PHYSICAL SCIENCES

A. MEANS OF ASSESSMENT

Paper 1	3 hours	200 marks (scaled to 150 marks)
Paper 2	3 hours	200 marks (scaled to 150 marks)
Portfolio (Continuous Assessment or CASS)		100 marks

400 marks

B. REQUIREMENTS

- Assessment tasks and questions will be based on the National Curriculum Statement for the Physical Sciences for Grade 12 provided in Section C of this document.
- This document outlines the content focus for the final written examination that will be used to assess the students' skills in the three Learning Outcomes. It is anticipated that teachers will cover further topics in the National Curriculum Statements, which are not examined, through informal and alternate assessment strategies.
- A variety of questioning styles will be employed in the final examination with a maximum of 10% of the marks being in the multiple choice format.

INFORMATION PAMPHLET (DATA SHEET)

Included with each of the Question Papers is a booklet containing the following information:

Formulae and Equations
Physical Constants
Standard Electrode Potentials and Half-Reactions
The Periodic Table of Elements including electro-negativity values

N.B. Formulae and equations could be included for two reasons:
(a) To be used in the numerical calculation of physical quantities
(b) To illustrate, in symbolic form, a scientific law or principle that should be known and applied verbally in the answer to a question.

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WEIGHTING OF KNOWLEDGE AREAS

Table 1 - PHYSICAL SCIENCES PAPER 1 (Physics)

	KNOWLEDGE AREAS	Marks	Approximate %
1	**MECHANICS**	75 – 85	40
2	**WAVES, SOUND AND LIGHT**	25 – 35	15
3	**ELECTRICITY AND MAGNETISM**	65 – 75	35
4	**MATTER AND MATERIALS (Optical phenomena & properties of materials)**	15 – 25	10
	TOTAL	200	100

Table 2 - PHYSICAL SCIENCES PAPER 2 (Chemistry)

	KNOWLEDGE AREAS	Marks	Approximate %
1	**CHEMICAL CHANGE**	75 – 85	40
2	**CHEMICAL SYSTEMS**	55 – 65	30
3	**MATTER AND MATERIALS (Organic molecules and macromolecules)**	50 – 70	30
	TOTAL	200	100

WEIGHTING ACCORDING TO A TAXONOMY OF COGNITIVE LEVELS APPLIED TO BOTH PAPER 1 AND PAPER 2

Table 3.1
Examination Assessment tasks are designed to the following weighting:

Level		Approximate %
1	**Knowledge, recall, low demand**	**15**
2	**Comprehension, routine exercises**	**45**
3	**Application (15%) and analysis (10%)**	**25**
4	**Synthesis and Evaluation/ Creativity**	**15**
		100

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Table 3.2 PHYSICAL SCIENCES ASSESSMENT TAXONOMY

[Info Adapted from: <http://tep.uoregon.edu/resources/assessment/multiplechoicequestions/blooms.html>]

LEVEL	COGNITIVE LEVEL	EXPLANATION	EXAMPLES IN PHYSICAL SCIENCES	ACTION VERBS
4	EVALUATION	The ability to judge the value of material (statement, research report) for a given purpose. The judgments are to be based on definite criteria, which may be internal (organisation) or external (relevance to the purpose).	• Has the experiment been successful in enabling you to decide on the truth of your hypothesis? • From these results judge the adequacy with which conclusions are supported by data. • Make judgements on the suitability of experimental procedure to test a certain hypothesis. • Consider the arguments for and against using solar, nuclear and fossil fuels for our energy requirements and make judgements. • Makes choices based on reasoned arguments. • When blowing up a balloon John reports that both the volume and pressure increase. He states that pressure is proportional to volume. Discuss the validity of his conclusion. • Recognises subjectivity.	Justify, appraise, evaluate, judge *x* according to given criteria. Which option would be better/ preferable to party *y*? Decide, recommend, convince, select, discriminate, support, conclude, critique.
4	SYNTHESIS	The ability to put parts together to form a new whole. This may involve the production of a unique communication, a plan of operations (research proposal), or a set of abstract relations (scheme for classifying information). Learning outcomes in this area stress creative behaviours, with major emphasis on the formulation of new patterns or structure.	• Propose a plan for an experiment. • Design a 6V battery with a capacity of 40 Ah and with low internal resistance. • What conclusion can be drawn from these results? • What general advice would you give motorists about 'following distance' when travelling at different speeds? • Rearrange the equation $hf = W_f + ½ mv^2$ to obtain an expression which has h, W_f, or v as its subject.	Design, construct, develop, formulate, imagine, create, change, combine, integrate, modify, rearrange, substitute, plan, invent, compose, formulate, prepare, generalise, rewrite, compile, reconstruct, generate.
3	ANALYSIS	The ability to break down material into its component parts. Identifying parts, analysis of relationships between parts, recognition of the organisational principles involved.	• Describe ways in which you could improve the reliability of your results. • Circle any anomalous points on the graph and suggest an explanation for any anomaly. • Examine the graph to determine the relationship between the two variables. • Given the colours of the halogens, observe that the colour gets darker the further down in Group 17 of the Periodic Table that the halogen is situated. • The actual value for the Molar Latent Heat of Vapourisation of water is 40,7 $kJmol^{-1}$. What do you think are the most important reasons for your result not being accurate? Explain.	Differentiate, compare/ contrast, distinguish *x* from *y*, how does *x* affect or relate to *y*? why? how? What piece of *x* is missing/ needed? Analyse, separate, order, connect, classify, arrange, divide, select, infer, break down, diagram, illustrate, identify, outline, relate

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3	**APPLICATION**	The ability to use learned material in new and concrete situations. Applying rules, methods, concepts, principles, laws, and theories.	• Apply Le Chatelier's principle to predict the colour change if sodium chloride is added to a particular equilibrium mixture. • Show by calculation that the collision is inelastic. (i.e. two step calculations) • Draw a labelled free body force diagram of the car during the braking process. Ignore wind resistance. • From the velocity-time graph plot a corresponding displacement-time graph. • Write down the structural formula of the acid that could be used to combine with an alcohol in the synthesis of $CH_3CH_2CH_2CO_2CH_2CH_3$. • Ethanol and propane have nearly the same number of electrons. Explain why ethanol has a higher boiling point than propane. • Use the Standard Redox Table to determine the reaction between SO_2 and $KMnO_4$	How would you show, make use of, modify, demonstrate, solve, or apply *x* to conditions *y*? apply, calculate, illustrate, change.
2	**COMPREHENSION**	The ability to grasp the meaning of material. Translating material from one form to another (words to numbers), interpreting material (explaining or summarising), estimating trends (predicting consequences or effects).	• Use the graph and read off the pressure at a time of 10 seconds. • Explain why an increase in pressure increases rate of a gaseous chemical reaction. • Calculate the current if the voltage is 2 V and the resistance is 4 Ω. (i.e. 1 step calculation) • Write a balanced equation for the complete combustion of octane, C_8H_{18}. • Identify a dependent variable that you could measure to follow the rate of a given reaction. • What is the relationship between inter-molecular force strength and boiling point? • What does a positive E^0 value indicate about the reaction? • Describe the observation that can be made when bromine reacts with ethane.	Explain, predict, interpret, infer, summarise, convert, translate, give example, account for, paraphrase *x*, describe, associate, distinguish, estimate, extend, comprehend, generalise, give example, rewrite.
1	**RECALL**	The learner recalls and remembers facts, low cognitive demand.	• Name the instrument used to measure current. • State the law of conservation of mechanical energy. • Define momentum. • Label the parts indicated on this diagram of an electric motor. • Define Standard Electrode Potential. • Write down the **formula** of the three main compounds found in NPK fertiliser. • Identify and name the functional group in ethanol.	List, define, tell, state, identify, show, know, label, collect, select, reproduce, match, recognise, examine, tabulate, quote, name

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WEIGHTING OF LEARNING OUTCOMES IN BOTH PAPERS

Table 4
Examinations are designed to the following weighting

LO 1	LO 2	LO 3
20 ± 3%	70 ± 3%	10 ± 3%

RECORDING AND REPORTING

Table 5
Assessment tasks are reported against a seven point rating scale:

RATING CODE	RATING	MARKS %
7	Outstanding achievement	80 – 100
6	Meritorious achievement	70 – 79
5	Substantial achievement	60 – 69
4	Adequate achievement	50 – 59
3	Moderate achievement	40 – 49
2	Elementary achievement	30 – 39
1	Not achieved	0 – 29

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PORTFOLIO REQUIREMENTS (SBA)

School based assessment (SBA) comprises 25% of the total assessment for the National Senior Certificate. The minimum requirements for the school-based component of the National Senior Certificate assessment are outlined in Table 6A. Where schools are able to do more than the minimum requirements then the students may select their best work for the portfolio. However, where there is a choice, the tasks should be of a comparable standard.

Table 6A: PORTFOLIO REQUIREMENTS FOR GRADE 12

Task	Percentages
2 Practical Investigations (1 Physics Focus; 1 Chemistry Focus)	2 × 20% = 40%
Alternative Assessment	10%
Controlled Test (Physics Focus) Controlled Test (Chemistry Focus) *N.B. Mid-year examinations may be used*	2 × 10% = 20%
Preliminary Examinations	2 × 15% = 30%
TOTAL	**100%**

Controlled Tests and Examinations

Controlled tests (minimum 40 minutes) and examinations are written under controlled conditions within a specified period of time. Questions in tests and examinations should assess performance at different cognitive levels across all the Learning Outcomes, with a greater focus on Learning Outcome 2.

Practical Investigations and the Alternative Assessment

Learners need to spend a minimum of 2 hours on each of the practical investigations and a minimum of 1 hour on the Alternative Assessment. There needs to be contact time between the learners and the teacher to facilitate guidance, support and monitoring of the achievement of specific targets. This contact time should be scheduled at mutually agreed intervals. These interactions create opportunities for teachers to

- check for plagiarism (for example by using oral questioning)
- carry out formative assessment
- monitor progress

The teacher should guard against marking the task at these times, but should question the learner about the project and respond to queries initiated by the learner. Marking occurs once, only when the task is finally submitted.

Practical investigations

The new FET focuses on teaching and assessing an investigative approach. The motivation for teaching and assessing this type of approach is that it has the potential to reflect what life is about. The investigative approach not only teaches skills essential to science but skills essential for living in a modern world. But what is an investigative approach? What are the components that make up an investigation in the 'real' world? What skills, understanding and mental processing are required to carry out a successful investigation?

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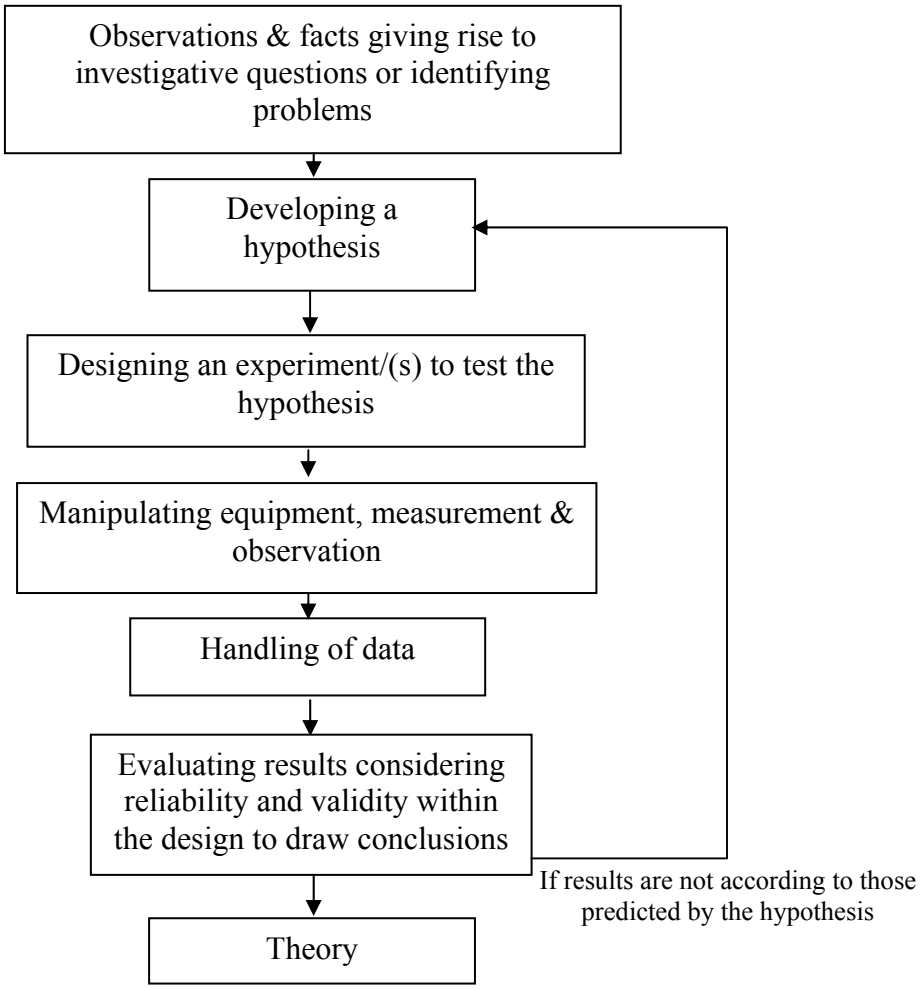
A very simplified perspective of the investigative approach is represented in the flow chart which follows:



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One way to create an opportunity to proceed through an investigation is to identify a science problem to be solved. In trying to solve a science problem one will certainly need to proceed through an investigative approach. In addition, one will find that it is impossible to be restricted by purely an experimental approach focusing on only LO 1 of the NCS. Problem solving in science requires a mastering of basic skills (LO 1), basic facts (LO 2), an understanding of theory (LO 2) and practical process skills (LO 1). In today's world, everybody wants to see relevance and therefore there is also a focus on LO 3. It is for this reason that within the two investigations a minimum of 10% of the marks must be allocated to LO 2 and another 10% must be allocated to LO 3. LO 1 must be assessed with a minimum weighting of 60%.

Investigations do not, however, need to be restricted to a complex problem that needs to be solved. It is possible to combine a number of traditional one lesson experiments to produce the same learning objectives as a large single focused task. Where smaller tasks are compiled together it is advisable to have a central theme to facilitate continuity, and it is also important that the combined skills assessed across all these tasks together represent the objectives achieved by a more open-ended larger task. In other words the smaller tasks must not all assess the same things.

The investigations are expected to take 4 to 5 hours which equates to more than 1 week of teaching time in most schools. During this process it is hoped that the investigation assesses a range of investigative skills in addition to LO 2 and LO 3.

The following is suggested as a guide to what should be assessed in a balanced way (according to cognitive levels) across an investigation.

1. Developing a hypothesis. This could include:
   - formulating a question which can be investigated.
   - combining scientific ideas with observations or recorded facts.
   - making predictions based on available knowledge and observations.
   - writing a statement of the hypothesis.

2. Manipulation of equipment, measurement and observations. This could include:
   - correct choice of equipment.
   - ability to read scales accurately.
   - safe use of equipment.
   - meaningful observations.

3. Planning and designing. This could include:
   - identifying variables to be measured and controlled.
   - organising activities in a appropriate sequence.
   - recognising whether or not an experiment is valid. (Will the results answer the investigative question?)
   - recognising the importance of the reliability of results and planning accordingly. (Are the sample size and number of readings sufficient?)

4. Presentation of Data. This could include:
   - tabulating.
   - graphing.
   - use of data loggers and other software.

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5. Analysing, concluding and evaluating. This could include:
   - weighing advantages and disadvantages.
   - drawing appropriate conclusions that address the hypothesis or questions.
   - making/ evaluating general conclusions that go beyond the experimental or given conditions.
   - analysing problems to determine the relevant relationships, concepts, and problem-solving steps.

6. Communicating and presenting information. This could include:
   - a model.
   - a role play, song, dance, speech or presentation.
   - a poster.
   - a written report.

Alternative Assessment

Suggestions for Alternative Assessment tasks:

1. **Debate, discussion, short essay, e.g. on ethical issues in science**

   The website www.peep.ac.uk has many ideas to engage learners in discussions and critical thinking about the impact of science on everyday life.
   e.g. Alternative fuels
   Provide the learner with 2 or 3 short concise articles on alternative fuels, a graph of the projected national estimates of fuel consumption for the next 10 years.

   Pose the problem, e.g.
   Choosing one of the alternative fuels as the main fuel to be used in South Africa in 10 years time, draw up a consequence chart to show how this will affect businesses, the general public, transport operators and the government.

2. **Translation task**

   Given an article from a scientific magazine, journal, newspaper or video clip, analyse, discuss and/or answer questions and solve problems related to it.

3. **Research project**

   A research project is a report that weighs up evidence about a scientific question where a decision needs to be made. Generally the topic should focus on an area where the science is not certain or where conflicting evidence is available.

   The following are examples of typical topics involving questions about **decision making using scientific information:**
   - Should government introduce laws which make it an offence to drive a vehicle which emits visible exhaust fumes?
   - Do mobile phones cause brain damage? If so, what should be done about it?
   - Are pharmaceutical companies reluctant to research dichloro-acetate as an alternative cure for cancer patients and what should be done?
   - Why has it taken so long for hybridised cars to reach the market? Is it deliberate and if so, could companies face legal action?

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- How has the introduction of artificial fertilisers improved the quality of human life in South Africa?
- Is it time for renewable energy to stop being the alternative and start becoming the mainstream, eventually transforming our lives? What is the next big energy source?
- What is best way to disinfect a swimming pool?
- Will bio-fuel help save our world from global warming? Should it be encouraged? If so how?

A research project is similar to an experimental investigation. The essential difference is the source of the data or information. Both the experimental investigation and the research project will usually include some (or all) of the following steps:

- identify a problem to be solved
- formulate a 'research' question (or collection of questions) to be investigated
- formulate a hypothesis to be tested (that is generated from the investigative question)
- collect data/ information (books, magazines, journals, Internet, experts, …) and record these references as a bibliography in the report
- select and arrange relevant data
- evaluate the data/ information
- draw conclusions

During research tasks, learners should be encouraged to obtain information from other resources. In order to avoid plagiarism, they must be taught explicitly how to reference correctly. Information obtained from other sources **must** be synthesised and re-written in the learner's own words (unless it is given in quotation marks). The reference used **must** be cited in the text and a reference list **must** be included. Teachers are encouraged to allocate marks for correct citation and for producing a suitable reference list. Since teachers have to sign a declaration (Appendix B) which states that they have monitored work for plagiarism, it is incumbent upon them to make sure that learners are properly instructed in referencing and that they do check for plagiarism.

This task should be marked on how the learners represent the information they have obtained and on what they do with this information. It is **NOT** only about putting other people's information in their own words. It is, more importantly, about the ideas and beliefs which the learner holds as a result of the research and information he or she has obtained.

Table 6B: An example of the Formal Programme of Assessment

SCHOOL BASED ASSESSMENT (25%)			**EXTERNAL ASSESSMENT (75%)**
Practical investigation Physics Focus	Practical investigation Chemistry Focus	Alternative Assessment	Final Examinations
Two Controlled Tests	Midyear Examinations or two Controlled Tests	Preliminary Examinations	

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Additional explanatory comments

- Table 6B describes the Formal Programme of Assessment and includes only summative assessment. However, formative assessment is integral to teaching and learning. It should take place on a daily basis. Daily assessment can be informal or formal and formative or summative (recorded). In this process teachers will set many more tasks than are required for the portfolio as described in Table 6 above. This is to the advantage of their learners. However, teachers may only submit the tasks requested in Table 6A and only these tasks can be taken into account when teachers calculate the SBA mark.
- Teachers are encouraged to set metacognitive tasks in the SBA component, e.g. ask candidates to set a test, prepare marking guidelines and analyse answers for misconceptions.
- Portfolios should be transferred with a learner from one school to another.
- The final SBA mark should be reported as a percentage.

Moderation of the assessment tasks in the Programme of Assessment

Table 7

Level	Moderation Requirements
School	The Formal Programme of Assessment should be monitored at the beginning of the year to ensure compliance with requirements. Each task which is to be used as part of the Formal Programme of Assessment should be moderated before learners attempt the task. Teacher and learner portfolios should be monitored for compliance before submission for cluster moderation. Learners and teachers must sign a letter of authenticity to be included in the learner portfolio. The principal signs a letter, to be included in the teacher portfolio, stating that appropriate moderation has taken place at school level.
Cluster	Teachers are required to attend two cluster meetings per year, the first before 15 March and the second by 15 September The Formal Programme of Assessment should be monitored at the first meeting to ensure compliance with requirements and proposed tasks discussed to ensure they are of an appropriate standard. No formal moderation of portfolios will take place at the second meeting. However, it is suggested that the teachers discuss the tasks that they have set, the standard of those tasks and how they will be marked. The second meeting is also an opportunity to share resources so that schools in a cluster can maintain a common standard.
IEB	Following the second cluster meeting, some schools/subjects may be regionally moderated by a moderator appointed by the IEB. A school which has been regionally moderated may not need to send portfolios for National moderation, unless either a particular problem is identified or the portfolios are identified as exemplary. During the December National Senior Certificate marking session a moderating committee, appointed by the IEB, under the leadership of a portfolio moderator, carries out the following checks: • monitors the teacher portfolio and the sample of learner portfolios, prescribed by the IEB, for compliance, from each examination centre. • monitors the standard of the portfolio tasks. • moderates a sample of learner tasks (the standard of the marking is checked) to ensure comparable standards across centres across the IEB. • completes a report on the portfolio work of each centre. A copy of this report is returned to the centre. • recommends mark changes to the IEB if the marks allocated for school based assessment at a particular centre do not reflect an appropriate standard of performance.

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Candidate's Portfolio

- Each candidate must be able to produce all the work as listed in Table 6A. This work is evidence of the candidate's performance and justification for the marks the candidate has been allocated for SBA. This work must be collected together in some convenient format that is neither expensive nor bulky. A flat folder or file or even a set of 'treasury tags' to bind the sheets together, will suffice. This folder of work constitutes the learner's portfolio and must be available for moderation if called for by the IEB.
- For performances or the production of models, or any other situation where it is not possible to keep the products of the task, the task assessment sheet should be retained in the portfolio. The assessment sheet in such cases should list the criteria against which the candidate was assessed and give details of the performance (marks).
- All the tasks in the portfolio must be in the same sequence as the task sheets in the teacher's portfolio for ease of moderation.
- The first page (Appendix B) in each portfolio must give the centre number, the candidate's examination number and include an index of tasks and the mark allocation for the tasks.
- The declaration of authenticity (see Appendix B) must be completed and included as the second page of the portfolio.

Teacher's Portfolio

- Each teacher must submit his/ her own portfolio with his/ her learners' portfolios for the compulsory moderation process.
- The teacher's portfolio must include all summative assessment task sheets or question papers with marking schemes, rubrics and marking guidelines (tests and examinations), as applicable.
- The teacher's portfolio must also include a mark sheet to provide evidence of all the individual marks that contribute to each component for each candidate described in Table 6. The final SBA mark should also be given as a percentage. The documentation must make it clear how the final percentage was determined.

Absence from a portfolio task

- Pupils should be given an opportunity to make up missed tasks. If necessary an equivalent task can be done.
- An authentic reason in writing, i.e. a doctor's letter, should be produced if a pupil misses a portfolio task.

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EXAMINATION DATA SHEET FOR THE PHYSICAL SCIENCES (PHYSICS & CHEMISTRY)

TABLE 1 PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Approximate magnitude of acceleration due to gravity	g	$10\ m{\cdot}s^{-2}$
Speed of light in a vacuum	c	$3{,}0 \times 10^{8}\ m{\cdot}s^{-1}$
Magnitude of charge on electron	e	$1{,}6 \times 10^{-19}\ C$
Mass of an electron	m_e	$9{,}1 \times 10^{-31}\ kg$
Planck's constant	h	$6{,}6 \times 10^{-34}\ J{\cdot}s$
1 electron volt	1 eV	$1{,}6 \times 10^{-19}\ J$
Standard pressure	p^{θ}	$1{,}013 \times 10^{5}\ Pa$
Molar gas volume at STP	V_m	$22{,}4\ dm^3{\cdot}mol^{-1}$
Standard temperature	T^{θ}	273 K

TABLE 2 PHYSICS FORMULAE

MOTION

$v_f = v_i + a\Delta t$ **or** $v = u + a\Delta t$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ **or** $s = \left(\frac{v+u}{2}\right)\Delta t$
${v_f}^2 = {v_i}^2 + 2a\Delta x$ **or** $v^2 = u^2 + 2as$	$\Delta x = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$ **or** $s = u\Delta t + \frac{1}{2}a(\Delta t)^2$

FORCE

$p = mv$	$F_{net} = \frac{\Delta p}{\Delta t}$	$F_{net}\Delta t = m\Delta v$
$F_{net} = ma$	$F_g = mg$	

WORK, ENERGY AND POWER

$W = F\Delta x$ **or** $W = Fs$ or $W = F\Delta x\cos\theta$	$P = Fv$	$P = \frac{W}{t}$
$E_p = mgh$	$E_k = \frac{1}{2}mv^2$	

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WAVES, LIGHT AND SOUND

$v = f\lambda$		$T = \frac{1}{f}$
$E = hf$	$E = \frac{hc}{\lambda}$	$E = W_f + \frac{1}{2}mv^2$
$f_o = \left(\frac{v}{v - v_s}\right) f_s$ or $f_o = \left(\frac{v}{v + v_s}\right) f_s$		

ELECTROMAGNETISM

$emf = -N\frac{\Delta\Phi}{\Delta t}$

ELECTRIC CIRCUITS

$Q = I\Delta t$	$R = \frac{V}{I}$
$P = VI = I^2R = \frac{V^2}{R}$	$V = \frac{W}{Q}$
$R = R_1 + R_2 + \ldots\ldots$	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$
$C = \frac{Q}{V}$	$emf = I(R + r)$

TABLE 3 CHEMISTRY FORMULAE

$n = \frac{m}{M}$ $c = \frac{n}{V}$	$E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ $E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$
$W = VQ$ $Q = I\Delta t$	$K_w = [H_3O^+][OH^-] = 10^{-14}$ at 298 K

TABLE 4 PERIODIC TABLE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 2.1 **H** 1		Atomic number (Z)				1 2.1 **H** 1		Electronegativity									2 **He** 4
2	3 1.0 **Li** 7	4 1.5 **Be** 9					Relative atomic mass						5 2.0 **B** 10.8	6 2.5 **C** 12	7 3.0 **N** 14	8 3.5 **O** 16	9 4.0 **F** 19	10 **Ne** 20
3	11 0.9 **Na** 23	12 1.2 **Mg** 24.3											13 1.5 **A** 27	14 1.8 **Si** 28	15 2.1 **P** 31	16 2.5 **S** 32	17 3.0 **C** 35.5	18 **Ar** 40
4	19 0.8 **K** 39	20 1.0 **Ca** 40	21 1.3 **Sc** 45	22 1.5 **Ti** 48	23 1.6 **V** 51	24 1.6 **Cr** 52	25 1.5 **Mn** 55	26 1.8 **Fe** 56	27 1.8 **Co** 59	28 1.8 **Ni** 59	29 1.9 **Cu** 63.5	30 1.6 **Zn** 65.4	31 1.6 **Ga** 70	32 1.8 **Ge** 72.6	33 2.0 **As** 75	34 2.4 **Se** 79	35 2.8 **Br** 80	36 **Kr** 84
5	37 0.8 **Rb** 85.5	38 1.0 **Sr** 88	39 1.2 **Y** 89	40 1.4 **Zr** 91	41 1.6 **Nb** 93	42 1.8 **Mo** 96	43 1.9 **Tc** 99	44 2.2 **Ru** 101	45 2.2 **Rh** 103	46 2.2 **Pd** 106	47 1.9 **Ag** 108	48 1.7 **Cd** 112	49 1.7 **In** 115	50 1.8 **Sn** 119	51 1.9 **Sb** 121	52 2.1 **Te** 128	53 2.5 **I** 127	54 **Xe** 131
6	55 **Cs** 133	56 **Ba** 137.3		72 **Hf** 178.5	73 **Ta** 181	74 **W** 184	75 **Re** 186	76 **Os** 190	77 **Ir** 192	78 **Pt** 195	79 **Au** 197	80 **Hg** 200.6	81 **T** 204.4	82 **Pb** 207	83 **Bi** 209	84 **Po** -	85 **At** -	86 **Rn** -
7	87 **Fr**	88 **Ra**																

57 **La**	58 **Ce**	59 **Pr**	60 **Nd**	61 **Pm**	62 **Sm**	63 **Eu**	64 **Gd**	65 **Tb**	66 **Dy**	67 **Ho**	68 **Er**	69 **Tm**	70 **Yb**	71 **Lu**
89 **Ac**	90 **Th**	91 **Pa**	92 **U**	93 **Np**	94 **Pu**	95 **Am**	96 **Cm**	97 **Bk**	98 **Cf**	99 **Es**	100 **Fm**	101 **Md**	102 **No**	103 **Lw**

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TABLE 5 STANDARD ELECTRODE POTENTIALS

Half –reaction			E°/ volt
$Li^+ + e^-$	⇌	Li	-3.05
$K^+ + e^-$	⇌	K	-2.93
$Cs^+ + e^-$	⇌	Cs	-2.92
$Ba^{2+} + 2e^-$	⇌	Ba	-2.90
$Sr^{2+} + 2e^-$	⇌	Sr	-2.89
$Ca^{2+} + 2e^-$	⇌	Ca	-2.87
$Na^+ + e^-$	⇌	Na	-2.71
$Mg^{2+} + 2e^-$	⇌	Mg	-2.37
$A^{3+} + 3e^-$	⇌	A	-1.66
$Mn^{2+} + 2e^-$	⇌	Mn	-1.18
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	-0.83
$Zn^{2+} + 2e^-$	⇌	Zn	-0.76
$Cr^{3+} + 3e^-$	⇌	Cr	-0.74
$Fe^{2+} + 2e^-$	⇌	Fe	-0.44
$Cd^{2+} + 2e^-$	⇌	Cd	-0.40
$Co^{2+} + 2e^-$	⇌	Co	-0.28
$Ni^{2+} + 2e^-$	⇌	Ni	-0.25
$Sn^{2+} + 2e^-$	⇌	Sn	-0.14
$Pb^{2+} + 2e^-$	⇌	Pb	-0.13
$Fe^{3+} + 3e^-$	⇌	Fe	-0.04
$2H^+ + 2e^-$	⇌	$H_2(g)$	0.00
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+0.14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+0.15
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+0.17
$Cu^{2+} + 2e^-$	⇌	Cu	+0.34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+0.40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+0.45
$I_2 + 2e^-$	⇌	$2I^-$	+0.54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+0.68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+0.77
$Hg^{2+} + 2e^-$	⇌	Hg	+0.79
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+0.80
$Ag^+ + e^-$	⇌	Ag	+0.80
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+0.96
$Br_2 + 2e^-$	⇌	$2Br^-$	+1.09
$Pt^{2+} + 2e^-$	⇌	Pt	+1.20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+1.21
$O_2 + 4H^+ + 4e^-$	⇌	$2H_2O$	+1.23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+1.33
$C_2 + 2e^-$	⇌	$2C^-$	+1.36
$Au^{3+} + 3e^-$	⇌	Au	+1.42
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+1.51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1.77
$F_2(g) + 2e^-$	⇌	$2F^-$	+2.87

Increasing oxidising ability ↓

Increasing reducing ability ↑

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C. SUPPORT MATERIAL

CORE CONTENT FOR THE PHYSICAL SCIENCES FOR GRADE 12

Rationale

There has been uncertainty amongst many teachers as to the depth and breadth of the subject content knowledge that learners need to know and be able to use to demonstrate the achievement of the learning outcomes for Physical Sciences in the two three hour examinations. In their efforts to ensure learners achieve similar results to those in the past, teachers are tempted to drill and practise content to help their learners answer questions typical of past examination question papers based on content. The quantity of subject content knowledge listed in the NCS document makes this approach impossible in the teaching time available. Teachers should therefore rather focus on helping their learners develop the skills and attitudes they need to use their knowledge in new contexts. The questions that arise are:

- What knowledge do learners need to know and at what depth and breadth?
- How will learners need to use this knowledge to answer the new data response questions that will be designed to assess the achievement of the three Learning Outcomes?
- Mindful of the relationship between Learning Outcomes, Assessment Standards and content as described in the NCS, viz. the three Physical Sciences Learning Outcomes will be assessed against the Assessment Standards, using the content as described here.
- A few of the ***key concepts*** covered in earlier grades have been included. Introducing the concepts from earlier grades where they are treated in a simpler way creates opportunities to assess them at a lower level and include easier tasks/ questions.
- This document does not replace the content to be taught and learned but only describes that which learners are expected to know and be able to answer in the two 3 hour examinations.
- Non-examinable content can be covered and assessed through informal or alternate means.

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Core Content to be the focus of the assessment of Physical Sciences grade 12 Examination (Physics)		
Core knowledge and concepts as in the NCS for the Physical Sciences	**Core knowledge and concepts**	**Comments**
MECHANICS		
Motion in two dimensions:	Learners must be able to:	
Projectile motion represented in words, diagrams, equations and graphs.	• Work with projectiles in 1 and 2 dimensions. • Assume that the effects of air resistance are negligible. • Explain that projectiles: – fall freely with gravitational acceleration 'g' – accelerate downwards with a constant acceleration whether the projectile is moving upward or downward – move horizontally with constant velocity – have zero velocity in the vertical direction at their greatest height – take the same time to reach their greatest height from the point of upward launch as the time they take to fall back to the point of launch • Resolve velocity and displacement into their vertical and horizontal components and realise that the vertical and horizontal components are independent of each other. • #Use equations of motion, e.g. to determine – the greatest height reached given the velocity with which the projectile is launched (initial velocity). – the time at which a projectile is at a particular height given its initial velocity. – the height relative to the ground of a projectile shot upward at launch, given the time for the projectile to reach the ground. – the maximum range of the projectile. • #Draw position vs. time, velocity vs. time, and acceleration vs. time graphs for the vertical and horizontal components of a projectile in motion. • Interpret position vs. time, velocity vs. time, and acceleration vs. time graphs relating to the vertical and horizontal components of a projectile in motion.	This section on Projectiles in **two dimensions** will appear as an optional question in the 2009 examination and will become compulsory from 2010. One dimensional projectiles may be examined in 2009.

Refers to content taught in lower grades

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts	Comments
Projectile motion represented in words, diagrams, equations and graphs (Contd.)	• Interpret graphs of components of displacement, velocity and acceleration. • Describe the motion of an object from a variety of graphs e.g. – ball bouncing, – ball thrown vertically upwards – ball thrown vertically downward, and so on	
Conservation of momentum (one direction only)	• Know that the total momentum of a system is conserved when no net external forces act on it. • Know that a net external force causes the momentum to change. The impulse delivered by the net force is $F_{net}\Delta t = \Delta p$. • Solve problems involving impulse and momentum when the applied force is in the horizontal or vertical direction. • Distinguish between elastic and inelastic collisions. • Solve problems involving collisions for objects moving parallel to each other. • #Use Newton's 1st, 2nd and 3rd Laws of Motion to provide qualitative explanations of relevant aspects of the principle of conservation of linear momentum, e.g. impulse and its relationship to change of momentum during explosions and collisions and when a resultant (net) force is applied to a body.	
Frames of reference. (one dimension only)	• Define a frame of reference. • Give examples of the importance of specifying the frame of reference. • Define relative velocity. • Specify the velocity of an object relative to different frames of reference (in 1 dimension only), e.g. for a person walking inside a train give the velocity relative to the train and relative to the ground. • Use vectors to find the velocity of an object that moves relative to something else that is itself moving, e.g. if the velocity of a bird relative to the air is $\vec{v}_{ba}$ and of the air relative to the ground is $\vec{v}_{ag}$ then the velocity of the bird relative to the ground is $v_{bg} = v_{ba} + v_{ag}$	

Refers to content taught in lower grades

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Core knowledge and concepts as in the NCS for the Physical Sciences	**Core knowledge and concepts**	**Comments**
Work, power and energy:	Learners must be able to:	Comments
When a force exerted on an object causes it to move, work is done on the object (except if the force and displacement are at right angles to each other).	• Define the work done on an object by a force. • Give examples of when an applied force does and does not do work on an object. • Calculate the work done by an object when a force F, applied at angle θ to the direction of motion, causes the object to move a distance d, using components.	
The work done by an external resultant force on an object/ system equals the change in kinetic energy of the object/system;	• Know that an object with larger potential energy has a greater capacity to do work. • Distinguish between total work done and 'useful' work on an object that produces changes in its kinetic and potential energy. • Solve problems using the fact that the 'useful' work done on an object is equal to the change in its mechanical energy; e.g. this could lead to calculating the efficiency of a machine, or electric motor. • #State and make use of the law of conservation of mechanical energy.	
Power (rate at which work is done).	• Define power as the rate at which work is done or energy is transferred. • Calculate the power involved when work is done. • If a constant force causes an object to move at a constant velocity, calculate the power using P=Fv. • Apply calculations of power to real life examples, e.g. the minimum power required of an electric motor to pump water from a borehole of a particular depth at a particular rate, the power of different kinds of cars operating under different conditions.	

Refers to content taught in lower grades

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts	Comments
WAVES, SOUND AND LIGHT		
Doppler Effect (source moves relative to observer):	Learners must be able to	Comments
With sound and ultrasound;	• State what the Doppler Effect is for sound and give everyday examples. • Explain why a sound increases in pitch when the source of the sound travels towards a listener and decreases in pitch when it travels away. • Use the appropriate equation: $f_O = \frac{v}{v - v_S} f_S \qquad f_O = \frac{v}{v + v_S} f_S$ to calculate the frequency of sound (f_O) detected by an observer (O) when stationary relative to a moving source (S). The frequency of the moving source is f_S. • #Describe the differences between sound and ultrasound. • Recognise and apply the Doppler Effect qualitatively where sufficient information is provided, e.g. to explain how the Doppler Effect is used to measure the rate of blood flow or the heartbeat of a foetus in the womb.	
With light – red shifts in the universe (evidence for the expanding universe).	• Recognise that the Doppler Effect also applies to light (and all other forms of electromagnetic radiation). • State that light observed from many stars is shifted toward the red (i.e. the longer wavelength) end of the spectrum. • Qualitative application of the Doppler Effect to these 'red shifts' leads us to conclude that these stars are moving away from Earth.	

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts	Comments
2D and 3D wavefronts:	Learners must be able to	Comments
Diffraction.	• Define a wavefront as an imaginary line that connects points on a wave that are in phase (e.g. all points at the crest of their cycle). • Define diffraction as the ability of a wave to spread as it passes through a small aperture or around a sharp edge in a shadow region.	A discussion of Huygen's principle may assist stronger learners in gaining a better understanding of diffraction.
Interference (special kind of superposition).	• Describe interference as occurring when two waves pass through the same region of space at the same time, resulting in the superposition of waves. • Explain the concepts of constructive and destructive interference. • Predict areas of constructive and destructive interference for two waves that are in phase and of the same wavelength generated by diffraction through a double slit or from two points. • Investigate the interference of waves on the surface of water from two coherent sources, vibrating in phase. • Interpret diagrams of an interference pattern marking nodal and antinodal lines and noting positions of maximum constructive and destructive interference.	
Shock waves, sonic boom.	• Describe, with the aid of a diagram, the formation of a shock wave as an example of interference of wavefronts formed when the object emitting waves is travelling faster than the speed of the waves in the medium. • Define the terms: – subsonic – supersonic – 'Mach' number • Explain the phenomenon of shockwaves in terms of the constructive interference of sound waves. • State that a 'sonic boom' is the sound heard by an observer as a shockwave passes.	

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts	Comments
ELECTRICITY AND MAGNETISM		
Electrodynamics:	Learners must be able to	Comments
Electrical machines (generators, motors);	• State that generators convert mechanical energy to electrical energy and motors convert electrical energy to mechanical energy. • Explain why an emf is induced in a coil that is rotated in a magnetic field, use Lenz's law to explain the direction of the induced emf and Faraday's Law to explain the factors affecting the magnitude of the induced emf. • #Use Lenz's law to describe how an a.c. transformer works. • Use words and pictures to explain the basic principle of an a.c. generator (alternator) in which a coil is mechanically rotated in a magnetic field. • Use words and pictures to explain how a d.c. generator works and how it differs from an a.c. generator. • 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 a d.c. electric motor. • Give examples of the use of a.c. and d.c. generators. • Give examples of the use of electric motors.	
• Alternating current.	• Explain the advantages of distributing electrical energy through long distances using alternating current. • Draw a graph of voltage vs. time and current vs. time for an a.c.generator.	

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts	Comments
• #Electrical circuits.	• #Use the concepts of d.c. current, potential difference, resistance, electrical cells, electrical energy and power to be able to explain behaviour of d.c. circuit elements, calculate values, draw and interpret simple d.c. circuit diagrams. • #Define the resistance of a circuit element e.g. an electric motor, a lamp, a resistor, a diode, an LED. • #Recognise and draw circuit diagrams using symbols for the circuit elements listed below: Cells (batteries), switches, voltmeters, ammeters, galvanometers, resistors, electric motors, lamps, diodes, LEDs. • #Students will be assessed on electrical circuits that contain a maximum of three resistors (including the internal resistance of a battery or d.c. generator). Resistors may be connected in series or parallel, or any other combination. • #Determine values of current, potential difference, emf, resistance and/or internal resistance from a given circuit diagram. • #Know that capacitors are devices which store electric charge. • #Define capacitance in terms of $C = \frac{Q}{V}$ and use this formula appropriately in calculations. • #Give examples or recognise the use of capacitors in electric circuits.	This section on electrical circuits will appear as an optional question in the 2009 examination and will become compulsory from 2010.
Electronics:	Learners must be able to	
Active circuit elements, diode, light emitting diode (LED).	• Describe a diode as a device used in electronics that allows current to flow in one direction only. • Describe the LED as a diode that emits light when conducting. • Give examples of the use of diodes in everyday life e.g. rectify a.c. current.	Physics investigations may include the use of field effect transistors (FET) and operational amplifiers. AND, OR and NOT gates may also be included in these investigations. Candidates will not be examined on the use of the above electronic circuit elements.

Refers to content taught in lower grades

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Electromagnetic radiation:	Learners must be able to	
Dual (particle/wave) nature of EM radiation.	• Explain that some aspects of the behaviour of EM radiation can best be explained using a wave model and some aspects can best be explained using a particle model.	EM radiation always has a dual nature; it is not sometimes a wave and sometimes a particle.
Nature of an EM-wave as mutual induction of oscillating magnetic/electric fields.	• Describe the source of electromagnetic waves as an accelerating charge. • Use words and diagrams to explain how an EM wave propagates when an electric field oscillating in one plane produces a magnetic field oscillating in a plane at right angles to it, which produces an oscillating electric field, and so on. • State that these mutually regenerating fields travel through space at a constant speed of 3×10^8 m/s, represented by c.	
EM spectrum.	• Given a list of different types of EM radiation, arrange them in order of frequency or wavelength. • Given the wavelength of EM waves, calculate the frequency and vice versa, using the equation $c = f\lambda$. • Give an example of the use of each type of EM radiation, i.e. gamma rays, X-rays, ultraviolet light, visible light, infrared, microwave and radio and TV waves.	
Nature of EM as particle – energy of a photon related to frequency and wavelength.	• Calculate the energy of a photon using $E = hf = hc/\lambda$. • Be able to convert J to eV and eV to J.	
Penetrating ability.	• Indicate the penetrating ability of the different kinds of EM radiation and relate it to energy of the radiation. • Describe the dangers of gamma rays, X-rays and the damaging effect of ultra-violet radiation on skin.	

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts proposed	Comments
MATTER AND MATERIALS		
Optical phenomena and properties of materials:	Learners must be able to:	
Photoelectric effect.	• Describe the photoelectric effect as the process that occurs when light shines on the surface of a metal and electrons are emitted. • Explain that monochromatic light is made up of photons, each of energy E = hf. • Explain why electrons are not emitted from a metal when the monochromatic light is below the threshold frequency (work function) for that metal. • Use the relationship: Work function $W_f = hf_{threshold}$ to predict whether electrons will be emitted from a metal. • Explain why the intensity of light does not affect the maximum kinetic energy of the emitted electrons (photoelectrons). • Make use of Einstein's equation: $hf = W_f + ½ mv^2$. • Relate the intensity of light to the number of photoelectrons emitted per second. • State and explain the significance of the photo-electric effect: – it establishes the quantum theory – it illustrates the particle nature of light	
Emission and absorption spectra.	• #Explain the source of atomic emission spectra (cf discharge tubes) and their unique relationship to each element. • #Relate the lines on the atomic emission spectrum to electron transitions between energy levels. • Explain the difference between atomic absorption and emission spectra. • Use E = hf to determine the energy of photons of uv and visible light of varying colours. • Relate uv and visible light to atomic absorption and/or emission spectra.	

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Content to be the focus of the assessment of Physical Sciences Grade 12 Examination (Chemistry)		
Core knowledge and concepts as in the NCS for the Physical Sciences	**Core knowledge and concepts proposed**	**Comments**
CHEMICAL CHANGE		
Rate and Extent of Reaction:		
Rates of reaction and factors affecting rate (nature of reacting substances, concentration [pressure for gases], temperature and presence of a catalyst).	• Explain what is meant by reaction rate. • List the factors which affect the rate of chemical reactions. (Surface area (solid), concentration (solution), pressure (gas), temperature, and catalyst.) • Explain in terms of collision theory how the various factors affect the rate of chemical reactions.	
Measuring rates of reaction.	• Suggest suitable experimental techniques for measuring the rate of a given reaction including the measuring of gas volumes, turbidity (e.g. precipitate formation), change of colour and the change of the mass of the reaction vessel.	
Mechanism of reaction and of catalysis.	• Define activation energy – the minimum Ek of reacting molecules that can result in a reaction. • Use a graph showing the distribution of molecular energies (number of particles against their kinetic energy) to explain why only some molecules have enough energy to react and hence how adding a catalyst and heating the reactants affects the rate. • Explain (in simple terms) how some catalysts function by reacting with the reactants in such a way that the reaction follows an alternative path of lower activation energy.	
Chemical equilibrium and factors affecting equilibrium.	• Explain what is meant by: – Open and closed systems – A reversible reaction – Dynamic equilibrium • Explain the equilibrium shift by using collision theory. • Predict the effect of a stress using Le Chateliers' Principle.	

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Core knowledge and concepts as in the NCS for the Physical Sciences	**Core knowledge and concepts proposed**	**Comments**
Equilibrium constant	• List the factors which influence the value of the equilibrium constant. • Write down an expression for the equilibrium constant having been given the equation for the reaction. • Explain the significance of high and low values of the equilibrium constant.	
Application of equilibrium principles.	• Explain qualitatively, given appropriate data, the effects of changes of pressure, temperature, concentration and the use of a catalyst on the concentrations and amounts of each substance in an equilibrium mixture • Apply equilibrium principles to water ionisation and hence the effect on pH. • Relate the strength of an acid or base to the degree of its ionisation. • Apply the rate and equilibrium principles to important industrial applications, e.g. when provided with relevant information, describe and explain, where applicable, aspects of rates, equilibrium, type of reaction and the significance of the reaction in relationship to the fertilizer industry. This applies to the following aspects of the fertilizer industry: – NH_3 – Haber process; – HNO_3 – the Ostwald process; – H_2SO_4 – including the contact process;	Calculation of pH is not required. A qualitative understanding of pH decreasing with increasing $[H_3O^+]$ is sufficient.

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts proposed	Comments
Electrochemical reactions:	Learners must be able to	
Electrolytic and galvanic cells	• Define the galvanic cell in terms of – self sustaining electrode reactions. – conversion of chemical energy to electrical energy. • 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. • Define oxidation and reduction in terms of electron (e^-) transfer. • Define anode and cathode in terms of oxidation and reduction.	#Use of oxidation numbers
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 pd 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 viz. • V_{cell} decreases as the concentration of product ions increase and the concentration of reactant ions decrease until chemical equilibrium is reached when the $V_{cell} = 0$ (The cell is 'flat').	
Understanding of the processes and redox reactions taking place in cells	• Describe – the movement of ions through the solutions. – the electron flow in the external circuit of the cell – their relation to the half reactions at the electrodes. – the function of the salt bridge.	

Refers to content taught in lower grades

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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 and state the convention regarding positive and negative values. • Use the Table of Standard Reduction Potentials to deduce 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.	
Writing of 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. • 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) • Describe, using half equations and the equation for the overall cell reaction, the layout of the particular cell using a schematic diagram. Include potential risks to the environment of the following electrolytic processes used industrially: – The production of chlorine (see grade 12 chemical systems: the chloral-alkali industry). – The recovery of aluminium metal (in South Africa) from Bauxite mined in Australia (This may be examined under the Chemical Systems Section).	

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts proposed	Comments
CHEMICAL SYSTEMS		
Chemical industry – resources, needs and the chemical connection:	Learners must be able to	
SASOL, fuels, monomers and polymers, polymerisation;		
The chloroalkali industry (soap, PVC, etc);	• Given diagrams of any one of the following three types of cell used industrially to produce chlorine electrolytically: (1) Mercury (Castner-Kellner) Cell (2) Membrane Cell (3) Diaphragm Cell – explain the process using half reactions and the overall redox reaction taking place in the cells – identify all the products and give a use of each – make clear the meaning of the term electrolytic cell – identify the cathode (reduction, H_2) and anode (oxidation, $C\ell_2$) – describe the function of the cell membrane where applicable (ion exchange) • Identify the benefits to humankind of the products of this process. • Identify risks associated with operating each of these cells. • 'Learners, when provided with relevant information, will be expected to be able to compare and contrast relevant information about the three cell types.'	
The fertiliser industry (N, P, K).		Refer to application of equilibrium principles (chemical change)

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts proposed	Comments
Batteries, torch, car, etc.	• Use the knowledge gained studying galvanic cells to provide, for an unknown cell: – the equation for the cell reaction given the half equations – the cell voltage if supplied with the voltage of the half cells • Explain and use the concepts: – energy stored in cells and batteries W = VQ – cell capacity and use the unit Amp-hour (Ah and mAh) and the equation $Q = I\Delta t$ – primary cells and secondary cells • Describe features of cell structure and explain qualitatively the relationship between – cell emf and the electrochemical reaction (e.g. lithium-ion is 3,6 V while NiCad is 1,2 V) – internal resistance and the distance between electrodes – cell current and the surface area of the electrodes – cell capacity and amount of electrolyte • Provided with a diagram of a lead-acid accumulator showing its structure and components as an aid, use the lead acid accumulator to – Explain the relationship between the structure of the battery and its internal resistance, maximum current, capacity and emf – Explain the relationship between battery emf and the connection of cells – When given the half reactions – write the overall reactions for discharge and recharging the battery. – Determine the emf using the voltages for the half reaction – Explain the functioning of a secondary cell including the relationship between the emf and the voltage at which it needs to be charged – Discuss issues around disposal / recycling of battery components	

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Core knowledge and concepts as in the NCS for the Physical Sciences	**Core knowledge and concepts proposed**	**Comments**
Batteries, torch, car, etc.	• Provided with a diagram of a zinc-carbon dry cell (Leclanché) showing its construction and components as an aid – When given the half reactions determine the overall reactions during discharge – Determine the emf from the voltages of the half reactions – Explain the functioning of the cell – Explain the relationship between the structure of the battery and its internal resistance, maximum current, capacity and emf • Given a diagram of an unknown primary or secondary cell (including a fuel cell), the half equations and half cell voltages be able to comment on issues relating structure and reaction equations to discharge and recharge cycles (secondary cells), cell emf, capacity, internal resistance and maximum current. • Evaluate the impact of the use of batteries on humans and the environment.	

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts proposed	Comments
MATTER AND MATERIALS		
Organic molecules:	Learners must be able to:	
Organic molecular structures – functional groups, saturated and unsaturated structures, isomers.	• Recognise the following functional groups: alkane, alkene, alkynes haloalkane, alcohols), aldehydes, ketones, carboxylic acids and esters from structural formulae (condensed/semi- structural or displayed structural). • Draw the displayed structural formulae of these functional groups and molecules containing them, given sufficient information. eg an alkanol (alcohol) containing 3 carbon atoms. • Identify the homologous series to which a particular compound belongs, given the compound's molecular or structural formula. • Recognise isomers and draw possible structural formulae for isomers: (i) of a particular molecular formula. (ii) when a sketch of a displayed or condensed structure of one of the isomers has been given.	#Candidates should expect to be assessed on knowledge fundamental to molecular structure. Candidates must be able to: • draw Couper structures for organic molecules and the functional groups included for grade 11. • use Lewis diagrams and then deduce the geometry of the molecules (bond angles). • identify the relative polarity of bonds qualitatively using electro-negativities. • use relevant data to deduce factors that affect bond energy (or bond strength).
Systematic naming and formulae, structure physical property relationships.	• Apply systematic naming for branched alkanes, alkenes, alkynes, haloalkanes, alcohols, carboxylic acids and esters up to a maximum of 8 carbon atoms. (Name to structure or structure to name). • Recognise the type (hydrogen bonds and Van der Waals forces) of intermolecular forces involved given suitable information (names or formulae). • Make comparable predictions regarding melting points, boiling points and viscosities, given suitable information. • Relate relative values of melting and boiling points to the relative strengths of intermolecular forces for compounds with functional groups mentioned above.	

Refers to content taught in lower grades

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Core knowledge and concepts as in the NCS for the Physical Sciences	**Core knowledge and concepts proposed**	**Comments**
Substitution, addition and elimination reactions.	• Unsaturated compounds undergo addition reactions to form saturated compounds e.g. $CH_2=CH_2 + C\ell_2 \rightarrow CH_2C\ell\text{-}CH_2C\ell$ • Saturated compounds undergo elimination reactions to form unsaturated compounds e.g. $CH_2C\ell\text{-}CH_2C\ell \rightarrow CH_2=CHC\ell + HC\ell$ • Two types of saturated structure can be inter-converted by substitution e.g. $(CH_3)_3OH + HBr \rightarrow (CH_3)_3Br + H_2O$ (in acidic solution) $(CH_3)_3Br + KOH \rightarrow (CH_3)_3OH + KBr$ (in alkali solution) • State that alkanes are generally unreactive due to bond strength and lack of polarity. • State that alkenes are more reactive than alkanes due to the double bond and undergo addition reactions. eg with halogen; e.g. polymerisation. • Recall observations from practicals e.g. decolourisation of bromine. • Recognise functional groups where substitution is likely to take place because of polarity in the molecule. eg. haloalkane where halogen is substituted by hydroxide. • Recall experimental details and observations to indicate that substitution has taken place. e.g. the precipitation of silver halide to show that halide has been produced by the reaction. e.g. decolourisation of bromine when in presence of u.v. • Recall experimental details and observations to indicate that elimination has taken place. e.g. Pass alcohol vapour over a hot surface. e.g. Esterification. This can also be thought of as substitution i.e - OH replaced by -O-R). • Recognise the type of reaction (i.e.: elimination, substitution, addition) when given sufficient information. • Write equations for substitution, addition & elimination reactions provided with appropriate information. (This includes esterification) • Write equations for combustion reactions of the alkanes, alkenes and alcohols.	The following are classical types of reactions covered in this section of work. Learners are, however, expected to recognize the type of reaction when given sufficient information and must be able to write equations provided with appropriate information. Learners who are familiar with the following reactions should be in a good position to meet the objectives, irrespective of the particular chemical formula used. Learners will not be expected to memorise conditions but may be asked for suggested reasons as to why particular conditions are required. Some examples of the reaction types follow: **<u>Alkanes:</u>** Reaction to form halogenoalkane with U.V. light, room temperature and pressure. (Substitution reaction) e.g. $C_2H_6 + Br_2 \rightarrow C_2H_5Br + HBr$ (This reaction will continue with excess Br_2 to form C_2Br_6) **<u>Alkenes</u>** Reaction to form alkanes e.g. heat with H_2 under pressure and catalyst i.e. Ni or Pt (Addition) Reaction to form halogenoalkane e.g. react with halogen, HX etc. (addition) Reaction to form alcohol (pass alkene and steam (H_2O) over heated phosphoric acid catalyst under pressure. (addition)

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts proposed	Comments
		Halogenoalkane Reaction to form alkene by refluxing with conc. alcoholic alkali (Elimination reaction) e.g. $C_2H_5Br \rightarrow C_2H_4 + HBr$ Reaction to form alcohol by heating with dilute aqueous alkali (substitution) e.g. $C_2H_5Br \rightarrow C_2H_5OH$ **Alcohols** Reaction to dehydrate the alcohol forming an alkene (elimination) by heating and passing over hot pumice and Al_2O_3 e.g. $C_2H_5OH \rightarrow C_2H_4$ Reaction to form an halogenoalkane by distilling from a mixture of alcohol, conc. H_2SO_4 and KX. (KBr, KCl) (substitution) e.g. $C_2H_5OH \rightarrow C_2H_5Br$ Reaction to form an aldehyde e.g. distil on adding alcohol to acidified potassium dichromate (note a mixture of products is formed hence distillation). e.g.: $C_2H_5OH \rightarrow CH_3COH$ (This is a redox reaction!) Reaction of carboxylic acids to form esters with alcohols i.e. heat with carboxylic acid and acid catalyst (elimination[dehydration] or substitution) Reaction of ester to form carboxylic acid and alcohol by refluxing with water and acid catalyst. (addition or substitution)

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts proposed	Comments
		Note: Alcohols can be oxidised to aldehydes and carboxylic acids using acidified potassium dichromate. A colour change is observed. The reverse reaction (reduction) can be achieved using a reducing agent $NaBH_4$ in water or alcohol.
Mechanical properties:	This topic is non-examinable, but is suggested as a practical investigation.	
Hooke's Law, stress-strain, ductile and brittle materials.		This section on mechanical properties can be linked to the microscopic structure and the properties of the molecules of which a substance such as a metal or polymer is made. It could form part of the investigation in physics or chemistry to help learners link the mechanical properties to chemical structure e.g. of different types of materials: metals, rubber compounds, plastics.
Organic macromolecules:	Learners must be able to:	
Plastics and polymers – thermoplastic and thermoset.	• Describe the term polymer and include terms (possibly using a mind map) that refer to – their microscopic structure like macromolecule, chain, monomer, functional groups, … – their macroscopic properties like resistance to chemicals, thermal and electrical insulators, (varying) low density and varying (great) strength and versatility (foamed, molded, extruded into fibre, …) – their uses like packaging; fibres for clothing; tyres; adhesives; products from thin film to plastic 'crockery and cutlery' even furniture, sports equipment, automobile parts, floor coverings, paint, etc. – their commercial importance by giving the quantities of the most commercially important polymers produced annually, – the typical length (size) and molecular mass of these macromolecules relative to each other – examples	

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Core knowledge and concepts as in the NCS for the Physical Sciences	Core knowledge and concepts proposed	Comments
	• Illustrate the reactions to produce polymers by addition reaction using the radical polymerization of ethene to produce polythene. Refer to initiation, propagation and termination. • Identify the monomer used to produce a polymer from the structural formula of a section of a chain. • Identify a polymer as the product of an addition polymerization reaction, from its structural formula. • Identify a polymer as the product of an esterification reaction from its structural formula. • Draw the structural formula of an addition polymer that could be produced from monomers containing one carbon–carbon double bond, given the structural formula(e) of the monomer(s), or vice versa. • Illustrate the formation of polyester in terms of a diol reacting with a dicarboxylic acid. • Draw the structural formula of a polyester when provided appropriate monomers. • Describe the effects of heating on thermoplastic and thermoset polymers, and the consequent difference in ease of recycling. • Describe the advantages and disadvantages of the use of materials composed of polymers and fillers.	

NOTE: Mole calculations, involving the writing of chemical equations, the balancing of chemical equations and the determination of the number of moles of a substance, can be examined anywhere within the Chemistry Examination Paper. The calculations may involve the equations $n = \frac{m}{M}$; $c = \frac{n}{V}$; vol of gas = $n \times 22.4$ (at STP).

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D. ADMINISTRATIVE AND SUPPORT DOCUMENTATION

1. Appendix A: Task planning sheet
2. Appendix B: Portfolio Cover Sheet and Declaration of Authenticity
3. Appendix C: Sample moderation checklist
4. Appendix D: A suggestion for the letter from the principal
5. Appendix E: Summary mark sheet
6. Appendix F: Teacher Support Checklist (Not for moderation purposes)

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1. APPENDIX A

NATIONAL SENIOR CERTIFICATE EXAMINATION

PHYSICAL SCIENCES

APPENDIX A

SAMPLE PHYSICAL SCIENCES TASK PLANNING SHEET

Title of Task				**Date**	
Content Knowledge					
	Place a cross in the appropriate box				
TASK TYPE:	Alternative Assessment	Physics Practical Iinvestigation	Chemistry Practical Investigation	Controlled Test	Examination

Question	**Learning Outcomes**			**Cognitive level**			
	LO1	**LO2**	**LO3**	1	2	3	4
Total Actual Mark							
Total maximum marks for the task							
Target% (see SAGs)				**15**	**45**	**25**	**15**
Target Mark							
(Mark)-(Target)							

Preliminary Exam
LO 1: 20% ± 3%
LO 2: 7% ± 3%
LO 3: 10% ± 3%

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2. APPENDIX B: DECLARATION OF AUTHENTICITY

NATIONAL SENIOR CERTIFICATE EXAMINATION
PHYSICAL SCIENCES PORTFOLIO COVER SHEET
DECLARATION OF AUTHENTICITY

CENTRE NO. **CANDIDATE'S NO.**

NAME OF CANDIDATE: _____

NAME OF TEACHER: _____

Component	Task	Date	Out of	Mark	%	Weight	Calc. Value
Investigations	1. Physics Practical					**20%**	
	2. Chemistry Practical					**20%**	
	3. Alternative Assessment					**10%**	
Test	1. Physics:					**10%**	
Test	2. Chemistry:					**10%**	
Examination	Paper I: Physics					**15%**	
Examination	Paper II: Chemistry					**15%**	
FINAL MARK						**100%**	

DECLARATION BY THE CANDIDATE:

I, _____ (print full names)

declare that all external sources used in my portfolio have been properly referenced and that the remaining work contained in this portfolio is my own original work. I understand that if this is found to be untrue, I am liable for disqualification from the National Senior Certificate.

Signed: _____ Date: _____
Candidate

DECLARATION BY THE CANDIDATE'S TEACHER:

I _____ (print name and title of teacher) at

_____ (print name of school) declare that the work provided by this candidate has been monitored and checked for plagiarism.

Signed: _____ Date: _____
Teacher

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3. APPENDIX C: SAMPLE MODERATION CHECKLIST

NATIONAL SENIOR CERTIFICATE EXAMINATION

PHYSICAL SCIENCES

SAMPLE MODERATION CHECKLIST FOR REGIONAL OR NATIONAL MODERATION

To be completed and returned to the school

Examination Centre Number: _____ Date: _____

Records	Response and comment	
Candidate's portfolios supplied according to list from IEB	y/n	+2 / no list
Appendix A available for each task?	y/n	All / some available
Summary of assessment available (1st page of candidate's portfolio) – Appendix B?	y/n	accurate/ complete/ clear
Appendix C available (Cluster Moderator's Checklist)?	y/n	accurate/ complete/ clear
Evidence of school based moderation (Appendix E plus any other …)	y/n	Minutes/policy/checklists
Summary of candidates' marks available (teacher file) – Appendix F	y/n	accurate/ complete/ clear
All the tasks with marking memoranda are available in teacher's file	y/n	mostly / several missing /
Appropriate aggregation of marks (1st page of candidate's portfolio)	y/n	accurate/ complete/ clear

Tasks completed and marked according to requirements	Response and comment	
Physics Investigation - 1 item.	y/n	innovative/traditional
Chemistry Investigation - 1 item.	y/n	individual/ varied/ group
Alternative Assessment	y/n	innovative/traditional
Controlled tests – 2	2/4	original/ IEB questions/ new
Preliminary examination (Paper 1 & Paper 2)	y/n	original/ IEB questions/ new
Marking in accordance with the memoranda	y / n	rubrics used/ other tools
Correct weighting LO 1 : 2 : 3 for preliminary examinations	y/n/p	Tasks for which incorrect

Additional Comments (including descriptions of any tasks or questions of particular merit):

_____

_____

_____

_____

_____

_____

_____

_____

_____

Portfolio Moderator's signature _____ Date: _____

4. APPENDIX D: A SUGGESTION FOR THE LETTER FROM THE PRINCIPAL

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NATIONAL SENIOR CERTIFICATE EXAMINATION

PHYSICAL SCIENCES

A SUGGESTION FOR THE LETTER FROM THE PRINCIPAL

_____ SCHOOL _____
_____ ADDRESS _____
_____
_____

The IEB
P O Box 875
Highlands North
2037

Dear IEB Portfolio Moderator

RE: SCHOOL BASED ASSESSMENT AND MODERATION OF PHYSICAL SCIENCES SBA IN GRADE 12

We certify that

teachers of the same subject have ensured that	Circle your response	
they have met regularly to reflect on and discuss issues of standardisation	YES	NO
the assessment tasks they have set learners are of the required standard	YES	NO
the memoranda they have used for marking are accurate and functional	YES	NO
the tasks learners have completed meet the criteria described in the IEB Subject Assessment Guidelines	YES	NO
marking is complete and of the appropriate standard	YES	NO
all administrative procedures have been correctly completed	YES	NO
all information on the 1st page of the portfolio (Appendix B) in each learner's portfolio is complete and correct	YES	NO

_____ _____
TEACHER PRINCIPAL

DATE: _____ DATE: _____

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5. APPENDIX E: SUMMARY MARK SHEET

NATIONAL SENIOR CERTIFICATE EXAMINATION

PHYSICAL SCIENCES

Year	Exam No.	Name	(Enter the Calculated Value for each candidate rounded off to one decimal place)								Round off to an integer
					Prelim Examinations		Investigations		Alternative Assessment	SBA	
			Test 1 (Physics)	Test 2 (Chem)	Paper I: Physics	Paper II: Chem	Physics Practical	Chemistry Practical			
%			10	10	15	15	20	20	10	100	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

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6. APPENDIX F: TEACHER SUPPORT CHECKLIST (NOT FOR MODERATION PURPOSES)

NATIONAL SENIOR CERTIFICATE EXAMINATION

PHYSICAL SCIENCES

TEACHER SUPPORT CHECKLIST

Teachers should aim to have most of the blocks ticked in this table.	
To what extent did the School Based Assessment <u>submitted</u> for moderation <u>assess</u> the candidate's ability to :	✓
identify a phenomenon that can be investigated?	
formulate an hypothesis or write (formulate) a question that can be investigated or predict observations that will follow a particular intervention (PEE – predict explore explain)?	
identify variables?	
design an investigation?	
improve on the design or criticize the design of an investigation?	
manipulate apparatus?	
make observations?	
make measurements like time, mass, length, force, others, using instruments?	
record and organise data (into tables, graphs, …)?	
draw a conclusion from data collected and organised?	
explain the observations (colour changes during chemical reactions)?	
explain the scientific concepts under investigation?	
construct a scientific argument	
A <u>survey</u> of the task types used for School Based Assessment (Teachers should aim to have several blocks ticked in this table.)	
Are there School Based <u>Assessment</u> tasks submitted for moderation that require candidates to produce?	✓
answers to tests and examinations?	
answers to question sheets (tutorials)?	
labelled sketches /drawings (free body /force diagrams, vector diagrams, scale diagrams, of apparatus …)?	
translation tasks (interpret a graph in words, make a diagram to explain a concept, write words to describe a relationship given in the form of an equation or graph …)?	
spider diagrams, mind maps, concept maps, flow charts, thinking maps, …?	
computer products e.g. graphics, spreadsheets, simulations, power point presentations, …?	
a demonstration of an experiment / use of apparatus (by a candidate or group of candidates)?	
a model (built by a candidate or group of candidates)?	
test questions with memoranda (products of a metacognitive process – an analysis of their own or a peers thinking, e.g. identifying a mistake in an answer, explaining the reason for the mistake and correcting it)?	
tasks that are self assessed or peer assessed (requiring reflection about the candidate's own learning)?	
a role play, song, dance, speech, presentation, …. – script written or actual performance?	
a product of computer aided learning – e.g. after going through a simulation of an experiment or industrial process, submitted answers to a set of questions?	
group work - group work skills?	
group work - a product of group work?	
other ?	
other ?	
other ?	

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