CHAPTER 11

PHYSICAL SCIENCES

The following report should be read in conjunction with the Physical Sciences question paper of the November 2017 examinations.

11.1 PERFORMANCE TRENDS (2014–2017)

The number of candidates who wrote the Physical Sciences examination in 2017 decreased by 13 149 in comparison to that of 2016. The performance of the candidates in 2017 reflects a marked improvement at the 30% level to 65,1% and at the 40% level to 42,2%.

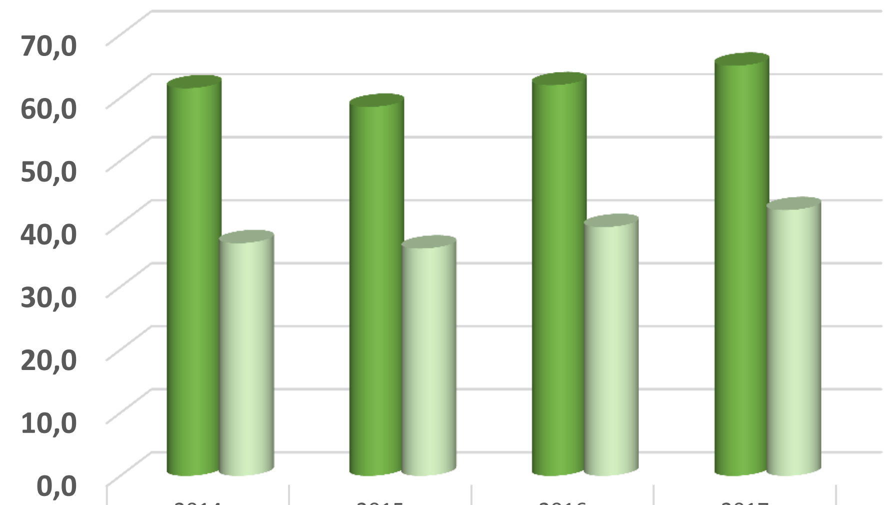
Table 11.1.1 Overall achievement rates in Physical Sciences

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2014	167 997	103 348	61,5	62 032	36,9
2015	193 189	113 121	58,6	69 699	36,1
2016	192 710	119 467	62.0	76068	39.5
2017	179 561	116 862	65,1	75 736	42,2

The improvement in performance of candidates in 2017 can be attributed to the stability in the curriculum and both teachers and candidates becoming familiar with the assessment style of the subject.

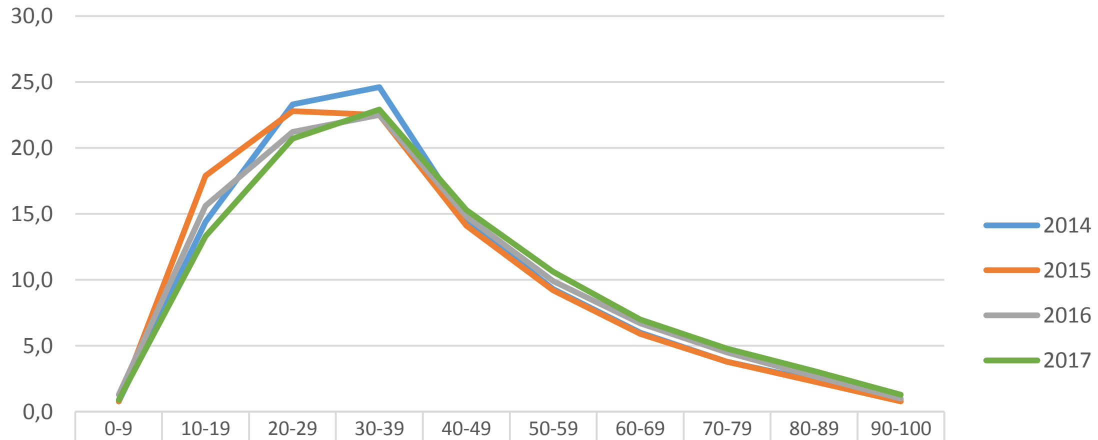
However, there is still room for improvement in the performance of the candidates if the challenges surrounding problem-solving skills, mathematical skills, conceptual understanding and integration of topics are addressed. In this regard, integrated problem solving must become an integral part of teaching and learning.

Graph 11.1.1 Overall achievement rates in Physical Sciences (percentage)



	2014	2015	2016	2017
% achieved at 30% and above	61,5	58,6	62,0	65,1
% achieved at 40% and above	36,9	36,1	39,5	42,2

Graph 11.1.2 Performance distribution curves in Physical Sciences (percentage)



	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-100
2014	0,8	14,4	23,3	24,6	14,5	9,3	6,0	3,8	2,4	0,9
2015	0,8	17,9	22,8	22,5	14,1	9,2	5,9	3,8	2,3	0,8
2016	1,3	15,6	21,2	22,5	14,8	9,9	6,7	4,5	2,7	1,0
2017	0,9	13,3	20,7	22,9	15,3	10,6	7,0	4,8	3,1	1,3

11.2 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

General Comments

(a) Questions on Newton's Laws of Motion, Momentum, Doppler Effect and Electric Circuits (Q2, Q4, Q6 and Q9) were generally well answered.

(b) Grade 11 work is poorly understood. Grade 11 work should be included in classwork, homework and tests in Grade 12.

(c) Questions pertaining to pure recall of content were very poorly answered. Teachers are advised to use short informal assessment tasks to a greater extent in order to reinforce basic concepts and principles, e.g. short speed tests (± 10 minutes). This can be used to good effect in content relating to definitions and laws listed in CAPS and the Examination Guideline.

(d) Learners are still struggling with drawing and labelling free-body diagrams correctly. The drawing of free-body diagrams is central to solving problems involving forces acting on objects and therefore teachers should ensure that learners are able to draw free-body diagrams for such problems in classwork, homework and tests.

(e) Interpretation of graphs is a challenge for many learners. Each learner should be provided with a graph book or graph paper. Problem-solving exercises that involve graphs should be done in a variety of topics and the graph book or graph paper should also be utilised for some of these problems. However, learners should also be given the opportunity to sketch graphs without the use of graph paper. The scale of graphs, gradient, ordered-pairs and x and y-intercepts need to be emphasised within problem-solving in science contexts.

(f) Some learners still cannot work with scientific formulae correctly. Teachers should emphasise the use of the relevant formula provided on the formula sheet, correct substitution and providing the answer with the correct unit and direction if required.

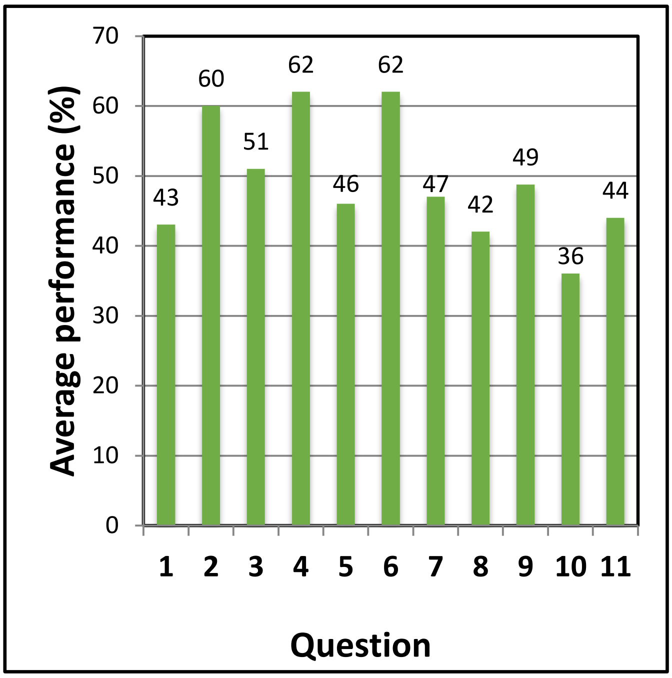
(g) The application of mathematics is still a challenge for many learners. Learners should be given a variety of problem-solving activities that involve mathematical knowledge pertaining to simultaneous equations, quadratic equations, binomials, factorization, trigonometry and graphs in classwork, homework, tests and examinations.

(h) Many learners have poor problem-solving skills. Problem-solving activities where different knowledge areas are integrated should be given to learners.

11.3 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 1

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

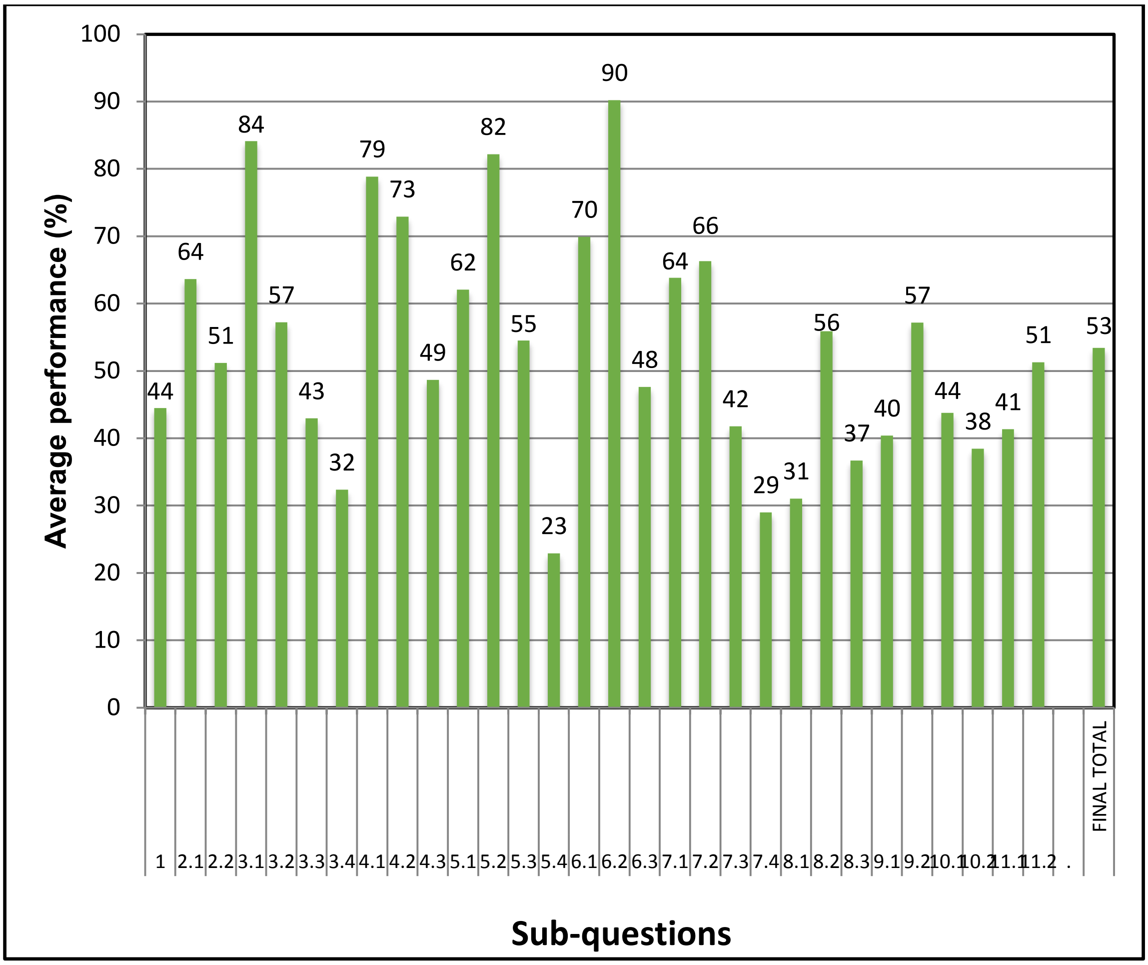
Graph 11.3.1 Average marks per question expressed as a percentage in Paper 1



Q1	Multiple choice questions - all topics
Q2	Newton's laws of motion
Q3	Vertical projectile motion
Q4	Momentum
Q5	Work, energy and power
Q6	Doppler effect
Q7	Electrostatics (Coulomb's Law)
Q8	Electrostatics (Electric Fields)
Q9	Electric circuits
Q10	Electrodynamics: Motors, generators and alternating current
Q11	Photo-electric effect

There was an improvement in performance in six topics, viz. Newton's Laws (Q2), Momentum (Q4), Work Energy Power (Q5), Electrostatics – Coulomb's Law (Q7); Electrostatics – Electric Fields (Q8); Electric Circuits (Q9) and Photo-electric Effect (Q11) as compared to 2016. Q10 on Electrodynamics was the question in which the candidates performed the worst.

Graph 11.3.1 Average marks per sub question expressed as a percentage for Paper 1



11.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: MULTIPLE CHOICE

Common errors and misconceptions

(a) In Q1.1, many candidates could not establish the correct relationship between gravitational acceleration, weight and mass.

(b) In Q1.4, candidates associated the sign of the velocity with a decrease in velocity and not the direction of motion.

(c) Most candidates did not understand that the work done on an object in Q1.5 is independent of time.

(d) In Q1.9, many candidates failed to apply Fleming's left-hand motor rule to determine the direction of the force experienced by the conductor.

(e) In Q1.10, candidates could not relate the maximum kinetic energy of the ejected photo-electron to threshold frequency (work function) when incident photon energy is constant.

Suggestions for improvement

(a) Teachers must use multiple-choice questions in every assessment activity so that content can be mastered and misconceptions addressed.

(b) During the revision of multiple-choice questions, learners must be given an opportunity to explain or demonstrate the choices they made so that misconceptions can be identified and corrected.

(c) The relationship between variables in formulae should be emphasised,

e.g. $E = W_0 + K_{max}$

QUESTION 2: NEWTON'S LAWS OF MOTION

The question was well-answered.

Common errors and misconceptions

(a) Candidates omitted key words in their definition, e.g. 'at rest' or 'constant velocity', 'net' force. They also mixed their definitions by defining the second or third law instead of the first law.

(b) Many candidates used incorrect labels for their forces, omitting arrows and drawing force diagrams instead of free-body diagrams.

(c) Many candidates omitted units in the final answer.

(d) Many candidates failed to convert km to m before substituting in the correct formula and did not square the radius.

Suggestions for improvement

(a) Teachers should stick to and emphasise the definitions in the *Examination Guidelines*.

(b) The importance of drawing free-body diagrams correctly and their usefulness in problem solving must be emphasised.

(c) Similarities and differences between related formulae should be highlighted, referring to the different contexts where each law can or cannot be used.

QUESTION 3: VERTICAL PROJECTILE MOTION

Common errors and misconceptions

(a) Many candidates failed to choose a direction for the vector quantities.

(b) Many candidates failed to recognise that two free-falling bodies, although one is moving upward and the other downward, have the same gradient.

Suggestions for improvement

(a) Expose learners to a variety of contexts in which the equations of motion can be applied. More complex contexts must first be broken down into simpler scaffolding questions to develop the cognitive skills of the learners.

(b) Provide learners with translation tasks in which information is converted from one form to another (e.g. statements equations, graphs).

QUESTION 4: MOMENTUM

Common errors and misconceptions

(a) Some candidates defined the law of conservation of energy instead of linear momentum and omitted key words in their definition e.g. “total” linear momentum.

(b) Use of the formula $\Delta p_{bullet} = \Delta p_{block}$ instead of $\Delta p_{bullet} = -\Delta p_{block}$ and $\Sigma E_{k(before)} = \Sigma E_{k(after)}$ instead of $\Sigma p_{(before)} = \Sigma p_{after}$

Suggestions for improvement

(a) Expose learners to a variety of contexts for problem solving, focusing on one or a few skills at a time, such as interpreting the context and identifying relevant formulae while explaining why others cannot apply.

(b) Use the data sheet and formula sheet throughout the year. Integrate related topics during problem-solving activities, such as ‘momentum and its conservation’, ‘equations of motion’ and ‘work, energy and power’.

QUESTION 5: WORK, ENERGY AND POWER

Common errors and misconceptions

(a) Many candidates used the incorrect equation $W_w = Ep = mgh$ instead of $W_w = -\Delta Ep = -mg\Delta h$

(b) Some candidates used the conservation of mechanical energy, which was not applicable as this was not an isolated/closed system.

(c) Many candidates did not show/choose their sign convention. They were confused regarding the sign of the weight, tension and acceleration in their equations.

Suggestions for improvement

(a) Teachers are urged to integrate Newton's laws of motion, and work, energy and power so that these concepts can be reinforced.

(b) A systems approach can be used when solving a two-body problem using energy principles.

QUESTION 6: DOPPLER EFFECT

Common errors and misconceptions

(a) Many candidates failed to copy the equation correctly from the formula sheet.

Suggestions for improvement

(a) Teachers need to provide learners with a variety of questions involving the use of the Doppler Effect equation. It seems teachers tend to focus on the calculation of either f_L or f_s, whereas the scope is much broader given the number of variables in the equation.

QUESTION 7: ELECTROSTATICS (COULOMB'S LAW)

Common errors and misconceptions

(a) Calculator skills are severely lacking.

(b) Candidates lacked integration skills related to the vector diagram and to the Theorem of Pythagoras.

Suggestions for improvement

(a) Expose learners to vector diagrams (1D and 2D) and vector triangles when working with forces (electrostatic, gravitational and when determining the resultant of forces acting on a body).

(b) Remind learners of the vector nature of physical quantities when answering questions.

QUESTION 8: ELECTROSTATICS (ELECTRIC FIELDS)

Common errors and misconceptions

(a) Many candidates wrote the formula from the formula sheet as $F = \frac{kQ}{r^2}$ instead of $E = \frac{kQ}{r^2}$.

(b) Candidates failed to contextualise the definition in Q8.1 in context.

Suggestions for improvement

(a) Revisit vector diagrams in 1D and 2D when revising this section

(b) Clarify the distinction between the two equations $E = \frac{kQ}{r^2}$ and $E = \frac{F}{q}$

(c) Learners confused the negative sign of the charge with vector characteristics.

QUESTION 9: ELECTRIC CIRCUITS

Common errors and misconceptions

(a) Many candidates failed to identify the series and parallel connections from the graph which indicates their lack of understanding of the differences between series and parallel connections in a circuit.

(b) Many candidates could not establish the relationship between resistance, current and potential difference between points a and b.

(c) Some candidates failed to apply Ohm's law to different sections of the circuit.

Suggestions for improvement

(a) Although the principles of series and parallel circuits are taught from Grade 9, the basic principles have to be revisited constantly.

QUESTION 10: ELECTRODYNAMICS

Common errors and misconceptions

(a) Sketching a graph of the output of a DC generator proved to be a challenge for many learners.

(b) Many candidates failed to read the question properly as they calculated the average power or the generator instead of the device, ignored the power dissipated in the wires and omitted subscripts in their equations.

Suggestions for improvement

(a) Proper analysis of the question must be encouraged. Learners must learn to understand questions before answering them.

(b) Learners must be taught the differences between generators and motors and how to draw the graphs of a DC and a AC generator. They must be made to understand why the graphs differ in shape and direction.

QUESTION 11: PHOTO-ELECTRIC EFFECT

Common errors and misconceptions

(a) The principle that a quantum of energy (photon is formed) when energy is emitted by an electron that makes a transition from a higher energy state to a lower one and that the change in energy relates to the frequency of the photon, is not understood by many of the candidates.

(b) Many candidates could not differentiate between the absorption and emission spectra.

(c) Some candidates failed to integrate concepts learnt under electromagnetic radiation with the photo-electric effect.

Suggestions for improvement

(a) Teachers must teach the conditions leading to each type of spectrum. Conditions influencing the ejection of electrons from a metal surface must be clearly given to learners.

(b) Learners must be given various problems to solve so that they can use the equations involved in a wide range of problem-solving situations.

11.5 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 2

General Comments

(a) The question on organic nomenclature (Q2) was answered the best by candidates. Performance in organic reactions (Q4) has improved compared to previous years.

(b) Performance in questions on reaction rate (Q5), chemical equilibrium (Q6) and electrolytic cells (Q9) was very poor.

(c) There was a steady improvement in performance in galvanic cells (Q8) over the years and the question on fertilisers (Q10) was answered much better than in previous years.

(d) Questions pertaining to pure recall of content were answered very poorly. Teachers are advised to use more short informal assessment tasks in order to reinforce basic concepts and principles, e.g. short speed tests (± 10 minutes). This can be used to good effect in content relating to definitions and laws listed in *CAPS* and the *Examination Guidelines*.

(e) Grade 11 work (Stoichiometry) is poorly understood. Grade 11 work should be included in classwork, homework and tests in Grade 12.

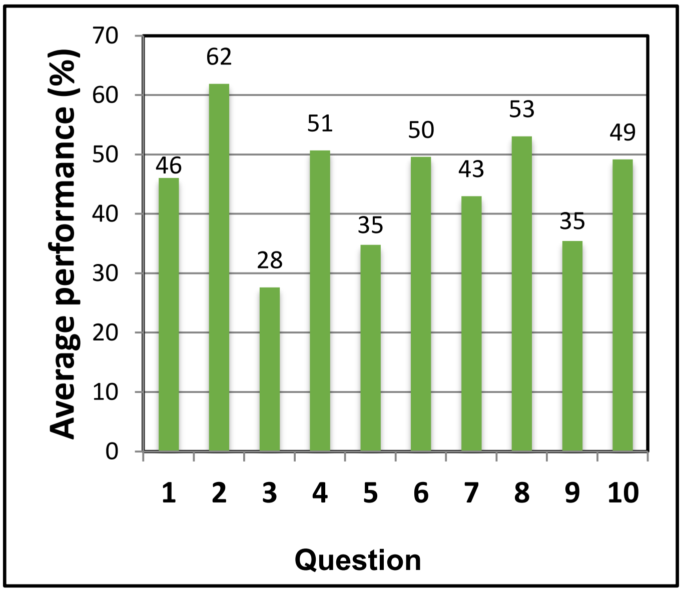
(f) Interpretation of graphs is a challenge for many learners. Problem-solving exercises that involve graphs should be done in a variety of topics. The scale of graphs, gradient, ordered-pairs and *x* and *y*-intercepts need to be emphasised within problem solving in science contexts.

(g) Some learners still cannot work with scientific formulae correctly. Teachers should emphasise the use of the relevant formula provided on the formula sheet, correct substitution and providing the answer with the correct unit and direction, if required.

11.6 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

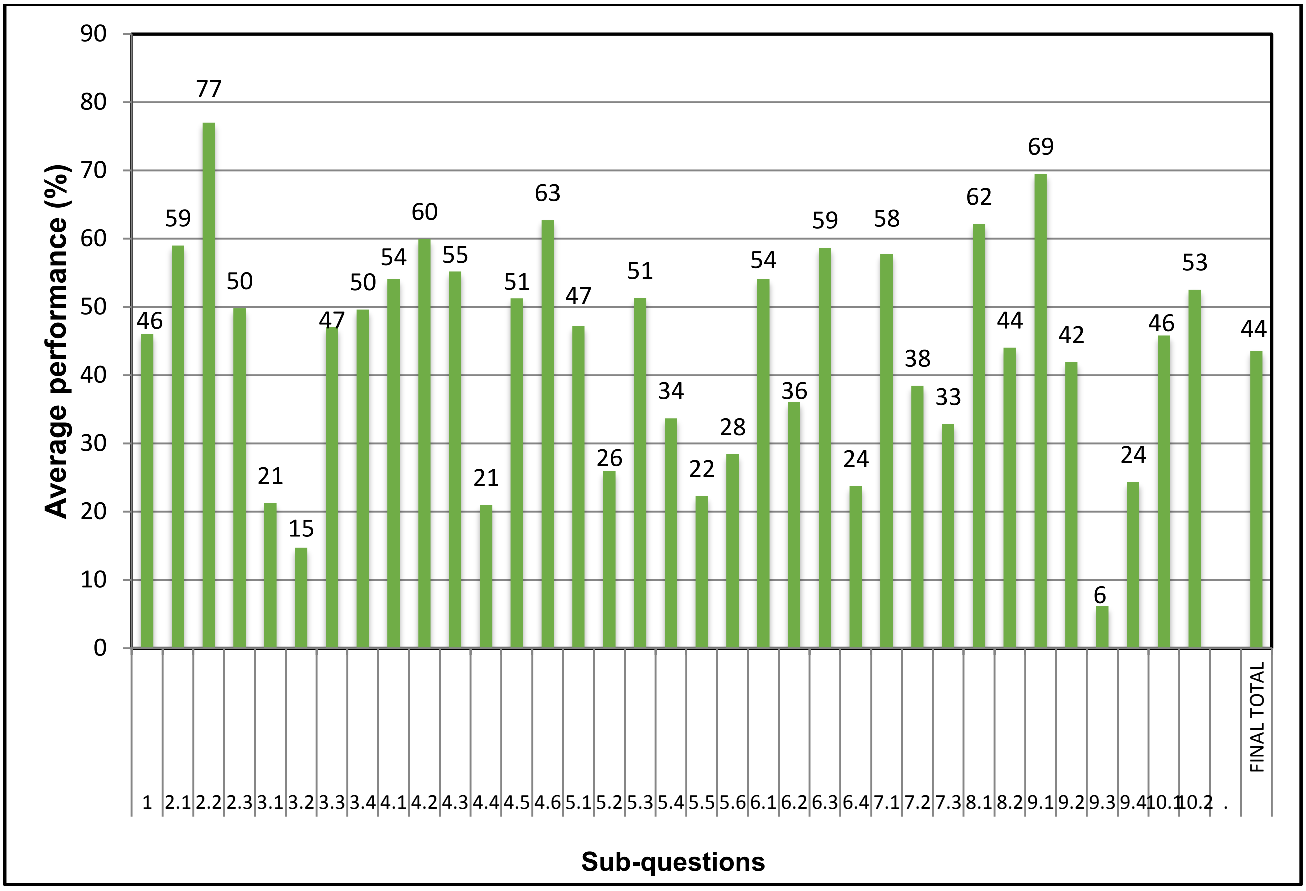
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

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



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

Graph 11.6.2 Average marks per sub question expressed as a percentage: Paper 2



11.7 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: MULTIPLE Choice Questions

Common errors and misconceptions

(a) In Q1.3, candidates failed to understand that after the cracking process, the number of atoms of hydrogen and carbon remains the same.

(b) In Q1.5, candidates showed a poor understanding of the interpretation of a given K_c value.

(c) In Q1.6, candidates had a misconception regarding the effect of the addition of a solid to an equilibrium mixture of gases.

(d) In Q1.7, candidates could not identify the given compounds as either acid or base. Na_2CO_3 was the only base given and therefore had the highest pH. The highest pH was incorrectly associated with the strongest acid.

(e) In Q1.9, candidates were not familiar with the products of the electrolysis of NaCℓ and as a result they expected sodium to be part of the products.

Suggestions for improvement

(a) The application of Le Chatelier's principle to the addition of more of a solid reactant was not well understood. The concentration of a solid is a constant and does not change when more solid is added. Therefore addition of more HgO(s) to the equilibrium mixture at constant temperature will have no effect on the equilibrium position.

(b) The meaning of a low and high value of the equilibrium constant should be addressed. Learners should be given the opportunity to interpret given or calculated K_c values.

$K_c = 1$	[products] = [reactants]
$K_c > 1$	[products] > [reactants]
$K_c < 1$	[products] < [reactants]

(c) Electrolytic cells need more attention in class. Learners have a poor understanding due to too little time spent on this topic in most schools. Learners should be supplied with summaries on electrolytic cells and then guided on how to study and distinguish among the different electrolytic cells prescribed.

QUESTION 2: NOMENCLATURES OF ORGANIC COMPOUNDS

Common errors and misconceptions

(a) Candidates included numbers in the IUPAC name of the ester in Q2.1.2 and the IUPAC name of the acid in Q2.1.3.

(b) Many candidates showed a poor understanding of the term *functional isomer* and wrote the structural formula of an ester (positional isomer) in Q2.1.4.

(c) When drawing structural formulae in Q2.1.4 and Q2.2, there was still a tendency to place too many bonds around a C atom or to omit bonds and/or H atoms in the structure.

(d) Q2.3.1 was not read properly. Instead of giving the general formula to which the compound belongs, most of the candidates gave the homologous series (alkynes) to which the compound belongs.

(e) In Q2.3.2, hyphens and commas are still not correctly used in IUPAC names and many candidates also failed to arrange the substituents in alphabetical order.

Suggestions for improvement

(a) The different types of structural isomers should be emphasised. Learners must be made aware that *positional*, *chain* and *functional isomers* are all different types of structural isomers and learners should be exposed to examples of such isomers.

(b) When writing IUPAC names, substituents should be placed in alphabetical order. However, learners should be taught that the prefixes, di, tri, etc., are not considered when arranging substituents in alphabetical order.

QUESTION 3: PHYSICAL PROPERTIES OF ORGANIC COMPOUNDS

Common errors and misconceptions

(a) Merely stating that alkanes have single bonds between C atoms in Q3.1 is not enough because alkanes and alkynes also have single bonds between C atoms.

(b) Candidates experienced difficulty to provide a definition of vapour pressure in Q3.2.

(c) Interpretation of the graph in Q3.3.2 was a challenge for many candidates. They failed to see that the boiling points of the compounds are the temperatures at which each of the graphs cuts the dotted line which represents atmospheric pressure.

(d) In Q3.3.3, many learners failed to refer to the variables (labels on the axes of the graph) in their explanations. Most learners failed to compare the vapour pressures of the four compounds at a particular temperature.

(e) In Q3.4.1, some candidates found the drawing of the chain isomer of pentane challenging.

Suggestions for improvement

(a) The safest and easiest reason why alkanes are considered saturated is that alkanes have no multiple bonds.

(b) Ensure that learners understand the meaning of a particular definition. For example, the definition of vapour pressure is about the pressure exerted by a vapour in equilibrium with its liquid phase (liquid $\rightleftharpoons$ vapour) in a closed system.

(c) When using a graph to answer a particular question, learners should be taught to refer to the variables.

QUESTION 4: REACTIONS OF ORGANIC COMPOUNDS

Common errors and misconceptions

(a) Although Q4.1.1 was answered moderately well, many candidates could not supply a correct reason why compound **P** is a secondary alcohol.

(b) Although Q4.2 was well answered, the analysis of the flow diagram to identify types of reactions was a challenge to some candidates.

(c) In Q4.3.2, differentiation between the conditions for substitution (dilute strong base) and elimination (concentrated strong base) was a challenge for many candidates.

(d) In Q 4.4, most candidates failed to write the correct formula for the inorganic reactant needed for the elimination reaction (D) of a halo-alkane to form an alkene.

(e) When writing a balanced equation using structural formulae in Q4.5, many candidates used molecular formulae.

(f) The IUPAC name in Q4.6 was often written as but-1-ane. Some wrote platbutane or Pt-butane or platinumbutane, not knowing that Pt is only a catalyst.

Suggestions for improvement

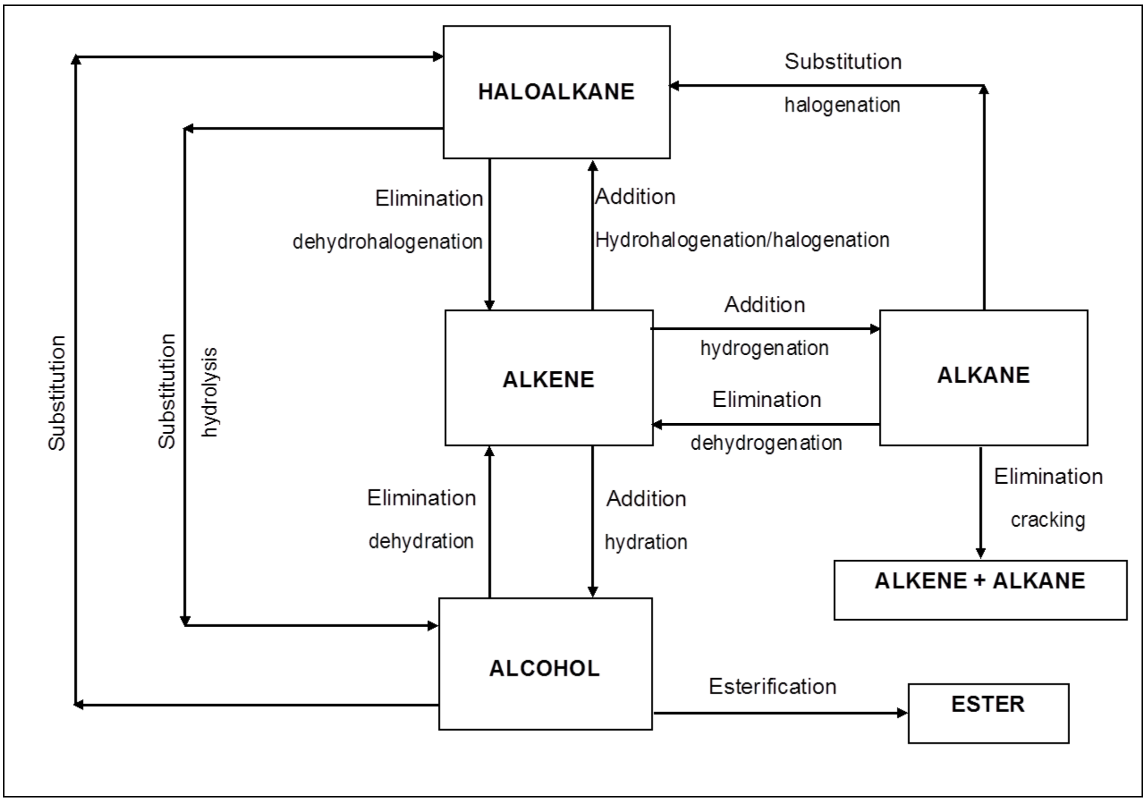
(a) In alkanes, numbers are only used to indicate the position of alkyl groups (substituents) on the parent chain. Numbering within the parent name, for example but-1-ane, is incorrect.

(b) A flow diagram should be used in class to show the difference between elimination, substitution and addition reactions.

ADDITION: Compounds with DOUBLE BONDS (alkenes) form compounds with SINGLE BONDS (alcohols, alkanes or haloalkanes).

ELIMINATION: Compounds with SINGLE BONDS (alcohols, alkanes or haloalkanes) form compounds with DOUBLE BONDS (alkenes).

SUBSTITUTION: Compounds with SINGLE BONDS (alcohols, alkanes or haloalkanes) form compounds with SINGLE BONDS from a different homologous series (alcohols or haloalkanes)



QUESTION 5: REACTION RATE

Common errors and misconceptions

(a) The definition of reaction rate in Q5.1 is still a challenge to many candidates.

(b) In Q5.2, many candidates failed to identify the dependent and independent variables correctly*.*

(c) In Q5.3, most candidates identified graph Q correctly but failed to give a correct explanation.

(d) Common errors in Q5.4 are: Ignoring the reaction rate and the time to calculate the volume of H_2 produced; substituting 22,4 dm^3 instead of the given 24 000 cm^3; using the ratio between Zn and HCℓ (1:2) instead of that between Zn and H_2 (1:1) and using formulae not applicable to the problem e.g. $c = \frac{n}{V}$ and/or $c = \frac{m}{MV}$

(e) Many candidates did not know how an increase in temperature would influence the heat of reaction of a reaction in Q5.5.1.

(f) A poor understanding of the use of the collision theory to explain why the rate in experiment III is higher in Q5.6 was evident.

Suggestions for improvement

(a) When stating a definition that can be expressed as a mathematical equation, learners should be taught to define in terms of the quantities in the expression. For example, reaction rate has the unit of concentration per second/volume per second/moles per second/mass per second.

(b) When stating an investigative question, learners should be taught that when the answer to the question can be 'YES' or 'NO', the question does not ask for a relationship between the variables. The best way to formulate an investigative question, after identification of the dependent and independent variables, is to start with 'What is the relationship between ...'.

(c) Learners should get more exposure to reading, interpretation as well as drawing of graphs.

QUESTION 6: CHEMICAL EQUILIBRIUM

Common errors and misconceptions

(a) When stating the definition of chemical equilibrium Q6.1, many candidates omitted the word *rate* and therefore stated that 'the forward reaction is equal to the reverse reaction'.

(b) The K_c calculation in Q6.2.1 was answered better than expected. Common errors were:

No K_c expression (Note that $\frac{[\text{products}]}{[\text{reac tan ts}]}$ is NOT a K_c expression!)

(c) In Q6.2.2 many candidates did not use the answer obtained in Q6.2.1 to answer this question.

(d) In Q6.4, candidates failed to explain using Le Chatelier's principle, the effect of decreasing pressure on a system at equilibrium.

Suggestions for improvement

(a) Place more emphasis on explanations requiring Le Chatelier's principle. Learners struggle to express themselves when explaining in terms of Le Chatelier's principle. They should be exposed to more exercises to practise such explanations involving all the factors that influence equilibrium namely concentration, pressure and temperature.

(b) Teachers should avoid using ($K_c = \frac{[\text{products}]}{[\text{reac tan ts}]}$ in class. Use chemical equations to teach the writing of K_c expressions.

(c) Ensure that learners know that square brackets are used to indicate concentration.

QUESTION 7: ACIDS AND BASES

Common errors and misconceptions

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

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

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

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

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

Suggestions for improvement

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

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

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

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

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

QUESTION 8: GALVANIC CELLS

Common errors and misconceptions

(a) Many candidates failed to name component Y in Q8.1.1.

(b) The writing of the cell reaction in Q8.1.3 proved challenging for the candidates.

(c) Common errors in Q8.1.4 were: Failing to copy the correct equation from the formula sheet; swapping the reduction potential of the anode with that of the cathode when substituting; substituting the reduction potential of the Aℓ half-reaction as a positive value instead of -1,66 V and omitting / providing the unit at the final answer.

(d) In Q 8.2.1, most candidates did not know that an *inert electrode* should be used because $C\ell_2$ is a gas and $C\ell^-(aq)$ a solution.

(e) When writing the standard conditions under which the half-cells function in Q8.2.2, many candidates omitted units or used incorrect unit for example 25 ° and mol·dm^3.

(f) The use of the Table of Standard Reduction Potentials to determine the strongest reducing agent in Q8.2.3 is still a major problem.

(g) In Q8.2.4 many learners again showed that they do not understand how to use the Table of Standard Reduction Potentials.

Suggestions for improvement

(a) Emphasis should be placed on the difference between cell potential, the cell reaction and cell notation.

(b) Ensure that learners use formulae on the formula sheet. This will prevent the use of an incorrect formula for the calculation of the cell potential.

(c) More time should be spent to ensure that learners understand how to use the Table of Standard Reduction Potentials. Learners should be taught that, for example, Zn^{2+} can never be a reducing agent because it cannot undergo oxidation (lose electrons). Oxidising agents are listed to the left in the Table of Standard Reduction Potentials and reducing agents to the right (see the section of Table 4B below).

Section of the TABLE OF STANDARD REDUCTION POTENTIALS (4B)

Most negative reduction potential

Weakest oxidising agent

Most negative reduction potential

Strongest reducing agent

$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	$-0,27$
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	$-0,14$
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	$-0,13$
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	$-0,06$
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	$+0,14$
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	$+0,15$
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	$+0,16$
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	$+0,17$
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	$+0,34$
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	$+0,40$
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	$+0,45$

Most positive reduction potential

Strongest oxidising agent

Most positive reduction potential

Weakest reducing agent

QUESTION 9: ELECTROLYTIC CELLS

Common errors and misconceptions

(a) In Q9.1 many candidates failed to link the increase in mass of electrode **P** to reduction and therefore **P** is the cathode.

(b) In Q9.3, most candidates could not explain why zinc ions will not influence the quality of the pure copper.

Suggestions for improvement

(a) More time should be spent to ensure that learners understand how to use the Table of Standard Reduction Potentials to compare relative strengths of two oxidising agents or of two reducing agents.

QUESTION 10: FERTILISERS

Common errors and misconceptions

(a) In Q10.1.1 many candidates wrote the formula instead of the name.

(b) In Q10.1.2 many candidates wrote NO_3 instead of NO_2 as the formula of the gas.

(c) In Q10.1.3 most candidates did not know that the name of the process

(d) In Q10.1.4 most candidates did not know the catalyst used in the catalytic oxidation of ammonia

(e) In Q10.1.7 many candidates wrote the incorrect formula for ammonium nitrate.

(f) Many candidates did not know how to use the given data in Q10.2 to calculate the mass of phosphorus (Q10.2.1) and the mass of filler in the bag (Q10.2.2).

Suggestions for improvement

(a) Teachers should provide learners with more flow diagrams of the processes to practice.

(b) Expose learners to more calculations involving the NPK ratio.