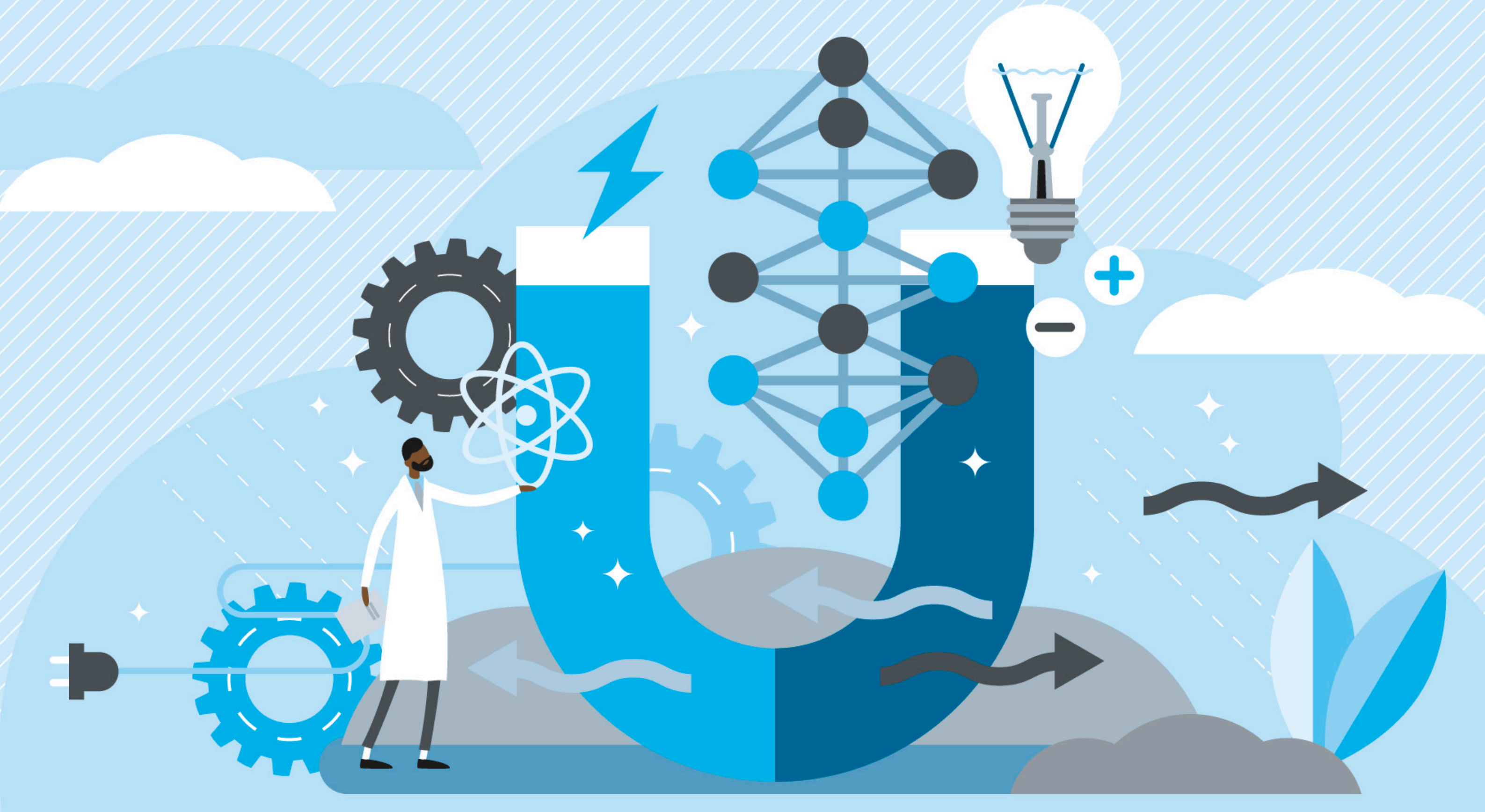
FACILITATOR'S GUIDE

2018 TRAINING WORKSHOP NO.1

# PHYSICAL SCIENCES



GRADES 10-12

PILO

IMPROVING LEARNER PERFORMANCE

education

Department: Education

PROVINCE OF KWAZULU-NATAL

# FET
# Just-in-Time Training Workshop
# 2018: No.1

# Facilitator's Guide

## Physical Sciences

Jika iMfundo

what I do matters

**Endorsed by:**

SADTU NAPTOSA NATU

# Improving Learning Outcomes in Physical Sciences

## Objective of Workshop

This workshops aims to equip HODs and lead teachers in the use of different tools so that teachers are supported and learners' understanding of targeted topics can be corrected and strengthened. The targeted content area used in this workshop is Acids & Bases.

## Workshop Outline

There are three parts to this workshop.

In the first session, **The Circle of (a teacher's) Life**, we explore how planning, tracking, assessment and reflections are related in an ongoing cycle. We explore different tools that can be used to assist in each stage of the teaching and learning process. This session is planned to take no more than 1 hour.

In the 2nd session, **Reflections on Assessment**, we explore the power of reflection as a vehicle to facilitate change in areas where learners do not perform as well as they could do. We have selected the topic of Acids and Bases. We analyse exam questions from the National Senior Certificate and then identify the chain of concept development that learners should have gone through and suggest where the chain is often broken. This session is planned to take about 2 hours.

The 3rd session of the workshops focuses on **Planning for Teaching Acids & Bases in 2018.** We start by identifying in which Grade and at which time of the year, the concepts related to the topic of Acids and Bases are taught by using the ATPs and Planner and Trackers.  We will plan practical steps to remediate common errors and address misconceptions that learners in Grades 10 – 12 hold. These practical steps can be incorporated into a subject improvement plan.

## Reflection:

By the end of this workshop I would like to:

| Jika iMfundo Workshop Programme | | |
|---|---|---|
| | **Description** | **Resources** |
| **Session 1 (1 hour)** | **The Circle of (a teacher's) Life** | |
| 30 min | Activity 1: Jig Saw on Planning Tools | Flip chart paper<br>Markers<br>ATP<br>Trackers & Planners<br>Diagnostic Report |
| 30 min | Activity 2: Designing Cycles | |
| **Session 2 (2 hours)** | **Reflections on Assessment** | |
| 40 min | Activity 1: Feedback from NSC Nov 2017 Paper 2 | |
| 40 min | Activity 2: A closer look at Question 7: Acids & Bases | Flip chart paper<br>Markers<br>Prestik |
| 40 min | Activity 3: Common Errors & Misconceptions | Post It Notes or Small cards & Prestik<br>Flip Chart Paper |
| **Session 3 (2 hours)** | **Planning for Teaching Acids & Bases 2018** | |
| 40 min | Activity 1: Recommended Actions Steps | |
| 30 min | Activity 2: Working backwards | Coloured rectangular cards<br>White card<br>Prestik<br>Pens / Markers |
| 40 min | Activity 3: Building inter-related concept chains | Wool / String<br>Tape<br>Prestik<br>Coloured rectangular cards<br>White card<br>Red markers |
| 10 min | Closure & Thanks | |

## Session 1: The Circle of (a teacher's) Life

**Introduction**

Science teachers are very familiar with the idea that life is full of cycles. We all know the steps of the water cycle and can explain the carbon or nitrogen cycle. But do we always recognise the different parts of a teaching cycle? The cycle or circle illustrated in this session is not by any means the only cycle but is a useful framework for integrating the Annual Teaching Plan (ATP), Planner and trackers, feedback and reflections from different sources including the National Senior Certificate Examinations Diagnostic Report written in November of the previous year, in our preparation for teaching different topics.

**Activity 1 Jig Saw on Planning Tools 30 min**

1. Discuss in groups of three what you understand is found in each of the documents listed below and suggest the purpose of each. **10 min**

- **Annual Teaching Plan**
- **Planner and Tracker**
- **NSC Diagnostic Report**

**Facilitator's Note:**

*The point of this activity is to encourage educators to share ideas and to develop an understanding of what each document consists of and more importantly what it was designed to do. This is an open end activity and different answer could be accepted.*

2. **Form specialist groups** **10 min**

Assign a participant to each document. Re-group and have all participants now focus on one of the documents. Use flip chart paper to collate all the ideas. Use different coloured pens to note the description and purpose.

3: **Presentations** **10 min**

Ask each group to display their flip chart paper. Stick the flip charts on different walls in the room. Each group must select one representative who stands next to the chart and discusses the group's ideas. Allow participants to move around the room and make suggestions / comments about each other's charts.

*Ask participants to add answers that are displayed on the charts to suggested answers given in Appendix 1 on page 26*

**Facilitator's Note:**
*These are the suggested answers found in Appendix 1 on page 26 of the Participants Guide.*

**Annual Teaching Plan**

- A provincial plan on the sequence of teaching topics based on CAPS
- Provides guidelines on what needs to be taught and what assessments need to be completed during specified time frames.
- A document used to record progress of curriculum delivery

**Planner and Tracker**

- A planning tool that links CAPS and approved Learners & Teachers Support Materials (LTSMs) to assist teachers, HODs and district specialists to measure curriculum coverage.
- A dynamic tool that encourages **authentic reflection** on weekly progress by teachers so that HODs and district specialists can improve support of teachers so that greater curriculum coverage is achieved.
- A tool that gives details on assessment task and provides alternative resources that can be used for assessment where there may be gaps in particular LTSMs.

**NSC Diagnostic Report**

- A summary of the NSC examination learner performance based on a sample of 100 learners scripts from each province that shows the trends in learner performance over multiple years.
- A detailed question by question analysis that highlights misconceptions, common errors and provides suggestions on how to remediate these for future Grade 12 learners.
- A tool aimed to improve learner performance in the future. Targets specific areas of weakness and seeks to remedy these by providing suggestions teachers should implement when teaching specific topics.

**Activity 2 Designing Cycles** **30 min**

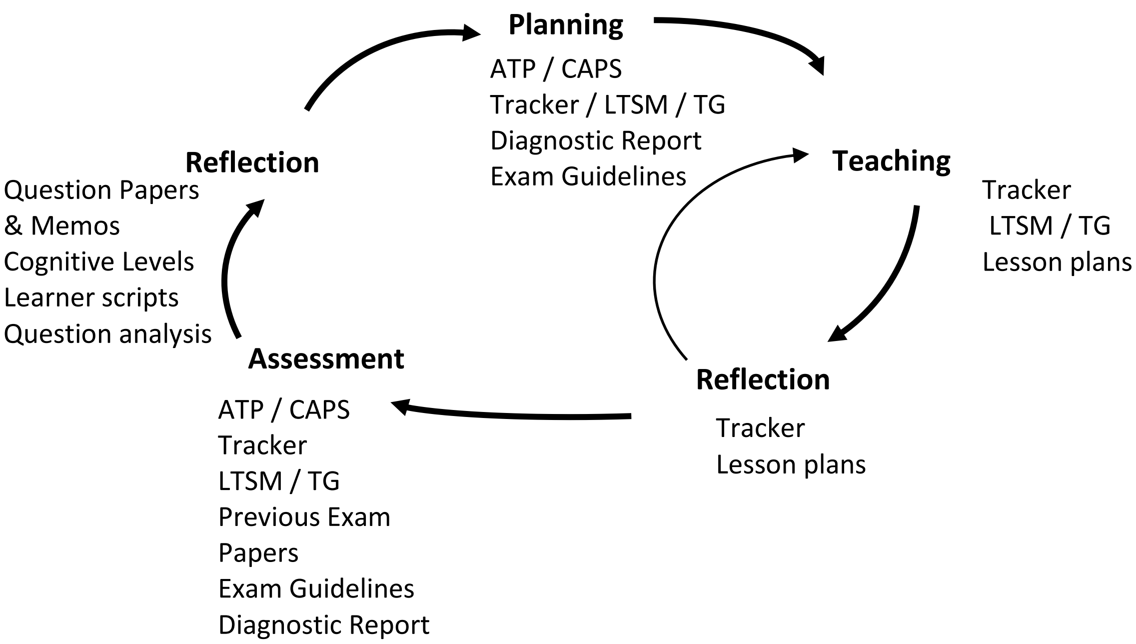
Work in different groups of between 3 and 4 participants. 5 min

1. Draw a circular flow diagram on a sheet of flip chart paper to illustrate the process of teaching and learning. You may want to include the following activities:

   - Planning
   - Teaching
   - Reflection
   - Assessment

2. Show when you will use the three documents discussed in Activity 1 as well as any other resources. 10 min

*Suggested answer that shows stages of cycle and resources used:*




*If participants are struggling after 5 minutes ask them to refer to Appendix 1 on page 27. They may design different cycles.*

3. What activities would take place at each step of the cycle? 15 min

*Ask participants to compare their answers to the suggestions found in Appendix 1 on page 27 - 28. They will need to update this list to include their suggestions that are not included.*

*Suggested answers to be updated by participants found in Appendix 1 on page 27 - 28.*

**Activities that teachers need to include in different stages of the cycle**
**Planning:**

- Annual planning – consider diagnostic report and plan to include recommendations
- ATP / CAPS – review sequence of topics and assessment requirements
- Tracker / LTSM / TG – refer to activities for each lesson to develop lesson plans that need to include recommended learner activities.
- Create lesson plans & presentations
- Develop open & closed questions
- Plan for informal & formal assessments – theory & practical investigations
- Check new Exam Guidelines – make these available to learners
- Review tracker reflections from previous year's
- Review learner performance and plan remediation, revision and new assessment
- Revise lesson plans based on learner feedback
- English across curriculum
- Expectations of teachers & learners

**Teaching**

- Implement lesson plans
- Engage learners in activities & by using questions
- Include practical activities
- Formative assessment activities
- Answer learner questions

**Reflection**

- Review tracker and record progress on curriculum coverage
- Answer reflection questions
- Discuss areas of concerns with HOD
- Suggest strategies to stay on track
- Evaluate learners progress in terms of areas highlighted in Diagnostic Report
- Reflect on learner responses after both formal and informal assessment

**Assessment**

- Check requirements for CAPS ATP using Tracker
- Check levels for informal assessments
- Use questions from previous exams for informal assessment to focus on areas in diagnostic report.
- Evaluate questions with respect to Exam Guidelines

## Session 2: Reflections on Assessment

**Introduction**

The purpose of assessment should not be to rank learners and award some certificates of competence. The data we extract from different types of assessment should play a vital part in our planning, reflection and teaching. This data can focus our attention and efforts in moving learners to a better understanding of critical concepts. In this session, we will focus on Acids and Bases but a similar approach should be encouraged for other topics too. It is recommended that HODs and subject advisors focus on no more than two areas per term.

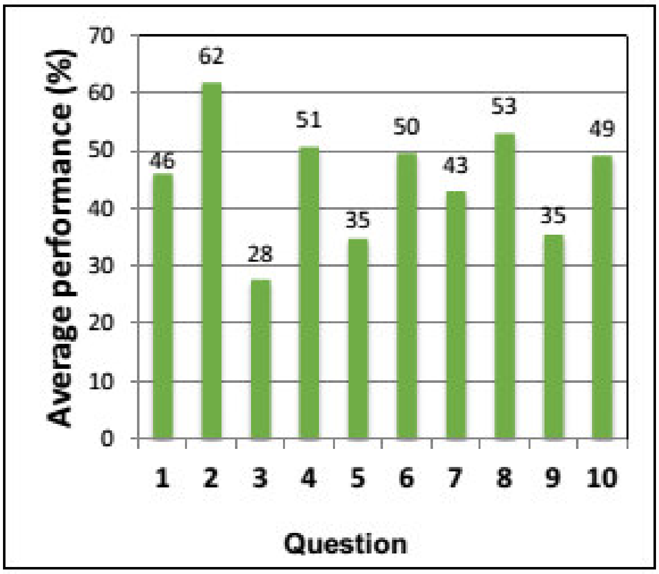
**Activity 1: Feedback from NSC Nov 2017 Paper 2 40 min**

Refer to the paragraph and graph below taken from the Diagnostic Report Nov 2017 (pg 185):

### 11.6 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

**Graph 11.6.1 Average marks per question expressed as a percentage: Paper 2**




| | |
|---|---|
| **Q1** | Multiple-choice questions; all topics |
| **Q2** | Organic nomenclature |
| **Q3** | Physical properties of organic compounds |
| **Q4** | Organic reactions |
| **Q5** | Reaction rate & stoichiometry |
| **Q6** | Chemical equilibrium |
| **Q7** | Acids and bases & stoichiometry |
| **Q8** | Galvanic cells |
| **Q9** | Electrolytic cells |
| **Q10** | Fertilisers |

Answer the questions that follow individually. You have 10 minutes to answer the questions

**Questions:**

1. What topics taught in term 2 need remedial attention ?
2. What topics in other terms need attention?
3. Suggest reasons why learners did poorly in the topics highlighted.
4. Where will you find evidence to support your claims made in Question 3?

**Facilitator's Notes**
*The participants should not need more than 10 minutes to answer the questions. Provide answers for Questions 1 & 2. Select participants to provide answers to questions 3 and 4. Allow some discussion but manage you're the time allocation carefully.You only have 15 min for feedback.*

**Suggested Answers:**

*1. Rates, Stoichiometry, Acids & Bases (Question 5 & 7)*

*2. Properties of Organic molecules (Question 3) & Electrolysis (Question 9)*

*3. Learners have a poor foundation of basic chemistry. The theory of Acids & Bases is covered in Grade 11. Only titrations are done in Grade 12. This should be done for a Practical Assessment at the end of term just before the July Exams. Teachers may not have time to complete Acids & Bases in term 2 and leave it for learners to revise as a self study before the practical assessment. Concepts of Stoichiometry are recognised to be more demanding are are an important part of Acid & Bases calculations. Learners do not have the mathematical grounding in logarithms, especially learners who do Mathematical Literacy, to perform pH calculations.*

*4. Learner answers in July Exams, the Acids & Bases formal practical assessment task, answers to Prelim Exam questions and the annual Diagnostic report. You will also find evidence in journal articles on students' and teachers' misconceptions in Chemistry.*

**Activity 2 A closer look at Question 7: Acids & Bases 40 min**

*Organise participants into groups of between 4 and 6 participants.*

**Instructions**

Study the part of Question 7 you are given and the sections of the tracker you have been given. Answer the following questions on a piece of flipchart paper:

1. Does the exam question link to a topic in the tracker? Identify the week and session when this concept should be taught.
2. Rate the level of cognitive demand for each of the questions you have been given
3. What errors or misconceptions do you think learners will have when answering this question? Are there other common errors misconceptions learners have related to the topic of Acids & Bases.
4. What strategies do think you should adopt to ensure that all learners are given support to overcome these common errors / misconceptions?

**Group A**

7.1 Ammonia ionises in water to form a basic solution according to the following balanced equation:

$$NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

7.1.1 Is ammonia a WEAK or a STRONG base? Give a reason for the answer. (2)

7.1.2 Write down the conjugate acid of $NH_3(g)$. (1)

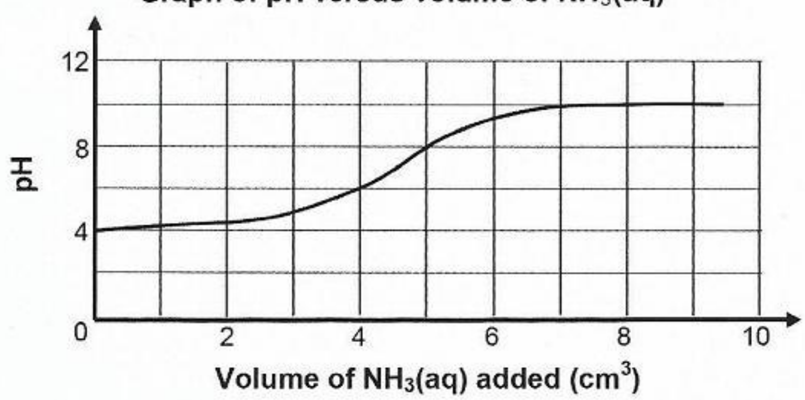
7.1.3 Identify ONE substance in this reaction that can behave as an ampholyte in some reactions. (1)

**Group B**

7.2 A learner adds distilled water to a soil sample and then filters the mixture. The pH of the filtered liquid is then measured.

He then gradually adds an ammonia solution, $NH_3(aq)$, to this liquid and measures the pH of the solution at regular intervals. The graph below shows the results obtained.

**Graph of pH versus volume of $NH_3$(aq)**



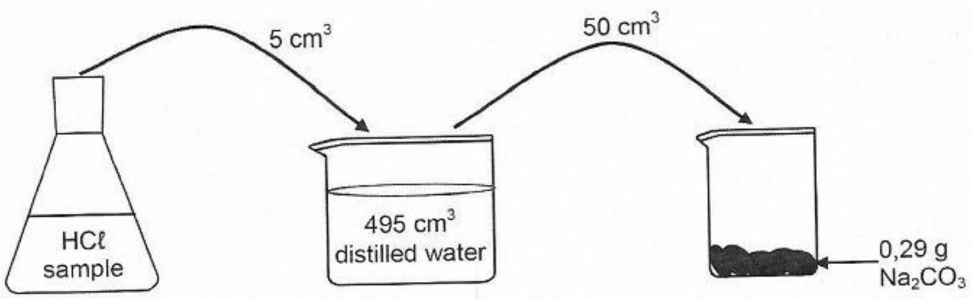
7.2.1 Is the soil sample ACIDIC or BASIC? Refer to the graph above and give a reason for the answer. (2)

7.2.2 Calculate the concentration of the hydroxide ions ($OH^-$) in the reaction mixture after the addition of 4 $cm^3$ of $NH_3(aq)$. (4)

**Group C**

7.3 A laboratory technician wants to determine the concentration of a hydrochloric acid (HCℓ) sample. He adds 5 $cm^3$ of the HCℓ sample to 495 $cm^3$ of distilled water to give 500 $cm^3$ of dilute hydrochloric acid, HCℓ(aq).

During a reaction 50 $cm^3$ of this dilute hydrochloric acid solution, HCℓ(aq), reacts completely with 0,29 g of sodium carbonate, $Na_2CO_3(s)$.




The balanced equation for the reaction is:

$$Na_2CO_3(s) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + CO_2(g) + H_2O(\ell)$$

Calculate the concentration of the hydrochloric acid sample. (7)

**[17]**

**Extract from Grade 10 Tracker** **Term 3**

| *Study and Master Physical Sciences* Week 1: Reactions in aqueous solution | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S # | CAPS concepts, practical activities and assessment tasks | CAPS pp. | LB pp. | LB Act. | TG pp. | *Everything Science* | | Class | | | | |
| | | | | | | LB pp. | TG pp. | Date completed | | | | |
| **Ions in aqueous solution: their interaction and effects** | | 46–48 | | | | | | | | | | |
| 1 | • **Explain** how water is able to dissolve ions<br>• **Represent** the dissolution process using balanced equations using the abbreviations (s) and (aq), e.g. $NaCl(s) \rightarrow Na^{+}(aq) + Cl^{-}(aq)$<br>• **Define** the process of dissolving (solid ionic crystals breaking up into ions in water) | 46 | 214–216 | | D62 | 309–312 Ex. 18.1 | 50, 192 | | | | | |
| **Homework:** LB Act. 2 pp. 216–217 | | | | | | | | | | | | |
| 2 | **Practical work**<br>Investigate different types of solutions<br>Write balanced equations for each<br>Investigate different types of reactions in aqueous medium and write balanced ionic equations for the different reaction types<br>**Activity:** Explain what is meant by ion exchange reactions and use an experiment to illustrate the concept of ion exchange reactions | 46 | 216 | Act. 1 | D62–D64 | 310–312 | 50, 192 | | | | | |
| **Homework:** LB Act. 2 pp. 216–217; read LB pp. 217–218 | | | | | | | | | | | | |
| **Electrolytes and extent of ionisation as measured by conductivity** | | 47 | | | | | | | | | | |
| 3 | • Define the process of hydration where ions become surrounded with water molecules in water solution<br>• Describe a simple circuit to measure conductivity of solutions<br>• Relate conductivity to the **concentration of ions** in solution and this to the solubility of particular substances<br>**Experiment:** Determine the electrical conductivity and the physical or chemical changes of solutions | 47 | 217–219 | Act. 3<br>Act. 4 | D64–D65 | 312–315 | 50, 192–193 | | | | | |
| **Homework:** LB Act. 5 p. 219 | | | | | | | | | | | | |
| **Precipitation reactions** | | 48 | | | | | | | | | | |
| 4 | • Write balanced reaction equations to describe precipitation of insoluble salts | 48 | 219–220 | | D64–D65 | 315–316 | 50, 193 | | | | | |
| **Homework:** LB p. 220 Re-read solubility rules; ES p. 317 | | | | | | | | | | | | |

| *Study and Master Physical Sciences* Week 2: Reactions in aqueous solution | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S #** | **CAPS concepts, practical activities and assessment tasks** | **CAPS pp.** | **LB pp.** | **LB Act.** | **TG pp.** | ***Everything Science*** | | **Class** | | | | |
| | | | | | | **LB pp.** | **TG pp.** | **Date completed** | | | | |
| **Precipitation reactions** | | 48–49 | | | | | | | | | | |
| 1 | • Explain how to test for the presence of anions in solution<br>• Identify an ion or ions in a solution from a description of the reactants mixed and the observations of the products | 48 | 221–223 | Act. 6 | D65–D66 | 317–319 | 50, 193 | | | | | |
| **Homework:** LB p. 223 Complete writing ionic equations | | | | | | | | | | | | |
| 2 | • Identify an ion or ions in a solution from a description of the reactants mixed and the observations of the products | 48 | 223–224 | Act. 7 | D67 | 319–320 | 50, 193–194 | | | | | |
| **Homework:** LB p. 224 Method points 6 and 7; ES p. 320 Ex. 18.2 | | | | | | | | | | | | |
| **Other chemical reaction types in water solution** | | 49 | | | | | | | | | | |
| **S #** | **CAPS concepts, practical activities and assessment tasks** | **CAPS pp.** | **LB pp.** | **LB Act.** | **TG pp.** | ***Everything Science*** | | **Date completed** | | | | |
| | | | | | | **LB pp.** | **TG pp.** | | | | | |
| 3 | • Ion exchange reactions<br>• Precipitation reactions<br>• Gas-forming reaction<br>• Acid-base reactions<br>• Redox reactions which are an electron transfer reaction<br>• Use the charge of the atom to demonstrate how losing or gaining electrons affects the overall charge of an atom | 49 | 225–230 | Act. 8 | D67 | 320–322 | 50, 193–194 | | | | | |
| **Homework** LB p. 232–233 Case Study Act. 10 | | | | | | | | | | | | |
| 4 | **Recommended experiment for informal assessment**<br>Identify **chemical reaction types** experimentally<br>Identify the driving force of each reaction type<br>Identify each reaction type in a group of miscellaneous chemical reactions | 49 | 231 | Act. 9 | D68–D69 | 322–323 | 50, 195–197 | | | | | |
| **Homework:** ES p. 324–326 End-of-chapter exercises | | | | | | | | | | | | |

***Study and Master Physical Sciences*** **Week 3: Quantitative aspects of chemical change**

| S # | CAPS concepts, practical activities and assessment tasks | CAPS pp. | LB pp. | LB Act. | TG pp. | *Everything Science* | | Class | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | LB pp. | TG pp. | Date completed | | | | |
| **Atomic mass and the mole concept** | | 50–51 | | | | | | | | | | |
| 1 | • Describe the mole as the SI unit for amount of substance<br>• Relate amount of substance to relative atomic mass | 50 | 234–237 | | D69–D70 | 327–329 | 50–51, 198–199 | | | | | |
| **Homework:** Review example LB p. 237; ES pp. 328–329 Ex. 19.1 | | | | | | | | | | | | |
| **Molecular and formula masses** | | 51 | | | | | | | | | | |
| 2 | • Reason qualitatively and proportionally the relationship between number of moles, mass and molar mass<br>• Calculate mass, molar mass and number of moles according to the relationship: $n = \frac{m}{M}$<br>• Determine the **empirical formula** for a given substance from percentage composition<br>• Determine the number of moles of **water of crystallisation** in salts | 51 | 237–239 | | D70 | 329–333 Ex. 19.2 | 50–51, 199–203 | | | | | |
| **Homework:** ES p. 331 Ex. 19.3 | | | | | | | | | | | | |
| 3 | • Determine the **empirical formula** for a given substance from percentage composition<br>• Determine the number of moles of **water of crystallisation** in salts<br>**Experiment:** Do an experiment to remove the water of crystallisation from copper(II) sulphate or cobalt(II) chloride and determine the number of moles of water removed from the crystals | 51 | 240–243 | Act. 1 | D70–D72 | 336–337 Act. 19.4 | 50–51, 203–205 | | | | | |
| **Homework:** LB p. 242–243 Act. 2 | | | | | | | | | | | | |
| **Determining the composition of substances** | | 51 | | | | | | | | | | |
| 4 | Determine **percent composition** of an element in a compound<br>Define and determine concentration as moles per volume | 51 | 243–244 | Act. 4 Exp. 1 | D72–D73 | 337–342 Ex. 19.5 | 50–51, 206–210 | | | | | |
| **Homework:** LB p. 245 Complete Q. a–g; LB p. 244 Act. 3 | | | | | | | | | | | | |

## *Study and Master Physical Sciences* Week 4: The mole concept

| S # | CAPS concepts, practical activities and assessment tasks | CAPS pp. | LB pp. | LB Act. | TG pp. | *Everything Science* | | Class | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | LB pp. | TG pp. | Date completed | | | | |
| **Determining the composition of substances** | | 51 | | | | | | | | | | |
| 1 | • Determine **percent composition** of an element in a compound<br>• Define and determine concentration as moles per volume | 51 | 245–246 | Act. 4<br>Exp. 2 | D72–D73 | 346–348<br>Ex. 19.6 | 50–51,<br>210–213 | | | | | |
| **Homework:** LB p. 246 Complete questions | | | | | | | | | | | | |
| **Amount of substance (mole), molar volume of gases, concentration of solutions** | | 51 | | | | | | | | | | |
| 2 | • Calculate the number of moles of a salt with given mass<br>• Define volume<br>• Calculate the molar concentration of a solution | 51 | 246–250 | | D73 | 348–350 | 50–51 | | | | | |
| **Homework:** LB p. 250 Act. 5 | | | | | | | | | | | | |
| **Basic stoichiometric calculations** | | 52 | | | | | | | | | | |
| 3 | • Do calculations based on concentration, mass, moles, molar mass and volume<br>• Determine the theoretical yield of a product in a chemical reaction, when you start with a known mass of reactant | 52 | 250–253 | | D73–D74 | 350–353 | 50–51 | | | | | |
| **Homework:** LB p. 252 Act. 6 | | | | | | | | | | | | |
| 4 | • Do calculations based on concentration, mass, moles, molar mass and volume<br>• Determine the theoretical yield of a product in a chemical reaction, when you start with a known mass of reactant | 52 | 250–253 | | D74–D75 | 350–353<br>Ex. 19.7 | 50–51,<br>213–216 | | | | | |
| **Homework:** LB p. 254–255 Assessment Task Examples 1–3 | | | | | | | | | | | | |

**Extract from Grade 11 Tracker** **Term 2**

| *Study and Master* Week 7: Quantitative aspects of chemical change | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S # | CAPS concepts, practical activities and assessment tasks | CAPS pp. | LB pp. | LB act. | TG pp. | *Everything Science* | | Class | | | | |
| | | | | | | LB pp. | TG pp. | Date completed | | | | |
| 1 | **Stoichiometric calculations (Revision Grade 10) #**<br>• Definition of the mole and Avogadro's constant<br>• Formula mass, relative atomic mass and molar mass<br>**Molar volume of gases, concentration of solutions #**<br>• 1 mole of gas occupies 22.4 $dm^3$ at 0 °C (273 K) and 1 atmosphere (101.3 kPa)<br>• Interpret balanced reaction equations in terms of volume relationships for gases under the same conditions of temperature and pressure (volume of gases is directly proportional to the number of particles of the gases) | 82 | 181–183 | 182<br>Act. 1<br>1–3 | D69 | 290–293 | | | | | | |
| **Homework** | | | | 182<br>Act. 1<br>4–6 | D69 | 293<br>Ex. 8.1<br>1<br>297<br>Ex. 8.2<br>1 | 231–232<br>232 | | | | | |
| 2 | **Molar volume of gases, concentration of solutions #**<br>• Molar concentration of a solution<br>• Do titration calculations | 82 | 183–188 | 188<br>PA<br>Act. 2<br>188<br>Act. 3<br>1–3 | D69<br>D69–D70 | 293–298 | | | | | | |
| **Homework** | | | | 188<br>Act. 3<br>1–3 | D70 | 297<br>Ex. 8.2<br>2a & 2b | 232–234 | | | | | |
| 3 | **More complex stoichiometric calculations #**<br>• Do calculations to determine empirical formula and molecular formula of compounds<br>• Revise empirical formula calculations done in Grade 10 | 82 | 189–1991 | 191<br>TYS 1<br>1 & 2 | D70 | 301–310 | | | | | | |
| **Homework** | | | | 191<br>TYS 1<br>3 | D71 | 304<br>Ex. 8.5<br>1<br>306<br>Ex. 8.6<br>1 | 238<br>239 | | | | | |

| S # | CAPS concepts, practical activities and assessment tasks | CAPS pp. | LB pp. | LB act. | TG pp. | *Everything Science* | | Date completed | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | LB pp. | TG pp. | | | | | |
| 4 | **More complex stoichiometric calculations #**<br>• Do stoichiometric calculations to determine the percent yield of a chemical reaction<br>• Perform stoichiometric calculations using balanced equations that may include limiting reagents | 82 | 191–196 | 196<br>TYS 2<br>1 & 2 | D72 | 298–302 | | | | | | |
| **Homework:** Prepare for Act. 4 | | | | 196<br>TYS 2<br>3 & 4 | D72–D73 | 301<br>Ex. 8.3<br>1<br>302<br>Ex. 8.4<br>1 | 235–236<br>237 | | | | | |

**Extract from Grade 11 Tracker** **Term 3**

| ***Study and Master Physical Sciences*** **Week 7: Types of reactions** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S #** | **CAPS concepts, practical activities and assessment tasks** | **CAPS pp.** | **LB pp.** | **LB act.** | **TG pp.** | ***Everything Science*** | | **Class** | | | | |
| | | | | | | **LB pp.** | **TG pp.** | **Date completed** | | | | |
| 1 | **Acid–base**<br>• Use the acid–base theories of Arrhenius and Brønsted and Lowry to define acids and bases<br>• Define an acid as an $H^+$ donor and a base as an $H^+$ acceptor in reactions | 92 | 260–261 | 261<br>TYS 5<br>1 | D93 | 438–441 | 330–331 | | | | | |
| | **Homework** | | | 261<br>TYS 5<br>2 | D93 | 441–442<br>Ex. 13.1<br>1–2 | 331–332 | | | | | |
| 2 | **Acid–base**<br>• Identify conjugate acid/base pairs<br>• Define an ampholyte<br>• List common acids (including hydrochloric acid, nitric acid, sulfuric acid and acetic acid) and common bases (including sodium carbonate, sodium hydrogen carbonate and sodium hydroxide) by name and formula | 92 | 262–264 | 262<br>TYS 6<br>1a–b | D93 | 442–443 | | | | | | |
| | **Homework** | | | 262<br>TYS 6<br>1c–d | D93 | 443<br>Ex. 13.2<br>1–2 | 332–333 | | | | | |
| 3 | **Acid–base**<br>• Write the overall equation for simple acid–metal hydroxide, acid–metal oxide and acid–metal carbonate reactions and relate these to what happens at the macroscopic and microscopic level | 92 | 264–267 | 266<br>TYS 7<br>1, 3 | D93–D94 | 443–445,<br>447–450 | | | | | | |
| | **Homework:** Prepare for informal practical investigation on indicators | | | 269–270<br>Act. 10 | D94–D95 | 447<br>Ex. 13.3 1<br>448<br>Ex. 13.4 1<br>450<br>Ex. 13.5 1 | 334 | | | | | |
| 4 | **Acid–base**<br>• What is an indicator?<br>• Look for some natural indicators | 92 | 268–270 | 269–270<br>Act. 10 | D94–D95 | 445–446 | | | | | | |
| | **Homework:** Complete report on indicators | | | 269–270<br>Act. 10 | D94–D95 | 467<br>Ex. 13.9<br>4–6 | 344–345 | | | | | |

| ***Study and Master Physical Sciences*** **Week 8: Types of reactions** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S #** | **CAPS concepts, practical activities and assessment tasks** | **CAPS pp.** | **LB pp.** | **LB act.** | **TG pp.** | ***Everything Science*** | | **Class** | | | | |
| | | | | | | **LB pp.** | **TG pp.** | **Date completed** | | | | |
| 1 | **Acid–base**<br>• Use acid–base reactions to produce and isolate salts, e.g. $Na_2SO_4$, $CuSO_4$ and $CaCO_3$ | 92 | 271 | 267<br>PA<br>Act. 9 | D94 | 450–452 | | | | | | |
| | **Homework:** Complete report on titration | | | 267<br>PA<br>Act. 9 | D94 | 452<br>Ex. 13.6<br>1–2 | 334 | | | | | |
| 2 | **Acid–base**<br>• Use acid–base reactions to produce and isolate salts, e.g. $Na_2SO_4$, $CuSO_4$ and $CaCO_3$ | | | 271<br>Act. 11 | D95 | | | | | | | |
| | **Homework** | | | 266<br>TYS 7<br>2 | D94 | 452<br>Ex. 13.6<br>3 | 334 | | | | | |
| **S #** | **CAPS concepts, practical activities and assessment tasks** | **CAPS pp.** | **LB pp.** | **LB act.** | **TG pp.** | ***Everything Science*** | | **Date completed** | | | | |
| | | | | | | **LB pp.** | **TG pp.** | | | | | |
| 3 | **Acid–base**<br>• Use acid–base reactions to produce and isolate salts, e.g. $Na_2SO_4$, $CuSO_4$ and $CaCO_3$ | 92 | 272–273 | 272<br>Act. 12 | D96 | 450–452 | | | | | | |
| | **Homework** | | | 273<br>Act. 13 | D96 | 452<br>Ex. 13.6<br>4–6 | | | | | | |
| 4 | **Acid–base**<br>Consolidation, revision and remediation | 92 | 274–275 | 275<br>9–11 | D98 | | | | | | | |
| | **Homework** | | | 274<br>1–4 | D97 | 467–468<br>Ex. 13.9<br>7–9 | 345 | | | | | |

**Extract from Grade 12 Tracker** **Term 2**

| *Solutions for All* Week 6: Chemical equilibrium, acids and bases | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S # | CAPS concepts, practical activities and assessment tasks | CAPS pp. | LB pp. | LB act. | TG pp. | *Everything Science* | | Class | | | | |
| | | | | | | LB | TG | Date completed | | | | |
| 1 | • Explain the significance of high and low values of the equilibrium constant | 125 | 272–273 | CP 11<br>Ex. 7.3<br>Q. 1–6 | 191–194 | 312 | | | | | | |
| **Resource:** Mindset Learn: Using the equilibrium constant (15:11); http://learn.mindset.co.za/resources/physical-sciences/grade-12/chemical-equilibrium/03-using-equilibrium-constant | | | | | | | | | | | | |
| **Homework:** EY 2–3 | | | 278–279 | EY<br>Q. 2–3 | 193–194 | | | | | | | |
| 2 | **Application of equilibrium principles**<br>• Interpret (only simple) graphs of equilibrium | 125 | 274–276 | Ex. 7.4<br>Q. 1 | 194–196 | 320–328 | | | | | | |
| **Homework:** Ex. 7.4 Q. 2 EY Q. 1 | | | 277–278 | EX 7.4<br>Q. 2<br>EY Q. 2 | | 328–329<br>Ex. 8.3<br>Q. 1–2 | 173–175 | | | | | |
| 3 | **Application of equilibrium principles**<br>• Interpret (only simple) graphs of equilibrium | 126 | 280–281 | EY<br>Q. 4 | | 328–332 | 175–178 | | | | | |
| **Homework:** Summarise Chemical equilibrium | | | | | | 331<br>Ex. 8.4<br>Q. 1 | 178 | | | | | |
| 4 | **Acids and bases**<br>• Explain what is meant by acids and bases<br>• State acid-base models (Arrhenius, Lowry-Brønsted)<br>• Write the reaction equations of aqueous solutions of acids and bases<br>• Give conjugate acid-base pairs for given compounds | 127 | 283–289 | CP 1<br>CP 2 | 201–205 | 331–339 | 181–183 | | | | | |
| **Resources:** Mindset Learn: Arrhenius' theory of acids and bases (14:49); http://learn.mindset.co.za/resources/physical-sciences/grade-12/acids-and-bases/01-arrhenius%E2%80%99-acid-base-model<br>Mindset Learn: Lowry-Brønsted theory of acids and bases (10:20); http://learn.mindset.co.za/resources/physical-sciences/grade-12/acids-and-bases/02-lowry-bronsted-acid-base-model<br>Mindset Learn: Conjugate acid-base pairs (14:20); http://learn.mindset.co.za/resources/physical-sciences/grade-12/acids-and-bases/03-acid-base-conjugate-pairs | | | | | | | | | | | | |
| **Homework:** Ex. 8.1 Q. 1–2 | | | 289 | Ex. 8.1<br>Q. 1–2 | 205 | 339<br>Ex. 9.1<br>Q. 1–3 | 183–184 | | | | | |

## *Solutions for All* Week 7: Chemical equilibrium, acids and bases

| S # | CAPS concepts, practical activities and assessment tasks | CAPS pp. | LB pp. | LB act. | TG pp. | *Everything Science* | | Class | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | LB | TG | Date completed | | | | |
| 1 | • Distinguish between concentrated and dilute acids<br>• Distinguish between strong and concentrated acids<br>• Compare strong and weak acids by looking at:<br>– pH<br>– conductivity<br>– reaction rate<br>• Name some common strong and weak acids and bases | 127–128 | 290–294 | CP 3<br>CP 4 | 206–207 | 340–345 | | | | | | |
| **Resources:** Mindset Learn: Neutralisation (5:46); http://learn.mindset.co.za/resources/physical-sciences/grade-12/acids-and-bases/04-neutralisation<br>Mindset Learn: Indicators and strengths of acids and bases (18:28); http://learn.mindset.co.za/resources/physical-sciences/grade-12/acids-and-bases/05-indicators-and-strength-acids-and-bases | | | | | | | | | | | | |
| **Homework:** Ex. 8.2 Q. 1–8 | | | 294 | | 207 | 344–345<br>Ex. 9.2<br>Q. 1–3 | 184–185 | | | | | |
| 2 | • Compare $K_a$ and $K_b$ values of strong and weak acids and bases<br>• Give the neutralisation reactions of common laboratory acids and bases | 127–128 | 294–298 | CP 5<br>CP 6<br>Ex. 8.3<br>Q. 1–6 | 208–211 | 345–354 | 187 | | | | | |
| **Resource:** Mindset Learn: Ionisation and dissociation constants (5:32); http://learn.mindset.co.za/resources/physical-sciences/grade-12/acids-and-bases/08-ionisation-and-dissociation-constants | | | | | | | | | | | | |

| S # | CAPS concepts, practical activities and assessment tasks | CAPS pp. | LB pp. | LB act. | TG pp. | *Everything Science* | | Date completed | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | LB | TG | | | | | |
| **Homework:** Ex. 8.4 Q. 1–4 | | | 301 | | 213–214 | 348<br>Ex. 9.3<br>Q. 1–2<br>354<br>Ex. 9.4<br>Q. 1–3 | 186<br>188 | | | | | |
| 3 | • Explain the pH scale<br>• How do indicators work?<br>• What is the range of methyl orange, bromothymol blue and phenolphthalein indicators?<br>• Calculate pH values of strong acids and strong bases<br>• Define the concept of $K_w$<br>• Explain the auto-ionisation of water | 127–128 | 299–304 | CP 7<br>CP 8<br>CP 9<br>CP 10 | 212–215 | 354–359 | 190 | | | | | |
| **Resource:** Mindset Learn: The pH scale (4:33); http://learn.mindset.co.za/resources/physical-sciences/grade-12/acids-and-bases/07-ph-scale | | | | | | | | | | | | |
| **Homework:** Ex. 8.5 Q. 1–6 | | 304–305 | | EX 8.5<br>Q. 1–6 | 215–216 | 356<br>Ex. 9.5<br>Q. 1–3 | 189–190 | | | | | |
| 4 | • Determine the approximate pH of salts in salt hydrolysis<br>• Do simple acid-base titrations | 127 | 305–310 | CP 11<br>CP 12<br>CP 13 | 217–220 | 357–362 | 190–192 | | | | | |
| **Homework:** Ex. 8.6 Q. 1–2, Ex. 8.7 Q. 1–4 | | | 310 | Ex. 8.6<br>Q. 1–2<br>Ex. 8.7<br>Q. 1–4 | 218<br>220 | 366<br>Ex. 9.6<br>Q. 1–2 | 193–194 | | | | | |
| **Reflection** | | | | | | | | | | | | |

**Notes for facilitator:**

*You will not need to discuss the answers to questions 1 & 2 but refer participants to the suggested answers given in Appendix 2 on page 28. Participants will work with these in the next session. They can add to the suggested answers.*

*Please discuss the purpose of Questions 1 & 2. The following ideas could be mentioned:*

*The purpose of question 1 is to show that questions are related to topics in CAPS. This question also illustrates a fair coverage of concepts mentioned in CAPS. The question also illustrates the inter-related nature of Chemistry topics. The main thrust of the question is Acids and Bases but concepts related to Quantitative Chemistry are included too.*

*In question 2 we look at the cognitive demand required for each question. Assigning levels of cognitive demand is often a subjective process and must be done in context. This activity was included to illustrate that the question in the examination was fair. Learners should have performed better than the sample group did. If an assessment is not fair, one cannot blame learners or teachers for a poor result. We need to reflect on feedback and analysis of assessment continually. If this becomes a habit, incremental improvement will follow.*

***Suggested answers for Questions 1 & 2***

**Group A**

1. *7.1.1 Definition of strong and weak bases Grade 11 Term 3*
   *7.1.2 Acids – Base pairs Grade 11 Term 3*
   *7.1.3 Ampholyte Grade 11 Term 3*

2. 7.1.1 ***Level 4: Evaluation & Synthesis (Easy)***
   *There is a large element of recall in this question that learners need to synthesise. Learners need to recall:*
   *a.) the definition of a weak base / strong base*
   *b.) that ammonia does **not** ionise completely*
   *Based on these two statements they need to conclude that ammonia is a weak base. In their answer they must state that ammonia does **not** ionise completely*
   *7.1.2* ***Level 3: Application (Easy)***
   *Identification of an base and it's conjugate acid requires application of the definition of a conjugate acid. Learners should know that a conjugate acid is the acid of the reverse reaction. If they recognise that an acid is a proton donor then they should identify the ammonium ion ($NH_4^+$) as the conjugate base. This example is used in most textbooks so it could be ranked as Level 1 or level 2*
   *7.1.3* ***Level 2: Comprehension***
   *Learners need to recognise the word ampholyte and recall that this is a substance that can act as either an acid or a base. They then need to recognise that only water*

*($H_2O$) that is present in this reaction is an ampholyte. This example is used in most textbooks so it could be ranked as Level 1.*

**Group B**

1. 7.2.1 Grade 11 Term 3 & Grade 12 Term 2

   7.2.2 Grade 12 Term 2

2. 7.2.1 Level 3 Application (medium)

   7.2.2 Level 3 Application & Synthesis.

**Group C**

1. Grade 10 Term 2 / Grade 11 Term2 & 3 / Grade 12 Term 2

2. Level 3: Application & Synthesis.

***Facilitator's Note***

*There are no answers provided to questions 3 & 4 because some answers are provided in the next activity. Participants will need to take note of answers other groups have come to. One way to do this is to allow groups to stick up the answers on a flip chart and allow the participants to move around the room. The participants can take photos of the flip charts and ask question if they are not sure of what is written on the flip chart.*

*You could also do this by asking participants to form groups of three. They can then share the answers they found via WhatsApp or by sharing photos of their flip charts.*

**Activity 3 Common Errors & Misconceptions 40 min**

*Participants work in the same groups as in Activity 2 for Question 1. The purpose of Part 1 is to show that the common errors / misconceptions are well known. Participants should not need more than 10 minutes to complete part 1.*

**Part 1**

Compare the answers you have given in Activity 2 Question 3 to the errors and misconceptions identified in the diagnostic report.

**Diagnostic Report 2017: Physical Sciences Paper 2 Pg 184 / 192 - 194**

**Common errors and misconceptions 10 min**

(a) Although Q7.1.1 was well answered, many candidates thought ammonia is a strong base. Those who knew it is a weak base supplied an incorrect reason, such as ‘completely ionised’.

(b) Although Q7.1.2 was well answered, some candidates omitted the charge of $NH_4^+$.

(c) The interpretation of the graph in Q7.2.1 was a challenge to many candidates. They could not deduce from the graph that the soil is acidic.

(d) Common errors made in the pH calculation in Q7.2.2 were: Mixing the pH and pOH formulae, e.g. pH = -log[$OH^-$] or pH = -log[$H_3O$] or pH = -log($H_3O^+$); omitting the pH formula and just starting with 6 = -log[$H_3O^+$] and using formulae not applicable to the calculation e.g. $c = n \div V$ and/or $c = m \div (MV)$ .

(e) Common errors in Q7.3 were: Using an incorrect molar mass for sodium carbonate; using an incorrect formula e.g $n = c \div V$ or using $n = V \div V_m$ when calculating n($Na_2CO_3$); incorrect substitution of volumes e.g. 495 $cm^3$ instead of 500 $cm^3$ and substituting 5 $cm^3$ instead of 50 $cm^3$ to calculate the concentration of the dilute acid; incorrect or no conversion from $cm^3$ to $dm^3$ when substituting volumes into $c = n \div V$ and using dilution factors without showing how it was obtained.

**Facilitator’s Note**

*It is important to note that there are misconceptions / common errors that are not highlighted by Question 7. You need to encourage participants to include all of these in the Part 2 summary.*

**Part 2** **30 min**

Make a summary of the errors / misconceptions that learners' have in the topic of Acids & Bases by writing down a word or phrase on a post it note. Stick post it notes onto a wall. You can move your notes so that similar ideas are grouped together. You need to work together to establish no more than 8 groups of misconceptions / common errors.

**Facilitators' Note**

*The purpose of the Part 2 Activity is to develop a comprehensive list of common errors / misconceptions. We then show that these errors can grouped / categorised into about 8 focus areas.*

*Participants work individually for Part 2. Each participant needs about 15 Post It notes. If you don't have post it notes, participants can use small pieces of paper and stick these onto the wall using Prestik. Allow participants no more than 20 min to write down words on the Post Its. Once they have stuck notes on the wall allow them about 20 min to group notes together. The participants need to check that all of the errors/ misconceptions mentioned in Activity 2 Question 3 do fit in to one of the categories.*

*After the notes are all grouped together write down the list of common errors / misconceptions onto a sheet of Flip Chart Paper. You may need to add in a more generic phrase or word to group similar ideas. For example, manipulating an equation and using correct SI units could be group together under Maths Skills. This process should not take longer than 20 min. Make sure that no common errors / misconceptions are left out.*

*In this process, you will find that there are errors that are general and not directly related to Science concepts but are more general and related to Exam skills. These are errors which arise because learners don't read the question carefully. They don't answer the question directly or the make careless mistakes like not writing down the correct equation from the data sheet or leaving out units. Poor Exam skills needs to be included in the list.*

*Give participants time to write down the final list of misconceptions / common errors. They will need to use this list in another activity. The suggested answer shown below is also to be found on pg 29 of the participants guide*

*A suggested list of misconceptions / common errors include the following:*

- Terminology & definitions
- Application of definitions to examples
- Write formula and balancing equations
- The pH scale (Concept, link to Chemical Equilibrium & calculations)
- Acid – Base reactions including titrations
- Stoichiometric calculations related to acid – base reactions
- Using $K_W$ , $K_A$ and $K_B$ – links Acids & Bases to Chemical Equilibrium
- Hydrolysis of salts

## Session 3 Preparations for teaching Acids & Bases in 2018

**Activity 4 Recommended Actions Steps 40 min**

*Participants work in the same groups as in the previous Activity. The purpose of part 1 is to show that the common errors / misconceptions are well known. Participants should not need more than 10 minutes to complete part 1.*

**Part 1 10 min**

Compare the answers you have given to Question 4 of Activity 2 to the recommendations made in the diagnostic report that can improve learners' understanding of Acids and Bases and be better prepared to answer exam questions.

**Diagnostic Report 2017: Physical Sciences Paper 2 Pg 184 – 185 / 192 - 194**

**Suggestions for improvement**

(a) Learners should be made aware that the square brackets in the pH formula indicate concentration and that the use of round brackets is incorrect.

(b) The pH scale is poorly understood by many learners. A high pH was often linked to an acid instead of a base.

(c) Learners should be taught to label formulae when doing multistep calculations, e.g.when calculating the number of moles of $Na_2CO_3$, the formula should be as follows: $n(Na_2CO_3) = m \div M$

(d) Ensure that stoichiometric calculations are properly taught in Grade 11. Expose learners to stoichiometric calculations from the beginning of their Grade 12 year to give them enough practice.

(e) Use the *Examination Guidelines* to ensure learners study the correct definitions, such as the definitions of strong and weak acids and bases.

**Facilitator's Note**

*Part 2 is designed to link strategies to areas of focus identified in the previous Activity.*

- *Divide participants into groups equal to the number of errors / misconceptions identified in the previous Activity.*
- *Participants must each write down a different area of focus at the top of the page. Give the groups 1 min to fill in strategies in the first row.*
- *Ask participants to hand the given grid to the participant on the left. Participants now have 1 min to read the suggestions written in row 1 and to add in new suggestions in row 2. Continue in the same way until the grid is full.*
- *Now pass the grid around and ask participants to select two methods they like best. Continue until the grid is passed back to the first person.*

**Part 2 Linking strategies to misconceptions / errors 30 min**

On the grid provided, write down strategies that you have used or think will work to correct errors or misconceptions. You can also mention strategies to prevent a misconception from developing.

**Facilitator's Note**

*Once all the grids are full and have been evaluated, stick them on to the wall. Allow different groups to compare suggested strategies. You will need to give participants time to record the ideas of other groups. Taking a photo is the easiest way to do this.*

**Activity 2: Working backwards 30 min**

*Participants remain in the same groups as they were in for Session 2. Each group now works with a different part of question 7.*

Look at the exam questions for Acids & Bases again (Question 7).

**Instructions**

1. For each question identify the foundational concepts or skills that will help learners answer the question. Use the CAPS / ATP / Trackers to identify concepts that were not examined in this exam. Write down these concepts or skills too.
2. Write down the core concept on a piece of card. On different coloured card write down the building blocks required to develop the key concept. Build a concept chain using these cards and stick these on to the wall.
3. Identify when each of the building blocks are taught by looking at CAPS, ATP and / or Trackers. Stick this detail onto the wall using quite cards / pieces of paper.

**Facilitators' Note**

*This activity should not take more than 30 mins. Ask groups to take a photo of the chain they have created.*

**Activity 3: Building inter-related concept chains 40 min**

**Part 1 10 min**

You need to work together as a large group. Take the chain of concept development and build a network of related concepts across the Senior phase through to Grade 12.

You need to link the building blocks to the Grades these concepts are taught in. The concept chains must not have repeated building blocks. Secure three pieces of string or wool to the wool horizontally to a different wall. Place building blocks below the first string are concepts if they need to be developed in the Senior phase. Building blocks places between the 1$^{st}$ and 2$^{nd}$ string are covered in Grade 10. Those between the 2$^{nd}$ and 3$^{rd}$ string are for Grade 11 and those above the 3$^{rd}$ string are for Grade 12.

**Facilitator's Notes**
*Allow participants to join and overlap chains the concept chains they developed in the previous activity. Make sure they explain and negotiate linkages.*

**Part 2** **15 min**
Refer to Activity 3 of Session 2 when you identified misconceptions / errors. Identify the weak links in the chain of concept development. Mark these using a red marker

Refer back to the strategies you identified that will help eliminate errors and diminish misconceptions in Activity 1 of Session 3. Add these strategies to chains which have weak links.

**Part 3** **15 min**
Work in groups of 3 or 4. Each group is given a different chain of concept development that may have a weak link in it. Complete the planning for your Science department's subject improvement plan by completing the following table:

| Key Concept | Grades | Strategies for improvement |
|---|---|---|
| | Senior Phase | |
| | Grade 10 | |
| | Grade 11 | |
| | Grade 12 | |

## Closure & thanks **10 min**
Please complete the questionnaire at the end of this manual. Before you start writing review the expectations they wrote down at the beginning of the workshop.

*Close the workshop by thanking all participants for their contributions.*