

THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA



**CANDIDATES' ITEM RESPONSE ANALYSIS
REPORT FOR THE CERTIFICATE OF SECONDARY
EDUCATION EXAMINATION (CSEE) 2019**

092 WORKSHOP TECHNOLOGY

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FOREWORD

The Candidates Items Response Analysis (CIRA) Report for Workshop Technology subject in the Certificate of Secondary Education Examination (CSEE) 2019 was prepared in order to provide feedback to candidates, teachers, parents, policy makers and the public in general on how the candidates answered the questions.

The Certificate of Secondary Education Examination (CSEE) marks the end of four years of secondary education. It is a summative evaluation which, among other things, shows the effectiveness of education system in general and education delivery system in particular.

The analysis presented in this report is intended to contribute towards understanding of possible reasons behind the candidates' poor or good responses in Workshop Technology subject. The report highlights the factors that made the candidates fail to score high marks in the questions. Such factors include inability to identify the demand of the question, inability to follow instructions and inadequate knowledge and skills of the concepts related to the subject. The feedback provided will enable the educational administrators, school managers, teachers, candidates and other stakeholders to take appropriate measures in order to improve the candidates' performance in future.

Finally, the Council would like to thank all examiners and others who participated in one way or another to process and analyse the data used in this report.



Dr. Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

The report analysed the performance of candidates who sat for Workshop Technology subject in the Certificate of Secondary Education Examination (CSEE) 2019. The Workshop Technology Examination examined the candidates' competences as stipulated in the 1994 syllabus and examination format.

The paper consisted of three sections; A, B and C. Section A consisted of ten multiple choice items (i) – (x) and each carried one mark, making a total of ten (10) marks. Section B comprised nine (09) short answer questions. Each carried five (5) marks. Section C consisted of four (4) structured questions in which candidates were required to answer only three (3) questions. Each carried fifteen (15) marks.

A total of 299 candidates sat for the examination in 2019. Out of them, 107 (35.79%) candidates passed and 192 (64.21%) failed the examination. In 2018, a total of 371 candidates sat for the examination and 214 (57.68%) passed. The performance has thus decreased by 21.89 percent compared to that of 2018.

This analysis highlighted the requirement of each question, the percentage of candidates who attempted the question and the percentage of those who scored various marks basing on their responses. It also shows the levels of candidates' performance in each question, the strengths and weaknesses of candidates' responses and possible reasons for such weaknesses.

The performance of candidates for Workshop Technology subject has been written using the range of 0 to 29 (Poor), 30 to 64 (average) and 65 to 100 (good). These intervals contain the percentage of candidates who scored 30 percent or above out of the total marks allocated to a particular question. Also red, yellow and green colors have been used to denote poor, average and good performance respectively.

Therefore, the report is intended to help teachers, candidates and other educational stakeholders to identify specific areas of weaknesses and make strategies for improvement.

2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE IN INDIVIDUAL QUESTIONS

2.1 SECTION A: OBJECTIVE TYPE QUESTIONS

2.1.1 Question 1: Multiple Choice Items

This question comprised ten multiple choice items (i – x), derived from seven (7) topics of workshop technology, which are: Introduction to Engineering Materials, Identification of Metals, Limits and fits, Lubrication/coolants, Heat Treatment of Steel, Mechanical Properties of Metals and Production of Engineering Materials. The candidates were required to choose the correct answer from the given alternatives and write its letter beside the item number in their answer booklets.

The question was attempted by 299 candidates, of which 22.7 percent scored from 0 to 2 marks with those who scored 0 mark being 0.7 percent. Also 74.6 percent scored from 3 to 6 marks and 2.7 percent scored from 7 to 8 marks. No candidate scored 10 marks. Figure 1 exhibits the performance graphically.

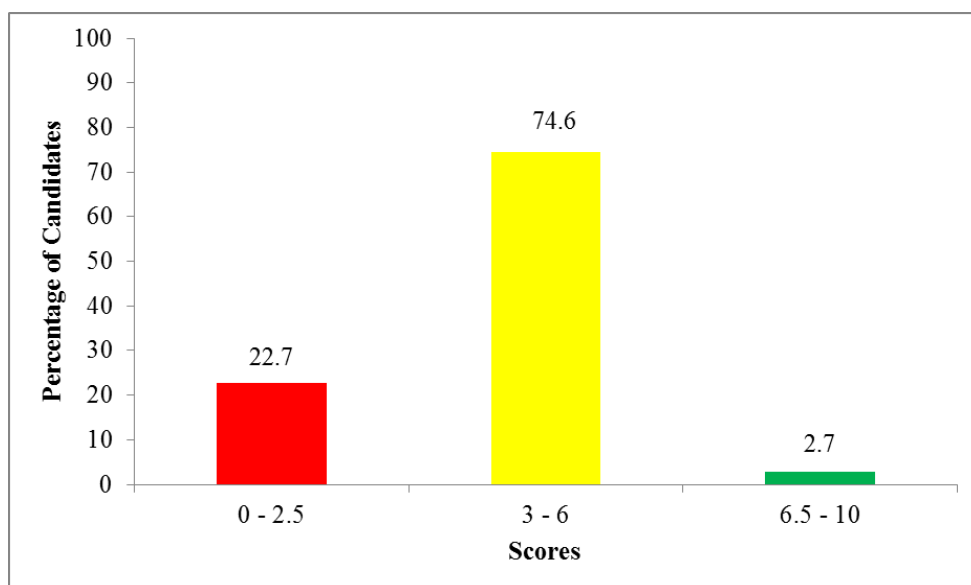


Figure 1: *The candidates' Performance in Question 1*

Figure 1 shows that, the candidates' performance on this question was good since majority (77.3%) of the candidates scored average marks and above.

The candidates who performed well in this question had a good ability of utilizing the knowledge acquired in different topics to identify the correct answers among the given alternatives. All the items were attempted by the candidates but those in which most candidates failed were items (i) from the topic *Production of engineering materials* and (iii) from the topic *Identification of metals*. The analysis of candidates' responses also shows that most of the candidates opted correctly on items (ix) and (x). The rest of items were performed averagely. The following is the analysis of candidates' performance in each item:

- (i) *A machinist in a workshop observes that the temperature of the metal rises when machining it. What is the cause of heat generation?*
- A *Plastic deformation*
 - B *Elastic deformation*
 - C *Isotropic deformation*
 - D *Twining*
 - E *Refining of grains.*

In item (i), the candidates were required to identify among the given alternatives the cause of heat generation in the metal cutting process. Alternative A, *Plastic deformation* was the correct answer and was chosen by few candidates who were able to use the concept of metal cutting where deformation of the metal occurs together with heat generation. Most of those who failed this item chose distractor E, *refining of grains* which relates with heat treatment processes not metal cutting processes. Other few candidates who opted for distractors B, C and D failed to understand the metal cutting phenomena.

- (ii) *You are required to select a metal for particular work. Which characteristics would you consider in identifying mild steel from other ferrous metals?*
- A *Red and scaly surface with rolling marks*
 - B *Grey and sand surface*
 - C *Fine and smooth surface with bluish sheen*

- D Smooth and black surface*
E Smooth and fine surface.

Majority of the candidates failed to respond correctly in item (ii) which required them to recognize the correct characteristic which can help to identify mild steel from other metals. The correct answer was C, *Fine and smooth surface with bluish sheen*. Most of the candidates who failed in this item chose distractor A, *Red and scaly surface with rolling marks*. They were attracted by the word rolling following the fact that most the steel materials are produced by rolling processes. The choices of other candidates on distractors B, C and D did not form any particular pattern and those candidates were not familiar with ferrous metals so they made their choice by guessing.

(iii) *The following table shows pairs of materials and their respective products:*

<i>S/N</i>	<i>Material</i>	<i>Products</i>
<i>1</i>	<i>Silicon steel</i>	<i>Transformer stampings</i>
<i>2</i>	<i>Duralumin</i>	<i>Cooking utensils</i>
<i>3</i>	<i>Gun metal</i>	<i>Bearings</i>
<i>4</i>	<i>Bronze</i>	<i>Swords</i>

Which one represents the correct matched pair of material and product?

- A 1, 2 and 3*
B 1 and 2
C 1 and 3
D 2 and 3
E 3 and 4

Item (iii) was poorly done and the candidates who failed were in two categories. Some chose distractor B, *1 and 2* and others chose distractor E, *3 and 4* as the correct pairs of the matching between materials and their uses. Those who chose alternative B failed to realize that the pair of material and its use in 3 was also correct. Likewise, those who chose E did not understand that, copper has no enough strength and hardness to

maintain sharp edge for cutting so it cannot be used as a material for making swords. The correct answer was A, 1, 2 and 3. The candidates who chose other distractors B, C and D wrongly associated the term pairs in the question with the alternative answers thinking that the correct answer must be among those with two numbers. They failed to understand that the term pairs referred to four pairs of material and respective uses.

(iv) *Which pair of heat treatment processes can be used to make steel strong and tough?*

- A *Tempering and annealing*
- B *Annealing and normalising*
- C *Normalising and tempering*
- D *Hardening and tempering*
- E *Anodizing and carburising.*

In item (iv), the candidates were required to identify two heat treatment processes which can be used to make steel strong and tough. This item was averagely performed as there were candidates who were able to choose the correct answer D, *Hardening and tempering*. They understood that, hardening makes steel strong and tempering eliminates brittleness and promotes toughness to the steel. On the other hand, there were candidates who did not understand the question or the procedure of imparting both strength and toughness to steel. Some of these candidates chose distractor B, *Annealing and normalising* and others C, *Normalising and tempering* while few candidates opted for distractor A, *Tempering and annealing*. These candidates did not understand that the annealing process softens steel and tempering just relieves internal stress of steel instead of making it strong and tough. They proved to have insufficient knowledge on heat treatment processes.

(v) *Which process is suitable to produce steel materials for use in structural construction works?*

- A *Casting*
- B *Extrusion*
- C *Rolling*
- D *Forging*
- E *Deep drawing.*

Item (v) required the candidates to identify the proper process for producing materials for structural work construction. This was another item in which candidates' performance was average. The correct answer was C, *Rolling*. Those candidates who chose the correct alternative were able to use their knowledge on production of engineering materials, to recall the types of materials such as steel bars (round, square rectangular, or hexagonal) angle bars and channels and associate with the process used to produce them. Therefore, the candidates who failed to recognize types of materials involved in structural construction works could not make correct choice of the processes. Some of them opted for distractor A, *Casting* while others chose distractor D, *Forging*. They failed to understand that these two processes are mainly employed in the production of machine parts and tools.

(vi) *In which condition do carbon and iron exist when steel is heated to eutectic state?*

- A *Insoluble in solid and liquid state*
- B *Soluble in liquid state*
- C *Soluble in solid state*
- D *Insoluble in liquid state*
- E *Soluble in solid and liquid states.*

In item (vi), the candidates were required to identify the condition in which carbon and iron exist when steel is heated to an eutectic state. The performance of the candidates on this item was also moderate. The correct answer was C, *Soluble in solid state*. Only few candidates were able to locate the correct answer. These candidates proved to have the knowledge of changes which occur to steel as it undergoes heat treatment. The remaining candidates were of two categories; those who chose distractor B, *Soluble in liquid state* and others who chose distractor A, *Insoluble in solid and liquid state*. The candidates who chose B were attracted by the term liquid but failed to remember that in the iron carbon equilibrium transformation, an eutectic steel is not in molten state but exists in a condition that carbon is said to have dissolved in iron. Moreover, those who chose A were not knowledgeable on the changes that take place when steel is heated to elevated temperatures in heat treatment processes. Likewise, those who chose distractor D and E were also attracted by the term liquid as

in most cases solubility goes with liquid and solid materials such as salts in liquids.

(vii) *Which one is a necessary condition for plastic moulding?*

- A Application of heat only*
- B Application of pressure only*
- C Application of heat and pressure*
- D Application of plasticizers only*
- E Application of pressure and plasticizers.*

In item (vii), the candidates were required to recognize the necessary condition for plastic moulding. The candidates were required through their knowledge on production of engineering materials to recognize things which are necessary so as to be able to form plastics in different shapes. The correct answer was C, *Application of heat and pressure*. Only few candidates were able to select this answer. Most of them chose distractor E, *Application of pressure and plasticizers*. These candidates were distracted by the term plasticizers and failed to recognize the fact that, in order to change the shape of plastic material, heat is necessary to soften the plastic and enable it to pass through the die opening and assume the required shape. Other distractors A, B and D were chosen at random by few candidates who were not conversant with plastics making.

(viii) *One of the properties of copper and aluminium is their good conductivity of electricity but aluminium is preferably used in overhead electricity transmission line. Why is it so?*

- A It is in weight and better in electric conductivity than copper.*
- B It is better in corrosion resistance and electric conductivity*
- C It is less in weight and cheaper than copper*
- D It is better in corrosion resistance and less in weight than copper*
- E It is less in weight and better in electric conductivity than copper*

In item (viii), the candidates were required to identify properties which render aluminium to be mostly used for overhead electricity transmission lines compared to copper. The correct answer was C, *It is less in weight and cheaper than copper* and it was opted by candidates who had

knowledge of the properties of metals. Some of the candidates who failed to identify the correct properties chose alternative B, *It is better in corrosion resistance and electric conductivity*. These candidates failed to realize that electric conductivity is stated in the question as a common property so they were supposed to look for additional properties. This proved that, those candidates did not understand the requirement of the question. However, other candidates who had insufficient knowledge on properties of metals opted for distractors A, D and E.

(ix) *Which one of the following are the limits of size for the component which is manufactured with the dimensions 30 ± 0.05 mm?*

- A *30.00 mm, - 0.05 mm and +0.05 mm*
- B *29.95 mm, - 0.05 mm and + 0.05 mm*
- C *29 mm and 31 mm*
- D *29.95 mm and 30.05 mm*
- E *30 mm and 30.05 mm*

In item (ix), the candidates were required to identify the correct limits of size from a given dimension for the manufacturing of a component. They were supposed to apply knowledge of limits and fits to compute the limits of size from the given dimension so as to be able to choose the correct answer. Most of the candidates were able to compute the limits of size hence chose the correct answer D, *29.95 mm and 30.05 mm*. However, few candidates who had insufficient knowledge on limits and fits either did not know how to compute the limits of size so chose the answer by guessing or computed the limits wrongly. Consequently, they chose the wrong alternative. Some of them chose distractor A, *30.00 mm, - 0.05 mm and +0.05 mm* and others chose B, *29.95 mm, - 0.05 mm and + 0.05 mm* which were not correct. Lack of basic knowledge on the topic of limits and fits was a reason for failure for these few candidates.

(x) *Which one is the best cutting solution for drilling mild steel?*

- A *Lard oil*
- B *Paraffin*
- C *Soluble oil*
- D *Turpentine*
- E *Natural oil.*

In item (x), the candidates were required to identify the suitable type of cutting fluid or solution to be used for drilling mild steel. The performance of the candidates in this item was also good as most of the candidates who attempted made a correct choice of the answer. The correct answer was C, *Soluble oil*. Few candidates failed to locate the correct answer as they chose distractor B, *Paraffin*. They chose this simply because it is commonly used in homes so it is well known to them. Moreover, other candidates made choice on the rest of the distractors. Those candidates lacked enough knowledge on cutting fluids.

2.2 SECTION B: SHORT ANSWER QUESTIONS

2.2.1 Question 2: Properties of Materials

This question had two parts, (a) and (b). In part (a), the candidates were required to state the required property for a material to be used for casting parts with intricate shapes. In part (b), the candidates were required to give three materials which have desirable properties for casting intricate shaped components. The total marks allotted for this question was 5.

The question was attempted by 288 candidates, which is equivalent to 96.32 percent, of which 54.9 percent scored from 0 to 1 mark with those who scored 0 mark being 26.7 percent. Moreover, 45.1 percent scored from 2 to 3 marks. There were no candidates who scored 4 to 5 marks. Figure 2 shows the analysis of data in this question.

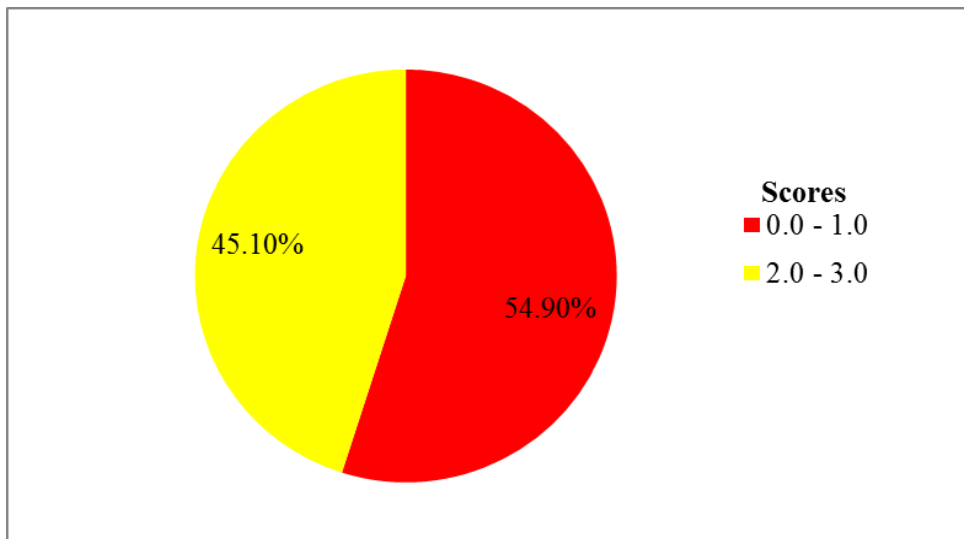


Figure 2: *The Candidates' Performance in Question 2*

Figure 2 shows that the candidates' performance in this question was average since only 45.1 percent scored from 2 to 3 marks.

The candidates with poor performance in this question (954.9%) either had partial or no knowledge of the question. Some provided partial responses which could not deserve more than 1 mark while others scored 0 as they completely provided irrelevant responses. For example, some of the candidates mentioned name of material in (a) instead of the property of a material which can be used to produce parts with intricate shapes. Likewise, other candidates mentioned properties of metals instead of names of metals which are suitable for producing parts with intricate shapes. The analysis of candidates' responses show that, there were some of the candidates who named the forms of material supply such as; *round bars*, *square pipe*, *sheets*, *plates* and *angle bars*. All such irrelevant answers reveal that, the candidates failed to understand the requirements of the question. Extract 2 shows a sample of a poor response from one of the candidates.

2(a)	i/ Brittle and weak
	ii/ Easily machinable
	iii/ Hard material
(b)	i/ Anvil
	ii/ Bed ways of lathe machine
	iii/ Swage block

Extract 2: A sample of the candidate's poor response in question 2

In Extract 2, the candidate gave the properties which are not important to a material which is intended to be used for casting parts with intricate shapes in part (a). In part (b), the candidate named the tools and parts of the tools which are used in the workshop. The candidate failed to meet the demand of the question in both parts because of misconception as well as lack of knowledge of properties of metals.

However, some of the candidates who scored average marks (2 to 3 marks) managed to provide correct responses in either part or responded partially in both parts by providing few relevant points in each part. There was no candidate who performed above average. This is an indication that most of the students lacked adequate knowledge of the properties of metals. The correct responses were as follows: (a) *The materials suitable for this purpose should have the cast-ability property or good fluidity in molten state.* (b) *Examples of metals with this property are cast-steel, cast-iron, brass, bronze, lead, aluminium alloys, tin and copper alloys.*

2.2.2 Question 3: Lubricants /Coolants

This question required the candidates to (a) give one lubricant in solid state (b) give four types of lubricant in liquid state. The total marks allotted for this question was 5.

The question was attempted by 292 candidates, which is equivalent to 97.66 percent whereby 88.7 percent scored from 0 to 1 mark, 10.3 percent scored from 2 to 3 marks and 01 percent scored 4 marks. The general performance of this question was poor as shown in Figure 3.

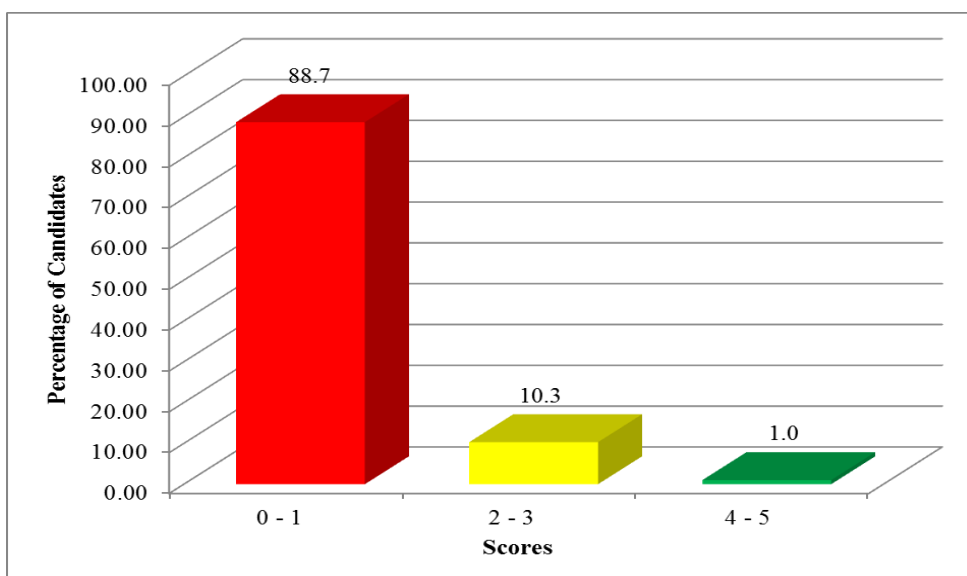


Figure 3: *Performance of Candidates in Question 3*

Figure 3 shows that the candidates' performance in this question was poor because a big number of candidates 259 (88.7%) scored below average (0 to 1 mark). Only 33 (11.3%) candidates scored average marks and above.

The candidates who scored from 0 to 1 mark could not adequately meet the demands of the question as some of them managed to give only one name of lubricant in either solid state or liquid state. Others gave names of fluids which have no lubricating properties such as; *caustic soda*, *acetic acid*, *water* and *brine* for liquid lubricant. However, some of the candidates misconceived the question by giving the properties of oil such as; *viscosity* and *oiliness* instead of names of liquid lubricant. These irrelevant responses signified that the candidates lacked knowledge of the topic *Lubricants*. Extract 3.1 shows a sample of poor response from one of the candidates.

3	a)
	i) Cutting Lubricant
	b)
	i) cutting Lubricant
	ii) plate Lubricant
	iii) surface Lubricant
	iv) sphere Lubricant.

Extract 3.1: A sample of the candidate's poor response in question 3

In Extract 3.1, the candidate mentioned repeatedly the application of lubricant as cutting lubricant in (a) and (b) (i) which was not demanded by the question. Moreover, in (b)(ii) to (b)(iv) the candidate mentioned things which were illogical.

The candidates who scored from 2 to 3 marks were able to provide answers in either of the two parts. Analysis of their responses indicated weakness such as mixing correct and incorrect names of lubricants as well as misspelling of the names. Inadequate knowledge of properties of metals seemed to be a cause of difficulties of those candidates in providing satisfactory answers to this question.

On the other hand, few candidates (1%) had enough knowledge of the subject matter and therefore were able to identify the requirements of the question. Their score was only 4 marks because some of them were able to give the name of one lubricant which is in solid state but gave three instead of four names of lubricants in liquid state. Others failed to give the name of a lubricant in solid state but gave the four names of lubricants in liquid state. The correct responses of this question to all parts were as follows: (a) *The lubricant in solid state is graphite.* (b) *Liquid state lubricants are: Mineral oils, Vegetable oils, Animal oils and Blended or synthetic oils.* Extract 3.2 shows a response from a candidate who relatively met the requirements of the question.

a)	Graphite.
b)	Animal Fat.
	ii) Vegetable oil.
	iii) Mineral oil.
	105

Extract 3.2: A sample of the candidate's relatively good response in question 3.

In Extract 3.2, the candidate mentioned correctly one solid lubricant and three instead of four names of lubricants in liquid state, therefore failed to score all 5 marks.

2.2.3 Question 4: Heat Treatment

In this question, the candidates were required to give five reasons of employing heat treatment to steel. The total marks allotted for this question was 5.

The question was attempted by 291 candidates, which is equivalent to 97.32 percent. Out of them, 46 percent scored from 0 to 1 mark, 18.9 percent scored from 2 to 3 marks and 35.1 percent scored from 4 to 5 marks. Figure 4 illustrates the performance.

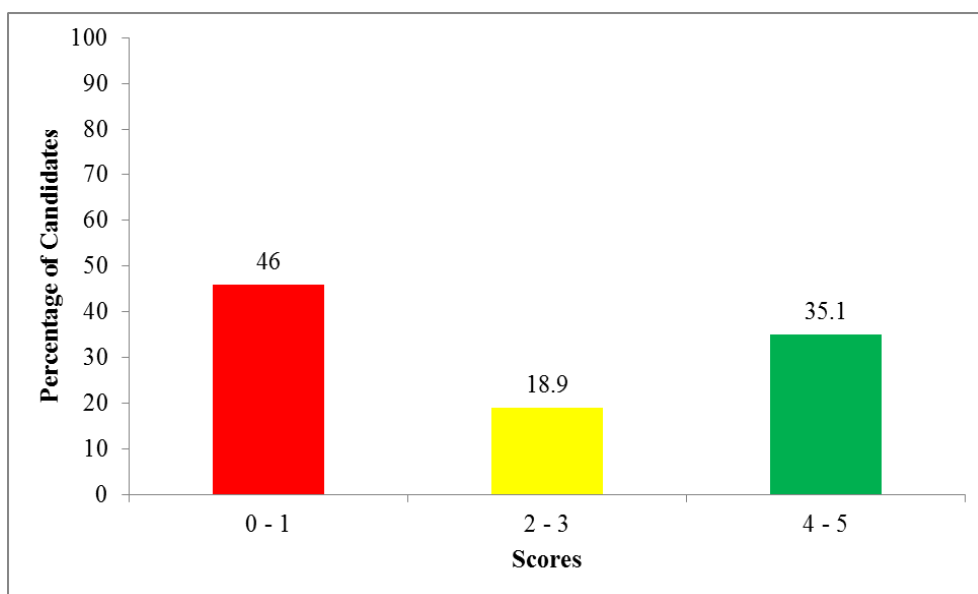


Figure 4: *The Candidates' Performance in Question 4*

Figure 4 shows that the candidates' performance in this question was average because 54 percent of the candidates who attempted this question scored average marks and above (2 to 5 marks).

The candidates who scored low marks (from 0 – 1 mark) failed to comply with the requirement of the question as they failed to provide the correct reasons for doing heat treatment of steel. Only few candidates (6.8%) managed to provide one correct reason hence scored 1 mark. Those who scored 0 mark provided responses which had inappropriate explanations or gave reasons which were out of the question context. For example, one candidate gave reasons as follows: (i) *To produce pig iron* (ii) *To help to design different shape of steel.*(iii) *to remove cracks in steel.* Likewise, there were those candidates who misconceived the question by writing advantages of using cutting fluids with the points such as; *to reduce power consumption* and *to reduce time of manufacturing* instead of reasons for doing heat treatment of steel. These responses and others of similar nature revealed that, the candidates in this category lacked adequate knowledge of the topic *heat treatment*. Extract 4.1 shows a sample of a poor response from one of the candidates.

4.	Heat treatment accomplished by heat steel manufacturing is	→ Case hardening.
		→ Annealing
		→ Normalizing
	Where	
	Case hardening is the heat treatment which make steel harden by addition of carbon and then quenching it.	
	Annealing is the heat treatment process for making a steel soft by heating at desirable rate and cooling at required rate.	
	Normalizing is the heat treatment process for making or for giving a steel its normally structure.	
	Reasons for using these heat treatment	
	→ Steel has a low melting point	
	→ Is easy to be machined.	
	→ Has low amount of carbon about 0.3-1%	
	→ Steel has no ability to resist deformation.	
	→ Steel is soft and have low boiling and melting point.	

Extract 4.1: A sample of the candidate's poor response in question 4

In Extract 4.1 the candidate misconceived the question by first defining the heat treatment terms which are not in the question then secondly by writing metal properties instead of giving reasons for heat treatment.

The candidates who scored from 2 to 3 marks managed to provide two to three correct reasons of doing heat treatment of steel. Others provided all

five reasons but some were illogical or had a mixture of correct and incorrect points. This revealed that, those candidates had partial knowledge of heat treatment of steel.

On the other hand, the candidates who scored high marks in this question were able to give the main reasons of performing heat treatment of steel. These candidates understood the requirements of the question and had sufficient knowledge on heat treatment of steel. However, the differences in their scores (4 to 5 marks) were due to the fact that some of them were able to give correctly all five reasons while others failed to exhaust the five reasons. Likewise, some missed some important points in stating the reasons for heat treatment of steel. Some of the correct responses provided were: (i) *to increase hardness of the metal* (ii) *to remove internal stress* (iii) *to improve machinability* (iv) *to remove excessive brittleness*. Extract 4.2 shows a further example of a good response from one of the candidates.

Q4.	(i) To improve cutting ability of a metal.
	(ii) To improve machine ability.
	(iii) To improve corrosion resistance.
	(iv) To remove brittleness of the metal
	(v) To improve hardness of the metal

Extract 4.2: A sample of the candidate's good response in question 4

In Extract 4.2, the candidate managed to provide correctly all five reasons for heat treatments of steel therefore scored all 5 marks.

2.2.4 Question 5: Production of Engineering Materials.

This question had three parts, (a), (b) and (c). Part (a) required the candidates to identify the type of cast iron which is easily machined. In part (b), candidates were required to give the purpose of chilled castings as it is

applied in cast iron production. In part (c), the candidates were required to identify two components in which cast iron is used as engine construction material. The total marks allotted for this question was 5.

This question was attempted by 295 (98.66%) candidates, out of which 87.5 percent scored from 0 to 1 mark, and 11.5 percent scored from 2 to 3 marks and 1 percent scored from 4 to 5 marks. The general performance in this question was poor because most of the candidates (87.5%) scored below average as presented in Figure 5.

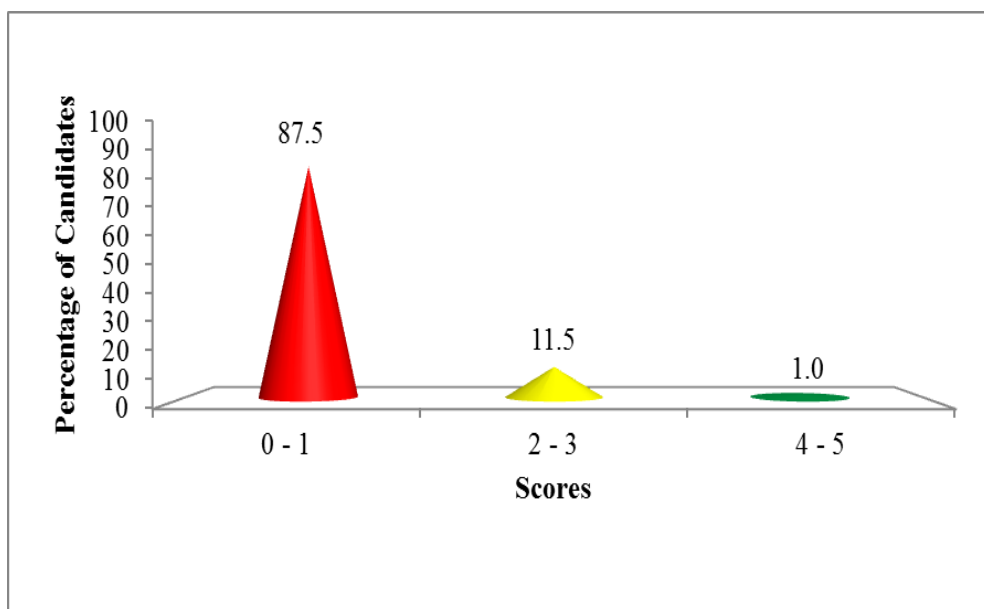


Figure 5: *The Candidates' Performance in Question 5*

Figure 5 shows that, the candidates' performance in this question was poor because a big number of candidates (87.5%) scored below average (0 to 1 mark). Only 12.5 percent of the candidates scored average marks and above.

The analysis indicated that, this question was done poorly by most of the candidates. The candidates who scored low marks failed in part (a) to associate the presence of graphite in the gray cast iron and its consequence on the machining process. They could not recall that graphite in cast iron acts as a lubricant which reduces friction making the machining process easy. Some of them mentioned the *iron ore* which is a raw material in the

production of iron and not the type of cast iron. In part (b), majority of these candidates failed to explain the purpose of chilled castings. They did not realize that chilled castings are obtained by rapid cooling therefore, their outer surfaces are hard and this condition makes chilled castings suitable where abrasion between sliding parts occurs. Likewise, in part (c), the candidates failed to identify parts of engines which are made from cast iron. Some of them did not comprehend the question. As a result, they failed by writing irrelevant points. For example; one candidate wrote the properties of cast iron with the points such as; *cast iron has high carbon content* and *cast iron contains graphite*. Another candidate mentioned types of cast iron as follows: *malleable cast iron*, *grey cast iron* and *alloyed cast iron* instead of names of engine components which are made of cast iron such as; *cylinder block*, *piston rings*, *cylinder head*, *inlet and exhaust manifold*, *camshaft* and *crankshaft*. The candidates' poor responses in all parts of this question indicate lack of knowledge and poor understanding of the question. Extract 5.1 illustrates a sample of a poor response from one of the candidates.

5.a.	Which types of Cast Iron
	i/ Lubricant
	ii/ Iron chips
	iii/ Sheet
b.	What is the purpose of chilled casting as applied in cast iron product
	When the metal which to produce in cast iron which deal to the hard process when the cast iron to produce the metal in the chilled.
c.	Identify two components in which iron is used in engine construction
	i/ engine material
	ii/ engine lathe

Extract 5.1: A sample of the candidate's poor response in question 5

In Extract 5.1, the candidate in part (a) wrote things which do not correlate with the question and in part (b) formulated unclear and illogical expressions while in part (c) responded by writing the terms 'engine material' and 'engine lathe' which did not relate to the requirements of the question.

Few candidates (11.5%) who scored from 2 to 3 marks were partially knowledgeable on production of cast iron as they were able to provide correct responses in either one part, two or all parts but with some weakness in their expressions such as; lack of clarity or factual.

On the other hand, the candidates who scored high marks in this question had adequate knowledge on the production of engineering materials, particularly cast iron. They were able to recognize in part (a) that, grey cast iron contains graphite which makes the machining process easier due to its

lubricating properties. In part (b), they realized the fact that chilled castings bear hard surfaces, so they managed to provide relevant explanations of the purposes for chilled castings. Moreover, in (c), the candidates were able to give two of the engine components which are made of cast iron such as; piston rings, camshaft, inlet and exhaust manifold and engine block and cylinder head. Extract 5.2 shows a response of a candidate who responded well in all three parts of this question.

5	(a) Type of Cast iron which easy to machine is Grey Cast iron.
	(b) Chilled cast iron used to manufacture wear-resistant parts of machine, such as bed of lathe machine.
	(c) The components are (i) Cylinder head (ii) Engine block.

Extract 5.2: A sample of the candidate's good response in question 5

In extract 5.2, the candidate managed to mention the type of cast iron which is easy to machine, explained the purpose of chilled castings and named correctly the parts of the engine which are made of cast iron, therefore scored all 5 marks.

2.2.5 Question 6: Identification of Metals

The candidates were required to identify the types of metals which correspond to the following types of sparks:

- Sparks in long, light yellow streaks with a little tendency to burst.
- Similar sparks as material in test (a) but has more sparks which burst with sparkler effect.
- Numerous little yellow stars burst very close to the grinding wheel.
- Interrupted spark lines with a dark red, ball shaped spark at the end.
- Definite torpedo shaped spark with a feather like effect near the end. It changes from a dark red to gold colour.

The question was attempted by 240 candidates, which is equivalent to 80.27 percent. Out of which, 92.1 percent scored from 0 to 1 mark with those who scored 0 mark being 78.3 percent. Also, 5.8 percent scored from 2 to 3 marks and 2.1 percent scored from 4 to 5 marks. Table 1 depicts the candidates' performance in this question.

Table 1: *The Candidates' Performance in Question 6*

Scores	0 – 1	2 – 3	4 – 5	Total
Performance	Poor	Average	Good	
Number of Candidates	212	14	5	240
Percentage	92.1	5.8	2.1	100

Table 1 shows that the candidates' performance in this question was poor because a big number of candidates 212 (92.1%) scored below average (0 to 1 mark). Only 7.9 percent of the candidates scored average marks and above.

Majority of the candidates (78.3%) who scored 0 mark showed both lack of knowledge of metal identifications as well as failure to comprehend the question. Analysis of the responses revealed that, there were candidates who understood the given characteristics of sparks but named the type of metals interchangeably i.e. they failed to correspond the type of metal and the given characteristics of sparks. For example; one of the candidates gave the metals corresponding to characteristics of sparks in the following order: (a) *medium carbon steel*, (b) *high carbon steel*, (c) *cast iron*, (d) *mild steel* and (e) *wrought iron*. The correct order of correspondence was as follows: (a) *low carbon steel*, (b) *medium carbon steel*, (c) *high carbon steel* (d) *high speed steel* and (e) *cast iron*. Likewise, another candidate misconceived the question and responded without specifying the type of metal as follows: (a) *ferrous metals*, (b) *ferrous metals*, (c) *nonferrous metal ferrous metal* and (e) *nonferrous metal*. They were supposed to understand that these were groups of metals while the question needed specific type of metal for each spark characteristic. Extract 6.1 portrays a sample of a poor response from one of the candidates.

06.	a) Low carbon steel.
	b) Medium carbon steel.
	c) High carbon steel.
	d) High speed steel.
	e) cast iron.

Extract 6.2: A sample of the candidate's good responses in question 6

In extract 6.2, the candidate managed to provide correctly all five reasons for heat treatments of steel, therefore scored all 5 marks.

2.2.6 Question 7: Limits and Fits

This question had two parts: (a) and (b). In part (a), the candidates were required to outline the benefits of using limits, fits and tolerances in manufacturing of mechanical components. In part (b), the candidates were required to give three methods in which parts made with interference fit can be assembled. The total marks allotted for this question were 5.

This question was attempted by 284 (94.98%) candidates, of which 78.9 percent scored from 0 to 1 mark, 18.3 percent scored from 2 to 3 marks and 2.8 percent scored from 4 to 5 marks. Figure 6 illustrates the performance of candidates in this question.

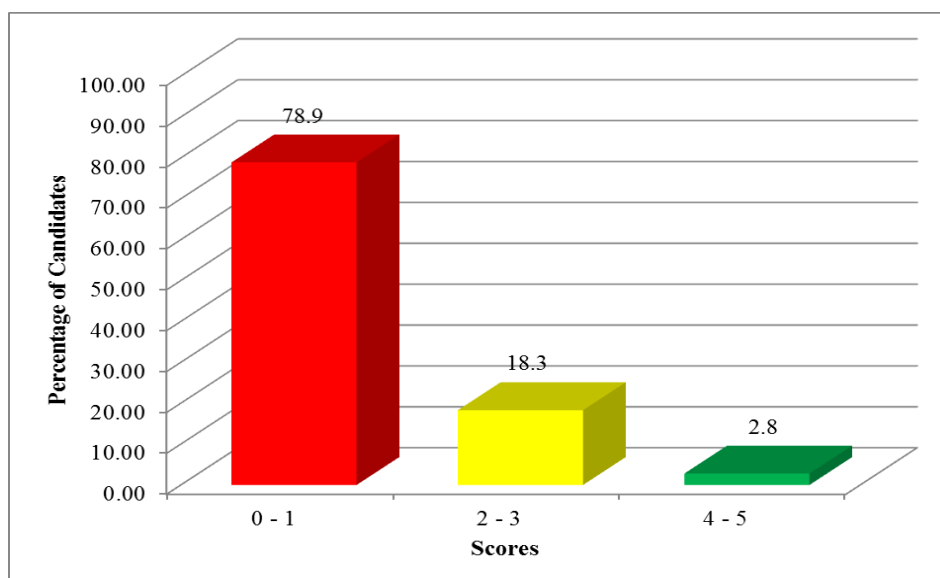


Figure 6: *The Candidates' Performance in Question 7*

Figure 6 shows that the candidates' performance in this question was poor since only 21.1 percent of the candidates scored from 2 to 5 marks.

The candidates who scored 0 to 1 mark had inadequate knowledge of limits and fits. Others misinterpreted the demands of the question. Consequently, they responded contrary to its requirements. For example; in part (a), some of the candidates provided benefits of using limits, fits and tolerances as *to protect mechanical components* and *to help lengthen the life of components* while others wrote the benefits as *to give good shape* and *to give good surface finish*. Also, other candidates gave incorrect benefits of using limits with points such as; *to help in measuring* and *to help in increasing or reducing diameter* which were not correct. The correct answers for this part were as follows: (i) *It makes easy to produce components in large quantity with less rejects.* (ii) *It makes easy and possible to have parts which are interchangeable* (iii) *It simplifies assembling.* In part (b), some of the candidates misconceived the question by writing three methods of assembling parts with interference fit such as; *soldering, riveting and brazing*. Those candidates wrongly thought that the question required the types of permanent and temporary joints. Others wrote the methods of assembling parts with interference fit with the points such as; *by using maximum size, by using minimum size and by using basic size*. These

responses revealed that, the candidates were not familiar with the uses of limits and fits. Extract 7.1 is a sample response of a candidate who did not understand the demand of the question.

7	<p>i) Limits - Are Maximum and Minimum permissible of the basic systems.</p> <p>ii) fits - Are the two Matching parts that are hole and shaft which are Assembled together.</p> <p>iii) Tolerances - Is the difference between Upper limit of hole and lower limit of shaft which are assembled together.</p> <p>6) i) because Interference fits hole and shaft are equals in sizes.</p> <p>ii) Interference fit increase the soft of that assembled together.</p> <p>iii) Interference fits increases the hardness of the grinding wheels.</p>
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Extract 7.1: A sample of the candidate's poor responses in question 7

In extract 7.1, the candidate defined the terms limits, fits and tolerances instead of writing the benefits of using limits, fits and tolerances in the manufacturing of mechanical components. In part (b), the candidate responded by writing irrelevant expressions instead of explaining three methods which are to be used to assemble two parts which are made with interference fit.

Despite the large number of candidates who failed this question, a small number (18.3%) scored from 2 to 3 marks as they showed weakness in their responses. Some of them managed to give the two benefits of using limits, fits and tolerances in part (a) but failed to give the correct methods of assembling parts which have interference fit in part (b). Others provided

responses in both parts but mixed unclear explanations therefore failed to score more than 3 marks.

On the other hand, the candidates who scored from 4 to 5 marks provided responses with relevant points and explanations. However, some of those candidates failed to score full marks in this question because they provided insufficient explanations to some of the items especially in part (b) where they were required to explain three methods of assembling parts made with interference fit. The candidates in this category had adequate knowledge in the area of limits, fits and tolerances. Extract 7.2 shows a sample of a relatively good response from one of the candidates.

7.	(a) Importance of using limits, fits and tolerances:	
	(i) Ensuring low friction between shafts and holes due to the correct type of fit used.	
	(ii) Minimizing the cost because the limits and fits of the matching parts are in correct order and preferred to a manufacturer's. There is no tendency of oversizing or undersizing the system of two matching parts.	
	(b)-By heating a hole in fire or heat source to enable it to expand and placing a shaft across it, when it cools and contracts it will undergo interference fit.	
	- By placing a hole and shaft together in mesh, then applying forces on the hole in order to be in interference with the shaft.	
	- The placing a small diameter hole and larger diameter shaft together by pressure or forces in order for them to be in interference.	

Extract 7.2: A sample of the candidate's relatively good response in question 7.

In extract 7.2, the candidate gave the benefits of using limit and fits and tolerances in the manufacturing of components in part (a). In part (b), the candidate explained how two parts made with interference fit can be assembled but the third expression is repetition of the second expression

as they both involve the use of pressure or force therefore awarded as one point.

2.2.7 Question 8: Engineering Materials

This question required the candidates to give five reasons for non-ferrous metals to have wide application in our daily activities. The total marks allotted for this question were 5.

The question was attempted by 291 candidates, which is equivalent to 97.32 percent whereby 61.5 percent scored from 0 to 1 mark, 21.7 percent scored from 2 to 3 mark and 16.8 percent scored from 4 to 5 marks. Figure 7 illustrates the performance of candidates in this question.

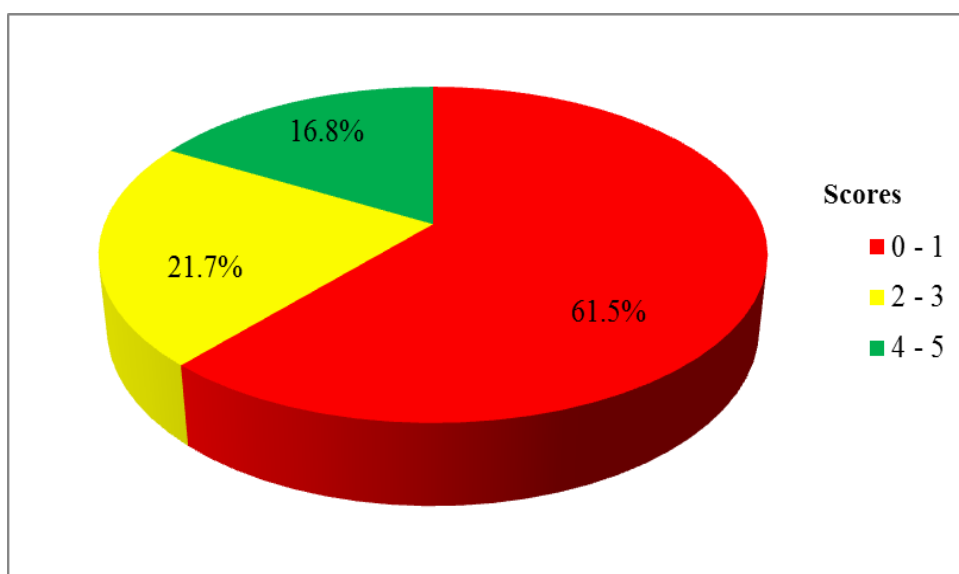


Figure 7: *The Candidates' Performance in Question 8*

Figure 7 shows that, the performance in this question was average because the percentage of candidates who scored average marks and above was 37.5 percent.

The candidates who scored low marks failed to recognize the demand of the question while others lacked knowledge on the subject matter. They gave some points which comprised inappropriate explanations and therefore scored not more than 1 mark. For example, one candidate wrote

the answer to this question as follows: *Because they are many and also easy and cheap to find them and be with it.* Another candidate wrote as follows: *It is plasticity and hardened it cannot harm a user such plastic; it has an elastic limit, it prevent the transformation of electricity but also can be melted.* The correct answers were: *Some of them have low density therefore are suitable where lightness is important. (ii) They have attractive colour (iii) They have good formability (iv) They have good fusibility and ease of casting (v) They are resistance to corrosion (vi) They are soft and can be cold worked (vii) They are special for electrical and magnetic properties there.* Furthermore, there were others who had misconception of the question as a result they gave the uses of nonferrous metals instead of the factors which make them useful in our daily activities. For example; one of the candidate responded by writing as follows: *Because they are used in making overhead cables, because they are used in electroplating of other metals they are used in making widow frames, they are used in making roofing sheets, they are used in making foils and cooking pan.* Further example of irrelevant responses is shown in extract 8.1 as follows:

8.	Example of non-Ferrous Metals.
	1. Wrought Iron.
	2. Cast Iron.
	Importance of Wrought or applications of wrought
	Iron in our daily activities.
	1. Building It help in building construction.
	2. Hangers.
	3. It help in Railways.
	4. It help in bridge.
	5. It help in manhole cover.
	So above it's application of non-ferrous metals accordi
	ng to types of non-ferrous metals.

Extract 8.1: A sample of the candidate's poor responses in question 8

In extract 8.1, the candidate gave the ferrous metals; *wrought iron* and *cast iron* as examples of nonferrous metals. Then he/she went further by giving the importance of wrought iron contrary to the question which required the

factors which make nonferrous metals useful in our daily activities. The candidate failed to comprehend the question.

The candidates (21.7%) who scored from 2 to 3 marks were partially knowledgeable as they managed to give two to three factors correctly. Some of those candidates gave all factors but some of their responses comprised minor errors such as illogical flow of explanations and lack of clarity.

On the other hand, the candidates who scored high marks, had adequate knowledge of the subject matter and could identify the requirements of the question. They managed to give the factors which make nonferrous metals useful in our daily activities with the points such as; *some of them have low density therefore are suitable where lightness is important, they have attractive colour, they have good formability, they have good fusibility so easy to cast, they are resistant to corrosion, they are soft so can be cold worked and they are special for electrical and magnetic properties.* Some of the candidates did not score full marks because they either missed few relevant points in their expressions or gave only four factors instead of five. Extract 8.2 shows a response of the candidate who understood the demands of the question.

8.	i) Because they are easy to cast.
	ii) Because they are resistance of rust and scales.
	iii) Because they have attractive colour.
	iv) Because they have electriz and magnetiz properties.
	v) Because they are more ductile.

Extract 8.2: A sample of the candidate's good responses in question 8

In extract 8.2, the candidate managed to provide correctly all five factors which make the nonferrous metals useful in our daily activities.

2.2.8 Question 9: Heat Treatment

This question had two parts: (a) and (b). In part (a), the candidates were required to differentiate induction hardening from flame hardening. In part

(b), the candidates were required to give two factors on which the depth of hardness for case hardened part depend. The total marks allotted for this question were 5.

The question was attempted by 181 candidates, which is equivalent to 60.53 percent whereby 80.3 percent scored from 0 to 1 mark, 10.4 percent scored from 2 to 3 marks and 9.3 percent scored from 4 to 5 marks. Figure 8 represents the data analysis.

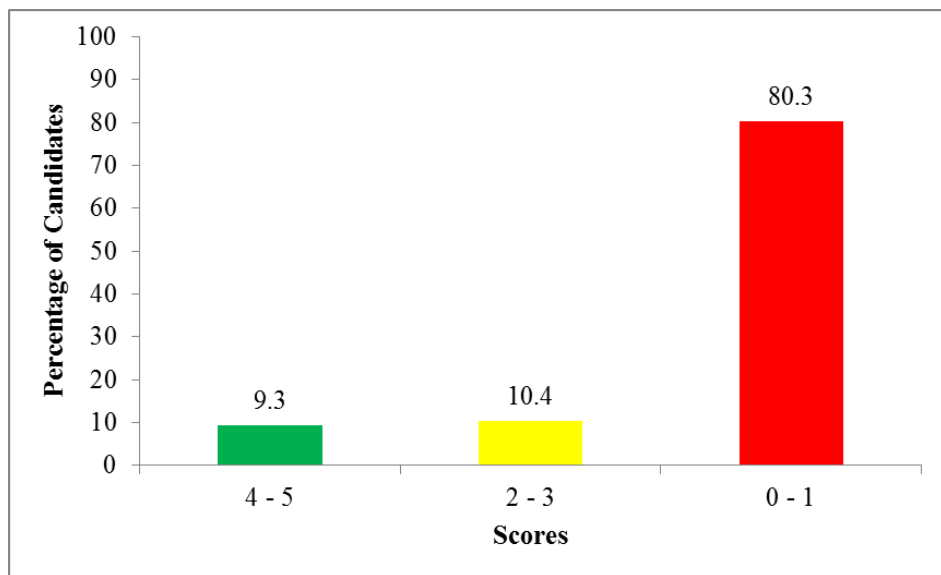


Figure 8: *The Candidates' Performance in Question 9*

Figure 8 shows that the performance in this question was poor because the percentage of candidates who scored low marks is high (80.3%) while that of the candidates who scored average marks and above (2 to 5 marks) was only 19.7%.

The analysis shows that the candidates who performed poorly in this question failed to provide correct responses to both parts of the question. In part (a) and (b), majority of the candidates failed to differentiate between induction hardening and flame hardening. Some of the incorrect responses provided by these candidates were as follows: One candidate wrote *(a) induction hardening is the process of hardening which is steel harden in elastic deformation while flame hardening is the property of steel which is*

called upper and lower temperatures (b) the factors on depth of hardness depends are carburizing and case hardening. This candidate failed to know that, induction hardening and elastic deformation are two unrelated things. Another candidate responded by writing; *Induction hardening is the process by which steel or metal is hardened by using contact between one metal and another while flame hardening is the process of using flame as adding to the hardening. The factors are hardness before and hardness after.* Furthermore, another candidate in this category went astray by writing as follows: (a) *induction hardening is the process of making the metal hard by reducing the impurities from the metal by quenching while flame hardening is the process of making the metal hard by using part of the metal to combine with the machine.* (b) *The factors on which the hardness depends are dimension of the material and size of the material used.* These responses given by these candidates were contrary to the demand of the question. Some of these candidates realized that; induction hardening and flame hardening increases hardness of metal but failed to recognize the difference. These responses and others of this kind revealed poor knowledge of the candidates in the topic *Heat Treatment*. Extract 9.1 shows further example of poor responses from the candidates in this question.

9	(a) Induction Hardening is the type of hardening which it causes Induction it make metal tough while flame hardening is type of hardening that it produces in a temperature but it causes the metal soft.
	(b) i/ Diameter
	ii/ Hole

Extract 9.1: A sample of the candidate's poor responses in question 9

In extract 9.1, the candidate failed to provide the difference between flame hardening and induction hardening by writing illogical explanations. Moreover, the candidate in part (b) wrote *diameter* and *hole* as factors which influence hardness; which is not correct.

The candidates who scored from 2 to 3 marks had partial knowledge in the area of Heat Treatment of metals as most of them managed to respond correctly in part (a) of the question and failed in part (b). Moreover, some of the candidates provided responses for both parts of the question but some of their responses contained few incorrect points or lacked clarity. However, the candidates who scored from 4 to 5 marks adhered to the demand of the question. Their performance implied that, they had sufficient knowledge of the topic *Heat Treatment*. Most of these candidates were able to differentiate between induction hardening and flame hardening as they recognized that with flame hardening, the metal or component being hardened is heated using a flame with excess carbon up to the required temperature then quenched. They were able to understand that, through induction hardening, the component is heated in an induction furnace which uses electricity to heat until the hardening temperature reaches then followed by quenching. Moreover, they managed to write the factors on which hardness of a case hardened surface depends as follows: *the temperature reached during heating of the surface, the time taken to heat and enrich the surface with carbon and the type of material or metal being hardened*. However, the candidates' scores varied depending on clarity of their expressions and the number of correct points given by individual candidates. Extract 9.2 shows a sample of a relatively good response from one of the candidates.

9. b) Induction hardening - Is the hardening process where by high frequency current is supplied to a block of coil around material to be hardened. High frequency current causes heat which rise temperature of steel above its upper critical temperature, followed by process of cooling it by water passed in water jets to the steel. while.
Lack Flame hardening is the process which involve heating steel using high temperature flame above its upper critical temperature followed by process of quenching it.
b) i) Temperature at which steel is heated.
ii) Time at which process takes place.

Extract 9.2: A sample of the candidate's good response in question 9

In extract 9.2, the candidate correctly wrote the difference between flame hardening and induction hardening and mentioned the correct factors on which the hardness of a case hardened part depends, hence scored 5 marks.

2.2.9 Question 10: Engineering Materials

This question had two parts, (a) and (b). In part (a), the candidates were required to outline three properties of aluminium material which make it more popular. In part (b), the candidates were required to identify four common forms in which aluminium material is supplied during its manufacturing. The total marks allotted for this question were 5.

The question was attempted by 291 (97.32 %) candidates, of which 44.3 percent scored from 0 to 1 mark, 41.6 percent scored from 2 to 3 marks and 14.1 percent scored from 4 to 5 marks. Figure 9 depicts the performance in this question.

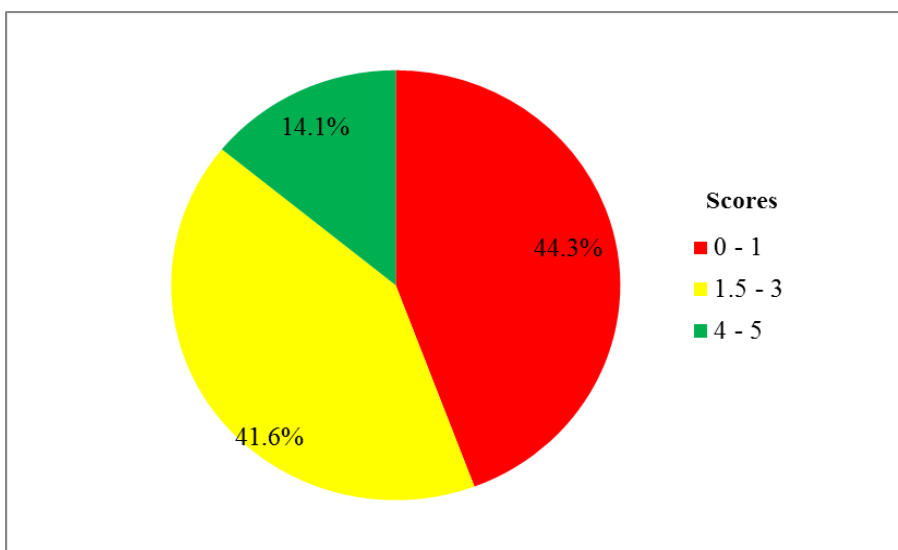


Figure 9: *The Candidates' Performance in Question 10*

Figure 9 indicates that the performance in this question was average because 55.7 percent of the candidates who attempted this question scored from 1.5 to 5 which is average marks and above.

The analysis of the candidates' responses indicated that 44.3 percent scored low marks (below average). Most of these candidates lacked knowledge of the characteristics of aluminium which make it useful for window frames and roofing sheets and the common forms of aluminium as they wrote incorrect responses. Others did not comprehend the question as they wrote things which are not related to the question. For example; one candidate named the types of steel such as; *plain carbon steel, high carbon steel and medium carbon steel* in part (a) instead of characteristics of aluminium. Another candidate listed the raw materials such as; *iron ore, coke, limestone and air blast* which are fed in the blast furnace for manufacturing of iron instead of the forms in which aluminium materials are supplied in part (b). Also, some of the candidates wrote the uses of aluminium with the points such as; *it is used for making electric wires, it is used for making cooking pots, it is used for making foils, it is used for making widows* instead of the characteristics as it was required by the question. Extracts 10.1 and 10.2 exhibit the samples of poor responses from the candidates.

10a.	i/ Working space
	ii/ Engines material
	iii/ depth haldner
b.	Identify four Amin
	i/ Alumin
	ii/ limit
	iii/ fits
	iv/ tolerances

Extract 10.1: A sample of the candidate's poor response in question 10

a)	In the buiding industry, aluminium is good choice for window frame and roofing sheets. Outline three properties of this material which make it more popular in use.
	⇒ To use in Power
	⇒ Table
	⇒ And Cheas
b)	Identify four (4) Common form in which aluminium material is supplied during its manufacturing.
	⇒ Carbon
	⇒ Non-ferous metal
	⇒ Steel
	⇒ Plaster

Extract 10.2: A sample of the candidate's poor response in question 10

In extract 10.1, the candidate went astray by writing the words working space, engine material and depth haldner instead of the characteristics of aluminium in part (a) and the words alumin, limit, fits and tolerances which do not relate with the question instead of the forms of aluminium material. Moreover, in extract 10.2, another candidate wrote irrelevant things such as 'to use in power, table, and cheas' in part (a) and the terms 'carbon, nonferrous metal, steel and plastic' in part (b) which were contrary to the demand of the question.

On the other hand, the candidates who scored averagely were able to give two to three correct points. Some of them responded correctly in only one part of the question by either giving few characteristics of aluminium material or giving some of the forms in which aluminium is supplied while others responded partially on both parts. Another weakness found to these candidates is that, some of them did not realize that the question in part (a) was specific on the characteristic that renders aluminium useful for making window frames and roofing sheets. Therefore, they mixed with the characteristics which make aluminium useful in other activities such as making cooking pots and electricity transmission. The failure of the candidates to exhaust the necessary points revealed that they had inadequate knowledge of characteristics and forms of aluminium material.

Furthermore, a total of 41 (14.1%) candidates who scored 4 to 5 marks comprehended the question and were knowledgeable to write correctly the characteristic of aluminium that renders it useful for making window frames and roofing sheets in part (a). They also responded correctly in part (b) by writing the forms in which aluminium material is supplied. They recognized that, the required characteristics of aluminium in part (a) were those based on the use of aluminium for window frame and roofing sheets making. However, the variation in the marks in this category (from 4 to 5) was due to varied magnitudes of relevance of the candidates' responses. Extract 10.3 is an example of a good response from one of the candidates.

10	a. (i) It is soft
	(ii) It has less weight
	(iii) It resists corrosion.
	(b) Bar form of supply
	(i) Sheet form of supply
	(ii) Wire form of supply
	(iii) Tube form of supply

Extract 10.3: A sample of the candidate's good response in question 10

In extract 10.3, the candidate wrote correctly the properties of aluminium which make it popular in the manufacture of window frames and roofing sheets as well as the forms in which aluminium material is supplied therefore scored 5 marks.

2.3 SECTION C: STRUCTURED QUESTIONS

2.3.1 Question 11: Properties of Metals

This question had two parts, (a) and (b). In part (a), the candidates were required to describe the type of test that can be used to verify the suitability of steel in hand as a construction material for a structural work which will be subjected to shock loads. In part (b), the candidates were required to explain the Brinel Testing procedure for steel. The total marks allotted for this question were 15.

This question was attempted by 89 (29.76%) candidates, of which 98.9 percent scored 0 mark and 1.1 percent scored 6 marks. There were no candidates who scored from 10 to 15 marks.

Table 2: *Performance of Candidates in Percentage in Question 11*

Scores	0 – 4	4.5 – 9.5	10 - 15	Total
Performance	Poor	Average	Good	
Number of Candidates	88	01	00	89
Percentage	98.9	1.1	00	100

Table 2 shows that the performance of candidates in this question was very poor. It was the most poorly performed question because 98.9 percent scored 0 mark. Only 1 candidate managed to score 6 out of 15 marks.

The analysis of the candidates' responses shows that, all the candidates who attempted this question scored low marks. This is because most of them failed to understand the demand of the question. In part (a), some of the candidates did not take into account the concept of shock loads as stated in the question. This concept could lead them to select toughness testing

method because toughness relates with shock loads than other methods as they did. For example one candidate responded by writing as follows: (a) *the type of test that can be used to verify the suitability of steel materials in hand such as straight tool conical tool all used to verify the suitability of steel.* (b) *Brinell testing is the hand tool used to produce steel shape material in the situation on the work.*

Another candidate answered part (a) by providing sketches of a hand hacksaw, file and a chisel while another candidate drew sketches showing different types of sparks that occur when grinding different metals such as; *low carbon steel, high carbon steel and medium carbon steel.* Moreover, another candidate in part (b) wrote as follows: *Brinell testing for steel is the process of quenching the steel in the water or the fluids. So after cooled the steel may be placed again in the part of formation because must be to improve the surface of the work.* These responses and others of this category suggest that the candidates failed to understand the requirement of the question and had poor knowledge of material testing particularly on destructive testing. They failed to understand that, if the metal structure had to carry shock loads then the suitable material for constructing the structure is the one possessing toughness property. Then in connection with toughness property, the suitable test for toughness was the impact test using either the Charpy testing machine or izod testing machine. Moreover, they failed to understand that brinell testing is a method used to determine hardness of a metal and it is accomplished by using a machine that presses a very hard steel ball on a metal and the impression formed is measured. Then by using a special formula, the hardness of a metal can be determined. Extracts 11.1 and 11.2 are further examples of poor responses given by the candidates.

11. a) The types of testing is distinctive test and non-distinctive test. The distinctive test is the types of testing used to testing metal example ferritic metal example cast iron, wrought iron and carbon steel. The example of distinctive testing is sound test and spark test. The spark test the test all metal example carbon steel, cast iron and wrought iron and sound test used to test or identify metal example cast iron alloy steel and other is very important while non distinctive test is the types of testing used to testing all non-ferrous metal example the non-distinctive testing the metal copper, aluminium, lead and other brass, cobalt. the non-distinctive test example colour code, example to identify metal to colour code is copper-red, aluminium-white, brass-yellow, lead-blue. There non-distinctive testing.
- b) The brinell testing procedure for steel is to testing by manufacturing stamp, testing by the appearance, testing by color colour code, testing by sound test, testing by spark test.

Extract 11.1: A sample of the candidate's poor response in question 11

11. @	The type of Test also includes the Manufacture of cementite of the construction of Materials that are as the Used to important cementite and carbides of Metals construction of projects.
⑥	Brinell testing procedure for steel. The brinell testing procedure of steel also increases the importance of hardness and quenching of steel into the carbon powder during heating and cooling curve for heat treatments of steel.

Extract 11.2: A sample of the candidate's poor response in question 11

In extract 11.1, the candidate answered without considering the key concept 'shock loads' in the question which implied that if the structure was to sustain shock loads then materials should be tough then the test should be toughness testing. The candidate wrote *distinctive test* which does not exist and *spark test* which is not used to determine toughness. In extract 11.2, the candidate for part (a) wrote about the manufacture of a hard structure of steel called *cementite* which was not asked in the question. Likewise, in part (b), the candidate wrote about heat treatment of steel instead of explaining how brinell testing of steel is carried out.

2.3.2 Question 12: Limits and Fits

This question comprised three parts, (a), (b) and (c). In part (a), the candidates were required to produce a shaft that can be able to fit on a plain bronze bushing of 35.05mm diameter. If the clearance required between shaft and bush is 0.05 mm, with the aid of drawing they were needed to indicate limits and tolerances of the fit.

In part (b), the candidates were required to state the allowance obtained in 12(a).

In part (c), the candidates were instructed to briefly explain three types of limit gauges used in checking components. The total marks allotted for this question were 15.

The question was opted by 223 (74.58%) candidates, whereby 98.2 percent scored from 0 to 4 marks, 1.8 percent scored from 4.5 to 7 marks. There were no candidates who scored above 7 marks. Figure 10 illustrates the trend of performance in this question.

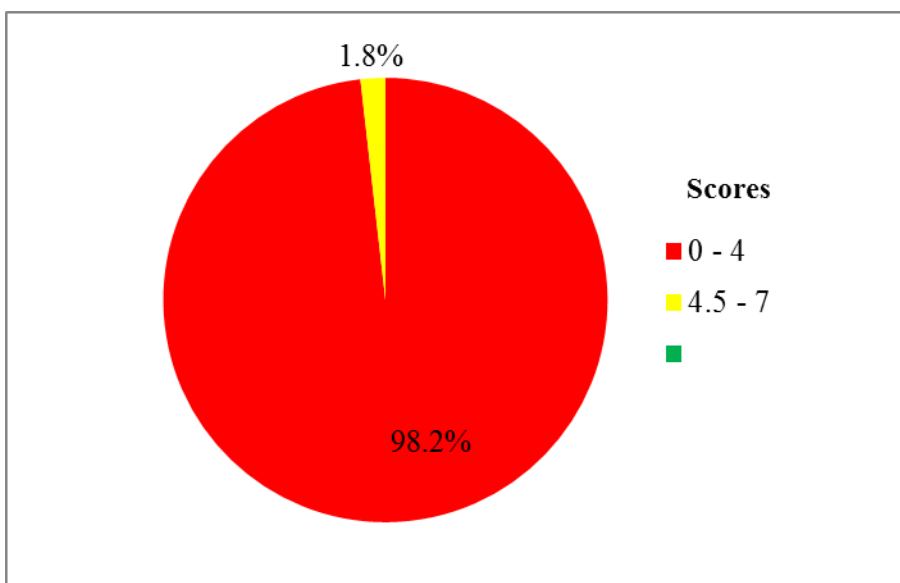


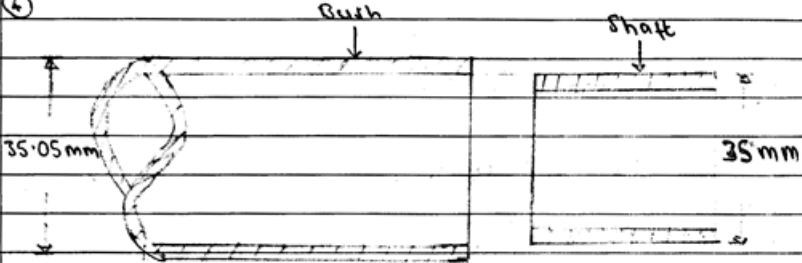
Figure 10: *The Candidates' Performance in Question 12*

Figure 10 ascertains that, the candidates' performance in this question was poor because most of the candidates (98.2%) scored below average (0 – 4 marks).

The candidates who scored low marks failed to provide relevant answers to most of the parts in the question. Among them, there were those who completely failed to provide appropriate responses to any part hence scored 0 mark. The analysis from candidates' responses showed that they had limited knowledge on the topic of *Limits and Fits*. Some of the candidates showed inadequate knowledge of the concepts while others misconceived the demand of the question as they were unable to answer correctly most

parts of the question. For example; in part (a), there were some of the candidates who failed to produce sketches representing shaft and bronze bush. Others produced correct sketches but misallocated the dimensions as a result they failed to obtain correct values of limits and tolerance for both shaft and bronze bush. In part (b), most of the candidates did not follow the correct procedure to obtain allowance of the fit drawn in 12(a). Instead of calculating the difference between the maximum size of shaft and minimum size of hole, they obtained the difference between maximum hole and minimum hole by stating it as an allowance.

In part (c), most of the candidates misconceived the question as they responded by writing things which are contrary to the demand of the question. Their responses revealed that, they were not familiar with the type of gauges used for checking manufactured components if they are within tolerable dimensions. For example; one of the candidates provided improper definitions of the terms used in limits and fits as follows: (i) *Upper limit gauge of hole and shaft and hole is the maximum dimension measure into hole or shaft.* (ii) *Lower limit gauge of shaft and hole is the minimum dimension measured to a hole and shaft.* (iii) *Clearance gauge is used to limit holes and shaft and consider their size.* Some of the candidates mentioned and explained the types of gauges such as *depth gauges, feeler gauge and micro screw gauge* instead of the limit gauges such as; *ring gauge, plug gauge and snap gauge* as it was required by the question. Also other candidates named and explained types of fits such as; *clearance fit, transition fit and interference fit* instead of the limit gauges. Such irrelevant responses suggested that, the candidates were not familiar with the limit gauges used for inspection or checking of components. Extract 12.1 and 12.2 exhibit poor responses from the candidates who failed to provide relevant answers.

12	(a) Solution.	
	Data Given	
	Bushing diameter = 35.05 mm	
	Clearance = 0.05 mm	
	(b)	
		
	(c) The type of clearance allowance is minimum allowance.	
	(i) Radius limit gauge is the type of limit gauge which it used to inspect the diameter of the hole is it GO or NOT GO.	
	(ii) Pillar limit gauge; is the type of limit gauge which it can inspect the length of the workpiece or width if it is GO or NOT GO.	
	(iii) Feeler limit gauge; It used to inspect the accurate of the workpiece.	

Extract 12:1 A sample of the candidate's poor response in question 12

In extract 12.1, the candidate produced a sketch in which the limits of dimensions were not correctly indicated. Moreover, the candidate mentioned and explained the wrong type of gauges.

12	(a) Tolerance of the fit	
	^{from} Tolerance = Maximum Limit - Minimum Limit	
	= 35.05 - 30.00	
	∴ Tolerance of the fit = <u>5.05 mm</u>	
	(c) Types of limit gauges used in checking components.	
	(i) Micrometer screw gauge.	
	- This is used to measure the accuracy of external dimension.	
	(ii) Vernier Caliper	
	- This is used to measure the accuracy of dimension.	
	(iii) Tap and Die	
	They are used to cut internal and external threads.	

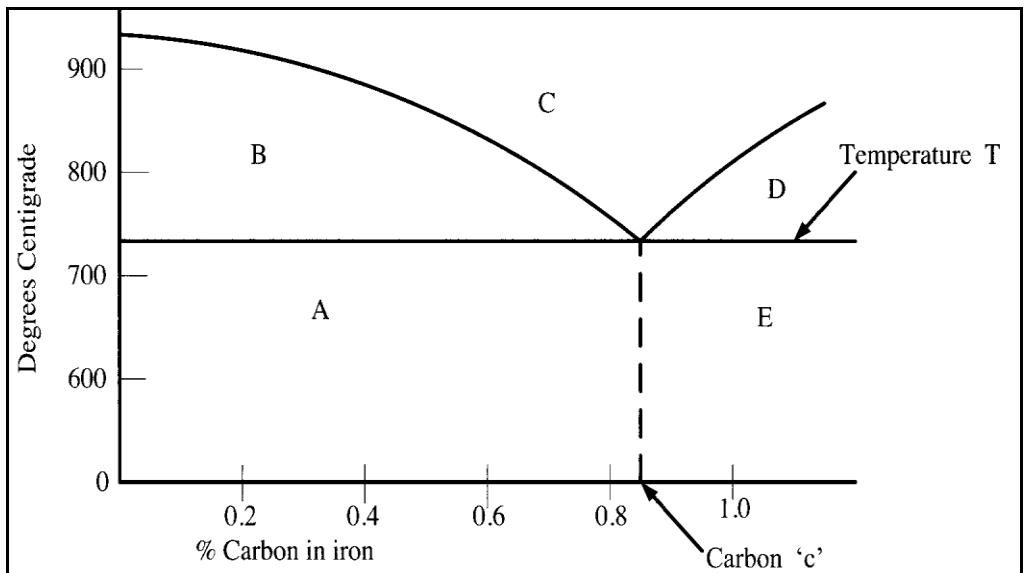
Extract 12.2: A sample of the candidate's poor response in question 12

In extract 12.2, another candidate made wrong computation of the limits and tolerances and mentioned measuring tools such as; micrometer screw gauge and vernier caliper and thread cutting tools hand taps used for cutting threads instead of limit gauges.

However, few candidates (1.8%) whose scores ranged from 4.5 to 7 marks responded correctly in some parts while giving incorrect answers in other parts. For example, in part (a), some candidates drew the sketches to indicate hole and shaft but failed to indicate shaft and hole tolerances. In part (b), some of the candidates gave partially correct expressions of the type of allowance obtained in 12(a), Nevertheless, they failed to calculate the allowance and give it in numerical figures. Likewise, in part (c), some of the candidates mixed correct and incorrect answers for the types of limit.

2.3.3 Question 13: Heat Treatment.

This question comprised two parts; (a) and (b). In part (a), the candidates were required to (i) explain the composition and characteristics of the iron in the regions marked as A, B, C, D and E of the iron carbon thermal equilibrium.



In part (b), the candidates were required to state two factors which tend to cause warping and cracking of metals during quenching.

In part (c), the candidates were required to give three reasons as to why some hot rolled steel need to be cold rolled. The total marks allocated for this question were 15.

The question was opted by 216 (72.24%) candidates, whereby 80.6 percent scored from 0 to 4 marks and 19.4 percent scored from 5 – 9 marks. There were no candidate who scored above 9 marks.

Table 3: Performance of Candidates in Percentage in Question 13

Scores	0 – 4	4.5– 9.5	10 - 15	Total
Performance	Poor	Average	Good	
Number of Candidates	174	42	00	216
Percentage	80.6	19.4	00	100

Table 3 shows that the performance in this question was poor as most of the candidates scored below average marks.

The candidates with poor performance in this question either had partial or no knowledge of the topic *Heat Treatment*. Some provided partial responses which could not deserve more than 4 marks while others scored 0 as they provided irrelevant responses. In part (a)(i), the candidates failed to relate the increase of temperature concurrently with increase of carbon content to the change of behavior of iron. Therefore; they could not recognize that in the region A, iron exists in the form of layers of *ferrite* and *pearlite* and its characteristic is *soft*. In the region B, the iron exists in the form of *austenite* and *pearlite* and has two characteristics; it *loses magnetic properties* and becomes *harder when quenched*. In the region C, the iron exists as *full austenite* and in characteristics it is *completely antimagnetic* and when quenched it produces *very hard structure called martensite*. In the region denoted by the letter D, iron exists in the form of *austenite and cementite* and when it is cooled rapidly it gives *harder structure than that in B*. Likewise, in the region E, iron exists in the form *alternating layers of cementite and pearlite* and its characteristic is *harder compared to the iron in A*.

Some of the candidates' inappropriate answers to part (a)(i) are as follows: one of the candidates responded wrongly by writing the carbon content in the regions such as; *in the region A the composition is 0.3% of carbon in iron, in the region B the composition is 0.25% of carbon in iron, in the region C the composition is 0.65% of carbon in iron, in the region D the composition is 1.5% of carbon in iron and in the region E the composition is 1.4% of carbon in iron*. Another candidate wrote answers for this part as; *A represent lower carbon thermal equilibrium that is used to make first*

step in heat treatment. B represents upper thermal equilibrium in the left that is made up of material cooling down to 123°. C represents upper middle thermal equilibrium made up of material from left that solidify. D represents upper right thermal equilibrium made with material that solidifies in less temperature and E represents lower right thermal equilibrium that is made up temperature 0 to 123°. Furthermore, another candidate went astray by writing; Iron at A is hard and soluble liquid but In B it becomes softened and insoluble liquid while at C it becomes soluble liquid also at D it start to become like polidge but also soluble and finally at E it fracture and bust to lose its properties. These responses and others of similar category revealed that, these candidates had limited knowledge of the iron carbon thermal equilibrium diagram.

In item (a)(ii), most of the candidates who failed, did not realize that at the temperature $T = 723^{\circ}\text{C}$, the phase changes in iron begin so it is known as eutectoid temperature or phase transformation temperature. Some of the candidates who failed this part wrote answers such as; *when steel is heated to 723 °C it involve low production of materials*. Another candidate wrote *when steel is heated to 723 °C the composition of carbon in iron increases from 0.8% to 0.87%*. Also, another candidate responded by writing *when steel is heated to 723 °C it help to make the steel change its color and shape*

In part (b), majority of the candidates failed to write the two factors which tend to cause warping and cracking of metals during quenching. Those who failed to comprehend the question in this part mentioned the types of cooling medium such as *compressed air, cold water, oil and brine*. Others understood the question but failed by providing incorrect factors such as *volume of cooling water and number of pieces to be quenched*. Such responses signified their lack of knowledge of heat treatment of metals. Extracts 13.1 and 13.2 show samples of the responses of the candidates who performed poorly in this question.

13	<p>i) A - Iron is increased in temperature. B - Iron is heated in high temperature. C - Iron is decrease for cooled. D - Iron expanded in temperature. E - Iron is cooled and can drop in the temperature.</p> <p>ii) Steel heated to temperature $T = 723^\circ\text{C}$ It help to the Making of steel in good conductor of heat and electricity and the make the metal hard in the Machine so that help to the getting of good Material supplied in the Workshop example square bar, Round tube and other Material supplied.</p> <p>b) Quenching can give the factor that cause the warping and cracking of metal during quenching. First of all are the because the Metal need to be heated in the heating furnace in order to make the metal hard and strengthen of them the metal.</p>	
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Extract 13.1: A sample of the candidate's poor response in question 13

13	<p>i) High melting point because of the metal have high melting point in the workshop</p> <p>(i) conductivity (ii) electricity (iii) ductility (iv) malleability (v) machinability.</p> <p>ii) The steel is manufactured and produced in the strong, and hardening occur.</p> <p>(b) ii) distortion 1. Solubility</p>	
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Extract 13.2: A sample of the candidate's poor response in question 13

In extract 13.1, the candidate wrote wrong compositions and characteristics of iron in the regions denoted by letters A-E. Also, he/she wrongly stated that when steel is heated to 723°C it becomes good conductor of heat and electricity. The candidate also provided unclear expressions of the factors which cause warping when quenching metals. In extract 13.2, another candidate wrote things which do not relate to the question such as the terms which represent properties of metals for (a)(i) unclear expression for (a)(ii) and wrong factors in (b).

However, the candidates who scored average marks (5 to 9 marks) were able to give relevant answers to some parts of the question. Some of them attempted all parts in the question but scored partially in each part. In part (a)(i), some of the candidates new all the phase changes that take place when steel is heated but located some of them in the wrong regions. For example, some located *pearlite and cementite* in the region marked *A* and *ferrite and pearlite* in the region marked *E* which as not correct. Other candidates in this category were able to explain the composition of the iron in the indicated regions but did not give the characteristics of the iron in each region. Also, there were others who did well in part (a) of the question but failed to give the factors which tend to cause warping of quenched metals in part (b) and vice versa. These shortcomings contributed to their average performance.

2.3.4 Question 14: Production of Engineering Materials

This question comprised three parts, (a), (b), and (c). In part (a), the candidates were required to compare cold working from hot working hot working processes by giving five points. In part (b), the candidates were required to suggest the suitable material for making each of the following components:

- (i) Base plate of a pillar drilling machine
- (ii) Blade of a power hacksaw
- (iii) Crane hooks and chains

In part (c), the candidates were required to give reasons of their choice of material in 14(b) for any two parts.

The question was opted by 225 (75.25%) candidates, whereby 49.8 percent scored from 0 to 4 marks, 28.9 percent scored from 5 to 9 marks and 21.3 percent scored from 10 to 15 marks. The total marks allotted for this question was 15. Generally, the performance in this question was average.

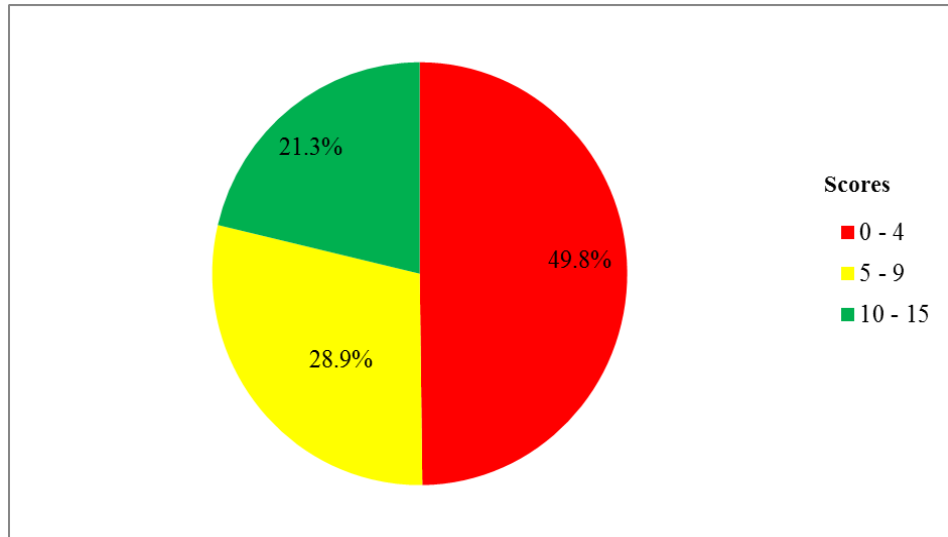


Figure 11: *The Candidates' Performance in Question 14*

Figure 11 indicates that, the general performance of the candidates in this question was average because 50.2 percent of the candidates scored from 5 to 15 marks which is average marks and above.

However, a total of 112 (49.8%) candidates who scored low marks had inadequate knowledge of Production of Engineering Materials. Those who scored from 1 to 4 marks managed to provide few relevant points in part (a) for comparison of hot and cold working or were able to suggest one or two materials in (b) without supporting their choices with reasons. Those who scored 0 mark were not knowledgeable and failed to comprehend the question as well. For example; one candidate gave the similarities of the cold and hot working by writing; *Both tend to reduce the thickness of the material, Both uses rolling mill to produce metal in various form. Both produce the same product in various form.* Moreover, another candidate responded poorly to part (a) by writing as follows: (i) *Hot rolling destroys the component while cold working does not destroy the component* (ii) *hot rolling provides unsuitable structure as required while cold rolling*

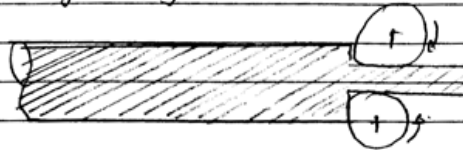
provides suitable structure as required. (ii) Hot rolling requires a lot of materials while cold rolling does not require a lot of materials. Another candidate among those who did not comprehend the question wrote unrelated things such as; *to support the metals hard, to support the colour of metals, to make the metals solid and to make the metals liquid in part (a).*

In part (b), one candidate suggested that the materials suitable for making base plate of a lathe machine power hacksaw blade, crane hooks and chains were *diamond, cast iron and aluminium* respectively. This candidate failed to realize that a baseplate of a machine is considerably large and provides support and means of mounting the machine so using diamond material could bring unnecessary high expenses. Also, the candidate failed to understand that power hacksaw blade have to retain sharp cutting edges and hardness at high temperatures the properties which are not possessed by cast iron. Likewise, the candidates did not understand that crane hooks and chains work under shock loads so need strong and tough material such as; *wrought iron* instead of *aluminium*. Another candidate suggested the suitable materials in part (b) as *plastic* for base plate of a drilling machine, *ferrous metal* and *nonferrous metal* for *hacksaw blade* and *crane hooks* respectively. This candidate also did not understand that plastic is not strong enough to support the pillar drill and did not specify the type of ferrous metal intended for a hacksaw blade. The candidate was also supposed to know that most of the nonferrous metals do not have strength to sustain the loads carried by crane hooks and chains. These responses in both parts of the question revealed that, the candidates in this category lacked knowledge of the production of Engineering Materials particularly in the area of cold and hot working of metals. Extract 14.1 is a sample of the responses from the candidate who did not understand the demand of question.

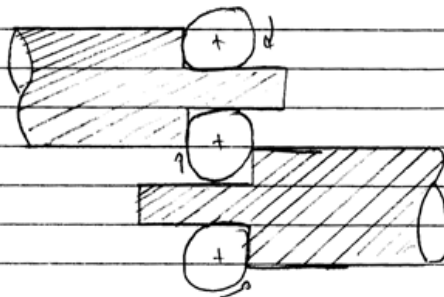
14.

⇒ Types of rolling

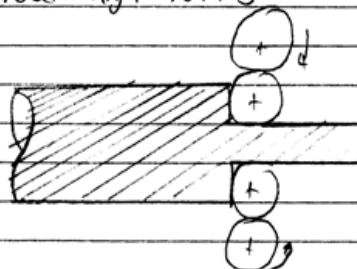
a) Two - high rolling.



b) Three high rolling.



c) Four high rolling.



There is (d) Five high rolling

(e) six high rolling

This is the working process that to application of force and to compare cold working and hot working process

i) To making smooth surface.

14.	(a) i) To producing shape	
	iii/ To increasing ability of metal.	
	iv/ To resist wear	
	v/ To building hardness of material for applying the cold and hot rolling.	
	b)(i) Pig Iron material - (Hardness)	
	ii/ Cast iron material. (malleability)	
	iii/ Cast iron material (Ductility)	
	(c) Pig iron material is the material that is produced from the Blast furnace. Pig iron is the hardness material that used to produce the pillar drill machine (Hardness material).	
	Cast iron is the material that is produced malleability and Ductility material that to force apply force to break but without breaking material.	

Extract 14.1: A sample of the candidate's poor response in question 14

In extract 14.1, the candidate failed to comply with the demand of the question thus provided sketches of the types of rolling mills while the question required the candidate to give comparison of hot working and cold working of metals in part (a). In part (b), the candidate suggested a wrong type of materials to be used for making given items and gave definitions of the terms pig iron and cast iron in part (c) instead of giving reasons of suggested materials in part (b) as the question required.

The analysis further showed that, the candidates who scored from 5 to 9 marks attempted only one part of the question while others attempted both parts but provided explanations which were missing relevant points or represented illogical points with disorganized work, therefore failed to fulfil the requirement of the question. Also, others were able to suggest the suitable materials for the given components in part (b) but failed

completely to support with reasons for their choices, consequently scored average marks.

Despite the failure of 49.8 percent, the analysis of the candidates' responses showed that, there were candidates who scored from 10 to 15 marks. Their performance revealed good understanding of the question and enough knowledge of the topic *Production of Engineering Materials* as they were able to compare cold and hot working of metals. Also, they were able to suggest the proper materials for making base plate of pillar drilling machine, identify suitable materials for blade of a power hacksaw and crane hooks and chains and give the reasons for their choice of such materials. The candidates in this category presented clear explanations to most of the items in this question.

However, their scores varied depending on the strength of their responses based on the organization of the relevant points, clarity and facts of the expressions. Extract 14.2 shows a sample of the response of the candidate with a good performance.

14.		
	COLD WORKING	HOT WORKING.
(i)	It performed while material is in cold condition.	It performed while material is in hot condition.
(ii)	It produce good surface finish on the surface of the material.	It leave scale and scratches on the surface of the material.
(iii)	It performed when metal is in below lower critical temperature.	It performed when metal is in above lower critical temperature.
(iv)	It is not easily affordable.	It's easily affordable.
(v)	It need high pressure for the work to be done and force.	It does not need high pressure and force for the work to be done.
14.	(b)	(i) CAST IRON.
		(ii) HIGH CARBON STEEL
		(iii) WROUGHT IRON
	(c)	(i) CAST IRON.
		(i) Because it is strong and tough.
		(ii) It resist corrosion.
		(ii) HIGH CARBON STEEL.
		(i) Because it can stand withstand on high temperature especially during cutting. (hardenability)
		(ii) It resist wear and corrosion.

Extract 14.2: A sample of the candidate's good response in question 14

In extract 14.2, the candidate gave five points to compare the hot and cold working. Also, the candidate made correct suggestion of the materials for making the items in question and gave correct reasons for the suggestion.

3.0 THE CANDIDATES' PERFORMANCE IN EACH TOPIC

The syllabus for Workshop Technology indicates that there are seven (7) topics but according to the examination format the paper has 14 questions, therefore some of the topics repeat in more than one question. To obtain the performance of the candidates in each topic, the average percentages were calculated for the topics which repeated in more than one (1) question.

The overall performance of candidates in Workshop technology subject for the CSEE 2019 was poor. The analysis of the candidates' responses in different topics showed that, the multiple-choice question (question 1) which was set from various topics was the only question with good performance whereby 77.3 percent of candidate performed well.

Moreover, the candidates averagely performed in the topics *Engineering Materials* (47.1%), *Production of Engineering Materials* (31.4%) and *Heat treatment* (31). The candidates lacked sufficient knowledge which could enable them perform above average in these topics.

Additionally, the candidates performed poorly in the topics of *Properties of metals* (23.1%), *Lubricants/Coolants* (11.3%), *Limits and Fits* (10,0 %) and *Identification of Metals* (7.9%) and from which the questions 2, 3, 6,7,11 and 12 were derived. During the analysis, it was observed that; inability of candidates to identify the requirements of the questions, misinterpretation of the question demand and improper use of the knowledge and skills learned to respond to the question were the causes of poor performance for these topics. Figure 12 illustrates the performance of candidates in each topic.

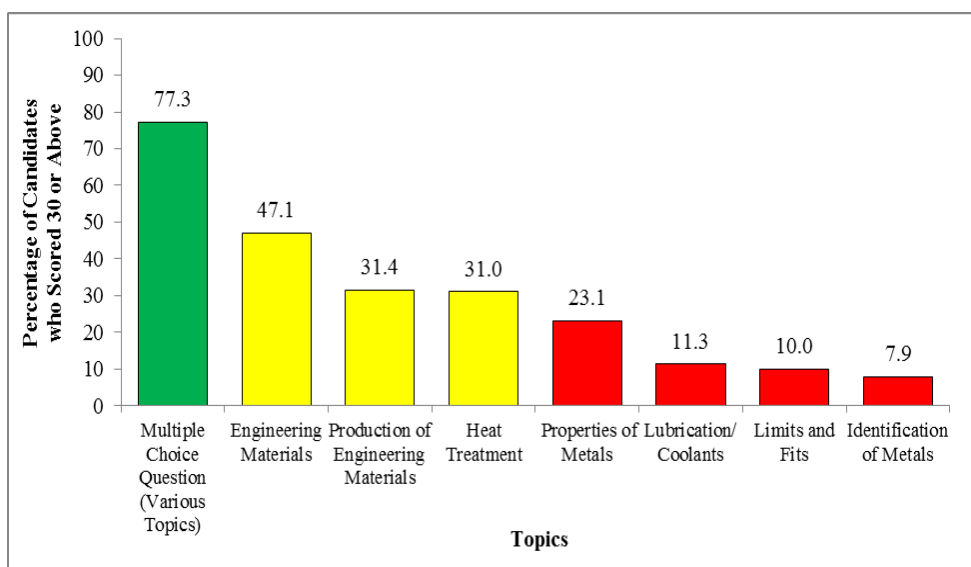


Figure 12: *The Candidates' Performance in Each Topic*

Eventually, the appendix shows the performance of candidates in each question where the red, yellow and green colours represent the question with poor performance, average performance and good performance respectively.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The general performance of the candidates in Workshop Technology for CSEE 2019 was poor because the candidates' performance was poor in 8 questions which is more than half of the given questions in that paper. (See appendix). The candidates with good performance demonstrated good understanding of the requirements of questions and had adequate knowledge on the subject matter.

The analysis of the candidates' performance in each question indicated that, the poor performance was contributed by the various factors such as; in adequate knowledge on the subject content in a specific topic, misinterpretation of the demand of the question and inability in using English language. These weaknesses led the candidates to provide answers

not correlating to the questions, partial answers and omission of some questions.

Therefore, the report has exposed the questions in which most candidates failed to give relevant responses and it has come up with suggestions, opinions and measures which can probably help to improve performance in those areas for academic excellence.

4.2 Recommendations

In order to improve the standard of performance in workshop technology subject, it is recommended that;

- (a) Students should be encouraged and guided to read various Workshop Technology books so as to improve their knowledge and skills. This will help them to avoid providing partial and fragmented answers.
- (b) Teachers and other education stakeholders' effort should be directed at improving students' English language skills, namely speaking and writing by encouraging students to participate in debates, discussion and presentation of various assignments.
- (c) Teachers should guide candidates to develop and practice drawing skills as this will help them acquire appropriate skills to draw neatly and label diagrams correctly.
- (d) Follow - up on the learning and teaching processes in schools made by Academic Masters, Head of School, Educational Quality Assurers and other Education Stakeholders should be directed at identifying and re-dressing or eliminating the shortfalls mentioned in this report.
- (e) Teachers should develop in students the culture of reading questions carefully before attempting so that they understand the requirements of a question.

Appendix

Summary of Candidates' Performance Question Wise in Workshop Technology Subject CSEE 2019.

S/N	Topic	Question Number	Percentage of Candidates Who Scored 30% or More	Remarks
1	Various topics	1	77.3	Good
2	Engineering Materials	10	55.7	Average
3	Heat Treatment	4	54	Average
4	Production of Engineering Materials	14	50.2	Average
5	Properties of Metals	2	45.1	Average
6	Engineering Materials	8	38.5	Average
7	Limits and Fits	7	21.2	Poor
8	Heat Treatment	9	19.7	Poor
9	Heat treatment	13	19.4	Poor
10	Production of Engineering Materials	5	12.5	Poor
11	Lubricants/coolants	3	11.3	Poor
12	Identification of Metals	6	7.9	Poor
13	Limits and Fits	12	1.8	Poor
14	Properties of Metals	11	1.1	Poor

