GRADE 12

Physical Sciences

Teacher Toolkit: CAPS Planner and Tracker

2019 TERM 3

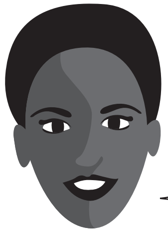
CONTENTS

A. ABOUT THE PLANNER AND TRACKER

1. Your quick guide to using this planner and tracker

What is the NECT and where do I fit in?

What you do matters! What you do every day as a teacher can change the life-chances of every child that you teach. The NECT supports teachers by providing CAPS planners and trackers so that teachers can plan to cover the curriculum, track progress, and seek help when they are falling behind.

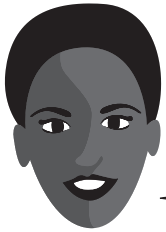


But who will help me?

The NECT will work with your school management team (SMT) and assist them to have supportive and professional conversations with you about curriculum coverage that will be orientated to identifying and solving problems.

I have looked at the planner and tracker. It goes too fast!

The CAPS planner and tracker is an expanded ATP. It helps you pace yourself as if you were able to cover everything in the ATP/CAPS. When you fall behind because time has been lost, or because the learners are progressing slowly, you need to confidently discuss this with your teaching team without feeling blamed. The pace of coverage will be determined by the pace of learning. That is why coverage must be tracked by the teacher and the SMT.



How do I use the planner and tracker?

See the "**Quick 5-step Guide to Using the CAPS Planners and Trackers**" on the opposite page.

QUICK 5-STEP GUIDE TO USING THE CAPS PLANNERS AND TRACKERS

1. Find the textbook that YOU are using.

2. Use the planning page each week to plan your teaching for the week. It will help you link the CAPS content and skills to relevant material in the textbook, the teacher's guide, and other materials such as the DBE workbook.

3. Keep a record of the date when you were able to complete the topic. It may be different from the date you planned, and for different classes. Write this date in the column on the right for your records.

4. At the end of the week, reflect and check if you are up to date. Make notes in the blank space.

5. Be ready to have a professional and supportive curriculum coverage conversation with your HoD (or subject or phase head).

The CAPS planners and trackers also provide guidelines for assessment with samples, and may also have enrichment and remedial suggestions. Read the introduction pages carefully for a full explanation.

2. Purpose of the tracker

The Curriculum and Assessment Planner and Tracker is a tool to support you in your role as a professional teacher. Its main purpose is to help you keep pace with the time requirements and the content coverage of the CAPS by providing the details of what should be taught each day of the term; and of when formal assessments should be done. Each of the sessions for Physical Sciences in Grade 12 is linked to the approved sets of Learner's Books and Teacher's Guides on the National Catalogue, as well as the ***Everything Science*** textbook (Siyavula) which has been distributed to schools by the Department of Basic Education as an additional resource. You can download it from www.everythingscience.co.za.

The tracker provides a programme of work that should be covered each day of the term and a space for reflection of work done for each of the LTSMs on the National Catalogue. By following the programme in the tracker for the Learner's Book you are using, you will cover the curriculum in the allocated time, and complete the formal assessment programme. By noting the date when each session is completed, you can assess whether or not you are on track. If you are not, strategise with your head of department (HOD) and colleagues to determine the best way in which to make up time to ensure that all the content prescribed for the term is completed. In addition, the tracker encourages you to reflect on what parts of your lessons were effective, and which parts of your lessons can be strengthened. These reflections can be shared with colleagues. In this way, the tracker encourages continuous improvement in practice.

This tracker should be kept and filed at the end of the term.

3. Links to the CAPS

The Grade 12 Physical Sciences tracker is based on the requirements prescribed by the Department of Basic Education's Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences in the Further Education and Training (FET) band. The CAPS prescribes four hours per week for Physical Sciences. The work set out in the tracker for each day is linked directly to the topics and subtopics given in the CAPS, with the specified amount of time is allocated to each topic. It gives the page number in the CAPS document of the topics and subtopics being addressed in each session. This enables you to refer to the curriculum document directly should you wish to do so.

4. Links to approved LTSMs

There is a tracker for each set of Learner's Books and Teacher's Guides of the approved books on the National Catalogue. The tracker aligns the CAPS requirements with the content set out in the approved Learner's Books and Teacher's Guides. You must refer to the tracker for the book that is used by learners at your school. If you have copies of other Learner's Books, you can also refer to these trackers to give you ideas for teaching the same content in a different way. However, ensure that you cover the content systematically. For each set of LTSMs in the tracker, links are given to the relevant pages in both the Learner's Book and Teacher's Guide to make it easier for teachers to access the correct resources. Links to the ***Everything Science*** materials have been inserted in the trackers for all Learner's Books.

In addition, further suggestions for extension, enrichment, and/or homework exercises have been made. We recommend that you always have an extra activity available for those learners who complete their work earlier than others.

Each tracker is based on the latest print editions of the two approved LTSMs. Take note that page numbers may differ slightly from other print runs of the same Learner's Book. If the page numbers in your edition are not exactly the same as those given in the tracker, you should use the activity/exercise numbers given in the tracker to guide you to the correct pages. These should only differ by a page or two from those given in the tracker.

5. Managing time allocated in the tracker

The tracker provides a suggested plan for 32 hour sessions, organised into four 60-minute sessions per week. Depending on your school's timetable, you may use two of these sessions in one double period. You might also need to adjust the work prescribed for a session to meet other demands of your timetable. However, the content that needs to be covered in a week, should always be covered in a week. If for some reason you do not complete the work set for the week, you need to find a way to get back on track.

The breakdown of work to be done each week corresponds to the annual teaching plan and programme of assessment drawn up by the Department of Education; however, the tracker gives a more detailed outline of what should be taught each day.

The tracker has been planned for a second term of 11 weeks. Eight weeks are allocated for covering the set curriculum. Weeks 9, 10 and 11 are set aside for the preliminary examinations (Trials). If the year in which you are using it has a longer or shorter first term, you will need to adjust the pace of work. It is important that you take note of this at the start of the year.

Homework has been allocated for most sessions. For learners to benefit from these activities, it is necessary to provide feedback on the homework. Do this at the beginning of the next lesson or at the end of a topic. Learners who do not complete their written work in time can complete the activity for homework. If some learners complete their work well ahead of schedule, consider providing them with enrichment activities. We have provided some examples of enrichment activities in this tracker. If some learners do not complete their written work in time, they can complete the enrichment activity for homework. If for any reason you miss a lesson, or find that you need to spend more time than planned on some aspect of the work, find a way to get back on track so that the curriculum for the term is covered as required.

6. Links to assessment

The tracker indicates where in the series of lessons the CAPS formal assessment activities/tasks/practical activities should be done. This varies slightly from Learner's Book to Learner's Book, but is always in line with the CAPS specifications. We suggest that you discuss testing times with your colleagues who teach other subjects. In this way you can avoid having learners write several tests on the same day in a single week.

For informal assessment tasks, you may want to use a variety of assessment methods, including peer assessment, self-assessment and spot marking.

7. Resource list

The tracker suggests resources that you could use for certain lessons. In addition, suggestions for alternative equipment and resources have been made. Learners need to **interact** with learning material as much as possible, therefore every attempt has been made to allow for such interaction.

8. Columns in the tracker

The following columns can be found in the tracker for each set of LTSMs:

1. Session number
2. Relevant CAPS page number
3. CAPS content, concepts and skills for the day
4. Learner's Book page number
5. Learner activity number
6. Teacher's Guide page number
7. ***Everything Science*** Learner's Book page number
8. ***Everything Science*** Teacher's Guide page number
9. Date completed – this needs to be filled in each day and there are columns for each of the classes you teach

9. Weekly reflection

The tracker provides a space to record reflections on a weekly basis. This weekly reflection provides you with a record for the next time you implement the same lesson, and also forms the basis for collegial conversations with your head of department (HOD) and colleagues. It should be shared both informally and at regular departmental meetings. Together with your HOD and colleagues, think of ways of improving your lessons and in turn your learners' work. If for some reason not all the work for the week has been covered, strategise with your HOD and colleagues as to how best to catch up so that the curriculum is covered.

You are encouraged to reflect on your lessons daily – thinking about what went well, or did not go so well in each, and how better to help learners grasp the content being taught. Briefly jot down your reflection by following the prompts in the tracker. When reflecting, you could think about things such as:

- Was my preparation for the lesson adequate? For example: Did I have all the necessary resources? Had I thought through the content so that I understood it fully and could teach it effectively?
- Did the purpose of the lesson succeed? For example: Did the learners reach a good understanding of the key concepts for the day? Could the learners use the language expected from them? Could the learners write what was expected from them?
- Did the learners cope with the work set for the day? For example: Did they finish the classwork? Was their classwork done to an adequate standard? Did I assign any homework?
- What can I do to support learners who did not manage the work, or to extend those who completed the work easily?
- What might I change next time I teach this same content? Will I try a different approach?

B. TERM PLANNING

Before considering weekly and daily plans which are set out in the tracker, think about the term as a whole.

1. Check the term focus

Take note of the focus for the term. The CAPS document provides clear details regarding the focus for Grade 12:

Term 1 – *Physics:*
Momentum and impulse
Vertical projectile motion in one dimension

Chemistry:
Organic chemistry

Term 2 – *Physics:*
Work, energy and power
The Doppler effect

Chemistry:
Rate and extent of reaction
Chemical equilibrium
Acids and bases

Term 3 – *Physics:*
Electric circuits
Electrodynamics
Optical phenomena

Chemistry:
Electrochemical reactions
The chemical industry

Term 4 – Revision

Overview of Term 3

The preliminary examinations usually take up 3 weeks of the time allocated to teaching and learning, so it is essential to keep up to date with the CAPS schedule of work for Grade 12 during this term.

Electric circuits

In Grade 11, learners solved problems of series, parallel, and combinations of series and parallel circuits using Ohm's Law, the formulae for calculating effective resistance of combinations of resistors, and for calculating energy transferred and power in circuits. This topic builds on this knowledge and understanding by introducing the electromotive force (emf) of the battery and its internal resistance.

The prescribed experiment for Term 3 measures the internal resistance of a cell, and determines the effective resistance of a series and parallel combination of resistors. This experimental work gives learners the opportunity to test theory with a practical investigation. Both of the textbooks have detailed and clear instructions on how these investigations can be carried out. A post-investigation worksheet is provided in Section F. This worksheet can be used to test the learners' understanding of the practical work and to find out whether they are able to apply knowledge to solve problems. A memorandum is supplied.

The internal resistance can be treated just like another resistor in the circuit. The sum of the voltages across the external circuit plus the voltage across the internal resistance is equal to the emf.

$$\varepsilon = V_{load} + V_{internal\ resistance}$$

V_{load} is also referred to as the terminal potential difference $V_{terminal}$ in some textbooks and examination questions.

$V_{internal\ resistance}$ is sometimes referred to as the 'lost volts' since the energy per unit charge in transferring charge through the battery (cell) is 'lost' for use in the external circuit. The voltage is, however, not 'lost'.

Electrodynamics

Faraday's Law of electromagnetic induction governs the generation of electricity when a coil is linked to **changing** magnetic flux. This is how generators work.

The **motor effect** governs the rotation of a current-carrying coil when it is placed within a magnetic field.

Although both a motor and a generator consist of a coil placed in a magnetic field, they operate on these two distinct principles. It is useful to remind learners that a motor requires electricity in order to work – e.g. you have to plug a fan into the power supply to turn it on to move the air. A generator generates electricity – it therefore does not have a power supply attached to it – it provides electricity at its terminals.

Optical phenomena and properties of matter

The photoelectric effect gives definitive evidence of the quantisation of electrons in energy levels. The mystery of why and how it occurs fascinated Einstein, because it cannot be explained by the classical model of light as a wave. Einstein came up with the startling idea that light is both a wave and a particle. When explaining the details of this effect, it is important to emphasise how Einstein's explanation of it changed scientists' thinking from 1905 onwards.

Section E contains some ideas on how to teach the photoelectric effect. These ideas come from the British Institute of Physics TAP (Teaching Advanced Physics) series which is available on the internet.

The University of Colorado produce the PHET simulations that cover many topics in Physics, Chemistry and Biology. The beauty of these simulations is that they are designed to give similar results to 'real-life' experiments, and they are authored and checked by university professors before they are released to the public.

The PHET simulation for the photoelectric effect is an excellent teaching tool. You can use it in many different ways to demonstrate the photoelectric effect experiment. There are also quite a few YouTube videos of teachers explaining the effect while making use of the PHET simulation. One of the better clips, found at https://www.youtube.com/watch?v=ubkNGwu_66s, demonstrates the basics of the effect.

Another very useful article is https://allinonehighschool.files.wordpress.com/2013/06/day-168-photoelectric-lab.pdf. The author shows how learners can use the simulation to work their own way through the theory. This site also provides a worksheet for the learners, as well as a memorandum.

Another topic that is difficult to explain or demonstrate is line emission and absorption spectra, as many schools do not have the necessary apparatus. The origin of spectral lines is well presented and explained in http://www.avogadro.co.uk/light/bohr/spectra.htm. The TAP series also has a very useful set of teaching tips for this topic. These can be found in Section F of this tracker.

Electrochemical reactions

Redox reactions were introduced to the learners in Grade 11. They need to be reminded about oxidation, reduction, oxidising and reducing agents and oxidation numbers when you start teaching this topic.

It is important that single arrows are used in redox chemical equations and half reactions because the equations show that the reaction will effectively be proceeding in that direction, even though we know that all chemical (equilibrium) reactions are by nature able to be reversed.

The electrochemical (galvanic) cell transfers chemical energy to electrical energy, and the process of electrolysis transfers electrical energy to chemical energy. These two cells work in the 'opposite' way. Learners tend to confuse the processes by which they work, and hence they struggle to write appropriate half reactions and/or to identify the cathode and anode correctly.

The chemical industry

The chemical industries topic involves considerable amounts of rote learning, as well as integration of prior knowledge of chemical equilibrium, stoichiometry and redox reactions. The CAPS syllabus stipulates 6 hours of teaching time for this topic; however, it will have to be condensed into 4 hours in order to complete the syllabus before the preliminary examinations. While teaching this you can revise many of the other sections too.

Section G of this document provides an extract from the Chemical Industries Resource Pack which may help learners to work through the content. The complete resource pack is found at http://open.uct.ac.za/handle/11427/7445. This site also has animations of the processes and will enhance your learners' understanding.

2. Prepare resources

This stage in your preparation is vital. The prescribed Learner's Books provide both information and activities. The Teacher's Guides also provide valuable information as teaching guidelines. When you are planning, you need to be familiar with the information in the textbook your learners will be using. This will ensure that you do not need to either read from the textbook or ask your learners to copy down notes from the chalkboard or projector.

Teaching Physical Sciences should not be based on reading and discussing the textbook. Learners need activities, demonstrations, problem solving opportunities and active debates. This all takes careful planning and preparation of resources.

Resources can range from everyday objects such as a battery powered toy car moving up an inclined plane, to more scientific apparatus like burettes, volumetric flasks and universal pH strips, or even digital resources like a short video clip or simulation. Whatever resource you select as the focus of the lesson, make sure you think carefully about the questions you will ask learners to think about and discuss. You may plan these discussions in pairs or small groups. Through observation, reflection and discussion you will engage learners in helping them construct their own knowledge. It is important to challenge this knowledge and at times disagree with them even if they are correct. You can also present a common misconception and encourage them to be critical of the proposed idea.

Problem solving and application of knowledge are very important in Physical Sciences. Your learners will need to practise exam-type questions; the textbooks all give worked examples. There are also end-of-chapter or unit questions, exam practice and additional worksheets. These have been referenced in the tracker for each book and are included as homework activities. However, in some cases the Learner's Book may not have enough questions and we have referred you to additional activities from the ***Everything Science*** textbook. If your learners don't have a copy, they can access these questions online from www.everythingscience.co.za. The Learner's Books can also be downloaded or print copies can be ordered from a supplier referred to on the same site. There is a huge database of questions that will be very useful for learners to work through both for remediation, revision and extension. Not all the activities are referenced in the tracker. If you identify that your learners are struggling in a particular section, select questions that are relevant to them.

A list of resources for the term appears below in case you want to collect these well in advance. Otherwise resources are listed per week. You will find it worthwhile to collect these well in advance and leave them in a box or something similar. This way, you will avoid a last-minute rush. Remember that some materials are used on several different occasions, so keep laboratory equipment safe and well cleaned. Depending on how quickly your learners complete a section, and on what activities you choose, you may find that you are still on a certain week when the following week's requirements are listed. Continue normally and check with the CAPS document to find out what you still need.

Solutions for All	
Week	**Resources**
1	1,5 V battery (cell), resistor, ammeter, voltmeter, switch, connecting leads Length of low-resistance wire Copies from Section F of "Further questions to answer after completing the investigation on electric currents".
2	https://www.youtube.com/watch?v=gQyamjPrw-U https://www.youtube.com/watch?v=gQyamjPrw-U http://www.physics-chemistry-interactive-flash-animation.com/electricity_electromagnetism_interactive/laplace_lorentz_force_electric_motor_principle_brushes_split_ring.htm Optional: Materials to build a generator and/or motor: Enamel-coated copper wire, 4 large ceramic block magnets, cardboard (packaging), large nail, 1.5 V 25 mA light bulb, 9 V cell
3	Gold leaf electroscope, zinc plate, UV lamp (see Section F of this tracker) Mercury discharge lamp, photosensitive vacuum tube, set of light filters, circuit to produce retarding voltage across phototube, oscilloscope, ammeter Copies of Section G Worksheet 1 (as homework) https://phet.colorado.edu/sims/photoelectric/photoelectric_en.jnlp
4	Zinc, lead, aluminium and copper electrodes, zinc sulphate, copper sulphate, lead nitrate, sodium hydroxide, potassium nitrate, four beakers, sandpaper Three test tube racks; 9 large test tubes; solutions of chlorine water, bromine water and iodine water; 0,2 $mol.dm^{-3}$ solutions of halides NaCℓ, Na Br and NaI; non-polar solvent such as xylene or dichloromethane; three droppers; glass stirring rod
5	Water bowl, electrodes for the electrolysis of water, test tubes, conductivity wires, 9 V battery, current indicator (LED), water and sodium iodide and sodium sulphate

Solutions for All	
Week	**Resources**
6	Zinc; lead; aluminium and copper electrodes; solutions of zinc sulphate, copper sulphate, lead nitrate, sodium hydroxide and potassium nitrate; 2 beakers; U-tube; cotton wool; voltmeter; connecting leads
7	Section G Worksheet 4: Chemical industries (fertilisers)

Study and Master	
Week	**Resources**
1	1,5 V battery, 3 resistors of different values, ammeter, voltmeter, switch, 7 connecting leads 1,5 V battery, 3 resistors of different values, ammeter, voltmeter, switch, minimum of 7 connecting leads **Demonstration:** Battery, connecting wires, several resistors of different values, several voltmeters, several ammeters, switches, a length of low resistance wire Copies from Section F of "Further questions to answer after completing the investigation on electric currents".
2	https://www.youtube.com/watch?v=gQyamjPrw-U https://www.youtube.com/watch?v=gQyamjPrw-U http://www.physics-chemistry-interactive-flash-animation.com/electricity_electromagnetism_interactive/laplace_lorentz_force_electric_motor_principle_brushes_split_ring.htm Enamel-coated copper wire, 4 large ceramic block magnets, cardboard (packaging), large nail, 1.5 V 25 mA light bulb, 9 V cell
3	Gold leaf electroscope, zinc plate, UV lamp (see Section F of this tracker) Mercury discharge lamp, photosensitive vacuum tube, set of light filters, circuit to produce retarding voltage across phototube, oscilloscope, ammeter Copies of Section G Worksheet 1 (as homework) https://phet.colorado.edu/sims/photoelectric/photoelectric_en.jnlp
4	Zinc, lead, aluminium and copper electrodes; solutions of zinc sulphate, copper sulphate, lead nitrate, sodium hydroxide and potassium nitrate; 2 beakers; U-tube; cotton wool; voltmeter; connecting leads
5	Materials for the electrolysis of water: Water bowl, two electrodes for the electrolysis of water, two test tubes, conductivity wires, 9 V battery, current indicator (LED), water, sodium iodide or sodium sulphate, glass or plastic rod Materials for the reduction of metal ions and halogens: Test tube stand with test tubes, glass rod, thermometer, spatula and glass rod; Metal powders: Mg, Zn, Cu, Fe Salt solutions: $CuSO_4$(aq), $ZnSO_4$(aq), $MgSO_4$(aq), $NaC\ell$(aq) Halide solutions: $KC\ell$ (aq), KBr(aq), KI(aq), chlorine water (or household bleach), bromine water; Non-polar solvent: tetrachloromethane ($CC\ell_4$)
7	Copies of Section G Worksheet 4: Chemical industries (fertilisers)

3. Plan for required formal assessment tasks

In Term 3, the CAPS requires that learners do practical work to determine the emf of a cell (battery) and to compare the effective resistance of a series and parallel circuit with its theoretical value. They also write the preliminary examination. Most of the Learner's Books and/or Teacher's Guides provide examples of CAPS-compliant formal assessment tasks, including practical investigations and revision activities.

Table 1 gives an overview of the practical task/investigations in each of the sets of LTSMs, and the week in which the work is scheduled in each tracker. This will help you in your preparation.

Please note: The DBE occasionally makes changes to the assessment requirements published in the CAPS. If any changes are made after this document is printed, you will need to adjust the assessment programme provided here and in the trackers accordingly.

Table 1: FORMAL ASSESSMENT TASKS INCLUDED IN EACH SET OF APPROVED LTSMs FOR TERM 3

Name of book	Practical investigation	Control test
Solutions for All	**Week 1:** EMF of a cell Effective resistance of a series and parallel circuit LB pp. 339–340 TG pp. 242–244	**Week 9–11:** Prelim examinations provided by the KZN Department of Education
Study and Master	**Week 1:** Emf of a cell Effective resistance of a series and parallel circuit LB pp. 267–269 TG pp. D71–D72	**Week 9–11:** Prelim examinations provided by the KZN Department of Education

The mid-year and prelim examinations are not only used as the basis of the School Based Assessment but provide learners with an opportunity to prepare for the final examination. It is extremely important that learners do not repeat the same types of errors. This means that learners need feedback about their strengths and weaknesses. No time has been allocated in the tracker for this review and feedback so you will need to build this into lessons or arrange feedback after school hours.

A grid for the analysis of results has been included in Section F to assist you and your learners. You can use this grid to identify individual learner strengths and weaknesses, as well as to help you reflect on your teaching. Look for topics where the majority of your learners are getting the questions correct – these topics have most probably been taught well. Also identify questions where the majority of learners got the answers wrong. You should identify common errors and address these with learners.

The reason for poor performance may not only be related to an understanding of Science concepts. Learners may also perform poorly in exams because of poor exam techniques. You may need to give learners guidelines to help them improve. For example, many learners struggle to manage their time in the exam and so do not finish all the questions. Learners can improve their time management by sticking to a strict schedule of spending a minute per mark for each question. If they are stuck they must leave the question and move on. There will be time to come back to more difficult questions at the end of the exam. It is also important that learners answer the topic they like best first. This will give them confidence to do well.

Apart from good exam techniques, you need to encourage your learners to learn the definitions and laws. They should be very familiar with the data sheet but are not required to learn the values of constants. You should encourage learners to go through the Examination Guidelines for Physical Sciences in preparation for both the prelim and final exams. They can use the items listed as a checklist in their exam preparation. The Exam Guidelines can be downloaded from: www.ecexams.co.za/Exam_Guidelines.htm

4. Plan for informal assessment

In addition to specifying the number and nature of the formal assessment tasks, the CAPS document suggests that there should also be ongoing informal assessment each term. Learners can do a variety of informal assessment tasks, both in class and for homework, and many of the Learner's Book activities are useful for this purpose. Informal assessment tasks do not have to be marked by the teacher. You can allow learners to mark their own or each other's work. You should consider taking in about five or six pieces of work from time to time to help you assess progress informally and also to keep learners attentive. Give learners a surprise by changing your review techniques from time to time.

While learners do not always need marks for their work, they do need feedback, and you need to know what they managed or did not manage in the task in order to correct and support their learning. You may like to record any marks that are awarded or key comments for your own interest.

Table 2: INFORMAL ASSESSMENT TASKS FOR TERM 3

Name of book	Informal practical investigation	Page numbers
Solutions for All	**Week 1:** Short circuits and open circuits	LB pp. 345–346 TG pp. 248–249
	Week 3: The photoelectric effect	LB pp. 402–403 TG pp. 329–330
	Week 4: Investigate the reduction of metal ions and halogens	LB pp. 434–438 TG pp. 351–353
	Week 5: Investigate electrolysis of water and sodium iodide	LB pp. 449–451 TG pp. 361–363
	Week 6: Find the galvanic cell with the highest potential	LB pp. 453–454 TG pp. 363–365
Study and Master	**Week 1**: Short circuits and open circuits	LB pp. 270–271 TG pp. D73–D75
	Week 3: The photoelectric effect	LB pp. 306–307 TG p. D84
	Week 4: Find the galvanic cell with the highest potential	LB pp. 325–326 TG p. D89
	Week 5: Investigate electrolysis of water and sodium iodide	LB pp. 326–327 TG pp. D89–D90
	Investigate the reduction of metal ions and halogens	LB pp. 327–328 TG pp. D90–D91

C. DAILY LESSON PLANNING AND PREPARATION

The tracker provides details of the content (in hour sessions) that you need to teach to your class. However, to deliver the lessons successfully, you must do the necessary preparation yourself. This entails a number of key steps that range from ensuring that you have a good understanding of the term focus through to checking the detailed preparation of resources needed for each lesson. The Physical Sciences require a range of resources, from printed material to typical science apparatus, such as test tubes, or household items including food items.

1. Check your own knowledge of the content

However well you know your work, it is easy to make small mistakes when in a classroom with learners asking questions. Always read through the content that you are going to cover to ensure that you are very familiar with the work. If possible, also do additional reading from other sources. Refer to Section E *Additional Information and Enrichment Activities* of this document where additional information about many of the topics for the term and some common errors – not always made explicit in the Learner's Books or Teacher's Guides – are addressed.

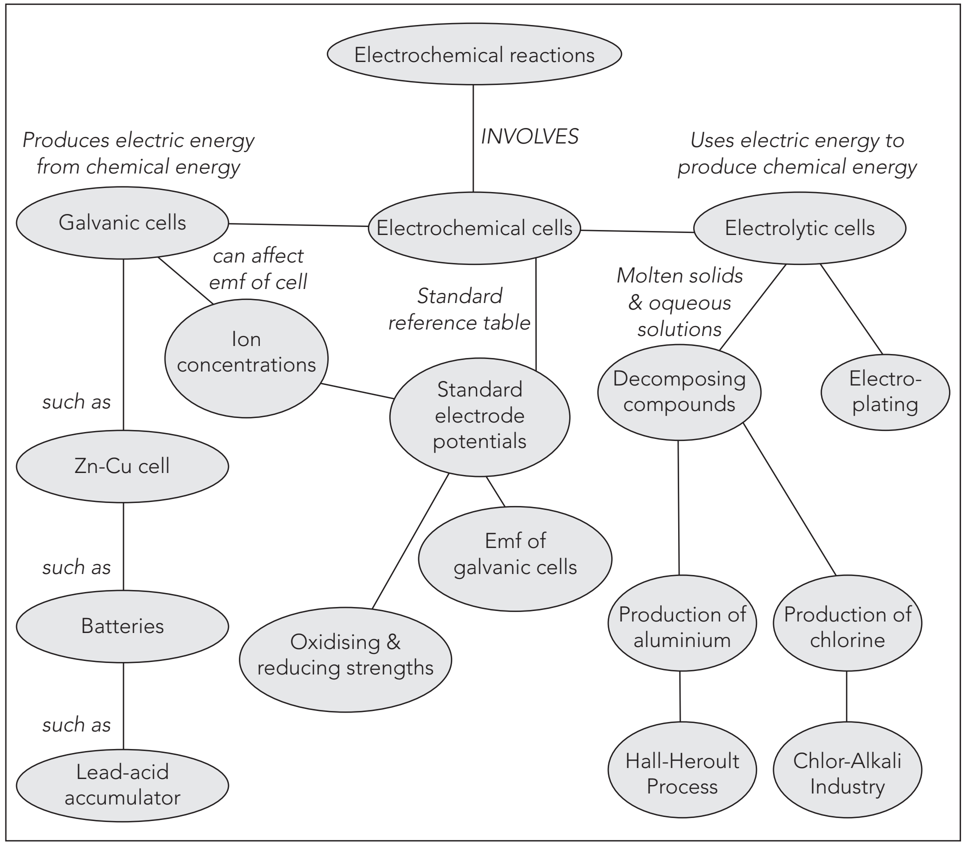
2. Prepare the conceptual framework for the lesson topic

When preparing the content to be taught think carefully about how the concepts are organised in a conceptual framework; how to help learners develop this framework for themselves; what possible questions learners might ask; and difficulties learners might have and how to address these.

One way of preparing the content is to summarise it using a tool like a concept map, as shown in Figure 1. Note that a concept map is different from a mind map because it describes the links between the concepts to show the relationship between concepts. When you introduce a topic, learners will benefit from seeing the big picture and a concept map is a useful way to present this. It is also a useful way of showing learners how the class is progressing. At the end of the topic encourage your learners to make their own summaries in words and/or pictures. In this way, they will interact with concepts, and this in turn will promote deep learning.

While you prepare the conceptual framework, it is important to think about what prior knowledge learners should have and to have a clear idea of where and when they will need to draw on the concepts taught in the Grade 12 lessons. For this purpose, it is vital that you are familiar with the Grade 12 Examination Guide for Physical Sciences and also with the topics taught in Grades 10 and 11. In your preparation, think carefully about the types of questions learners will ask. You may want to pre-empt some of these questions by asking open-ended questions to arouse learners' curiosity and to engage them in the process of learning. It is also a good idea to leave a question unanswered for a short time and let the lesson activities suggest a possible answer. If the question is still unanswered, then you should provide the necessary help. Doing this will provide good opportunities for you to correct any wrong ideas or misconceptions.

Figure 1: CONCEPT MAP OF ELECTROCHEMICAL REACTIONS



3. Baseline assessment and remediation of misconceptions

Baseline assessment should take place at the beginning of each new topic. This enables you to establish what learners already know and to pick up any possible misconceptions. Some of the most common misconceptions have been addressed in relation to the relevant CAPS content in Section E *Additional Information and Enrichment Activities*. Baseline assessment can take many forms – such as a quick question and answer session; or a paper and pencil activity. Once a gap in understanding or a misconception has been identified (e.g. some people think that when you kick a ball, it continues to move forward because of the force of the kick), address these misconceptions before moving on to teaching the new work for the term. In this context the word remediation refers to overcoming the learners' wrong ideas.

4. Learner activities

Think about the tasks that learners need to complete in each lesson because it is important that they do something constructive. On rare occasions they may copy something from the chalkboard or another medium, but this should not be the sole focus of the lesson. Some examples of activities they can do in each lesson include, answering questions by writing the answers (the CAPS encourages writing); completing translation activities by converting a drawing to a description, or a table to a graph. You set the stage for the learner activities by giving explanations about different concepts, asking questions, setting problem-solving activities, or giving clear instructions about what learners need to do.

In Section E *Additional Information and Enrichment Activities* you will find ideas for activities linked to several CAPS topics beyond the scope of those given in many of the LTSMs. Refer to this resource when preparing your lessons. In some instances, a more appropriate practical activity than the one in the Learner's Book has been included for your use.

Ensure that you have enough chalk or markers. Where instructions in the Learner's Book that you are using is not clear, use the chalkboard (or whatever media you use in your classroom) to draw or write instructions about what the learners need to do in order to complete the prescribed activity. Chalkboards are also useful for the writing down and explaining of new vocabulary.

Always allow time in your lessons to review learners' work and to give formative feedback on any assessment that has been done. Ensure that during peer or self-assessment you have a list of possible answers.

5. Learners with special needs

People are not all the same. Learners will attend the Physical Science classes with different needs, styles of learning and also with a variety of alternative ideas about scientific phenomena. It is challenging for a teacher to accommodate all these differences, but it is important that you consider these differences during your preparation.

For different learning styles, the teacher can use a variety of teaching methods. These include whole class teaching, peer interaction, small-group learning, writing activities, drawing and mind-mapping activities, presentations, debates and role play. Wherever possible, encourage reading, writing and speaking skills.

There is a large amount of additional information to help you in the Teacher's Guides. The Learner's Books also provide additional suggestions. Additional to this, the DBE has published some excellent materials to support you in working with learners with learning barriers. Two such publications are:

- Directorate Inclusive Education, Department of Basic Education (2011) *Guidelines for responding to learner diversity in the classroom through curriculum and assessment policy statements.* Pretoria. www.education.gov.za, www.thutong.doe.gov.za/InclusiveEducation
- Directorate Inclusive Education, Department of Basic Education (2010) Guidelines for inclusive teaching and learning. Education White Paper 6. Special needs education: Building an inclusive education and training system. Pretoria. www.education.gov.za, www.thutong.doe.gov.za/InclusiveEducation

6. Enrichment

In certain tasks, learners will work at different speeds. For those learners who complete their work earlier than others, refer to enrichment or extension activities in the Teacher's Guide, those suggested in Section E *Additional Information and Enrichment Activities* or provided in Section G *Additional Worksheets* and in ***Everything Science***.

7. Homework

It is essential for Grade 12 learners to do homework every day. Examine the tracker and decide what sorts of tasks are appropriate for homework each week. Allow a few minutes at the end of each lesson to provide homework instructions. Homework can be a useful consolidation exercise and need not take learners very long. If well planned in advance, learners can sometimes be given a longer homework exercise to be handed in within a week. This arrangement allows for flexibility.

If you allocate homework tasks, it is essential to allow a few minutes at the start of the following lesson to review the previous day's homework.

8. Practical work

Practical work must be integrated with theory to strengthen the concepts being taught. This may take the form of simple practical demonstrations or an experiment or practical investigation. Some of these practical activities will be done as part of formal assessment and others can be done as part of informal assessment. In Grade 12, learners must do three out of the four prescribed experiments for formal assessment (one Chemistry, one Physics and then a choice between a Chemistry or Physics experiment). Learners need to understand and experience that practical work in Physical Science distinguishes this discipline from other knowledge areas.

In Term 3, learners are required to determine the emf of a cell (battery) and to compare the effective resistance of a series and parallel circuit with its theoretical value.

For learners to achieve the most from their experience of practical work, you need to be extremely well prepared. Think carefully and plan how to accommodate all learners in doing practical activities. In most schools, there may be a limited amount of equipment. This means that you may need to give groups of learners the opportunity to complete the practical work after school hours. If equipment is limited, one solution is to set up different stations with different equipment. Learners rotate from one station to the next in order to complete a series of experiments.

Learners also need to be well prepared for any formal or informal practical work. In the trackers, you will see that learners are required to review the investigations for homework on the day before they are required to do the investigation. You could ask them to complete pre-practical questions.

Safety is critical whenever doing practical work. Please ensure you discuss safety rules with your learners regularly. Refer to the websites below that deal with laboratory safety:

- International chemical safety cards: www.inchem.org/pages/icsc.html
- Merck safety data sheets: www.merck-chemicals.com/msds-search/
- School chemistry laboratory safety guide: www.cdc.gov/niosh/docs/2007-107/pdfs/2007-107.pdf

- WCED laboratory safety guidelines: www.curriculum.wcape.school.za/site/52/pol/view/

To conduct a successful practical activity, the following procedures are suggested:

- Before the practical session, check that the materials are the correct ones so that no mistakes occur.
- Talk through the activity with learners or get them to read the descriptions from the Learner's Book before they come to a practical class.
- Stop from time to time to emphasise certain points. For example, **remember to use safety glasses and not to look directly at burning magnesium**.
- Let learners sometimes work in their chosen groups of friends and change the groups on other occasions.
- Keep a watchful eye on the activity and walk around looking at what learners are doing. This teaching strategy provides you with the opportunity to assess their skills of working with apparatus.
- Drawing the experimental set-up on the chalkboard or another medium helps learners to focus.
- Ensure that books and bags are safely stowed away from the practical work area.
- Enforce a strict rule of **no tasting**. There should be no eating of any kind in the laboratory or classroom where investigations are conducted.
- Ensure that work areas are clean both before and after the practical activity.
- Encourage learners to wear plastic aprons and safety glasses and insist on closed shoes wherever possible.
- Insist on the correct labelling of all tubes and bottles.
- Set a good example by following correct procedures at all times.
- Insist that learners tidy their workplaces when they have finished.
- Have a supply of tap water at hand in case of accidental acid spills. Do not attempt to neutralise acids and bases on a learner or yourself. Simply wash with plenty of water.
- Have a fire extinguisher handy and know how to use it.
- Keep a supply of gauze and plasters in a simple first aid box. A plastic container works well.

D. TRACKERS FOR EACH SET OF APPROVED LTSMs

This section maps out how you should use your Physical Sciences Learner's Book and Teacher's Guide in a way that enables you to cover the curriculum sequentially and in a well-paced manner, aligning with the CAPS for meaningful teaching.

The following components are provided in the columns of the tracker:

1. Lesson number
2. CAPS concepts, practical activities, assessment tasks and page reference number
3. Learner's Book page number
4. Learner's Book activity/task
5. Teacher's Guide page number
6. ***Everything Science*** Learner's Book page number
7. ***Everything Science*** Teacher's Guide page number
8. Completion date

In addition, a list of resources for each session and enrichment ideas are provided.

Weekly reflection

The tracker provides space for you to jot down both successes and ideas for a different approach in future years. This reflection should be based on the daily sessions you have taught during the week.

Share your ideas with colleagues and with your HOD. Discuss aspects that went well and aspects that did not go as well as you expected.

- Did the learners grasp the main concepts of the lesson?
- Was my content preparation adequate?
- Did I have all the correct resources in sufficient numbers?
- Did the learners interact with the learning material provided?
- Did learners ask and answer questions relating to the concept?
- Did the learners finish their work in time?
- Was there enough work to keep learners busy for the allocated time?
- What quality of homework did learners produce?

Put your thoughts in writing by briefly jotting down your reflections each week but **think** about your lessons daily.

The prompts for reflection in the tracker are as follows:

- *What went well?*
- *What did not go well?*
- *What did the learners find difficult or easy to understand or do?*
- *What will you do to support or extend learners?*
- *What will you change next time? Why?*
- *Did you complete all the work set for the week?*
- *If not, how will you get back on track?*

The reflection should be based on the daily lessons you have taught each week. It will provide you with a record for the next time you implement the same lesson, and also forms the basis for collegial conversations with your HOD and peers.

Explanation of abbreviations and symbols used in the trackers

#	Examined in Grade 12
A	Answer
Act.	Activity
CA	Class activity
CP	Check Point (*Solutions for All*)
Demo.	Demonstration
ES	*Everything Science*
Ex.	Exercise
Exp.	Experiment
EY	Extend Yourself (*Solutions for All*)
HOD	Head of Department
IA	Informal assessment
IKS	indigenous knowledge systems
Inv.	Investigation
LB	Learner's Book
No.	Number
p.	Page
PA	Practical activity
pp.	Pages
PT	Periodic table
Q.	Question
S #	Hour session
SA	Summative Assessment (*Study and Master*)
TG	Teacher's Guide
TY	Test Yourself (*Study and Master*)
WS	Worksheet

1. *Physical Sciences Solutions for All* (Macmillan South Africa)

This Learner's Book has a wide variety of exercises for classwork and homework as each concept is introduced. The exercises are relatively challenging. They promote the development of thinking skills and adequately cover the type of questions that learners can expect to answer in the CAPS NSC examinations.

If the learners in your class(es) have difficulty solving these problems, there is an option to set them homework from ***Everything Science*** and to tackle the more demanding questions collaboratively in a class during lessons. You will find references to the exercises in ***Everything Science*** which could supplement or replace the homework for the day. This idea may work very well with classes of mixed ability. The more able learners will be extended by the exercises in *Solutions for All*, while those learners who work at a slower pace can gain confidence through working with the ***Everything Science*** exercises.

***Physical Sciences Solutions for All* Week 1: Electric circuits**												
S #	**CAPS concepts, practical activities and assessment tasks**	**CAPS pp.**	**LB pp.**	**LB act.**	**TG pp.**	***Everything Science***		**Class**				
						LB	**TG**	**Date completed**				
1	**Internal resistance and series and parallel networks** • Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel • State that a real battery has internal resistance • The sum of the voltages across the external circuit plus the voltage across the internal resistance is equal to the emf: $\varepsilon = V_{load} + V_{internal\ resistance}$ *or* $\varepsilon = IR_{ext} + I_r$	129	332–335	CP 1 CP 2	253–293 231–234 238–240	376–389	198					
	Homework: Check Myself Q. 1–19	129	328–331	Q. 1–19	234–238	385–387	199–211					
2	• Solve circuit problems in which the internal resistance of the battery must be considered • Solve circuit problems, with internal resistance, involving series-parallel networks of resistors	129	335–338 341	CP 3 CP 4 Ex. 9.1 Q. 1–3	240–242 244–245	391–401	211–214					
	Homework: Ex. 9.1 Q. 4–8	129	342–344	Ex. 9.1 Q. 4–8	245–246	402–405	214–221					
3	**Prescribed experiment for formal assessment:** **Part 1:** Determine the internal resistance of a battery **Part 2:** 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 Section F: Further questions to answer after completing the investigation on electric circuits	129	339–340	Practical	242–244 247–248	389–391						

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Date completed				
						LB	TG					
Resources: **Part 1:** 1,5 V battery, resistor, ammeter, voltmeter, switch, 6 connecting leads **Part 2:** 1,5 V battery, 3 resistors of different values, ammeter, voltmeter, switch, minimum of 7 connecting leads												
Homework: Ex. 9.1 Q. 9–11		129	344	Ex. 9.1 Q. 9–11	247							
4	**Demonstrate short circuits and open circuits (recommended practical investigation)** Solve circuit problems, with internal resistance, involving series-parallel networks of resistors	129	345–346 346–347	Practical EY Q. 1–3	248–251	384–385						
	Recommended practical investigation for informal assessment: Set up a series-parallel network with an ammeter in each branch and external circuit and voltmeters across each resistor, branch and battery, position switches in each branch and the external circuit Use this circuit to investigate short circuits and open circuits **Materials:** Battery, connecting wires, several resistors of different values, several voltmeters, several ammeters, switches, a length of low resistance wire											
Homework: EY Q. 4–6		129	347–348	EY Q. 4–6	251–253	376–384						

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why?
	HOD: **Date:**

Physical Sciences Solutions for All — Week 2: Electrodynamics												
S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Class				
						LB	TG	Date completed				
1	**Electrical machines (generators, motors)** • State that generators convert mechanical energy to electrical energy and motors convert electrical energy to mechanical energy • Use Faraday's Law to explain why a current is induced in a coil that is rotated in a magnetic field	130	352–362	CP 1 CP 2	293–299	408–412	224					
Resources: https://www.youtube.com/watch?v=gQyamjPrw-U												
Homework: Ex. 10.1 Q. 1–5			364–365		300–303	408–412						
2	• Use words and pictures to explain the basic principle of an AC generator (alternator) in which a coil is mechanically rotated in a magnetic field • Use words and pictures to explain how a DC generator works and how it differs from an AC generator • Give examples of the use of AC and DC generators	130	359–368		304							
Resources: https://www.youtube.com/watch?v=gQyamjPrw-U												
Homework: Ex. 10.2 Q. 1–7			369		305–307	415 Q. 1–4	224–225					
3	• Explain why a current-carrying coil placed in a magnetic field (but not parallel to the field) will turn by referring to the force exerted on moving charges by a magnetic field and the torque on the coil • Use words and pictures to explain the basic principle of an electric motor • Give examples of the use of motors	130	370–375	CP 3 CP 4	307–309	412–415						
Resources: Electric motor simulation http://www.physics-chemistry-interactive-flash-animation.com/electricity_electromagnetism_interactive/laplace_lorentz_force_electric_motor_principle_brushes_split_ring.htm												
Homework: Ex. 10.3 Q. 1–9			376–379		310–313	415 Q. 5–8	224–225					
4	**Alternating current** • Explain the advantages of alternating current • Write expressions for the current and voltage in an AC circuit • Define the rms (root mean square) values for current and voltage as: $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ and $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ respectively, and explain why these values are useful • Know that the average power is given by: $P_{av} = I_{rms}V_{rms} = \frac{1}{2}I_{max}V_{max}$ for a purely resistive circuit • Draw a graph of voltage vs time and current vs time for an AC circuit		380–383	CP 5 CP 6	313–315	416–422						

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science* LB	*Everything Science* TG	Date completed				
Homework: Ex. 10.4 Q. 1–3		131	383–384		315	418–419	225–227					
	Project: Build a simple electric generator **Project:** Build a simple electric motor **Materials:** Enamel-coated copper wire, 4 large ceramic block magnets, cardboard (packaging), large nail, 1.5 V 25 mA light bulb, 9 V cell											

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why? **HOD:** **Date:**

Physical Sciences Solutions for All Week 3: Electrodynamics, optical phenomena and properties of materials

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science* LB	*Everything Science* TG	Class				
								Date completed				
1	• Solve problems using the concepts of: I_{rms} V_{rms} P_{av}	131	383–385	Ex. 10.4 Q. 4–10	315–319	419–422						
Homework: EY Q. 1–4			389–390	EY Q. 1–4	321–323	423	227–229					
2	Advantages of using AC current	131	386–388	Ex. 10.5 Q. 1–5	319–321							
Homework: EY Q. 5–9			389–390 390–391 396–397	EY Q. 5–9	323–325							

<table>
<tr><th rowspan="2">S #</th><th rowspan="2">CAPS concepts, practical activities and assessment tasks</th><th rowspan="2">CAPS pp.</th><th rowspan="2">LB pp.</th><th rowspan="2">LB act.</th><th rowspan="2">TG pp.</th><th colspan="2">Everything Science</th><th rowspan="2">Date completed</th></tr>
<tr><th>LB</th><th>TG</th></tr>
<tr><td rowspan="2">3</td><td>• Photoelectric effect
• Describe the photoelectric effect as the process that occurs when light shines on a metal and it ejects electrons
• Give the significance of the photo-electric effect:
– it establishes the quantum theory
– it illustrates the particle nature of light
• Define cut-off frequency, f_o</td><td>132–133</td><td>398–403</td><td>Practical demon-stration</td><td>326–330</td><td>426–429</td><td>232</td><td></td></tr>
<tr><td colspan="8">Practical demonstration: Photoelectric effect
Materials: Gold leaf electroscope, zinc plate, UV lamp (see Section F of this tracker)
Mercury discharge lamp, photosensitive vacuum tube, set of light filters, circuit to produce retarding voltage across phototube, oscilloscope, ammeter</td></tr>
<tr><td colspan="9">Resources: https://phet.colorado.edu/sims/photoelectric/photoelectric_en.jnlp</td></tr>
<tr><td colspan="2">Homework: Read and make short notes on pp. 398–403</td><td></td><td>398–403</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4</td><td>• Define work function and know that the work function is material-specific
• Know that the cut-off frequency corresponds to a maximum wavelength
• Apply the photo-electric equation: $E = W_o + KE_{max}$ where $E = hf$, $W_o = hf_o$ and $KE_{max} = \frac{1}{2}mv^2_{max}$
• Know that the number of electrons ejected per second increases with the intensity of the incident radiation</td><td>132–133</td><td>404–409</td><td>CP1
CP2
CP3
CP4</td><td>330–332</td><td>428–434</td><td>233</td><td></td></tr>
<tr><td colspan="2">Homework: Ex. 11.1 Q. 1–4
Alternative homework: Section G Worksheet 1</td><td></td><td>412–413</td><td></td><td>333–334</td><td>434–435
Ex. 12.1
1–2</td><td>233</td><td></td></tr>
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<table>
<tr><th colspan="2">Reflection</th></tr>
<tr><td rowspan="2">Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?</td><td>What will you change next time? Why?</td></tr>
<tr><td>HOD: Date:</td></tr>
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<table>
<tr><th colspan="13">Physical Sciences Solutions for All Week 4: Optical phenomena and properties of materials, electrochemical reactions</th></tr>
<tr><th rowspan="3">S #</th><th rowspan="3">CAPS concepts, practical activities and assessment tasks</th><th rowspan="3">CAPS pp.</th><th rowspan="3">LB pp.</th><th rowspan="3">LB act.</th><th rowspan="3">TG pp.</th><th colspan="2">Everything Science</th><th colspan="5">Class</th></tr>
<tr><th></th><th></th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><th>LB</th><th>TG</th><th colspan="5">Date completed</th></tr>
<tr><td>1</td><td>• Know that if the frequency of the incident radiation is below the cut-off frequency, then increasing the intensity of the radiation has no effect, i.e. it does not cause electrons to be ejected
• Understand that the photoelectric effect demonstrates the particle nature of light</td><td>132–132</td><td>409–415</td><td>Ex. 11.1 Q. 5–10</td><td>335–337</td><td>434–435 Ex. 12.1 3–5</td><td>233–235</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Homework: EY Q. 1–3</td><td></td><td>427–428</td><td></td><td>343–345</td><td>441 Ex. 12.3 1–2</td><td>236–237</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Emission and absorption spectra
• Explain the source of atomic emission spectra (of discharge tubes) and their unique relationship to each element
• Relate the lines on the atomic spectrum to electron transitions between energy levels</td><td>133</td><td>416–421</td><td>CP 5</td><td>337–339</td><td>435–437</td><td>235–236</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Homework: Ex. 11.2 Q. 1–5</td><td>133</td><td>422</td><td></td><td>339–340</td><td>Ex. 12.2 1, 2, 5</td><td>235–236</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>• Explain the difference between atomic absorption and emission spectra
• Application to astronomy</td><td></td><td>423–426</td><td>CP 6 Ex. 11.3 Q. 1–5</td><td>340–343</td><td>437–441</td><td>235–236</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Homework: EY Q. 4–5</td><td></td><td>428–430</td><td></td><td>345</td><td>Ex. 12.2 3, 4, 6</td><td>235–236</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">4</td><td>Electrolytic cells and galvanic cells
• Define oxidation and reduction in terms of electron (e-) transfer
• Define oxidising agent and reducing agent in terms of oxidation and reduction</td><td>134</td><td>432–438</td><td>Practical (recom-mended)</td><td>346–354</td><td>444–451</td><td>240–242</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Recommended experiment for informal assessment
Investigate the reduction of metal ions and halogens
Materials: Zinc, lead, aluminium and copper electrodes, zinc sulphate, copper sulphate, lead nitrate, sodium hydroxide, potassium nitrate, four beakers, sandpaper
Three test tube racks; 9 large test tubes; solutions of chlorine water, bromine water and iodine water; 0,2 $mol.dm^{-3}$ solutions of halides NaCℓ, Na Br and NaI; non-polar solvent such as xylene or dichloromethane; three droppers; glass stirring rod</td></tr>
<tr><td colspan="2">Homework: Complete the report on the practical investigation and answer the questions</td><td></td><td>434–438</td><td></td><td>352–354</td><td>449 Ex. 13.2 1–2</td><td>242–244</td><td></td><td></td><td></td><td></td><td></td></tr>
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Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why?
	HOD: **Date:**

Physical Sciences Solutions for All Week 5: Electrochemical reactions												
S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Class				
						LB	TG	Date completed				
1	• Define the galvanic cell in terms of: – self-sustaining electrode reactions – conversion of chemical energy to electrical energy • Define anode and cathode in terms of oxidation and reduction		438–441	CP 1 CP 2	354–356	452–455	240–241					
Homework: Make summary notes on pp. 438–441			438–441			451 Ex. 13.3 1, 2	244–245					
2	• Define the electrolytic cell in terms of: – electrode reactions that are sustained by a supply of electrical energy – conversion of electrical energy into chemical energy		442–443	CP 3 CP 4	356–358	456–457	245–248					
Homework: Make summary notes on pp. 442–443						461 Ex. 13.4 Q. 2	246–248					

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Date completed				
						LB	TG					
3	**Understanding of the processes and redox reactions taking place in cells** • Describe: – the movement ions through the solutions – the electron flow in the external circuit of the cell – the half-reactions at the electrodes – the function of the salt bridge in galvanic cells • Use cell notation or diagrams to represent a galvanic cell		444–447	CP 5 CP 6	358–360	462–465	248–250					
Homework: Ex. 12.1			447		360	464 Ex. 13.5 1–3	248–250					
4	**Recommended experiment for informal assessment** Investigate the electrolysis of water and sodium iodide **Materials:** Water bowl, electrodes for the electrolysis of water, test tubes, conductivity wires, 9 V battery, current indicator (LED), water and sodium iodide and sodium sulphate		448–452		360–363	456–461						
Homework: CP 7			452		363	461–462 Ex. 13.4 1, 3, 4	246–248					

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why? **HOD:** **Date:**

Physical Sciences Solutions for All Week 6: Electrochemical reactions

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Class				
						LB	TG	Date completed				
1	**Standard electrode potentials:** • Give the standard conditions under which standard electrode potentials are determined • Describe the standard hydrogen electrode and explain its role as the reference electrode • Explain how standard electrode potentials can be determined using the reference electrode • State the convention regarding positive and negative values		453–456	CP 8	363–366	467–471	250–251					
	Recommended experiment for informal assessment Find the galvanic cell with the highest potential **Materials:** Zinc; lead; aluminium and copper electrodes; solutions of zinc sulphate, copper sulphate, lead nitrate, sodium hydroxide and potassium nitrate; 2 beakers; U-tube; cotton wool; voltmeter; connecting leads											
Homework: CP 8			456		366	471–472 Ex. 13.6 1–4	250–251					
2	• Use the Table of Standard Reduction Potentials to calculate the emf of a standard galvanic cell • Use a positive value of the standard emf as an indication that the reaction is spontaneous under standard conditions **Relation of current and potential to rate and equilibrium:** • Give and explain the relationship between current in an electrochemical cell and the rate of the reaction • State that the potential difference of the cell (V_{cell}) is related to the extent to which the spontaneous cell reaction has reached equilibrium • State and use the qualitative relationship between Vcell and the concentration of product ions and reactant ions for the spontaneous reaction: *V_{cell} decreases as the concentration of product ions increases and the concentration of reactant ions decreases until equilibrium is reached at which V_{cell} = 0 (the cell is 'flat')* • (Qualitative treatment only, Nernst equation is NOT required) • Illustrate processes submicroscopically • Le Chatelier's principle can be used to argue the shift in equilibrium		456–459	CP 9 CP 10	366–368	466 472–475	251					
Homework: CP 9, CP 10			457		367–368	476 Ex. 13.7 1–3	251–252					

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science* LB	*Everything Science* TG	Date completed				
3	**Writing equations to represent oxidation and reduction half-reactions and redox reactions** • Predict the half-cell in which oxidation will take place when connected to another half-cell • Predict the half-cell in which reduction will take place when connected to another half-cell • Write equations for reactions taking place at the anode and cathode • Deduce the overall cell reaction by combining two half-reactions		460–462	CP 11 Ex. 12.2 Q. 1–3		476–480	252–253					
Homework: Ex. 12.2 Q. 4–6			463		371	480 Ex. 13.9 1–4	253–256					
4	• Describe, using half-equations and the equation for the overall cell reaction, the following electrolytic processes: – the decomposition of copper chloride – a simple example of electroplating (e.g. the refining of copper)		461–463	CP 12	370	481–482 487–489	259–260					
Homework: EY Q. 1–2			472		375	489 Ex. 13.11 1–3	259–260					

Reflection

Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why?
	HOD: **Date:**

Physical Sciences Solutions for All Week 7: Electrochemical reactions, the chemical industry

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	_Everything Science_ LB	_Everything Science_ TG	Class				
								Date completed				
1	**Oxidation numbers and application of oxidation numbers** • Revise from Grade 11 and extend in Grade 12 • Describe the electrolytic process used industrially in the recovery of aluminium metal from bauxite: – half-equations and the equation for the overall cell reaction – the layout of the particular cell using a schematic diagram – potential risks to the environment (South Africa uses bauxite from Australia)		466–469	CP 13 CP 14	371–374	487–488 490–491	260–263					
Homework: CP 15, EY Q. 4			468 472		374 376	490–491 Ex. 13.11 Q. 4–8	260–263					
2	• Describe the electrolytic process used industrially in the production of chlorine (the chemical reactions of the chloroalkali industry): – half-equations and the equation for the overall cell reaction – the layout of the particular cell using a schematic diagram – potential risks to the environment		467–471	CP 16	374	482–486	256–259					
Homework: EY Q. 3, 5			472		375–376	486–487 Ex. 13.10 1–4	256–259					
3	• **The fertiliser industry (N, P, K)** • List, for plants: – three non-mineral nutrients, i.e. nutrients that are not obtained from the soil: C, H and O and their sources, i.e. the atmosphere (CO_2) and rain (H_2O) – three primary nutrients N, P and K and their source, i.e. the soil • These nutrients are mineral nutrients that dissolve in water in the soil and are absorbed by the roots of plants • Fertilisers are needed because there are not always enough of these nutrients in the soil for healthy growth of plants • Explain the function of N, P and K in plants • Give the sources of N (guano), P (bone meal) and K (German mines) before and after the First World War • Interpret the N:P:K fertiliser ratio • Describe and explain (rates, yields, neutralisation, …), using chemical equations wherever appropriate, the following aspects of the industrial manufacture of fertilisers, given diagrams, flow charts and so on for: – N_2 – fractional distillation of air – H_2 – at SASOL from coal and steam – NH_3 – Haber Process – HNO_3 – Ostwald Process		479–488	CP 1 CP 2 CP 3 CP 4 CP 5	377–383	494–500	266–268					

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science* LB	*Everything Science* TG	Date completed				
Homework: Ex. 13.1 Q. 1–3			484		381–382	499–500 Ex. 14.1 Q. 1–5	268–269					
4	• Describe and explain (rates, yields, neutralisation, …), using chemical equations wherever appropriate, the following aspects of the industrial manufacture of fertilisers, given diagrams, flow charts and so on for: – H_2SO_4 – including the Contact Process – H_3PO_4 and $Ca(H_2PO_4)_2$ (superphosphates) – NH_4NO_3 (ammonium nitrate), $(NH_4)_2SO_4$ (ammonium sulfate) and H_2NCONH_2 (urea) • Give sources of potash (mined imported potassium salts like KNO_3, K_2SO_4) • Link SASOL to the production of fertilisers, e.g. ammonium nitrate (fertiliser and explosive)		488–493	CP 6–9 Ex. 13.2	383–384	270–279						
Homework: Section G Worksheet 4: Chemical industries (fertilisers)			480 493	WS 4		WS 4 Memo						

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why? **HOD:** **Date:**

Physical Sciences Solutions for All Week 8: The chemical industry

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science* LB	*Everything Science* TG	Class				
								Date completed				
1	• Discuss advantages of inorganic fertilisers • Discuss alternatives to inorganic fertilisers (IKS) • Define eutrophication • Discuss how the public can help to prevent eutrophication • Keep the details in this section limited to applications • Evaluate the use of inorganic fertilisers on humans and the environment • Discuss alternatives to inorganic fertilisers as used by some communities • (Knowledge of eutrophication is expected)		494–497	CP 10 CP 11	385–386	500–505	280–281					

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Date completed				
						LB	TG					
Homework: Ex. 13.3 Q. 1–3			497		387–388	506–512						
2	• The quality of water sources in the country has been on the news a lot in our country • Rivers used to be clean sources of water • Do an investigation on the causes of this high pollution of rivers near you • Assess how many people rely on fertilisers for their gardens in your area • Assess whether the use of inorganic fertilisers has increased • Research if this can be related to the quality of water in the river near your village, town or city		498–499	EY Q. 1–6	388–389	506–512	282–284					
3	**Revision**											
4	**Revision**											

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why?
	HOD: **Date:**

<table>
<tr><th colspan="2">Physical Sciences Solutions for All Week 9–11: Preliminary Examinations</th></tr>
<tr><th colspan="2">End-of-term reflection</th></tr>
<tr><td>Once the tests and the formal practical have been marked, think about and make a note of:
1. Was the learners' performance during the term what you had expected and hoped for? Which learners need particular support with Physical Sciences in the next term? What strategy can you put in place for them to catch up with the class? Which learners would benefit from extension activities? What can you do to help them?</td><td>3. What ONE change should you make to your teaching practice to help you teach more effectively next term?</td></tr>
<tr><td>2. With which specific topics did the learners struggle the most? How can you adjust your teaching to improve their understanding of this section of the curriculum in the future?</td><td>4. Did you cover all the content as prescribed by the CAPS for the term? If not, what are the implications for your work on these topics in future? What plan will you make to get back on track?</td></tr>
<tr><td>HOD:</td><td>Date:</td></tr>
</table>

2. *Study and Master Physical Sciences* (Cambridge University Press)

This Learner Book contains many solved problems which teach the learners how to tackle many problems set in varying scenarios. It is short on exercises for the learners themselves on a day-to-day basis. To overcome this, extra practice has been set from ***Everything Science*** for homework and sometimes also for class work. These exercises are marked with an asterisk (*ES) to denote ***Everything Science***.

Study and Master **Week 1: Electric circuits**												
S #	**CAPS concepts, practical activities and assessment tasks**	**CAPS pp.**	**LB pp.**	**LB act.**	**TG pp.**	***Everything Science***		**Class**				
						LB	**TG**	**Date completed**				
1	**Internal resistance and series and parallel networks** • Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel • State that a real battery has internal resistance • The sum of the voltages across the external circuit plus the voltage across the internal resistance is equal to the emf: $\varepsilon = V_{load} + V_{internal\ resistance}$ *or* $\varepsilon = IR_{ext} + Ir$	129	260–265	ES Ex. 10.1 Q. 1–8 TY 1 Q. 1–3	D70	376–391	198–211					
Homework: *ES Ex. 10.2 Q. 1–7		129	*ES 391–392		*ES 211–214	391–392	211–214					
2	• Solve circuit problems in which the internal resistance of the battery must be considered • Solve circuit problems, with internal resistance, involving series-parallel networks of resistors	129	265–267	TY 2 Q. 1–2	D70–D71	392–401						
Homework: *ES Ex. 10.3 Q. 1–6		129	*ES 403–405		*ES 214–221	402–405	214–221					
3	**Prescribed experiment for formal assessment:** **Part 1:** Determine the internal resistance of a battery **Part 2:** 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 Section F: Further questions to answer after completing the investigation on electric circuits	129	267–269	Act. 1	D71–D73	389–391						
Resources **Part 1:** 1,5 V battery, resistor, ammeter, voltmeter, switch, 6 connecting leads **Part 2:** 1,5 V battery, 3 resistors of different values, ammeter, voltmeter, switch, minimum of 7 connecting leads												
Homework: SA Q. 3–7		129	301–302		D79–D80							

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Date completed					
						LB	TG						
4	**Demonstrate short circuits and open circuits (recommended practical investigation)** Solve circuit problems, with internal resistance, involving series-parallel networks of resistors	129	270–275	Act. 2	D73–D75	384–385							
	Recommended practical investigation for informal assessment: Set up a series-parallel network with an ammeter in each branch and external circuit and voltmeters across each resistor, branch and battery, position switches in each branch and the external circuit Use this circuit to investigate short circuits and open circuits **Materials:** Battery, connecting wires, several resistors of different values, several voltmeters, several ammeters, switches, a length of low resistance wire												
Homework: Act. 3 Q. 1–2		129	275		D75–D76	376–384							

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why?
	HOD: **Date:**

Study and Master Week 2: Electrodynamics

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science* LB	*Everything Science* TG	Class Date completed				
1	**Electrical machines (generators, motors)** • State that generators convert mechanical energy to electrical energy and motors convert electrical energy to mechanical energy • Use Faraday's Law to explain why a current is induced in a coil that is rotated in a magnetic field	130	276–281			408–412	224					
Resources: https://www.youtube.com/watch?v=gQyamjPrw-U												
Homework: TY 3 Q. 1–3			283		D76	408–412						
2	• Use words and pictures to explain the basic principle of an AC generator (alternator) in which a coil is mechanically rotated in a magnetic field • Use words and pictures to explain how a DC generator works and how it differs from an AC generator • Give examples of the use of AC and DC generators	130	281–284									
Resources: https://www.youtube.com/watch?v=gQyamjPrw-U												
Homework: TY 3 Q. 3–5			283		D76	415 Q. 1–4	224–225					
3	• Explain why a current-carrying coil placed in a magnetic field (but not parallel to the field) will turn, by referring to the force exerted on moving charges by a magnetic field and the torque on the coil • Use words and pictures to explain the basic principle of an electric motor • Give examples of the use of motors	130	284–291	TY 4 Q. 1–4 Act. 6 1–8	D76 D77–D78	412–415						
Resources: Electric motor simulation http://www.physics-chemistry-interactive-flash-animation.com/electricity_electromagnetism_interactive/laplace_lorentz_force_electric_motor_principle_brushes_split_ring.htm												
Homework: SA Q. 1–2; *ES Ex. 11.1 Q. 1–8		130	299–300 *ES 415		D79 *ES 224–225	415 Q. 5–8	224–225					
4	**Alternating current** • Explain the advantages of alternating current • Write expressions for the current and voltage in an AC circuit • Define the rms (root mean square) values for current and voltage as: $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ and $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ respectively, and explain why these values are useful • Know that the average power is given by: $P_{av} = I_{rms}V_{rms} = \frac{1}{2}I_{max}V_{max}$ for a purely resistive circuit • Draw a graph of voltage vs time and current vs time for an AC circuit	131	291–298	Act. 7	D78–D79	416–422						
Homework: SA Q. 8–11		131	302–303		D80–D82	418–419	225–227					

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Date completed
						LB	TG	
	Project: Build a simple electric generator **Project:** Build a simple electric motor **Materials:** Enamel-coated copper wire, 4 large ceramic block magnets, cardboard (packaging), large nail, 1.5 V 25 mA light bulb, 9 V cell							

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why? **HOD:** **Date:**

Study and Master Week 3: Electrodynamics, optical phenomena and properties of materials

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Class				
						LB	TG	Date completed				
1	• Solve problems using the concepts: I_{rms} V_{rms} P_{av}	131				419–422						
Homework: *ES Ex. 11.2 Q. 1–9		131	*ES 418–419		*ES 225–227	423	227–229					
2	Advantages of using AC current	131	*ES 423	*ES Ex. 11.3 Q. 1–7	*ES 227–229							
Homework: Revise and learn all the work on Electrodynamics		131	260–303									

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Date completed
						LB	TG	
3	**Photoelectric effect** • Describe the photoelectric effect as the process that occurs when light shines on a metal and it ejects electrons • Give the significance of the photo-electric effect: – it establishes the quantum theory – it illustrates the particle nature of light • Define cut-off frequency, f_o	132–133	304–309		D84	426–429	232	
	Practical demonstrations: Photoelectric effect **Materials:** Gold leaf electroscope, zinc plate, UV lamp Mercury discharge lamp, photosensitive vacuum tube, set of light filters, circuit to produce retarding voltage across phototube, oscilloscope, ammeter							
Homework: TY 8 Q. 1–3			309–310		D84			
4	• Define work function and know that the work function is material-specific • Know that the cut-off frequency corresponds to a maximum wavelength • Apply the photo-electric equation: $E = W_o + KE_{max}$ where $E = hf$, $W_o = hf_o$ and $KE_{max} = \frac{1}{2}mv^2_{max}$ • Know that the number of electrons ejected per second increases with the intensity of the incident radiation	132–133	310–314		D84	428–434	233	
Resources: https://phet.colorado.edu/sims/photoelectric/photoelectric_en.jnlp								
Homework: TY 9 Q. 1–2 Alternative homework: Section G Worksheet 1			314	WS 1	D84 WS 1 memo	434–435 Ex. 12.1 1–2	233	

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why?
	HOD: **Date:**

Study and Master Week 4: Optical phenomena and properties of materials, electrochemical reactions												
S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Class				
						LB	TG	Date completed				
1	• Know that if the frequency of the incident radiation is below the cut-off frequency, then increasing the intensity of the radiation has no effect, i.e. it does not cause electrons to be ejected • Understand that the photoelectric effect demonstrates the particle nature of light	132	321–322	SA Q. 4–8	D85–D87	434–435 Ex. 12.1 3–5	233–235					
Homework: Make summary notes on the photoelectric effect; Section G Worksheets 2 and 3		132	304–314	WS 2 and 3	WS 2 and 3 memos	441 Ex. 12.3 1–2	236–237					
2	**Emission and absorption spectra** • Explain the source of atomic emission spectra (of discharge tubes) and their unique relationship to each element • Relate the lines on the atomic spectrum to electron transitions between energy levels	133	314–318			435–437	235–236					
Homework: SA Q. 1–3		133	320–321		D85	Ex. 12.2 1, 2, 5	235–236					
3	• Explain the difference between atomic absorption and emission spectra • Application to astronomy	133	318–319	TY 10 Q. 1–2	D85	437–441	235–236					
Homework: SA Q. 9–11		133	322		D87	Ex. 12.2 3, 4, 6	235–236					
4	**Electrolytic cells and galvanic cells** • Define oxidation and reduction in terms of electron (e-) transfer • Define oxidising agent and reducing agent in terms of oxidation and reduction	134	323	Informal practical	D88–D89	444–449 470–471	240–242					
	Recommended experiment for informal assessment Find the galvanic cell with the highest potential **Materials:** Zinc, lead, aluminium and copper electrodes; solutions of zinc sulphate, copper sulphate, lead nitrate, sodium hydroxide and potassium nitrate; 2 beakers; U-tube; cotton wool; voltmeter; connecting leads				D89							
Homework: Complete the report on the practical investigation and answer the questions; *ES Ex. 13.1 Q. 1–2		134	*ES 445		*ES 241–242	449 Ex. 13.2 1–2	242–244					

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why?
	HOD: **Date:**

Study and Master Week 5: Electrochemical reactions

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Class				
						LB	TG	Date completed				
1	**Recommended experiment for informal assessment** Investigate the electrolysis of water and sodium iodide Investigate the reduction of metal ions and halogens	134	326–328	Informal practical	D89–D91	458–461 474–475	240–241					
	Materials for the electrolysis of water: Water bowl, two electrodes for the electrolysis of water, two test tubes, conductivity wires, 9 V battery, current indicator (LED), water, sodium iodide or sodium sulphate, glass or plastic rod **Materials for the reduction of metal ions and halogens:** Test tube stand with test tubes, glass rod, thermometer, spatula and glass rod Metal powders: Mg, Zn, Cu, Fe Salt solutions: $CuSO_4$(aq), $ZnSO_4$(aq), $MgSO_4$(aq), NaCℓ(aq) Halide solutions: KCℓ (aq), KBr(aq), KI(aq), chlorine water (or household bleach), bromine water Non-polar solvent: tetrachloromethane ($CC\ell_4$)											
Homework: Complete the report on the practical investigation and answer the questions		134	326–328		D89–D91	451 Ex. 13.3 1–2	244–245					
2	• Define the galvanic cell in terms of: – self-sustaining electrode reactions – conversion of chemical energy to electrical energy • Define anode and cathode in terms of oxidation and reduction • Define the electrolytic cell in terms of: – electrode reactions that are sustained by a supply of electrical energy – conversion of electrical energy into chemical energy **Understanding the processes and redox reactions taking place in cells:** • Describe: – the movement ions through the solutions – the electron flow in the external circuit of the cell – the half-reactions at the electrodes – the function of the salt bridge in galvanic cells • Use cell notation or diagrams to represent a galvanic cell	134	329–331			452–455 462–465						
Homework: Make summary notes on how an electrochemical cell works; *ES Ex. 13.4 Q. 2		134	329–331 *ES 461		*ES 246–248	461 Ex. 13.4 Q. 2	246–248					
3	**Relationship of current and potential to rate and equilibrium:** • Give and explain the relationship between current in an electrochemical cell and the rate of the reaction • State that the potential difference of the cell (V_{cell}) is related to the extent to which the spontaneous cell reaction has reached equilibrium • State and use the qualitative relationship between V_{cell} and the concentration of product ions and reactant ions for the spontaneous reaction: *V_{cell} decreases as the concentration of product ions increases and the concentration of reactant ions decreases until equilibrium is reached at which V_{cell} = 0 (the cell is 'flat')* • (Qualitative treatment only; Nernst equation is NOT required)	136	328–329	*ES Ex. 13.5 Q. 1–3	*ES 248–250	462–465	248–250					

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science* LB	*Everything Science* TG	Date completed				
	Homework: Include the relationship of current and potential to rate and equilibrium in your summary notes	136	328–329			464 Ex. 13.5 1–3	248–250					
4	**Standard electrode potentials**: • Give the standard conditions under which standard electrode potentials are determined • Describe the standard hydrogen electrode and explain its role as the reference electrode • Explain how standard electrode potentials can be determined using the reference electrode • State the convention regarding positive and negative values	136	332–336 355–356		SA Q. 5, 9	456–461						
	Homework: Make notes to summarise standard electrode potentials; *ES Ex. 13.4 Q. 1, 3, 4	136	332–336 *ES 461–462		*ES 246–248	461–462 Ex. 13.4 1, 3, 4	246–248					

Reflection

Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why? **HOD:** **Date:**

Study and Master Week 6: Electrochemical reactions

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science* LB	*Everything Science* TG	Class				
								Date completed				
1	Use the Table of Standard Reduction Potentials to calculate the emf of a standard galvanic cell Use a positive value of the standard emf as an indication that the reaction is spontaneous under standard conditions	136 134	336–339 341–342	TY9 Q. 2, 4	D91–D92	467–471	250–251					
	Homework: *ES Ex. 13.6 Q. 1–4		*ES 471–472		*ES 250–251	471–472 Ex. 13.6 Q. 1–4	250–251					

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science* LB	*Everything Science* TG	Date completed				
2	**Writing equations representing oxidation and reduction half-reactions and redox reactions** • Predict the half-cell in which oxidation will take place when connected to another half-cell • Predict the half-cell in which reduction will take place when connected to another half-cell • Write equations for reactions taking place at the anode and cathode • Deduce the overall cell reaction by combining two half-reactions	136	339-	ES Ex. 13.7 Q. 1–3	ES 251–252	466 472–475	251					
	Homework: TY9 Q. 3, 5, 6	136	342–343		D91–D92	476 Ex. 13.7 Q. 1–3	251–252					
3	• Describe, using half-equations and the equation for the overall cell reaction, the following electrolytic processes: – the decomposition of copper chloride – a simple example of electroplating (e.g. the refining of copper)	137	340–341	ES Ex. 13.9 Q. 1–4	ES 253–256	476–480	252–253					
	Homework: TY 9 Q. 1, 7–9; TY 10 Q. 2	137	341 349		D91–D93	480 Ex. 13.9 1–4	253–256					
4	**Oxidation numbers and application of oxidation numbers** • Revise from Grade 11 and extend in Grade 12	137	343–344	SA Q. 6–8, 10	D96–D97	481–482 487–489	259–260					
	Homework: *ES Ex. 13.11 Q. 1–3		349 ES 489		*ES 259–260	489 Ex. 13.11 1–3	259–260					

Reflection

Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?

What will you change next time? Why?

HOD: **Date:**

Study and Master Week 7: Electrochemical reactions, the chemical industry

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Class				
						LB	TG	Date completed				
1	• Describe the electrolytic process used industrially in the production of chlorine (the chemical reactions of the chloroalkali industry): – half-equations and the equation for the overall cell reaction – the layout of the particular cell using a schematic diagram – potential risks to the environment	137	344–346 353	Act. 15	D94–D95	487–488 490–491	260–263					
Homework: SA Q. 10, 11; *ES Ex. 13.11 Q. 4–8		137	356–357 *ES 490–491		D97 *ES 260–263	490–491 Ex. 13.11 Q. 4–8	260–263					
2	• Describe the electrolytic process used industrially in the recovery of aluminium metal from bauxite (South Africa uses bauxite from Australia): • half-equations and the equation for the overall cell reaction • the layout of the particular cell using a schematic diagram • potential risks to the environment	137	347–348 350–351	Act. 14	D94	482–486	256–259					
Homework: TY 10 Q. 1; *ES Ex. 13.10 Q. 1–4		137	349 *ES 486–487		D91 *ES 256–259	486–487 Ex. 13.10 1–4	256–259					
3	**The fertiliser industry (N, P, K)** • List, for plants: – three non-mineral nutrients, i.e. nutrients that are not obtained from the soil: C, H and O and their sources, i.e. the atmosphere (CO_2) and rain (H_2O) – three primary nutrients: N, P and K and their source, i.e. the soil • These nutrients are mineral nutrients that dissolve in water in the soil and are absorbed by the roots of plants • Fertilisers are needed because there are not always enough of these nutrients in the soil for healthy growth of plants • Explain the function of N, P and K in plants • Give the sources of N (guano), P (bone meal) and K (German mines) before and after the First World War • Interpret the N:P:K fertiliser ratio • Describe and explain (rates, yields, neutralisation, …), using chemical equations wherever appropriate, the following aspects of the industrial manufacture of fertilisers, given diagrams, flow charts and so on for: – N_2 – fractional distillation of air – H_2 – at SASOL from coal and steam – NH_3 – Haber Process – HNO_3 – the Ostwald Process	138–139	359–367	TY 1 Q. 1–4	D99	494–500	266–268					

S #	CAPS concepts, practical activities and assessment tasks	CAPS pp.	LB pp.	LB act.	TG pp.	*Everything Science*		Date completed				
						LB	TG					
	Homework: TY 2 Q. 1–4; *ES Ex. 14.1 Q. 1–5	139–140	367 *ES 499–500		D99 *ES 268–269	499–500 Ex. 14.1 Q. 1–5	268–269					
4	• Describe and explain (rates, yields, neutralisation, …), using chemical equations wherever appropriate, the following aspects of the industrial manufacture of fertilisers, given diagrams, flow charts and so on for: – H_2SO_4 – including the Contact Process – H_3PO_4 and $Ca(H_2PO_4)_2$ (superphosphates) – NH_4NO_3 (ammonium nitrate), $(NH_4)_2SO_4$ (ammonium sulfate) and H_2NCONH_2 (urea) • Give sources of potash (mined imported potassium salts like KNO_3, K_2SO_4) • Link SASOL to the production of fertilisers, e.g. ammonium nitrate (fertiliser and explosive)	139–140	368–371	TY3 Q. 1–3	D100	270–279						
	Homework: Learn the work covered so far in 'The chemical industry' unit; TY 4 Q. 1–3	139–140			D100– D101	271–279						

Reflection

Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?

What will you change next time? Why?

HOD: **Date:**

Study and Master Week 8: Chemical industry												
S #	**CAPS concepts, practical activities and assessment tasks**	**CAPS pp.**	**LB pp.**	**LB act.**	**TG pp.**	***Everything Science***		**Class**				
						LB	**TG**	**Date completed**				
1	• Give sources of potash (mined imported potassium salts like KNO_3, K_2SO_4) • Link SASOL to the production of fertilisers, i.e. ammonium nitrate (fertiliser and explosive) **Homework:** Section G Worksheet 4: Chemical industries (fertilisers)	139–140	372–376	WS 4	WS 4 Memo	500–505	280–281					
Homework: SA Chemical change: Q. 1–7			377–378		D102–103	506–512						
2	• Give sources of potash (mined imported potassium salts like KNO_3, K_2SO_4) • Link SASOL to the production of fertilisers, i.e. ammonium nitrate (fertiliser and explosive)	139–140	379–380	SA Q. 8–12		506–512	282–284					
3	**Revision**											
4	**Revision**											

Reflection	
Think about and make a note of: What went well? What did not go well? What did the learners find difficult or easy to understand or do? What will you do to support or extend learners? Did you cover all the work set for the week? If not, how will you get back on track?	What will you change next time? Why?
	HOD: **Date:**

Study and Master Week 9–11: Preliminary Examinations	
End-of-term reflection	
Once the tests and the formal practical have been marked, think about and make a note of: 1. Was the learners' performance during the term what you had expected and hoped for? Which learners need particular support with Physical Sciences in the next term? What strategy can you put in place for them to catch up with the class? Which learners would benefit from extension activities? What can you do to help them?	3. What ONE change should you make to your teaching practice to help you teach more effectively next term?
2. With which specific topics did the learners struggle the most? How can you adjust your teaching to improve their understanding of this section of the curriculum in the future?	4. Did you cover all the content as prescribed by the CAPS for the term? If not, what are the implications for your work on these topics in future? What plan will you make to get back **on track**?
HOD:	**Date:**

E. ADDITIONAL INFORMATION AND ENRICHMENT ACTIVITIES

CAPS concepts, practical activities and assessment tasks	Additional information and enrichment activities

Week 1: Electric circuits

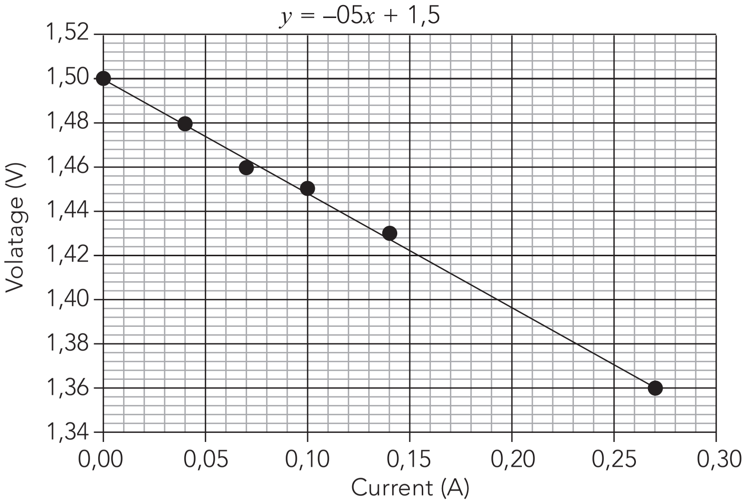
Electric circuits

An alternative method of determining the internal resistance of a cell (battery) is to take various readings of the load voltage and current through the circuit, using resistors of different values. A set of results of such an experiment are shown below.

Load voltage (V)	Current (A)
1,36	0,27
1,43	0,14
1,45	0,10

Load voltage (V)	Current (A)
1,46	0,07
1,48	0,04
1,50	0

Graph of load Voltage agains Current through the cell



The graph is linear with a negative slope.

$\varepsilon = V_{load} + V_{internal\ resistance}$

$\varepsilon = IR + Ir$ where R = external circuit resistance, r = internal resistance

The graph was plotted as V_{load} against I, therefore we change the subject of the formula for this equation to V_{load}

$V_{load} = \varepsilon - V_{internal\ resistance}$

$V_{load} = -rI + \varepsilon$

Thus the equation of the graph $y = mx + c$ (which in this case is $y = –0,5x + 1,5$) gives us the emf of the cell (1,5) and its internal resistance (0,5 Ω).

NB There have been some questions based on these kinds of results in past NSC papers. It is worth explaining this reasoning to the learners once they have mastered the basics.

Week 2: Electrodynamics

Electrodynamics

There are many YouTube videos that can help in explaining how a generator and a motor work. There are also simulations showing the principles of Faraday's Law. Animations and videos are often more helpful in explaining how things work than reading the text in a book.

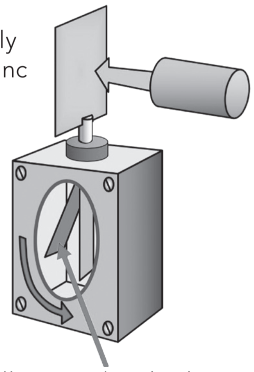
A 1-hour video presentation on how to teach electrodynamics is available from the Mindset Learn website: How to teach electrodynamics: http://teach.mindset.co.za/physical-science/teaching-grade-12-electrodynamics

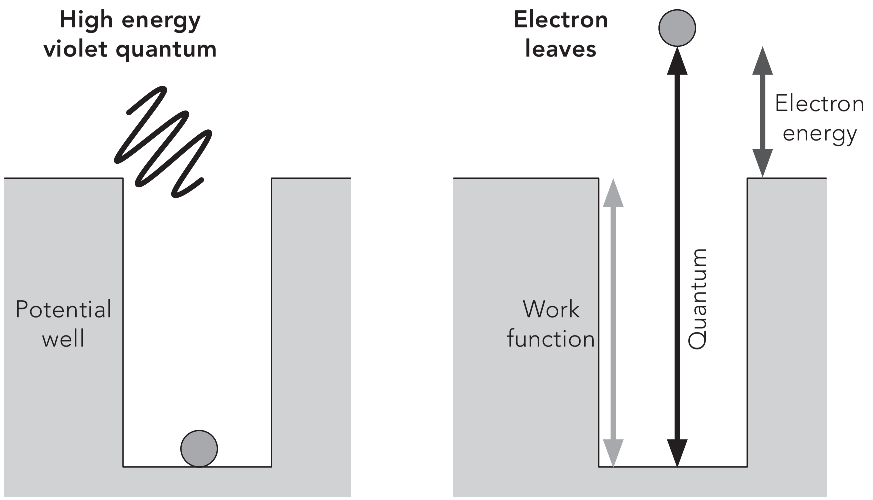
The generator

The generator works on the principle of electromagnetic induction. Faraday's Law describes the relationship between the rate of change of magnetic flux and the magnitude of the induced emf. Lenz's Law is used to predict the polarity of the induced emf. Lenz's Law is not examinable in the NSC.

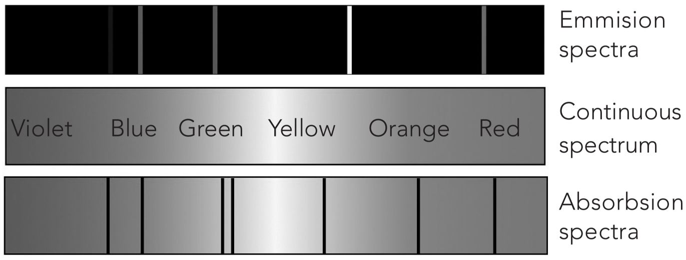
Generating electricity: https://www.youtube.com/watch?v=20Vb6hlLQSg

The world's simplest generator: https://www.youtube.com/watch?v=n4uQIOSp14o&feature=iv&src_vid=AS74oAmjpxU&annotation_id=annotation_2154302197

CAPS concepts, practical activities and assessment tasks	Additional information and enrichment activities
Week 3: Electrodynamics	
The DC motor	The electric motor works on the 'motor effect' principle. When a current-carrying conductor is placed in a magnetic field, the conductor experiences a force which is given by $F = BIL \sin \theta$. Learners do not have to learn how to use this formula, but it is useful to remember the following: • If the direction of flow of current is parallel to the direction of the magnetic field, the conductor will not experience force because $\sin 0° = 0$ • When the direction of flow of current is perpendicular to the direction of the magnetic field, the conductor will experience maximum force because $\sin 90° = 1$ • The force on the conductor increases when: – magnetic field intensity increases – current increases – the length of the conductor within the magnetic field increases The following factors are used to design more powerful motors: • If the current flows at 90° to the magnetic field, the conductor experiences maximum force – the position of the coil determines the torque (turning force) on it • When the current is increased, the motor rotates faster • Many turns are wrapped on the coil to increase the torque on the coil **NB** Faraday's Law does not apply to explanations on how the electric motor works. The DC motor: https://www.youtube.com/watch?v=LAtPHANEfQo
Alternating current	Learners sometimes struggle to understand why we use high voltage transmission lines to transmit energy over long distances. We transmit electrical energy with minimum power loss in the power lines by sending the energy at low current and high voltage. The power loss in the lines is given by $P_{rms} = I_{rms}^2R$, where I_{rms} is the current and R is the resistance of the line. The resistance of the power lines is relatively low, and if the current is also low, there will be very little electrical energy transferred to other forms of energy (e.g. thermal energy) as it travels from the power station across the country to various towns and cities. AC is easily transformed from low voltage to higher voltage using a step-up transformer. Similarly, it is easily stepped down when it reaches the town, so that the consumer receives electricity at a lower (safer) voltage. Transformers work on principles of electromagnetic induction, so they require a changing magnetic flux to be linked with the conductor. AC provides changing magnetic flux in the primary coil to induce AC voltage in the secondary coil. It is therefore convenient to work with AC rather than DC electrical systems when supplying energy nationally.
Week 4: Optical phenomena and properties of materials	
The photoelectric effect	**Demonstration:** **The basic phenomenon** Introduce the topic by demonstrating the electroscope and zinc plate experiment.  Gold leaf falls immediately, the zinc plate is illuminated with ultraviolet light (Diagram resourcefulphysics.org) Point out to learners that the photoelectric effect is apparently instantaneous. However, the light must be energetic enough – for zinc this is in the ultraviolet region of the spectrum.

CAPS concepts, practical activities and assessment tasks	Additional information and enrichment activities
Week 4: Optical phenomena and properties of materials	
The photoelectric effect (cont.)	If light were waves, we would expect the free electrons to steadily absorb energy until they escape from the surface. This would be the case in the classical theory, in which light is considered as waves. But in reality, we could wait all day and still red light would not liberate electrons from the zinc plate. So what is going on? We picture the light as quanta of radiation (photons). A single electron captures the energy of a single photon. The emission of an electron is instantaneous as long as the energy of each incoming quantum is big enough. If an individual photon has insufficient energy, the electron will not be able to escape from the metal. **Discussion:** **Summarising the phenomenon** Summarise the important points about the photoelectric effect: • There is a threshold frequency (i.e. energy), below which no electrons are released • The electrons are released at a rate proportional to the intensity of the light (i.e. more photons per second means more electrons released per second) • The energy of the emitted electrons is independent of the intensity of the incident radiation – they have a maximum KE. **Discussion:** **An analogy** Try this analogy, which involves ping-pong balls, a bullet and a coconut on a stand. A small boy tries to dislodge a coconut from the stand on which it is placed by throwing a ping-pong ball at it – no luck, the ping-pong ball has too little energy! He then tries a whole bowl of ping-pong balls but the coconut still stays put! Along comes a physicist with a pistol (and an understanding of the photoelectric effect), who fires one bullet at the coconut – it is instantaneously knocked off its support. Ask how this is an analogy for the zinc plate experiment. (The analogy simulates the effect of infrared and ultraviolet radiation on a metal surface. The ping-pong balls represent low energy infrared, while the bullet takes the place of high-energy ultraviolet.) Now you can define the work function. Use the potential well model to show an electron at the bottom of the well. It has to absorb the energy in one go to escape from the well and be liberated from the surface of the material. **Units** The electronvolt is introduced because it is a convenient small unit. You might need to point out that it can be used for any (small) amount of energy, and is not confined to situations involving electrically accelerated electrons. **Potential well** It is useful to compare the electron with a person in the bottom of a well with totally smooth sides. The person can only get out of the well by one jump; they can't jump half-way up and then jump again. In the same way an electron at the bottom of a potential well must be given enough energy to escape in one 'jump'. It is this energy that is the work function for the material. 

CAPS concepts, practical activities and assessment tasks	Additional information and enrichment activities
Week 4: Optical phenomena and properties of materials	
The photoelectric effect (cont.)	Now you can present the equation for photoelectric emission: Energy of photon $E = hf$ Picture a photon being absorbed by one of the electrons which is least tightly bound in the metal. The energy of the photon does two things. Some of it is needed to overcome the work function $W_o = hf_o$ The rest remains as the kinetic energy of the electron (E_k). $E = W_o + E_k = hf_o + \frac{1}{2}mv^2$ where m = rest mass of the electron A voltage can be applied to bind the electrons more tightly to the metal. The stopping potential V_s is just enough to prevent any from escaping: $hf = E_o = eV_s$ **Learners' questions and answers** Worksheet 1 in Section G has questions on the photoelectric effect; a memorandum with answers is also provided. **Einstein's ideas** Albert Einstein explained the photoelectric effect in a paper published in 1905. It was the first of four ground-breaking papers he published that year. In the second paper, Einstein explained the mysterious Brownian motion of microscopic particles as due to the random impact of much smaller particles. This work led to the acceptance of the molecular or atomic nature of matter, which until then had been quite speculative. Einstein's third paper that year is now his most famous. Here Einstein introduced his Special Theory of Relativity which, in a fourth paper, led to probably the most famous equation in science, $E = mc^2$, which describes the equivalence of mass and energy. But it was Einstein's first paper, which contained his work on the photoelectric effect, that at the time was the most revolutionary of the four, and it was for this work that Einstein was eventually awarded the Nobel Prize in 1921. (The Nobel Committee works somewhat more slowly than the speed of light!) In this paper Einstein broke away from the idea that light (electromagnetic radiation) is continuous in nature and introduced us to the idea of the quantum (plural quanta) or photon as a 'packet' of light. (The term quantum is used for any packet of energy, while a photon is a quantum associated with electromagnetic radiation.) The wave model of light had been fairly conclusively established a century earlier, mainly due to the work of Thomas Young, who demonstrated and explained interference patterns. But the wave model cannot explain the photoelectric effect; Einstein realised this and took the bold step of putting forward a completely different model in order to explain the following experimental results: • For any given metal, with radiation below a certain threshold frequency, no electrons are released even if the radiation is very intense • Provided the frequency is above the threshold, some electrons are released instantaneously, even if the radiation is very weak • The more intense the radiation, the more electrons are released • The kinetic energy of the individual photoelectrons depends only on the frequency of the radiation and not on its intensity Einstein was the first to use the equation E = hf to explain the photoelectric effect. It is known as the Planck equation, and h is called Planck's constant, because Max Planck had already proposed that when electromagnetic radiation is absorbed or emitted, energy is transferred in packets. This work earned Planck the 1918 Nobel Prize. **External references** The material in this section has been adapted from Salters Horners Advanced Physics, section DIG, activity 30 and from Salters Horners Advanced Physics, section DIG additional sheet 11 (http://saltersinstitute.co.uk/course-the-salters-horners-advanced-physics/)

CAPS concepts, practical activities and assessment tasks	Additional information and enrichment activities
Week 5: Electrochemical reactions	
Electrochemical reactions	Some useful video clips for this topic can be found at the following web addresses: How the galvanic cell works: https://www.youtube.com/watch?v=J1ljxodF9_g Principles of the Zn-Cu Cell: https://www.youtube.com/watch?v=0oSqPDD2rMA&feature=player_embedded Revision of galvanic and electrolytic cells: https://www.youtube.com/watch?v=Rt7-VrmZuds
Week 6: Optical phenomena and properties of materials	
Line emission and absorption spectra	**Demonstration:** **Looking at emission spectra** Show a white light and a set of standard discharge lamps: sodium, neon, hydrogen and helium. Allow learners to look at the spectrum of each gas. They can do this using a direct vision spectroscope or a bench spectroscope, or simply by holding a diffraction grating up to their eye. What is the difference? (The white light shows a continuous spectrum; the gas discharge lamps show line spectra.) **Emission and absorption spectra**  (Diagram resourcefulphysics.org) The spectrum of a gas gives a kind of 'fingerprint' of an atom. You could relate this to the simple flame tests that learners may have seen in earlier grades. Astronomers examine the light of distant stars and galaxies to discover their composition. Astronomers also use these spectra to tell if a star or galaxy is moving towards the Earth or away from the Earth. If the spectral pattern is the same as a known element but the lines are all shifted to a lower frequency (longer wavelength), we say the light has experienced a red shift. According to the Doppler effect, the source of light (the distant star or galaxy) must be moving away from the Earth. In a similar way, stars and galaxies moving towards the Earth will have a spectral pattern that has been blue-shifted, i.e. the lines appear at a higher frequency (shorter wavelength). Based on many observations of red-shifted stars and galaxies, cosmologists argue that this shows that the Universe is expanding and at some time in the distant past must have started this expansion in a Big Bang. **Discussion:** **The meaning of quantisation** Relate the appearance of the spectra to the energy levels within the atoms of the gas. Learners will already have a picture of the atom with negatively charged electrons in orbit around a central positively charged nucleus. Explain that, in the classical model, an orbiting electron would radiate energy and spiral in towards the nucleus, resulting in the catastrophic collapse of the atom. The classical model must be replaced by the Bohr atomic structure in which orbits are quantised. The electron's energy levels are discrete. An electron can only move directly between such levels, emitting or absorbing individual photons as it does so. The ground state is the condition of lowest energy – most electrons are in this state. Think about a bookcase with adjustable shelves. The bookshelves are quantised – only certain positions are allowed. Different arrangement of the shelves represents different energy level structures for different atoms. The books represent the electrons, added to the lowest shelf first, and so on.

CAPS concepts, practical activities and assessment tasks	Additional information and enrichment activities
Week 6: Optical phenomena and properties of materials	
Line emission and absorption spectra (cont.)	See below

Demonstration:
Illustrating quantisation

Throw a handful of polystyrene balls round the classroom and see where they settle. The different levels on which they end up – the floor, on a desk, on a shelf – gives a very simple idea of energy levels.

The A4 poster from Resourceful Physics > Teachers > OHT > Emission of Light is given at the end of this section. It shows the following:

An energy input raises the electrons to higher energy levels. This energy input can be by either electrical, heat, radiation or particle collision. When the electrons fall back to a lower level there is an energy output. This occurs by the emission of a quantum of radiation.

Discussion:
Energy levels in a hydrogen atom

Show a scale diagram of energy levels. It is most important that this diagram is to scale to emphasise the large energy drops between certain levels.

The learners may well ask the question, 'Why do the states have negative energy?' This is because the zero of energy is considered to be that of a free electron 'just outside' the atom. All energy states 'below' this – i.e. within the atom – are therefore negative. Energy must be put into the atom to raise the electron to the 'surface' of the atom and allow it to escape.

Worked example and learner questions:
Calculating frequencies

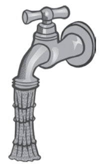
Calculate the frequency and wavelength of the quantum of radiation (photon) emitted due to a transition between two energy levels. (Use two levels from the diagram for the hydrogen atom.)

$E_2 - E_1 = hf$

Point out that this equation links a particle property (energy) with a wave property (frequency).

Ask your learners to calculate the photon energy and frequency for one or two other transitions. Can they identify the colour or region of the spectrum of this light?

Emphasise the need to work in SI units. The wavelength is expressed in metres, the frequency in hertz, and the energy difference in joules. You may wish to show how to convert between joules and electronvolts.

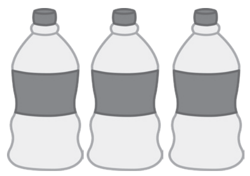


Discussion:
Distinguishing quantisation and continuity

The difference between the quantum theory and the classical theory is similar to the difference between using bottles of water (quantum) or water from a tap (classical). The bottles represent the quantum idea and the continuous flow from the tap represents the classical theory.

The quantisation of energy is also rather like the kangaroo motion of a car when you first learn to drive – it jumps from one energy state to another, there is no smooth acceleration.

It is all a question of scale. We do not 'see' quantum effects generally in everyday life because of the very small value of Planck's constant. Think about a person and an ant walking across a gravelled path. The size of the individual pieces of gravel may seem small to us but they are giant boulders to the ant.



We know that the photons emitted by a light bulb, for example, travel at the speed of light (3×10^8 ms^{-1}) so why don't we feel them as they hit us? (Although all energy is quantised we are not aware of this in everyday life because of the very small value of Planck's constant.)

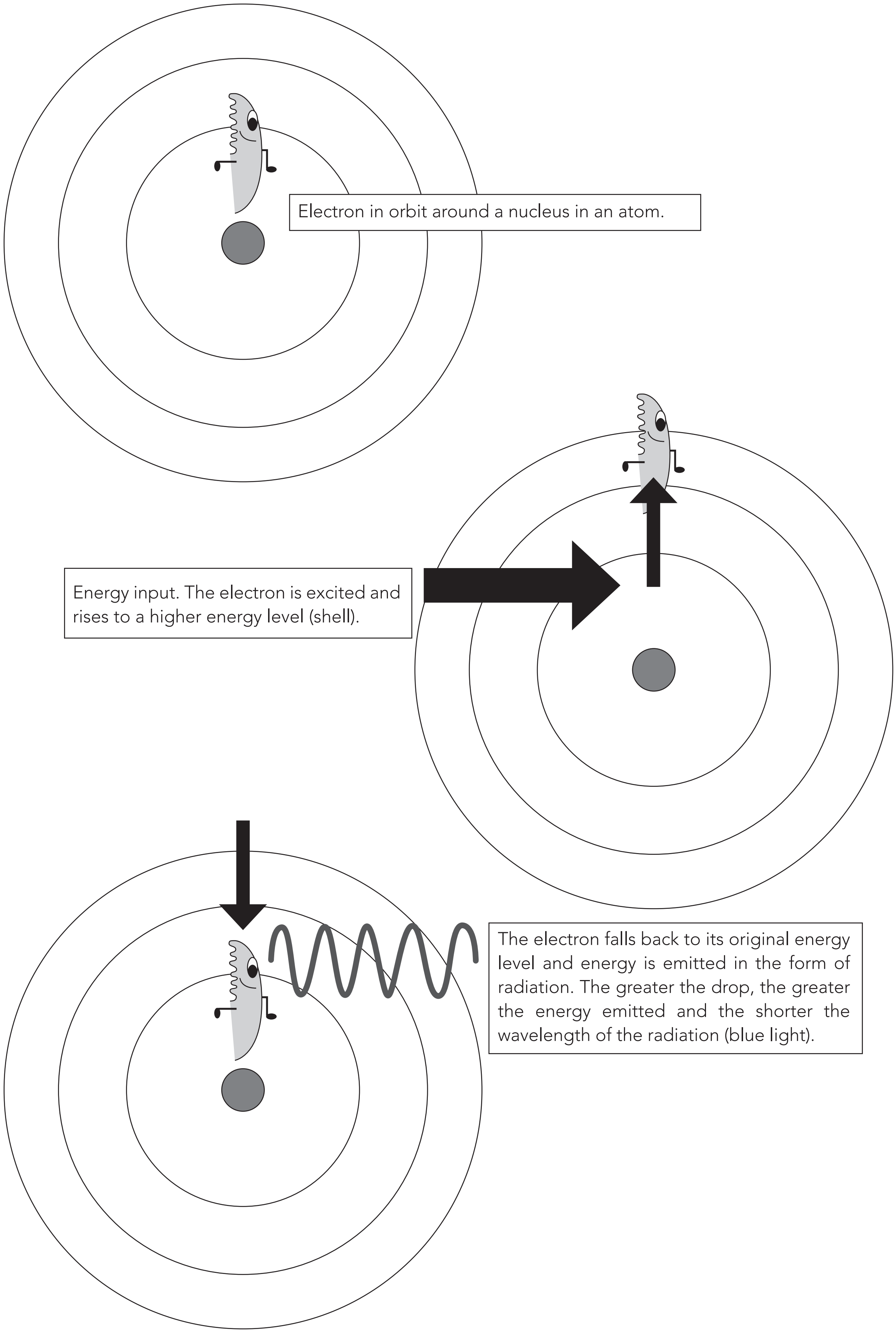
Learners may worry about the exact nature of photons. It may help if you give them this quotation from Einstein:

'All the fifty years of conscious brooding have brought me no closer to the answer to the question, "What are light quanta?" Of course, today every rascal thinks he knows the answer, but he is deluding himself.'

CAPS concepts, practical activities and assessment tasks	Additional information and enrichment activities
Week 6: Optical phenomena and properties of materials	
Line emission and absorption spectra (cont.)	**Worked example: Photon flux** Calculate the number of quanta of radiation being emitted by a light source. Consider a green 100 W light. For green light the wavelength is about 6 x 10^{-7} m and so: Energy of a photon: $E = hf = \frac{hc}{\lambda} = 3.3 \times 10^{-19}$ J The number of quanta emitted per second by the light: $N = \frac{P}{E} = \frac{100}{3,3 \times 10^{-19}} = 3 \times 10^{20}\ s^{-1}$ **Learner calculations: Photon flux** Worksheet 2: Photons streaming from a lamp (Section G) Worksheet 3: Quanta (Section G)
Week 7–8: Chemical reactions and the chemical industry	
	Worksheet 4: Chemical industries (Section G) Adapted from the Chemical Industries Resource Pack, developed at UCT and published under Creative Commons copyright http://open.uct.ac.za/handle/11427/7445 See this site for animations, posters and short online quizzes too.
Week 9–11: Preliminary Examinations	
Revision	

Poster: The emission of light from an atom

(Adapted from TAP 501-1)



F. ASSESSMENT RESOURCES

1. Sample item analysis sheet

PHYSICAL SCIENCES TERM 3 GRADE 12

SUGGESTED ITEM ANALYSIS RECORD SHEET FOR FORMAL ASSESSMENT

PHYSICS PRELIMINARY EXAMINATIONS

		Newton's Laws	Vertical projectile motion	Momentum & impulse	Work, energy & power	Doppler effect	Electrostatics	Electric circuits	Electrodynamics	Optical phenomena Properties of materials	Total
	Topic	Mechanics				Waves, sound & light	Electricity & magnetism			Matter & materials	
	Marks (target	±63				±17	±55			±15	150
	Marks (actual)										
Learner name	Learner surname										

CHEMISTRY PRELIMINARY EXAMINATIONS

		Stoichiometry	Intermolecular forces	Organic chemistry	Energy & change Rate & extent of reactions	Chemical equilibrium	Acids & bases	Electrochemical reactions	Chemical Industry & Fertiliser Industry	Total
	Topic	Matter & materials			Chemical change				Chemical systems	
	Marks (target	±48			±84				±18	150
	Marks (actual)									
Learner name	**Learner surname**									

PRACTICAL ASSESSMENT DETERMINE THE INTERNAL RESISTANCE OF A CELL (BATTERY)								
		Practical skills and questions						
		1	2	3	4	5	6	Total
		Pre-practical preparation	Setting up equipment Conducting experiment	Collection of data	Tabulation and calculations	Discussion of results and conclusion	Questions	
	Marks (target							
	Marks (actual)						40	
Learner name	Learner surname							

2. Further questions to answer after completing the investigation on electric circuits

These questions are to be answered individually, under supervision, and without reference to notes, textbooks or other sources of information. A data sheet is provided for reference.

Question 1

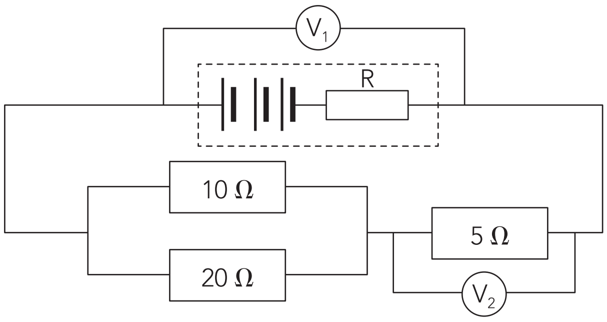
A battery consists of three cells, each of emf 1,5 V and internal resistance 0,5 Ω, connected in series.

1.1 Explain what is meant by 'a cell has an emf of 1,5 V'. (3)

1.2 Calculate the emf of the battery. (2)

1.3 Calculate the total internal resistance R of the battery. (2)

The circuit diagram below shows this battery connected to a combination of resistors. Two resistors of 10 Ω and 20 Ω are connected in parallel with each other, and the parallel combination is connected in series to a 5 Ω resistor.



1.4 Determine the total resistance of the external circuit. (5)

1.5 Calculate the current through the battery. (5)

1.6 Calculate the reading on voltmeter V_1. (3)

1.7 If the 20 Ω resistor is removed from the circuit how are the following values affected? Justify your answers with a calculation.

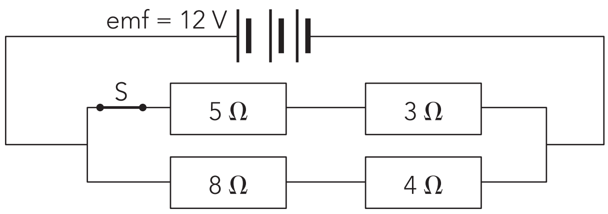
a) The current through the battery (5)

b) The voltage reading on the voltmeter V_1 (3)

[28]

Question 2

The battery in the circuit shown below has an emf of 12 V and negligible internal resistance. It is connected to a network of four resistors.



2.1 Determine the current through the 5 Ω and 3 Ω resistors. (2)

2.2 Determine the current through the 8 Ω and 4 W resistors. (2)

2.3 Determine the total resistance of all the resistors in the circuit. (2)

2.4 Explain how the total resistance of the circuit changes when switch S is opened. (3)

2.5 Explain how the current changes when switch S is opened. (3)

[12]

TIME: 30 MINUTES
TOTAL MARKS: 40

DATA SHEET FOR THE PHYSICAL SCIENCES (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Magnitude of charge on electron	e	$1,6 \times 10^{-19}$ C
Mass of an electron	m_e	$9,1 \times 10^{-31}$ kg

TABLE 2: PHYSICS FORMULAE
ELECTRIC CIRCUITS

$I = \frac{q}{t}$	$V = \frac{W}{Q}$
$R = \frac{V}{I}$	$emf = I(R_{ext} + r)$
$R_T = R_1 + R_2 + \ldots$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$
$W = Pt$	$P = VI = I^2R = \frac{V_2}{I}$

3. Memorandum: Further questions to answer after completing the investigation on electric circuits

Question 1

1.1 An emf of 1,5 V tells us that a total energy ✓ of 1,5 J is transferred by the cell ✓ per coulomb of charge which passes through it. ✓ (3)

1.2 emf = 3 × 1,5 ✓
= 4,5 V ✓ (2)

1.3 R = 0,5 + 0,5 + 0,5 ✓
= 1,5 Ω ✓ (2)

1.4 $\frac{1}{R} = \frac{1}{10}$ ✓ + $\frac{1}{20}$ ✓
R = 3,67 Ω ✓
$R_{external}$ = 3,67 + 5 ✓ = 8,67 Ω ✓ (5)

1.5 emf = I(R + r) ✓
4,5 ✓ = I(8,67 ✓ + 1,5) ✓
I = 0,44 A ✓ (5)

1.6 V_1 = IR ✓
= (0,44)(8,67) ✓
= 3,84 V ✓ (3)

1.7 a) Current through the battery decreases
R = 10 + 5 ✓ = 15 Ω ✓
Emf = I(R + r) ✓
4,5 = I(15+ 1,5) ✓
I = 0,27 A ✓ (5)

b) The reading on the voltmeter V_1 increases
V = IR
= (0,27) ✓ (15) ✓
= 4,09 V ✓ (3)

[28]

Question 2

2.1 V = IR
12 = I(5 + 3) ✓
I = 1,5 A ✓ (2)

2.2 V = IR
12 = I(8 + 4) ✓
I = 1 A ✓ (2)

2.3 $R = \frac{V}{I}$
$= \frac{12}{2,5}$ ✓
$= \frac{12}{5+3}$ ✓
= 4,8 Ω ✓

ALTERNATIVE:

$\frac{1}{R} = \frac{1}{5+3} + \frac{1}{8+4}$ ✓
$= \frac{1}{8} + \frac{1}{12}$
R = 4,8 Ω ✓ (2)

2.4 The total resistance increases ✓ when switch S is opened because there are only two resistors in series in the circuit.
R = 8 + 4 ✓ = 12 Ω ✓ (3)

2.5 The current decreases ✓ when switch S is opened.
12 = I(12) ✓
I = 1 A ✓ (3)

[12]

TOTAL MARKS: 40

G. ADDITIONAL WORKSHEETS

Worksheet 1 Photoelectric effect

(Adapted from TAP 502-2: Photoelectric effect)

$hf = W_o + \frac{1}{2}mv^2$ and $hf = W_o + eV_s$

$e = 1{,}60 \times 10^{-19}$ C

$h = 6{,}63 \times 10^{-34}$ Js

mass of electron = $9{,}11 \times 10^{-31}$ kg

1. The work function for lithium is $4{,}6 \times 10^{-19}$ J.
   1.1 Calculate the lowest frequency of light that will cause photoelectric emission.
   1.2 What is the maximum energy of the electrons emitted when light of $7{,}3 \times 10^{14}$ Hz is used?

2. Complete the table.

Metal	Work function (eV)	Work function (J)	Frequency used (Hz)	Maximum KE of ejected electrons (J)
Sodium	2,28		6×10^{14}	
Potassium		$3{,}68 \times 10^{-19}$		$0{,}32 \times 10^{-19}$
Lithium	2,9		1×10^{15}	
Aluminium	4,1			$0{,}35 \times 10^{-19}$
Zinc	4,3			$1{,}12 \times 10^{-19}$
Copper		$7{,}36 \times 10^{-19}$	1×10^{15}	

3. The stopping potential when a frequency of $1{,}61 \times 10^{15}$ Hz is shone on a metal is 3 V.
   3.1 What energy is transferred by each photon?
   3.2 Calculate the work function of the metal.
   3.3 What is the maximum speed of the ejected electrons?

4. Selenium has a work function of 5,11 eV. What frequency of light would just eject electrons? (The threshold frequency is when the max KE of the ejected electrons is zero.)

5. A frequency of $2{,}4 \times 10^{15}$ Hz is used on magnesium with work function of 3,7 eV.
   5.1 What is the energy transferred by each photon?
   5.2 Calculate the maximum KE of the ejected electrons.
   5.3 Calculate the maximum speed of the electrons.
   5.4 Calculate the stopping potential for the electrons.

Answers for Worksheet 1

1. 1.1 $hf = W_o$

$hf = 4{,}60 \times 10^{-19}$

$f = 4{,}60 \times \frac{10^{-19}}{6{,}63} \times 10^{-34} = 6{,}94 \times 10^{14}$ Hz

1.2 $hf = W_o + \frac{1}{2}mv^2$

$(6{,}63 \times 10^{-34} \times 7{,}30 \times 10^{14}) = 4{,}60 \times 10^{-19} + \frac{1}{2}mv^2$

$4{,}84 \times 10^{-19} - 4{,}60 \times 10^{-19} = \frac{1}{2}mv^2 = 0{,}24 \times 10^{-19}$ J

2.

Metal	Work function (eV)	Work function (J)	Frequency used (Hz)	Maximum KE of ejected electrons (J)
Sodium	2,28	**$3{,}65 \times 10^{-19}$**	6×10^{14}	**$0{,}35 \times 10^{-19}$**
Potassium	**2,30**	$3{,}68 \times 10^{-19}$	**6×10^{14}**	$0{,}32 \times 10^{-19}$
Lithium	2,90	**$4{,}64 \times 10^{-19}$**	1×10^{15}	**$1{,}99 \times 10^{-19}$**
Aluminium	4,10	**$6{,}56 \times 10^{-19}$**	**$1{,}04 \times 10^{15}$**	$0{,}35 \times 10^{-19}$
Zinc	4,30	**$6{,}88 \times 10^{-19}$**	**$1{,}2 \times 10^{15}$**	$1{,}12 \times 10^{-19}$
Copper	**4,60**	$7{,}36 \times 10^{-19}$	1×10^{15}	**0**

For copper 1×10^{15} Hz is below the threshold frequency so no electrons are ejected.

3. 3.1 $1{,}07 \times 10^{-18}$ J

3.2 $hf = W_o + eV_s$ so $W_o = hf - eV_s$

$W_o = 1{,}07 \times 10^{-18} - (1{,}6 \times 10^{-19} \times 3) = 5{,}9 \times 10^{-19}$ J

3.3 $eV_s = \frac{1}{2}mv^2$

$(1{,}60 \times 10^{-19} \times 3) = 0{,}5 \times 9{,}11 \times 10^{-31} \times v^2$

$v^2 = 1{,}04 \times 10^{12}$

$v = 1{,}02 \times 10^{6}$ m s^{-1}

4. $1{,}2 \times 10^{15}$ Hz

5. 5.1 $1{,}6 \times 10^{-18}$ J

5.2 $\frac{1}{2}mv^2 = 1 \times 10^{-18}$ J

5.3 $v^2 = 1{,}1 \times 10^{12}$

$v = 1{,}1 \times 10^{6}$ m s^{-1}

5.4 $eV_s = \frac{1}{2}mv^2$

$eV_s = 1{,}00 \times 10^{-18}$

$V_s = 0{,}63$ V

Worksheet 2 Photons streaming from a lamp

(Adapted from TAP 501-2)

What to do

Complete the questions below on the sheet. Provide clear statements of what you are estimating; show what calculations you are performing and how these give the answers you quote. Try to show a clear line of thinking through each stage.

Steps in the calculation

1. Give the power of a reading lamp in watts.
2. Estimate the average wavelength of a visible photon.
3. Calculate the energy transferred by each photon.
4. Calculate the number of photons emitted by the lamp in each second.

Practical advice

This question, or a substitute for it, needs to come early on in the discussion of photons to avert questions concerning our inability to be aware of single photons. However, single photon detectors are now used in astronomy and other fields.

Answers for Worksheet 2

1. $P = 40\ W$

2. $\lambda = 5 \times 10^{-7}\ m$

3. Calculate the frequency of the photons corresponding to this wavelength:

   $f = \frac{c}{\lambda}$

   $= \frac{3 \times 10^{8}\ ms^{-1}}{5 \times 10^{-7}\ m}$

   $= 6 \times 10^{14}\ Hz$

   Now calculate the energy of each photon:

   $E = hf$

   $= 6 \times 10^{-34}\ J\ s^{-1} \times 6 \times 10^{14}\ Hz$

   $= 4 \times 10^{-19}\ J$

4. Energy per second = $40\ W = 40\ J\ s^{-1}$

   Energy per photon = $4 \times 10^{-19}\ J$

   phontone per second = $\frac{\text{energy per second}}{\text{energy per photon}}$

   $= \frac{40\ J\ s^{-1}}{4 \times 10^{-19}\ J}$

   $= 1 \times 10^{20}$

Worksheet 3 Quanta

(Adapted from TAP 501–3)

Speed of electromagnetic radiation in free space (c) = $3{,}00 \times 10^{8}$ m s^{-1}

Planck's constant (h) = $6{,}63 \times 10^{-34}$ J s

1. Write down the equation for the quantum energy of a photon in terms of its frequency.

2. Calculate the energies of a quantum of electromagnetic radiation of the following wavelengths:
   - 2.1 gamma rays, wavelength: 10^{-3} nm
   - 2.2 X-rays, wavelength: 0.1 nm
   - 2.3 violet light, wavelength: 420 nm
   - 2.4 yellow light, wavelength: 600 nm
   - 2.5 red light, wavelength: 700 nm
   - 2.6 microwaves, wavelength: 2,00 cm
   - 2.7 radio waves, wavelength: 254 m

3. Calculate the wavelengths of quanta of electromagnetic radiation with the following energies:
   - 3.1 $6{,}63 \times 10^{-19}$ J
   - 3.2 $9{,}47 \times 10^{-25}$ J
   - 3.3 $1{,}33 \times 10^{-18}$ J
   - 3.4 $3{,}98 \times 10^{-20}$ J

Practical advice

Learners may need to be reminded that a wavelength of 10^{-3} nm = 1×10^{-12} m and some learners may need help in using their calculators.

Answers for Worksheet 3

1. $E = hf$

2.
   - 2.1 $f = \frac{c}{\lambda}$

     $E = hf$

     So $E = \frac{hc}{\lambda}$

     $= \frac{(6{,}63 \times 10^{-34})(3{,}00 \times 10^{8})}{(1 \times 10^{-12})}$

     $= 1{,}99 \times 10^{-13}$ J
   - 2.2 $E = 1{,}99 \times 10^{-15}$ J
   - 2.3 $E = 4{,}74 \times 10^{-19}$ J
   - 2.4 $E = 3{,}01 \times 10^{-19}$ J
   - 2.5 $E = 2{,}84 \times 10^{-19}$ J
   - 2.6 $E = 9{,}95 \times 10^{-24}$ J
   - 2.7 $E = 7{,}83 \times 10^{-19}$ J

3.
   - 3.1 $\lambda = \frac{hc}{E}$

     $\lambda = \frac{(6{,}63 \times 10^{-34})(3{,}00 \times 10^{8})}{(6{,}63 \times 10^{-19})}$

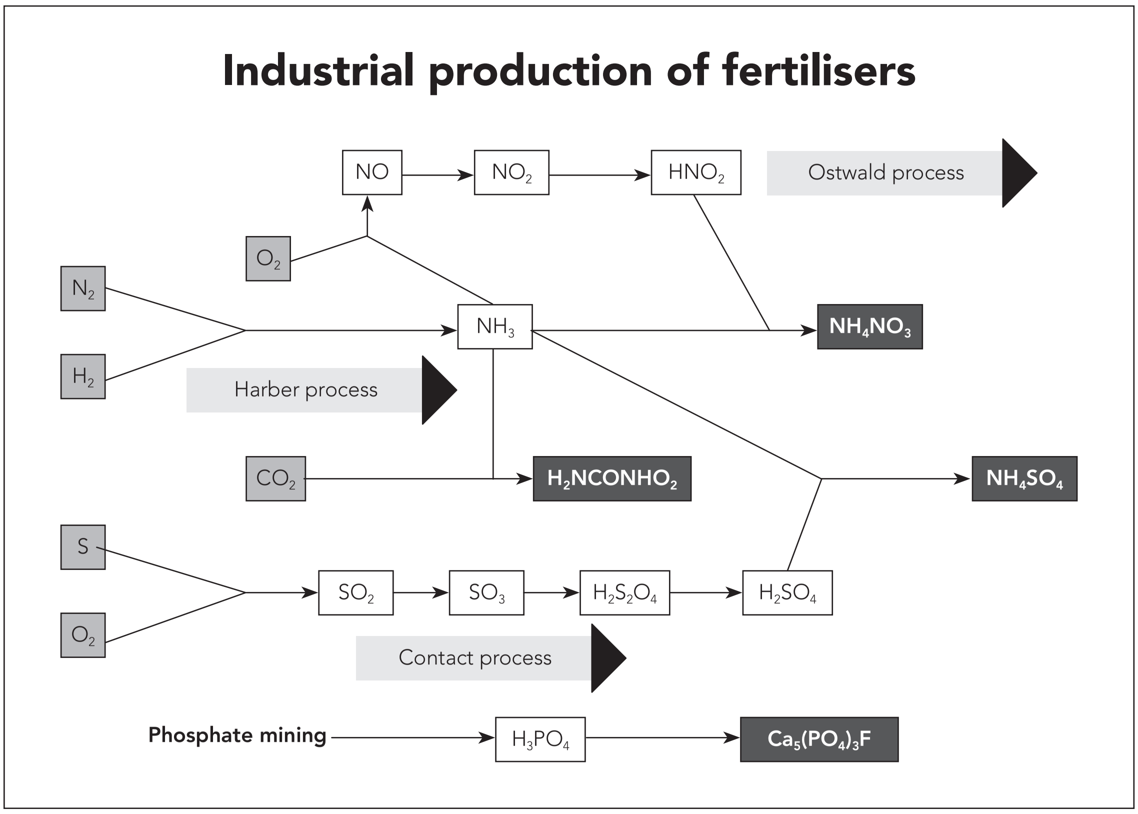
     $= 3{,}00 \times 10^{-7}$ m (300 nm)
   - 3.2 0,21 m
   - 3.3 $1{,}5 \times 10^{-7}$ m (150 nm)
   - 3.4 5×10^{-6} m

Worksheet 4 Chemical industries (fertilisers)

Learner's Copy

(Adapted from Chemical Industries Resource Pack – UCT Chemical Engineering Department)

Fertilisers

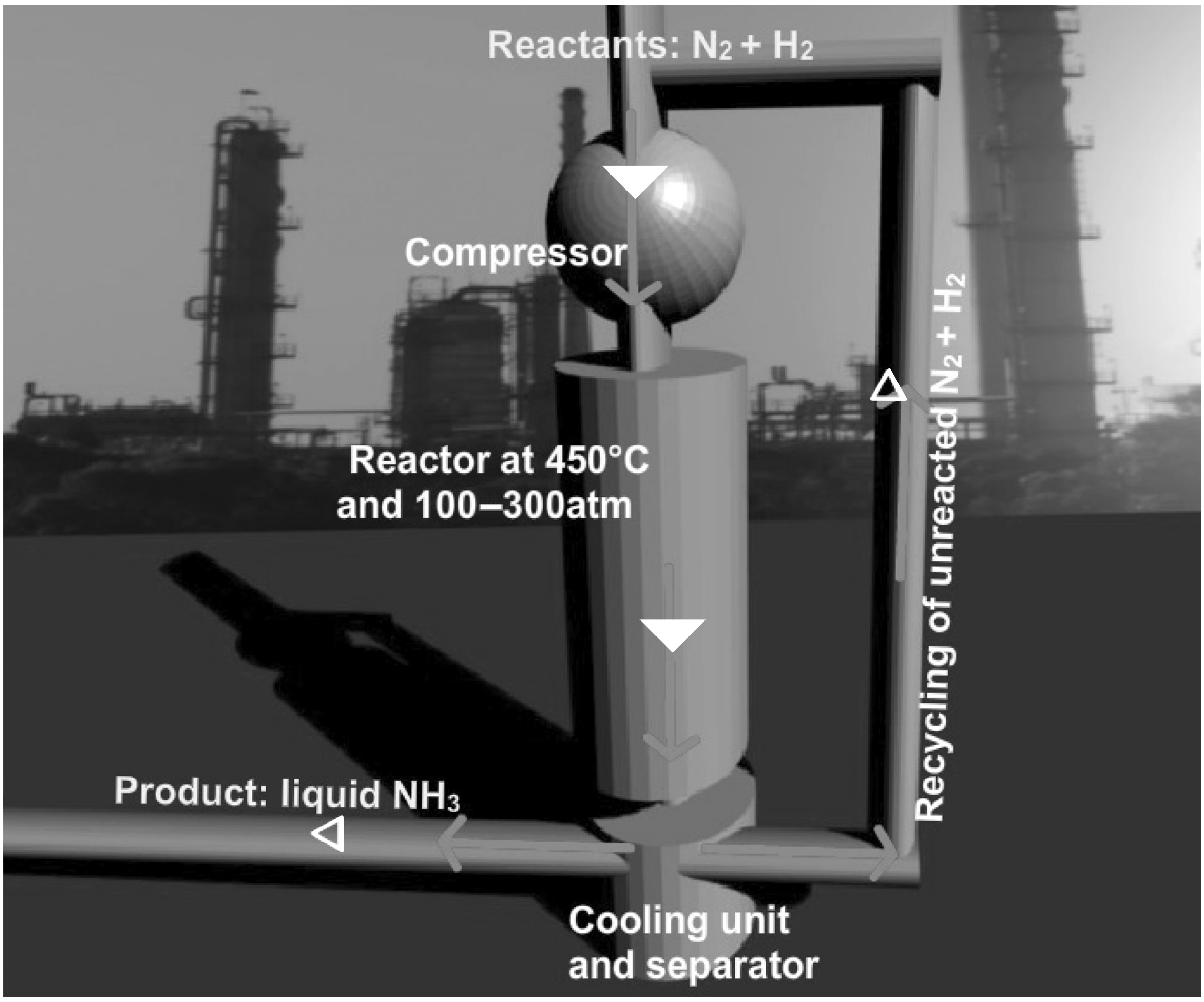


Overview

1. Why is nitrogen important to plants?
2. In what forms can plants absorb nitrogen?
3. Summarise the industrial processes by filling in the correct chemical formulae:

Process	Reactants	Products of step 1	Products of step 2	Final products
Haber		Not applicable		
Ostwald				
Contact				

Haber Process



4. What is the purpose of the Haber Process?
   To produce ______________________________
   from ______________ and ______________ .

5. Write a balanced equation for the Haber Process's reversible reaction:
   __________ + __________ $\leftrightarrows$ __________

6. Name some uses of ammonia.

7. Name two conditions that must be met for a reaction to reach equilibrium.

8. Name two characteristics of equilibrium.

9. In the Haber Process an iron oxide catalyst is usually used. Ruthenium can also be used. What does a catalyst do in a reaction, and how does it do this?

10. Circle the correct option (True/False) for each of the following:
    a) A catalyst speeds up the Haber Process's forward reaction more than the reverse. [True/False]
    b) A catalyst will cause more product to be formed. [True/False]

c) A catalyst will decrease the time it takes to reach equilibrium because it speeds up both forward and reverse reactions.

[True/False]

d) A catalyst speeds both forward and reverse reactions equally.

[True/False]

11. Link each element from column A with its corresponding element in column B.

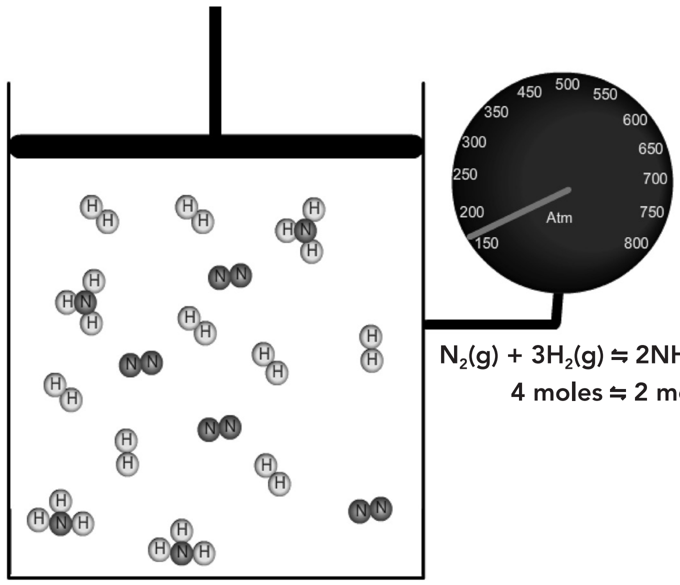
Write the letter from A next to each item in B in the Answer column.

A	B	Answer
a) dynamic equilibrium	absorbs more heat than released	11.1
b) endothermic	a measure of the average kinetic energy of particles	11.2
c) exothermic	disturbs equilibrium, favours increased crowding: more molecules per unit volume	11.3
d) Le Chatelier's principle	273 K and 101,3 kPa	11.4
e) decrease in pressure	disturbs equilibrium, favours exothermic reaction	11.5
f) increase in pressure	releases more heat than absorbed	11.6
g) removing heat	a state in which forward and reverse reactions occur at equal rates	11.7
h) adding heat	force per area, in gases related to rate of particle collisions	11.8
i) temperature	disturbs equilibrium, favours decreased crowding, fewer molecules per unit volume	11.9
j) pressure	disturbs equilibrium, favours endothermic reaction	11.10
k) STP	when a system which is in equilibrium is disturbed, it will respond in such a way as to counteract the disturbance	11.11

Le Chatelier: Effect of pressure in the Haber Process

12. Study the diagrams below representing the same container and gases under different pressure at the same temperature.

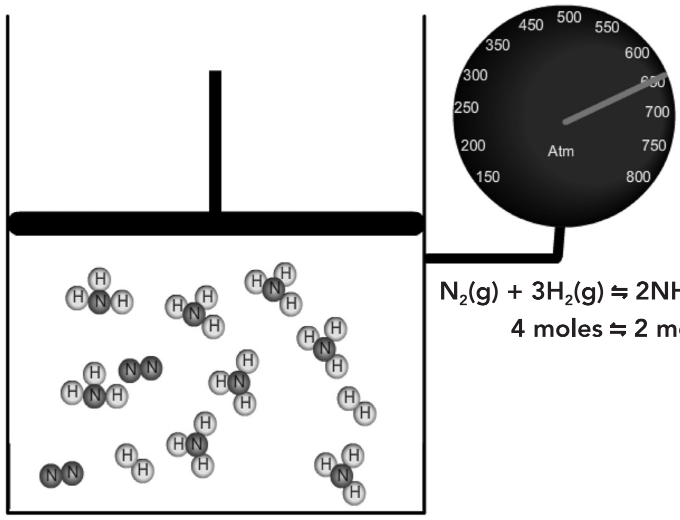
Condition 1



$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

4 moles ⇋ 2 moles

Condition 2



$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

4 moles ⇋ 2 moles

Complete the explanation by filling in the gaps or choosing from the options given.

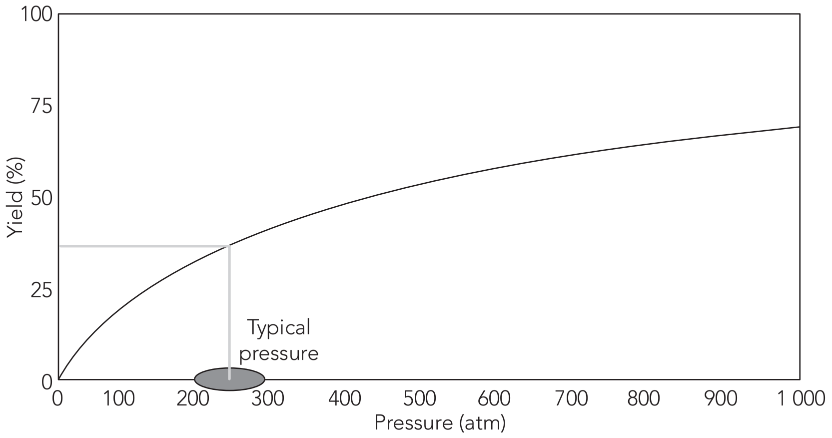
12.1 **Increased pressure**

According to **a)** ______________________ principle, when a system which is in equilibrium is disturbed, it will respond in such a way as to **b)** ______________________ the disturbance. An increase in pressure **[c) decreases/increases]** the crowding of gaseous molecules. The system will respond by **[d) decreasing/increasing]** their crowding. Crowding is decreased in gases when **[e) fewer/more]** molecules are formed. In the Haber Process the **[f) forward/reverse]** reaction makes fewer molecules than the **[g) forward/reverse]** reaction. In the forward reaction, **h)** ________ molecules of ammonia are made from every **i)** ________ molecules of reactants **j)** ________ N_2 and **k)** ________ H_2 molecules). Consequently, an increase in pressure **l)** ______________________ equilibrium for a while by making the **[m) forward/reverse]** reaction occur at a higher rate than the **[n) forward/reverse]** reaction. This causes **[o) more/less]** ammonia to be formed and **[p) more/less]** nitrogen and hydrogen. After a while a new dynamic equilibrium is reached. The rates of forward and reverse reactions are again **q)** ____________________________ to one another, and the amounts of reactants and products will **[r) change/remain constant]**. However, compared to before the pressure was applied, there will now be **[s) more/less]** ammonia present at equilibrium. The equilibrium constant value, Kc, however, will be **[t) higher than/lower than/the same as]** it was in the original equilibrium.

12.2 **Decreased pressure**

Decreasing pressure **[a) decreases/increases]** the crowding of gaseous molecules. The system will respond by **[b) decreasing/increasing]** their crowding. Crowding can be increased by forming **[c) fewer/more]** molecules. In the Haber Process, that means that for a while the **[d) forward/reverse]** reaction will occur at a higher rate than the **[e) forward/reverse]** reaction. The reverse reaction changes every **f)** __________ molecules of ammonia into **g)** ____________________________ molecules **h)** __________ nitrogen and **i)** __________ hydrogen molecules). This causes the amount of ammonia present to **[j) decrease/increase]** and the amount of nitrogen and hydrogen to **[k) decrease/increase]**. While this is happening the system **[l) is/is not]** in equilibrium. After a while a new dynamic equilibrium will be reached, in which the rates of both forward and reverse reactions will **m)** ____________________________ one another, and the amounts of reactants and products will remain **n)** ____________________________. However, compared to before the pressure was decreased, there will now be **[o) more/less]** ammonia present at equilibrium. The equilibrium constant value, Kc, however, will be **[p) higher than/lower than/the same as]** it was in the original equilibrium.

Study the graph representing the different yields of ammonia under different pressures.



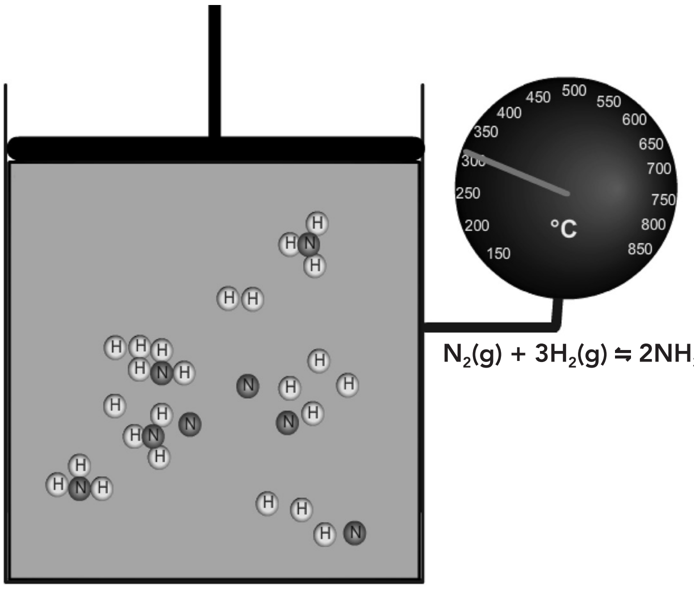
12.3 **Optimum pressure in the Haber Process**

In the Haber Process, we want to make as much **a)** ____________________________ as possible. We want the dynamic equilibrium to be such that a lot of **[b) reactant/product]** is formed. A(n) **[c. decrease/increase]** in pressure will cause more products to form. We need as **[d) low/high]** a pressure as it is safe and economical to use. We say we need to use an **e)** ____________________________ pressure – the pressure for which we get a good yield for a reasonable price while still being safe. Even though a high pressure will increase the yield of ammonia, the cost of compressing the gases and the cost of ultra-high pressure reactors are very high and are not a viable solution for making ammonia. Pressures of 200–300 atmospheres are typically used in chemical factories using the Haber Process.

Le Chatelier: Effect of temperature in the Haber Process

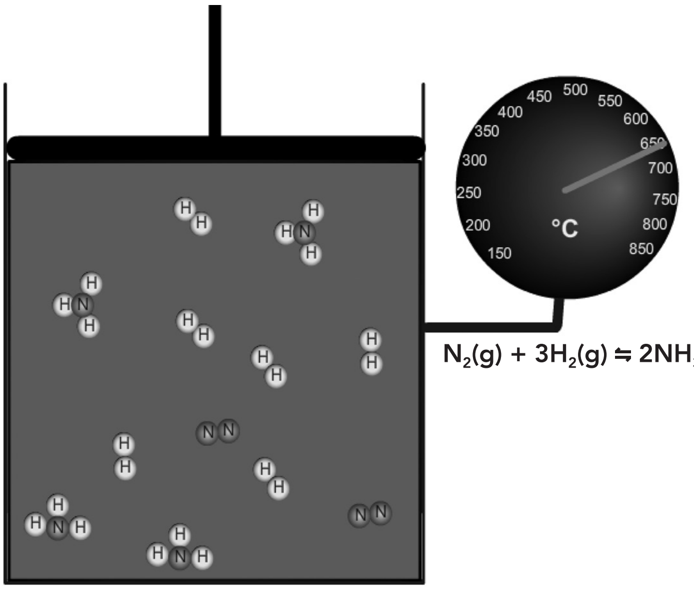
13. Study the diagrams below representing the same container and gases under different temperatures at the same pressure.

Condition 1



$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ + energy

Condition 2



$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ + energy

Complete the explanation by filling in the gaps or choosing from the options given.

13.1 **Heating**

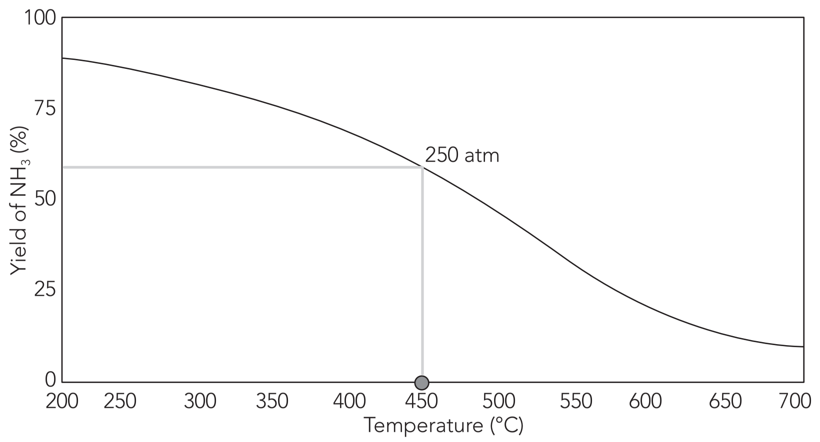
Heating a reaction up increases the **a)** ______________________________ energy of the particles, and so causes them to react more **[b) slowly/rapidly]** with one another. Additionally, heat can have an effect on disturbing the **)** ______________________________ of a reaction. In the Haber Process the forward reaction is **[d) exothermic/endothermic]** and the reverse is **[e) exothermic/ endothermic].** This means that as nitrogen and hydrogen react with one another to form ammonia, heat is **[f) absorbed/released]**, but as ammonia breaks up into hydrogen and nitrogen, heat is **[g) absorbed/released].** According to Le Chatelier's principle, when a system which is in equilibrium is disturbed, it will respond in such a way as to counteract the disturbance. So if heat is added to a system in the Haber Process, the **[h) exothermic/endothermic] [i) forward/ reverse]** reaction is favoured to **[j) absorb/release]** some of that heat and so **[k) cool the system back down/heat the system back up].** Both the forward and reverse reactions occur at **[l) lower/higher]** rates than before the heat was added, due to the additional kinetic energy of all the particles, but the **[m) forward/reverse]** reaction will have been speeded up to a greater extent than the **[n) forward/reverse]** reaction. So for a while, the system will not be in **o)** ______________________________ as the **[p) forward/reverse]** reaction occurs more rapidly than the **[q) forward/reverse]** reaction. This will **[r) increase/decrease]** the amount of ammonia present, and **[s) increase/decrease]** the amount of hydrogen and nitrogen. After a while a new dynamic equilibrium is reached. The rates of forward and reverse reactions are again **t)** ______________________________ to one another, and the amounts of reactants and products will remain **u)** ______________________________. However, compared to before the heat was added, there will now be **[v) less/more]** ammonia present at equilibrium. A new equilibrium constant, Kc, **[w) higher than/lower than/the same as]** that of the original equilibrium, is reached.

13.2 **Cooling**

Cooling a system that is in equilibrium has two effects. Firstly, by **[a. decreasing/increasing]** the kinetic energy of all the molecules, it **[b) reduces/increases]** the rates of both the forward and reverse reactions. Secondly, it has the effect of disturbing the **c)** ______________________________ by favouring the **[d) exothermic/endothermic]** reaction until a new equilibrium is reached with **[e) the same/a different]** equilibrium constant.

If heat is removed from a system in the Haber Process, the **[f) exothermic/endothermic]** **[g) forward/reverse]** reaction is favoured to **[h) cool the system back down/heat the system back up].** For a while, the system will not be in **i)** ______________________________ as the **[j. forward/reverse]** reaction occurs more rapidly than the **[k. forward/reverse]** reaction. This will **[l. increase/decrease]** the amount of ammonia present, and **[m. increase/decrease]** the amount of hydrogen and nitrogen. After a while a new dynamic equilibrium is reached. The rates of forward and reverse reactions are again **n)** ______________________________ to one another, and the amounts of reactants and products will remain **o)** ______________________________. However, compared to before the system was cooled, there will now be **[p) less/more]** ammonia present at equilibrium. A new equilibrium constant, Kc, **[q) higher than/lower than/the same as]** that of the original equilibrium, is reached.

Study the graph representing the different yields of ammonia under different temperatures.



13.3 **Optimum temperature**

In the Haber Process, we want to get a high ammonia yield. We want a dynamic equilibrium which makes as much ammonia product as possible. Consequently, we need to use a fairly **[a) high/low]** temperature. However, this causes a problem, namely **b)** ______________________________. Therefore, a compromise is made, and a temperature of approximately 450°C is often used.

Units of pressure and temperature

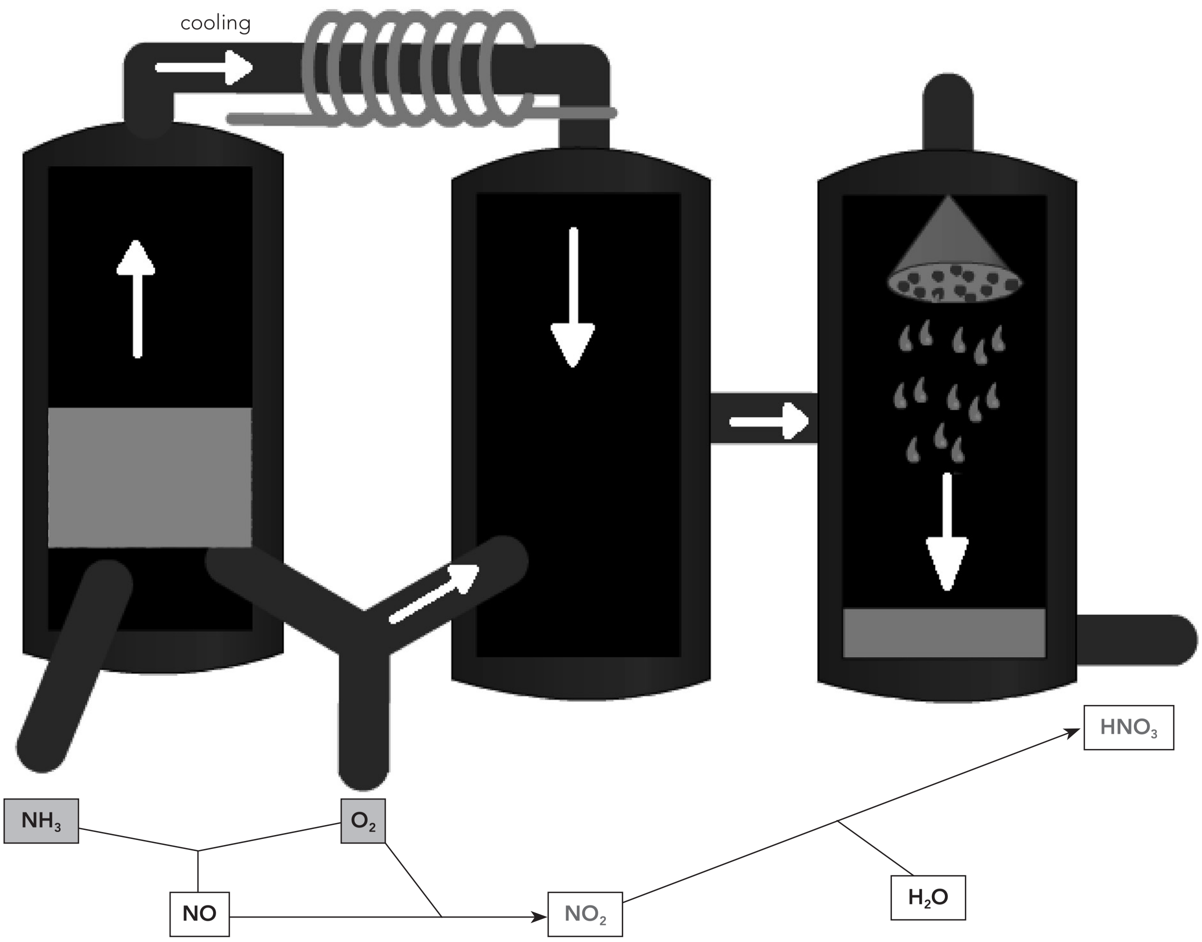
14. Complete for units of pressure:

Unit		Pressure at sea level at 0 °C
Name	Symbol	
Bar		
	atm	
		101,3 kPa
		760 mm Hg

15. Kelvin is the SI (Standard International) unit for temperature. Complete for conversions:

Temperature in degrees Celsius (°C)	Temperature in Kelvin (K)
0	
	0
100	
	200
25	

Ostwald Process



16. What is the purpose of the Ostwald Process?

To produce ________________ from ________________.

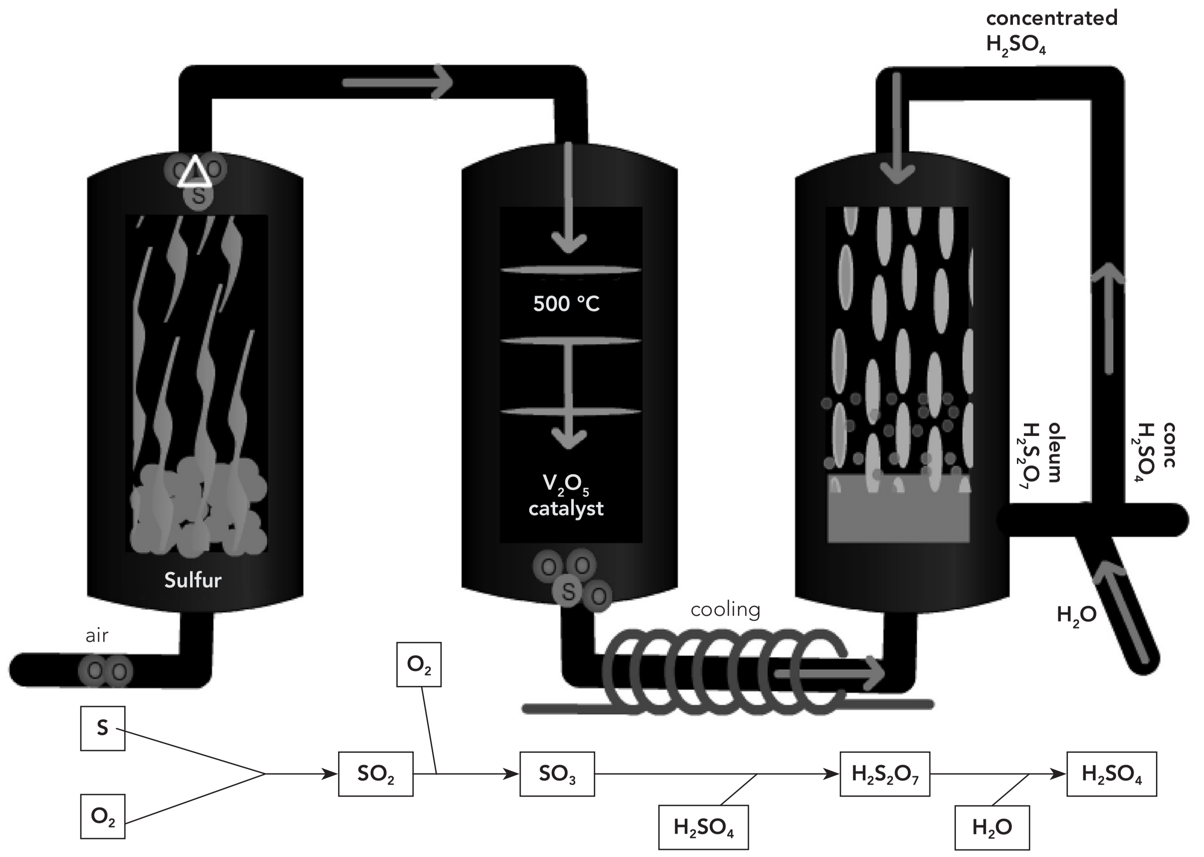
17. How is the product of the Ostwald Process useful for the fertiliser industry?

18. Why doesn't it matter that the platinum catalyst used is very expensive?

19. Complete the table by filling in the chemical formulae of the substances in the Ostwald Process:

Step 1	Step 2	Step 3
______ + ______ → (catalyst) ______	______ + ______ → ______	______ + ______ → ______

Contact Process



20. What is the purpose of the Contact Process?

To produce ______________ from ______________.

21. Name some uses of sulfuric acid.

22. Complete the table by filling in the **balanced** chemical equations for the Contact Process:

Step 1	Step 2	Step 3	Step 4
______ + ______ → ______	______ + ______ → (catalyst) ______	______ + ______ → ______	______ + ______ → ______

Answers for Worksheet 4

1. Nitrogen is found in all proteins, and so it is an essential nutrient.
2. Dissolved urea, nitrate, nitrite and ammonium ions.
3.

Process	Reactants	Products of step 1	Products of step 2	Final products
Haber	$N_2 + H_2$	Not applicable		NH_3
Ostwald	$NH_3 + O_2$	NO	NO_2	HNO_3
Contact	$S + O_2$	SO_2	SO_3	H_2SO_4

4. To produce ammonia (NH_3) from nitrogen (N_2) and hydrogen (H_2)
5. $N_2 + 3H_2 \leftrightarrows 2NH_3$
6. As a cleaning agent; as a coolant in some air conditioners; to manufacture nitrogen fertilisers.
7. Reversible reaction closed system
8. Rates of forward and reverse reactions are equal to one another.
   The concentrations of reactants and products remain constant.
9. It speeds up a reaction by lowering its activation energy. It does this by serving as a binding site on which the reaction can occur.
10. a) False
    b) False
    c) True
    d) True
11. 11.1 b
    11.2 I
    11.3 e
    11.4 k
    11.5 g
    11.6 c
    11.7 a
    11.8 j
    11.9 f
    11.10 h
    11.11 d
12. 12.1 a) Le Chatelier's
    b) counteract
    c) increases
    d) decreasing
    e) fewer
    f) forward
    g) reverse
    h) 2
    i) 4
    j) $1N_2$
    k) $3H_2$
    l) disturbs
    m) forward
    n) reverse
    o) more
    p) less
    q) equal
    r) remain constant
    s) more
    t) the same as

    12.2 a) decreases
    b) increasing
    c) more
    d) reverse

e) forward
f) 2
g) 4
h) 1
i) 3
j) decrease
k) increase
l) is not
m) equal
n) constant
o) less
p) the same as

12.3 a) ammonia
b) product
c) increase
d) high
e) optimal

13. 13.1 a) kinetic
b) rapidly
c) equilibrium
d) exothermic
e) endothermic
f) released
g) absorbed
h) endothermic
i) reverse
j) absorb
k) cool the system back down
l) higher
m) reverse
n) forward
o) equilibrium
p) reverse
q) forward
r) decrease
s) increase
t) equal
u) constant
v) less
w) lower than

13.2 a) decreasing
b) reduces
c) equilibrium
d) exothermic
e) a different
f) exothermic
g) forward
h) heat the system back up
i) equilibrium
j) forward
k) reverse
l) increase
m) decrease
n) equal
o) constant
p) more
q) higher than

13.3 a) low

b) it causes both reactions to be slow, and so it takes a long time for equilibrium to be reached

14.

Unit		Pressure at sea level at 0 °C
Name	**Symbol**	
Bar	bar	**1 bar**
Atmospheres	atm	**1 atm**
Kilopascals	**kPa**	101,3 kPa
millimetres mercury	**mm Hg**	760 mm Hg

15.

Temperature in degrees Celsius (°C)	Temperature in Kelvin (K)
0	**273**
–273	0
100	**373**
–27	200
25	**298**

16. To produce nitric acid (HNO_3) from ammonia (NH_3)

17. Nitric acid can be used to make nitrate fertilisers.

18. It can be used over and over again because it is not used up. Catalysts speed up reactions without themselves being changed in the process.

19.

Step 1	Step 2	Step 3
$NH_3 + O_2 \xrightarrow{\text{Pt catalyst}} NO$	$NO + O_2 \rightarrow NO_2$	$NO_2 + H_2O \rightarrow HNO_3$

20. To produce sulfuric acid (H_2SO_4) from sulfur (S) and oxygen (O_2)

21. Manufacture of fertilisers; electrolyte in car batteries; as a dehydrating (drying) agent.

22.

Step 1	Step 2	Step 3	Step 4
$S + O_2 \rightarrow SO_2$	$2\,SO_2 + O_2 \xrightarrow{V_2O_5 \text{ catalyst}} 2SO_3$	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$	$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$