CHAPTER 12: PHYSICAL SCIENCES

The following should be read in conjunction with the Physical Sciences question paper of November 2016 examination.

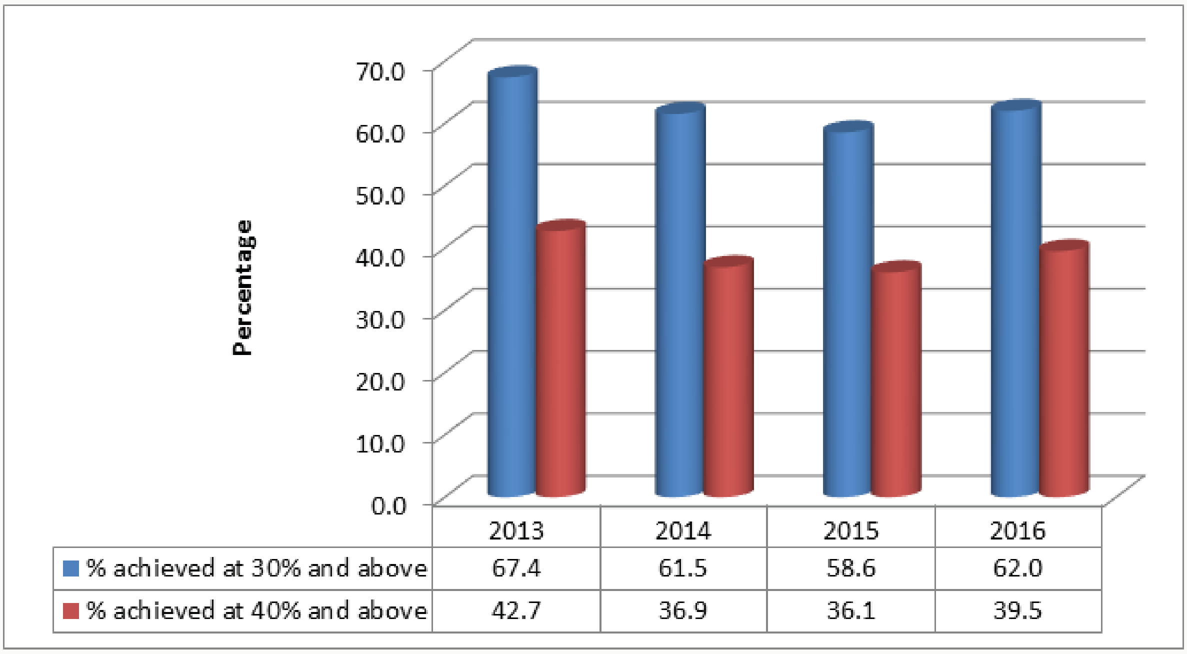
12.1. PERFORMANCE TRENDS (2013 – 2016)

The general performance of candidates improved this year as indicated by 62,0% of candidates achieving at 30% and above, with 39,5% achieving at 40% and above.

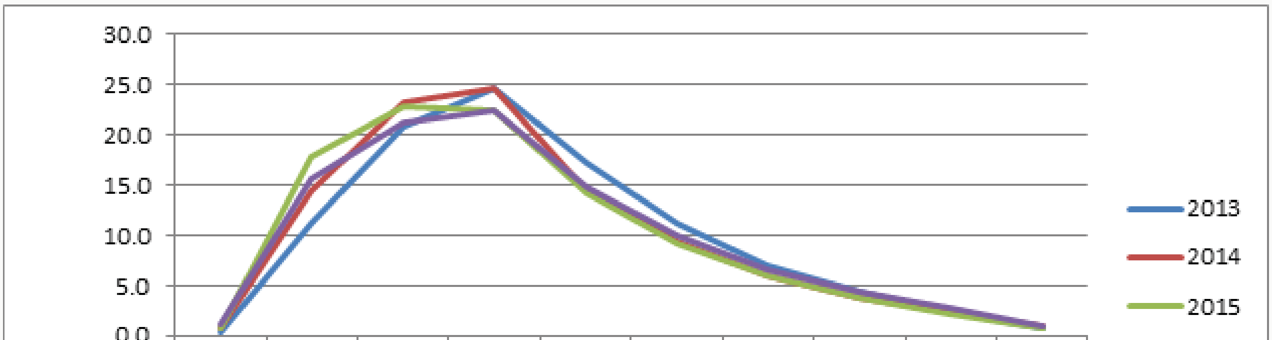
Table 12.1.1 Overall achievement in Physical Sciences

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
2013	184 383	124 206	67,4	78 677	42,7
2014	167 997	103 348	61,5	62 032	36,9
2015	193 189	113 121	58,6	69 699	36,1
2016	192 618	119 427	62.0	76 044	39.5

Graph 12.1.1 Overall achievement in Physical Sciences



Graph 12.1.2 Performance distribution curves in Physical Sciences



	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	70-79.9	80-89.9	90-100
2013	0.4	11.3	20.9	24.7	17.2	11.2	7.0	4.3	2.4	0.7
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

From the above graphs, it is evident thatthere has been anincrease in the performance of candidates compared to last year.

12.2. OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

General Comments

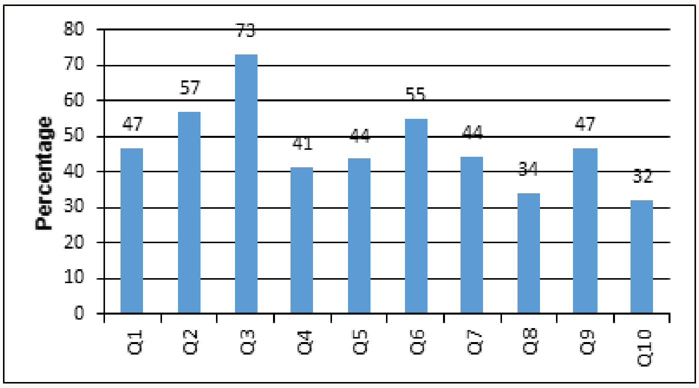
(a) Questions on Newton's Laws of Motion, Vertical Projectile Motion, Doppler Effect and Electrodynamics (Q2, Q3, Q6 and Q9) were generally well answered.

(b) Candidates did not perform well in Q8 (Electric Circuits) and performed very poorly in Q10 (Photo Electric Effect).

12.3. DIAGNOSTIC QUESTION ANALYSIS FOR 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.

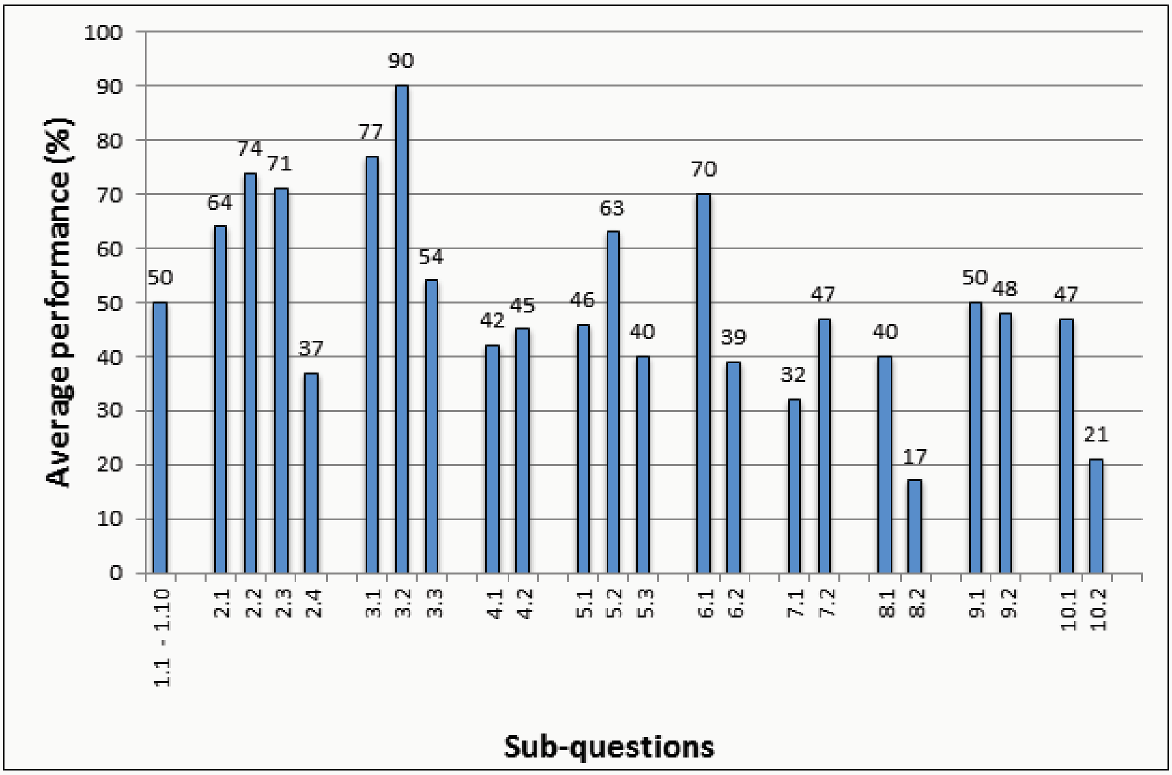
Graph 12.3.1 Average marks per question expressed as a percentage for Paper 1



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 and Electric fields)
Q8	Electric circuits
Q9	Electrodynamics: Motors, generators and alternating current
Q10	Photo-electric effect

Q8 on electric circuits was the worst answered question followed by the photo-electric effect in Q10. This is probably due to a lack of emphasis on practical work and an inability to solve problems that require learners to integrate knowledge learnt in different sections of Physics e.g. mechanics with electricity.

Graph 12.3.2 Average marks per sub question: Paper 1



12.4. ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: MULTIPLE CHOICE

This question was fairly well answered. However, Q1.2, Q1.5, Q1.8 and Q1.9 were poorly answered.Q1.2 was the worst answered question while Q1.1 and Q1.6 were the best answered questions.

Common errors and misconceptions

(a) Most candidates saw Q1.2as a proportionality question rather than a question that tests their understanding that the mass of an object is always the same irrespective of its position above the earth.

(b) Candidates failed to realise that in Q1.5, the block was released from rest, i.e., the velocity is zero at point Q. As a result of this, its kinetic energy is zero, and its mechanical energy is conserved.

(c) Q1.8: The graph was presented differently, with the gradient representing $\frac{1}{R}$ (conductance) instead of R (resistance). Candidates had a challenge with logical reasoning ability. They failed to see that the straight-line graph with the largest slope represented the smallest resistor, i.e. the greater $\frac{1}{R}$ is,the smaller R is.

(d) Q1.9: Candidates failed to apply the relationship between *area of the coil* and *induced emf* in a generator.

Suggestions for improvement

(a) Teachers must use multiple choice questions in every assessment activity.

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

(c) Greater emphasis should be placed on interpretation of graphs including an interpretation of the shapes of graphs as well as the gradients of graphs

(d) The relationship between variables in formulas should be emphasized.

QUESTION 2: NEWTONS LAWS OF MOTION

The question was fairly well answered, with some sub-questions (e.g. Q2.4.1) answered very poorly. The skill of solving equations simultaneously is still lacking.

Common errors and misconceptions

(a) Q2.1 required definitions. The definitions should be taken from the Curriculum and Assessment Policy Statement (CAPS) and the Examination Guideline. The omission of important key words, such as 'net force' and 'directly proportional' were still quite common. Candidates are still using the term 'indirectly proportional' instead of inversely proportional.

(b) In Q2.2, candidatesommittedthe subscripts in the formula and units in the final answer (confusing 'kinetic frictional force' with 'coefficient of kinetic friction'), used the wrong formula 'F_{net} = ma' instead of '$f_k = \mu_k N$', and wrote F_N as 'mg·cos30º'instead of just 'mg'.

(c) In Q2.3, candidates drew free body diagrams in which the lines representing the forces have no arrows and do not make contact with the object.

(d) In Q2.4.1, candidates failed to calculate the vertical component of the applied force and incorrectly calculated the normal as being equal in magnitude to the gravitational force. Many candidates did not know that the normal is not always equal in magnitude to the gravitational force.

Suggestions for improvement

(a) The simultaneous equation/two system method using free body diagrams must be taught at schools.

(b) Learners should be exposed to a variety of contexts in which they do problem-solving involving Newton's second law.

(c) Emphasize the sketching of labelled free body diagrams.

QUESTION 3: VERTICAL PROJECTILE MOTION

This was the best performed question.

Common errors and misconceptions

(a) InQ3.1, candidates omitted the key word 'only' in their definitions and confused'gravitational force' with 'gravitational acceleration'.

(b) In Q3.2.2, candidates interchanged the initial and final velocities, didnot follow sign convention, didnot round off the final answer to a minimum of two decimal places and wrote the unit of time as 'sec' instead of 's'.

(c) The skill of graph sketching required in Q3.3 is still severely lacking.

(d) Some candidates could not substitute correctly.

Suggestions for improvement

(a) Use the CAPS and the Examination Guideline documents for definitions.

(b) Learners should be taught to indicate their chosen sign convention at the beginning of the problem and to use their chosen sign convention in solving the problem.

(c) Emphasise the basics of graphing skills.

QUESTION 4:
MOMENTUM

This question was fairly well answered.

Common errors and misconceptions

(a) In Q4.1, candidates failed to define an isolated system. Most of them defined it as a system in which momentum is conserved.

(b) In Q4.2.1,candidates used incorrect equations, namely Δp = mv and $F_{net} = \Delta p$

(c) In Q4.2.2,candidates were unable to read and interpret the graph. They could not read the initial momentum and final momentum of car A correctly from the graph.

(d) In Q4.2.3,candidates did not realise that the slope of the graph is equal to the net average force. Co-ordinates were incorrectly read from the graph.

Suggestions for improvement

(a) Learners should be exposed to different contexts of momentum type problems.

(b) Learners must be taught to differentiate between ‘momentum’ and the ‘change in momentum’. The vector nature of velocity must always be considered when dealing with momentum related questions.

(c) Teachers must represent information using graphs and allow learners to read, analyze and interpret the graphs.

(d) Teachers should expose learners to problem-solving exercises that require them to draw graphs from given or inferred information.

(e) Learners should be encouraged to explore different ways of solving the same problem.

QUESTION 5:
WORK, ENERGY AND POWER

This question was generally well answered with the exception of Q5.1.2.

Common errors and misconceptions

(a) In Q5.1.1, candidates usedthe principle of conservation of mechanical energy instead of simply calculating the kinetic energy from the given information and the formula for kinetic energy on the data sheet.

(b) In Q5.1.2,candidates used the principle of conservation of linear momentum instead of the conservation of mechanical energy.

(c) A number of candidates could not state the work-energy theorem.

(d) In Q5.3 candidates could not identify frictional force as the only non-conservative force that can do work on the object.

(e) Candidates could not apply the ‘conservation of mechanical energy’ to a system of objects.

Suggestions for improvement

(a) Learners must draw free body diagrams for questions requiring calculations using work-energy principles.

(b) Teachers should provide learners with different types of questions on conservative and non-conservative forces, work-energy theorem, and conservation of mechanical energy.

(c) Show learners that $W_{net} = \Delta Ek$ and $W_{nc} = \Delta K + \Delta U$ can both be used to solve the same problem.

(d) Learners should be given problem-solving exercises that require them to apply the 'conservation of mechanical energy' to systems that have more than one object.

QUESTION 6: DOPPLER EFFECT

Candidates performed well in this question.

Common errors and misconceptions

(a) In Q6.1.1,most candidates failed to state the Doppler effect correctly.

(b) In Q6.1.2, common errors were:

- The use of the formula $c = f\lambda$ instead of $v = f\lambda$.
- They used speed of the ambulance (30 $m \cdot s^{-1}$) instead of speed of sound in air (340 $m \cdot s^{-1}$) to calculate the frequency of the source.
- Use of the Doppler equation to calculate the frequency of the source.
- Writing hz as a unit for frequency instead of Hz.

(c) In Q6.1.3,common errors were:

- They calculated f_s in Q6.1.2 substituted as f_L
- f_s was substituted as 30 and not the value calculated in Q6.1.2

(d) In Q6.2,candidates could not explain the phenomenon in terms of frequency. They could not relate frequency of light to colour.

Suggestions for improvement

(a) Teach learners definitions as prescribed in the CAPS and the Examination Guidelines for Physical Sciences.

(b) Learners mustknow that there is only one formula for the Doppler Effect as well as the meaning of each symbol in the Doppler equation.Learners also need to understand why velocities are added or subtracted in the Doppler Effect formula. Diagrams depicting wavefronts would assist in teaching this.

(c) Learners should be exposed to more problems requiring the analysis of data from a table or graph.

QUESTION 7:
ELECTROSTATICS (COULOMB'S LAW AND ELECTRIC FIELDS)

Q7.1.4 was poorly answered.

Common errors and misconceptions

(a) In Q7.1.1, candidates confused Coulomb's law with the law of Universal Gravitation as they made mention of the mass.

(b) Performance in Q7.1.2, Q7.1.3 &Q7.1.4 was below expectation as candidatesdisplayed their inability to analyze and interpret the graph correctly. They could not identify the dependent variable from the graph.

(c) Q7.1.4 was the worst performed question as candidates failed to use the slope of the graph to calculate the charge on each sphere. Candidates used the incorrect formula F = to answer the question. Candidates confused the concepts of 'electric field' with 'electric force' and hence made up an incorrect formula.

(d) In Q7.2.1, candidates could not draw a simple electric field pattern.

(e) In Q7.2.2,most candidates calculated force, F, instead of electric field, E. Candidates also failed to convert centimeters to meters and some expressed micro-coulombs as 10^{-9} instead of 10^{-6}. They also ignored the vector nature of the electric field in their calculation.

Suggestions for improvement

(a) Learners should know that the dependent variables are in the y-axis and familiarize themselves with the terms 'direct' and 'inversely proportional'.More time should be spent on interpreting the graphs as well as how to use the graph to calculate the gradient.

(b) Learners should practice the drawing of electric fields as well as the conversion of units and should also know the difference between an 'electrical field' and an 'electrostatic force'.

(c) Revision of electrostatics done in Grades 10 and 11 should be ongoing throughout the Grade 12 year,exposing learners to solve problems where they must interpret graphs.

(d) Learners should be given enough electrostatics exercises from previous exam papers and other supplementary sources as homework in the Grade 12 year where they need to apply the principle of superposition of fields.

(e) Teachers must teach the appriopriate strategy for converting units on a daily basis in all sections of the curriculum.

QUESTION 8:
ELECTRIC CIRCUITS

This question was answered poorly.

Common errors and misconceptions

(a) In Q8.1.1,candidates could not clearly distinguish between the concepts ‘emf’, ‘potential difference’ and ‘lost volts’. They could not define the emf of a battery.

(b) In Q8.1.2 &Q8.1.3 some candidates misunderstood the question and wrote ‘increase’ or ‘decrease’ instead of the reading on the voltmeter.

(c) In Q8.2.1,candidates omitted subscripts in the formula $P_{ave} = Fv_{ave.}$

(d) Q8.2 was an integration of two topics viz. power in the gravitational field to the power in the electric field. Candidates could not integrate concepts learnt in mechanics to concepts in electricity.

(e) Candidates displayed incorrect use and manipulation of the parallel resistors formula. They used $R = \frac{1}{R_1} + \frac{1}{R_2}$ instead of $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$.

Suggestions for improvement

(a) It is critical that learners are given problem solving exercises that integrate the different knowledge areas in the curriculum, e.g. mechanics with electricity, mechanics with electrostatics, etc.

(b) The basics of resistors connected in series and parallel should always be revised.The concept of power of components in electric circuits should be emphasised.

(c) Emf = I(R + r), V = IR and $V_{\text{"lost"}}$ = Ir are all equations used to determine potential difference. Explain their differences thoroughly.

(d) It is absolutely critical that learners conduct the prescribed experiments in CAPS.

QUESTION 9:
ELECTRODYNAMICS

This question was generally well answered.

Common errors and misconceptions

(a) Although most candidates managed to identify the generator in Q9.1.1, they could not give a correct reason for identifying it as a DC generator.

(b) In Q9.1.2,most candidates could not draw the graph of induced emf vs time correctly.

(c) In Q9.2.1 &Q9.2.2,candidates did not use the formulae given on the formulae sheet. Omitting of subscripts and rounding off final answers to two decimal places were common.

Suggestions for improvement

(a) The features of a DC generator that make it different from an AC generator must be emphasised.

(b) Learners must be trained to draw graphs and be able identify a complete cycle from either an AC or a DC graph.

(c) The importance of using subscripts in AC circuits should be emphasised.

QUESTION 10:
PHOTO-ELECTRIC EFFECT

This question was not well answered.

Common errors and misconceptions

(a) In Q10.1.1, many candidates could not define 'threshold frequency'.

(b) In Q10.1.2 to Q10.1.4, candidates were unable to analyze and interpret the graphs correctly.

(c) In Q10.2.1,candidates lacked of knowledge of the term 'efficiency'. Candidates calculated only the energy of the photon.

(d) In Q10.2.2, candidates could not relate the number of photons calculated in Q10.2.1 to number of electrons released in Q10.2.2

Suggestions for improvement

(a) Learners must be taught accurate interpretation of formulae, e.g. $W_{0} = hf_0$from which it can be deduced that $W_o \alpha f_o$.

More practice is needed in analysing variables in different forms e.g. $E_k$vs $\frac{1}{\lambda}$.

(b) Emphasise the relationship between 'energy' and 'number of photons'.

(c) Learners need more exposure in this section to questions based on data in tables and graphs.

12.5. OVERVIEW OF LEARNER PERFORMANCE IN PAPER 2

General Comments

(a) Candidates performed poorly in the following questions: Q5, Q6, Q7 and Q10.

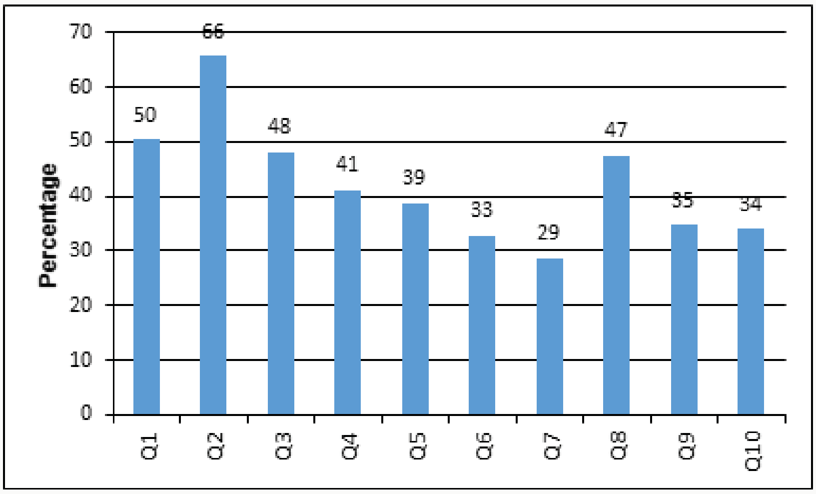
(b) The questions on organic chemistry (Q2, Q3) were generally well answered.

(c) Candidates lacked the skills required to use the Table of Standard Reduction Potentialsrequired for Q8 and Q9 to identify the correct oxidising and reducing agents.

12.6. DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 2

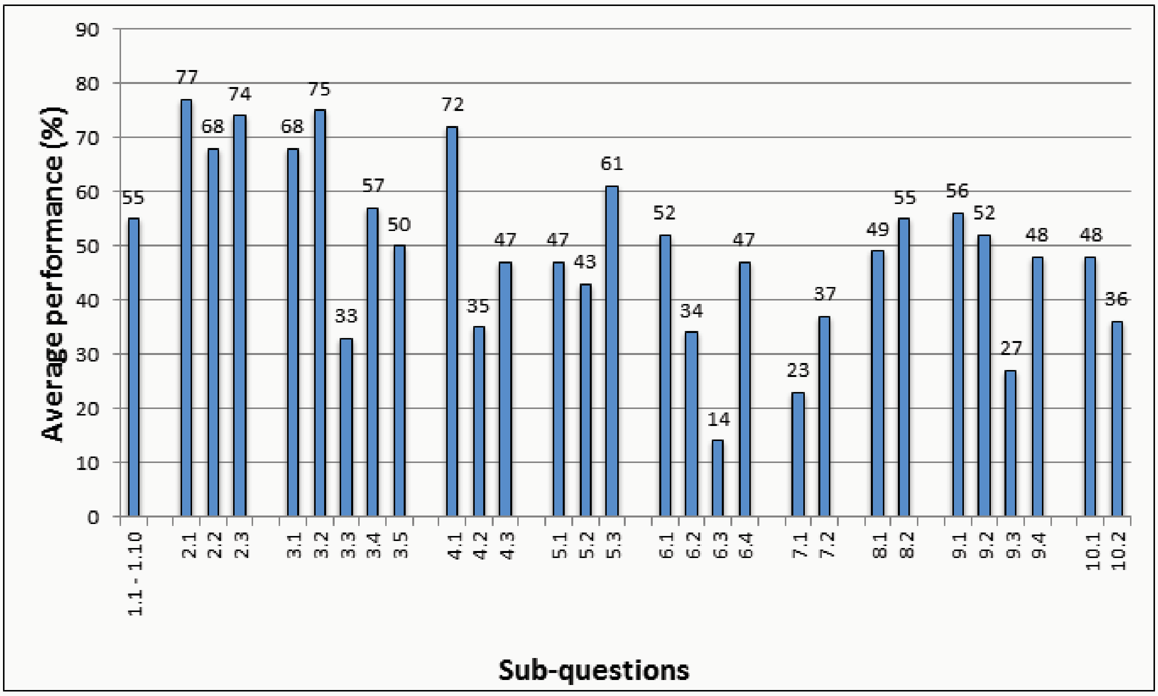
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 12.6.1 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 12.6.2 Average marks per sub question: Paper 2



12.7. ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: MULTIPLE CHOICE QUESTIONS

Q1.3, Q1.4 and Q1.5 were well answered. Q1.7 to Q1.10 were poorly answered. Questions 1.9 and 1.10 were the most challenging to candidates.

Common errors and misconceptions

(a) Q1.1 was not well answered. Many candidates thought that an oxidising agent is oxidised and thus loses electrons.

(b) In Q1.2, candidates may not have been aware of the word'FALSE'in the question.

(c) In Q1.6,many candidates did not know that both reactions I and II are part of the Ostwald process.

(d) In Q1.7, candidates struggled to choose the pair that is NOT a conjugate acid-base pair correctly. $H_2PO_4^-$ and HPO_4^{2-} was the most common incorrect answer. Conjugate acid-base pairs differ by only one H^+.

(e) In Q1.8, candidates failed to understand that pressure will have no effect on the given equilibrium because the number of moles of reactants is the same as the number of moles of product. As pressure increases, the number of moles of reactants and products will remain constant as there is no preferred side to the equation.

(f) In Q1.9, most candidates failed to identify the cathode half-reaction applicable to the electroplating an object and that option *B*is the only half-reaction resulting in the formation of a metal with an oxidation state of zero.

(j) In Q1.10,candidates did not recognise H_2SO_4 as a diprotic acid and thus having twice the H^+ ion concentration than HCℓ, which will result in a higher reaction rate (concentration of reacting species). Due to the mole ratios in the balanced equations, the HCℓ will react with half the amount of Mg (2:1) than H_2SO_4 (1:1) and will also form half of the amount of H_2 than with H_2SO_4. Therefore a greater mass of Mg will remain in test tube **X** after the reaction.

Suggestions for improvement

(a) When explaining the meaning of 'oxidising agent', learners should be made aware that an *oxidising agent* oxidises another substance and it is therefore reduced (gains electrons). Similarly a *reducing agent* reduces another substance and it is therefore oxidised (loses electrons).

(b) When teaching conjugate acid-base pairs, learners should be made aware that the conjugate acid can be obtained from its conjugate base by adding a H^+ to the base. The conjugate base can be obtained from its conjugate acid by removing a H^+.

(c) Learners must be taught that electroplating involves the formation of a metal (a solid) on the cathode of the electrolytic cell and therefore the only half-reaction at the cathode of such a cell is a reduction in which a metal is formed as a product.

QUESTION 2:
NOMENCLATURE OF ORGANIC COMPOUNDS

This question was generally well answered.

Common errors and misconceptions

(a) The weaker performance in Q2.2.2 and Q2.2.3 shows that while candidates have a good knowledge of the basics, concepts like *esterification* and *polymers* need more attention.

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.

(b) Hyphens and numbers should not be used in the stem of the IUPAC names of alkanes. In alkanes, numbers are only used to indicate the position of alkyl groups on the parent chain.

(c) Learners should be made aware that the structural formula of the monomer of a polymer should not be placed in brackets with 'n' as coefficient, subscript or superscript.Each of these positions for 'n' has a different meaning.The question was only about the monomer.

QUESTION 3:
PHYSICAL PROPERTIES OF ORGANIC COMPOUNDS

The question was, with the exception of Q3.3 and Q3.5, relatively well answered.

Common errors and misconceptions

(a) Q3.3 required an explanation. Many candidates struggled to give a complete logical explanation, as is also evident from Q4.2, Q5.1.4, and Q6.2.2. In this specific question, candidates had to link the shape of the molecule to the strength of the intermolecular forces, and then the energy needed to overcome the intermolecular forces at the boiling point.

(b) Q3.5 was very poorly answered mostly because candidates did not know the meaning of 'combustion'.

Suggestions for improvement

(a) Learners should be taught definitions.

(b) When an explanation of trends in boiling points, vapour pressures and melting points is required, learners should be taught to refer to all three factors,*structure*, strength of *intermolecular forces*as well as the *energy* needed to overcome intermolecular forces, in their explanations.

(c) Learners should be taught that the products in any complete combustion reaction are CO_2 and H_2O.

QUESTION 4:
REACTIONS OF ORGANIC COMPOUNDS

The question was relatively well answered, with the exception of Q4.2 & Q4.3.3.

Common errors and misconceptions

(a) Many candidates did not know that thermal cracking is associated with high temperature(Q4.1.1).

(b) Many identified the homologous series of compound **X** (Q4.1.3) as an *alkanes*instead of an alkene.

(c) The identification of the gas that will decolourise bromine water (Q4.2) was poorly answered. Most candidates chose *butane* as the answerinstead of hexene.

(d) Q4.3.3 was poorly answered. Most candidates found this question challenging. Many of those who drew the structural formula of an alkene, placed the double bond between C_1 and C_2 instead of between C_2 and C_3.

Suggestions for improvement

(a) When teaching cracking of alkanes, learners should be taught that one of the two products must always be an alkene. They should also be made aware every reaction has a unique set of conditions under which it takes place.

(b) Decolourisation of bromine by an alkene (addition, without light) or an alkane (substitution, only in sunlight or when heated) is an easy experiment to demonstrate and will assist learners to understand the difference between these two reaction types better.

(c) More time should be spent teaching learners how to analyse flow diagrams.

QUESTION 5:
REACTION RATE

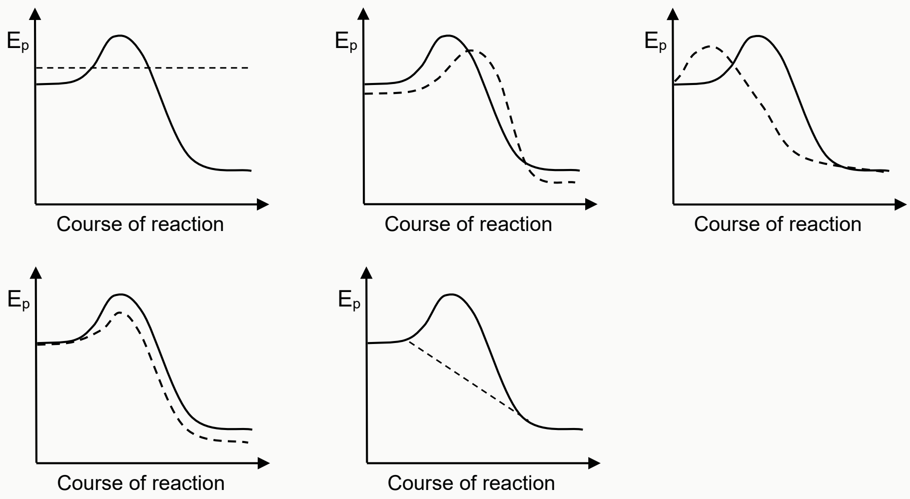
This question was poorly answered with Q5.1.3 & Q5.1.4 having the worst performance.

Common errors and misconceptions

(a) Many candidates omitted the word *minimum* when stating the definition of *activation energy* in Q5.1.1.

(b) The drawing of the potential energy diagram was poorly done as candidates failed to interpret the given data in Q5.1.2.

(c) Many candidates could not display the effect of a catalyst on the potential energy diagram (Q5.1.3). Common errors were:



(d) Many candidates failed to interpret that manganese dioxide was used as a catalyst in the reaction and consequently answered Q5.1.4 in terms of the collision theory very poorly. Common errors were:

- No reference to the effect of a catalyst on the activation energy i.e. a catalyst provides an alternative pathway of lower activation energy.
- Stating that more molecules have higher kinetic energy instead of more molecules have *sufficient kinetic energy*. (A catalyst CANNOT change the kinetic energy of molecules).
- Stating that more effective collisions take place instead of more effective collisions *per unit time*.
- Stating that effective collisions take place per unit time instead of *more* effective collisions per unit time.

(e) Candidates failed to relate the gradient = $\frac{\Delta y}{\Delta x}$ to the rate of the reaction in Q5.2.1. Common errors were:

- Using incorrect volume values from the graph.
- Calculating $\frac{52}{40}$ and $\frac{16}{10}$ separately instead of $\frac{52-16}{40-10}$.
- Addition of volumes and time e.g. $\frac{52+16}{40+10}$.
- Swapping either the two volume values or the two time values e.g. $\frac{52-16}{10-40}$ or $\frac{16-52}{40-10}$.

(f) In Q5.2.2, the common errors were:

- The use of 22,4 $dm^3.mol^{-1}$ instead of the given value of 24 $dm^3.mol^{-1}$
- Using an incorrect volume reading from the graph

- Using the molar mass of O_2 to calculate the mass of H_2O_2
- Using an incorrect mole ratio of $O_2 : H_2O_2$

Suggestions for improvement

(a) Interpretation of data and identification of variables need to be addressed in class. Learners must be exposed to more exercises which require practical skills, starting from Grade 10.Learners need to be able to express knowledge graphically and also read and use information off graphs.

(b) To assist learners to answer questions which require explanations, more such exercises must be given to learners.

(c) Stoichiometry should be integrated with all topics taught in Grade 12.

QUESTION 6:
CHEMICAL EQUILIBRIUM

This question was poorly answered especially Q6.3

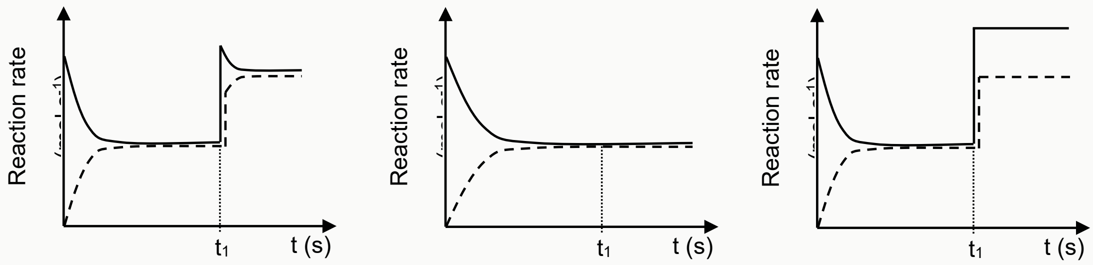
Common errors and misconceptions

(a) Candidates could not defineLe Chatelier's principle correctly in Q6.1.

(b) In Q6.2.1 , many candidates did not know that the addition of a solid will not affect the equilibrium position.

(c) Using Le Chatelier's Principle to explain the shift in the equilibrium position was difficult for candidates in Q6.2.2.

(d) In Q 6.3, many candidates failed to correctly draw the graph showing the effect of a catalyst on the reaction rates. Common errors were:



(e) Common errors in the calculation of K_c (Q6.4) were:

- No K_c expression - Note that $\frac{[\text{products}]}{[\text{react an ts}]}$ is NOT a K_c expression)
- Incorrect K_c expression – including S(s) in the expression

Suggestions for improvement

(a) Teachers should place more emphasis on explanations requiring Le Chatelier's principle. Learners should be exposed to more exercises where a theory/law/concept is used in order to practise such explanations.

(b) When explaining in terms of Le Chatelier's principle, learners should be taught to use the following steps:

- Identify the disturbance.
- State that the system will act to oppose this disturbance.
- State which reaction (forward or reverse) will be favoured when opposing the disturbance e.g. the reverse endothermic reaction will be favoured.
- State the effect on, for example, what happens to the number of moles of products/reactants e.g. the number of moles of H_2S will decrease.

(c) More graphical presentations explaining dynamic chemical equilibrium need to be incorporated in class and daily assessment on this section.

QUESTION 7:
ACIDS AND BASES

This question was poorly answered

Common errors and misconceptions

(a) The large majority of candidates failed to define the term hydrolysis in Q7.1.1.

(b) Many candidates did not know that $NH_4C\ell$ reacts with water to form an acidic solution in Q7.1.2.

(c) Many candidates calculated the molar mass of H_2SO_4 incorrectly in Q7.2.1.

(d) Common errors in Q7.2.2 were:

- Using an incorrect formula, e.g. $n = \frac{c}{V}$ or $n = \frac{m}{M}$ or $n = \frac{V}{V_m}$
- Using the pH formula as pH = -log[H_2SO_4]
- Failing to use the correct ratio of n(NaOH) : n(H_2SO_4)

Suggestions for improvement

(a) Learners should be taught to label formulae when doing multistep calculations e.g. when calculating the number of moles of H_2SO_4, the formula should be as follows: n(H_2SO_4) = cV

(b) Teach learners that the titration formula ($\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$) should only be used for neutralisation reactions. Calculations in which there is an excess of acid or base should be solved using stoichiometry as the above equation will not assist them.

(c) Do not do stoichiometry by using mass ratios. (e.g. 4 g of H_2 react with 32 g of O_2.). Proper use of the mole ratiosis much better, as the mass-mass calculations lead to misconceptions.

(d) The equation $n = \frac{V}{V_m}$ can only be used for gases.

(e) Stoichiometry involving word questions should be extended to all sections of chemistry since all molecules undergoes chemical change.

QUESTION 8:
GALVANIC CELLS

There has been an improvement in the candidates' performance as compared to that in 2015.

Common errors and misconceptions

(a) In Q8.1.1,candidates could not differentiate between an electrolyte and an electrode.

(b) Many candidates used a double arrow when writing the half-reaction in Q8.1.2 & Q8.1.3.They also confusedthe cell notation with the cell reaction.

(c) Instead of writing down the cell notation in Q8.2.2, many candidates calculated the cell potentials or wrote the cell reaction.

(d) Q8.2.4 was poorly answered as few candidates knew that increasing the concentration of the oxidising agent increases the emf of the cell.

Suggestions for improvement

(a) The Table of Standard Reduction Potentials is still not well understood by most learners. Time should be spent in class to thoroughly explain how to use the table to identify the oxidising agent and reducing agent and the oxidation and reduction half-reactions.

(b) When writing cell notation, the following convention should be used:

- The $H_2|H^+$ half-cell is treated just like any other half-cell.
- Cell terminals (electrodes) are written on the outside of the cell notation.
- For active electrodes the following sequence should be followed: reducing agent | oxidised species || oxidising agent | reduced species Example: Ni | Ni^{2+} || Ag^+ | Ag
- For inert electrodes (usually Pt or C) the following sequence should be followed: Pt | reducing agent | oxidised species || oxidising agent | reduced species | Pt Example: Pt | $C\ell^-$(aq) |$C\ell_2$(g) || F_2(g) | F^-(aq) | Pt

QUESTION 9:
ELECTROLYTIC CELLS

The question was poorly answered although the electrolysis of a concentrated sodium chloride solution is prescribed.

Common errors and misconceptions

(a) Q9.1 was poorly answered. Most candidates did not know that electrolysis is an endothermic process.

(b) In Q9.2,many candidates did not know that carbon is an inert electrode and that it is not oxidised but rather that oxidation takes place at this electrode where the $C\ell^-$-ions are oxidised.

(c) In Q9.3.1 & Q9.3.2, candidates experienced difficulty in the identifying the gases formed at each electrode.

(d) Q9.3.3 was also very poorly answered as candidates did not seem to understand that the Na^+-ion is a weaker oxidising agent than H_2O and therefore cannot undergo reduction in the presence of water.

(e) In Q9.4, although the overall cell reaction was given, candidates failed to associate the alkalinity of the solution with the hydroxide ions.

Suggestions for improvement

(a) Each learner should be supplied with a summary of the five types of prescribed electrolytic cells in which the differences and similarities are clearly differentiated.

(b) Demonstrate some of these reactions. Learners need to see some of the changes occurring in these reactions.

(c) The correct use of the electrode potential table (Table 4A and Table 4B) must be encouraged.

QUESTION 10:
FERTILISERS

This question was poorly answered.

Common errors and misconceptions

(a) Most candidates did not know the names of the processes required in Q10.1.1 & Q10.1.2.

(b) Most candidates could not write balanced equations required in Q10.1.4 & Q10.1.5.

(c) The calculation in Q10.2 was poorly answered. Many did not attempt the calculation.

Candidates subtracted the masses of nitrogen and phosphorous from 20 kg as if the mass of fertiliser in the bag was 20 kg.

Other common errors were:

- Ratios were not written as whole numbers
- Incorrect spelling of the names of the processes

Suggestions for improvement

(a) More attention should be paid to fertilisers as a topic. Every effort should be made to finish this section of the work so that there is enough time for revision and testing of this topic. Candidates need feedback on their tests in order to eradicate the common errors