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

STUDENTS' ITEM RESPONSE ANALYSIS REPORT ON THE FORM TWO NATIONAL ASSESSMENT (FTNA) 2020

MECHANICAL ENGINEERING

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090 MECHANICAL ENGINEERING

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FOREWORD

The Form Two National Assessment marks the end of two years of secondary education. It is a formative evaluation which among other things shows the effectiveness of the education system in general and education delivery system in particular. Essentially, student's response to the assessment questions is a strong sign of what the education system has been able or unable to offer to students in their two years of secondary education.

The students' Items Response Analysis (SIRA) report on the Form Two National Assessment (FTNA) 2020 for Mechanical Engineering was written in order to provide feedback to teachers, students, parents, policy makers, education administrators and other educational stake holders on the students' performance in the subject.

The report is intended to contribute towards understanding some of the reasons behind the performance of students in the assessment. The report highlights the factors that made students fail to score high marks. Such factors include failure to identify the task of the question, lack of knowledge on the concepts related to the subject and inability to express themselves in English language. The report also highlights the reasons that made some students to perform well. Such reasons include sufficient knowledge and correct interpretation of the requirement of the questions.

The National Examinations Council of Tanzania (NECTA) expects that the feedback provided in this report will enable the school managers, teachers, students, educational administrators, school quality assurers and other educational stakeholders to take appropriate measures to improve the teaching and learning of the Mechanical Engineering subject in secondary schools. This will eventually strengthen the performance of prospective candidates.

Finally, the Council would like to thank Examination Officers, Examiners and all who participated in the preparation of this report.

Dr. Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report analyses the Students' performance in Mechanical Engineering Paper of Form Two National Assessment (FTNA) conducted in November, 2020. The Assessment measured competences according to the 1994 Mechanical Engineering syllabus at the level of form two.

The paper consisted of fourteen (14) questions grouped into sections A and B. Section A had a total of seven (7) compulsory questions while section B had a total of seven (7) questions of which students were required to answer only one question with respect to their specialities. Section A had 40 marks and section B had 60 marks.

The number of students who sat for form two National Assessment in Mechanical Engineering subjects for the year 2020 was 272 of which 98 students (36.03%) passed and 174 students (63.97%) failed. In 2019 there were 377 students who sat for the Assessment of which 135 students (35.81%) passed, while the remaining 242 students (64.19%) failed. Therefore, the performance of students in 2020 has increased by 0.22 percent.

This report highlights the demand of each question, the general performance, the possible reasons for poor or good performance and the areas for improvement. In this analysis the performance of students for FTNA 2020 Mechanical Engineering subjects has been summarised using the range of 0 to 29 (weak performance), 30 to 64 (average performance) and 65 to 100 (good performance) as shown in table 1. These intervals contain the percentage of students who scored thirty percent or above out of the total marks allotted to a particular question.

Table 1: *General Students' Performance in Mechanical Engineering Subjects*

Grade Range	Percentage	Description	Students	
			Number	Percentage
0 – 2.9	0 - 29	Unsatisfactory	174	63.97
3.0 – 6.4	30 - 64	Average /Moderate	89	32.72
6.5 – 10.0	65 - 100	Good	9	3.3
Total			272	100

The analysis is presented in a way that it shows the requirements of the question, what the students were able to do, and the challenges encountered in answering the given questions. Samples of extracts for good and poor responses from the students were given to elaborate the cases stated. Lastly, the report ends with conclusions and recommendations

2.0 ANALYSIS OF INDIVIDUAL QUESTIONS

2.1 SECTION A: COMPULSORY PART

WORKSHOP TECHNOLOGY

2.1.1 Question 1: Multiple Choice Items (Various Topics)

The question comprised of five (5) items (i) – (v), which were set from various topics of the syllabus. Students were required to choose the correct answer from the four given alternatives for each item. Five (5) marks were allocated for this question.

The analysis shows that a total of 272 students (100%) attempted this question. Among them 15.8 percent scored from 0 to 1 mark out of which 1.8 percent scored 0 mark, 53 percent scored from 1.5 to 3 marks whereas 31.2 percent scored from 3.5 to 5 marks. Figure 1 summarizes the candidates' performance in this question.

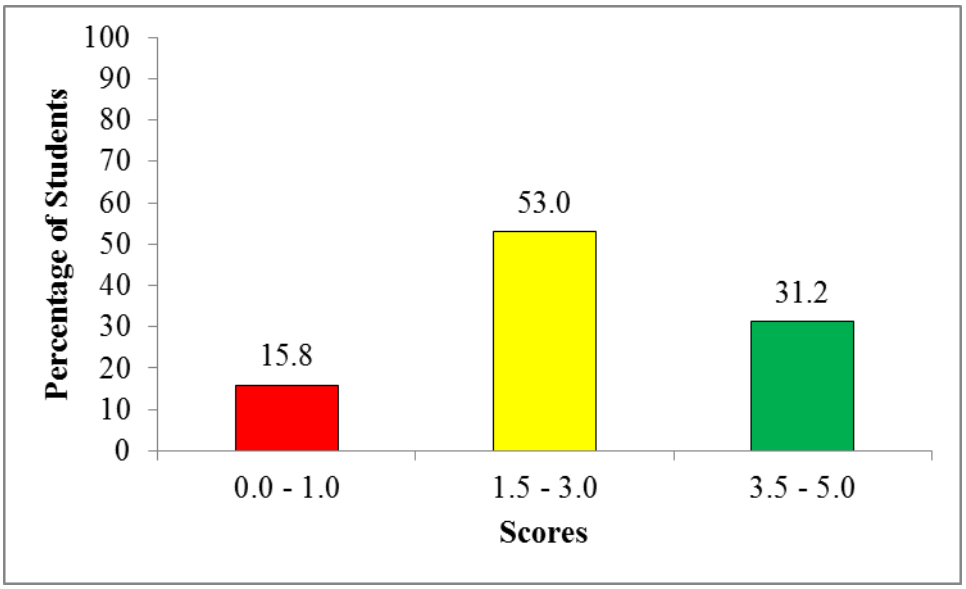


Figure 1: Performance of Students in Percentage for question 1.

Students' performance in this question was good because 84.2 percent scored average and above marks. Such a good performance shows that most of the students were able to identify the correct answer from the given options. Furthermore, the analysis shows that there were some students who could not make correct choices in some of the items. The following are the items in question number one;

(i) What is the name of metallic material which contains zero percentage of iron?

A Non-ferrous metals *B Ferrous metals*

C Non metallic *D Ferrite.*

In item (i), students were required to show their abilities to identify from the given alternatives the name of a metallic material which contains zero percentage of iron. The correct answer to this part was *A (Non-ferrous metal).* Among the students who failed to

choose the correct answer, some chose *B (Ferrous metals)*. These students did not understand how to distinguish ferrous metals from non-ferrous metal. Those who chose C, were not literate enough on classifications of engineering materials. Finally, those who chose D, either failed to know that the term ferrite implies iron or did not read carefully the question and understand the demand. All students who chose the destructors in this question had insufficient knowledge on engineering materials.

(ii) Which of the following materials fall under the group of non-ferrous alloy?

A Copper *B Brass*

C High carbon steel *D Silver steel*

In item (ii), students were required to show their abilities to identify material which fall under the group of non-ferrous alloys. The correct answer to this part was *B (Brass)* but most of the candidates who failed selected alternative *A (Copper)* and some selected alternative *C (High carbon steel)* and a few selected alternative *D (Silver steel)*. These students failed to recognize the concept that an alloy is a metal which is formed by a combination of two or more metals as this could lead them to the correct choice of the answer. Those who chose C, did not understand that high carbon steel is not a non-ferrous metal. This implies that the students lacked adequate knowledge on engineering materials especially on the concept of formulation of metallic alloys.

(iii) What are the two main groups of steel?

A Oxidised steel and carbon steel

B Carbon steel and tungsten

C Carbon steel and alloy steel

D *Alloy steel and molybdenum*

In item (iii), students were asked to show their competence in identifying groups of steel. The correct answer was ***C (Carbon steel and alloy steel).*** Among those who failed to choose correct answer, some chose *A (Oxidised steel and carbon steel)*. These students were not literate on the classification of steel. Those who chose *B (Carbon steel and tungsten)* or D (*Alloy steel and molybdenum)* failed to understand that tungsten and molybdenum are not among steel materials but alloying elements which are added to steel to improve its properties. This indicates that students were not conversant on the topic of engineering materials and materials classifications.

(iv) Why gray cast iron is most preferred in manufacturing of machine parts?

A It withstands shear forces

B It withstands compressive forces

C It withstands tensile forces

D It withstands bending forces

In item (iv), students were required to give select a correct reason why gray cast iron is most preferred in manufacturing of machine parts. The correct answer to this part was ***B (It withstands compressive forces).*** Among the students who failed, some chose *A (It withstands shear forces)*. Others who chose *C (It withstands tensile forces)* and the rest chose *D (It withstands bending forces)* These students were not literate on the properties of engineering materials therefore failed to understand that grey cast iron is better on compressive forces than on tensile and bending forces.

(v) *Which of the following lubricants is used to lubricate machine parts which operates at high temperatures?*

A Coke *B Grease*

C Rubber *D Graphite*

In item (v), students were required to select a lubricant used to lubricate machine parts which operates at high temperatures from the given alternatives. The correct answer to this part was ***D (Graphite).*** However, some students opted for *A (Coke)* as they failed to realise that coke is good as a fuel not as a lubricant. Others who opted for B (*Grease*) failed to take into account the condition of high temperature stated in the question as under this condition grease could not suit the purpose. Likewise, the students who opted for C (Rubber), also did not understand rubber is an elastic material used for other purposes apart from lubrication and cannot sustain high temperature. not a lubricant. Generally, the students who failed to choose the correct answer had a limited knowledge on the topic of Lubrication (Coolants) particularly the concept of properties of lubricants.

2.1.2 Question 2: Matching Items – Properties of Metals

This was a homogeneous question which consisted of five (5) matching items derived from the topic termed Properties of Metals. Students were required to match the properties of metals in B with the descriptions in A by writing its letter below the number of corresponding item in list A in the table provided. List A consisted of the five descriptions of some properties of metals while List B consisted of seven single terms used to denote the properties. This question tested the students' knowledge of different properties of metals.

The analysis indicates that, out of 272 students who attempted the question, 38.6 percent scored from 0 to 1 mark, 34.9 percent scored from 2 to 3 marks and 26.5 percent scored from 4 to 5 marks. Figure 2 summarises the result for this question.

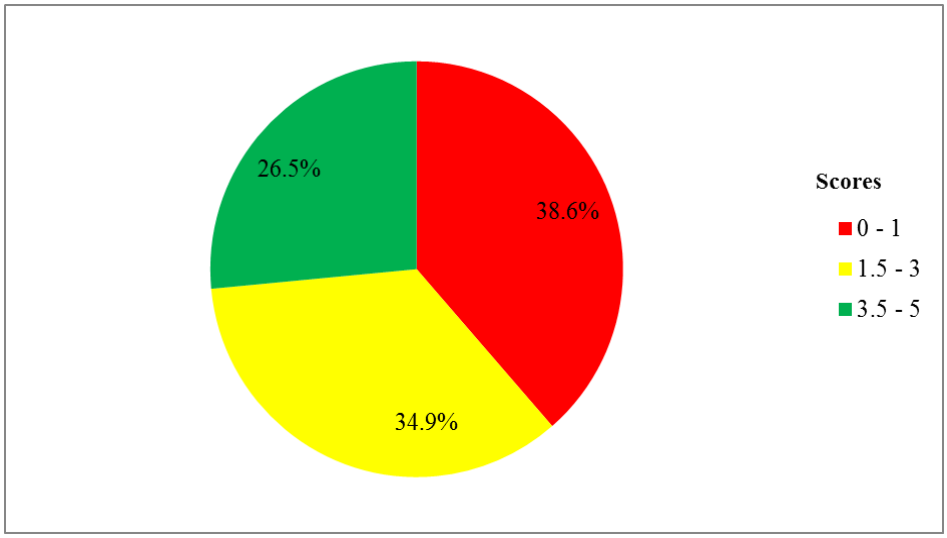


Figure 2: Performance of Students in Percentage for question 2.

As shown in Figure 2 the students' performance in this question was average since the majority (61.4%) scored 30 percent and above of the total marks allocated to this question. This performance implies that most students who attempted this question had reasonable knowledge on the topic of properties of metals.

Despite the average performance there were students (38.6%) who scored low marks in this question. These students failed to associate the stated properties with their respective descriptions. This implies that they had inadequate knowledge of properties of metals. On the other hand, there were students (26.5%) who scored from 4 to 5 marks. Their good performance shows that they understood well the requirement of the question and had sufficient knowledge on the properties of metals. The question stands as follows:

List A	**List B**
(i) A temperature at which a metal melts	A. Malleability
(ii) The ability of a metal to resist impact force before fracture	B. Strength
(iii) Ability of a metal to spread without breaking when acted upon by a force or hammered	C. Conductivity
(iv) A characteristic of a material which allows heat to travel through it from one point to another	D. Fusibility
(v) The resistance a metal gives to any scratching or indentation	E. Luster
	F. Hardness
	G. Toughness

The analysis of the response for individual items revealed that three items (i), (ii) and (iv) were matched correctly by most of the students, while items (iii) and (v) were matched correctly by few of them. The correct matching for item (i) was D *(Fusibility),* but some of the students wrongly matched it with *C (Conductivity).* These students failed to recognise that melting of metal was more related to fusing of metals and not conduction of heat which is a mode of heat transfer in solid matter.

In item (ii) students were required to select the response which matches correctly with the ability of a metal to resist impact force before fracture. Students who were conversant with mechanical properties of metals choose the correct response *G (Toughness).* However, most of the students who failed in this item mismatched it with *B (Strength).* They confused between the two terms because they related mechanical properties of metals where toughness is the amount of impact load that can be sustained by a metal before it fractures while strength is the ability of the metal to sustain the stresses or strains caused by a load regardless it is static or dynamic.

In item (iii) the majority of students failed to match the ability of a metal to spread without breaking when acted upon by a force or hammered. They matched it with responses which were not correct such as E. Luster. The reason for incorrect matching might have been contributed by lack of knowledge on material properties.

In item (iv), the students were inquired to correctly match response with A characteristic of a material which allows heat to travel through it from one point to another. The students who matched correctly had sufficient knowledge on properties of metals. Students who failed selected alternative *D (Fusibility)*, while other few chose *E (Luster)* instead of *C. (Conductivity)* which is the correct answer. These students failed to recognize the fact that heat traveling in a material does not directly imply melting of the material because fusing of metal depends on temperature reached. Those who chose E also did not understand that luster is not related with heat. These responses indicate that, the students had insufficient knowledge on properties of metals.

Items (v) inquired the students to match the statement which stated *The resistance a metal gives to any scratching or indentation*, with one of the given responses. The correct answer was *F (Hardness)*. The students who matched correctly had adequate knowledge of hardness of metals. However, most of the students who failed this part matched with *G. (Toughness)*. These students either did not understand the given statement or had misconception of the term toughness.

2.1.3 Question 3: Production of Engineering Materials

The question had two parts (a) and (b). In part (a) the question required students to explain the term mechanical working of metals and in part (b) students were required to give two categories of mechanical working of metals.

The question was attempted by 270 students which is (99.3%), where 90.4 percent scored from 0 to 1.5 mark, 1.5 percent scored from 2 to 3.5 marks and the rest 8.1 percent scored from 4 to 6 marks. The analysis indicates that students' performance was weak because 90.4 percent scored below average. Table 2 shows the scenario.

Table 2: Performance of Students in Percentage for Question 3

Scores	**0 – 1.5**	**2 – 3.5**	**4 .0 – 6.0**	**Total**
Performance	Weak	Average	Good	
Number of Students	244	4	22	270
Percentage	90.4	1.5	8.1	100

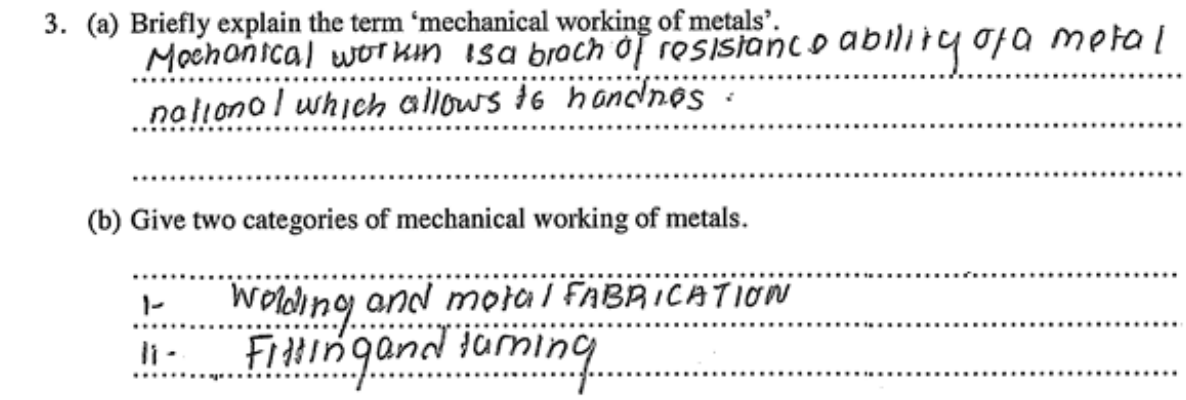
The analysis shows that 90.4 percent of the students who scored low marks (0 – 1.5) in this question. Among them many (83.7%) scored 0 mark as they failed to recall that mechanical working of metals involves changing shapes of metals by either hammering, twisting folding, bending, pressing or squeezing, rolling and piercing or punching. Few of them scored only 1 mark after giving explanations which were incomplete in either part. Furthermore, they couldn't categorise mechanical working of metals into two main groups as were required by the question. One of the students gave wrong explanation and categorisation of mechanical working as follows:

(a) Mechanical working is the type of metals which are mostly preferred for mechanical use in engines

(b) Two categories of mechanical working of metals are;

- *Cast iron*
- *Wrought iron*

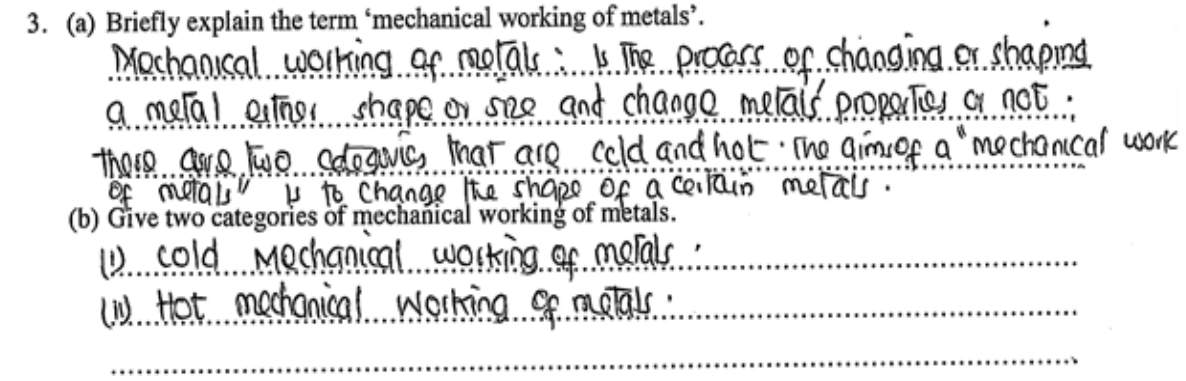
This student did not comprehend the question demand therefore gave types of metals instead of categories of mechanical working of metals. This kind of responses and others of similar nature given by the students implies that these students did not understand the demand of the question and lacked knowledge in the topic of production of engineering materials. Extract 3.1 shows the response of a student who failed to provide relevant answer to the question.



Extract 3.1 shows one of the poor response of a student who failed to either provide correct explanations of cold working of metals or give two categories of it.

In Extract 3.1 the student explained the term mechanical working of metals as the ability of the metal which allow to hardness in (a) which is not correct and gave two categories of mechanical working as welding and metal fabrication and Fitting and turning which is also wrong.

Some students who scored between 2 to 3.5 marks were able to name two categories of mechanical working of metals but failed to explain the term mechanical working of metals. Other students attempted both parts but their answers missed some relevant points. Their low performance was caused by insufficient knowledge on the topic of engineering materials. On the contrast, 7.7 percent of students who scored from 4 to 6 named two categories of mechanical working of metals and provided good explanation of the term mechanical working of metals. Extract 3.2 illustrates the response of the students who complied with the requirement of the question.



Extract 3.2: The response of the student who answered correctly the question.

In this Extract the student gave correct explanations of mechanical working and gave correctly the categories of mechanical working.

2.1.4 Question 4: Properties of Metals

The question demanded students to mention two non-ferrous metals which are malleable and two which are not.

This question was attempted by 272 students (100 %) and the analysis of performance shows that 58 percent scored from 0 to 1.5 marks and 23.4 percent scored from 2 to 3.5 marks. Moreover, the analysis indicates that 18.6 percent scored from 4 to 6 marks. Generally, the question was performed poorly because most students (58%) scored below average. Figure 3 illustrates the performance of students in this question.

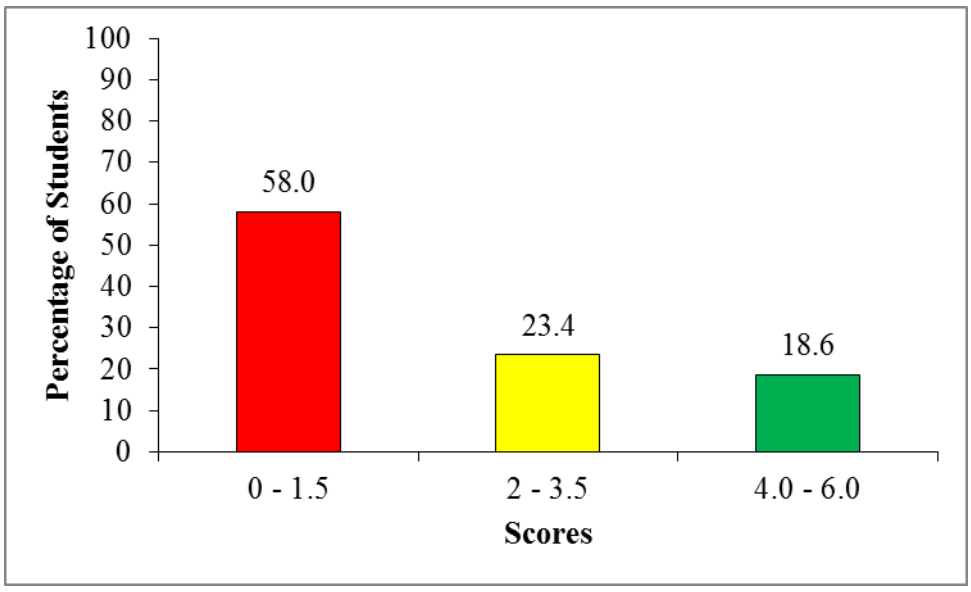


Figure 3: Performance of students in percentage for question 4

The data in Figure 3 indicates that the students' performance in this question was average as 42 percent scored 30 percent and above of the total marks allotted to the question. Despite the average performance, 58 percent of the candidates scored low marks because they failed to identify two non-ferrous metals which are malleable and two which are not. The analysis of the responses shows that students were not able to distinguish between ferrous metals and non ferrous metals and this situation led most of them to mention ferrous metals such as *steel* and *cast iron* instead of non ferrous metal. Furthermore, other students confused malleable non ferrous metal with some alloying element therefore wrongly mentioned tungsten and chromium as non ferrous metal which are malleable. They were supposed to mention *aluminium, lead and bronze* as malleable and *brass and zinc* as non ferrous metals which are not malleable. Also, there were students who left blanks in the space provided for answers. However, some students (31.2%) mentioned only one correct material in either part therefore scored 1.5 marks. The poor performance is an indication that these students were not conversant with the topic of properties of metals. Extract 4.1 shows a sample of response of a student who failed to comply with the demands of a question.

4. Mention two non-ferrous metals which are malleable and two which are not.

Malleable non-ferrous metals are:

(i) Brass

(ii) Carbon

Non-ferrous metals which are not malleable are:

(i) Aluminium

(ii) Copper

Extract 4.1: A poor response of the student who provided answers not related to the question needs.

In this extract the student mentioned three non ferrous metals but failed to place them in the right group. Copper and aluminium are malleable material so were supposed to be in the first part. Likewise Brass is not malleable so was supposed to be in the second part. Carbon is not a non ferrous metal.

On the other hand, 23.4 percent of the total number of students who attempted this question scored 3 marks. These were able to mention correctly two non-ferrous metals which are malleable but failed to mention two which are not and vice versa. Some of the students mixed both ferrous and non ferrous metal or non ferrous metals with non metals in their answers. For example one student mixed by writing malleable non ferrous metals as *aluminium and stainless steel*. Another student mixed by writing non ferrous metals which are malleable as *copper and rubber.* This demonstrates insufficient knowledge of the students on nonferrous metals.

Despite the average performance of most students, there were 51 students (18.8%), who scored 4 to 6 marks. Some of them mentioned correctly two materials in the first part and one correct material in the second part while others mentioned correct materials in both parts. This performance is an indicator that students comprehended the question and had enough knowledge of the concepts tested. Extract 4.2 shows a good response from one of the students.

4. Mention two non-ferrous metals which are malleable and two which are not.

Malleable non-ferrous metals are:

(i) Copper

(ii) Aluminium.

Non-ferrous metals which are not malleable are:

(i) Brass.

(ii) Zinc

Extract 4.2: The response of student who answered correctly in both parts of the question.

In Extract 4.2 the student mentioned correctly the two non ferrous metals which are malleable in one part and two non ferrous metals which are not malleable in another part.

2.1.5 Question 5: Production of Engineering Materials

The question had three parts (a), (b) and (c). The question required students to explain the terms (a) Slag, (b) Skipper and (c) Billet as used in production of iron and steel.

This question was attempted by 255 students (93.8%), where 70.6 percent scored from 0 to 1.5 mark, 22.3 percent scored 2 to 3.5 marks and 7.1 percent scored from 4 to 6 marks. 17 students did not attempt the question. Generally, the performance of students in this question was poor because 70.6 percent students scored below average marks as illustrated in Figure 4.

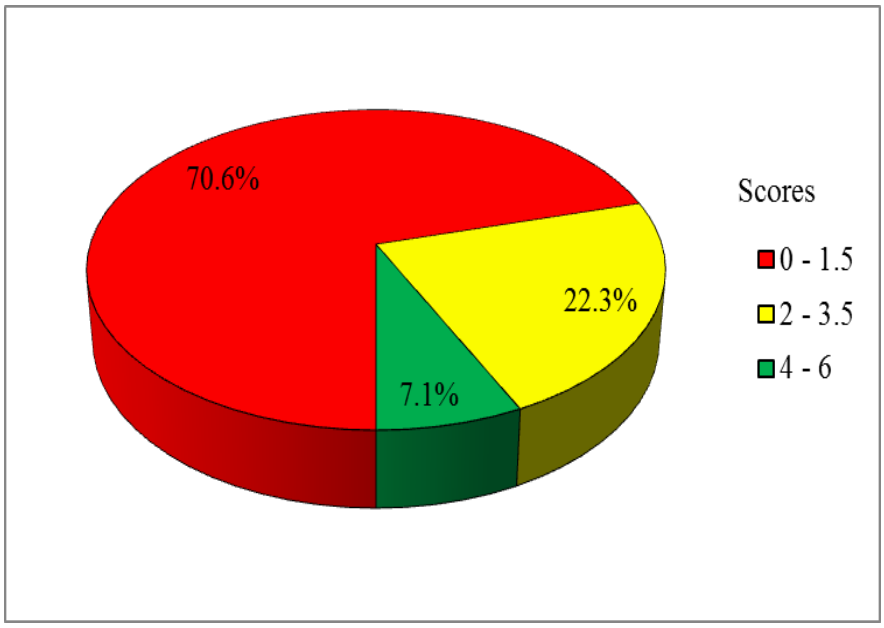


Figure 4: Performance of students in percentage for question 5.

The question tested students' ability to define the terms slag, skipper and billet as used in the production of iron and steel. The analysis of student's performance shows that 70.6 percent of students scored 0 – 1.5 marks. Some of them provided partial responses which could not deserve more than 1.5 mark while others scored 0 as they provided irrelevant responses. The analysis of their individual responses reveals that misconception of the question led them to writing of irrelevant answers such as explaining them as process or types of holes and others which do not relate instead of defining or stating the implication of each term in the production of iron and steel. For example one student wrongly defined all the terms as follows: *Slag used to construct engine*; *skipper is used to make oil*; *billet is used to cook oil*. Another student defined wrongly the terms as follows: *(a)* ***Slag*** *is the name of a metallic material which constrains (b)* ***Skipper*** *is the following material fall under a group of a non-ferrous alloy (c)* ***Billet*** *is the two main groups of steel.* These answers and others of similar

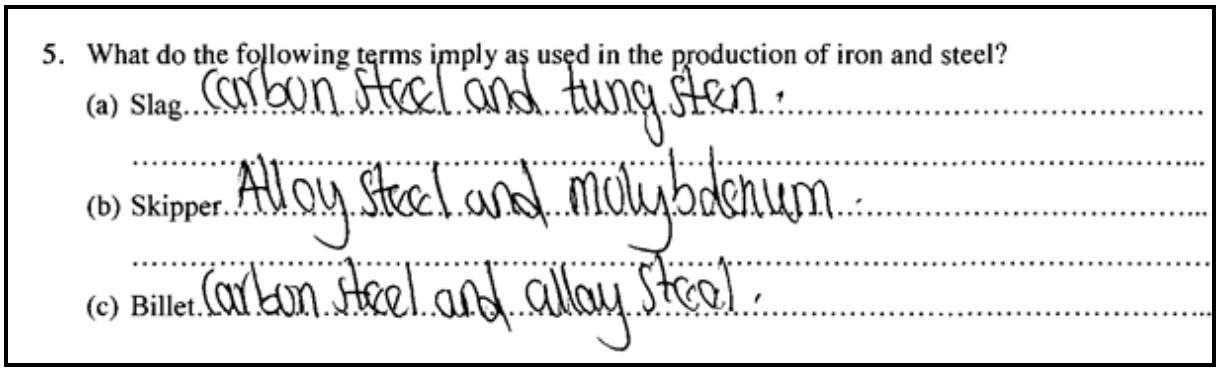
nature from the students demonstrated inadequate knowledge of students on the production of engineering materials as well as misconception of the question. The correct answers were as follows;

(a) Slag is the material which floats on top of molten metal in the furnace and it is poured out as residue material.

(b) Skipper is a car type bucket which travels on the rails built along the stack of the furnace used to carry the raw materials and feed the furnace through the hopper at the top.

(c) Billet is a rectangular bar of iron which is further rolled to give different final products such as sheets, plates or angle bars.

Extract 5.1 represents the sample of response from a student who provided irrelevant answers to the question.


5. What do the following terms imply as used in the production of iron and steel?

(a) Slag Carbon steel and tungsten.

(b) Skipper Alloy steel and molybdenum.

(c) Billet Carbon steel and alloy steel.

Extract 5.1: A sample response of a student who provided irrelevant answers.

In this Extract, the student put names of materials instead of writing the definition of the terms as required by the question.

Further analysis showed that, 57 students which is equivalent to 22.5 percent scored from 2 to 3.5 marks. Some of these students were able to define two terms only. Others defined all the terms, but some of their definitions were not exhaustive or the points were not arranged in a clear and logical manner. This kind of performance implies that these students were not well knowledgeable on the topic of production of engineering materials in which all the terms asked in the question are commonly used. Also limited English language proficiency led them to write some unclear definitions or statements.

On the other hand, 7.1 percent of students exhibited good performance because they managed to define correctly two or all three given terms. This showed that they had enough knowledge on the topic of production of engineering materials and they understood requirements of the question. Extract 5.2 depicts a sample of the response from a student who provided a relatively good answer to the question.

5. What do the following terms imply as used in the production of iron and steel?

(a) Slag...Is the unwanted materials that fall at the top of molten iron and is not needed.

(b) Skipper...Used to carry charging raw materials into the furnace.

(c) Billet...Used in the production of ships plates and bars.

Extract 5.2: A sample of relatively good response of a student who managed to give correct definitions of three terms.

In Extract 5.2 the student stated correctly what slag is in part (a).and gave the correct use of the skipper and billet in parts (b) and (c), this implies that the student was familiar with the materials and equipment in question.

2.1.6 Question 6: Engineering Materials

The question required students to explain the effects of the following alloying materials to steel; (a) Carbon (b) Manganese (c) Tungsten and (d) Chromium.

Analysis of data shows that 252 (92.6%) of the students attempted this question, whereas 86.9 percent scored from 0 to1.5 marks, 10.3 percent scored from 2 to 3.5 marks while 2.8 percent scored 4 out of 6 marks. None of the candidates scored full marks. A summary of candidates' performance is given in Table 7

Table 3: Performance of Students in Percentage for Question 6

Scores	**0 – 1.5**	**2 – 3.5**	**4 - 6**	**Total**
Performance	Weak	Average	Good	
Number of Students	234	26	8	268
Percentage	86.9	10.3	2.8	100

The data in Table 3 indicates that the students' performance in this question was poor as 86.9 percent scored below average marks in this question. The analysis of the students' response shows that students who scored 0 mark failed to explain the effect of the mentioned alloying element in all parts while those who scored 1.5 mark explained correctly the effect of only one alloying element.

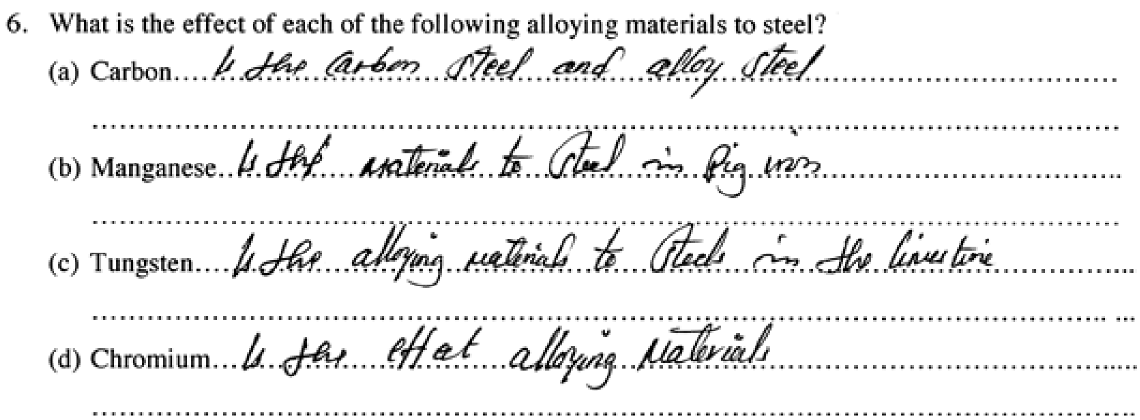
In part (a) students did not recall the fact that the more carbon added to steel the more harder is the steel that is why they failed to state the effect of carbon to steel. This is exemplified by some of the responses such as, *the effect of carbon is to remove impurities from steel* or *to support combustion during its manufacture* given by some of the students.

Students who performed poorly in part (b) failed to realise that manganese is a useful alloying element for steel as it makes steel not only harder but also makes it acquire good resistance to wear. They did not recognise that most parts of machines which are subjected to wear such as hoes, shovels and other earth moving equipment parts are made of steel parts alloyed with manganese.

Moreover in part (c) students were supposed to understand that, when tungsten is added to steel it gives steel an ability to maintain its cutting edges at high temperature so it is an important alloying element for steel which is intended for manufacturing of metal cutting tools such as lathe, drilling or shaping tools.

Likewise, most of the students responded poorly in part (d) where some stated that; *chromium is added to steel to make tool steel* and others wrote that, *chromium is added to steel to make it conduct heat*, while some wrote that *chromium is added to steel to bend it*. They could not recognize that chromium is added to steel to increase both hardness and resistance to corrosion and that is why it is used for the production of stainless steel. These answers were not correct.

Generally, the analysis showed that students had little knowledge on modification of qualities of steel so that it can be used in different areas of mechanical engineering such as making of steel structures for bridges and buildings or producing cereal grinding machine parts or metal cutting tools. Extract 6.1 shows a sample of a poor response for a student who did not comprehend to the demand of the question.


6. What is the effect of each of the following alloying materials to steel?

(a) Carbon... It the carbon steel and alloy steel

(b) Manganese.. It the materials to steel in pig iron

(c) Tungsten.... It the alloying materials to steel in the limestone

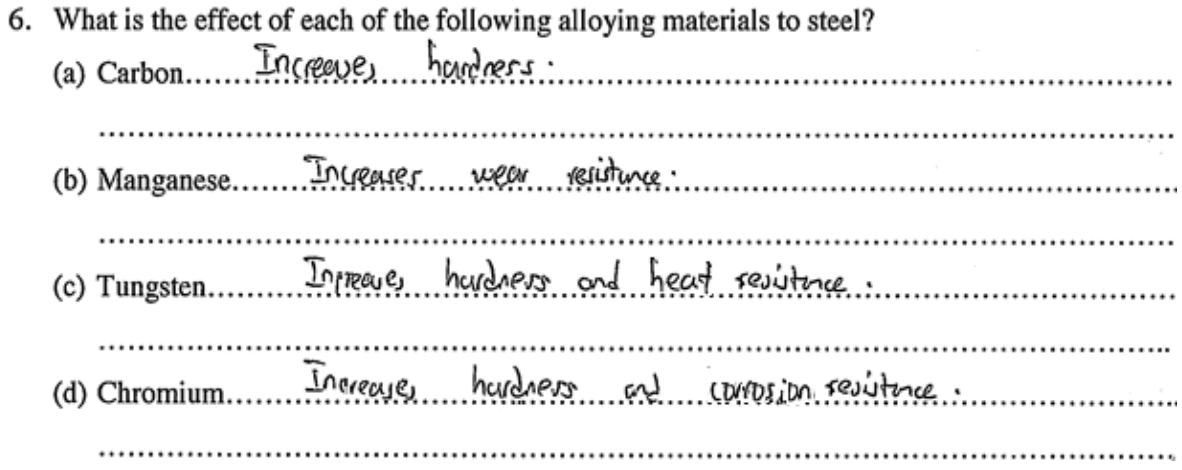
(d) Chromium... It the effect alloying materials

Extract 6.1: The response of students who failed to give relevant answer in all parts.

In this Extract the student wrote ungrammatical, illogical and incomplete statements which did not fulfil the question demand.

Moreover, 10.3 percent of the students who attempted this question scored average marks. Some were able to write correctly the effect of alloying elements in either two parts and others wrote the effects in in all four parts but with some of the their answers lacking clarity. This performance was contributed to inadequate knowledge of students and difficulty in providing clear explanations.

However, there were only eight students who scored 4 marks. They managed to write correctly the effects of given alloying elements to steel. This indicates that they comprehended the demand of the question and had sufficient knowledge on the concept of modification of mechanical properties of steel to suit the intended use of that steel. Extract 6.2 represents a sample of response from one of the students who provided the correct effect of engineering material to steel.


6. What is the effect of each of the following alloying materials to steel?
(a) Carbon..... Increases hardness .....
.....
(b) Manganese..... Increases wear resistance .....
.....
(c) Tungsten..... Increases hardness and heat resistance .....
.....
(d) Chromium..... Increases hardness and corrosion resistance .....
.....

Extract 6.2: A sample of a good response from a student.

In this extract the student wrote correctly effects of the alloying elements to steel in all parts.

2.1.7 Question 7: Engineering Materials

The question required the students to outline four uses of wrought iron. It tested the student's ability to recognise the application of different types of metals.

A total number of 281students (96%) attempted this question and their results were as follows: 69 percent scored from 0 to 1.5 marks, 20.8 percent scored from 2 to 3.5 marks and 10.7 percent scored from 4 to 6 marks. Generally, the performance of students in this question was poor because most of students (69%) scored below average. Figure 5 represents the performance of students in this question.

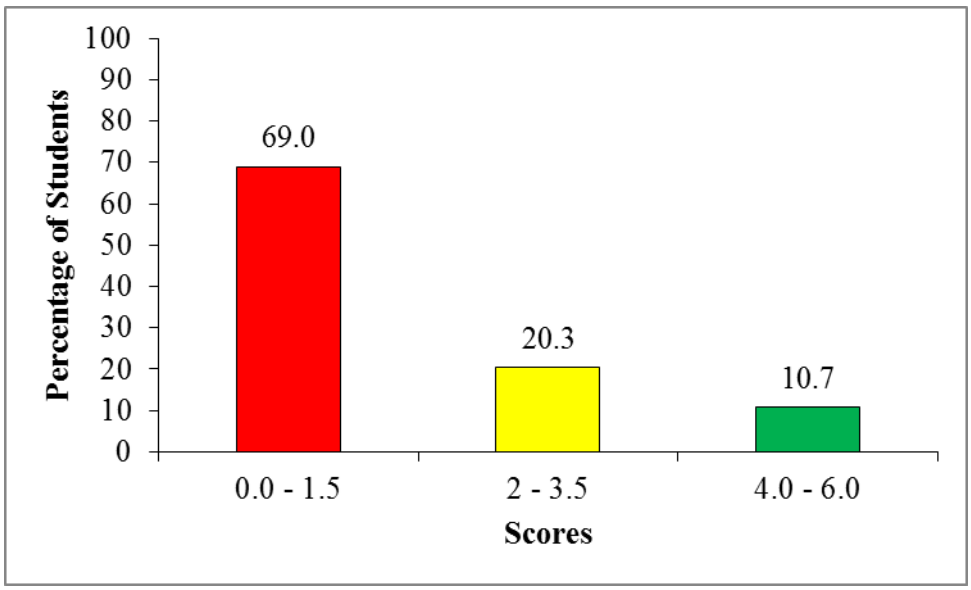


Figure 5: Performance of students in percentage for question 7

The analysis shows that most of the students scored from 0 to 1.5 marks with those who scored 0 mark being 52.5 percent. Some of the students who scored 0 mark provided answers which revealed that they failed to recall the uses of wrought iron. For example, one student wrote the uses of wrought iron as follows; *used to transfer electricity, used to prevent rust, used to produce heat, used to transfer sound.* Another student wrote that wrought iron *is used to reduce tear, used to manufacture chemicals, used to produce brass and used to produce galvanization* which were also incorrect. Moreover, others misunderstood the question therefore wrote the properties of metals instead of uses of wrought iron. For example one student wrote the uses of wrought iron as follows: *it withstands shear forces, it withstands compressive forces, it withstands tensile forces and it withstands bending forces*; whereas all were contrary to the demand of the question. However, 43 students were able to write only one correct use of wrought iron thus scored 1.5 marks. The reason for this failure could be attributed by lack of knowledge on the topic of engineering materials. The correct answers to the question were as follows:

The uses of wrought iron are;

(a) Used in general forging operations
(b) Used for making couplings for railways constructions
(c) Used in manufacture of pipes
(d) Used in manufacture of chains and books
(e) Used for manufacture of stay bolts, rivets and engine bolts.

The students were required to provide any four uses. Extract 7.1 is a sample of a poor response from a student who failed to comprehend the question.

7. Outline four uses of wrought iron.

(a) Used a furnace for Steel Iron

(b) Used to reduce friction between the moving parts

(c) Used to Coal the cutting tools

(d) Used to coal the work peace

Extract 7.1: A poor response of a student who provided answers which are not related to the question asked.

In this Extract the student considered wrought iron as a cooling or lubricating substance therefore wrote the uses as to reduce friction in (b), cool the cutting tool and workpiece in (c) and (d) which is not true. Also provided unclear statement in part (a)

The students with average marks in the question were able to write two uses of wrought iron, out of the required five. This was an indication that they did not have a conversant with wrought iron materials. It was further noted that, the students with average marks in the question mixed incorrect points in their answers; thus, scoring from 2 to 3.5 marks. For example, one of the students was able to provide the uses of wrought iron as *(a) used in the production of pipes, (b) used in the making of engine cylinder, (c) used in the making of bolts (d) used in the making of engine cylinder head*, thus scored in parts (a) and (d) and missed in parts (b) and (c).

Despite the average performance of students, there were some students (10.7%) who performed well in this question. They outlined correctly four uses of wrought iron. These students demonstrated a good understanding of the demand of the question and had adequate knowledge as well. Extract 7.2 represents the response of a student who met the demand of the question.

7. Outline four uses of wrought iron.

(a) It is used in railway construction.

(b) It is used to make the nuts.

(c) It is used to make bolts.

(d) It is used to make crane hooks.

Extract 7.2: A sample of a good response of a student who provided four uses of wrought iron.

In the Extract 7.2, the student provided the four correct uses of wrought iron materials.

2.2 SECTION B: OPTIONAL QUESTIONS

OPTION I: REFREGERATION AND AIR CONDITIONING

2.2.1 Question 8: Refrigeration cycle, Refrigerant, Brazing, Heat, Pressure and Temperature, Tools and Equipment.

This question had three parts (a), (b) and (c). In part (a) students were required to; (i) State the function of refrigerant in a refrigeration system, (ii) give five important characteristics that a refrigerant should have in order to be used in a refrigeration system and (iii) explain four methods which can be used to detect leakage of refrigerant in a refrigeration system.

In part (b) students were required to (i) give differences in the following;

- Heat capacity and specific heat capacity
- Gauge pressure and absolute pressure

(ii) Calculate the absolute pressure in the part of the system, while being guided by information given in the question.

(iii) draw a line diagram which shows four main components of a refrigeration cycle for a domestic refrigerator in the relative positions.

In part (c) students were required to (i) select the suitable tool (from the given hand tools and pipe cutter) for cutting pipes in the refrigeration workshop and also give the reason for a particular choice.

(i) Suggest two tools suitable to accomplish the following jobs;
   - Removing the burrs at the end of the refrigeration tube or pipe
   - Bending of refrigeration tubes or pipes

(ii) Sketch a neat diagram which shows the connection of a flare fitting and clearly indicate the flare fitting, flare nut, flare and tubing.

(iii) Provide six steps of obtaining a brazed joint in refrigeration works. Assuming that heat sources is there already.

This question was attempted by all 60 students (100%) who specialized in Refrigeration and Air Conditioning. The data analysis of performance shows that 7 students which is equivalent to 11.7 percent, scored from 1 to 17.5 marks, 78.3 percent scored from 18 to 38 marks and the rest 10 percent scored 39 to 50 marks. Generally, the performance in this question was average. Figure 6 gives a summary of results in this question.

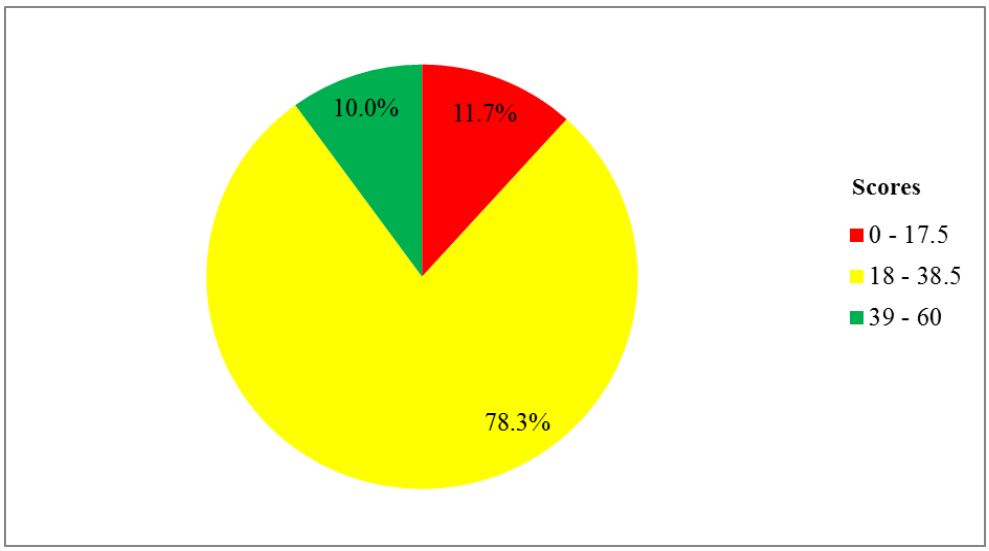


Figure 6: Performance of students in percentage for question 8

Figure 6 indicates that 11.7 percent of the students scored low marks (1- 17.5) in this question. These students failed to comprehend the demand of the question in most parts of the therefore they provided answers which were irrelevant to these parts. In part (a) most of them failed to state the function of refrigerant in (i), and explain four methods which can be used to detect leakage of refrigerant in (iii). For example in (iii) one of the students mentioned food preserving methods such as *canning, cooking, drying and refrigerating* while another mentioned refrigeration cycle components such as *compressor, condenser, evaporator and expansion valve* instead of methods which can be used to detect leakage of refrigerants. This item was the most poorly done in in part (a). some of the students also skipped it. It implies that students were not conversant with leak detecting methods such as leak detection by the use of *soapy water, sulphur candles, litmus paper electronic leak detector.* In (ii) few students were able to mention two to three out of five characteristics which a refrigerant should have while others failed.

In part (b) (i) students who did poorly, failed to give differences between heat capacity and specific heat capacity as well as gauge pressure and absolute pressure. Some of them defined correctly one of the two terms but did not compare with the other to elaborate their difference. Others misunderstood the question, instead of writing the difference between heat capacity and specific heat capacity they stated that specific heat is *the degree of hotness of a body*. They failed to remember that this was not the definition of specific heat capacity but a definition of temperature. Also one of the students wrongly stated that *specific heat capacity is twice heat capacity*, which is also not true. These responses indicated insufficient knowledge of the candidates on heat phenomena. Students who did poorly in (ii) failed to calculate the absolute pressure of the system from the given information in the question. They scored low marks in this item because some of them made mistakes in conversion of units from pascals to kilopascals while others made wrong substitution of values in the equation. Additionally others disregarded the negative sign used to express pressure in the question therefore obtained a wrong final answer. In (iii) students with low marks drew a poor line diagram and failed to place the components in their functional positions relative to

each other. This signifies that, students were not familiar with the arrangement of the components in the refrigeration system.

In part (c) (i) students who did poorly, failed to suggest which is more suitable for cutting pipes in the refrigeration workshop and also give the reason for such particular choice. They were supposed to know that a pipe cutter cuts the pipes squarely and this is difficult to maintain or achieve if a hand hacksaw is used. Those who performed poorly in (ii) failed to suggest two tools suitable for removing the burrs at the end of the refrigeration tube or pipes and other two for bending of refrigeration tubes or pipes. Some of the students suggested that *pipe cutter* can be used to remove burrs at the end of pipe. They did not realize that a pipe cutter is the one which causes the burrs at the end of pipe after cutting therefore it cannot be used to remove them. They were supposed to recognize that a *round file* and *a reamer* are the most suitable tools for removing burrs at the end of a refrigeration pipe.

However, item (iii) and (iv) were the most poorly done in this part. Majority of the students failed to recall the structure of a flared joint and put it into a sketch to show a flare fitting, flare nut, flare and tubing. Some of the diagrams presented were not related to the flare fitting but more related to weld joints. Likewise, the students failed to provide six steps of obtaining a brazed joint in refrigeration works. The poor performance in this part reveals students' inadequate skills in refrigeration works as this part consisted practical oriented questions. Extract 8.1 gives a sample of poor response for this question from one of the students.

8. (a) (i) What is the function of refrigerant in a refrigeration system?

refrigerant	refrigeration
is the process to move and to make thing cold.	is the process of put water meat, vegetable and etc.

(ii) Give five important characteristics that a refrigerant should have in order to be used in a refrigeration system.

- you should have air
- it help to make food cold
- it help to mark Vertable cold
- it help to make water cold
- it help to mark meat cold

(iii) Briefly explain four methods which can be used to detect leakage of refrigerant in a refrigeration system.

- the method which can be used to detect leakage of refrigerant is a refrigeration.
- The refrigerant is a refrigeration
- The process of make refrigerant to the refrigeration
- The process of mak recerse refrigerant to the refrigeration system.

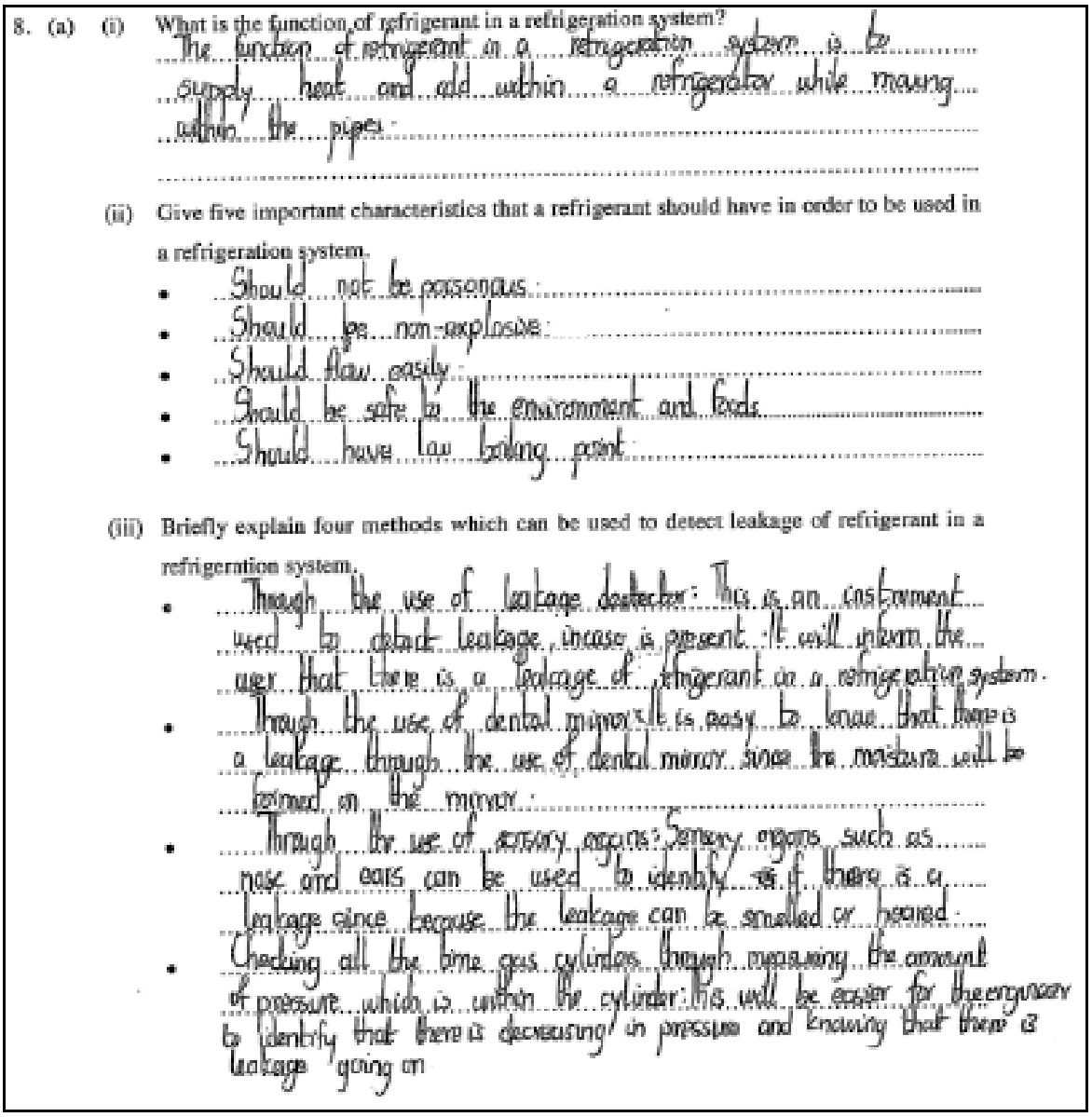
Extract 8.1: A poor response from one of the students who attempted only part (a) and the response were irrelevant.

In the Extract 8.1 the student explain refrigeration process instead of function of refrigerant in part (a) (i) and wrote incorrect characteristics of refrigerant in (ii). The student further used poor language to explain methods of detecting leakage of refrigerant and none of the explanations was correct.

Furthermore, 81.4 percent of the students performed averagely. Students in this category managed to provide correct answers to some of the items in the question but failed in others or skipped some of the items. The analysis of student's responses shows that most of them performed well in part (a) (ii) where they gave correct characteristics of refrigerants but failed or gave few correct points in (i) and (iii). It was also noted that in part (b) the students managed to give correctly the differences between heat capacity and specific heat capacity as well as gauge pressure in (i) and presented the diagram with most of the components

correctly locate in (iii). Similarly, in part (c) they were able to correctly suggest the suitable tools to be used for the activities described in (i) and (ii), but failed to respond well in (iii) and (iv) where they were required to provide a sketch of a flare fitting and six steps for obtaining a brazed joint in refrigeration.

On the other hand, there were few students (10.1%) who had good performance in this question as they responded correctly to most items in each of the three parts. They stated the function of refrigerant, gave important characteristics of refrigerant and explained the methods used to detect leakage of refrigerant in a refrigeration system. Also they correctly differentiated heat capacity and specific heat capacity, calculated the absolute pressure and drew a diagram to represent refrigeration cycle components. In addition they recognised and suggested suitable tools for cutting, bending removing burrs at the end of pipes, drew a diagram of flare fitting and stated the steps to obtain a brazed joint. This performance implies that students had sufficient knowledge on the topics tested. Extract 8.2 represents part of the response of a student who relatively complied with the requirement of the question.



8. (a) (i) What is the function of refrigerant in a refrigeration system?

The function of refrigerant in a refrigeration system is to supply heat and add within a refrigerator while moving within the pipes.

(ii) Give five important characteristics that a refrigerant should have in order to be used in a refrigeration system.

- Should not be poisonous.
- Should be non-explosive.
- Should flow easily.
- Should be safe to the environment and foods.
- Should have low boiling point.

(iii) Briefly explain four methods which can be used to detect leakage of refrigerant in a refrigeration system.

- Through the use of leakage detector: This is an instrument used to detect leakage, incase is present it will inform the user that there is a leakage of refrigerant on a refrigerating system.
- Through the use of dental mirror: It is easy to know that there is a leakage through the use of dental mirror since the moisture will be formed on the mirror.
- Through the use of sensory organs: Sensory organs such as nose and ears can be used to identify if there is a leakage since because the leakage can be smelled or heared.
- Checking all the time gas cylinder through measuring the amount of pressure which is within the cylinder: This will be easier for the engineer to identify that there is decreasing in pressure and knowing that there is leakage going on

(b) (i) Give the difference between the following terms:

- Heat capacity and specific heat capacity.

Heat capacity is the amount of heat required to rise the temperature of a body by 1°C while specific heat capacity is the amount of heat required to rise the temperature of a unit mass of a body by 1°C.

- Gauge pressure and absolute pressure.

Gauge pressure is the raw reading on the gauge during measuring pressure while absolute pressure is the sum of gauge and atmospheric pressure at any particular time.

(ii) A vacuum gauge connected to part of the refrigerator reads – 4.5 kPa. If the atmospheric pressure is 1.2 bar, what is the absolute pressure in that part of the system?

1bar = 10^5 Pa

1·2bar = ?

$= \frac{1 \cdot 2\text{bar} \times 10^5 \text{Pa}}{1\text{bar}} = 120000\text{Pa}$.

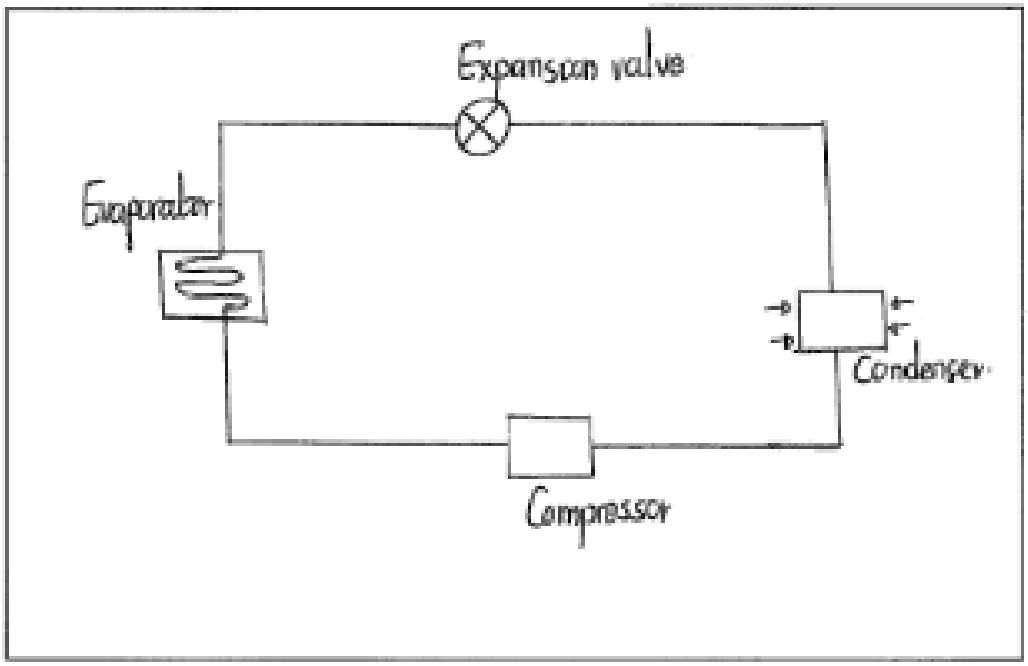
From,

Absolute pressure = Gauge + Atmospheric pressure

$= -4500 + 120000 = 115500\text{Pa} = 115 \cdot 5\text{KPa}$

∴ Absolute pressure = 115·5KPa

(iii) Draw a line diagram which shows four main components of a refrigeration cycle for a domestic refrigerator in their relative positions.



(c) (i) You are provided with a pipe cutter and a hand hacksaw and you are required to cut pipes in the refrigeration workshop. Which of the two is suitable for use? Give a reason for your choice.

The one suitable for use is a pipe cutter because it is designed for cutting pipes only.

(ii) Suggest two tools which are suitable to accomplish the following jobs:

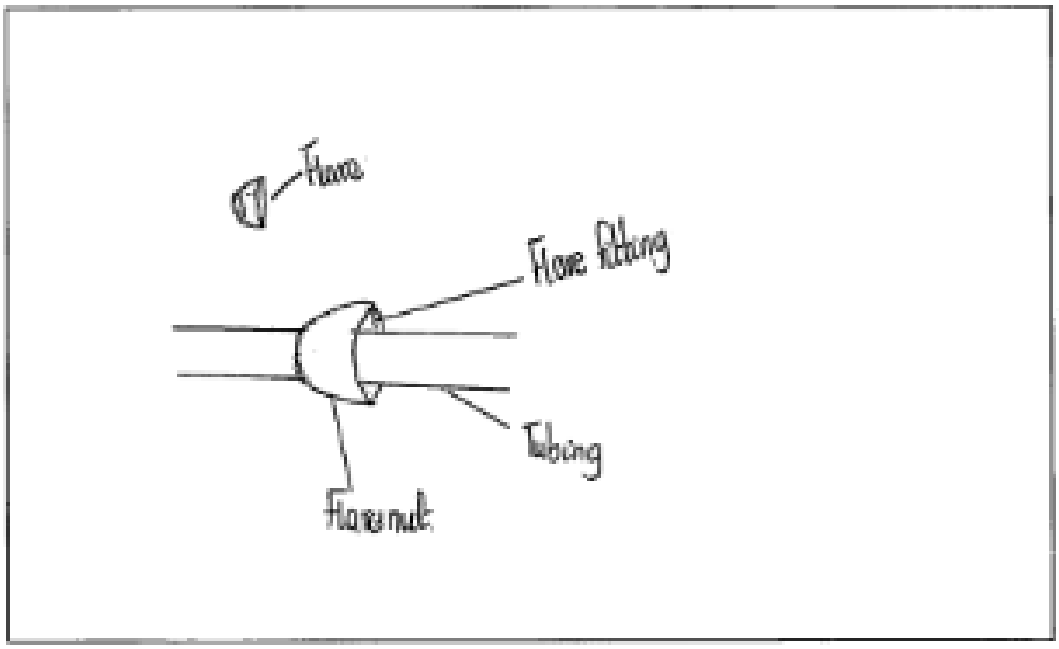
- Removing the burrs at the end of the refrigeration tube or pipe.

File and paper with an rough surface (Meraa)

- Bending of refrigeration tubes or pipes.

Bending machine and Spring

(iii) Sketch a neat diagram which shows the connection of a flare fitting and clearly indicate the flare fitting, flare nut, flare and tubing.



(iv) Provide six steps of obtaining a brazed joint in refrigeration works. Assume that the heat source is there already.

- Prepare the joints ready for joining.
- Put a solder between the ends of two pipes
- Apply heat so as to melt the solder.
- Make sure that the solder is well melted so as to be coated between the end of two pipes.
- Apply the flux so as to strengthen the joint and clean it.
- Make cleanliness on your workpiece after finishing

Extract 8.2: A sample of response from a student who provided relevant answers to most parts of the question.

In this Extract the student responded correctly in parts (a) (i) & (ii), (b) (i),(ii)&(iii). However the student provide uncommon methods of detecting refrigerant leaks in (a)(iii). Also in part (c) he/she responded correctly in (i), (ii) (iii) but misallocated the step of applying the flux which was supposed to come before applying the brazing rod in (iv) .

OPTION II: PLANT AND EQUIPMENT MAINTENANCE

2.2.2 Question 9: Maintenance, Preventive Maintenance and Corrective Maintenance

The question had three parts (a), (b) and (c). In part (a) students were required to; (i) mention four benefits of preventive maintenance to an equipment, (ii) give two possible causes of belt rupturing after installation and (iii) mention four activities performed while doing preventive maintenance.

In part (b) students were required to; (i) mention four basic information obtained in the operation manual of a machine, (ii) explain the use of torque wrench, pipe wrench and pullers in maintenance activities, (iii) give two points expressing what should be done to reduce tear and wear of machine parts and (iv) state the reason, why is it necessary to have a big stock of spare parts when a firm practices corrective maintenance style?

In part (c) students were required to; (i) outline four repair jobs which involve machining of metals, (ii) give two signs or symptoms for identifying a defective running bearing, and (iii) give four points why lubricant is applied between sliding surfaces during operation of machines.

This question was attempted by 5 students (100%) who specialized in Plant and Equipment Maintenance. The analysis of performance shows that 3 students which is equivalent to 60 percent, scored between 0 and 17.5 marks, 40 percent scored between 18 to 38.5 marks and no student scored between 39 and 60 marks. The performance in this question was poor. Figure 7 gives a summary of the results in this question.

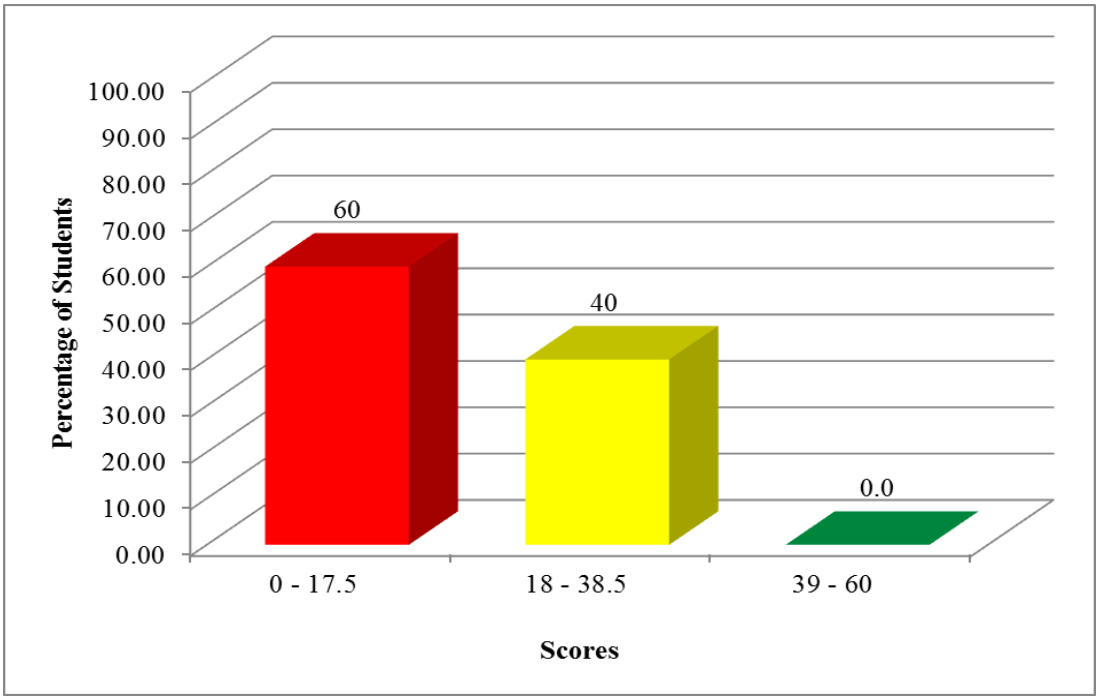


Figure 7: Performance of students in percentage for question 9

The analysis of students' performance in this question indicates that 60 percent scored low marks. Among them two students scored 2 marks and one student score 5 marks out of 60 allotted marks for the question. These students failed to understand the demand of the question in nearly all parts. They provided responses which were contrary to the questions. For example one of the students responded to the question in (a)(i) by writing the four benefits of doing preventive maintenance as *strength, bars, lusture and graphite.* These responses were irrelevant to the given question.

In (a)(iii) the student mentioned four activities which are performed in preventive maintenance as *it can prevent life of the machine, it can increase time of machine post, it can prevent friction of the machine parts, it can increase high production*. These are not activities carried out in preventive maintenance; they are more relating to benefits of preventive maintenance though not clearly written. Moreover, in (b)(i) the student wrongly mentioned the four basic information which can be obtained in the operation manual as *to take record of the machine, to do preventive maintenance to the machine, to do corrective maintenance in the machine and to make correction in the machine*. These do not comply with the demand of the question. Also another student who scored low marks outlined repair jobs which involve machining of metals as *general safety* and *general overhaul* instead of *removing a jammed pins or shaft by drilling, reconditioning of worn out shaft by machining, re-boring of sleeves or cylinders to a larger diameter, re-drilling of damaged holes, rethreading on housing and frames and reconditioning damaged cast components by grinding.* These inappropriate answers signify that the students had no knowledge in the tested topics of maintenance. Extract 9.1 gives a sample of poor response for this question from one of the students.

9. (a) (i) What are the four benefits of doing preventive maintenance to an equipment?

- ...Has...no...Stress.....
- ..Hing...quality.production.....
- ...working...space.....
- ..It...increase...long...life...Span...of...machine.....

(ii) It is observed that newly installed 'V' belts for a machine drive runs in too short time then ruptures. Give two possible causes of this situation.

- .....
- .....
- .....
- .....

(iii) What are the four activities performed while doing preventive maintenance?

- .....Has...no...stress.....
- .....Hing...quality...production.....
- .....It increase long life span of machine.....
- .....bearing...grease.....

(b) (i) Mention four basic information which can be obtained in the operation manual of a machine.

- ...It...Increase...lubricant...grease.....
- .....
- ...It...safe...life.....
- .....
- ..To...maximize...cost.....
- .....
- .....
- .....

(ii) Briefly explain the use of each of the following tools in maintenance activities:

- Torque wrench .....Puller.....

Extract 9.1: A poor response from one of the students who provided incorrect answer to the question.

In the extract 9.1the student wrote incorrect responses in all parts except in (a)(i) where two points were correct benefits of doing preventive maintenance to an equipment. These points are *high quality production* and *it increase long life span of machine*.

However, 2 students, equivalent to 40 percent of the students performed averagely. Students in this category managed to provide correct answers to some of the items in the question but failed in other or skipped some of the items. Furthermore, in part (c) (iii) the students managed to give at least two points out of four as reasons to why lubricant is applied

between sliding surfaces during operation of machines. This performance implies that students had insufficient knowledge on the topics tested. Extract 9.2 represents part of the response of a student who relatively conformed to requirements of the question.

9. (a) (i) What are the four benefits of doing preventive maintenance to an equipment?

- It increases the machines life span.
- It prevents further damage of a machine
- It reduces maintainance cost
- It ensures good production quality and quantity

(ii) It is observed that newly installed 'V' belts for a machine drive runs in too short time then ruptures. Give two possible causes of this situation.

- Industrial error in manufacturing such belts due to inappropriate raw materials or composition ratio.
- Improper fitting / installing of the belts to a machine that can result to the rupture

(iii) What are the four activities performed while doing preventive maintenance?

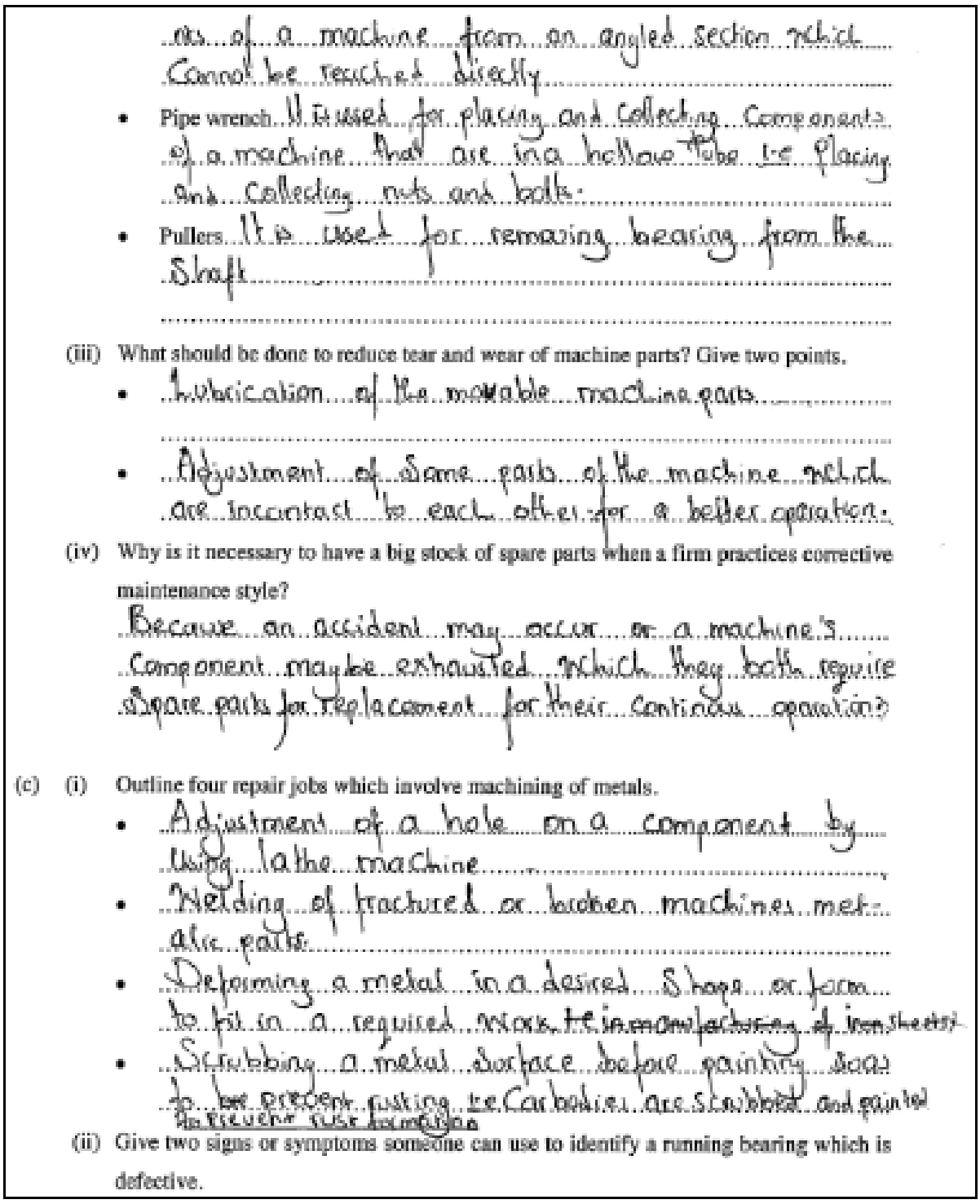
- Lubrication of movable parts
- Adjustment of some machine parts
- Replacement of the damaged accesories
- Monitoring the general machine's opeation

(b) (i) Mention four basic information which can be obtained in the operation manual of a machine.

- The intended function / functions of a particular machine
- Proper collection and assembling of the machine's accesories
- Proper usage / operation of the machine and some possible accidents
- Factors that may destruck, reduce efficiency or reduce the machine's life span of the machine

(ii) Briefly explain the use of each of the following tools in maintenance activities:

- Torque wrench It is used for picking and placing compone



Extract 9.2: A sample of response from a student who provided relevant answers to some parts of the question.

In the extract 9.2 the students managed to comply with the question demand by providing correct answers in some parts of the question. In part (a) the student wrote correctly all points in (i), last point in (ii) and all points in (iii). Among the answers provided in part (b) third and fourth point provided in (i) were correct information found in operation manual of a machine, last point in (ii) was a correct function of a puller and the second point in (iii) was also a correct measure to be taken to reduce tear and wear of machine parts. Likewise in part

(c) the correct points provided by the student are as follows: the first point in (i), both points in (ii) and the first two points in (iii).

OPTION III: MOTOR VEHICLE MECHANICS

2.2.3 Question 10: Locking devices and fasteners, Ignition systems, Lubrication system, Power unit and Safety Precaution.

This question was divided into three parts (a), (b) and (c). In part (a) students were required to; (i) explain the uses of spring washers, dowel pins, keys and key ways in motor vehicle and give one practical example for each device, (ii) mention four parts of an engine which are to be changed during overhaul and (iii) briefly explain the importance of chassis frame of the motor vehicle and give four vehicle system components which are carried by the chassis frame.

In part (b) students were required to; (i) calculate the volume of the combustion chamber from the given dimensions, (ii) explain the functions of choke, throttle, jet and float for the carburettor and (iii) differentiate a full flow from a by-pass oil filter system.

In part (c) students were required to; (i) study the given figure 1 then give the function of component represented by the figure and name the labelled parts A – F, (ii) give two differences between the high tension cables and low tension cables as used in engine ignition system, (iii) give three points on how the cooling rate or heat dissipating rate of air cooled engine increased and (iv) Identify two parts of an engine which are driven by the cam shaft.

This question was among the poorly performed questions as out of 141 (100%) students who attempted it (83%) percent scored from 0 to 17.5 marks. Only 26 students (15.6%) scored from 18 to 38.5 marks whereas, 2 students (1.4) percent scored from 39 to 60 marks. However, the highest marks scored in this question was 42.

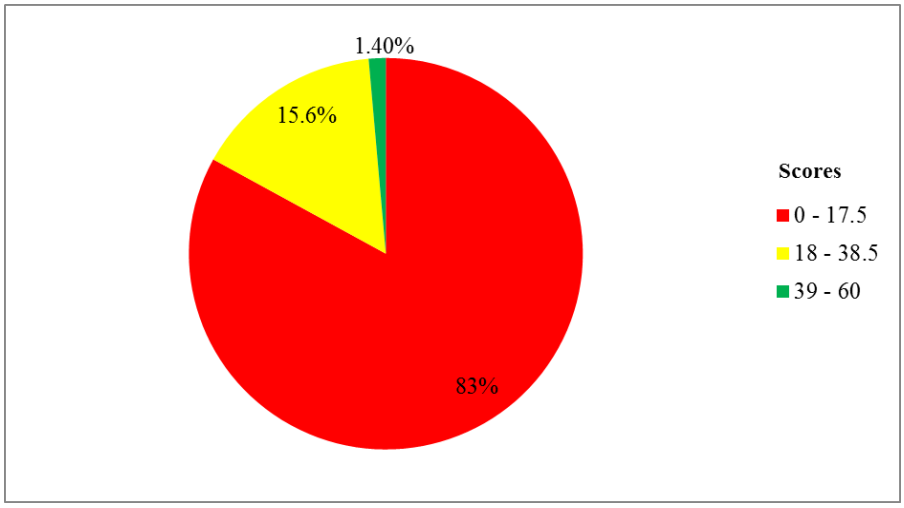


Figure 8: Performance of students in percentage for question 10

Figure 8 indicates that 83 percent of students scored low marks including those who scored 0 mark in this question. These students provided incorrect responses to the questions in many parts. Analysis of their responses revealed that they did not understand the questions in most of the parts and lacked knowledge and skills in different topics which were tested. For example in part (a) (i) Students failed to recall that a spring washer provides locking of the nut by exerting pressure, a dowel pin is used to locate together parts with surfaces which meet and lie flush and keys and keyways are used to lock components such as pulleys on shafts of machines. They instead gave irrelevant and illogical answers. For example one student wrote that, *the function of spring washer is to help the vehicle to bend down, the function of dowel pin is to connect the crankshaft and the keys and keyways are used when lighting or opening the engine*.

In part(a)(ii) some of the students wrongly mentioned parts such as *cylinder head , cylinder block, water jacket, and thermostat* for parts to be replaced during engine overhaul instead of 'piston rings and pistons, gaskets and other sealing materials, induction and exhaust valves, timing chain, oil filters and fuel filters'. Also students in this group of poor performance seemed not to understand what a vehicle chassis is, as their responses in part (a)(iii) did not satisfy the question demand. For example one of the students wrote that, the importance of vehicle chassis is *to prolong the two life of tool and parts attached to the chassis are piston camshaft and crankshaft* while another wrote that the importance of a vehicle chassis is *for travelling machine from one place to another and parts attached to the chassis are carburettor, water pump and fuel filter*. They were supposed to understand that the importance of vehicle chassis is to carry the loads, carry and support the components and parts so that they can perform their functions. Also, the components attached to it are: engine or power unit, brake system components, transmission system components, suspension system components and steering system components.

In part (b), students with poor performance failed to calculate the volume of the combustion chamber from the given dimensions in (i). Some of the mistakes noted in their calculations includes the use of incorrect formula for compression ratio for example some interchange the plus sign with the minus sign therefore instead of using Vs +Vc as the numerator in the formula, they used Vs - Vc. Others substituted directly the values of cylinder bore and stroke length without calculating first the swept and clearance volume (Vs and Vc) then substituting them in the formula. Additionally, others used the formula correctly but failed in their computations. Similarly, poor responses were observed in (b) (ii) where students explained incorrect functions of carburettor parts. For example one of the students wrote the functions of the components as follows: Choke; *to allow the fuel to enter the mixing chamber*. Throttle; *to allow the oil to enter the chamber*. Jet; *to allow air to enter floating chamber* and Float; *to mix the mixture completely*. In (iii) students failed to differentiate a full flow from a by-pass oil filter systems by writing irrelevant answers. One of those poor answers in this item was; *Full flow is the path in which oil flowing through a pipe while bypass oil filter is the device that filters*. Another answer of the same nature stated that; *full flow filter is when the filter is full while bypass oil filter is when the filter is empty*. The correct answer was: "In the full flow filter system the whole quantity of oil comes from the sump via filter to the lubricating components and then back to sump but in the bypass filter system, some of the oil comes

from the sump to the oil filter and some oil goes directly to lubricate the components and then comes back to the sump."

Students who did not score any mark in part (c) failed to comply with requirement of the question to all items (i-iv). In (i) some of the students confused and identified the component in the diagram as a distributer instead of an ignition coil thus named the parts A- F as distributer parts instead of ignition coil parts. Moreover, some of the responses given in (ii) implied that students were not conversant with the ignition coil. For example a student wrote that, *the high tension is the side where the direction of the driver wheel take place while the low tension is the side of the driven wheel.* This implies that the student did not remember the fact that a high tension cable carries about 20,000 volts while low tension cables carries only 12 volts. Also high tension cable is made from alloyed materials such as copper alloys while low tension cable is made of normal copper. Furthermore these students were also not able to give three ways of increasing heat dissipation in air cooled engines in (iii) as well as to name two parts of a vehicle which are driven by a camshaft. This denotes that students had no knowledge of the tested topics. Extract 10.1 gives a sample of poor response for this question from one of the students.

10. (a) (i) Briefly explain the uses of the following locking devices in motor vehicle. Give one practical example in each case.

- Spring washers. This is the device that used to locking a other device for locking and nut.
- Dowel pin. It used to lock a instrument or device for locking by using a key
- Keys and key ways. It used to lock an instrumets and another device by using a pin.

(ii) Which four parts of an engine have to be changed during overhaul?

- Crank shaft.
- Crank case
- Cam Shaft.
- Connecting rod.
-

(iii) Briefly explain the importance of the chassis frame of the vehicle and give four vehicle system components which are carried by the chassis frame.

Importance of vehicle chassis. This part is the vehicle that help a board of the vehicle to rest down so it resist a board to rest down

Vehicle components attached to the chassis are:

- A Car.
- Tractor.
- Motorcycle of three tyres.
- Train.
-

(b) (i) A petrol engine has a cylinder bore of 95mm and a stroke of 120mm. If the compression ratio is 9 to 1, calculate the volume of the combustion chamber in cubic centimeters.

Data given.
Cylinder bore 95MM.
Stroke 120MM.
Compression ration 9
Clearance volume ?

Soln.

$$\text{Clearance volume} = \frac{\text{Cylinder bore} + \text{Stroke}}{\text{Compression ratio}}.$$

$$CV = \frac{(120 + 95)}{9} = \frac{215}{9}$$

$$CV = 23.9\ CM^3$$

∴ the volume of Combustion Chamber is $23.9\ CM^3$.

(ii) What are the functions of the following carburetor parts?

- Choke. It increased the oil that path through in the Carburetor to the filter pump.
- Throttle. It to open and to closed a valve that through an oil from the Carburetor and into the Carburetor.
- Jet.
- Float. It used to maintainance that oil in the Carburetor.

(iii) Differentiate a full flow from a bypass oil filter system.

Full flow is the system that used to transport oil from the oil tank to the oil filter, and bypass oil filter system is the system of engine that used to take an oil for by pass on the Combustion Chamber.

(c) (i) Figure 1 shows one of the components in the ignition system. Study the figure carefully and answer the questions which follow:

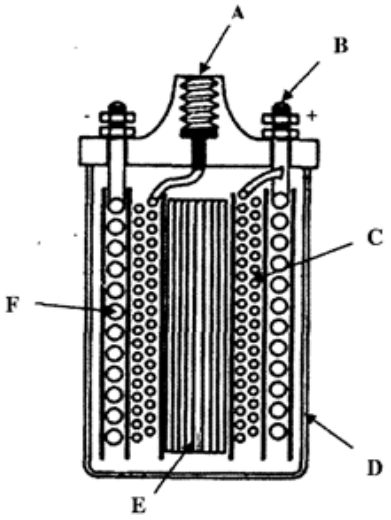


Figure 1

- Give the function of the component indicated by Figure 1.

  Function of this component is the to pump oil from the oil tank to the fuel filter and other component in the engine

- Name the parts indicated by letters A, B, C, D, E and F.

  A oil filter.
  B Cable of electricity.
  C oil that canbe pumped.
  D Wall of the oil pump.
  E Pump.
  F Tension of the cable.

(ii) Give two differences between the high tension cables and low tension cables as used in engine ignition system.

High tension cable has a pumped oil for high pressure and faster than low tension and low tension cable has a pumped oil for low pressure and lowest than high tension cable.

(iii) How is the cooling rate or heat dissipating rate of air cooled engines increased? Give three points.

- .....
- .....
- .....

(iv) Which two parts of the engine are driven by the camshaft?

- Crank shaft.
- Crank case.

Extract 10.1: A poor response from one of the students who provided irrelevant answers to the question.

In this extract, the student gave incorrect functions of the named locking devices, incorrect parts to be changed during overhaul of engine, incorrect explanation of the importance of the chassis and mentioned wrong parts which are carried by the chassis. The student also, failed to give proper answers in all items of (b) including the calculations of the volume of combustion chamber where he/she used cylinder bore and stroke length instead of swept volume and clearance volume as it was required for the proper calculation. Furthermore, the student failed to identify the type of component represented by Figure 1, supplied wrong answers to the rest of items and skipped item (b)(iii.

However, 15.4 percent of the students performed averagely. Students in this category managed to provide correct answers to some of the items of the question but failed in others. They also skipped some of the items in one, two or all parts of the question. Most of them scored marks in part (b) (i), (ii) and (iii) also in part (c). Furthermore, in part (b) (i) most of the students managed to calculate the volume of the combustion chamber from the given dimensions.

Despite the low performance in this question, there were few students (1.4%) whose performance was relatively good as their scores were above average but not full. They were able to answer correctly more than one item in each of the three parts of the question. This performance implies that these students had sufficient knowledge on the topics tested. Extract 10.2 represents part of the response of a student who relatively complied with the requirement of the question.

10. (a) (i) Briefly explain the uses of the following locking devices in motor vehicle. Give one practical example in each case.

- Spring washers are used together with flatwasher and nut to keep some parts of vehicle from become loose.
- Dowel pin are usde to holds parts together especially on a cosallated nuts.
- Keys and key ways are used for locking especiall on the vehicle doors and boot.

(ii) Which four parts of an engine have to be changed during overhaul?

- Piston rings
- plugs
- Cylinder gasket
- Piston.

(iii) Briefly explain the importance of the chassis frame of the vehicle and give four vehicle system components which are carried by the chassis frame.

Importance of vehicle chassis: Chassis are very important on the vehicle because is used to hold some parts of the vehicle at rear side.

Vehicle components attached to the chassis are:

- Clutch
- Engine
- Propeller shaft
- Gear box

(b) (i) A petrol engine has a cylinder bore of 95mm and a stroke of 120mm. If the compression ratio is 9 to 1, calculate the volume of the combustion chamber in cubic centimeters.

Solution

Data given

bore of 95mm.d

Stroke of 120mm.L

CR is 9:1

Clearance volume = ?

From: Compression ratio = $\frac{\text{Swept volume + Clearance volume}}{\text{Clearance volume}}$

$CR = \frac{\frac{\pi d^2 L}{4} + 1}{CV}$

$Sv = \frac{\pi d^2 L}{4}$

$Sv = \frac{3.14 \times 95^2 \times 120}{4}$

Swept volume = 851565 mm^3

$CR = \frac{Sv + CV}{CV}$

$9 = \frac{851565 + CV}{CV}$

$9CV = 851565 + CV$

$9CV - CV = 851565$

$\frac{8CV}{8} = \frac{851565}{8}$

$CV = 106269.375\ mm^3$

$CV = \frac{(106269.375)}{10}\ cm^3$

$CV = 10626.94\ cm^3$

∴ Volume of combustion chamber = $10626.94\ cm^3$

(ii) What are the functions of the following carburetor parts?

- Choke: It is used allow Petrol entering the float Chamber in a good proportion.
- Throttle: is used to allow fine air and petrol

mixture in good propurtions to the engine.

- Jet. Is used to allow petrol from float chamber to the mixture chamber of air and petrol particles.
- Float. are used to controll good ratio of petrol intering the float chamber are used together with float needle to adopt their function.

(iii) Differentiate a full flow from a bypass oil filter system.

Fullflow filter system it show the flow of oil from oil pan of the to other parts of vehicle and back to oil pan thoug oil filter while by puss oil filter syste oil can pass at one part of the filter and to the some parts of the vehide.

(c) (i) Figure 1 shows one of the components in the ignition system. Study the figure carefully and answer the questions which follow:

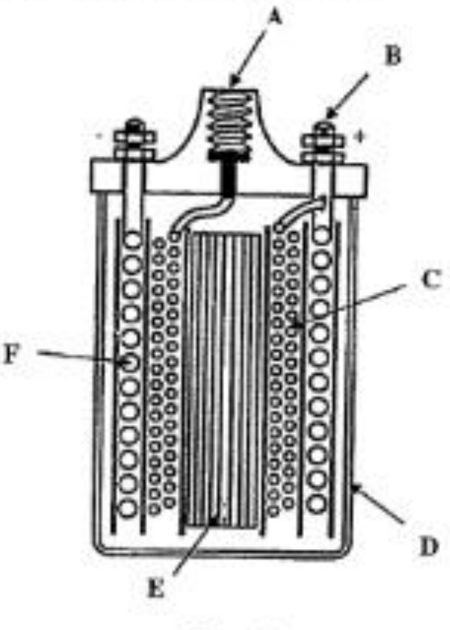


Figure 1

- Give the function of the component indicated by Figure 1.

  It is used to Supply electric current in the combustions Chambers in form of spark in order to produce combustion.

- Name the parts indicated by letters A, B, C, D, E and F.

  A Terminal
  B Positive plate
  C electrolyte
  D Case
  E Separator
  F Waste which is distilled

(ii) Give two differences between the high tension cables and low tension cables as used in engine ignition system.

Hightension cables are used to transmit high electric currents while low tension cables are contain low electric current in the ignition system.

(iii) How is the cooling rate or heat dissipating rate of air cooled engines increased? Give three points.

- Because it is cheap, air is available anywhere.
- Because air does not cause corrosion but water cause corrosion in some parts
- .....

(iv) Which two parts of the engine are driven by the camshaft?

- Fuel pump
- Valve gear

Extract 10.2: A sample of response from a student who provided relevant answers to some parts of the question.

In the extract 10 2, the student wrote correct functions of spring washers in the first bullet but failed in the other two bullets (dowel pin, key and keyways), supplied correct answers in (a)(ii), (a)(iii), and used correct procedure of calculating combustion chamber but failed to locate the correct position of the decimal point in the answer for (b)(i). Also, he/she explained correct functions of one part of carburettor and partially on others. Similarly, he/she provided unclear difference of two systems of oil filtration. The student stated correct function of ignition coil in the diagram, correctly named some of its parts in (c)(i), explained partly the difference between high tension and low tension cables in (c)(ii), mentioned parts which are driven by camshaft in (c)(iv) but gave reasons of using air for cooling engines rather than explain how efficiency of air cooled engine if increased in(c)(iii).

OPTION IV: WELDING AND METAL FABRICATION

2.2.4 Question 11: Resistance welding, Welding joints, Gas welding, Arc welding, Electric arc welding equipment and accessories, Production of welding gases and Filler metals

This question was divided into three parts (a), (b) and (c). In part (a) students were required to; (i) give four impurities which are removed from crude acetylene in the purification process, (ii) state the functions of cylinder gauges, (iii) explain the procedures of cleaning a gas welding nozzle tip and (iv) explain three steps of obtaining oxy-acetylene flame from a welding torch.

In part (b) students were required to; (i) mention three applications of soldering process, (ii) mention six functions of electrode coating, (iii) study the figure 2 then, give the names of parts indicated by letters A – D and explain the important property to be possessed by the material for part A

In part (c) students were required to; (i) make a sketch of a single 'V' butt joint preparation showing plate thickness, included angle, angle of travel, root face and root gap, (ii) mention three advantages of using a rightward welding techniques in gas welding, (iii) give three types of joints in which fillet welding is applied and (v) give three possible results if the welder applies too low speed in arc welding.

This question was attempted by 29 students (100%) who specialized in Welding and Metal Fabrication. The analysis of performance shows that, 22 students which is equivalent to 75.9 percent, scored from 0 to 17.5 marks, 4 students, equivalent to 13.8 percent scored from 18 to 38.5 marks and the rest 10.3 percent (3 students) scored from 39 to 60 marks. Generally, the performance in this question was poor because most of the students (75.9%) scored below average. Figure 9 gives a summary of results in this question.

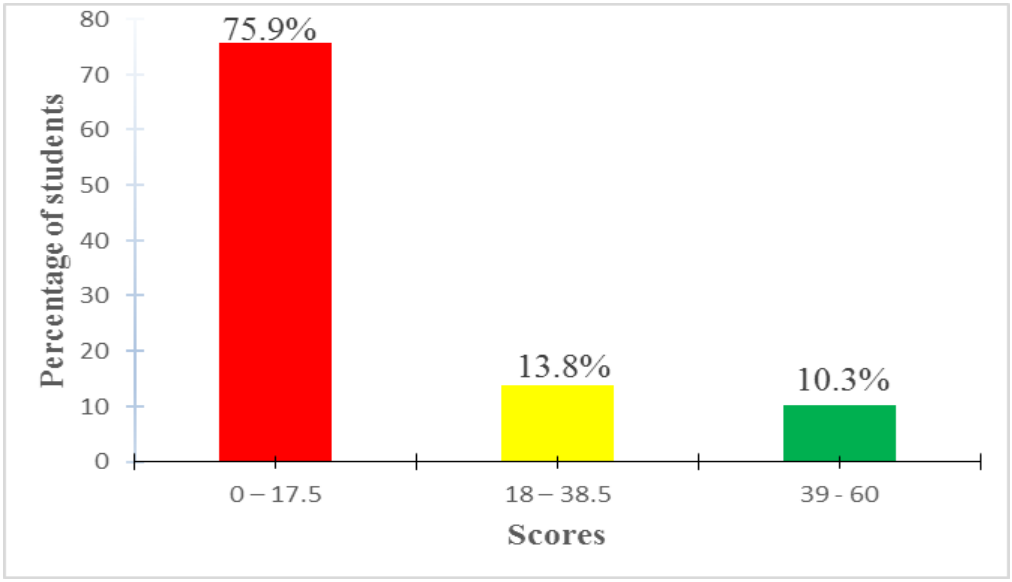


Figure 9: Performance of students in percentage for question 11

Figure 9 indicates that 75.9 percent of students scored low marks including those who scored 0 mark in this question. These students failed to comprehend the demand of the question and most of them provided answers which were irrelevant to it.

Students with poor performance (from 0 to 17.5) had varied weaknesses. Those who scored a 0 mark provided inappropriate responses in all parts of the question. In part (a)(i) for example, the students did not either understand the demand of the question or failed to recall the types of impurities found in crude acetylene which need to be removed before the gas is stored in cylinders for use. This scenario is shown by some students responses whereas one wrote that, *the chemical impurities are; oxy acetylene change, oxy acetylene equipment, oxyacetylene cylinder and oxyacetylene gas* while another wrote that, *the impurities are; acetylene cylinder, gas cylinder, oxygen cylinder and the pressure regulator*.. Also similar answers such as, *the function of cylinder gauges are to store acetylene gas, to store oxy acetylene gas as well as to remove the oxide and to keep the gas* were noted in (a)(ii). These answers are contrary to the question requirements. They were supposed to write the correct type of impurities which are: "ammonia, hydrides of phosphorous, sulphur, nitrogen, water vapour and particles of lime".

In part (b) the students who scored 0 marks could not adequately meet the demands of the question as they gave responses which comprised inappropriate explanations. Students wrote answers not conforming to the given tasks in the questions. For examples a student mentioned three applications of soldering process as, *low cost, it help to support acetylene flame and it helps to strong the soldering* and another one wrote the applications as, *for cooling, for heating and for melting* in (i). In (ii), a student wrote parts of stator and carburettor such as, *rotor, stator, rectifier parts, regulator, choke and throttle* instead of the functions of electrodes coatings. These answers depict students' misconception of the questions in this part. They were supposed to remember that soldering process is applied in wiring of radios and TV sets, wiring joints in electrical connections, battery and other

terminals, joints of radiator brass tube for motor car, joining copper tubing carrying liquid fuel, gas or air used on engine and repair of utensils.

Likewise in part (c), most of the students with poor performance diverged completely from the demands of the question in (i) by drawing corner joint, lap joint and tee joint instead of a but joint as required by the question. They failed to distinguish between but joint and other types of joints. They also went astray in responding to items (ii), (iii) and (iv). For example one of the students wrote the three types of joints in which fillet welding is applied as, *horizontal process, vertical process and overhead process* instead of "lap joint, corner joint and T- joint" in (iii). Also, another student wrote the results when a welder uses too low speed of electrode in arc welding as, *electric shock will occur, welding machine will switch off and electrode will stick* instead of "the occurrence of excessive weld deposits or reinforcement, under cut of the plates being welded and excessive penetration". This means students lacked the welding skills.

However, in most cases those who scored above 0 marks in the group of poor performance were able to provide some partial detail which did not deserve more than 17.5 marks. Extract 11.1 shows a sample of poor response for this question from one of the students.

11. (a) (i) Which chemical impurities are removed from crude acetylene in the purification process? Give four.

- ...oxygen...
- ...carbon...
- ...oxygen...
- ...oxyacetylene...

(ii) State two functions of cylinder gauges.

- ...to show the acetylene gas...
- ...to show oxyacetylene gas...

(iii) Explain the procedure of cleaning a gas welding nozzle tip.

...you should have wire brush and hand gloves...

(iv) Explain three steps of obtaining oxyacetylene flame from a welding torch.

- ...you should have goggle...
- ...you should have gloves...
- ...you should have wire brush...

(b) (i) Mention three applications of soldering process.

- ...painting...
- ...decorating...
- ...gold...

(ii) What are the six functions of electrode coating?

- to join metal flat joint
- to join different metals
- to join the T joint
- to join the corner joint
- to join edge joint
- to join corner joint

(iii) The diagram in Figure 2 shows one of the resistance welding methods.

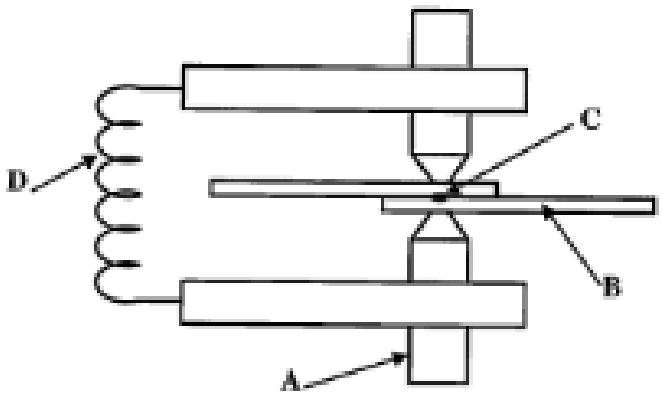


Figure 2

- Give the names of the parts indicated by the letters A – D

A. Arc

B. Stage

C. earth

D. Work

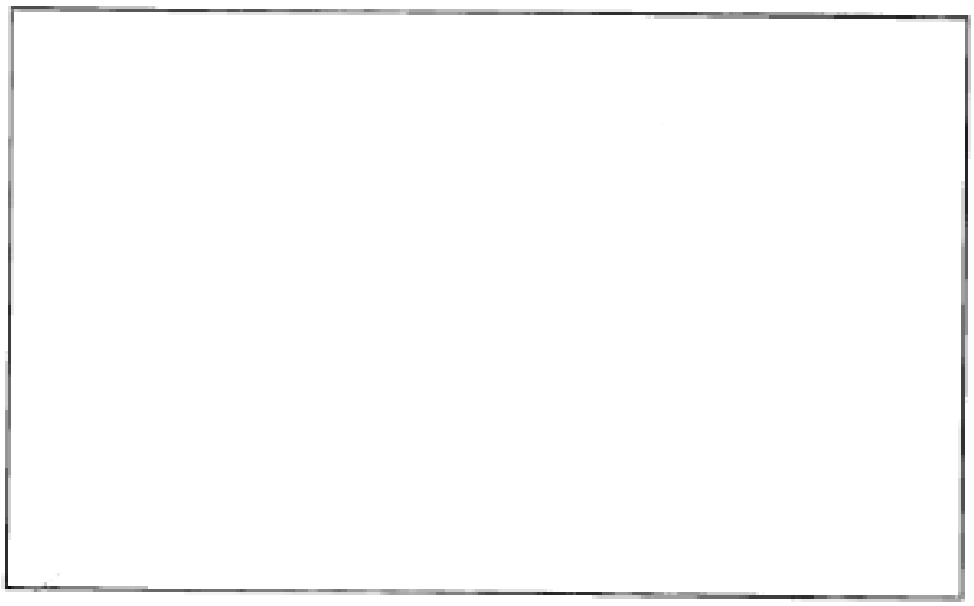
- What important property should be possessed by the material in part A?

  ...to.....touch.....and...giving...method.....

  .....

  .....

(c) (i) Make a neat sketch of a single 'V' butt joint preparation. Show the plate thickness, included angle, angle of bevel, root face and root gap.



(ii) What are the three advantages of using a right ward technique in gas welding?

- ...It...Simplify.....welds.....

  .....

- ...It.....make.....work.....easy.....

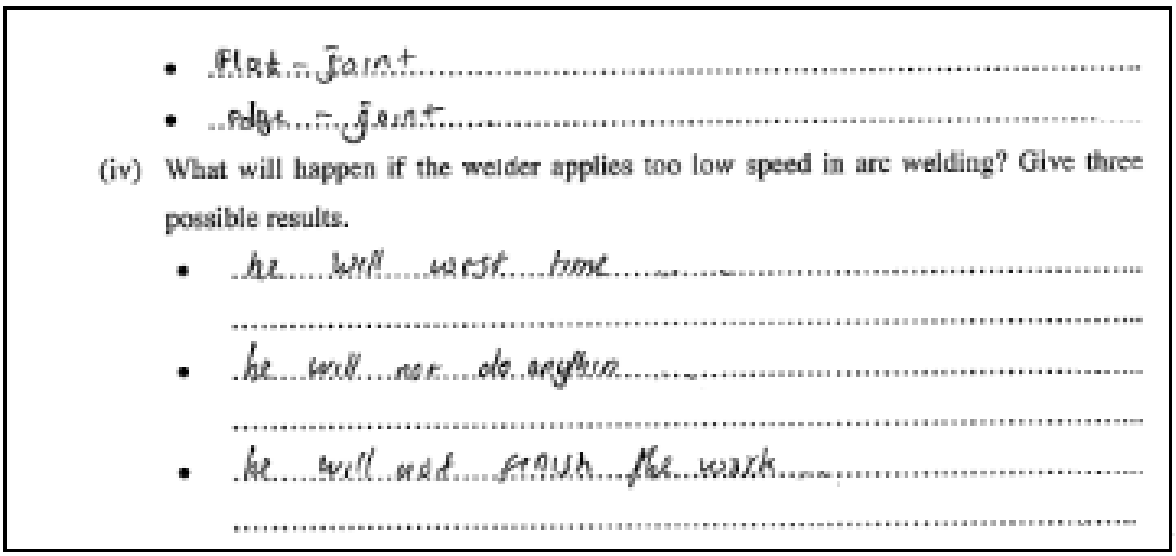
  .....

- It.....makes.....us...to...finish...early.....

  .....

(iii) Give three types of joints in which fillet welding is applied.

- ....T.-.Joint.....



Extract 11.1: A poor response from one of the students who provided irrelevant answer to the question.

In the Extract 11.1 the student provided responses which either did not relate to the question or related to the question but were incorrect. The responses in (b)(i) do not relate to the because the question is about applications of soldering process while the answers are about painting and decorating. The same in item ((ii), the question is about functions of electrode coating while the given answers are about types of weld joints. In all other parts the given answers relate to the question but do not exactly fulfil the given task in the question.

However, 13.8 percent of the students performed averagely. Students in this category managed to provide correct answers to some of the items but did poorly in others or did not attempt some of the items. Most of them scored marks in part (b) (i), (ii) and (iii). Also it was noted that in part (c) most of them did not do well in item (i) which asked them to draw a sketch of a single V, conversely they scored marks on some of the points in each of the rest items i e (ii), (iii) and (iv). Furthermore, students in this group did not attempt well most of the items in part (a), where only few students managed to state the functions of cylinder gauges in (ii).

Despite the low performance in this question, there were few students (10.3%) whose performance was above average. They were able to answer correctly more than one item in each of the three parts of the question. This performance implies that these students had adequate knowledge on the topics tested. Extract 11.2 represents part of the response of a student who relatively complied with the requirement of the question.

11. (a) (i) Which chemical impurities are removed from crude acetylene in the purification process? Give four.

- Air
- water vapour
- Sulphide
- Carbon hydrogen

(ii) State two functions of cylinder gauges.

- Indicate the gas supplied to the torch (blowpipe)
- Indicate the pressure of gas remained in the cylinder

(iii) Explain the procedure of cleaning a gas welding nozzle tip.

The if the welding nozzle tip has a dirty, the nozzle cleaner should pass through the nozzle tip orifice as many as time possible until the dirty is all removed. (but must use the correct tip or nozzle cleaner

(iv) Explain three steps of obtaining oxyacetylene flame from a welding torch.

- By supplying equal amount of oxygen and acetylene to the welding torch. (Neutral flame).
- By supplying more oxygen than acetylen to the welding torch (blowpipe). (Oxidising flame)
- By supplying more acetylen than oxygen to the the torch (blowpipe). (Carburising flame)

(b) (i) Mention three applications of soldering process.

- It is used to similar and joint similar and dissimilar metals together.
- It is used in shipmaking works.
- It is used in aircraft construction

(ii) What are the six functions of electrode coating?

- It makes easily starting of arc
- It helps to prevent rust on bead.
- It prevents the formation of of oxide
- It helps to make the joint stronger strong.
- It helps to cleans the surface to be welded.
- It prevents the cooling rate.

(iii) The diagram in Figure 2 shows one of the resistance welding methods.

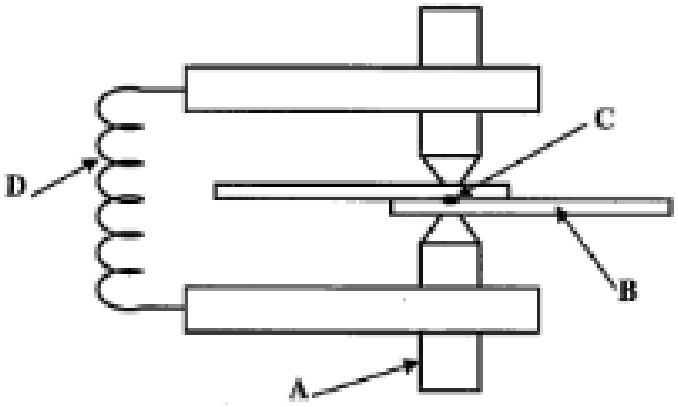


Figure 2

- Give the names of the parts indicated by the letters A – D

A Down fitted jaw (electrode)

B Base metal (parent metal)

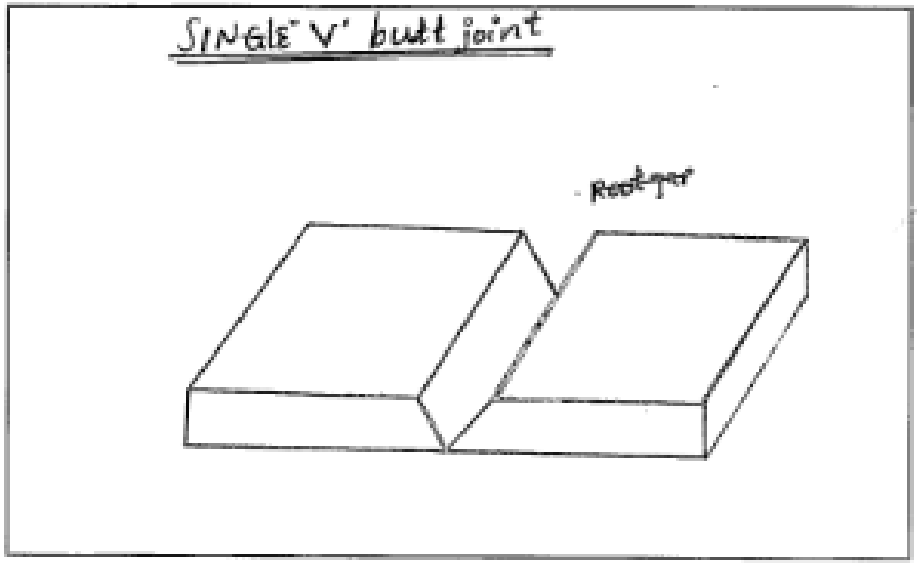
C Welded area (bead)

D Work cable Electric Cable

- What important property should be possessed by the material in part A?

  The important property should possessed by The material in part A is to be a good conductor of heat (passes heat easily to the backhand)

(c) (i) Make a neat sketch of a single 'V' butt joint preparation. Show the plate thickness, included angle, angle of bevel, root face and root gap.

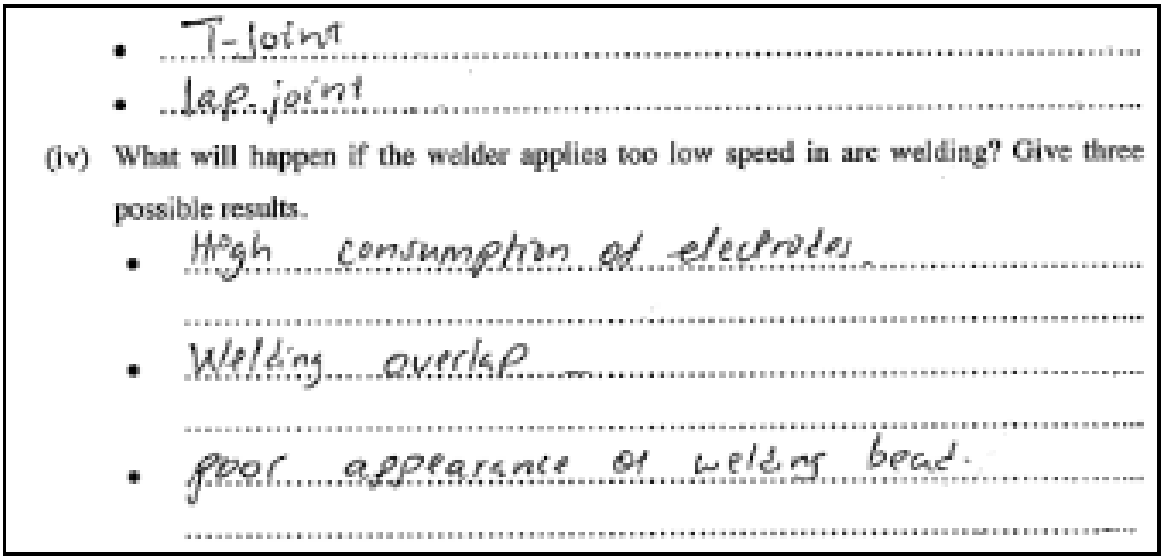


(ii) What are the three advantages of using a right ward technique in gas welding?

- It uses less electrodes (few electrodes) means that the consumption of electrodes is low.
- It is easy easily to be done or carried out
- The welding bead has good appearance.

(iii) Give three types of joints in which fillet welding is applied.

- Corner joint



Extract 11.2: A sample of response from a student who provided relevant answers to some parts of the question.

In the extract 11.2 the student responded correctly to most parts of the question. In part (a) the student obtained correct answers in all items except the first bullet of item (i) where *air* is not one of the impurities found in crude acetylene. In part (b) the student responded correctly to all items except the label D in item (iii) where he/she wrote *electric cable* instead of a "transformer coil". Also in part (c) the student complied to the question demand in (ii), (iii) and (iv) while in (i) he/she drew a a single V but joint but did not label to indicate plate thickness, included angle, angle of bevel, root face and root gap

OPTION V: FITTING AND TURNING

2.2.5 Question 12: Common tools, Drilling, Metal joining, Lathe machine and Hand tools

This question had three parts (a), (b) and (c). In part (a) students were required to; (i) mention three ways which can be used to determine the size of a lathe machine, (ii) give the functions of the following parts of a lathe machine; apron, saddle and cross slide and (iii) give four points to be considered when grinding a drill bit for hole making in steel.

In part (b) students were required to; (i) Give three methods of joining metals permanently, (ii) explain the uses of three main parts of a combination set, (iii) give three reasons, why micrometres are more preferred for precise measurements than vernier calliper? Finally in (iv) give the difference between a feeler gauge and a radius gauge based on their uses.

In part (c) students were required to; (i) draw a turning tool and show the following important angles; top rake angle, side rake angle, front clearance angle, side clearance angle, (ii) give two reasons which might cause a drill bit to produce oversized hall, (iv) draw a twist drill a show the flute, cutting lips and point angle or included angle and (iv) write in sequential order four grades of file cuts starting with the one which removes the surplus metal quickly.

The question was attempted by 28 students (100%) who specialized in Fitting and Turning, out of which 85.7 percent scored from 0 to 17.5 marks, which is a poor performance; 14.3 percent scored from 18 to 38.5 marks. However, the highest score in this question was 22 out of 60 allotted marks. This implies there were no students who had scored high marks, thus the question was poorly performed. Table 4 illustrates the students' performance in this question

Table 4: Performance of students in percentage for question 12

Scores	0 – 17.5	18 – 38.5	39 - 60	Total
Performance	Weak	Average	Good	
No. of students	24	4	0	28
Percentage	85.7	14.3	0	100

The analysis of the students' responses indicates that 85.7 percent of the students with poor performance in in this question either had partial or no knowledge of the question. Some provided partial responses which could not deserve more than 17.5 marks while others scored 0 as they provided irrelevant responses.

Students who did not score any mark in part (a) showed inability to mention three ways of determining the size of a lathe, state the functions of some parts of a lathe machine as well as to outline the some points to be considered when grinding a drill bit. Some of these students did not comprehend the question hence wrought things unrelated to the question requirement. For example a student wrote in (i) that, *three methods of determining the size of a lathe machine are drilling machine, lubricant drilling machine and non used drilling machine*. Another student mentioned *facing, parallel turning and drilling* operations performed by the lathe instead of the ways used to determine the size of a lathe machine. Others somehow understood the question but failed to recognize the correct answers. For example some of the students wrote names of measuring instruments such as *micrometre, steel rule and measuring tape* without elaborations of what is to be done. The correct answers were; 'measuring the maximum diameter of work that can be turned over the bed (swing), measuring the maximum length of the work that can be accommodated between centres and measuring the maximum swing in the gap, if the lathe has a gap-bed'.

In (ii) most of the students failed to formulate brief sentences to explain functions of the three lathe parts. Moreover, scenarios of misconception were noted in (iii), where provided answers which do note correlate with the question. For example a student mentioned; *table, spindle, base and head* as points to consider when grinding a drill bit while another student wrote incomplete statements as follows: *According to the type of shank, according to the type of flute according to the length, and according to application*.

In part (b) students who did poorly, failed to (i) give three methods of joining metals permanently. Some of them interchanged with the temporary methods which use fasteners such as bolts and nuts or screws. In (ii), It was noted that some of the students named only parts of a combination set while the question required uses of the parts. Others wrote

unrelated things for example a student wrote that, *making cast iron, making steel, making pig iron* as functions of a combination set parts. These answers signify that the student was not aware that a combination is a measuring instrument and cannot perform the function of iron or steel making furnace. Also some of the students skipped this item. In (iii) responses such as, *it is used to measure distance, it is used to measure gauge and it is used to measure it is used to measure voltage* and others of similar nature given by the students shows that they failed to realise the task in the question, which was to give three reasons why micrometres are more preferred for precise measurements than vernier callipers. Furthermore, in (iv) the weakness observed is that most of these students had a wrong concept that, 'a feeler gauge is used to measure length'. This concept led them to incorrect comparison between feeler gauge and radius gauge based on uses.

In part (c) students who scored low marks, failed to draw a turning tool and show the important angles. The analysis of their responses shows that, some of them failed to recall features of a lathe tool and lacked drawing skills as well, therefore drew sketches which did not represent real features of a lathe tool. Similar situation was noted on item (iii) where most of these students failed to draw a twist drill and show the given details. However, the responses to (ii) and (iv) revealed that students went astray by giving answers which did not meet question demands. Examples are the following answers to (ii): *No lubricant in the drill, no cheeps removal in the drill*; given by one student, and *low density (less mass), good chemical resistance;* given by another. These answers did not satisfy the question. The students were supposed to understand that the causes for a drill to produce oversized holes are: 'The drill ground with cutting lips which have unequal lengths or the drill bit ground with the cutting lips which inclines at different angles from the drill axis'. Furthermore, in item (iv) students confused between grades of file cuts asked in the question and types of files. Most of the students missed by mentioning types of files such as *hand file, flat file, triangular file, round file* instead of grades of file cuts which are, *rough cut, course cut, bastard cut and second cut*. Generally the failures of the students in all parts were contributed by lack of knowledge and skills on the tested topics. Extract 12.1 gives a sample of poor response for this question from one of the students.

(iii) What are the four points to be considered when grinding a drill bit for hole making in steels?

- Size
- Sharpener
- billets
- Force - Force size

(b) (i) Give three methods of joining metals permanently.

-
-
-

(ii) What are the uses of the three main parts of a combination set?

- Lathe machine
- Tool holder
- Purpose

(iii) Why micrometers are more preferred for precise measurements than vernier calipers? Give three reasons.

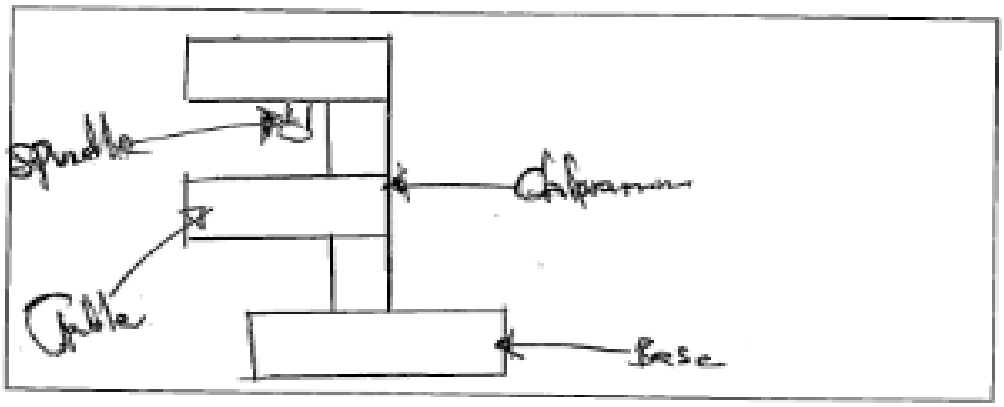
-

(ii) Give two reasons which might cause a drill bit to produce oversized holes.

- .....
- .....
- .....
- .....

(iii) Draw a twist drill and show the following parts:

- Flute
- Cutting lips
- Point angle or included angle



(iv) Write in sequential order four grades of file cuts starting with the one which removes the surplus metal quickly.

- .....
- .....
- .....
- .....

Extract 12.1: A poor response from one of the students who provided irrelevant answer and left empty spaces.

In the extract 12.1 the student did not comprehend the question, therefore wrote things which were contrary to the question demand and left blank in other items. In (a)(iii) the candidate wrote names of materials instead of the points to consider when when grinding a drill bit. Also, in (b)(ii), the student wrote names of machine parts instead of the uses of three parts of a combination set. Likewise, in (c)(iii) the student drew a drilling machine instead of the twist drill as required in the question.

However, 14.3 percent of the students performed averagely. Students in this category managed to provide correct answers to some of the items in the question but failed in others or They as well left some items unanswered. Most of them scored some marks in part (b) (i), (ii) and (iii) also in part (c). Additionally, in part (a) (ii) most of the students correctly gave the functions of the parts of a lathe machine. Extract 12.2 represents part of the response of a student who relatively complied with the requirement of the question therefore performed averagely.

12. (a) (i) Mention three ways which can be used to determine the size of a lathe machine.

- The Swing diameter over carriage
- The length of the bed
- The length between Centres

(ii) Give the functions of the following parts of a lathe machine.

- Apron Is a part of Carriage at lathe machine that feed mechanism applied.
- Saddle Is a part of Carriage at lathe machine which allow movements
- Cross-slide Is parts of Carriage at lathe machine that allow Tool post to travel at different direction

(iii) What are the four points to be considered when grinding a drill bit for hole making in steels?

- Put your twist drill accordingly to your hole
- Fit your work at a table of drilling machine
- Put on drilling machine
- Put a drill bit or twist drill in order to produce a hole at workpiece

(b) (i) Give three methods of joining metals permanently.

- Arc welding
- Using of stable Soldering gun
- Soldering Welding.

(ii) What are the uses of the three main parts of a combination set?

- protractor is used to measure a degrees at workshop.
- Compound head is used to support a work at headstock like Compound head.
- Steel rule is used at marking out Operation

(iii) Why micrometers are more preferred for precise measurements than vernier calipers? Give three reasons.

- micrometers are more precise than Vernier calipers

because of measue of small objects

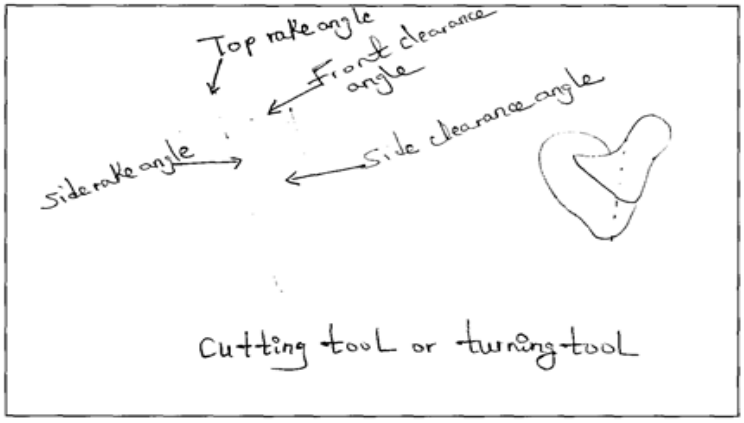
- Micrometer are simple wigs gauge than other like Vernier caliper
- Micrometer it is mart applicable at workshop while Using it Simplify work at short time

(iv) What is the difference between a feeler gauge and a radius gauge based on their uses?

feeler gauge and radius gauge gauge is the tool which used to measure or compare a component. feeler gauge and radius gauge are gauges that are different at radius and feel.

(c) (i) Draw a turning tool and show the following important angles:

- Top rake angle
- Side rake angle
- Front clearance angle
- Side clearance angle

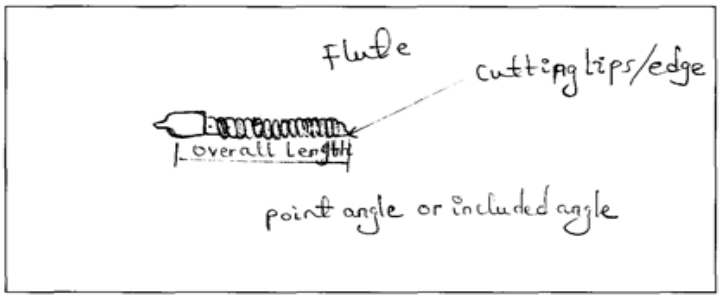


(ii) Give two reasons which might cause a drill bit to produce oversized holes.

- To put extreme speed which make a holes at high pressure which cause oversized holes
- Using a large drill bit which produce oversized holes.

(iii) Draw a twist drill and show the following parts:

- Flute
- Cutting lips
- Point angle or included angle



(iv) Write in sequential order four grades of file cuts starting with the one which removes the surplus metal quickly.

- Flat file
- Square file
- Triangular file
- Cross cut file

Extract 12.2: A sample of response from a student who provided correct answers to some parts of the question.

In the Extract 12.2, the student mentioned correctly the ways of determining size of a lathe machine and the functions of the lathe machine parts but missed the points to consider when grinding the drill bit in part (a)(iii). In part (b) the student provided correct answers in the first bullets of (i) and (ii), first two bullets of (iii) and missed all others. The students' performance was average.

OPTION VI: AUTO ELECTRICS

2.2.6 Question 13: Safety, Battery and Charging system

This question comprised three parts (a), (b) and (c). In part (a), students were required to; (i) give four faults on modern vehicle charging system that worn the driver by displaying warning light in the instrument panel, (ii) give six important criteria that a good charging system must meet when the engine is running, (iii) briefly explain the functions of the following parts; rotor, starter, rectifier parts and regulator.

In part (b), students were required to; (i) give three reasons why lead acid batteries are widely used in motor vehicles, (ii) give the possible causes of the battery being low in charge while the generator output is normal and (iii) briefly give reasons why only distilled water should be used for topping up a battery.

In part (c), students were required to; (i) studying the given figure 2 then, find the total resistance of the circuit and the current flowing in the circuit, (ii) give four main parts which form a dynamo, (iii) give three possible causes which may result into a car alternator working noisy and (iv) explain the purpose of fitting a cut-out in the charging system.

No student opted for this question.

OPTION VII: FOUNDRY AND BLACKSMITH

2.2.7 Question 14: Casting, Safety precautions, Pattern making, Forging, Foundry tools and Equipment

This question consisted of three parts (a), (b) and (c). In part (a) students were required to; (i) explain four essential qualities of a good core. (ii) explain with the help of sketches the uses swab, rammer and lifter as foundry hand tools.

In part (b) students were required to; (i) explain why binder is added to the moulding sand, (ii) mention four essential properties a binder material should possess, (iii) give a type of furnace used for melting cast iron in foundry shop for sand casting process, (iv) give two reasons why cast iron is widely used for producing castings and (v) explain briefly the characteristics of the hand hammers, sledge hammers and set hammers used in a forging shop.

In part (c) students were required to; (i) explain with the aid of sketches, how drawing down and fullering operations are done in hand forging, (ii) Explain, why shrinkage allowance, machining allowance, shake allowance and draft allowance are provided on patterns.

No student opted for this question.

3.0 SUMMARY ON THE STUDENTS' PERFORMANCE IN EACH QUESTION

The analysis of questions which were assessed in mechanical engineering subjects for FTNA 2020 has shown that the general students' performance was average. Good performance was observed in the question number 8 where the percentage of students who scored 30 percent and above was 88.3 percent, a multiple choice question number 1 from various topics where the students' performance was 84.2 and question number 2 with a performance of 61.4 percent. This good performance was attributed to student's adequate knowledge on the concepts related to the topics tested in the question, ability to understand the demand of the question and the nature of the items. Question number 8 was from topics of Refrigeration cycle, Refrigerant, Brazing, Heat, Pressure and Temperature, Tools and Equipment all of Refrigeration and Air Conditioning optional subject. Question 1 was derived from two topics production of engineering materials and properties of metals while question 2 was a matching item from Properties of Metals topic.

Question 3 to 7 were short answer questions derived from the topics of Production of Engineering Materials and Properties of Metals. Question 8 to 14 were optional questions falling under specialities known as Refrigeration and Air Conditioning, Plant and Equipment Maintenance, Motor Vehicle Mechanics, Welding and Metal Fabrication, Fitting and Turning, Auto Electrics and Foundry and Blacksmith. However, further analysis indicates that, the students performed averagely in three questions 4, 9, & 7 which were from the topics of Properties of Metals, Various Maintenance topics (Maintenance, Preventive Maintenance and Corrective Maintenance) and Production of Engineering materials respectively.

The poor performance of students was observed in six questions (3, 5, 6, 10, 11 & 12). Questions 2 and 5 were set from the topic of Production of Engineering materials and question 6 was from the topic of Engineering Materials. Question 10 was derived from the topics of Locking Devices and Fasteners, Ignition Systems, Lubrication System, Power unit and Safety Precaution whereas, question 11 was derived from the topics of Resistance Welding, Welding Joints, Gas Welding, Arc Welding, Electric arc Welding Equipment and Accessories, Production of Welding gases and Filler Metals. Moreover, question 12 was derived from the topics of Common tools, Drilling, Metal joining, Lathe machine and Hand tools.

Questions 13 and 14 from Auto electrics and Foundry and Blacksmith were not opted. The analysis of performance in the structured questions (8 to 12) shows that most of the students managed to answer only some parts in which they were knowledgeable and understood the requirement of the questions.. Question 3, 4, 5, 6 and 7 were short answers and they were

compulsory. The analysis indicates that the poor performance of students on various topics in these questions was contributed by the inadequate knowledge on the subject content, practical skills on particular topics as well as poor proficiency in English language.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The performance of students in mechanical engineering subjects for FTNA 2020 was average. The individual questions analysis indicates that three (3) questions had good performance and three (3) had average performance while other six (6) questions had poor performance and the remaining two (2) questions were not attempted.

Students who failed to score high marks lacked sufficient knowledge and skills for the tested topics in the question. They failed to recall and apply the concepts and principles of the subject matter so as to answer the questions in respective topics. In addition, most of them failed to understand the requirement of the question. This is justified through their answers, which were not correlating with what was asked in the question. The failure to identify the demand of the question was attributed to lack of students' carefulness in reading the questions before attempting them and poor command of English language. Therefore, more effort is needed to improve the student performance, especially in areas where students performed poorly.

4.2 Recommendations

The following are the recommendations aimed to improve students' performance;

(a) Teachers should take part in giving more emphasis for students to pay more attention to the given instructions on every examination paper and individual questions. This will help them to have a clear understanding on the requirement of the examination and individual questions in particular.

(b) Teachers should also advice students to build up a culture of reading variety of materials so as to broaden their general understanding and skills in mechanical engineering speciality.

(c) Teachers have to encourage students improve their writing skills in English language by giving them more exercises.

(d) Teachers should provide students with more practical assignments so as to help them correlate theoretical knowledge acquired in the class with actual practical skills.

(e) Invigilators from technical schools should help to remind students during technical subject examinations to observe instructions in their papers and not do otherwise.