occurrence is widespread, but they are found on the west coast going up to Namibia, at Cullinan (near Pretoria) and also in Botswana and Zimbabwe.

d. Coal is found largely near Witbank, Waterberg; Highveld; Utrecht; Ermelo. You need to stress that South Africa is rich in minerals and these are wide spread.

5. The stages of mining and extracting gold are given below:



a. What are the two most common types of mining, and which is most often used in the gold mining industry?

b. Name three disadvantages of the type of mining used in mining gold in South Africa.

c. Gold is often extracted using cyanide and then zinc.

i. Give the equation for the chemical reaction between gold and the cyanide ion (or sodium cyanide).

ii. What is a potential danger of this process?

iii. What is the function of zinc in the reaction:
$Au(CN)^-_2 + Zn \rightarrow 2Au + Zn(CN)^{2-}_4$?

Solution

This question moves from rote answers (Part a) through to looking at the socio-economic impacts of mining (Part b) and then into the underlying chemistry (Part c). We know from the grade 12 'fertilizer' section in the examination, that some learners struggle to relate the content to the chemical reactions.

a. There is open cast and underground mining. South African gold mines are usually (deep-level) underground mines. In fact we have many of the deepest mines in the world.

b. Underground mining is often more dangerous (rock falls etc.); needs extensive ventilation and cooling (so it is expensive); often requires water to be pumped out; needs extensive shafts to get to the minerals (any acceptable answer.)

c. i. There are several minor variations here, depending upon your text book:
$4Au + 8\ NaCN + O_2 + 2H_2O \rightarrow 4NaAu(CN)_2 + 4\ NaOH$
OR $4Au + 8\ CN^- + O_2 + 2H_2O \rightarrow 4[Au(CN)_2^-] + 4\ OH^-$

ii. The cyanide ion (CN^-) is toxic and must not be allowed to contaminate the environment at any stage, including when dealing with the waste after processing.

iii. Zinc is a reducing agent. (It is oxidised).

Note that redox chemistry is an important underlying concept for these reactions, but it is not the focus of this section. However, questions related to REDOX reactions

can be asked e.g. naming oxidising and reducing agents, naming the processes, determining oxidation numbers etc.

6. The use of fossil fuels increases the greenhouse gases in our atmosphere.

a. What is meant by the term 'greenhouse gases'?

b. Carbon dioxide is one of the most common greenhouse gases. If the alkanes found in oil are burned, carbon dioxide and water are produced. For example the compound, shown below, is often found in candles:

$C_{20}H_{42} + O_2 \rightarrow CO_2 + H_2O$

i. Balance this equation.

ii. If 1 kg of $C_{20}H_{42}$ is burnt, what mass of CO_2 will be formed?

iii. What volume of CO_2 will be formed at STP?

Solution

Many learners struggle with stoichiometric equations.

a Greenhouse gases trap heat that is radiated out from the earth and stop it from radiating into space (or equivalent definition.)

b. i. $2C_{20}H_{42} + 61O_2 \rightarrow 40CO_2 + 42H_2O$
(Just for your interest, the unbranched straight chain isomer of $C_{20}H_{42}$ is called n-icosane)

ii. mass = 1 kg; M = 20 (12) + 42 (1) = 282 g·mol^{-1}

$$n(C_{20}H_{42}) = \frac{m}{M}$$
$$= \frac{1\,000}{282}$$
$$= 3,55 \text{ mol}$$

The ratio of $C_{20}H_{42}$ to CO_2 produced = 2 : 40 (From the balanced equation)

Therefore 3,55 : 70,9

$$M(CO_2) = 70,9 \times (12 + 2(16))$$
$$= 3\,119,6 \text{ g}$$

iii. $V(CO_2) = n \times 22,4$ (Using V = nV_m at STP)
$$= 70,9 \times 22,4$$
$$= 1\,599 \text{ dm}^3$$

Note that these quantitative questions should be asked in this section. Part iii has a carry-over from part ii (n).

CHALLENGE LEVEL QUESTIONS

a. Now that learners have mastered the basic questions, they are ready to deal with more challenging questions.

b. These questions require learners to give reasoned opinions.

How to tackle these questions in the classroom:

- Work through these examples with learners.
- Tell the learners that this is a more challenging version of what they have been doing.
- Write the first example on the chalkboard.
- Ask the learners if they can see why it is more challenging. Often it will ask them to evaluate information, give their own opinions or integrate different concepts. They often have to generate a chemical reaction equation, which learners often find challenging.
- Discuss learners' ideas and ask probing questions to extend their answers.
- In generating their opinions and reaction equations, point the learners to the information that has been given and ask them how they can extend or use that information.
- Learners must copy down the questions and answer them correctly in their workbooks.

KEY TEACHING:

a. In these more challenging examples, learners must be able to express and validate their own opinions and consider the socio-economic and environmental implications of the mining and recovery processes.

b. Learners must also be able generate balanced reaction equations from partial word equations.

c. Learners also have to do limited independent research.

7. Refer to the list of mining activities below. Choose a mining activity that you have studied and then answer the questions that follow:

Gold; iron; phosphate; coal; diamond; copper; platinum; zinc; chrome; asbestos or manganese.

a. Where in Southern Africa is this mining activity located?

b. What type of mining is used to recover this mineral?

c. Mining has advantages and disadvantages:

i. Give two disadvantages that mining has on the environment.

ii. Give two major impacts that mining has in the labour market.

iii. Give three reasons why mining is so important for the South African economy.

Solution

a. Gold: Witwatersrand; Northern Free State (also North West near Klerksdorp and Mpumalanga)

Iron: Northern Cape (Sishen) and Thabazimbi, Limpopo

Phospates: Phalaborwa, Mpumalanga

Coal: Witbank, Waterberg; Highveld; Utrecht; Ermelo

Diamond: Kimberly and Orange river basin where their occurrence is widespread, but they are found on the west coast going up to Namibia, at Cullinan (near Pretoria) and also in Botswana and Zimbabwe.

Copper: Mpumalanga; Northern Cape; North West

Platinum: Rustenburg

Zinc: Northern Cape

Chromium: Rustenburg

Asbestos: Northern Cape

Manganese: Mpumalanga; Northern Cape

b. Underground or Open cast

c. i. The solid waste can occupy valuable land; can be difficult to rehabilitate; can cause dust and other pollution; there can be acid mine drainage contamination of water sources (other reasonable answers accepted).

ii. Mining is a major employer, but often uses unskilled labour. Mining is often dangerous and can lead to the workers being injured or killed (other reasonable answers accepted).

iii. Mining is a major employer; it gives us export products; it buys machinery etc. from suppliers; it may be seen as exploitative in the economy (other reasonable answers accepted.)

8. Limestone is a form of calcium carbonate and is a very useful mineral. When heated, it can be converted into quicklime (CaO).

a. Give the equation for this chemical reaction.

b. Do you think that this reaction is endothermic or exothermic? Explain your answer.

c. Do some research to determine how limestone is converted into marble.

Solution

a. $CaCO_3 \rightarrow CaO + CO_2$

The formula $CaCO_3$ comes straight from the word 'calcium carbonate'; and the formula CaO is given to them. By recognising the $CaCO_3$ as a reagent (on the left of the equation) and the CaO as a product (the right) the learners should see that a product with carbon and oxygen is missing, They must be able to recognise that the most stable product of carbon and oxygen is CO_2

b. It is most likely endothermic, as it requires high temperatures for the reaction to occur. *Please note however, that not all exothermic reactions will start without some heating.*

c. Calcium carbonate forms marble under conditions of high temperature and high pressure. *(The high pressure prevents the thermal decomposition of the calcium carbonate). The calcium carbonate crystals grow larger and become interlocking and this results in a much more stable and chemically resistant material.*

CHECKPOINT

At this point in the topic, learners should have mastered:

1. the basic information with regard to minerals in the lithosphere, mining and extraction of precious resources.
2. applying fundamental chemical ideas such as generating equations, redox reactions and stoichiometric ideas to this section.
3. formulating opinions on the socio-economic and environmental impact of the mining and extraction of our precious resources, and the use of fossil fuels.

Check learners' understanding of these concepts by getting them to work through:

Topic 14 Worksheet from the Resource Pack: Exploiting the Lithosphere: Questions 1–5. (Pages 4–5).

- Teachers can photocopy the worksheet for the learners, or learners can copy the worksheet into their book. Learners MUST end up with the questions and answers in their book.
- Check learners' understanding by marking their work with reference to the marking guidelines.
- If you cannot photocopy the marking guidelines for each learner, make three or four copies of it and place these on the walls of your classroom.
- Allow time for feedback.
- Encourage the learners to learn from the mistakes they make.

CONSOLIDATION

- Learners can consolidate their learning by completing **Topic 14 Consolidation Exercise**
- **from the Resource Pack: Exploiting the Lithosphere (Pages 6–7)**.
- Photocopy the exercise sheet for the learners. If that is not possible, learners will need to copy the questions from the board before attempting to answer them.
- The consolidation exercise should be marked by the teacher so that she/he is aware of each learner's progress in this topic.
- Please remember that further consolidation should also be done by completing the examples available in the textbook.
- It is important to note that this consolidation exercise is NOT scaffolded.
- It should not be administered as a test, as the level of the work may be too high in its entirety.

ADDITIONAL VIEWING/READING

In addition, further viewing or reading on this topic is available through the following web links:

1. https://www.youtube.com/watch?v=liFGHW4ZxrM
   A short video, just under 3 minutes long, going into a gold mine, with a very quick view of the milling and smelting (and the final product!)
2. http://www.chamberofmines.org.za/sa-mining
   This is a useful resource for teachers to give brief additional information on gold (or other) mining in South Africa
3. http://www.thisisgold.co.za/
   Is another useful resource for teachers to give brief additional information on gold (or other) mining in South Africa.
4. https://www.youtube.com/watch?v=Bk9KT-3-STY
   This is a long video (44 minutes) about South Africa's Mponeng Gold Mine (formerly Western Deep Levels), one the deepest mines in the world. From 38 minutes, there is a brief discussion on extraction, smelting and the removal of the slag.
5. https://www.youtube.com/watch?v=QdLT7_iy0h4
   This is a brief video with visuals only (no audio), giving some further background to the difficulties of the chemistry of the cyanide process. Best used as a teachers' resource.
6. https://www.youtube.com/watch?v=q-Co4Dc2IyA
   A short video (just under 3 minutes) on the environmental and socio-economic impact of a coal mine at Witbank.

7. https://www.youtube.com/watch?v=gBLQUplzZZo
   A simple 4 ½ minute video about climate change from fossil fuels, referring to the basic chemistry.

8. https://www.youtube.com/user/EducationCommonsRW/videos
   These are the "Mindset" videos that cover most of the syllabus. For example https://www.youtube.com/watch?v=UxF9l6bedZU is on the environmental impact of mining.