THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEMS RESPONSE ANALYSIS REPORT ON THE CERTIFICATE OF SECONDARY EDUCATION EXAMINATION (CSEE) 2022

WORKSHOP TECHNOLOGY

THE UNITEDREPUBLICOFTANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEMS RESPONSE ANALYSIS REPORTONTHE CERTIFICATE OF SECONDARY EDUCATION EXAMINATION (CSEE) 2022

092WORKSHOP TECHNOLOGY

Published by
National Examinations Council of Tanzania,
P.O. Box 2624,
Dar esSalaam, Tanzania.

TABLE OF CONTENTS

FOREWORD

This report presents Candidates' Item Response Analysis (CIRA) on Form Four National Examination which was conducted in November 2022. The report aims to provide feedback to all educational stakeholders on the factors that contributed to the candidates' performance in Workshop Technology subject.

The Certificate of Secondary Education Examination (CSEE) intends to monitor students' learning and to provide feedback that teacher, Students and other educational stakeholders can use to improve teaching and learning process. This analysis justifies candidates' performance in the Workshop Technology subject. The analysis shows that the candidates with good performance provided correct responses since they were able to identify the requirements of the questions, had adequate knowledge of the subject content, and good mastery of English language. However, the candidates with weak performance had shown contrary attributes.

This report will help to identify candidates'strengths and weaknesses so as to improve learning before sitting for their Certificate of Secondary Education Examination (CSEE). It will help teachers to identify the challenging areas and take appropriate measures during teaching and learning process.

The National Examinations Council of Tanzania (NECTA) expects that the feedback provided in this report will enable education stakeholders to take proper measures to improve teaching and learning in Workshop Technology subject. Consequently, prospective candidates will acquire knowledge, skills and competence indicated in the syllabus for better performance in future examinations.

The Council appreciates the contribution of all those who prepared this report.

Dr. Said A. Mohamed
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report focuses on the analysis of performance of the candidates on the Certificate of Secondary Education Examination (CSEE), 2022 in Workshop Technology subject. The examination paper consisted of questions which intended to measure the candidates' competencies, knowledge and skills on the subject contents as stipulated in the 1994 syllabus of Mechanical Engineering.

The paper hadthree sections namely A, B and C. Section A had one multiple choice question with ten (10) items;each carried1 mark. Section B had nine (9) short answer questions; each carried 5 marks. Section C hadfour (4) structured questions; each carried 15 marks. Candidates were instructed to answer all questions in section A and B while in section C they were required to answer three (3) questions.

A total of 231 candidates sat for Workshop Technology examination in 2022, out of which 196 (84.85%) candidates passed and 35 (15.15%) failed. In 2021 a total of 290 candidates sat for the Workshop Technology examination, out of which 205 (70.69%) passed and 85 (29.31%) failed. This indicates that there is an increase of 14.16 percent of the candidates who passed examinations in 2022 compared to 2021. Appendix II summarizes this performance.

In this report the candidates' performance in each question was considered as weak, average or good if the percentage of candidates who scored 30% and aboveranged from 0-29, 30-64 or 65-100 respectively. The poor, average and good performance are indicated by red, yellow and greencoloursrespectively. Samples of candidates' responses are inserted as extracts to represents good and weak cases. In addition, graphs and charts have been used to summarize the candidates' performance in a specific question. In the last part of the report there is Appendices which shows the general candidates' performance (question- wise) and comparison of candidates' performance (grade wise) in year 2021 and 2022.

The analysis presents the requirements of each question, candidates' strengths and weaknesses in their responses, the percentage of candidates' who attempted the question and the reasons for such performance in each group of scores. Thisinformation is useful to teachers, candidates, and other education stakeholders in identifying areas where candidates experienced

difficulties and assisting them in making decisions to improve the teaching and learning process.

2.0 ANALYSIS OF PERFORMANCE IN EACH QUESTION

This part describes the performance of the candidates in each question. The analysis covers the type of questions, topics from which the questions were constructed, demands of the questions as well as the performance of the candidates in each question.

2.1 SECTION A: OBJECTIVE QUESTIONS

This section had ten multiple choice items each carrying 1 mark, making a total of 10 marks. The scores were distributed in the following ranges: from 0 to 2.0 marks indicate weak performance; from 3.0 to 6.0 marks indicate average performance and 7.0 to 10.0 marks indicate good performance.

2.1.1 Question 1: Multiple Choice Items

This question consisted of 10 multiple-choice items, constructed from the following topics: *Production of Engineering Materials; Lubrications; Heat Treatment; Properties of Metals* and *Workshop tools and Equipment*. The candidates were required to choose the correct answer for each item (i) to (x) and write its letter in the answer booklet provided.

This question was attempted by 231 (100%) candidates out of whom 29 (12.6%) scored from 7.0 to 10 marks, 134 (58.0%) scored from 3.0 to 6.0 marks and 68 (29.4%) scored from 0 to 2.0 marks. The general performance on this question was good since 70.6 per cent of the candidates scored average and above. Figure 1 illustrates the performance on this question.

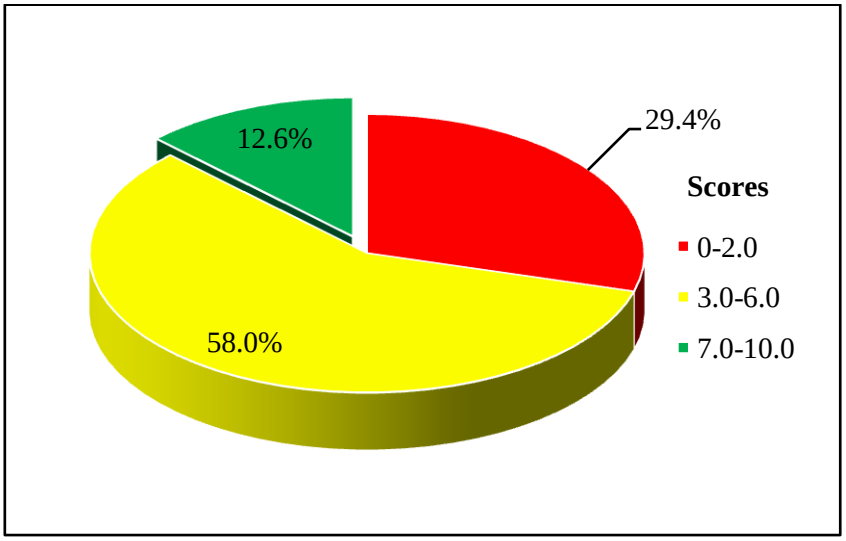


Figure 1: *TheCandidates' Performance in Question 1*

Most of the candidates were able to choose the correct answer in items (iii) and (iv) from the topics of *Properties of Metals*and *Heat Treatment*respectively. The analysis of the performance in each item shows that most of the candidates scored average marks (3.0-6.0). The following is the analysis of the candidates' performance on each item:

Item (i) was set from the topic of*Lubrications*. The question intended to measure candidates' ability to analyze the properties of material of grey cast iron in relation to lubricant during the cutting process. It required the candidates to identify the proper cutting fluid needed. The question was:

What gives the possibility of cutting grey cast iron without using cutting fluid?

A *The presence of pearlite* B *The presence of fine ferrite*
C *The presence of iron carbide* D *The presence of graphite*
E *The presence of Sulphur*

The correct answer was D,*The presence of graphite.*Candidates who chose the correct answer understood that graphite in the cast iron acts as a lubricant in itself. These candidates had adequate knowledge on the properties of material in relation to lubrication. In contrast, thecandidates who chose responses A, *the presence of pearlite*, did not know that pearlite is an iron alloy that contains around 88% ferrite and 12% cementite. Likewise,those who chose B, *the presence of fine ferrite* did not understand that the presence of fine ferrite in any material gives the magnetic properties. In addition, candidates who chose distractorC, *the presence of*

iron carbide did not know that iron carbide is an intermetallic compound of iron and carbonandfor those who chose*E, presence of Sulphur* did not understand that sulphur is an alloying element for cast iron that increases the strength and ductility. All these misconceptions reveal thatthese candidates had insufficient knowledge on properties of grey cast iron.

Item (ii) asked candidates to identify appropriate result of hot rolling process. The item was from the topic of *Properties of Metals*. The question was:

Which of the following is the result of hot rolling process?

A *Improvement of surface finish* B *Increased density of metal*
C *Improvement of ductility of metal* D *Improvement of fusibility*
E *Increased dimensional accuracy*

The correct response for this item was C, *Improvement of ductility of metal*. Candidates who chose the correct answer had enough knowledge on the properties of metals. However, candidates who chose distractorsA,*Improvement of surface finish*andE,*increased dimensional accuracy*had insufficient knowledge on properties of engineering materials and their applications.They did not understand that performing hot rolling results to poor surface finish and reduce dimensional accuracy.For those who chose response B, *Increased density of metal*were unaware that density gradually decreases when the hot rolling increases. Likewise, candidates who chose D, *improvement of fusibility* did not understand that fusibility is the process in which the metal can change from solid to liquid when their temperature is increasing.

Item (iii) required candidates to identify the process used to modify mild steel shaft with soft core and hard outside skin. The item was set from the topic of *Heat Treatment*. The question was:

Suppose you are working in a heat treatment workshop and a steel shaft with soft core and hard outside skin is required. Which process will you use to modify mild steel to suit the purpose?

A *Normalizing* B *Carburizing* C *Hardening*
D *Tempering* E *Annealing*

The correct answer was B, *Carburizing*. The analysis shows that most of the candidateschose the correct alternative due to an adequate knowledge onheat treatment of metals and their properties. They knew that only carburizing heat treatment process makes the outer surface of steel hard and

less hardness in the core.On the other hand, few candidates who chose distractors A, C, DandE had little knowledge on heat treatment processes. These candidates ought to know that normalizing aims to give the steel a uniform and fine-grained structure.Hardening of the steel increases the strength and toughness while annealing is the process of softening a material to obtain desired chemical and physical properties. Tempering helps to relieve stress making the metal easier to weld or machine.

Item (iv) required the candidates to determine the method of material testing suitable for deformation of material at constant load below its yield strength. The item was from the topic of *Properties of Metals*. The question was:

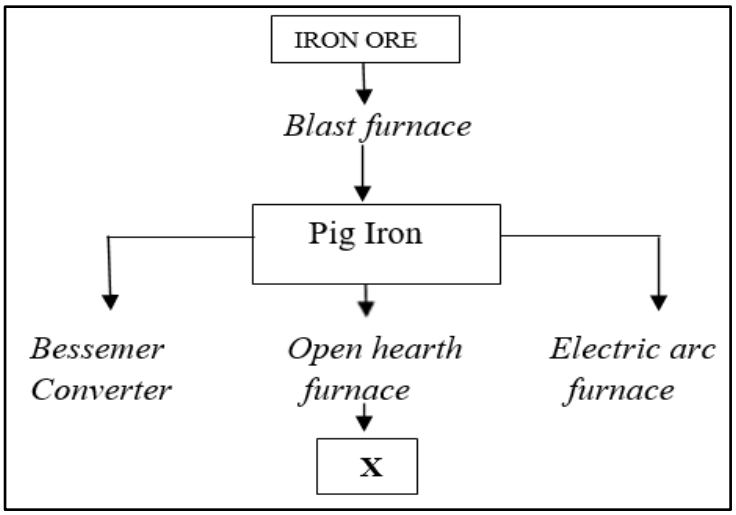
Which method of material testing suitable for determining the deformation of material at constant load below its yield strength?

A *Creep testing* B *Tensile testing* C *Compression testing*
D *Fatigue testing* E *Hardness testing*

The correct response for this item wasA, Creep testing.Majority of candidates chose the correct alternative. This reveals that they had enough knowledge onmethods of material testing. However, there were few candidates who chose distractors B, C, D, andE. This shows that they had insufficient knowledge on methods of material testing. These candidates did not understand that *tensile, fatigue* and *compression testing*are the methods of material testing in which the load is varying during testingof material while *hardness testing*is a test method that involves applying a constant load but measured to determine the hardness of the material.

In item (v), the candidates were required to identify product X from open hearth furnace. The question measures the ability of candidates to select the proper products of metal profile obtained through the process of extraction. The item was set from the topic of *Production of Engineering Materials*. The question was:

What is the product represented by letter X in Figure 1?



A *Blister steel* B *Tool steel* C *Shear steel*
D *Crucible steel* E *General purpose steel*

Few candidates who chose the correct answer E, *General purpose steel*applied the knowledge on production of engineering materials to determine the correct steps in production of general purpose steel from iron ore. However, most of the candidates randomly chose distractors A, B, C, and E. The candidates who chose A, *blister steel* did not understand that blister steel produced by heating wrought iron placed in contact with carbon.Those who chose C,*Shear steel* did not know that shear steel was produced by cutting and rolling the blister steel sheets together at high temperature. For those who chose B, *tool steel* and D, *crucible steel*, they did not understand that crucible is a process or technique used to produce tool steel.These candidates did not understand that general purpose steel isproduced from the pig iron by using open hearth furnace.This shows that they had insufficient knowledge and skills on the production of materials from iron ore. Still, they were unaware with functions of three furnaces namely Bessemer, open hearth and electric furnaces.

Item (vi) was extracted from the topic *Properties of metal*. Candidates were required to identify the function of silicon in cast iron. The question was:

What is the function of silicon in cast iron?

A *To promote graphite nodule formation and improve the ductility of cast iron.*

B *To promote graphite flake formation and increase fluidity of the molten metal.*

C *To promote graphite nodule formation and increase fluidity of the molten metal.*

D *To increase fluidity of the molten metal and improve the ductility of cast iron.*

E *To increase graphite flake formation and improve the ductility of cast iron.*

In this item, most of the candidates were able to choose the correct answer B, *to promote graphite flake formation and increase fluidity of the molten metal.*Candidates who chose the correct answer had adequate knowledge on engineering materials as they were able to determine the function of silicon in cast iron. On the other hand, those who chosealternativesA, C, DandEhad insufficient knowledge on positive effect of silicon in cast iron. Most of them confused the sentences*to promote* or *to increase graphite flake* and *to increase* or *to improve the ductility of the molten metal or cast iron*. This shows that they had little knowledge on properties of metal.

Item (vii) was extracted from the topic of*Production of Engineering Material.* It tested the ability of the candidates to identify the process used in production of bottles from thermoplastic material. The question was:

Which of the following processes is used to make bottles from thermoplastic materials?

A *Compression molding* B *Extrusion* C *Injection molding*
D *Blow molding* E *Transfer molding*

The item required the candidatesto determine theprocess used tomake bottlesfrom thermoplastic materials. The correct answer was D,*Blow molding.* Candidateswho chose the correct answerwere able to apply the knowledge on production process of engineering materials to determine different types of plastic and process used to make bottles. However, candidates who chose alternative A, *Compression molding*did not understand that compression molding is usedin manufacturing of automotive parts such as hoods and fenders. Those who chose B,*Extrusion* did not understand that it is a manufacturing process used to produce drinking straws thus, they failed to differentiate the drinking straws and bottles.For those who chose C, *Injection molding*did not know that injection molding is a manufacturing process for producing electrical housings, containers and bottle caps. Moreover, those who chose distracter E,

*Transfer molding*did not understand that transfer molding is used to make medical components such as syringe tips, grommets, tool holders, and parts for complex machinery used in surgery or life support. All these misconceptions reveal that candidates had inadequate knowledge on production process specifically types of mold used in different materials.

In item (viii), candidates were required to identify type of material used to produce cutting tools likelydrills, saw and milling cutters. The item was extracted from the topic of*Properties of Metal*. The question was:

Suppose you are a technician working in the factory which produces cutting tools e.g drills, saws and milling cutters; what type of material will you order for that purpose?

A *High speed steel* B *High carbon steel* C *Cast iron*
D *Mild steel* E *Silver steel*

The correct response was A, *High speed steel.* The candidateswho chose the correct response were aware that initially all cutting tools were made of high carbon steel but replaced to high speed steel due to its ability to maintain hot hardness in hot conditions and wear resistance. On the other hand, most of them chose distractorB, *High carbon steel.* This reveals that they were not aware of the convention from high carbon steel to high speed steel. For thosewho chose alternativesC, *Cast iron*they did not understand that due to the high strength of cast iron it is mostly used in machine parts like engine hence it cannot be used in a cutting material. For those who choseD, *Mild steel*did not know itis used inmachinery and automobile manufacturing. The candidateswere ought to understand the properties of different metals and its applications.

Item (ix) required the candidates to choose the correct statement about failure occurred in markinga hole on the cemented carbide surface by using center punch. The question intended to measure the candidates' ability to select appropriate tools and equipment as per activity to be done. The question was set from the topic of *Tools and Equipment*and was as follows:

A candidate used a center punch to mark a hole on the cemented carbide surface but failed. What could be the reason for the failure?

A *The surface was too slippery* B *The surface was casted*
C *The surface was too big in size* D *The center punch blunt*
E *The surface was harder than the center punch*

The correct response was E,*The surface was harder than the center punch.* Most of the candidates chose the correct response in this item. These candidates had adequate knowledge and skills on tools and equipment.However, few candidates chose distractors A, B, CandD. Those who chose A, *The surface was too slippery*did not understand that the cemented carbide surface cannot be slippery. In addition, those who chose B, *The surface was casted* were wrong because the casted surface has no effect on punching process and those who chose C, *The surface was too big in size* they were incorrect because centre punch does not depend on the size of the surface in marking a hole. Likewise, those who chose distractor D, *The centre punch blunt*were also wrong because any centre punch must have a pointy end that is utilized in making large indentations in a work piece. These candidates did not understand that the cemented carbide is one of the hardest engineering materials ever produced; hence they were supposed to know that the surface was too hard than the centrepunch used. This shows that the candidates had insufficient knowledge on properties of material as well as tool and equipment.

Item (x) was extracted from the topic of*Limits and Fits*. It intended to measure the ability of candidates to identify the system of assembling a number of unit taken at random to build a complete mechanism. The question was:

Which term denotes a system of assembling a number of unit components taken at random from stock so as to build up a complete mechanism or machine?

A *Tolerance* B *Allowance* C *Interchangeability*
D *Serviceability* E *Deviation*

The correct response was C,*Interchangeability.* Candidates who chose the correct response had adequate knowledge on limits and fits particularly on the process of assembling number of units to make a complete machine.In contrast, candidates who chose distractors A, B, D and E failed to apply the knowledge on limits and fitto determine the term which denotes a system of assembling a number of unit components to build a complete machine. In addition, they did not know that *serviceability* is the simplicity of the machine to be repaired or maintained; also *tolerance* is the total amount a dimension may vary and is the difference between the upper and lower limits. However, they had to understand that*allowance* is the difference between the basic dimensions of the mating parts and *deviation* is a process

condition outside of established design limits, safe operating limits, or standard operating procedures.

2.2 SECTION B: SHORT ANSWER QUESTIONS

This section had nine (9) compulsory short-answer questions set from the topics of *Production Engineering materials, Properties of Metal, Identification of metals, Lubrications, Heat Treatment* and *Limits and Fits.* Each question carried five(5) marks, making a total of 45 marks. In this section the scores were distributed in the following ranges: from 0 to 1.0 mark (weak), from 2.0 to 3.0 marks (average) and 4.0 to 5.0 marks (good). The analysis of each question is as follows:

2.2.1 Question 2: Production Engineering Materials

This question comprised of two parts(a) and (b). Part (a) required the candidates to classify metal heating furnace according to the fuel used. Part (b) required the candidates to mention two instruments used to measure furnace temperatures.

This question was attempted by 231(100%) candidates whose scores were as follows: 99 (42.9%) scored from 0 to 1.0 mark, 98 (42.4%) scored from 2.0 to 3.0 marks and 34 (14.7%) scoredfrom 4.0 to 5.0marks. Figure 2 illustrates the candidates' performance in this question.

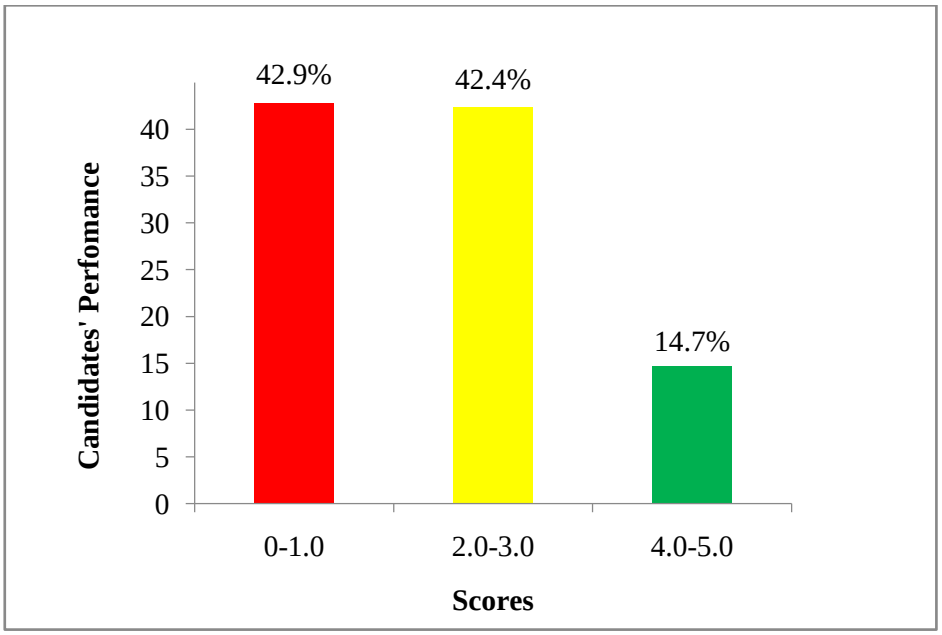
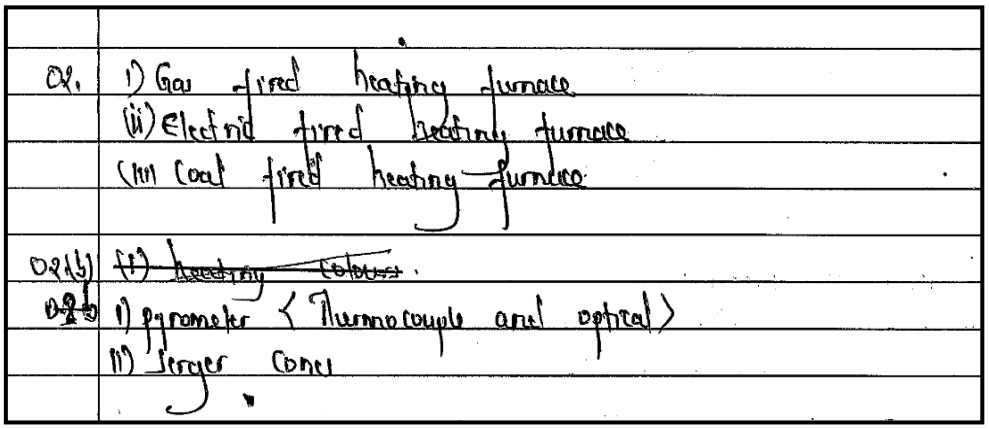


Figure 2: *TheCandidates' Performance in Question 2*

Generally, the performance of the candidates in this question was average because 67.1 per cent of the candidates scored average and above.The candidates with good scores (4.0-5.0 marks) managed to classify metal heating furnaces according to the fuel used as required in part (a).

In part (b), the candidates correctly described the instruments used to measure the furnace temperature during the operation. This shows that they had enough knowledge onProduction of Engineering Materials. Extract 2.1 is a sample of good responses from one of the candidate's script.



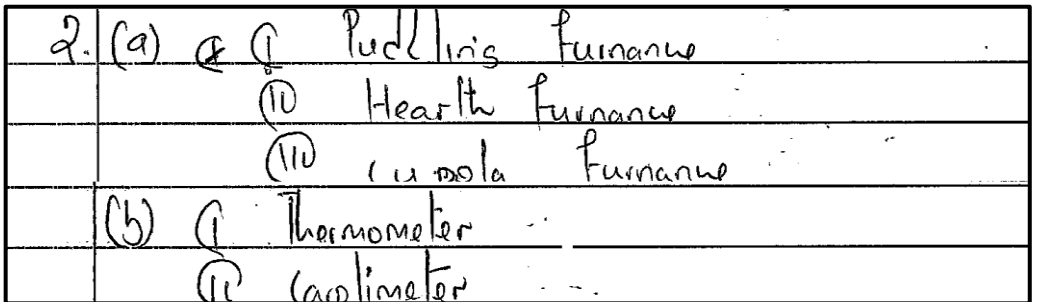
Extract 2.1: Asample of a good responsesto Question 2

In Extract 2.1, candidates provided correct classifications of furnance according to the fuel used. Also in part (b), he/she gave clearly instruments used to measure furnance temperature.

The candidates (42.4%) who scoredaverage marks (2.0 to 3.0) had partial knowledge on production of engineering materials. Most of them providedincorrect response in either part (a) or (b). For example, in part (a) one candidate wrote: *blast furnaces* and *Bessemer* instead of providing the type of fuel used on those furnaces. In part (b), he/she provided the correct instruments for measuring temperature. Others provided one or two correct classification of furnace in part (a) or instruments used to measure the furnace temperature in part (b). For example, in part (a) one candidate wrote: *blast furnace which uses coke as fuel* but repeated the same response in (ii) and (iii) and in part (b) he/she provided two correct instruments used to measure furnace temperature.

On the other hands, most of the candidates (42.9%)who scored low marks provided incorrect responses inpart (a) and (b) due to insufficient knowledge on the concept of production of engineering materials. For example, in part (a) one candidate provided the methods of heat treatment

such as: *annealing*, *normalizing*, and *tempering* instead of classifying the furnaces according to the fuel used. In part (b), he/she provided incorrect instruments such as: *pyromiter*. Other candidatesmisinterpreted the question's demand. For example, in part (a), one candidate listed the type of gas furnace such as *single stage and double stage furnace* instead of classifying the furnace according to fuel used. In part (b), another candidate listed the instruments used to measure body temperature such as *forehead thermometer* and *oral thermometer*, instead of writing the instrument used to measure temperature on the furnace. All thesewrong answersrevealthat the candidates' inadequate knowledge on subject matters. Extract 2.2 is a sample ofincorrect responses given by one of the candidates in this question.



Extract 2.2: Asample of the candidates' poor response toQuestion 2

In Extract 2.2, the candidate provided general industrial furnace instead of categories of furnace based on fuel used in part (a). In part (b), he/she failed to specify the type of thermometer as demanded by the question.

2.2.2 Question 3: Properties of Metals

The question required the candidates to explain why cast iron is extensively used in industries for making various machine parts. The question intended to measure the candidates' ability to identify the properties of cast iron to make various machine parts.

A total of 231 (100%) candidates attempted this question, out of whom91 (39.4%) scored from 0 to 1.0 mark, 94 (40.7%) scored from 2.0 to 3.0 marks and 46 (19.9%) scored from 4.0 to 5.0 marks. Figure 3summarizes these performances.

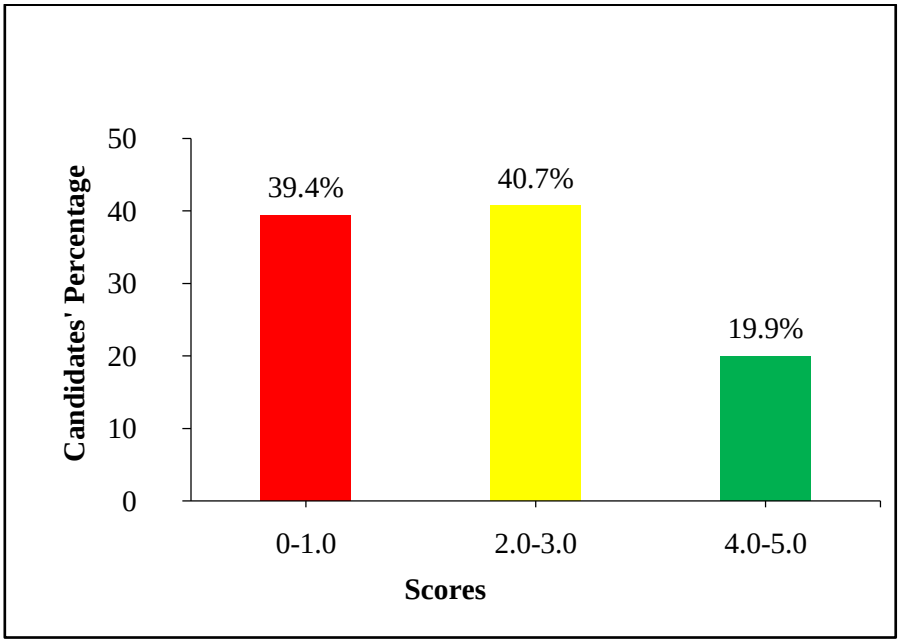
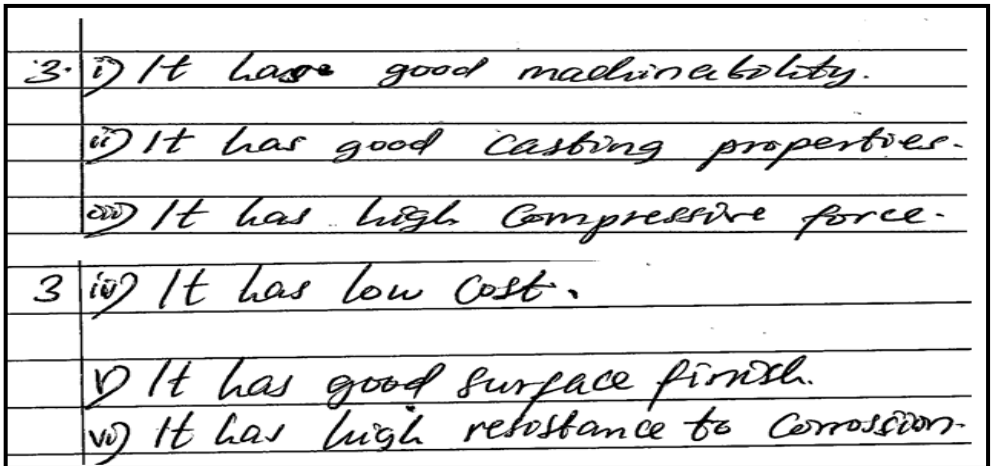


Figure 3: *TheCandidates' Performance in Question 3*

The general performance in this question was average since 60.6per cent of the candidates scored average and above.

The candidates (19.9%) who scored good marks (3.5-5.0) providedcorrect reasons for using cast iron in industries as a material for making machine parts. These candidates had clear understanding on the properties of cast iron. Extract 3.1is a sample of good responses provided by a candidate.

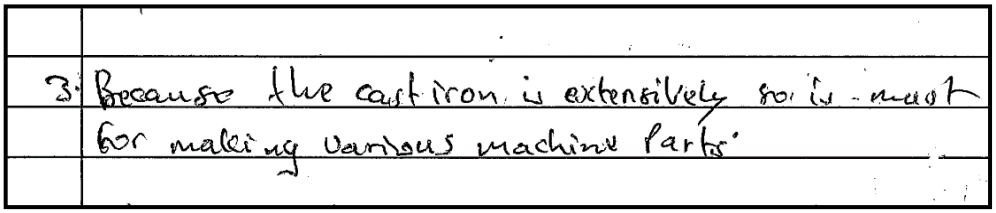

3. i) It has good machinability.
ii) It has good casting properties.
iii) It has high compressive force.
3 iv) It has low cost.
v) It has good surface finish.
vi) It has high resistance to corrosion.

Extract 3.1: A sample of good responsesto Question 3

In Extract 3.1, the candidates provided correct properties of cast iron which is used in industries for making various machine parts.

In addition, most of the candidates who scored average marks (2.0 to 3.0) had partial knowledge on production of engineering materials as well as properties of metals. Some candidates in this categoryprovided correct responses from one to two properties of cast iron out of five as demanded by the question. For example, one candidate wrote three correct properties of cast iron but mixed with incorrect properties such as *cast iron is ductile*.

In contrast, the analysis shows that 39.4 per cent of the candidates who scored low marks (0-1.0) had insufficient knowledge on the concept of production of engineering materials. Some of the candidates did not understand the demand of the question as they provided irrelevant responses. For example, one of the candidates wrote: *it is because cast iron produces a large number of tough, ductile and malleable metals.* Another candidate wrote: *cast iron is extensively used in industries for making groups*. In addition, most of them provided incorrect properties of cast iron. For example, one candidate wrote: *cast iron is soft*. Another candidate copied the question as a response such as *it is most applicable*. Extract 3.1 shows poor response from the candidatewho scored low marks.



Extract 3.2: Asample of poor responses toQuestion 3

In Extract 3.2, the candidate copied the question as a response instead of writing the properties of cast iron.

2.2.3 Question 4: Production of Engineering Material

This question had two parts, (a) and (b). In part (a) the candidates were required to explain three factors they will consider in order to select appropriate materials for a particular work in mechanical engineering.In part (b),they were required to classify the engineering materials into two main groups.

The question was attempted by 231(100%) candidates, out of whom83(35.9%) scored from 4.0 to 5.0marks, 98(42.4%) scoredfrom 2.0 to 3.0marksand 50(21.7%) scored from 0 to 1.0 mark. This performance is summarized in Figure 4.

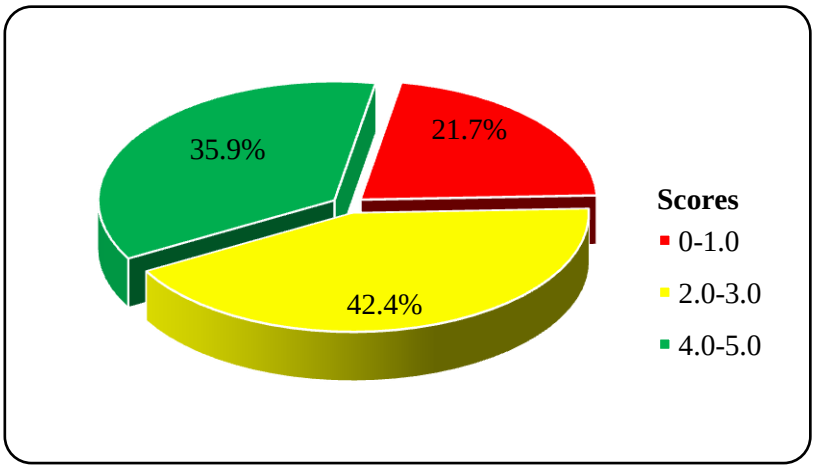
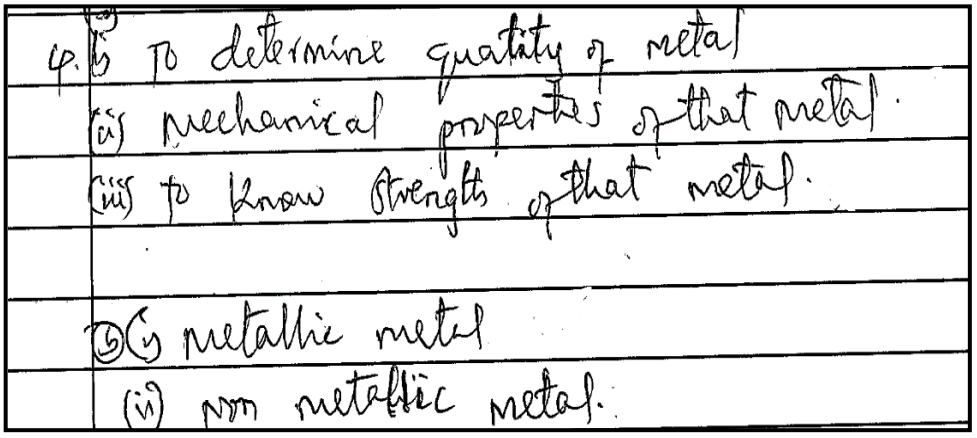


Figure 4: *TheCandidates' Performance inQuestion 4*

In general, the candidates' performance in this question was good since 183 (78.4%) of the candidates scored average and above.

The analysis shows that 35.9 per cent of the candidateshad good marks (4.0-5.0). The candidates in this group provided correctlythe factors to be considered during selection of material and classifications of engineering materials. These candidates had sufficient knowledge on the production of engineering material. Extract 4.1 is a sample of good responsestoQuestion 4.



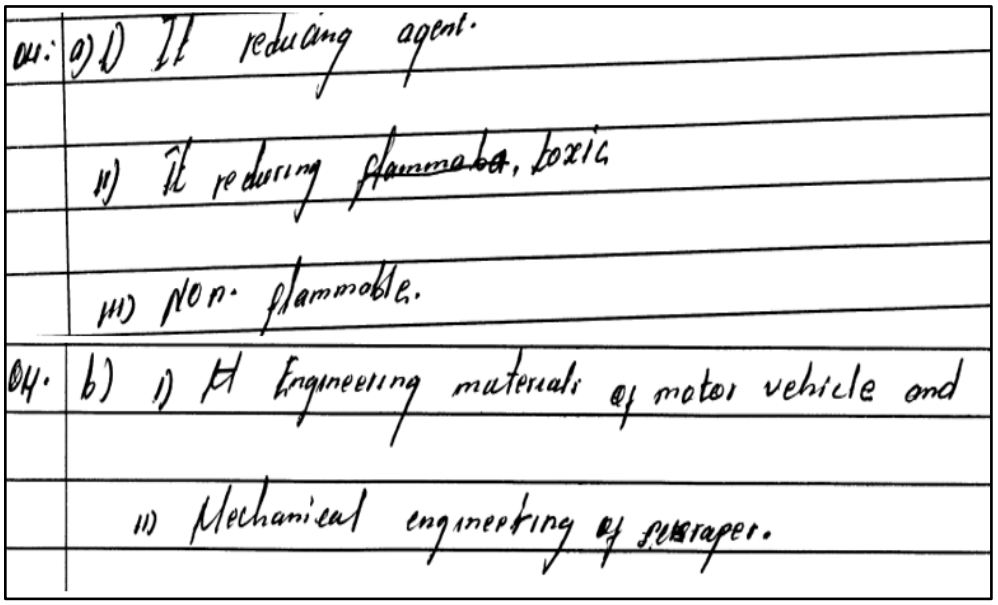
Extract 4.1: Asample of good responses to Question 4

In Extract 4.1, the candidate provided the correct factors for selection of metals for a particular work and in part (b) he/she provided correctly two classifications of engineering materials.

However, candidates who scored average marks (2.0-3.0) had partial knowledge on production of engineering materials. Most of them

explainedone or two correct factors for selection of metals in part (a) and other candidates provided correctly the two classifications of engineering materials in part (b). For example, one candidate provided two correct factors in part (a), but in part (b) wrote incorrect classifications such as *work and complex engineering materials.*

On the other hand, 21.6 per cent of the candidatesscored low marks (0-1.0), out of whom 13.4 per cent scored 0. These candidatesprovided incorrect factors for selection of materials and groups of engineering materials. For example, one candidate provided the properties of metal such as *toughness of the metal, malleability of the metal* and *ductility of metal* instead of writing the factors for selection of materials. This candidate did not understand that each metal has its own properties. Other candidates did not understand the demand of the question as they provided irrelevant responses. For example, in part (a) one of the candidates wrote: *drills, saws* and *milling cutters* instead of writing the factors for selection of metals. In part (b), he/she wrote *ferrous* and *non-ferrous metals* instead of metals and non-metals. This candidate did not understand that ferrous and non-ferrous metals are the types of engineering materials in the group of metals. All these misconceptions imply that the candidates lacked the knowledge on production of engineering materials.Extract 4.2 showsa sample of incorrect response from one of the candidates in this question.



Extract4.2: Asample of poor responses to Question 4

In Extract 4.2, the candidate provided irrelevant factors for selection of materials as well as incorrect classifications of engineering materials. This candidate did not understand the demand of the question in both parts.

2.2.4 Question 5: Identification of Metals

This question had two parts, (a) and (b). The question intended to measure the candidates' ability to comprehend the phenomenon on differentiating the metal combination to form the alloys in part (a). Part (b) required the candidates to identify the correct alloying elements.The question was:

(a) What alloys are formed by the combination of the following metal?
- *(i) 60%tin, 10%antimony, 1.5% copper and 28.5% lead*
- *(ii) 88% copper, 10% tin and 2% zinc*
- *(iii) 65%tin and 35%lead*

(b) What type of alloying element is required in each of the following cases?
- *(i) Alloying with steel to obtain material; for making excavator bucket for earth moving machine.*
- *(ii) Alloying with steel to make it cut other metals at high temperatures.*

This question was attempted by 231 (100%) candidates. The analysis indicates that 187 (80.9%) scored from 0 to 1.0 mark, 36(15.6%) scoredfrom 2.0 to 3.0 marks, and 8(3.5%) scored from 4.0 to 5.0 marks. Figure 5represents these scores.

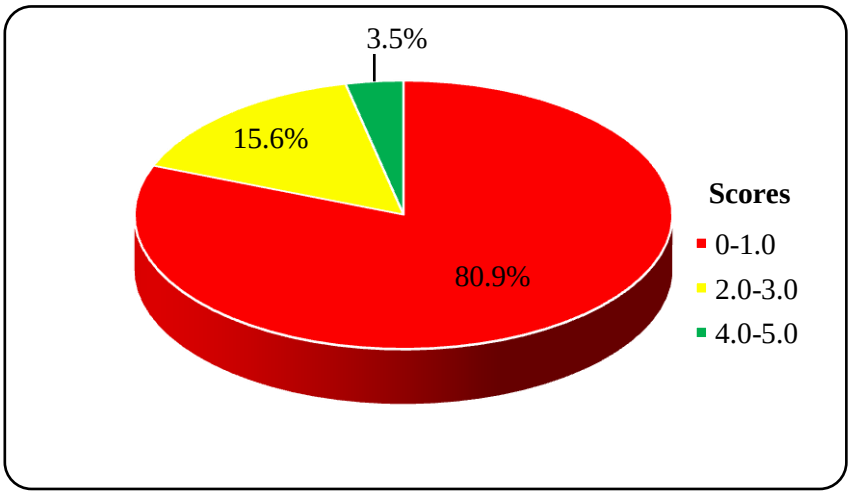
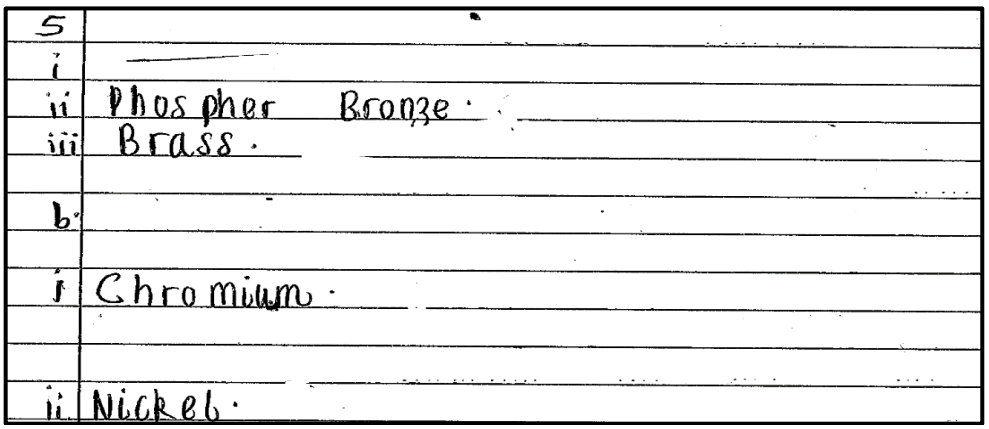


Figure 5: *The Candidates' Performance in Question 5*

Figure 5 shows that, thecandidates' performance in this question was weak since 80.9 per cent of the candidates scored below average.

Data analysis shows that among the 80.9 per cent of the candidates who scored low marks, 42.0 per cent scored 0. The candidates' in this category had insufficient knowledge on physical identification of metals particularly alloy of metals. Most of them provided incorrect responses. For example, in part (a) one candidate wrote *bronze as an alloy of 60% tin, 10% antinomy, 1.5% copper and 28.5% lead* also *brass as an alloy of 88% copper, 10% tin and 2% zinc*. This candidate did not understand that bronze is an alloy of 88% copper and 12% tin with an exception of zinc. Also brass is an alloy of copper and zinc, with small percentages of tin, lead and other elements. In part (b), candidates did not understand the demand of the question. Most of them provided irrelevant elements. For example, one candidate wrote *zinc as an element added in steel for making excavator bucket for earth moving machine instead of manganese*and *carbonas element added in steel to make it cut other metals at high temperature* instead of tungsten material. Further analysis from the candidates' responses reveals that most of candidates confused the metals with similar characteristics like zinc which can be used in most machines due to its characteristics of good corrosion resistance. The candidates had to know the specific characteristics of each metal, an alloy metals with its percentage and application of each metal. Extract 5.1 shows a sample of weak responses from the candidate's script.

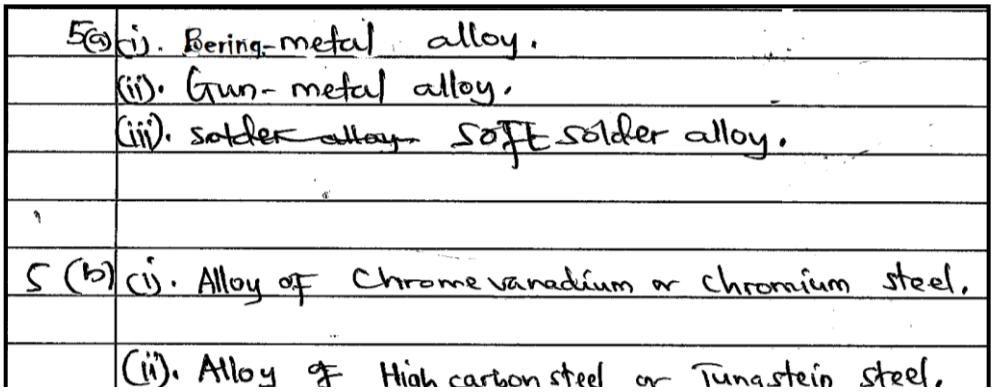


Extract 5.1*:* Asample of poor responses to Question 5

InExtract 5.1, the candidate wrote incorrect elements which are bronze and brass instead of gun metal and soft solder respectively. In part (b), he/she wrote irrelevant elements added in a steel to make excavator bracket and to cut other metals at high speed. This candidate did not understand that nickel-metal is used in manufacturing of batteries which are used in hybrid vehicles.

Despite the weak performance in this question, there were 15.6per cent of the candidates who scored average marks (1.5 to 3.0). These candidates were familiar with physical identification of some alloys of metal as they provided one to two correct alloys formed by the combinations given in part (a) while in part (b), some wrote incorrect type of alloying element in the given two cases. For example, in part (a) (iii) one candidate wrote correct metal but provided incorrect responses in (i) and (ii). Others wrote incorrect alloys in part (a), but correct alloying element in part (b).

However, 3.5 per cent of the candidates who scored good marks applied the knowledge on physical identification of metal to determine the alloys formed in the composition of different metals in part (a) as well as to identify the type of alloying element required for the given two cases in part (b). These candidates scored 4 marks out of 5 marks allotted to this question. Some of them provided all correct responses in part (a) but in part (b) wrote the correct alloy element in either (i) or (ii). This reveals that most of the candidates did not understand clearly the use of some metals. Extract 5.2 is a sample of goodresponses.


5(a) (i). Bering-metal alloy.
(ii). Gun-metal alloy.
(iii). ~~solder alloy~~ Soft solder alloy.
5 (b) (i). Alloy of Chrome vanadium or Chromium steel.
(ii). Alloy of High carbon steel or Tungstein steel.

Extract 5.2: A sample of good responsestoQuestion 5

In Extract 5.2, the candidate provided correct alloys used to form the compositions of metals given in part (a). In part (b) (ii), he/she wrote the correct element which is added in a steel to make it suitable to cut other metals at high temperature but provided incorrect element in (i) by saying chromium steel instead of manganese.

2.2.5 Question 6: Identification of Metal

This question comprised of two parts, (a) and b). Part (a) requiredthe candidates to explain thecolour codes indicated in metal identifiedbyblue, yellow and red colour and in part (b), they were required to decide the correct appearance colours of the high speed steel and copper materials.

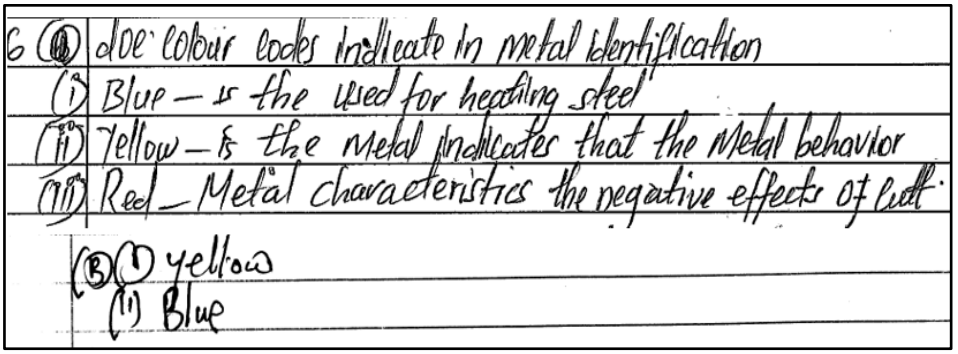
This question was attempted by 231 (100%) candidates.Data analysis shows that, 194 (84.0%) scored from 0 to 1.0 mark, 36 (15.6%) scored from 2.0 to 3.0 marks, and 1(0.4%) scored 4.0 marks. Table 1 illustratesthese performances.

Table 1: Candidate's Performance in Question 6

Scores Range	**0 – 1.0**	**2.0– 3.0**	**4.0 – 5.0**	**Total**
Performance	Weak	Average	Good	
Number of Candidates	194	36	1	231
Percentage (%)	84.0	15.6	0.4	100

Table 1shows that the general performance in this question was weak since 84.0 per cent of the candidates scored below average.

Data analysis shows that among 194 (84.0%) candidates who scored low marks, 44.2 per cent scored 0 marks. Most of these candidates provided incorrect responses in all parts of the question. For example, in part (a) one candidate wrote: *blue used as coding colour for copper, yellow used as coding high speed steel, red used as coding colour for dangerous*. The candidate confused thered colour used in warning signs to indicate danger with the colour code used in identification of metals.In part (b), he/she wrote*: yellow* and *blue* as colour code for high speed steel and copper respectively instead of silvery white and reddish-brown colour respectively. Other irrelevant answersprovided were, in part (a) one of the candidates wrote: *blue is the metal that needs the presence of luminous, yellow is a type of metal does not need too much heat* and *red is the metal need too much heat for the identification*. The candidates were supposed to write the materials in which the colour codes represents such as blue represents alloys steel, yellow represents mild steel and red represents high carbon steels. All these wrong answersreveal that they had inadequate knowledge on identification of metals by colour code.Extract 6.1 is a sample of incorrect responses from the candidate's script.

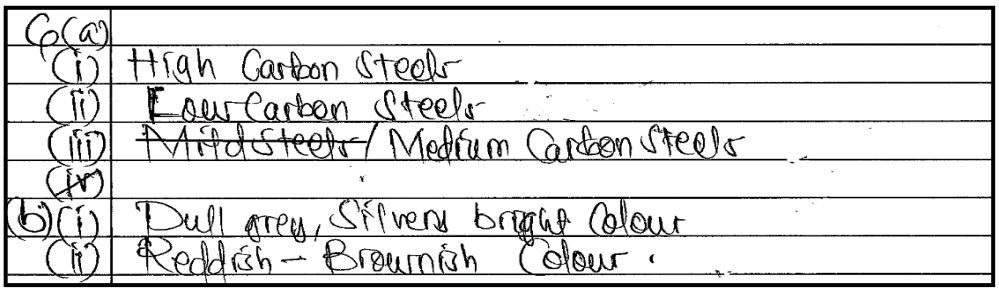


Extract 6.1: A sample of candidates'weak responsesto Question 6

In Extract 6.1,the candidate wrote incorrect indications of the colour codes such as *blue is used for heating steel* instead of blue is used as coding colour for the alloy steel. Also he/she wrote irrelevant responses in identifying yellow and red colours instead of writing the materials for the givencolourcodes. In part (b) the candidate copied the colour codes from part (a).

Some of thecandidates who scored average marks (2.0-3.0) provided one to two correct indications of the colour code given in part (a) but provided incorrect colour codes in part (b). Others provided correctly the colour codes in part (b) but failed to provide correct colours in high speed steel and copper material.

Despite the poor performance of the candidates in this question, one candidate scored 4.0 marks. This shows that he/she had adequate knowledge and skills about the identification of metals as he/she provided the correct metals of thecolour codes provides in part (a) as well as the colours of the materials in part (b). This candidate scored 4 marks out of 5marks allotted to this question due to the confusion between blue and red colours. He/she wrote: *blue colour indicates high carbon steel* instead of alloy steel. Extract 6.2 portrays responses of the candidate who scored 4.0 marks.



Extract 6.2: Asample of candidates'good responses to Question 6

In Extract 6.2, candidatemanaged to apply the concepts on identification of metal to determine the materials in which the colour codes indicated as well as writing the correctcolours of the materials but provided incorrect metal in part (a) (i) by writing *highcarbon steel* instead of alloy steel.

2.2.6 Question 7: Lubrication

This question required the candidates to explain five advantages of using chemical cutting fluids. The question intended to measurethe candidates' ability to identify and explain the advantages of using cutting fluid during machining.

A total of 231 (100%) of the candidates attempted this question and their scores were as follows: 23 (9.9%)scoredfrom 0 to 1.0 mark, 39 (16.9%) scoredfrom 2.0 to 3.0 marks, and 169 (73.2%) scored from 4.0 to 5.0 marks. These performances are depicted in Figure 6.

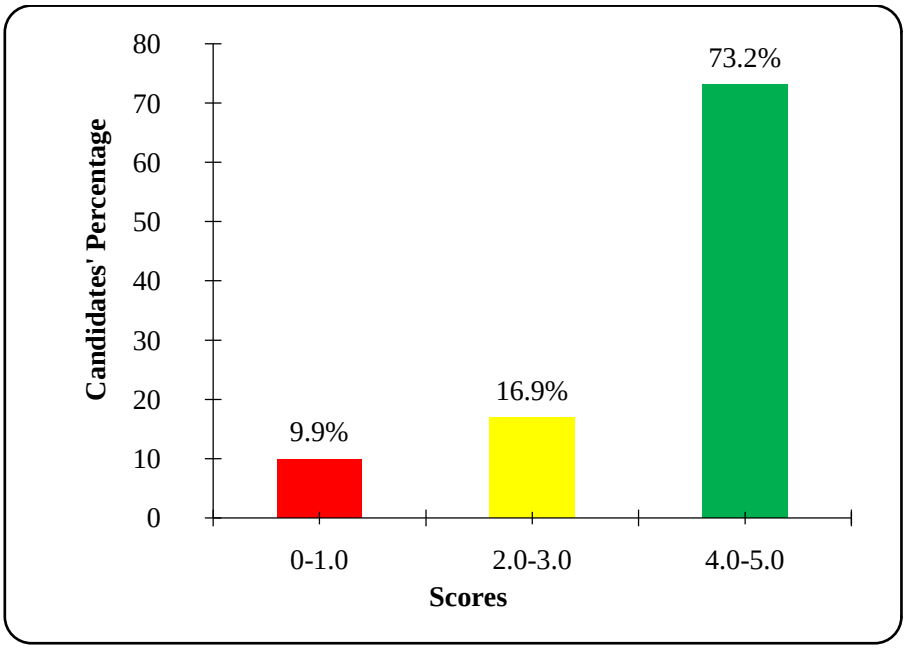
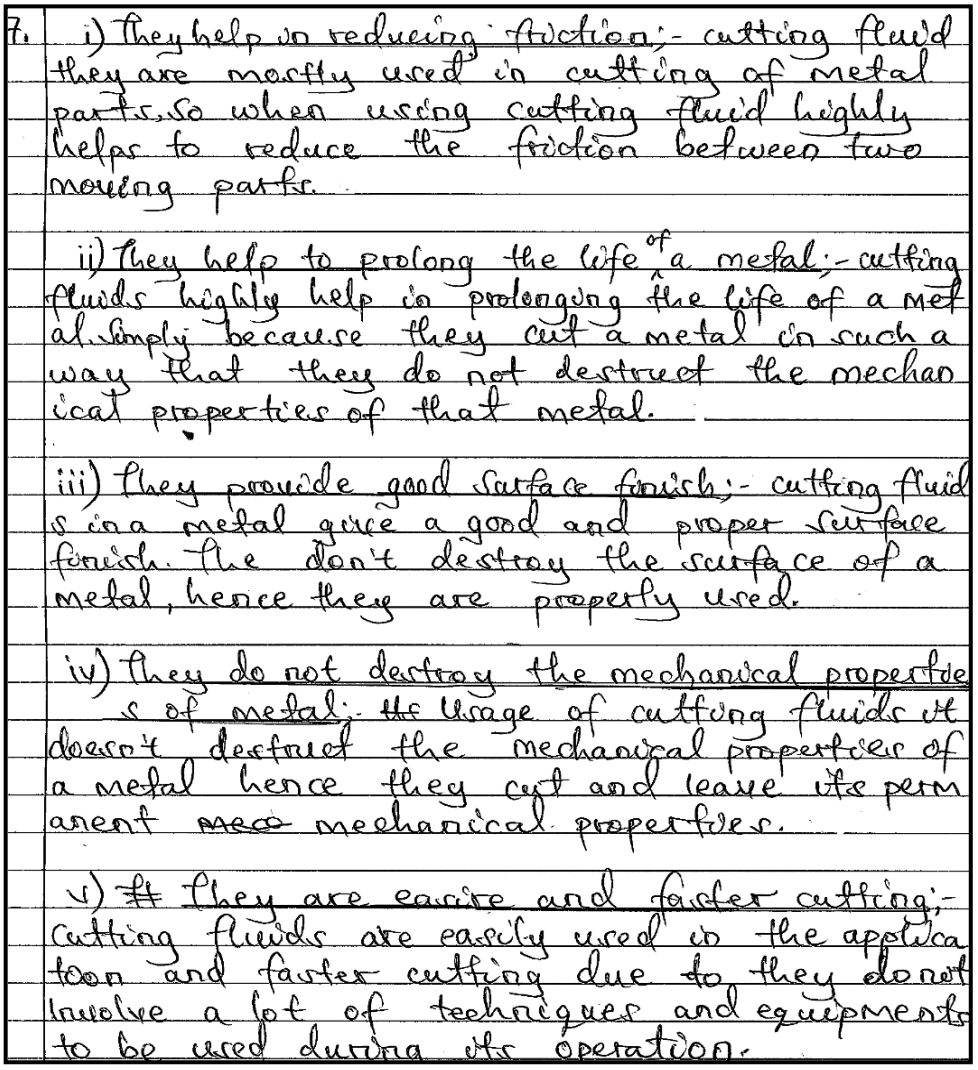


Figure 6: *TheCandidates' Performance in Question 7*

In general, theperformanceofthecandidatesinthis question wasgood because 90.1 per centofthecandidatesscoredaverage and above.

The candidates whoscored good marks(4.0 to 5.0) provided precisely the benefits of using chemical cutting fluid during machining process.These candidates had an adequate knowledge and skills on lubrication specifically lathe machine in which chemical cutting fluids is inevitable.Few candidates

lost some marks due to partial explanation. Extract 7.1,portrays a sample of good responses.


7. i) They help in reducing friction;- cutting fluid they are mostly used in cutting of metal parts, so when using cutting fluid highly helps to reduce the friction between two moving parts.

ii) They help to prolong the life of a metal;- cutting fluids highly help in prolonging the life of a metal. Simply because they cut a metal in such a way that they do not destroy the mechanical properties of that metal.

iii) They provide good surface finish;- cutting fluids in a metal give a good and proper surface finish. The don't destroy the surface of a metal, hence they are properly used.

iv) They do not destroy the mechanical properties of metal;- the Usage of cutting fluids it doesn't destroy the mechanical properties of a metal hence they cut and leave its permanent ~~mec~~ mechanical properties.

v) ~~#~~ They are easire and faster cutting;- Cutting fluids are easily used in the application and faster cutting due to they do not involve a lot of techniques and equipments to be used during its operation.

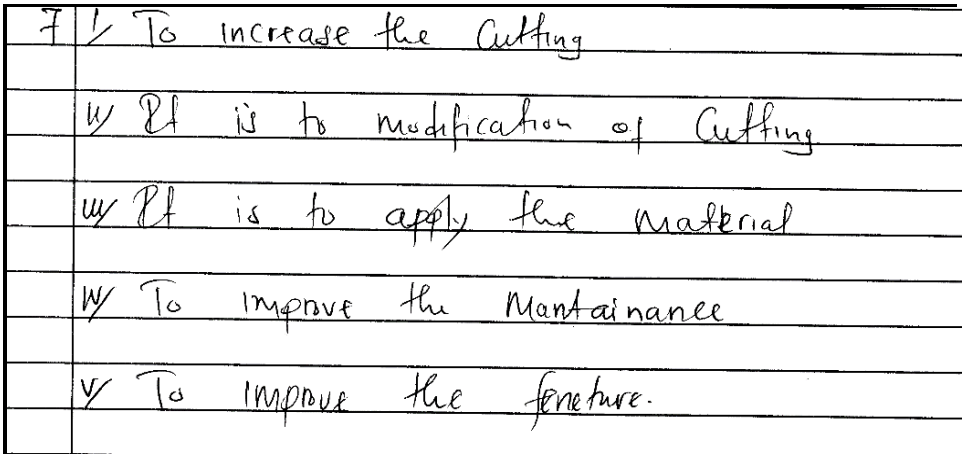
Extract 7.1: Asample of the candidates'good responsesto Question 7

In Extract 7.1, the candidate provided correct advantages of using chemical cutting fluid.

Furthermore, 16.9 per cent of the candidates who scoredaverage marks (2.0-3.0) provided at most three correct advantages of chemical cutting fluids out of five as required. Others had minor errors in their explanations hence ended up scoring average marks.These candidates had little knowledge and skills on application of chemical cutting fluids.

Conversely, 9.9 per cent of the candidates who scored low marks (0-1.0) had inadequate knowledge and skills on lubrication. For example, one

candidate wrote: *ensure safety process, presence of cementile, presence of austerite*. Another candidate copied the distractors from question 1 (vi) and (ix) such as: *the presence of graphite nodule formation increase, nodule formation and improve ductility, the surface was harder than center punch, the surface was too slippery.* Another candidate wrote:*briefly explain five advantage*and *quenching medium in heat treatment*instead of providing the advantages of chemical cutting fluids. These candidates were supposed to write the advantages of using chemical cutting fluids which are: to improve surface finish, facilitate chip cleanliness during cutting process, remove noise during cutting process, elongate cutting tool life span and increase speed of cutting. Extract 7.2 shows a sample of weak responses from the candidate'sscript.



Extract 7.2: Asample of incorrect responses to Question 7

In Extract 7.2, the candidate provided incorrect advantages of using chemical cutting fluid. This candidate had little skills on application of chemical cutting fluid.

2.2.7 Question 8: Heat Treatment

This question had two parts, (a) and (b). In part (a), the candidates were required to explain the three methods used for heating steel during case hardening. In part (b), they were required to give the advantage of using air as a quenching medium in heat treatment.

This question was attempted by 231 (100%) candidates, where 136 (58.9%) scored from 0 to 1.0 mark, 70(30.3%) scored from 2.0 to 3.0 marks and 25(10.8%) scored from 4.0 to 5.0 marks. Figure 7 presents a summary of candidates' scores in this question.

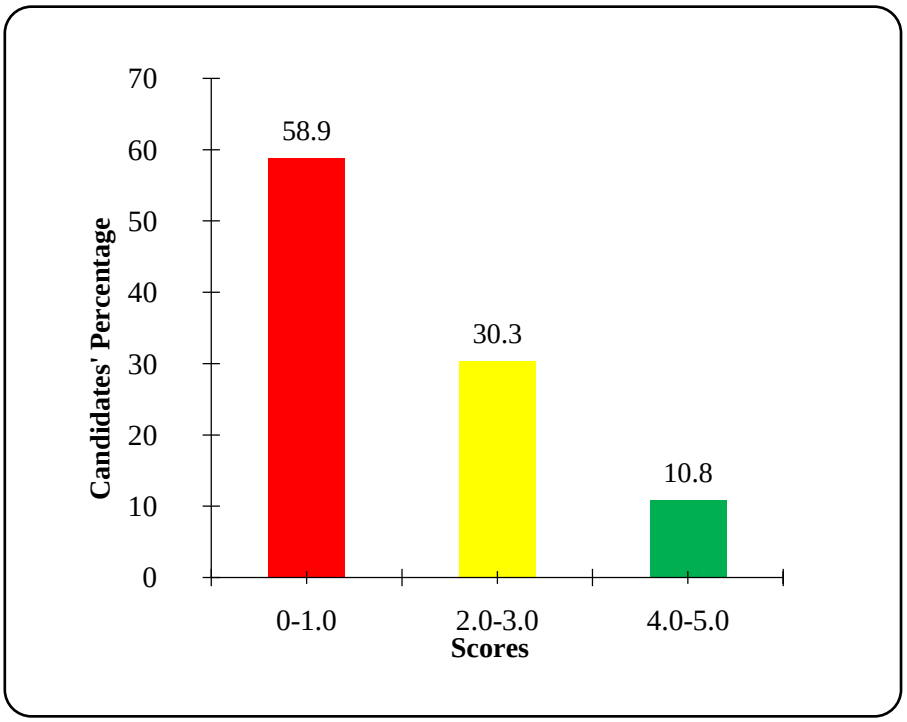
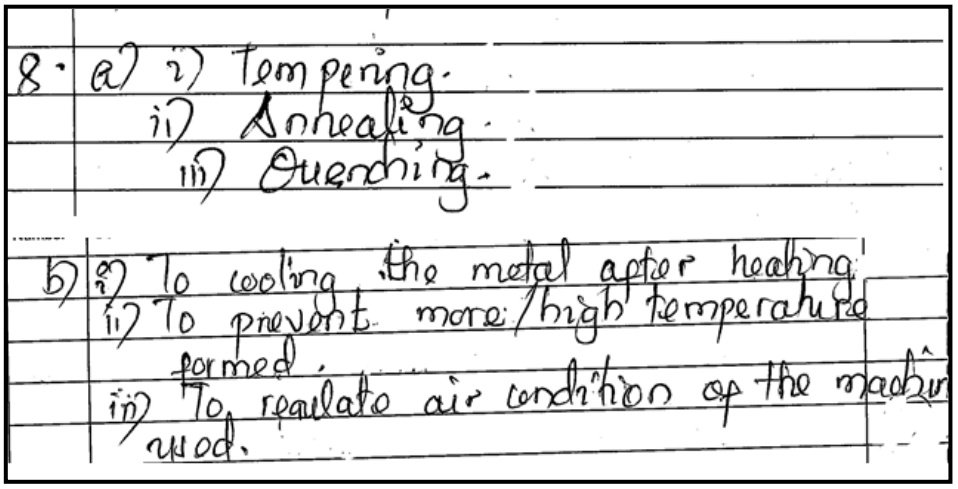


Figure 7:*The Candidates' Performance in Question 8*

Figure 7 shows that the general candidates' performance in this question was average since 41.1 per centof the candidatesscoredaverage and above.

Further analysis shows that 52.4 per cent of the candidates scored 0. This shows that most of the candidates were not familiar with the concept of heat treatment particularly methods of heating metals during case hardening. Also they did not understand the quenching medium in heat treatment. For example, in part (a) one candidate wrote the advantage of case hardening of steel such as: *improve the machinability of a metal* instead of providing methods of heating steel during case hardening. In part (b), he/she wrote: *in using air as quenching medium it reduces cost compared to the one who use oil*.Others wrote irrelevant answers. For example, in part (a) one candidate wrote: *alloying hardening, ore hardening, coke hardening*. In part (b), he/she wrote *it produce ductility, to produce grain and size treatment* and *to increase strength and hardening*. These candidates were ought to know that heating methods used for hardening are induction heating, flame heating and electron beam heating.In part (b), the advantage of air as quenching medium in heat treatment is that it gives desired property due to the slow cooling.Extract 8.1 shows a sample of incorrect responsesfrom the candidate's script.

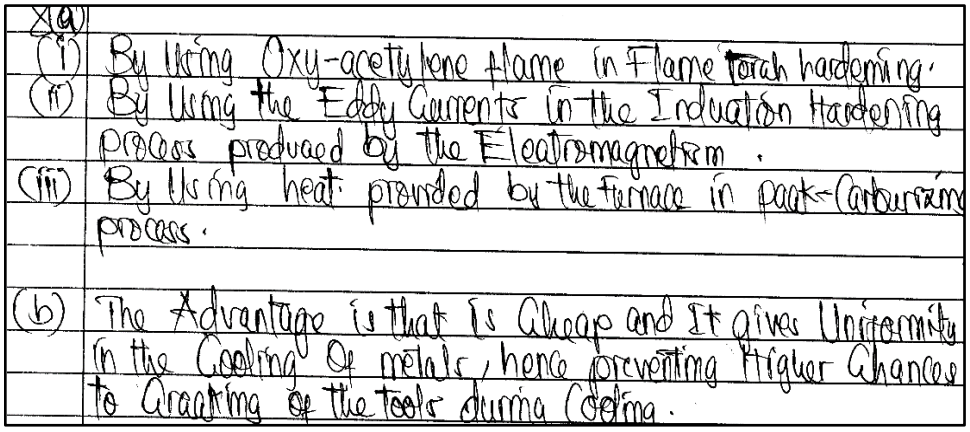


Extract 8.1:A sample of candidates'weakresponse to Question 8

Extract 8.1shows that, in part (a) the candidate provided the heat treatment processes instead of writing methods for heating steel during case hardening. In part (b), he/she provided irrelevant advantages of using air as a quenching medium in heat treatment.

Furthermore, the candidates who scored average marks (2.0 to 3.0) wrote one to two correct methods of heating steel while others provided correct advantage of using air as a quenching medium. These candidates had little knowledge on heat treatment.

On the other hand, few candidates 25 (10.8%) whose performances were good provided correctly three methods used for heating steel during case hardening.Alsothey showed their competencies in explaining the advantage of using air as the quenching medium in heat treatment. Extract 8.2is a sample of good responses.



Extract 8.2: Asample of good responsesto Question 8

In Extract 8.2, the candidate provided correct methods for heating steel during case hardenings as well as advantage of using air as a quenching medium in heat treatment.

2.2.8 Question 9: Limits and Fits

This question had two parts, (a) and (b). In part (a), the candidates were required to explain three techniques in assembling the components if the hole and the shaft are made with interference fit. Part (b) required the candidates to state the uses of plug and snap gauges.

A total of 231 (100%) candidatesattempted this question, out of whom 168 (72.7%) scored from 0 to 1.0 mark, 55(23.8%) scored from 2.0 to 3.0 marks and 8 (3.5%) scored 4.0marks. Figure 8illustrates these performances.

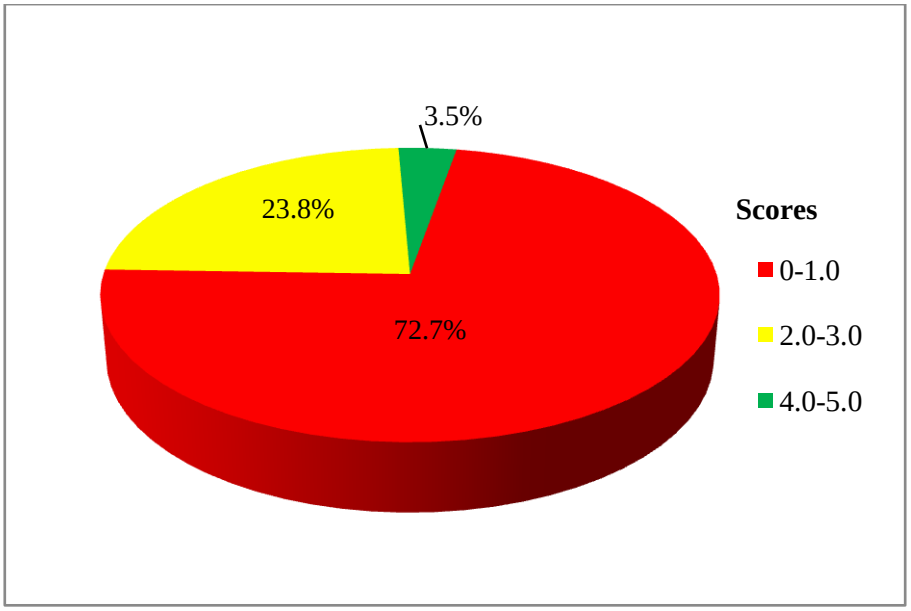
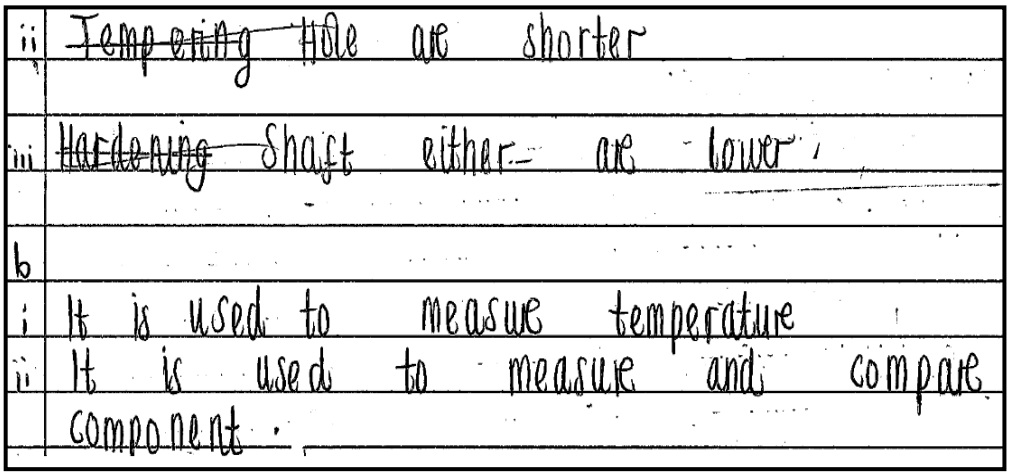


Figure 8: *TheCandidates' Performance in Question 9*

The analysis shows that the general performance in this question was weak because 72.7 per cent of the candidates scored below average.

The data analysis shows that 51.9 per cent of the candidates who scored0 had insufficient knowledge and skills on limits and fits. These candidates provided incorrect explanations on techniques used to assemble the shaft and hole with interference fits. For example, in part (a) one candidate wrote: *taking the shaft into the hole, taking the hole out the shaft* and *by making the hole large than shaft*. This candidate was not aware that interference fit is a fit where there will always be overlap in the joint

between shaft and hole, even at the minimum material condition values allowed by the shaft and maximum value allowed by the hole tolerance values.In part (b), he/she wrote: *plug gauge is used to measure plugs* and *snap gauge is used to measure snaps*. Also he/she did not understand the terminologies plug and snap. Other candidates did not understand the demand of the questions as they provided irrelevant responses in parts (a) and (b). For example, in part (a) one candidate wrote: *size, length and depth*. Extract 9.1 shows a sample of the candidates' weak responses.



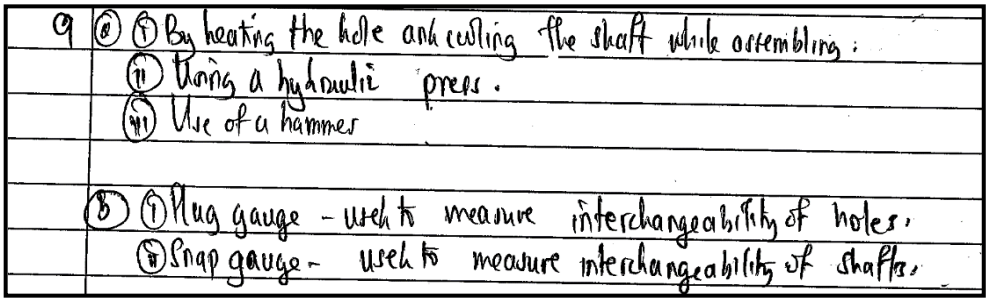
Extract 9.1: Asample of weak responses to Question 9

Part (a) of Extract 9.1 shows that the candidate wrote reasons which hinder the assembling the components if shaft and hole are made of interference fit instead of giving three techniques of assembling the components if shaft and hole are made of interference fit.In part (b), he/she provided incorrect uses of the plug and snap gauges.

In addition, the candidateswho scored average marks (2.0-3.0)had partial knowledge and skills on limits and fits as they provided correct responses in either part (a) or (b).

However, 3.5 per cent ofthe candidatesmanaged to apply the skills and knowledge of limits and fits to determine the techniques used to assemble the components when the shaft and a hole are made of interference fit. Also they were able to determine the uses of snap and plug.All candidates in this category scored 4 out of 5marks allotted to this question due to partial explanation on the techniques used in assembling components. Others provided two correct techniques out of three needed. For example, one candidate mixed incorrect techniques in part (a) such as *process that refine*

grain particles.Extract 9.2 shows a sample of good responsesof the candidatewho scored 4.0 marks.



Extract 9.2: A sample of poor responses toQuestion 9

Part (b) of Extract 9.2 shows that,the candidate explained the correct meaning of snap and plugs gauges. In part (a), he/she provided two correct techniquesof assembling the shaft and a hole made of interference shaft. This candidate scored 4 marks because he/she provided incorrect technique in part (a) such as *use of hammer*. It is wrong technique because hammer is not a recommended tool as it can distract the physical properties of material.

2.2.9 Question 10: Properties of Metal

The question required the candidates to explain the behavior of a metalhaving the following properties (a) toughness (b) ductility (c) malleability (d) brittleness and (e) elasticity. It tested the candidate's ability to understand the physical properties of materials.

The question was attempted by 231 (100%) candidates, where 59 (25.54%) scored from 0 to 1.0 mark,56 (24.24%)scored from 2.0 to 3.0 marks and 116 (50.22%) scored from 3.5 to 5.0 marks.These data are summarized in Figure 9.

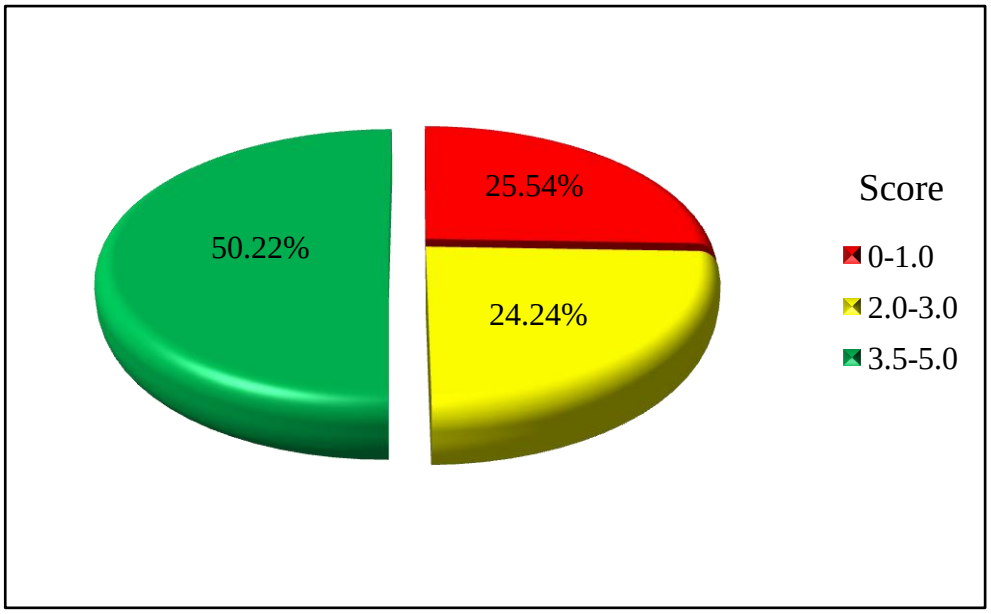
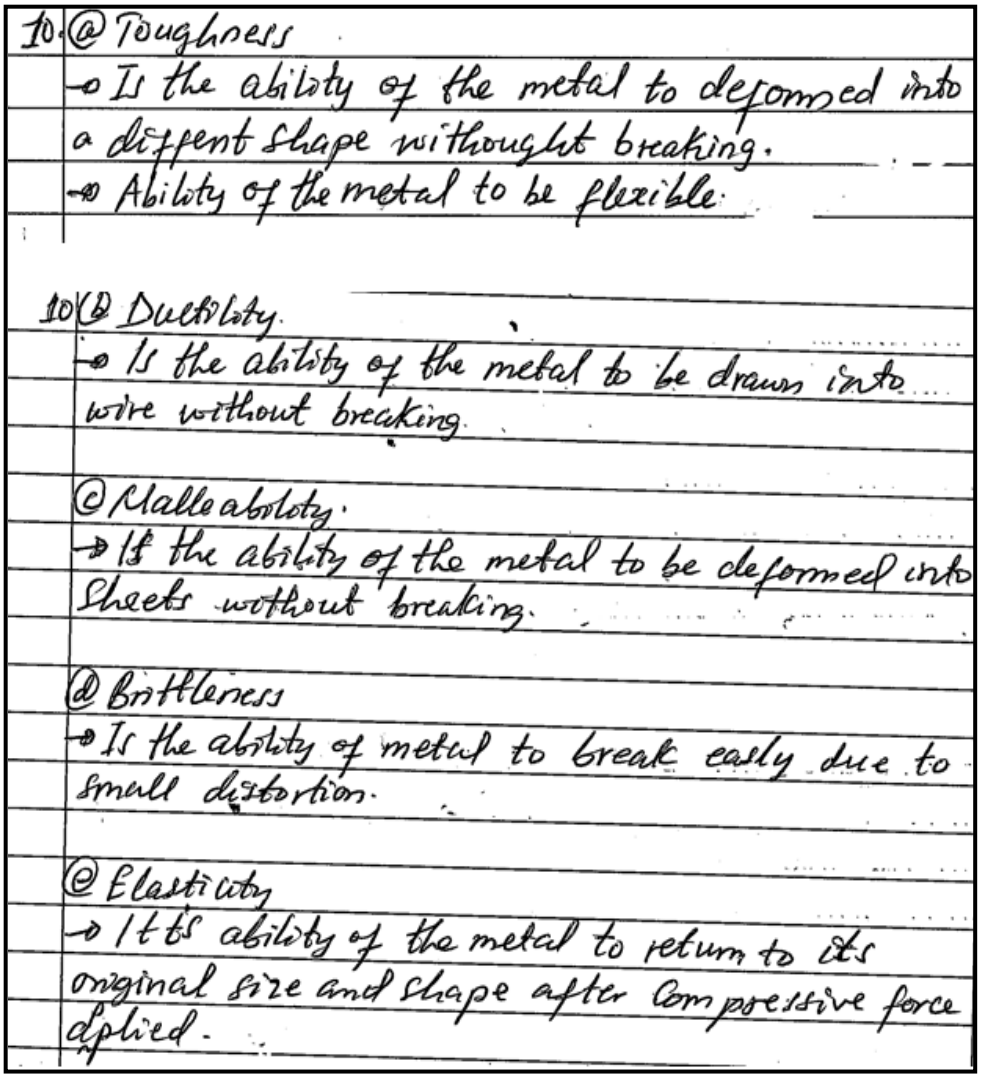


Figure 9:*The Candidates' Performance in Question 10*

Figure 10showsthat theperformance in this question wasgoodsince 74.46 percent of the candidates scoredaverage and above.

The 50.22 percent of the candidates scored good marks (4.0-5.0) due to an adequate knowledge on the concept properties of metal. Most of the candidates in this category provided the correct behavior of a metal in given properties. In addition, they understood clearly the demand of the question as they provided relevant responses in each property. Few of them had minor errors in their explanation which resulted in loss of some marks. Extract 10.1 depicts the good responses from the script of a candidate.


10 (a) Toughness
→ Is the ability of the metal to deformed into a diffent shape withought breaking.
→ Ability of the metal to be flexible.

10 (b) Ductility.
→ Is the ability of the metal to be draws into wire without breaking.

(c) Malleability.
→ Is the ability of the metal to be deformed into sheets without breaking.

(d) Brittleness
→ Is the ability of metal to break easly due to small distortion.

(e) Elasticity
→ It is ability of the metal to return to its original size and shape after compressive force aplied.

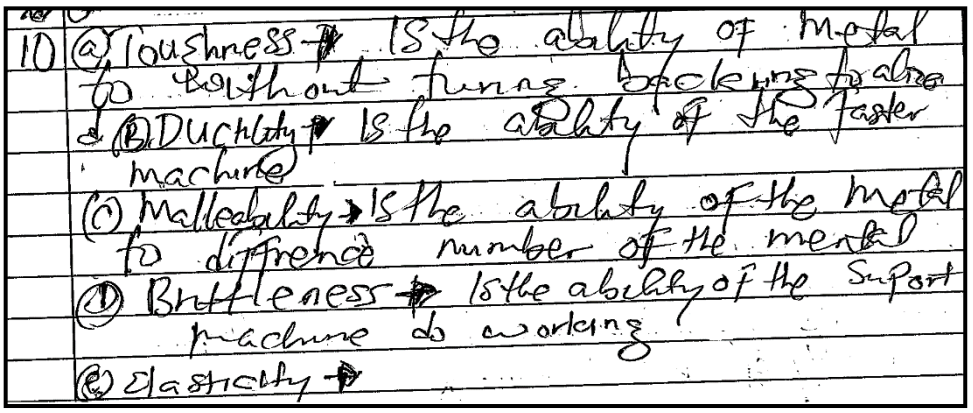
Extract 10.1: A sample of good responsestoQuestion 10

In Extract 10.1, the candidate extracted the knowledge on properties of metals and wrote the correct behavior of the metal having the properties of toughness, ductility, malleability, brittleness and elasticity.

The candidates who scored average marks (2.0-3.0) had partial knowledge on properties of metal as they managed toprovide some of the correct metal behavior of the properties given.

On the other hand, most of the candidates who scored low marks (0-1.0) lacked the knowledge on the properties of metal. Others did not understand the demand of the question as they provided irrelevant responses. For example, one candidate wrote: *toughness-harder in nature, ductility- they are ductile, malleability-they are malleable, brittleness-they are brittle,*

Elasticity- they are elastic. Extract 10.2 shows a sample of the candidates' incorrect responses.


10 (a) Toughness → Is the ability of metal to bolthout turns backwards to allow
(B) Duchlity → Is the ability of the faster machine
(C) Malleability → Is the ability of the metal to difference number of the mental
(D) Brittleness → Is the ability of the support machine do working
(E) Elasticity →

Extract10.2: Asampleofincorrect responses to Question10

In Extract 10.2, the candidate provided incorrect behavior of the properties of the metal given in each part.

2.3 SECTION C: STRUCTURED QUESTIONS

This section had four questions set from the topics of *Limits and Fits, Production of Engineering Materials,* and *Lubrication*. The candidates were required to answer three questions from this section;each question carried 15 marks making a total of 45 marks.In this section the scores were distributed in the following ranges: From 0 to 4.0 marks (weak), from 4.5 to 9.0 marks (average) and 9.5 to 15 marks (good).

2.3.1 Question 11: Production of Engineering Material

This question had four parts, (a), (b), (c) and (d). Part (a) required the candidates to explain the following material as usedin production of cast iron; (i) limestone (ii) coke (iii) iron ore (iv) scraps of steel. Part (b) required the candidates to explain the processes carried out in the production of metals: (i) casting of metals (ii) rolling of metals. Part (c), required them to determine four types of iron ores found in the earth crust andin part (d), the candidates wererequired to explain two commonmethods used in extracting (mining) iron ores in the earth crust.

The question was opted by 215 (93.1%) out of 231 candidates who sat for this examination. The analysis of candidates' performance shows that 71 (33.0%) scored from 0 to 4.0marks, 92 (42.8%) scored from 4.5 to 9.0 marks and 54 (24.2%) scored from 9.5 to 15marks. Figure 10 represents these performances.

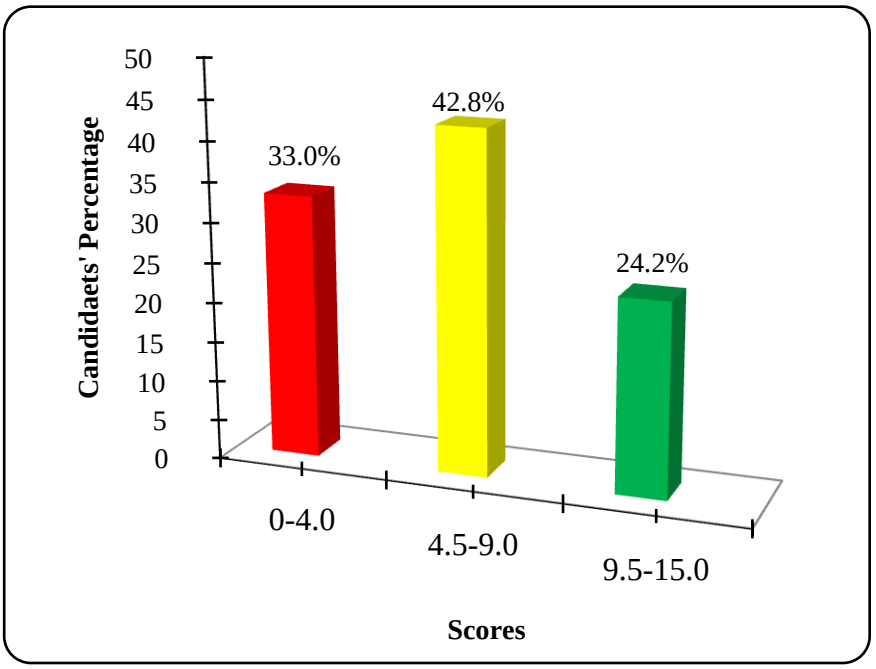


Figure 10: *The Candidates' Performance in Question 11*

Generally, the performance of the candidates' in this question was good because 67.0 per cent of the candidates scored average and above.

The candidates (24.2%) whoscored good marks (9.5-15.0) hadadequate knowledge on the concept of production of engineering material specifically in the production of pig and cast iron. In addition, they understood clearly the demand of the questions in each part as most of them provided correct responses in each part. Extract 11.1isa sample of good responses from one of the candidates.

11. a.

i, Limestone, is one among the raw materials for the production of cast iron in such that it functions to act as a flux to remove sand from the iron ore (Hematite) in form of a liquid slag. It helps to separate impurities (such as silicon and sulphur) from the mixture.

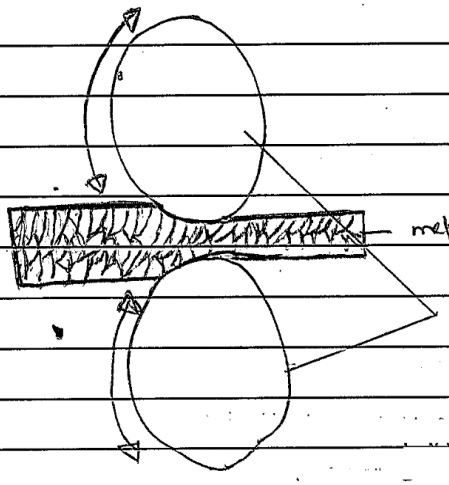
ii, Coke, is one among the raw materials for the production of cast iron in such that is firstly put in the cupola furnace so as to lit in such that, it acts as a fuel to provide heat for smelting as it also reduces iron oxide and carbonates to spongy mass of iron.

iii, Iron ore, as the main raw material for the production of cast iron in such that these iron ores are smelted by the passage of the coke in such that it acts as a chief raw material for the furnace to produce cast iron.

iv, Scraps of steel, as one among the raw materials in the production of cast iron in the cupola furnace, these scraps of steel may contain alloying elements that increase some chemical characteristics to the cast iron so as to make it more hard and brittle.

b. i, Casting of metals, is one among the processes carried out in the production of metals in such that the molten iron as it is tapped from the furnace through the ladle is then casted or poured in moulds e.g of sand, on which have the intricate shapes of objects to be produced thus as they cool down slowly they results to the formation of various casts

11. b ii, Rolling of metals, is one among the processes carried out in the production of metals in such that the metal is rolled among the rolling mills so as to provide a shape of the object required mainly used in production of sheets, tubes, pipes and etc.



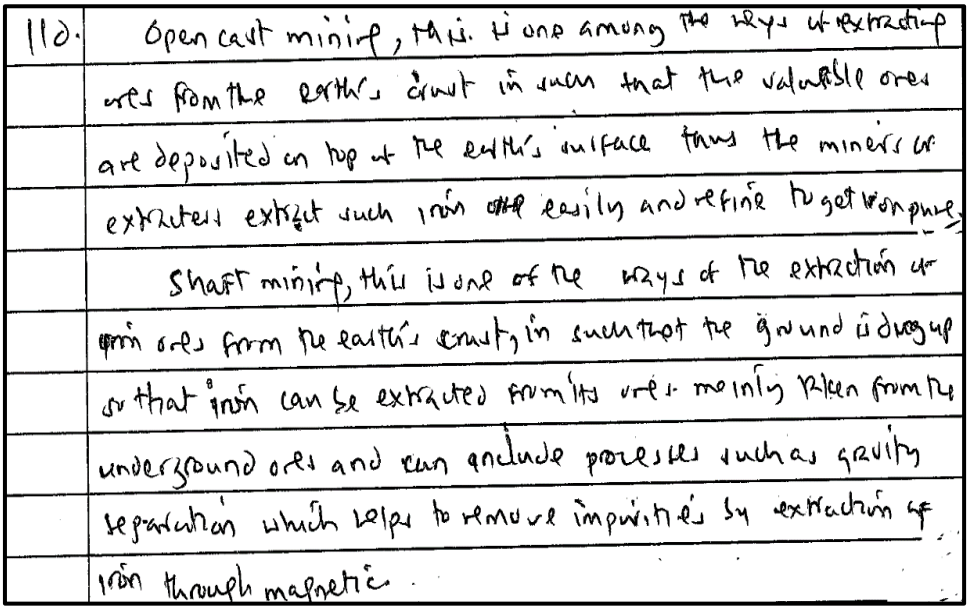
Two rolling mills.

c. Magnetite, this is one among the iron ores found in the earth's crust. It is also called black iron ore since it is black, dense and strongly magnetic properties. It has a high iron content of about 72.4%. (Fe_3O_4)

Hematite, is also one among the iron ores found in the earth's crust. It is also called red iron ore, in such that it contains 70% of iron content. (Fe_2O_3)

Siderite, it is also one among the iron ores found in the earth's crust. It is also known as chalybite, in such that it contains 48.2% of iron content. ($FeCO_3$).

Limonite, this is also the one of the iron ores found in the earth's crust in such that it is also known as 'lean' (low yield) iron ore. on which it is a hydrated iron oxide. ($2Fe_2O_3 \cdot 3H_2O$). Has a iron content of 20%.



Extract 11.1*:* Asample of good responses to Question 11

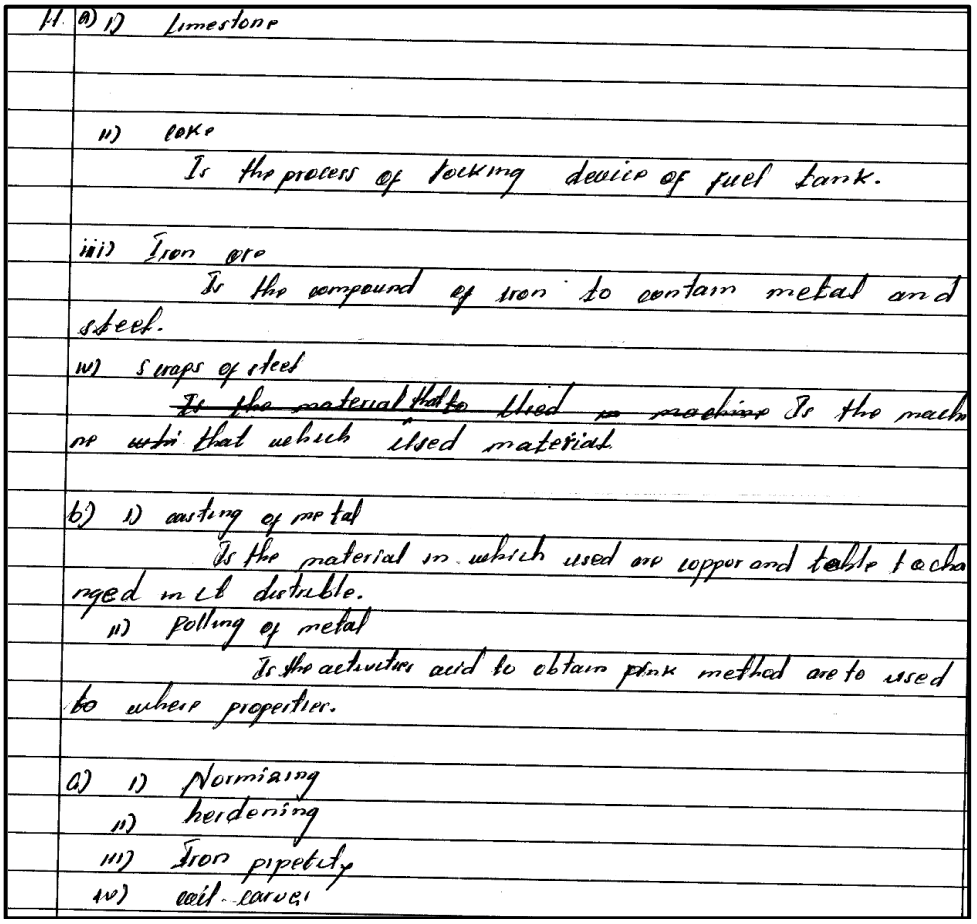
In Extract 11.1, the candidate showed competency on the production of engineering material. He/she provided precise explanations in both parts.

However, the candidates who scored average marks (4.5-9.0) had partial knowledge on production of engineering materials. Most of them wrote correct responses in some parts. Others provided partial explanations in some items and provided few points than what was demanded by the question. These responses indicate that they were competent in some concepts on production of engineering materials.

In contrast, 33.0 per cent of the candidates scored low marks (0-4.0) as they had inadequate knowledge and skills on production of engineering materials, poor understanding of the demand of the question in some parts and lack of English proficiency. Most of them provided correct responses in part (a), (b), (c) or (d) and others provided incorrect responses in all parts.For example, in part (a) one candidate provided correct function of limestone butother three were incorrect such as *coke is used to clean the blast furnace.* In part (b) (i), he/she provided incorrect process of casting of metals with grammatical errors such as: *metal become casted by casting machine to put the metals to cast as well as mechanical properties*. In part (c), he/she mixed correct types of iron ore with incorrect type such as *pearlite* as type of iron ore instead of pisolitic iron ore. In part (d) he/she provided incorrect methods used in extracting iron ore such as*concertation, calcination* and*refining.*Another candidate wrote irrelevant responses in

each part. In part (a), he/she provided the functions of the materials such as lime stone *support melting*, coke *used to increase pig iron*, iron ore *used in production of slag* and scraps of steel *used to make metals.* In part (b), he/she provided irrelevant responses on how the casting and rolling of metals are carried out in the production processessuch as*casting of metals is foundry* and *the process of rolling metal i*s *sheet metal work.*In part (c), he/she provide an alloy of metals mixed with source of heat in blast furnaces such as *wrought iron, cast iron, and coke*instead of providing the types of iron ore. Also in part (d), he/she wrote irrelevant methods for extraction of iron ore such as *use of coke*instead of open mining and underground mining.

Further analysis from the candidate's script reveals that in part (b), some of the candidates were not familiar with the processes carried out in the production of metals so they provided irrelevant responses. In part(c)and (d) most of them did not understand the questions demand as they wrote incorrect responses. Extract 11.2 shows incorrect responses from one of the candidates.


11. a) i) Limestone

ii) coke
Is the process of locking device of fuel tank.

iii) Iron ore
Is the compound of iron to contain metal and steel.

iv) Scraps of steel
~~Is the material that to used in machine~~ Is the machine with that which used materials.

b) i) casting of metal
Is the material in which used are copper and table to charged in it distrible.

ii) polling of metal
Is the activities acid to obtain pink method are to used to where properties.

c) i) Normaing
ii) heardening
iii) Iron pipebity
iv) coil. carbon

Extract 11.2: Asample of poor responses to Question 11

In Extract 11.2, the candidate provided irrelevant responses in parts (a), (b), (c) and (d). This shows that he/she either did not understand the demand of the question in either of the four parts or lacked knowledge and skills on production of engineering materials.

2.3.2 Question 12: Heat Treatment

The question required the candidates to explain with the aid of heat and cooling curve sketch the changes of metal characteristics that take place when steel is heated to 900^{o}C and allowed to cool. The question was intended to measure candidates' abilities to analyze various characteristics that take place when steel is heated and allowed to cool.

The question was attempted by 189 (81.8%) out of 23 candidates, where68 (36.0%)scoredfrom0to4.0 marks, 75 (39.7%) scored from 4.5 to 9.0 marks and 46 (24.3%) scored from 9.5 to 15.0 marks. Figure 11 summarizesthecandidates'performancein this question.

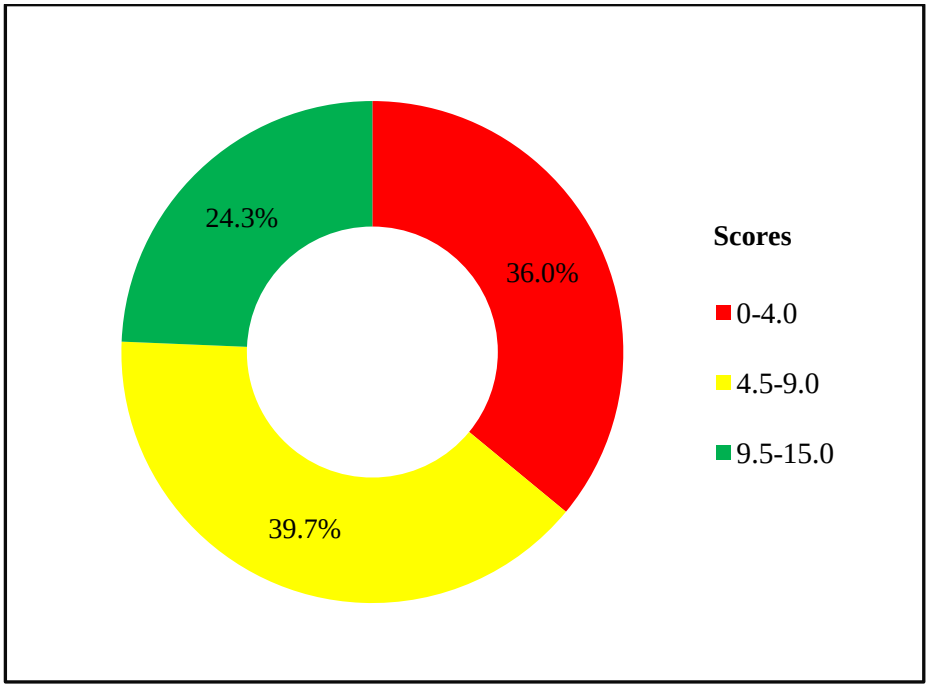
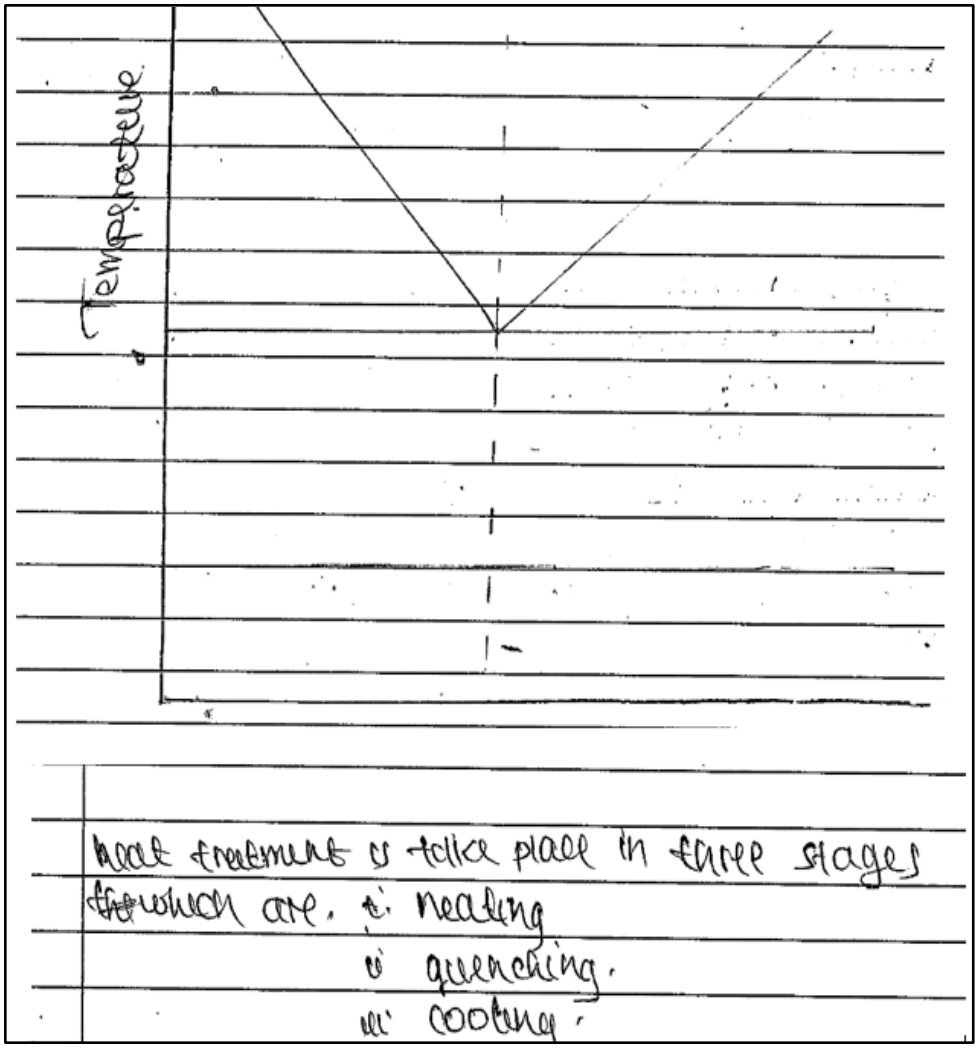


Figure 11: *The Candidates' Performance in Question 12*

The candidates' performance in thisquestion was average since 64.0 per cent of the candidates scored average and above.

Data analysis shows that 68 (36.0%) of the candidates scored low marks (0-4.0), among them 10.0 per cent scored 0. These candidates failed to apply the skills on heat treatment in sketching the heating and cooling curve and explaining the changes of metal characteristics that take place when steel is heated to $900^{o}C$ and allowed to cool. This was proved by most of candidates who provided irrelevant sketch and incorrect explanation on the changes of metal characteristics. For example, one candidate provided a sketch ofa graph with temperature in vertical line against types of iron ores found in the earth crust in the horizontal line, instead of sketching a graph with temperature in vertical line against time in the horizontal line. Also he/she provided the explanation of each iron ore such as: *hematiteis the type of iron carbide of steel and iron* instead of providing the changes occurred in a heating and cooling of steel. Extract 12.1is a sample of an incorrect responses.



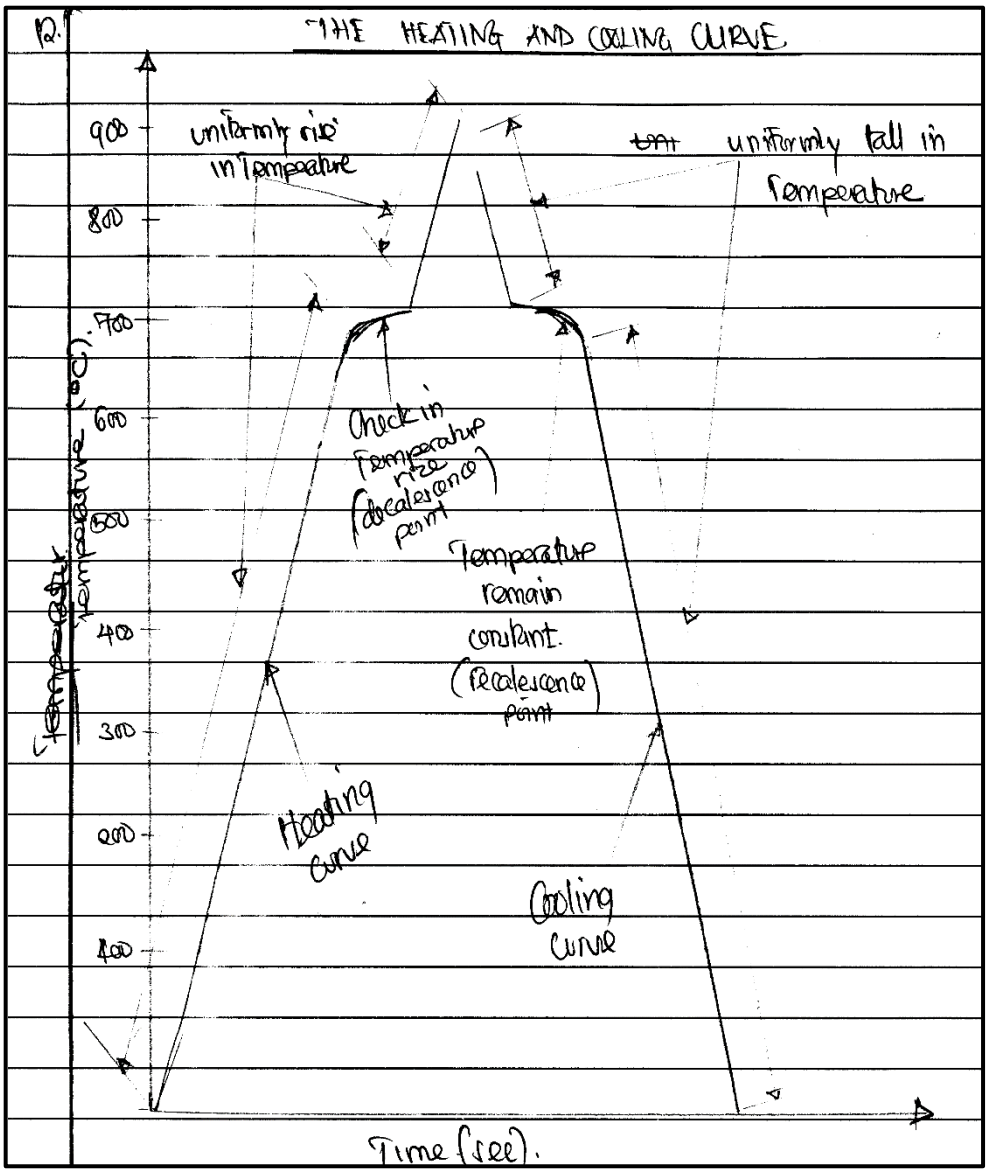
Extract 12.1: Asample of poor responses to Question 12

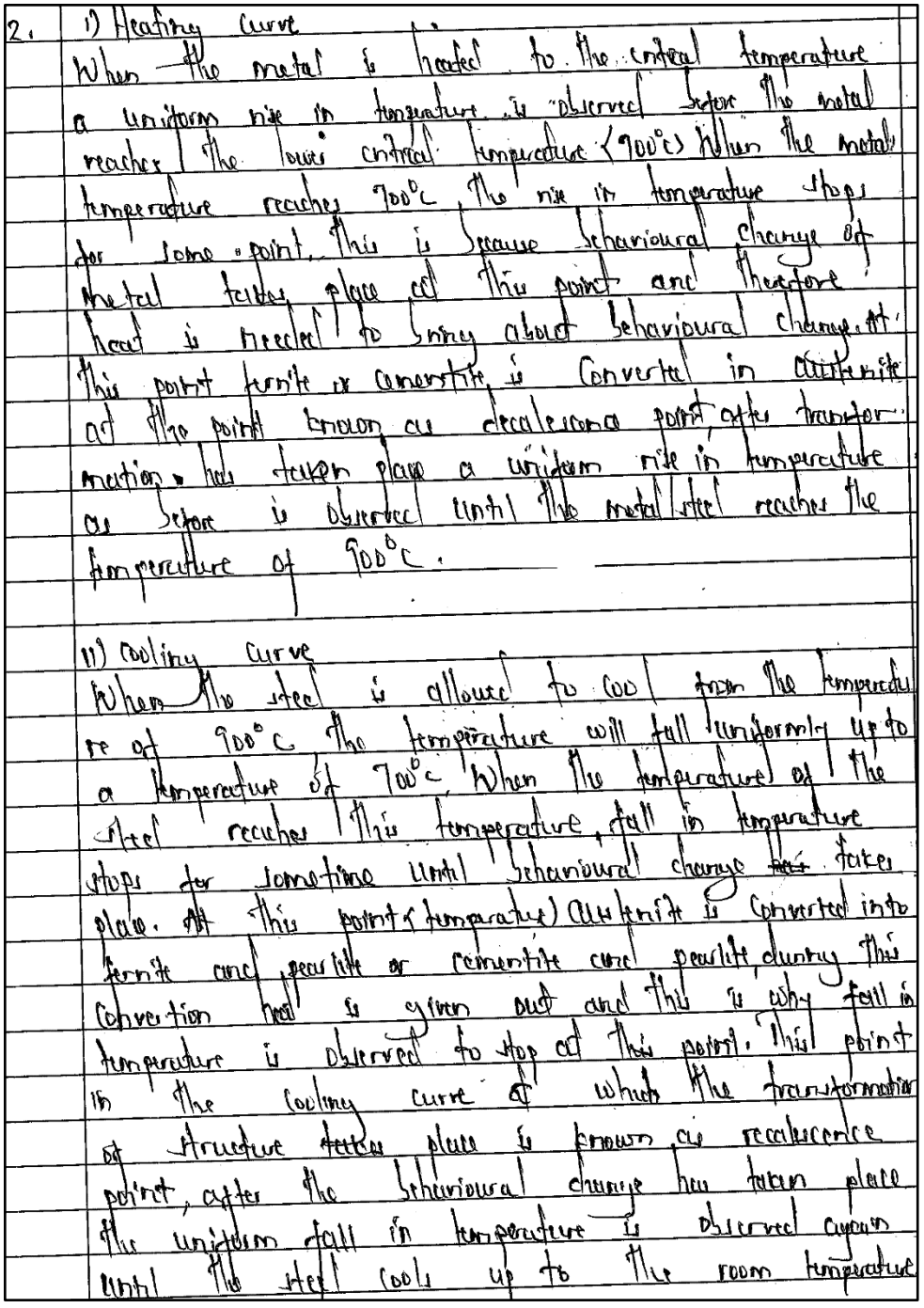
InExtract12.1, thecandidate provided irrelevant graph and incorrect explanations on the changes of metal characteristics that take place when steel is heated to 900^{o}C and allowed to cool.

Furthermore, the candidates (39.7%) who scored average marks (4.5-9.0) understood clearly the demand of the question but had insufficient skills on heat treatment. Most of them applied the skills on heat treatment to sketch the heating and cooling curve. Others provided partial explanation on the changes of steel metal when heated to 900^{o}C and allowed to cool.

On the other hand, 24.3 per cent of the candidates who had goodmarks demonstrated their knowledge and skills on production of engineering materialsto provide the correct sketch on heating and cooling curve as well

as precise explanations on the changes of metal characteristics that take place when steel is heated to 900^{o}C and allowed to cool. Extract 12.2is a sample of a candidate's correctresponse.




2. i) Heating Curve
When the metal is heated to the critical temperature a uniform rise in temperature is observed before the metal reaches the lower critical temperature (700°C) When the metal temperature reaches 700°C, the rise in temperature stops for some point. This is because behavioural change of the metal takes place at this point and therefore heat is needed to bring about behavioural change. At this point ferrite or cementite is converted in austenite at the point known as decalescence point after transformation has taken place a uniform rise in temperature as before is observed until the metal/steel reaches the temperature of 900°C.

ii) Cooling Curve
When the steel is allowed to cool from the temperature of 900°C the temperature will fall uniformly up to a temperature of 700°C When the temperature of the steel reaches this temperature, fall in temperature stops for sometime until behavioural change ~~has~~ takes place. At this point (temperature) austenite is converted into ferrite and pearlite or cementite and pearlite during this conversion heat is given out and this is why fall in temperature is observed to stop at this point. This point in the cooling curve at which the transformation of structure takes place is known as recalescence point, after the behavioural change has taken place the uniform fall in temperature is observed again until the steel cools up to the room temperature

Extract 12.2: A sample of good responses to Question12

In Extract 12.2, the candidate provided correct explanations on the changes of metal characteristics that take place when steel is heated to 900°C and allowed to cool. He/she also managed to sketch the heat and cooling curve.

2.3.3 Question 13: Lubrication

This question comprised of three parts, (a), (b) and (c). Part (a) required the candidates to explain the negative effect of cutting steel material with insufficient supply of cutting lubricant. Part (b) required the candidates to give a brief explanation of three methods which are used to supply lubricating oil to different parts of machines which requires lubrication. Part (c) required them to explain the procedure of applying coolant in metal cutting carried out on (i) flooding (ii) dripping and (iii) misting.

A total of 85 (36.8%) candidates opted for this question, out of 231. Among them 48 (56.5%) scored from 0 to 4.0 marks, 29 (34.1%) scored from 5.0 to 9.0 marks and 8 (9.4%) scored from 10.0 to 13.0 marks. Figure 12 depicts these performances.

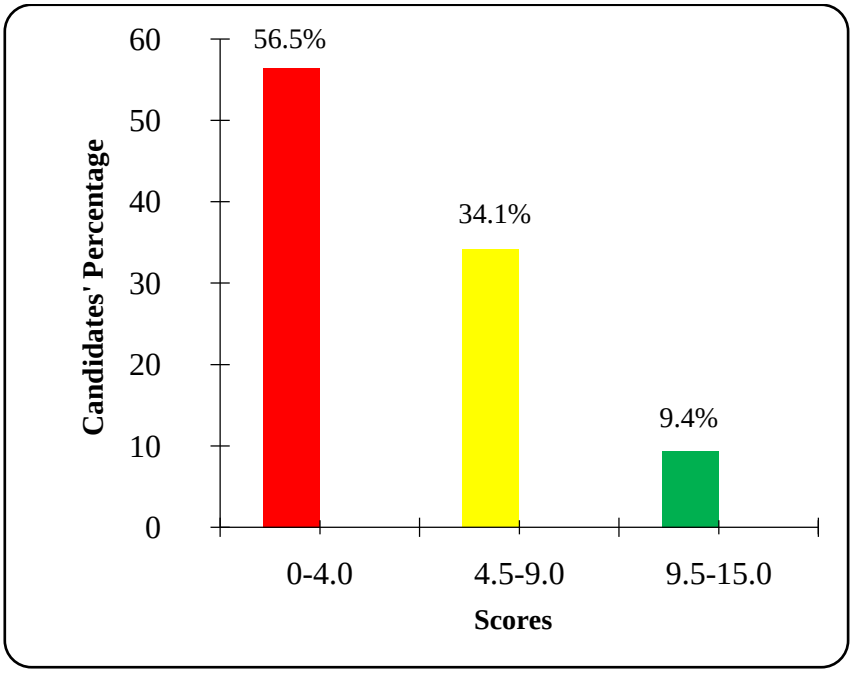
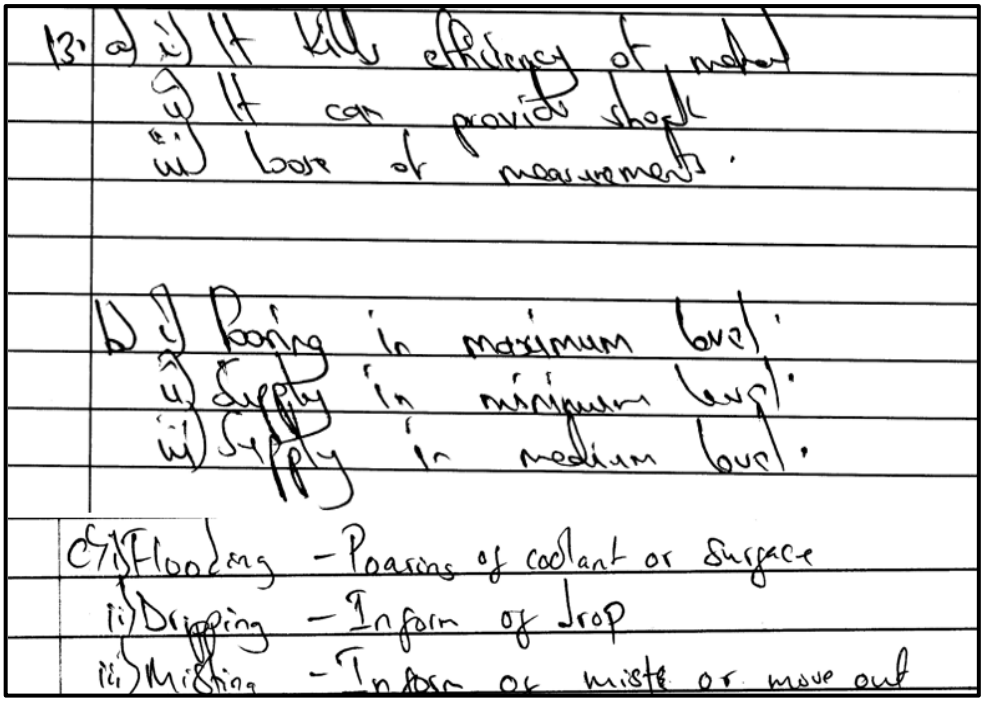


Figure 12: *The Candidates' Performance in Question 13*

Generally, the performance of the candidates in this question was average since 43.5 per cent of the candidates scored average.

There were48 (56.5%) candidates who scored low marks (0-4.0) had insufficient knowledge on the concept of lubrication. Most of them provided correct responses mixed with incorrect responses. For example, in part (a) one candidate wrote the negative effect of cutting steel material with insufficient cutting lubricants *is exposure to welding of metal, poor observable dimensions on the work piece.*In part (b), he/she provided

incorrect procedures of applying coolants such as *dripping lubrication: this involves use of drips in which lubricant flows in a minimal condition and it is under control of* instead of providing methods used to supply lubricating oil to different parts of machines. In part (c), candidate provided incorrect response on how misting is carried out as applied in lubrication of metal parts such as *by use of vegetable oil, this is inserted and connected between moving parts as they continue doing operation.*The candidate was required to explain that the coolant is supplied to the moving part in form of fine spray. Others failed to understand the demand of the question in some parts. For example, in part (a) candidate provided irrelevant negative effects of cutting steel material with insufficient supply of cutting lubricants such as *some of cutting lubricants are poison in nature, cutting lubricant cause skin cancer, other cutting lubricant does not prevent rusting.*The candidate provided the negative effect of using chemical fluid instead of providing the negative effect of using insufficient cutting lubricants while cutting steel material. Extract 13.1 is a sample of incorrect responses.



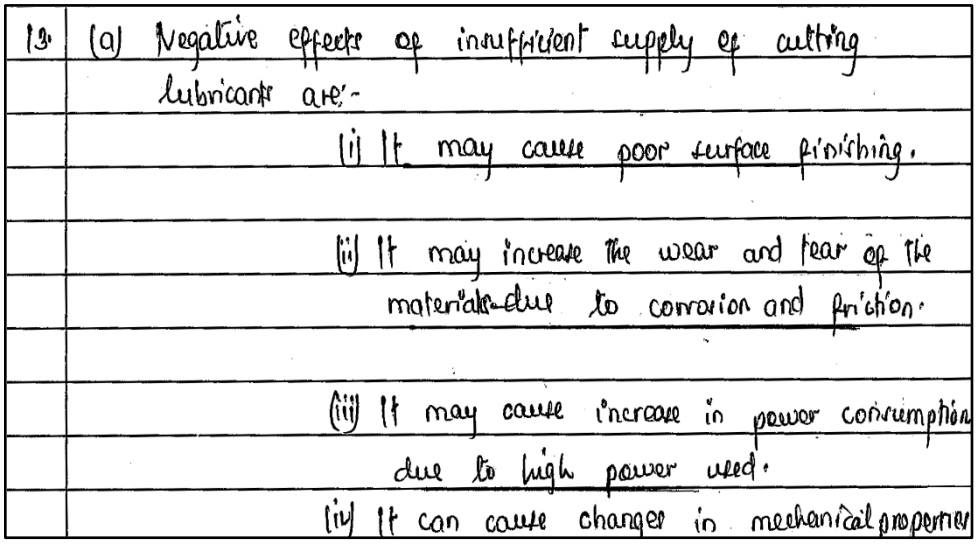
Extract 13.1: Asample of candidates'poor responses to Question 13

In Extract 13.1, the candidate had insufficient knowledge on lubrication as he/she provided irrelevant responses in parts, (a), (b) and (c). In part (a) he/she used improper terminologies in explaining the negative effect of cutting steel material with insufficient supply of cutting fluid such as

itkillsmaterial instead of writing either wear of the cutting tool edge, expansion to the working material or generation of rust to the steel material.

However, 34.1 per cent of the candidates who scored averagemarks (4.5-9.0) had partial knowledge onlubrication. Most of them provided correct points in part (a), (b) and (c) with partial explanation. Others provided correct responses in either part (a), (b) or (c).

On the other hand, only 8 (9.4%) candidates were able to give correct responses based on the subject matter. These candidates understood clearly the requirements of the question. Also they had sufficient knowledge and enough skill on lubrication as they were aware of cutting machines and its operation. High score attained was 13 out of 15 marks allotted in this question. This was because most of the candidates had minor errors in their explanations. Others listed the responses instead of giving brief explanation. Extract 13.2 portrays responses from one of the candidates who scored 13 marks.


13. (a) Negative effects of insufficient supply of cutting lubricants are:-

(i) It may cause poor surface finishing.

(ii) It may increase the wear and tear of the materials due to corrosion and friction.

(iii) It may cause increase in power consumption due to high power used.

(iv) It can cause changes in mechanical properties

13: (b) Methods used to supply lubricating oil to different parts of a machine are:-

(i) Splash method.

This is done by using a machine which splashes the oil to the different machine parts.

(ii) Force method.

It is done by applying force on a lubricating oil container and this results to the existance of the oils and therefore lubricate the machine parts.

(iii) Gravity method.

Is done by using gravitational force which acts on a container. A container is held above the parts to be lubricated and it is left open. The lubricating oils come drop by drop and therefore cause lubrication.

(c) (i) Flooding.

This is done by allowing much coolants at the same time to cool the machine.

(ii) Dripping.

This is done through drips which are in form of drop by drop.

(iii) Misting.

Is done by allowing the piece of work to cool inside the coolant.

Extract 13.2: Asample of good responses to Question 13

In Extract 13.2, the candidate provided precise explanation in part (a), (b) and (c) but provided incomplete response on how misting is carried out. He/she did not understand that in the process of misting, the coolant is supplied to the area to be cooled in the form of fine spray.

2.3.4 Question 14: Limits and fits

This question had three parts, (a), (b), and (c). In part (a), candidates were asked to explain three main types of fits used in assembling metal parts. In part (b), they were required to use hole and shaft dimensions to determine (i) hole tolerance, (ii) shaft tolerance and (iii) allowance of the fit. Part (c) required them to explain types of fit established in part (b).

The question was opted by 204 (88.3%)outof 231candidates. The analysis shows that, 17 (8.3%) scored from 0 to 4.0marks, 55 (27.0%) scored from 4.5 to 9.0 marksand 132 (64.7%) scored from 9.5 to 15.0 marks.These performances are summarized in Figure 13.

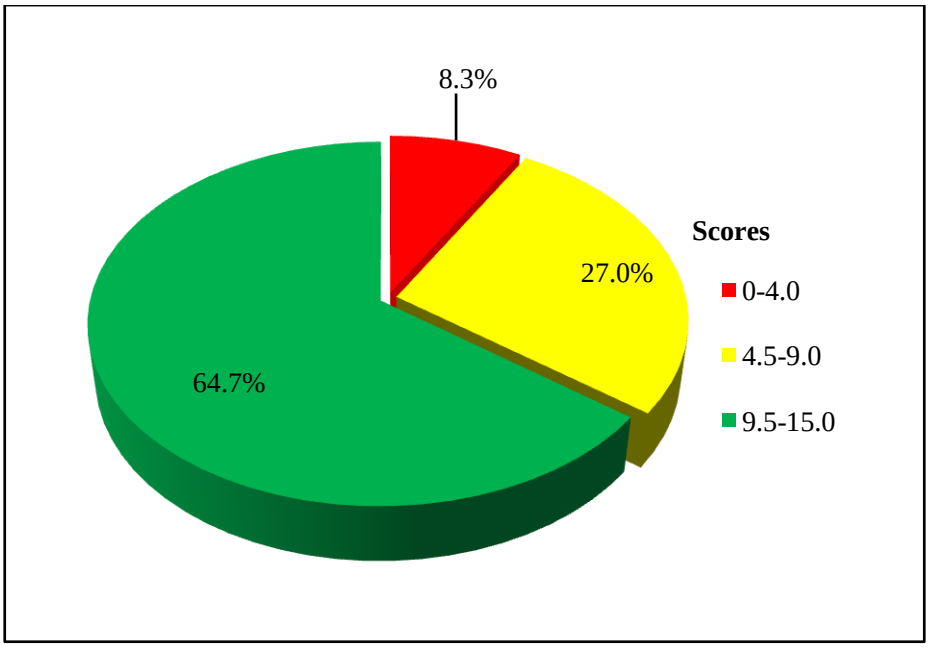
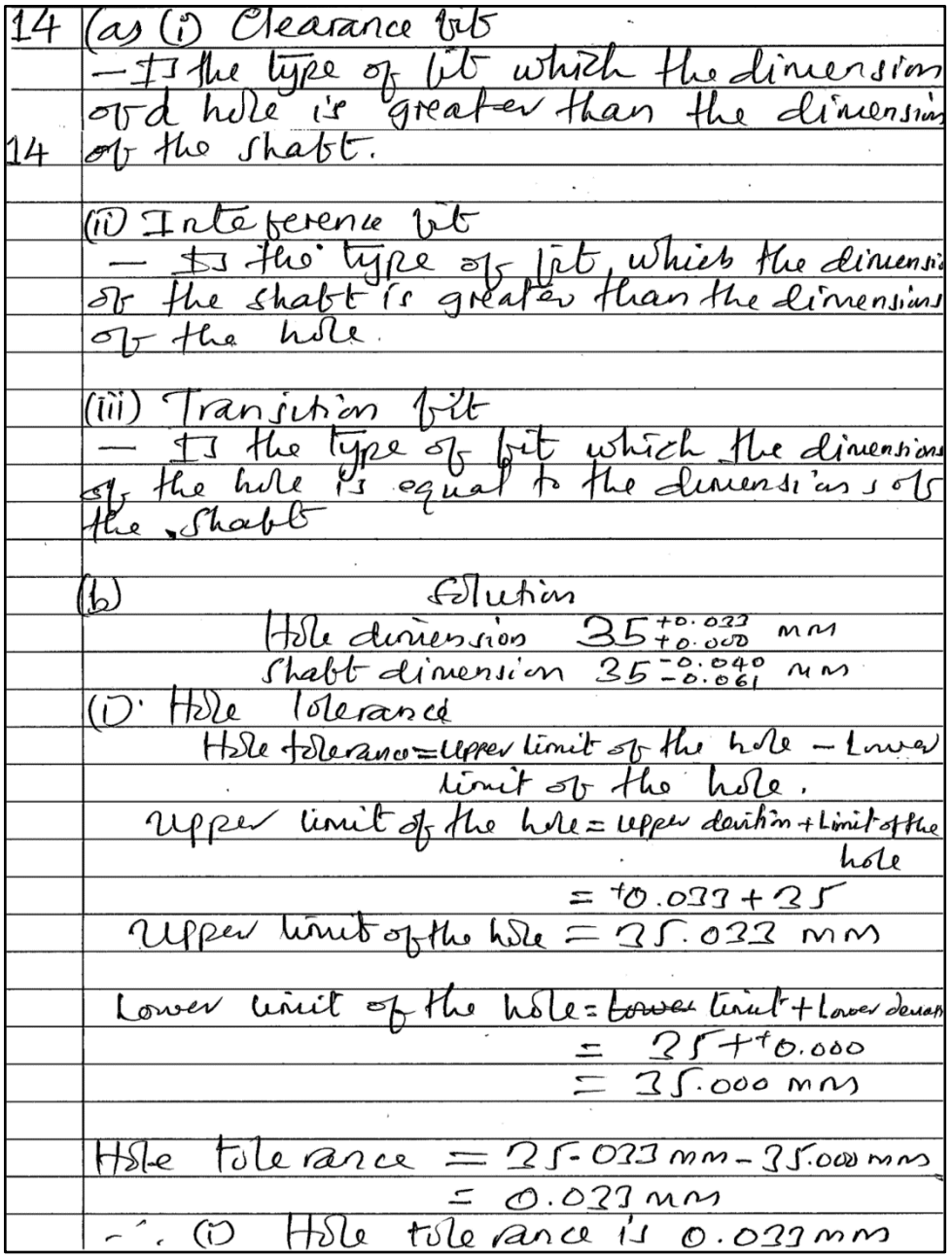


Figure 13: *TheCandidates' Performance in Question 14*

Figure 13 shows that the candidates' performance in this question was good since 91.7 per cent of the candidates scoredaverage and above.

The data analysis shows that 64.7 per cent of the candidates were competent on the concept limits and fit as they provided correct responses in all parts of the question. Further analysis on the candidates' responses shows that

they understood the demand of the question and requirement of each items. Extract 13.2 depicts an answer from one of the candidates who provided accurate responses.


14 (a) (i) Clearance fit
— It the type of fit which the dimension of hole is greater than the dimension
14 of the shaft.

(ii) Interference fit
— It the type of fit, which the dimensi of the shaft is greater than the dimensions of the hole.

(iii) Transition fit
— It the type of fit which the dimensions of the hole is equal to the dimensions of the shaft

(b) Solution
Hole dimension $35^{+0.033}_{+0.000}$ mm
Shaft dimension $35^{-0.040}_{-0.061}$ mm
(i) Hole tolerance
Hole tolerance = Upper limit of the hole − Lower limit of the hole.
Upper limit of the hole = upper deviation + Limit of the hole
= +0.033 + 35
Upper limit of the hole = 35.033 mm

Lower limit of the hole = lower limit + Lower deviation
= 35 + +0.000
= 35.000 mm

Hole tolerance = 35.033 mm − 35.000 mm
= 0.033 mm
∴ (i) Hole tolerance is 0.033 mm

Extract 14.1:A sample of good responses to Question 14

Additionally, almost 27.0 per cent of the candidates who scored average marks managed to explain correct types of fits used in assembling metal parts. In addition, some of them applied the skills on limits and fit

todetermine the hole tolerance, shaft tolerance and allowance of the fit. These candidates scored average marks due to some errors in their calculations and partial explanations in part (a) and (b).

In contrast, the analysis indicates that only 8.3 per cent of the candidates scored low marks (0-4.0). It shows that candidateshad little knowledge and skills on limits and fits. In part (b), most of themprovided incorrect formula and calculation ofhole tolerance, shaft tolerance and allowance of the fit. For example, one candidate wrote:hole tolerance *=basic size + upper size=35+0.033 =0.068 mmthen hole =basic size-lower limit=35+0.000=0.035 mm*,shaft tolerance *=basic size +upper limit=35+¯0.040 mm=¯0.075 mm then shaft =basic size + lower limit=35+¯0.061 mm=¯0.086 mm,* allowance of the fit *=upper limit shaft-lower limit shaft= ¯0.075-0.086=¯0.011mm*and *upper limit hole-lower limit hole=0.068 mm-0.035 mm=0.033 mm*. In part (c), he/she provided the difference between the *hole system and shaft system* instead of providing the type of fit established in part (b) based on the sizes of hole and shaft. Further analysis from the candidate's responses reveals that most of them failed part (b) and (c) due to poor interpretation of data and lack of mathematical skills of applying the correct formula to find the correct maximum and minimum sizes of hole and shaft. Extract 14.2 is a sample of incorrect responses from the script of a candidate.

14

i Clearance fit ; is the different of limit size of hole and shaft - when the shaft is greater than the Hole

ii Interference fit :- is different of limit size of hole and shaft when shaft is smaller then the hole.

iii Transition fit.

b)

Hole = $35^{+0.033}_{+0.000}$ mm

Shaft = $35^{-0.040}_{-0.061}$ mm

Solution

Maximum limit of shaft = 35 + 0.033
= 35.033 mm

and

Minimum limit of shaft = 35 − 0.000
= 35mm

Then,

The Maximum limit of Hole = 35 + 0.040
= 34.96 mm

and

The minimum limit of Hole = 35 + 0.061
= 35.061

So

∴ The maximum and minimum size of hole and shaft are

35.033mm 34.96 m

35mm 35.061 m

Extract 14.2: Asample of poor responses to Question 14

In Extract 14.2, the candidate applied incorrect formula in calculating the maximum and minimum sizes of hole and shaft. He/she added and subtracted to get maximum and minimum sizes of hole and shaft instead of adding the values to get the maximum and minimum size of hole as well as subtracting the values to get the minimum and maximum size of shaft.

3.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH TOPIC

A total of 14 questions were examined in workshop technology examination set from six (6) topics which were: *Limits and Fits, Properties of Metals, Production of Engineering Materials, Heat Treatment* and *Identification of Metals.*

The analysis of the performance indicates that questions 1, 4, 7, 10, 11 and 14 had good performance since the percentages of the candidates who passed were 70.6, 78.4, 90.0, 74.5, 67.0 and 91.7 respectively. Question 1 had ten multiple choice items set from the topics of*Lubrications, Properties of Metals, Heat Treatment, Production of Engineering Materials and Tools and equipment*. Questions 4, 7 and 10 were short answers questions set from the topics of *Production of Engineering Materials, Lubrication* and *Properties of Metals* respectively. Question 11 and 14 was structured questions set from the topics of*Production of Engineering Materials* and *Limits and Fits*respectively. The candidates who scored good marks understood clearly the demand of the questionsand had the ability to apply formulas in computing question 14. In addition, they had enough knowledge on the tested topics as they provided preciseresponses in a tested subject matter.

The data analysis reveals that question 3 from the topic of *Properties of metals* (60.6%), questions 8 &12 from the topic of *Heat Treatment* (52.6%) and question 13 from the topic of *Lubrication* (43.5%) were averagely performed. The candidates who scored average marks understood partially the demandof the question as they provided correct responses in some of the tested concepts. In addition, some of them had insufficient knowledge and lacked drawing skills ofsketching the heating and cooling curve in question 12.

In contrast, candidates'weak performance was observed on question 5 &6from the topic of*Identification of Metals* (17.5%) and question 9 from the topic of *Limits and Fits* (27.3%). The candidates' weak performance in these questions were associated with failure to understand the demand of the questions, lack of English proficiency, lack of knowledge as well as lack of mathematical and drawing skills.

4.0 CONCLUSION

The analysis of the candidates' performances in each question shows that general performance in Workshop Technology subject was good because 84.9 per cent of the candidates scored average and above.

The candidates'good and average performances were the result of the candidates' ability to understand the demands of the questions and their adequate knowledge and skills on Workshop Technology concepts.

Conversely, the poor performance was contributed by candidates' failure to understand the demands of the questions, inadequate knowledge and skills on tested topics as well as poor English language proficiency.

5.0 RECOMMENDATIONS

In order to improve the performance of candidates in this subject, the following are recommended:

(a) Studentsshould be guided and encouraged to read various Workshop Technology books so as to widen their knowledge and skills.

(b) Students should be aided to improve English language by developing the passion of speaking and writing in English. This can be achieved by allowing them to participate in debates, discussions and presentation of various assignments.

(c) Students should practice drawing different workshop technology systems, components and graphs. This will help them to acquire appropriate skills of drawing neatly and correctly label diagrams and graphs.

(d) Teachers should prepare practical activities so as studentscan perform well on topics of heat treatment and limits & fits

(e) Students should develop the culture of reading questions carefully before attempting them so that they understand the requirements of the questions.

Appendix I

Table 2: A summary of Candidates' Performance (question-wise) in 2022

S/N	Topics	Question Number	Per cents of Candidates Who Scored 30 and Above	Remarks
1	Lubrications, Properties of Metals, Heat Treatment, Production of Engineering Materials and Tools and equipment	1	70.6	Good
2	Lubrications	7 & 13	66.8	Good
3	Properties of Metals	3 & 10	67.6	Good
4	Production of Engineering Materials	2, 4 & 11	67.5	Good
5	Limits and Fits	9 & 14	59.5	Average
6	Heat Treatment	8 & 12	52.6	Average
7	Identification of Metals	5& 6	17.5	Weak

Appendix II

Table 3: Comparison of Candidates' Performance Grade-Wise

Grade	A	B	C	D	F	Total
2021	1	8	86	110	85	290
2022	16	27	87	66	35	231