Shape

Description automatically generated with low confidence

**QUALITATIVE ANALYSIS OF LEARNER RESPONSES AND EVALUATION OF QUESTION PAPERS: NSC 2021**

|  |
| --- |
| **REPORT 1: EVALUATION OF THE QUESTION PAPER AND MARKING GUIDELINE** |

|  |  |
| --- | --- |
| **SUBJECT** | **PHYSICAL SCIENCES** |
| **PAPER** | **2** |
| **DURATION OF PAPER:** | **3 HOURS** |

**SECTION 1: (General overview of Learner Performance in the question paper as a whole)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rasch analysis reveals that the candidates’ average score for the paper is 50 % based on the 100 scripts sample.  The seven-point scale reveals that percentage pass for the 2021 class is 46,8% in a population of 34 679 candidates that sat for the exam.  The population size has increased by 13% (30 647 learners in 2020 to 34 607 learners in 2021)  The pass rate 2,6 % lower than that of 2019 (49,4) though.  Number of level 7s has decreased (440 in 2019 and 233 in 2021- almost halved) even though the population has increased.  **The table below shows the percentage pass over a three year period (from 7 point scale)**   |  |  |  |  | | --- | --- | --- | --- | |  | **2019** | **2020** | **2021** | | Number wrote | 27 647 | 30 467 | 34 607 | | Percentage passed | 49,4% | 32,8% | 46,8% | |
| The learner population size has grown in 2021 by 13% compared to 2020.The % pass has improved in 2021 to 46,8% compared to 2020 (32,8%)  **The table below shows number of level 7s and 6s over as is three year period (from 7 point scale)**   |  |  |  |  | | --- | --- | --- | --- | |  | **2019** | **2020** | **2021** | | Number of level 7s | 440  (1,6%) | 729  (0,9%) | 301  (0,9%) | | Number of level6s | 793  (2,9%) | 534  (1,8%) | 499  (1,8) |   The quality of the pass has dropped i.e. fewer level 7s and 6s.  *The questions that were done well are:*  Question 2 (Basic organic chemistry) with a score of 71%  Question3(Physical properties of organic compounds) with a score of 58%  Question7(Acids and bases) with a score of 55%  *There was moderate performance in the following questions:*  Question 5 (Reaction rates) with a score of 46%  Question 6 (Chemical equilibrium) with a score of 46%  Question 8 (Galvani cells) with a score of 50%  *Poorly performed questions include:*  Question 4 (Organic reactions) scoring 40% and  Question9 (Electrolytic cells) scoring 37%-the lowest score |
|  |
| The topics organic reactions (question 4) and electrolytic cells (question 9) were poorly answered. |
| The following sub-questions were poorly answered by candidates:  1.4 Reaction rates (24%)  1.9 Galvanic cell (19%)  and 9.4 Electrolytic cell (17%)-the most poorly performed sub question. |

|  |
| --- |
| **The table and graph below show average percent per question in 2021 NSC exam**  **based on information from the Rasch analysis** |
| |  |  |  | | --- | --- | --- | | **QUESTION NUMBER** | **TOPICS** | **AVERAGE %** | | **1** | Matter and materials, Chemical change and chemical systems | 48 | | **2** | Organic molecules | 71 | | **3** | Organic molecules-physical properties | 58 | | **4** | Organic molecules-organic reactions | 40 | | **5** | Reaction rates | 46 | | **6** | Chemical equilibrium | 46 | | **7** | Acids and bases | 55 | | **8** | Galvanic cell | 50 | | **9** | Electrolytic cell | 37 | |

|  |
| --- |
| **The graph below is drawn from obtained in the 100 scripts for Rasch analysis** |
|  |
| **GRAPH OF AVERAGE % PER QUESTION** |
|  |
|  |

**SECTION 2: Comment on candidates’ performance in individual questions**

**(It is expected that a comment will be provided for each question on a separate sheet).**

|  |
| --- |
| **QUESTION 1** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| Candidates recorded a score of 48 % a drop compared to last year’s 63%. |
|  |
| Candidates did well in sub-questions 1.1(83%) ,1.2 (63%) and 1.3(61%) |
| *Sub questions 1.4, 1.7 and 1.9 were POORLY answered with scores of 24%,40% and 19% respectively* |
|  |

|  |
| --- |
| 1. Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions. |
|  |
| 1.4 Candidates confused the concept of Yield in a reaction with % yield. |
| 1.4 Some candidates did not take into account that Magnesium was the limiting reagent |
| 1.7 There was generally lack of understanding of stoichiometry. |
| 1.9 there was lack of understanding of how a galvanic cell works |
|  |

|  |
| --- |
| 1. Provide suggestions for improvement in relation to Teaching and Learning |
| * Assessing multiple choice on a regular basis in topic tests * Learners must practice the art of eliminating incorrect answers * Teach all the content that learners are supposed to learn |
| Use of Preparatory papers from other provinces as a resource for revision to expose learners to new questions. |

|  |
| --- |
| (d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc. |
| Learners must be taught not to leave multiple choice questions unanswered as there is no |
| negative mark for an incorrect answer. |
|  |

|  |
| --- |
| **QUESTION 2** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| The average score for this question was 83% the most well-done question by the candidates. Candidates’ performance in this question was VERY GOOD. |
| *Question 2.1 scored the highest at 83%(the second highest score by a sub-question) while 2.5 showed the lowest performance at 56%.* |

|  |
| --- |
| 1. Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions. |
|  |
| 2.1 Candidates give unacceptable responses like “compounds with more than one bond”,  “compounds with no single bonds”, “ compounds with single, double and triple bonds” |
| 2.1 Common response was to define melting point as a “ point where a solid changes into a liquid”. There was no marks for this definition. The word temperature is omitted in most of the incorrect definitions  Some candidates omitted the word “equilibrium” in the definition  Many candidates defined melting as a change of phase only “temperature where a solid changes to a liquid” a definition learnt in earlier grades and this carried one mark. |
|  |
| 2.5.1 The incorrect Ethan-1-ol was common even in strong centres. |
|  |
| 2.5.3 Few candidates could identify sulphuric acid as the catalyst in the reaction |
|  |
| 1. Provide suggestions for improvement in relation to Teaching and Learning |
| Planning for lessons by reading relevant documents e.g. examination guidelines will assist. The examination provides definitions and rules for naming organic compounds e.g. the guideline solves the question of which one has preference in numbering between halogens and alkyl groups.  Teachers must at all times take definitions from the exam guidelines to avoid situations where learners lose marks for missing terms in/words in the definition of concepts. |
|  |
| Learners (in Grade 12) must be made aware that for compounds containing one to two carbon one does must not indicate position of functional group in the IUPAC name except for halo alkanes |
|  |
| * + 1. Rules on nomenclature should be taught and practiced regularly when teaching IUPAC naming. |
| * + 1. Examination Guidelines, Chief Markers Report and the Diagnostic report should be used WITH the CAPS documents when preparing and planning for a lesson (so that educators can see the depth/extent of a specific topic). |
|  |
| Develop exercises that address the different type of isomers –definitions,  naming and structural formulae |

|  |
| --- |
| (d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc. |
|  |
| Most learners got the stem of the name correct. The challenge is on separation of word and number with a hyphen, omission of di- as well as incorrect order of substituents in the name. |

|  |
| --- |
| **QUESTION 3** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| Candidates recorded a score of 58%. |
|  |
| *Question 3.3 scored the highest at 85% while question 3.4 showed the lowest performance at 53%.* |
|  |
| 1. Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions. |
| 3.1 Inability to identify the two variables dependent and independent. Some learners thought  the relationship was between boiling point and melting point. |
| 3.2 Lack of correct interpretation of negative numbers (which one is bigger)  3.2 Some candidates wrote “Melting point is directly proportional to chain length” which is an  incorrect answer |
| 3.3 Some candidates wrote “van der Waal’s forces” which was an incorrect answer |
| 3.4 Due to lack of correct interpretation of negative numbers some candidates could not  identify the phase of the given substances |
| 3.5.3 Incomplete explanations e.g. “More energy is required by hexane”. This is an incomplete  answer as the question “Energy to do what” arises  Use of the word “bond” in place of intermolecular forces |
| 3.5.4 Misconception of linking the length of the name to the length of the compound e.g. the  name 2,2-dimethylbutane is longer than the NAME than hexane-to some learners this  meant hexane has the shorter chain length leading to incorrect comparison |

|  |
| --- |
| 1. Provide suggestions for improvement in relation to Teaching and Learning |
| Exercises in each topic starting in the lower grades where learners answer questions that address hypothesis testing e.g. Questions on Investigative questions, hypothesis, variables and conclusion will assist |
| 3.5.3 Learners need to structure their answers when explaining differences in physical  properties (boiling point and vapour pressure) |
| If the two compounds are from the same homologous series then the difference will be |
| surface area |
| The answer should look like |
| * Comparison of surface areas * Comparison of strength of intermolecular forces * Compare energy to overcome intermolecular forces |
| If the two compounds are from different homologous serie then they should structure their explanation as follows:   * Name the type of intermolecular force in each compound * Compare strength of intermolecular forces * Compare energy |
| Teachers must inform learners that no where in their answers learners will have an answer as “ van der Waals forces” as all intermolecular forces including Hydrogen bonds are classified as van der Waals forces. |

|  |
| --- |
| (d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc. |
| Use of exam guidelines as source of correct definitions for concept cannot be over-emphasised |
| There are centres who still use the phrase “break bonds” in place of “ break intermolecular forces. This has to be brought to the attention of teachers that this leads to loss of marks. The learners learn this phrase from their teachers and use it in their explanations. Teachers must refrain from using the word “bonds” when teaching physical properties as learners take it from teachers and think that it is correct. |
|  |
| It must be emphasised to learners that in compounds with 2 or less carbon atoms in chain one does not need to indicate the position of the functional group except for haloalkanes |

|  |
| --- |
| **QUESTION 4** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| Candidates recorded a score of 40%. |
|  |
| *Question 4.1 scored the highest at 48 % while question 4.2 showed the lowest performance at 38%.* |

|  |
| --- |
| 1. Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions. |
|  |
| 4.1.2 Candidates refer to the OH group as the functional group of alcohols when explaining primary alcohols – leading to incorrect explanation why the given compound is a primary alcohol. |

|  |
| --- |
| 4.1.3 Most candidates could not work backwards in this question to identify the number of carbon atoms in the longest chain. Most candidates wrote 5 carbon atoms in the longest  chain  4.1.7 Many candidates wrote 1-bromopentane or 2-bromopentane |
| 4.2 Most candidates could not cope with question 4.2 considering that the reaction conditions  were not given  4.2 Candidates used structural formulae and molecular formulae in place of condensed  structural formulae showing lack of understanding of the formulae used in organic  chemistry  4.2 The alkane to cracked in the reaction contains only 4 carbons -learners may have thought  it is not long enough to undergo cracking |

|  |
| --- |
| 1. Provide suggestions for improvement in relation to Teaching and Learning |
|  |
| 4.1.2 Teachers and learners must be made aware that the functional group of alcohols  according to CAPS guidelines is not -OH but  C-O-H |
| 4.2 Spend time with learners on assessing converting between the various types of formulae  used in organic chemistry molecular, condensed structural formulae and structural  formulae |
|  |
| 4.2 Prepare exercises on organic reactions where learners will work back from a given product  to identify the reactant. The new way of asking the question in 4.2 can be addresses by  using exercises where the learner links various steps to form a particular product e.g.  Equations for reactions that will lead to production of but-2-ene from but-1-ene e.t.c |
| 4.2 Administer exercises that address the different types of formulae used in organic chemistry  especially conversion from condensed structural formulae to structural formula or from  molecular formulae to structural formulae. |

|  |
| --- |
| **QUESTION 5** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| Candidates recorded a score of 46% |
|  |
| *Question 5.5 scored the highest at 93 % while question 5.2 showed the lowest performance at 32%* |
|  |
| 1. Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions. |
| 5.1 Common incorrect answers were “ Rate of change of concentration per unit time” no  marks for this as one cannot put in “per unit time” if the word rate is there |
| 5.1 Omission of the word “change” in the definition of rate of reaction. Learners wrote  concentration of reactants or products per unit time |
| 5.2 and 5.3 Interpretation of the graph was a challenge |
| Most candidates did not get 5.3.1 correctly but by fluke they managed to get part marks in  5.3.2 .Learners used equilibrium principles for a reversible reaction in a closed system to  answer a question for a non-reversible reaction |
| 5.4 Stoichiometric calculations were a challenge |
| 5.6 The factor affecting reaction was not recognized by most candidates. Explanation of the  increase in reaction rate in terms of concentration led to loss of marks. |

|  |
| --- |
| 1. Provide suggestions for improvement in relation to Teaching and Learning |
| When teaching reaction rates:   * do experiments and assess knowledge of hypothesis testing and graph drawing and interpretation * include various type of stoichiometric calculations i.e. using masses and volumes, examples that require learners to determine limiting reactant and to calculate percentage yield etc   Assessments should include drawing and interpretation of graphs |

|  |
| --- |
| (d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc. |
| Judging by learner responses there is a misconception in learners about rate of reaction and shift of equilibrium position. It appears that to learners the rule for effect of temperature on a reaction at equilibrium is misinterpreted. For example, the rule says, “Increase in temperature favours endothermic reaction”. The misconception created by that statement to learners is that an increase temperature increases the rate of the endothermic reaction while lowering the rate of the exothermic reaction-this is not the case. Increase in temperature increases the rates of both reactions whether endothermic or exothermic. |

|  |
| --- |
| **QUESTION 6** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| Candidates recorded a score of 46% |
|  |
| *Question 6.1 scored the highest at 68 % while question 6.2 showed the lowest performance at 42%.* |

|  |
| --- |
| 1. Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions. |
|  |
| 6.1 Omission of the word “rate” when defining chemical equilibrium led to loss of both marks.  Some candidates wrote “stage where forward reaction equals reverse reaction”,  “Amount of products equlas reactants” or Concentration of products equals reactants” |
|  |
| 6.2.2 Learners rewrote statement for Le Chateliers’ when asked to explain in terms of Le  Chatelier’s principle. Rewriting the statement for the principle carries no marks.  Even some performing learners centres could not get the full 3 marks in this subquestion as  they omitted the important information in their long explanations |
|  |
| 6.2.3 Omission of subscripts in chemical formulae that are in the Kc expression e.eg the 2 in  [Q2] was omitted by some candidates |
|  |

|  |
| --- |
| 1. Provide suggestions for improvement in relation to Teaching and Learning |
| Teachers need to point out to learners that when defining equilibrium omission of the  word “rate” leads to loss of marks |
| When explaining answers in terms of le Chatelier’s principle the following guide will assist |
| * Mention the disturbance * Describe the rule for the disturbance e.g. the disturbance in this question was an increase in temperature * Mention which reaction is favoured by the disturbance 9Forwar reaction or reverse reaction |
| 6.2.3 Teachers must start with simple problems when solving Kc calculations. Learners must be  taught and allowed to practice writing Kc expressions for reactions involving gases only,  gasses and liquids or solids, gasses and aqueous solutions etc. Give learners step to  follow when calculating Kc for example  1.Write down Kc expression  2.Substitute values into Kc expression and solve if possible  3.Convert mass and concentration to moles  4.Draw and complete a table  5.Go back to the Kc expression |
|  |

|  |
| --- |
| (d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc. |
| Common error “Equilibrium shifts to the left” or “Equilibrium shifts to the right” |
| Bothe statement are unacceptable because of the omission of the word “**position**” it should say equilibrium **position.**  Advice is that learners should rather avoid saying “equilibrium position shifts” as they inadvertently omit the word position-they should rather write “forward reaction is favoured or reverse reaction is favoured” in their explanations |
| Subject advisors must share these observations with their teacher during meetings. Class observation visits by subject is also highly recommended |

|  |
| --- |
| **QUESTION 7** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| Candidates recorded a score of 57% |
|  |
| Question 7.2 scored the highest at 55 % while question 7.1.3 showed the lowest performance at 49%. There was significant improvement in question 7 performance this year. |
|  |

|  |
| --- |
| 1. Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions. |
| 7.1 Some candidates defined an acid in terms of Arhenius theory  7.1.2 Man candidate identified H2O as the ampholyte in the reaction which was incorrect  7.1.3 This was a new question-teachers may not have taught electrical conductivity as it was  not taught before the 2021 exam guidelines. Learners could not link conductivity to the  strength of an acid. Lack of understanding of the meaning of Ka values |
|  |
| 7.2.1 Use of unconventional formulae like pH = - log [HCl] led to loss of marks |
| 7.2.1 Inability of candidates to convert from logarithmic form to exponential form-a  mathematical skill. |
| 7.2.2 Using non SI units in c = n/V |
| 7.2.2 Use of n = V/Vm even the question deals with liquids |
|  |

|  |
| --- |
| 1. Provide suggestions for improvement in relation to Teaching and Learning |
| 7.1 Differences between Lowry-Bronsted theory and Arhenius theory must be made clear  during teaching |
| 7.2.1 Do exercises that will afford learners opportunity to convert between logarithmic form  and exponential form |
| 7.2 Teachers should put emphasis to learners that n = V/Vm can only be used for gases |
|  |
| 7.2 Learners must be taught to convert volume units to SI units when using c = n/V. |
|  |
| Teachers need to take some time when teaching pH of revising the mathematical concept of converting between logarithmic form and exponential form. Logarithms are no addressed extensively in the mathematics syllabus as it was the case in the past. |

|  |
| --- |
| (d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc. |
|  |
| Subject advisors should do advocacy on using experiments as a teaching approach in this topic. Practical work to include testing pH of solutions using Universal indicator, testing conductivity of strong and weak acids, concentrated and dilute acids, dilution of acid solutions and titrations |
| We advise that teachers show learners how Kc calculation is marked and allow them to mark each other’s Kc calculations |

|  |
| --- |
| **QUESTION 8** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| Candidates recorded a score of 50% |
|  |
| *Question 8.1 scored the highest at 50 % while questions 8.2 and 8.6 showed the lowest performance at 32 %and 30% respectively.* |

|  |
| --- |
| 1. Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions. |
|  |
| 8.1 Learners using the term mechanical in place of chemical like “ mechanical energy  changes to chemical energy” |
| 8.2 Learners did not interpret STANDARD CONDITIONS to mean c= 1 mol.dm-3 as result some  used 22,4 dm3 as the concentration  8.2 Use of n = V/Vm  8.2 Use of 22,4 dm3.mol-1 as the concentration |
| 8.38.3 Reducing agent defined as “where oxidation occurs or as loss of electrons” leaving out  the word substance |
| 8.4.2 Omission of oxidation states and uncancelled electrons in net reaction led to loss of  marks |
| 8.4.2 Learners confused cell potential with cell notation-showing that some knowledge was  not embedded in learners on electrochemical cells by the time they wrote the paper |
| 8.5 Some candidates swapped the reduction potentials for cathode and anode obtaining a  negative Ecell |
| Use of unconventional formulae Ecell = Ecat – Ean or Ecell = Eox – Ered led to loss of marks |

|  |
| --- |
| 1. Provide suggestions for improvement in relation to Teaching and Learning |
| Teachers should practical work/experiment as teaching method to improve learner understanding of electrochemical cells. |
|  |
| 8.1 Teachers need to emphasise to learners when teaching energy conversions that the term  mechanical will be found in physics not in grade 12 chemistry |
| 8.2 Teachers need to have practice questions with learners to assist learners to attach  meaning to the term STANDARD CONDITIONS for a cell. |
| 8.4 and 8.5 Spend time teaching learners how to use the table of reduction potentials as most  questions in galvanic cells need understanding of the table |
|  |

|  |
| --- |
| (d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc. |
| There are still schools who write formulae that are not in the formula sheet e.eg Ecell = Eox-Ered leading to loss of marks. There are schools where learners write two arrows in a half reaction-learners should always write one arrow (even if there are two arrows in a given reaction) as they will not be penalized for writing one arrow  Teachers need to spend time teaching learners how to use the table of reduction potentials correctly  This section is taught at the busiest of times (third term). Teachers have to find term and avoid rushing when teaching electrochemistry. |

|  |
| --- |
| **QUESTION 9** |
| (a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered? |
| Candidates recorded a score of 37%the lowest performing question in the whole paper. There was generally poor performance in question 9 |
|  |
| *Question 9.1 scored the highest at 58% while question 9.4 showed the lowest performance in the whole paper at 17%.* |
|  |

|  |
| --- |
| 1. Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions. |
|  |
| Some candidates defined the electrolysis instead of electrolyte. |
| 9.1 Many candidates wrote “Substance that conducts electricity” omitting the phrase through  the movement of ions |
| 9.3 Some candidates could not choose the correct half reaction for chromium. Some wrote  the oxidation half reaction |
|  |
| 9.4 Most candidates could not integrate concepts learnt in Physics in chemistry |
| 9.4 Most candidates did not use the mole ratio to get moles of electrons |
| 9.4 The Avogadro number or the charge on a single electron was not used by candidates |
|  |

|  |
| --- |
| 1. Provide suggestions for improvement in relation to Teaching and Learning |
|  |
| 9.1 Use definitions as they are from the exam guidelines |
| 9.3 Learners must be taught which electrode (anode or cathode) that must be the IMPURE  copper and which one must be cathode. Stress the writing of ONE arrow in all reactions  NOTE: It is very important that when learners choose a half reaction from the table or a standard reduction potential of reduction potentials they first look at the oxidation stages of the substance in the question e.eg.Cr/Cr3+ and then what they choose from the table of reduction potentials must have the same oxidation states e.g. Cr3+ + 3e → Cr |
| 9.4 Prepare questions that involve stoichiometric calculations as well concepts from Physics for  learners to practice |
|  |

|  |
| --- |
| (d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc. |
|  |
| The trend going forward appears to be that integration of concepts from Physics with Chemistry. Give learners an opportunity to do questions that integrate the two topics in Physical sciences. For example, one can ask questions on EMF and internal resistance in a galvanic cell.  Prepare questions on stoichiometry that involve electrochemical cells |