THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

EXAMINERS' REPORT ON THE PERFORMANCE OF CANDIDATES CSEE, 2014

035 ENGINEERING SCIENCE
(For School Candidates)

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FOREWORD

The Engineering Science Examiners' report on the Performance of the candidates in the Certificate of Secondary Education Examination (CSEE) 2014 was written in order to provide a feedback to students, teachers, parents, policy makers and the public in general about the performance of the candidates and the challenges that they faced in attempting examination questions. The report, therefore, has attempted to reveal a number of factors that can be attributed to candidates' poor performance in the subject.

The Certificate of Secondary Education Examination marks the end of four years of Ordinary level Secondary Education. It is a summative evaluation which, among other things, shows the effectiveness of the education system in general and the education delivery system in particular. Essentially, the candidates' responses to the examination questions are strong indicators of what the education system was able or unable to offer to the students in their four years of Ordinary Secondary Education.

The analysis presented in this report is intended to contribute towards understanding of possible reasons behind the candidates' performance in Engineering Science subject. The report highlights the factors that made the candidates perform well in the questions. Such factors include ability to identify the task of the question, ability to follow instructions and candidates' knowledge on the concepts related to the subject. Despite the good performance the report also highlights factors which made few candidates fail. The feedback provided will enable the educational administrators, school managers, teachers, students and other stakeholders to identify proper measures to be taken in order to improve the candidates' performance in future examinations administered by the Council.

The National Examinations Council of Tanzania will highly appreciate comments and suggestions from teachers, students, school inspectors, curriculum developers and the public in general, that can be used in improving future Examiners' reports.

Finally, the Council would like to thank the Examination Officers and all others who participated in analysing the data used in this report, typesetting the document and in reviewing the report.

Dr. Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report on Engineering Science subject is based on the analysis of the performance of the candidates who sat for the Certificate of Secondary Education Examination (CSEE) in Engineering Science in 2014. The Engineering Science paper covered the form four Syllabus of 1994.

There were 16 questions distributed in three sections A, B and C. The candidates were required to answer all questions in sections A and B and choose three questions from section C. Section A carried 10 marks and B carried 30 marks while section C carried 60 marks.

A total of 1056 candidates sat for CSEE in Engineering Science paper out of which 651 (61.71%) passed while 405 (38.29%) candidates failed. The performance in 2014 decreased by 1.91 percent as compared to that of 2013 where 1203 candidates sat for CSEE of which 766 (63.67%) passed and 437 (36.3) candidates failed.

This analysis presents the requirements of each question, candidates' strengths and weaknesses in their responses and the percentage scores in each group. Finally, it provides the conclusion, recommendations and an attachment which contains the percentages of the candidates who scored 30 marks and above in each question.

According to this analysis, the performance of the candidates was categorised into three main groups which are weak, average and good. The pass mark for each question was 30 percent or above. Therefore the percentage of candidates from 0 - 29 who scored 30 percent or above had a weak performance (Red). Those from 30 - 49 had an average performance (Yellow) while those from 50 – 100 had a good performance (Green). Generally, the subject performance in CSEE 2014 was good.

2.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN INDIVIDUAL QUESTIONS

2.1 SECTION A: Objective Questions

2.1.1 Question 1: Multiple Choice

This question consisted of ten items (i)-(x) derived from various topics in the syllabus. For each of the items, the candidates were required to choose the correct answer among the given alternatives and write its letter beside the item number.

This question was attempted by 1054 candidates (98.2%), of which 3.4 percent scored 0 mark, 48.2 percent scored from 1 to 3 marks, 40.1 percent scored from 4 to 6 marks and 8.3 percent scored from 7 to 9 marks.

The items in which most candidates failed to select the correct responses were item number (iii), (iv), and (v).

In Item (iii), the candidates were required to select the correct effects produced by electric current. The correct answer was option C, which is *'heating, magnetic and chemical.* Most of the candidates opted for E, which is *heating, magnetic and attraction.* The candidate failed to recognize that '*attraction'* is not among the three effects of electric current, but confused the word attraction with magnetic.

In Item (iv), the candidates were required to choose the velocity - time graph which shows the speed of the ball thrown vertically upward from the ground. The correct option was A, but most of the candidates opted for B. The candidates failed to recognise the concept of solid body thrown vertically upward which means that the final velocity is 0. Therefore the candidates did not remember that the object thrown upward, its velocity decreases until reaches the final height before it starts falling down with initial velocity equal to zero.

In Item (v), the candidates were required to choose the factor which influences the size of the frictional force on the surface of a car moving at steady speed. The correct option was 'C' that is, 'its surface area only'. Most of the candidates opted for 'E' which was 'its weight only'. The candidates failed to differentiate between static friction and dynamic friction where by weight will have an effect on static friction and surface area on dynamic friction for example a moving car.

2.2 SECTION B: Short Answer Questions

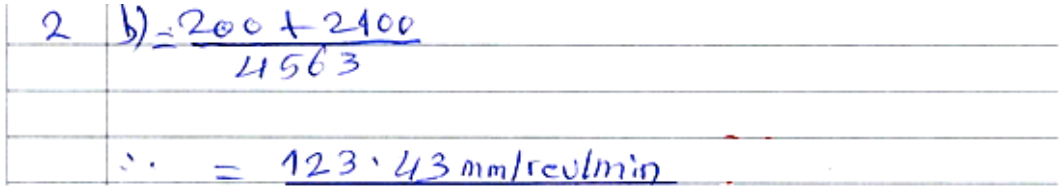
2.2.1 Question 2: Angular Motion

This question required the candidates in part (a) to define 'circumference speed' and in part (b) to calculate the circumferential grinding speed in m/s when a grinding wheel has a diameter of 200 mm which rotates at 2100 rev/min.

The question was attempted by 88.2 percent of all candidates whereby 45.8 percent scored a 0 mark, 53.1 percent scored from 0.5 to 2.5 marks and 1.1 percent of the candidates scored 3 marks.

The candidates who scored a 0 mark failed to define circumferential speed and could not identify the formula used to calculate the circumferential speed. This implies that, the candidates lacked knowledge on angular velocity. Extract 2.1 shows a sample of a response of a candidate who did not meet the question requirements.

Extract 2.1

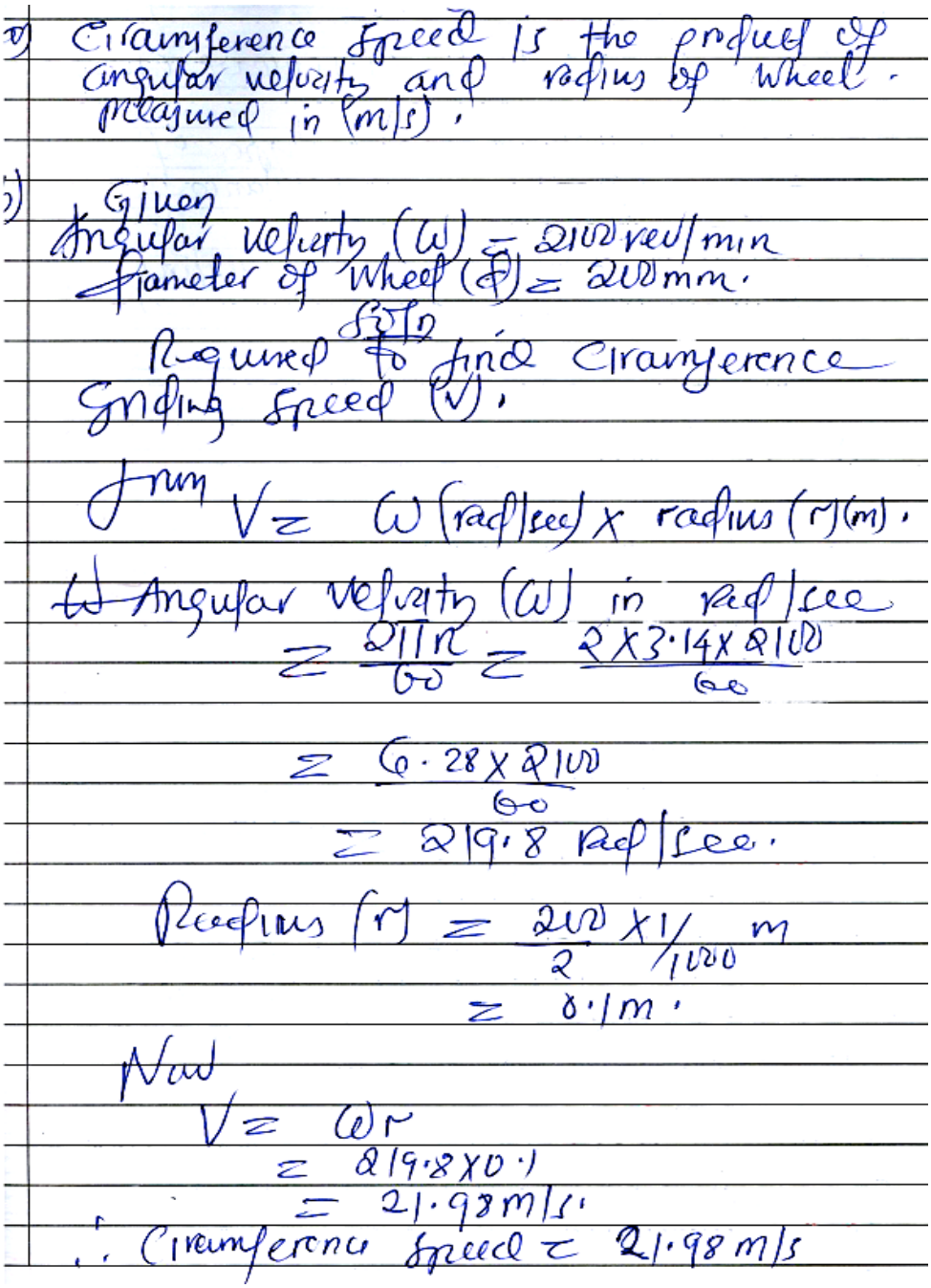


Extract 2.1 shows a sample of a response of a candidate who failed to define, calculate circumferential speed. He/she failed to recognize the formula for angular velocity.

The candidates who scored from 0.5 to 2.5 marks there were those who scored more than 1 mark managed to define 'circumference speed' and were able to identify the formula for the 'circumference speed'. However, they failed to convert 2100 rev/min into rad/second. Some of them (10.8%) only managed to either convert the 2100 rev/min into rad/sec or identified the formula for conversion of rev/min into rad/sec.

The candidates who scored 3 marks, managed to define 'circumference speed' knew the formula used to calculate the 'circumference speed' and did all the calculation steps including conversion of 2100 rev/min into rad/sec as shown in Extract 2.2.

Extract 2.2



Extract 2.2 shows a sample of a response of a candidate who was able to define 'circumference speed' and managed to calculate the 'circumference speed' by using the correct formula.

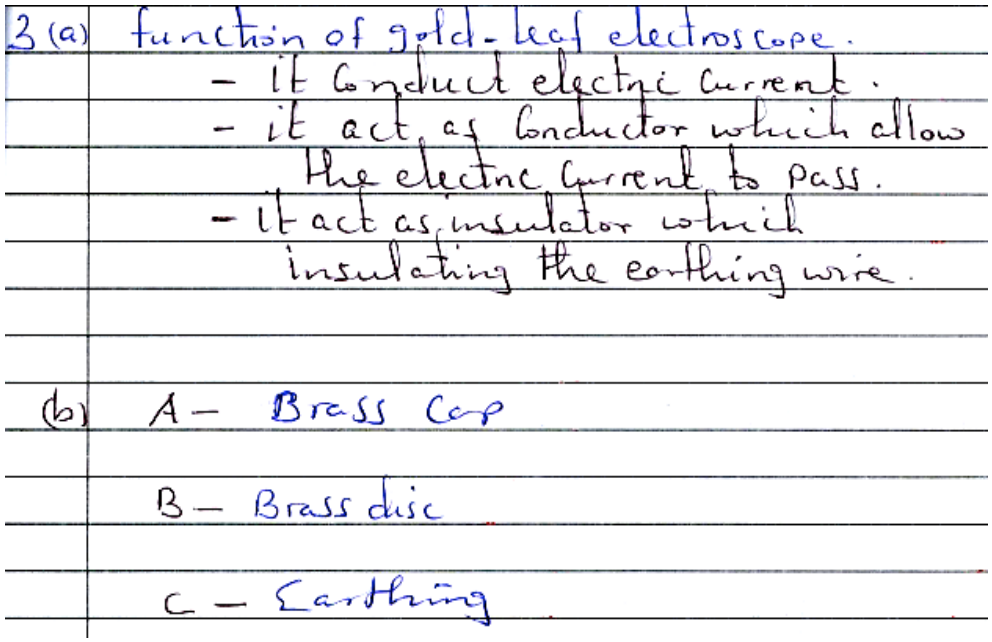
2.2.2 Question 3: Electricity and Magnetism

This question had two parts (a) and (b). In part (a) the candidates were required to list three functions which are done by a gold-leaf electroscope and in part (b) were required to give the names of the parts of a Gold –leaf electroscope indicated by the letters A-C in the Figure.

The question was attempted by 84.1 percent of all candidates whereby 30.9 percent of the candidates scored a 0 mark, 62.4 percent scored from 0.5 to 2.5 marks and 6.7 percent scored 3 marks.

The candidates who scored a 0 mark failed to list the three correct functions which are done by a gold-leaf electroscope and could not give the names of the parts of Gold–leaf electroscope indicated by the letters A-C as depicted in Extract 3.1. The candidates did not recall the apparatus as encountered in school laboratory.

Extract 3.1



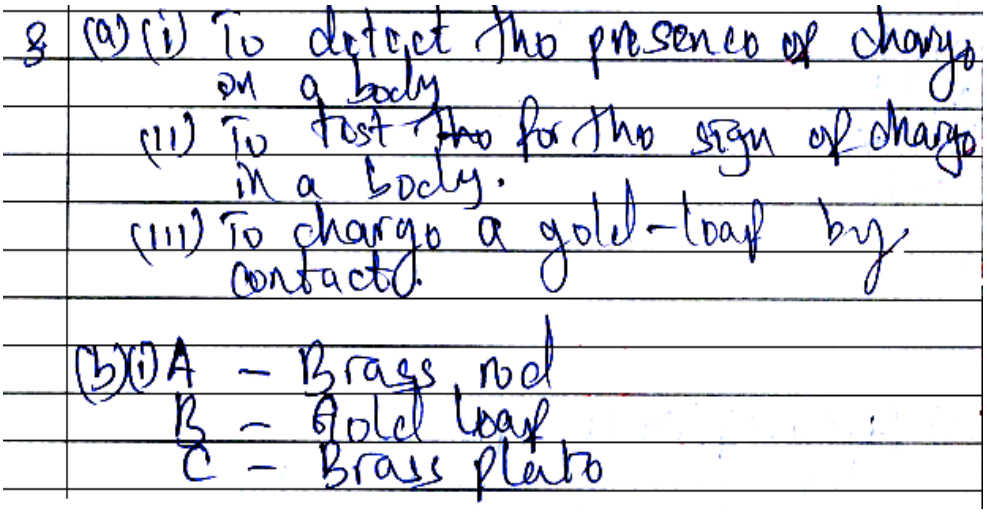
Extract 3.1 shows a sample of a response of a candidate who could not list three functions which are done by a gold-leaf electroscope. He/she also failed to give the names of the parts of a Gold–leaf electroscope.

The candidates who scored from 0.5 to 1 marks either listed one function which is done by a gold-leaf electroscope or only gave one name of the

parts of Gold–leaf electroscope indicated by the letters A-C but failed to list functions of a gold-leaf electroscope. Those who scored from1 to 2.5 marks managed to list either one, two or three functions which are done by a gold-leaf electroscope and named either two or all names of the parts of Gold–leaf electroscope indicated by the letters A-C.

The candidates, who scored 3 marks, were able to list the three correct functions which are done by a gold-leaf electroscope and identified the names of the parts of a Gold – leaf electroscope indicated by the letters A-C as shown in Extract 3.2.

Extract 3.2


8 (a) (i) To detect the presence of charge on a body
(ii) To test for the sign of charge in a body.
(iii) To charge a gold-leaf by contact.
(b)(i) A – Brass rod
B – Gold leaf
C – Brass plate

Extract 3.2 shows a sample of a response of a candidate who was able to list the three correct functions of gold-leaf electrode and could name the parts indicated by letters A-C.

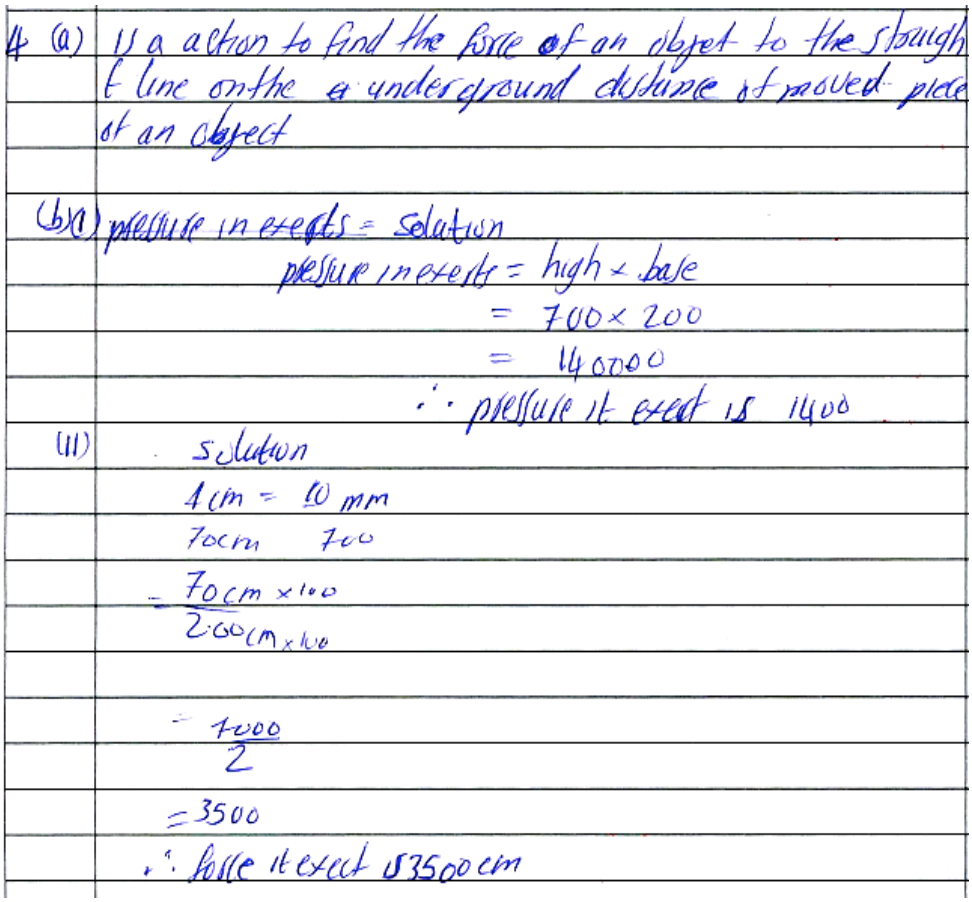
2.2.3 Question 4: Fluid Mechanics

The question had two parts, (a) and (b). In part (a), the question required the candidates to give the difference between pressure and force.
The question in part (b) was as follows: *A column of mercury is 700 mm high and the area of its base is 2.00 cm^2, find the;*
(i) Pressure it exerts.
(ii) Force it exerts.

The question was attempted by 93.1 percent of the candidates whereby 13.0 percent scored a 0 mark, 73.9 percent scored from 0.5 to 2.5 marks and 13.1 percent scored 3 marks.

The candidates who scored a 0 mark failed to give the difference between pressure and force. They were not able to recognise the formula used to calculate pressure and force exerted by a column of liquid as shown in Extract 4.1. This reveals that the candidates missed the knowledge concerning fluid mechanics where pressure depends on height of liquid.

Extract 4.1

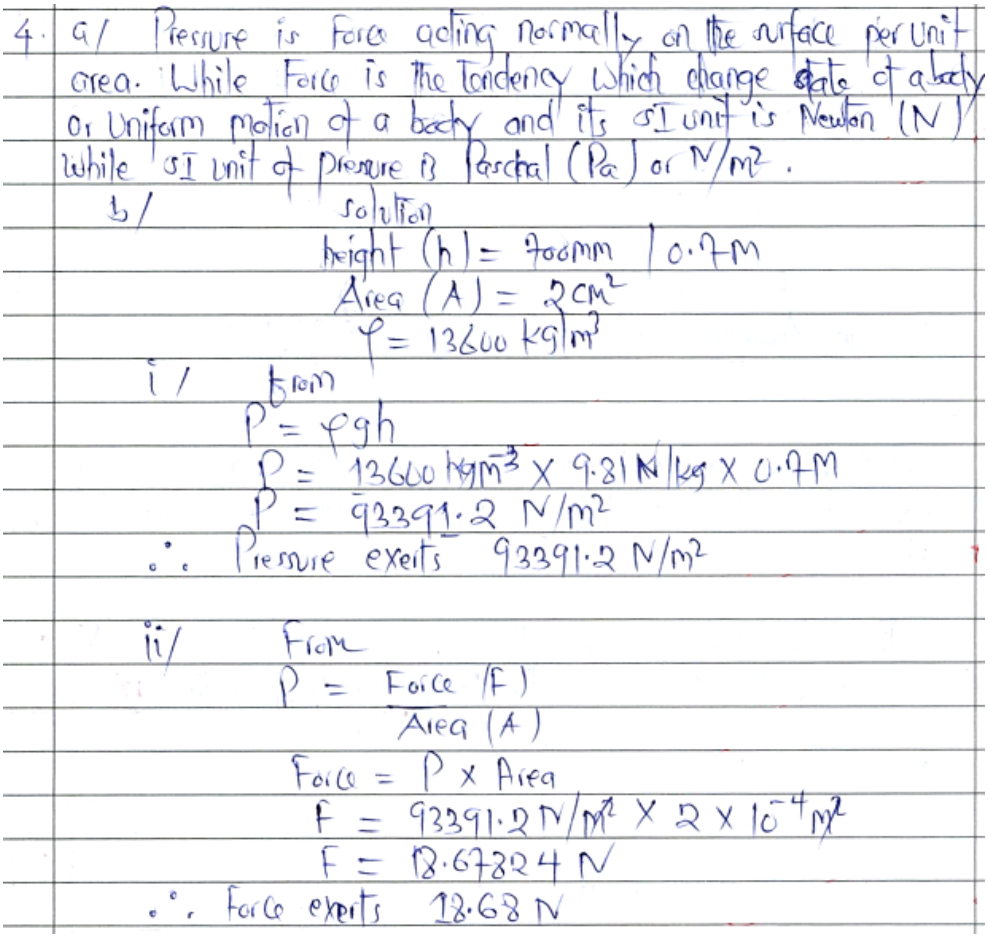


Extract 4.1 shows sample of a response of a candidate who could not differentiate between pressure and area and he/she failed to find the pressure and area exerted.

The candidates who scored from 0.5 to 1 mark could only either identify formula for pressure and force or differentiate between pressure and force. Those who scored between 1 to 2.5 marks managed to differentiate between pressure and force and were able to identify the formula used to find pressure or force. However, they failed to follow all the calculation steps.

The candidates who scored 3 full marks were able to differentiate between pressure and force and identified the formula used to find pressure and force and eventually followed all the steps in their calculations to find the pressure and force as shown in Extract 4.2.

Extract 4.2


4. a/ Pressure is force acting normally on the surface per unit area. While Force is the tendency which change state of a body or Uniform motion of a body and its SI unit is Newton (N) while SI unit of pressure is Pascal (Pa) or N/m².

b/ solution

height (h) = 700mm | 0.7m

Area (A) = 2cm²

ρ = 13600 kg/m³

i/ from

P = ρgh

P = 13600 kgm⁻³ X 9.81 N/kg X 0.7M

P = 93391.2 N/m²

∴ Pressure exerts 93391.2 N/m²

ii/ From

P = Force (F) / Area (A)

Force = P x Area

F = 93391.2 N/m² X 2 x 10⁻⁴ m²

F = 18.67824 N

∴ Force exerts 18.68 N

Extract 4.2 shows a sample of a response of a candidate who managed to differentiated between pressure and force and identified the formula used to calculate the pressure and force as requested in the question.

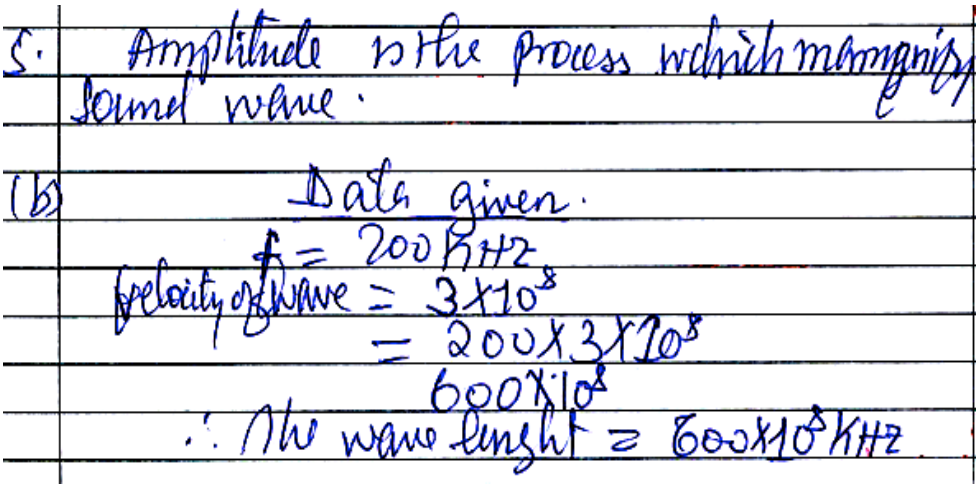
2.2.4 Question 5: Sound

This question required the candidates (a) to define the term amplitude as applied in wave (b) to calculate the wavelength of a radio wave of frequency 2000 kHz if the velocity of electromagnetic waves in free space is 3 x 108 m/s.

The question was attempted by 89.5 percent of all candidates whereby 25.9 percent scored a 0 mark, 44.7 percent scored from 0.5 to 2.5 marks and 29.4 percent of the candidates scored 3 marks.

The candidates who scored a 0 mark, failed to define the term amplitude as applied in wave and could not recognise the formula used to calculate the wavelength. These candidates were not familiar of the topic of wave as depicted in Extract 5.1.

Extract 5.1

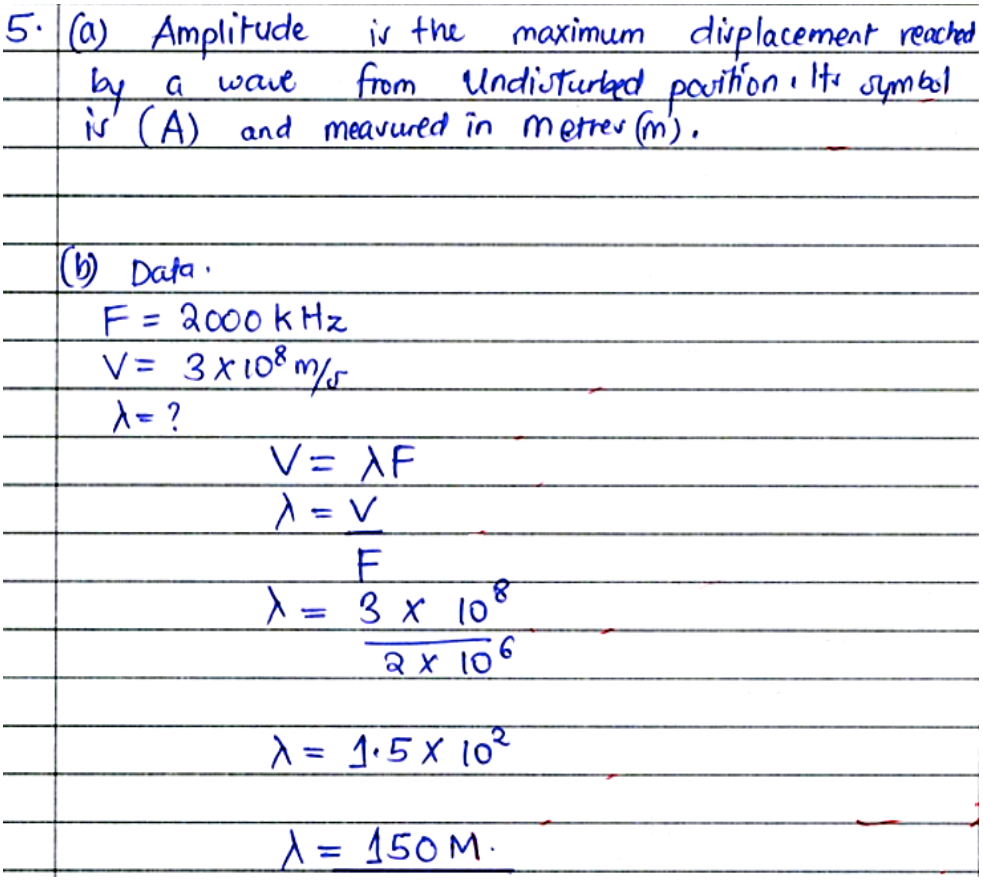


Extract 5.1 shows a sample of a response of a candidate who failed to define the term amplitude as applied in wave and could not recall the formula to calculate the wavelength.

The candidates who scored from 0.5 to 1 mark failed to define amplitude as applied in wave but managed to give the formula used to calculate the wavelength and therefore scored up to 1 mark. Those who scored more than 1 mark managed to define amplitude as applied in wave and identified the formula used to calculate the wavelength. However, these candidates missed some steps in calculations thus scored between 1 and 2.5 marks.

The candidates who scored 3 marks defined the amplitude as applied in wave and identified the formula used to calculate the wavelength and finally did all the calculation steps.

Extract 5.2



Extract 5.2 shows a response of a candidate who managed to define wavelength and identified the formula used to calculate wavelength.

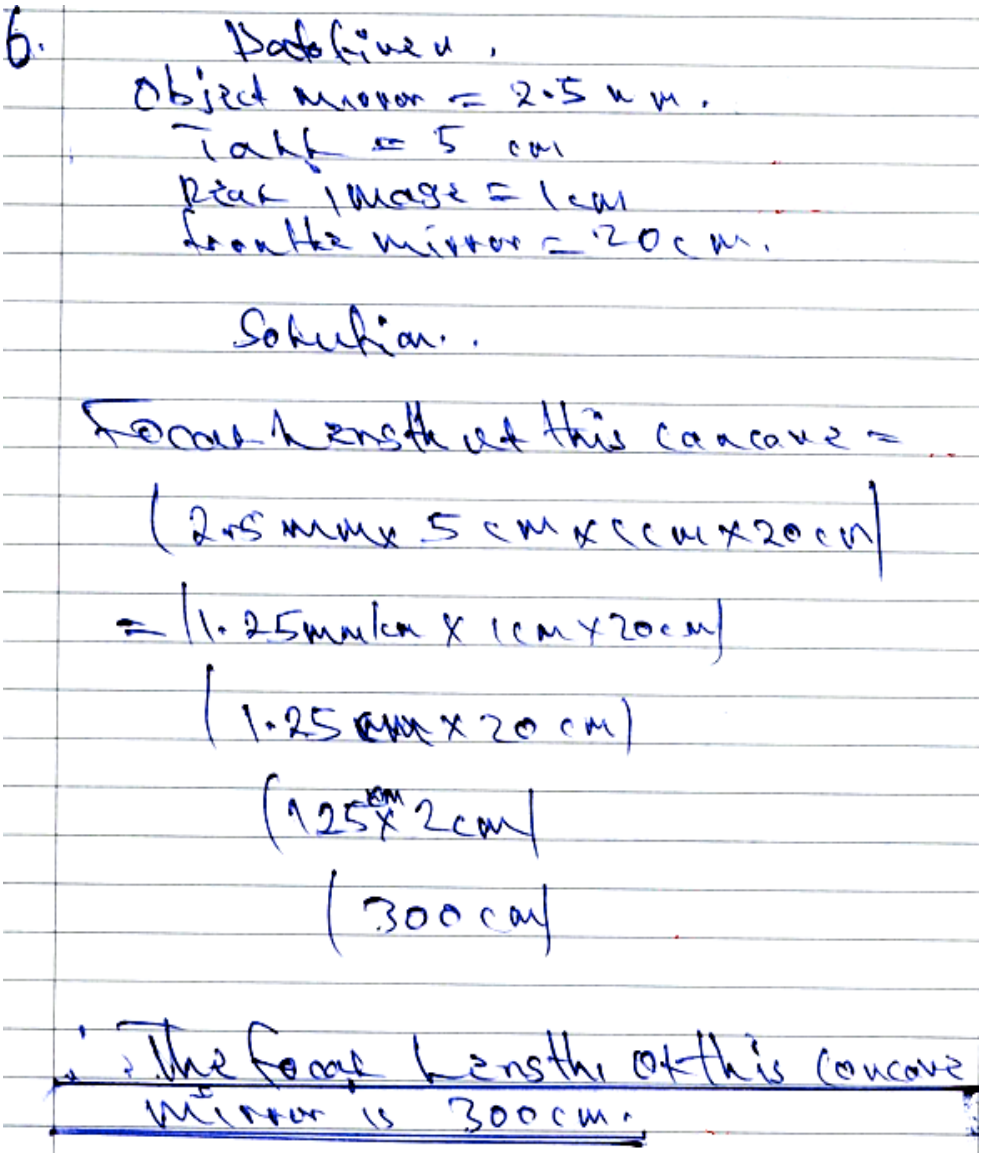
2.2.5 Question 6: Optic (Light)

This question required the candidates to find the focal length of the concave mirror when an object 2.5 mm tall is placed 5 cm from the concave mirror and produces a real image 1 cm tall at 20 cm from the mirror.

The question was attempted by 72.9 percent of all candidates whereby 24.7 percent scored a 0 mark, 27.5 percent scored from 0.5 to 2.5 marks and 47.8 percent scored 3 marks.

The candidates who scored a 0 mark, failed to recognize the formula used to find the focal length of the concave mirror. These candidates failed to demonstrate that, had knowledge on light parameters such as focal length, object distance and image distance as shown in Extract 6.1.

Extract 6.1

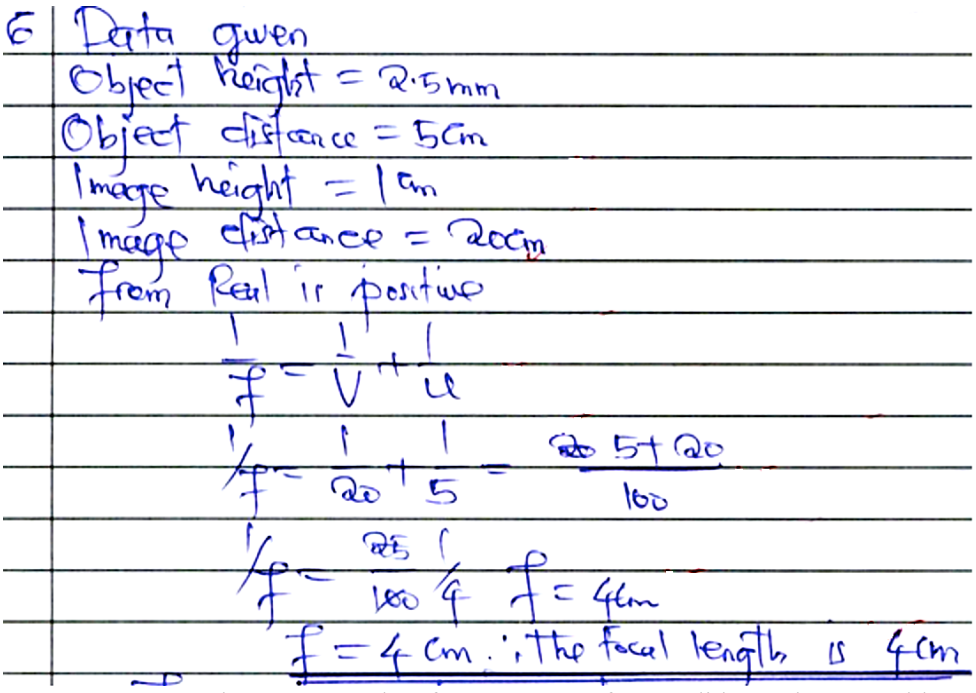


Extract 6.1 shows a sample of a response of a candidate who could not recall the formula used to find the focal length of the concave mirror.

The candidates who scored from 0.5 to 2.5 marks had the following weaknesses; some of them (1.9%) failed the question by scoring less than 1mark because they managed only to perform one step of calculation. Those who scored more than 1 mark managed to identify the formulas for the focal length. However, they failed to do some of the steps in their calculations.

Those who scored all the three marks knew the formula for the focal length and did all the steps in their calculations as shown in Extract 6.2.

Extract 6.2



Extract 6.2 shows a sample of a response of a candidate who was able to recognise formula used to find the focal length calculated the focal length.

2.2.6 Question 7: Force

This question required the candidates to explain three advantages and disadvantages of friction briefly.

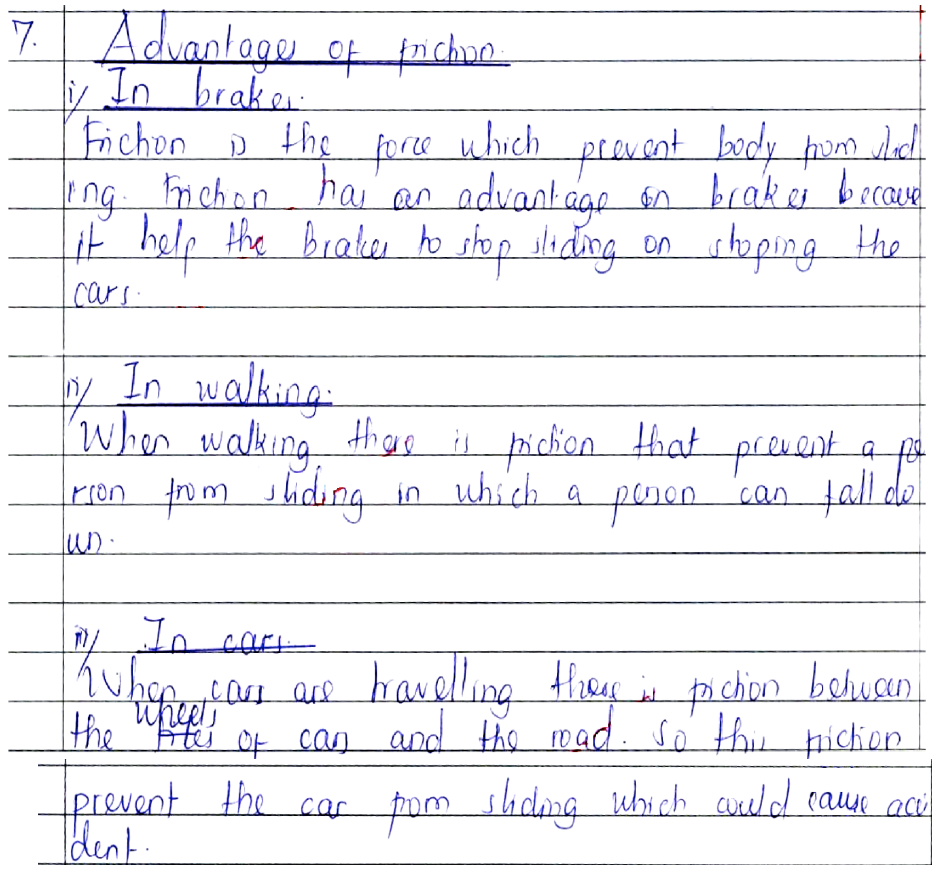
The question was attempted by 83.1 percent of all candidates whereby 7.7 percent scored a 0 mark, 77.3 percent scored from 0.5 to 2.5 marks and 15 percent scored 3 marks.

The candidates, who scored a 0 mark, mentioned three irrelevant advantages and disadvantages of friction. This group of candidates lacked the knowledge on phenomena of friction that appears on contact of two surfaces.

The candidates who scored from 0.5 to 2.5 marks had the following weaknesses; some of them (8.8%) only mentioned one advantage of friction or identified one disadvantage of friction. Those who scored more than 1 mark managed to mention two advantages of friction and were able to identify more than one disadvantage of friction. However, they failed to mention all the advantages and disadvantage of friction.

In the group of the candidates who scored 3 marks, managed to mention all the advantages and disadvantages of friction and explained all the advantages and disadvantages of friction briefly as shown in Extract 7.2.

Extract 7.2


7. Advantage of frichon.
i/ In brakes.
Frichon is the force which prevent body from slid ing. Frichon has an advantage on brakes because it help the brakes to stop sliding on shoping the cars.

ii/ In walking.
When walking there is frichon that prevent a pe rson from sliding in which a person can fall do wn.

iii/ In cars.
When cars are travelling there is frichon between the wheels of cars and the road. So this frichon prevent the car from sliding which could cause acci dent.

Extract 7.2 shows a part of a sample of a response of a candidate who was able to recall and explained briefly all three advantages and disadvantages of friction.

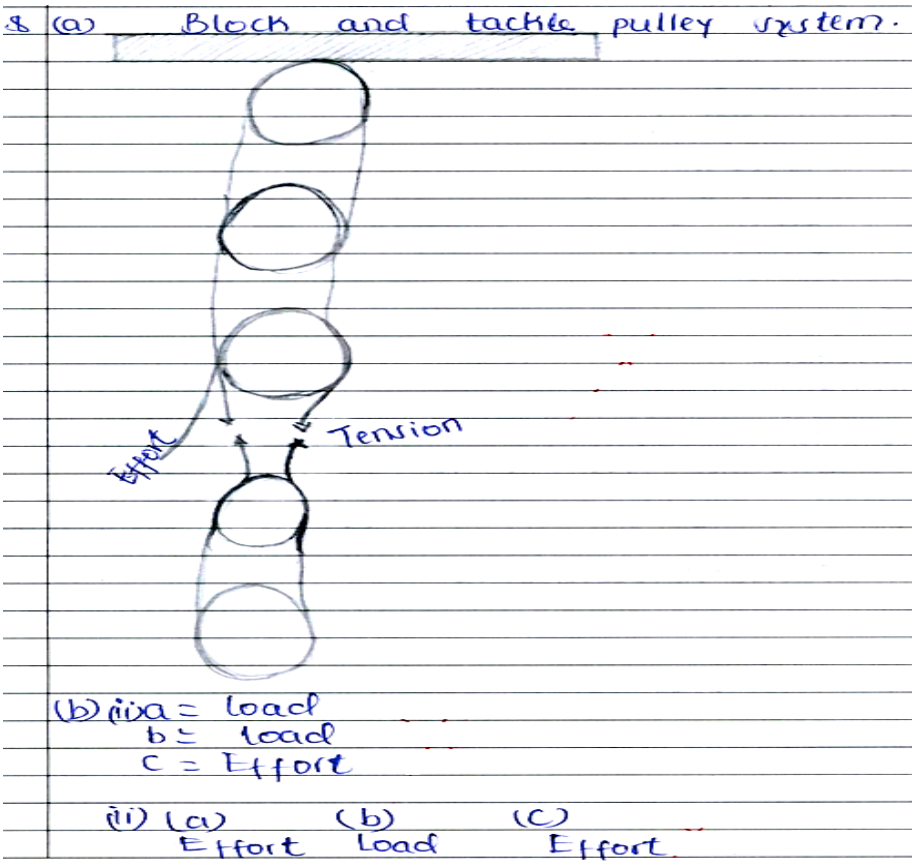
2.2.7 Question 8: Simple Machine

This question had part (a) and (b). Part (a) required the candidates to sketch a well labeled diagram of the block and tackle pulley system having a velocity ratio of 5 and part (b) required the candidate to study the diagrams of simple machines (i) – (ii) given in figure 3 carefully. In each diagram, candidates were required to indicate which was a fulcrum, load and effort between a, b and c as indicated by arrows.

The question was attempted by 90.7 percent of all candidates whereby 21.3 percent scored a 0 mark, 74.5 percent scored from 0.5 to 2.5 marks and 4.2 percent scored 3 marks.

The candidates who scored a 0 mark failed to sketch a well labelled diagram of the block and tackle pulley system having a velocity ratio of 5 in part (a) and were not able to indicate which was fulcrum, load and effort between a, b and c as indicated by arrows. These candidates had less knowledge on sketching practice of simple machine diagrams which could lead them to sketch the block and tackle pulley system and could remember the positions for fulcrum, load and effort. Extract 8.1 shows a sample of a poor response.

Extract 8.1

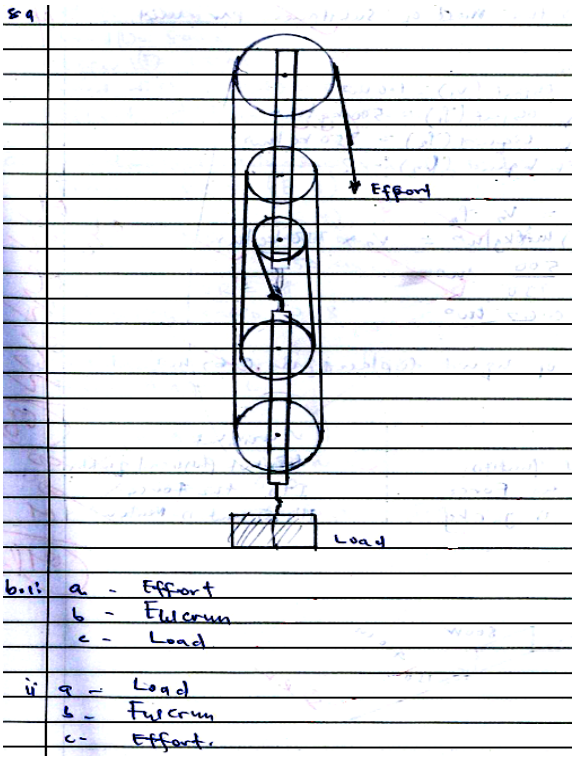


Extract 8.1 is a sample of a response of a candidate who failed to sketch a well labeled diagram of the block and tackle pulley system and could not indicate which was a fulcrum, load and effort between a, b and c as indicated by arrows.

The candidates who scored from 0.5 to 1 mark only managed to label part of the diagram of the block and tackle pulley system and others indicated on one diagram of figure 3 which was a fulcrum, load and effort between a, b and c. Those who scored more than 1 mark, some managed to sketch a well labeled diagram of the block and tackle pulley system and indicated which was fulcrum, load and effort between a, b and c but some failed to label diagram of the block and tackle pulley system.

The candidates who scored 3 marks, managed to sketch a well labelled diagram of the block and tackle pulley system having 5 pulleys and were able to indicate which was a fulcrum, load and effort between a, b and c as indicated by arrows and as shown in Extract 8.2.

Extract 8.2



Extract 8.2 shows a response of a candidate who managed to sketch a well labeled diagram of the block and tackle pulley system, and indicated which was fulcrum, load and effort between a, b and c.

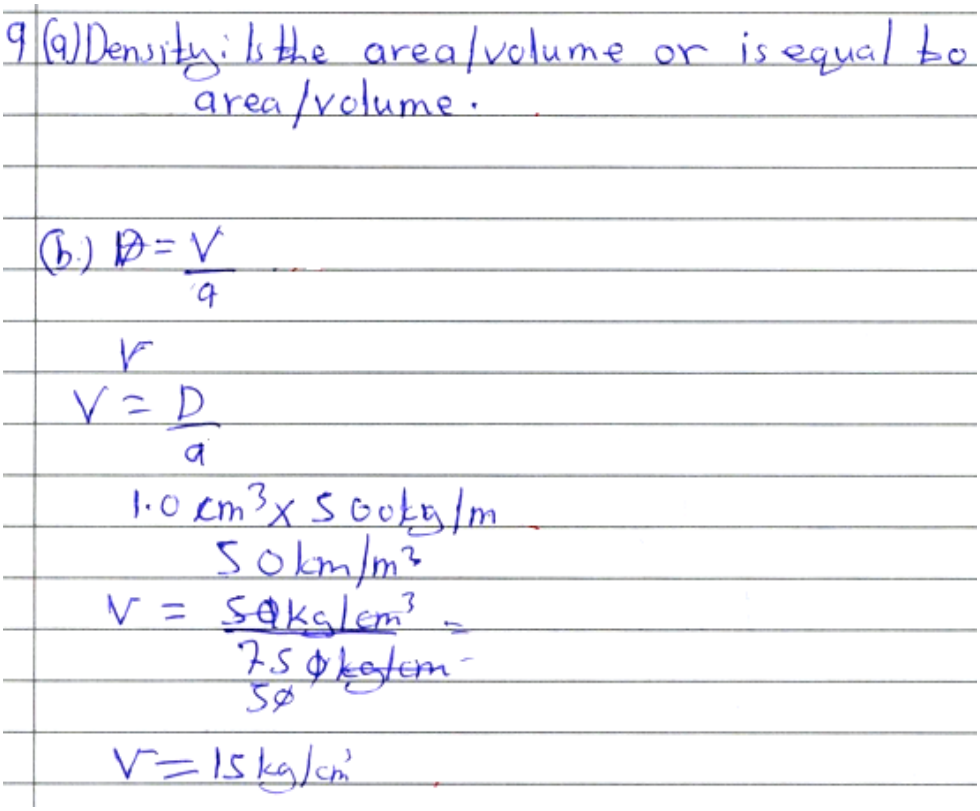
2.2.8 Question 9: Fluid Mechanics

This question had part (a) and (b). Part (a) required the candidates to define the term density and part (b) required the candidate to calculate 'the volume of liquid displaced', when an object of volume 1.0 m^3 and density 500kg/m^3 floats in a liquid of density 750kg/m^3.

The question was attempted by 94.7 percent of all the candidates of which 11.7 percent scored a 0 mark, 55.8 percent scored from 0.5 to 2.5 marks and 32.5 percent scored 3 marks.

The candidates who scored a 0 mark failed to define the term density and were unable to identify the formula of density and floatation law as shown in extract 9.1.

Extract 9.1

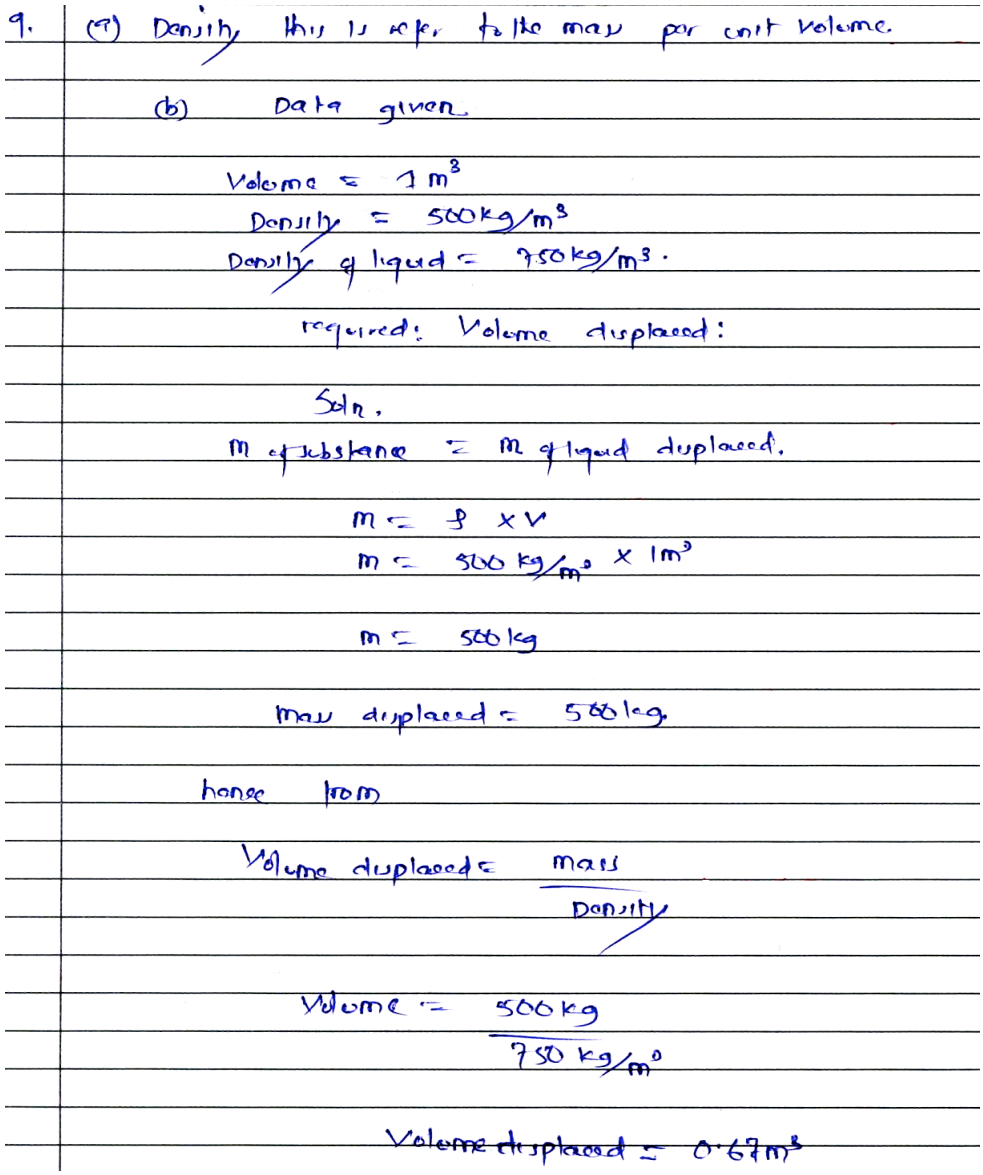


Extract 9.1 shows a sample of a response of a candidate who failed to define density and could not identify the formula of calculating the volume of oil displaced.

The candidates who scored low marks managed to identify the formula of density but failed all the other parts of the question thus scoring low marks. Others who scored more than 1 mark were able to define density and identified the formula used to calculate density but failed some calculation steps hence scored less than 3 marks.

The candidates who scored 3 marks identified the concepts of density, floatation law and the formula for calculating the volume of liquid displaced as can be seen in extract 9.2.

Extract 9.2



Extract 9.2 shows a sample of a good response of a candidate who was able to apply the concepts of density, floatation law and formula for calculating the volume of liquid displaced.

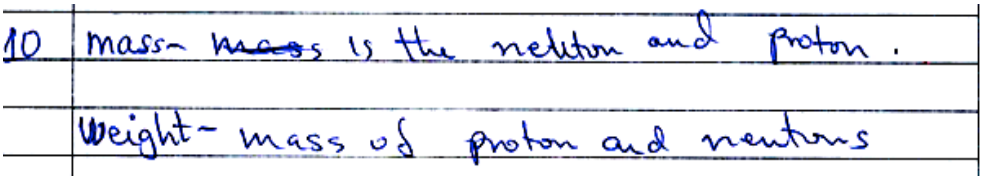
2.2.9 Question 10: Units and Measurements

This question required the candidates to briefly distinguish between mass and weight by giving three points.

The question was attempted by 84.6 percent of all candidates whereby 17 percent scored a 0 mark, 40.5 percent scored from 0.5 to 2.5 marks and 42.5 percent scored from 3 marks.

The candidates who scored a 0 mark failed to distinguish between mass and weight by giving three points. They could not give definitions which distinguish mass and weight. They further failed to know that the mass of an object is the same at all places but its weight can change.

Extract 10.1

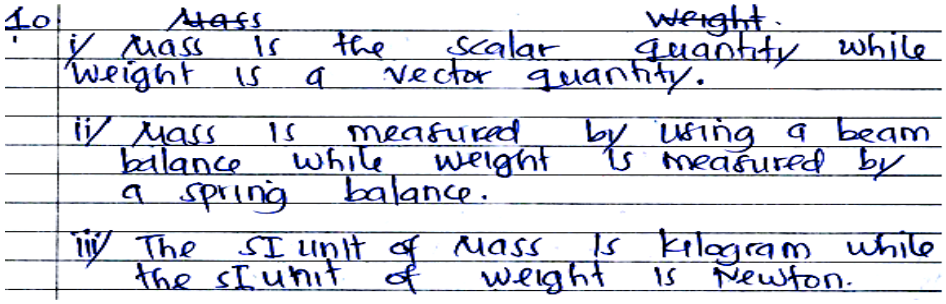


Extract 10.1 is a sample of a response from a script of a candidate who failed to distinguish between mass and weight.

The candidates who scored from 0.5 to 1 mark managed to write a definition of either mass or weight or unit of either mass or weight. Those who scored from 1to 2.5 marks gave either two or three points of mass or weight.

Those who scored three marks managed to give all three points to distinguish between mass and weight as shown in Extract 10.2.

Extract 10.2



Extract 10.2 shows a sample of a good response of a candidate who was able to give three points to distinguish mass and weight.

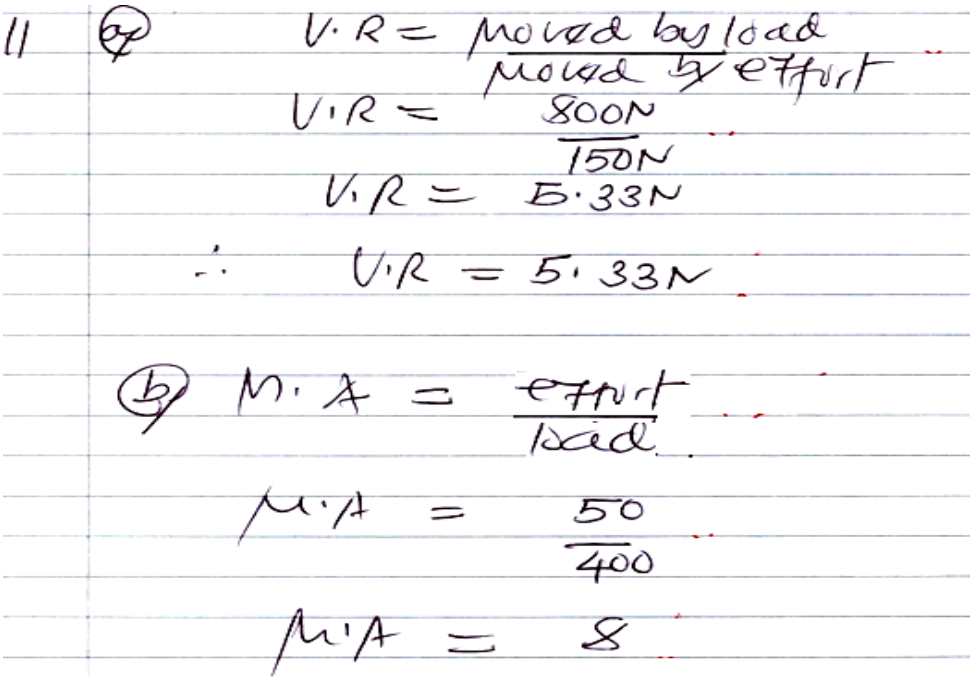
2.2.10 Question 11: Simple Machine

This question was as follows: *A loaded wheelbarrow of weight 800N is pushed up an inclined plane by a force of 150 N parallel to the plane. If the plane rises by 50 cm for every 400 cm distance measured along the plane;*
(i) Find the velocity ratio.
(ii) Compute the mechanical advantage.

The question was attempted by 89.7 percent of all the candidates whereby 10.9 percent scored a 0 mark, 34.5 percent scored from 0.5 to 2.5 marks and 54.6 percent scored 3 marks.

The candidates who scored a 0 mark failed to recognize the formula for velocity ratio of an inclined plane which is V.R = $\frac{\textit{length of the plane}}{\textit{height of the plane}}$ and used wrong formula of mechanical advantage as shown in Extract 11.1.

Extract 11.1

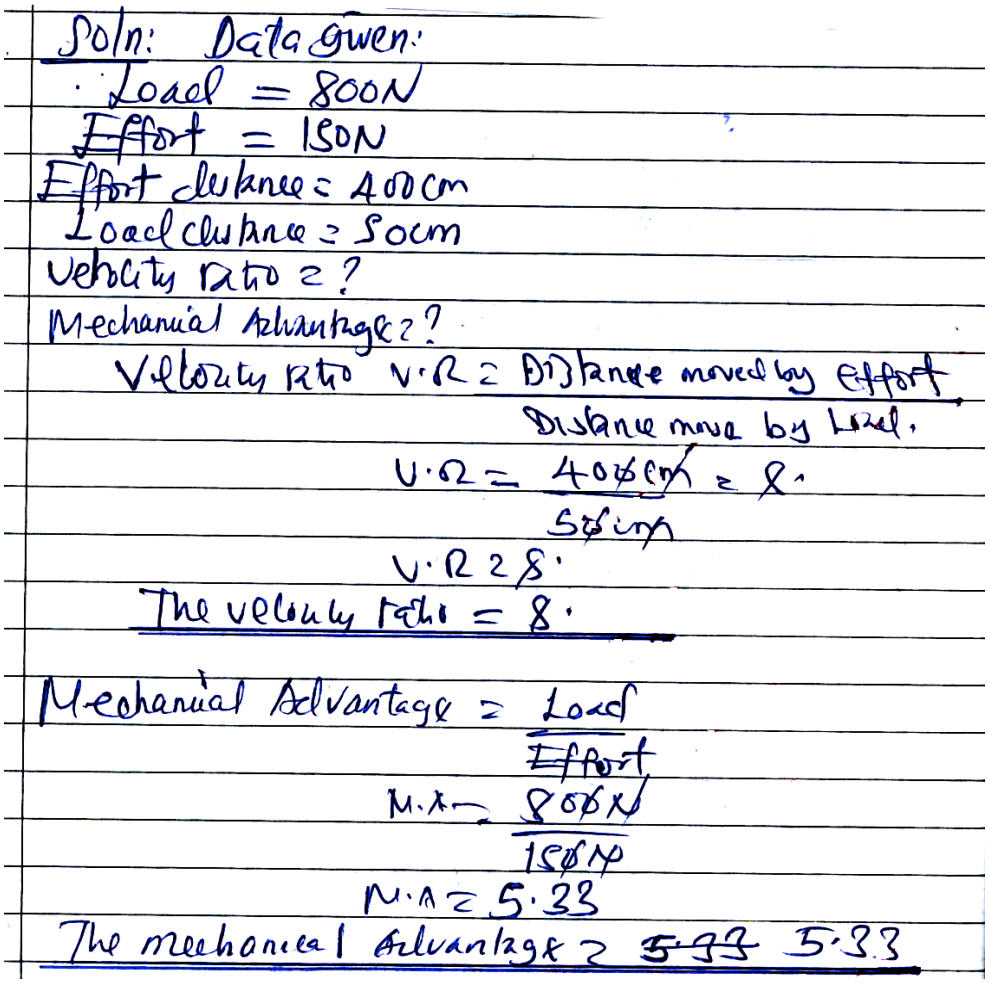


Extract 11.1 is a sample of a response of a candidate who failed to identify the formula for calculating the velocity ratio and mechanical advantage.

The candidates who scored from 0.5 to 1 only managed to either write the formula for velocity ratio or mechanical advantage. Those who scored more than 1 mark wrote the formula for velocity ratio and mechanical advantage However, they failed to do all the calculation steps.

Those who scored three marks wrote the formula for velocity ratio and mechanical advantage and did all the steps in calculations as shown in Extract 11.2.

Extract 11.2


Soln: Data given:
Load = 800N
Effort = 150N
Effort distance = 400cm
Load distance = 50cm
Velocity Ratio = ?
Mechanical Advantage = ?
Velocity Ratio V.R = Distance moved by Effort / Distance move by Load.
V.R = 400cm / 50cm = 8.
V.R = 8.
The velocity ratio = 8.
Mechanical Advantage = Load / Effort
M.A = 800N / 150N
M.A = 5.33
The mechanical Advantage = 5.33

Extract 11.2 shows a sample of a response of a candidate who was able to identify the formula of calculating the velocity ratio and mechanical advantage and managed to do all calculations.

2.3 SECTION C: Structured Questions

2.3.1 Question 12: Linear Motion

This question required the candidates to attempt the following problem:

(a) *(i) What is 'displacement' with regards to engineering science?*
(ii) Briefly explain why the speed differs from velocity while they share the same formulae and SI unit?

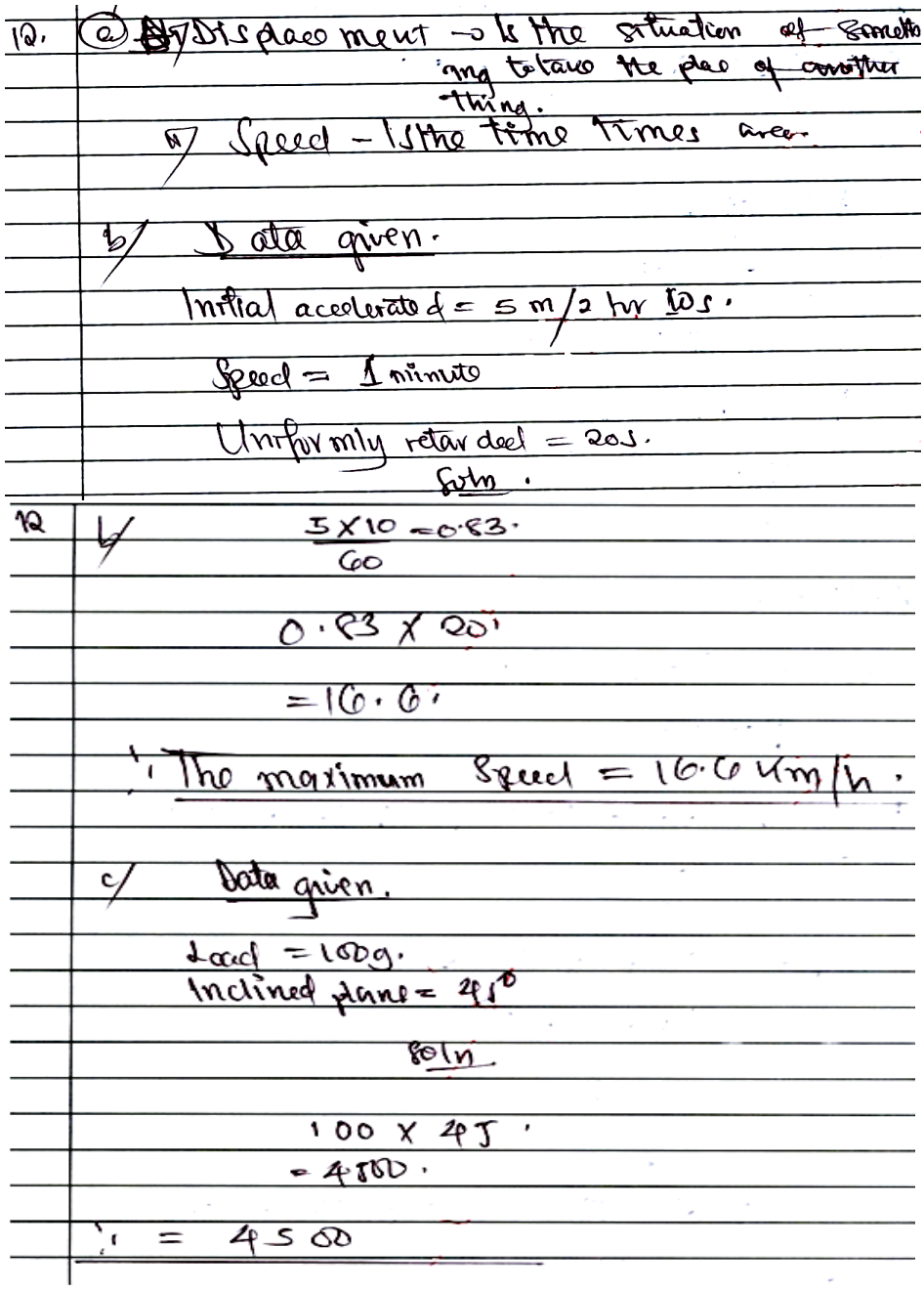
(b) *A car stars from rest and is accelerated uniformly at the rate of 5 m/s^2 for 10 s. it then maintains a constant speed for 1 minute. The brakes are then applied and the vehicle uniformly retarded to rest in 20 s. Find the maximum speed reached in km/h and the total distance covered in metres.*

(c) *A load of 100 g is placed on an inclined plane of 45^o to the horizontal. Neglecting the friction force, calculate;*
(i) in m/s^2, the acceleration of load as it slides down
(ii) distance it would move from rest in 0.4 seconds and
(iii) potential energy of a load before it start to slide.

The question was attempted by 69.8 percent of all the candidates, where 10.9 percent scored a 0 mark, 63.5 percent scored from 0.5 to 10.5 marks and 25.6 percent scored from 11 to 20 marks.

The candidates who scored a 0 mark failed to; define 'displacement' with regards to engineering science, could not explain why the speed differs from velocity while they share the same formulae and SI unit and could not identify and apply the formula in calculating the maximum speed reached in km/h and the total distance covered in metres. Moreover, the candidates were unable to identify the formula for calculating in m/s^2 the acceleration of load as it slides down the distance it would move from rest in 0.4 seconds and potential energy of a load before it starts to slide. These candidates' outcomes reveal that, the candidates lacked the knowledge on Kinematics topic. Extract 12.1 shows a sample of a poor response.

Extract 12.1



Extract 12.1 is a sample of a response of a candidate who failed to define 'displacement' and to explain why the speed differ from velocity and could not calculate the maximum speed reached and the total distance covered in metres. The candidate was also unable to calculate the acceleration, distance and potential energy.

The candidates who scored from 0.5 to 05 marks managed only to define ‘displacement’ and to explain why the speed differs from velocity and other defined ‘displacement’ and identified and applied the formula in calculating the maximum speed reached and the total distance covered in metres. Those who scored from 6 to 11 marks managed to define ‘displacement’ and explained why the speed differs from velocity and also calculated the acceleration, distance and potential energy but failed to identify and apply the formula in calculating the maximum speed reached and the total distance covered in metres.

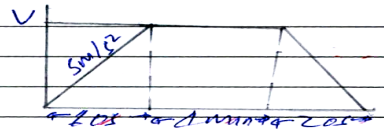
Those who scored from 12 to 20 marks were able to; define ‘displacement’, explain why the speed differ from velocity and could calculate the acceleration, distance and potential energy therefore scored less than 20 marks. Those who scored twenty marks managed to; define ‘displacement’, explain why the speed differ from velocity and calculated the acceleration, distance and potential energy and could calculate the maximum speed reached and the total distance covered in metres as shown in Extract 12.2.

Extract 12.2

12 a) i) Displacement
— Is a distance moved by a body in a definite direction.

ii) Speed is a ratio of distance moved with a time that means have no definite direction while velocity is a ratio of displacement with time.

b)



Satisfies
Acceleration = 5m/s²
T_1 = 10sec
T_2 = 1min
T_3 = 20sec
soln
from, $V = u + at$
$V = 0 + 5 \times 10$
$V = 50 m/s$
from, 10m/s = 36km/h
50m/s = ?
$V = 180 km/h$

→ Total distance = area.
$A = \frac{1}{2}(a+b)h$.

⇔ $A = \frac{1}{2}(a+b)h$
$= \frac{1}{2}(60+90)50$.
$= 150 \times 25$.
∴ Distance = 3750m.

Extract 12.2 is the part of a sample of a response of a candidate who defined 'displacement' and explained why the speed differ from velocity and could calculate the maximum speed reached and the total distance covered in metres. They calculated the acceleration, distance and potential energy.

2.3.2 Question 13: Heat

This question required the candidates to (a) differentiate between temperature and heat with respect to engineering science and in part (b) to solve the following problem:

A 50 W heating coil is totally immersed in 100 g of water contained in an insulated flask of negligible heat capacity

(i) if the temperature of water is 20^{o}C when the heater is switched on, how long would it take for water to boil?

(ii) after water has been boiling for 15 minutes it is found that, the mass of water in the flask has decreased to 80g. Assuming no external heat losses, calculate a value for the specific latent heat of vaporization of water.

In (c) candidates were required to solve the following problem:

(i) what is the difference between latent heat and specific heat capacity of a substance?

(ii) calculate the heat required to change 2 g of ice at -6^{o}C into steam at 100^{o}C given that, specific heat capacity of ice = 2100J/kgK, specific heat capacity of water = 4200J/kgK, and specific latent heat of ice = 336000J/kg.

The question was opted for by 47.1 percent of all the candidates whereby 6.5 percent scored a 0 mark, 67.6 percent scored from 0.5 to 10 marks and 25.9 percent scored from 10.5 to 20 marks.

The candidates who scored a 0 mark failed to differentiate between temperature and heat. They also failed to calculate time which would be taken for water to boil and the value for the specific latent heat of vaporisation of water. Moreover the candidates failed to give the difference between latent heat and specific heat capacity of the substance and could not identify the formulas used to calculate the quantity of heat required to change 2 g of ice at -6^{o}C into steam at 100^{o}C. The candidates had no understanding on the topic concerning heat especially on the concept that, any object has its own 'heat capacity' to receive temperature. Extract 13.1shows a poor response.

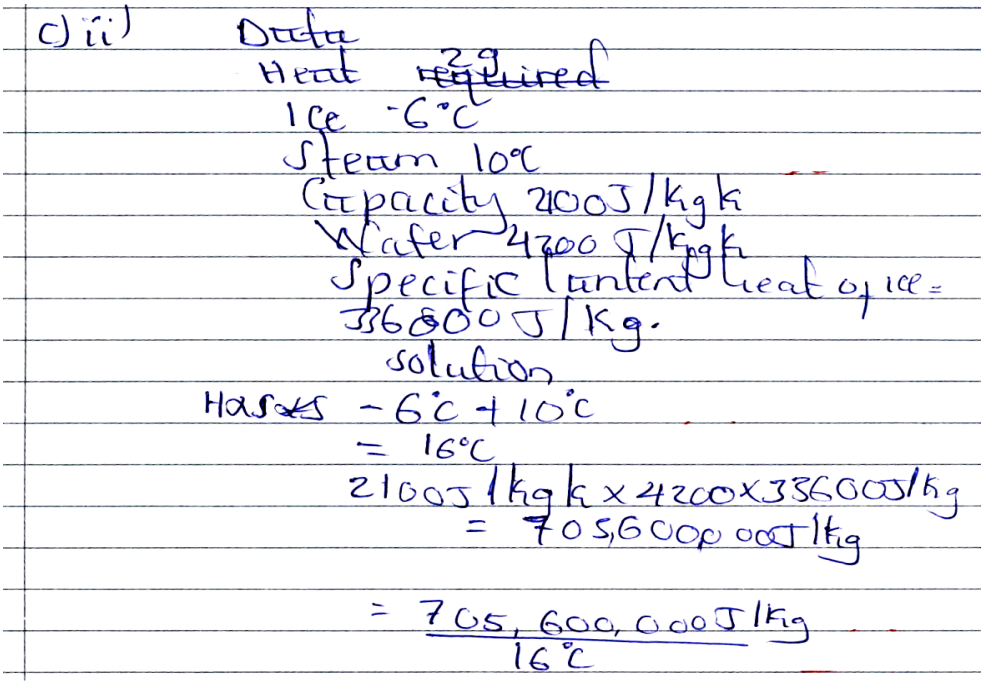
Extract 13.1

13. a) Temperature - Is the resistance of the speace area.
Heat - Is the

b) i) Data.
A 50w
100g
20°C
solution.
A 50wt 100g +
20
= 150wg = 5.25wg
20
= 5.25wg

ii) Data.
A 50w
100g
minutes is.
80g.

Solution.
A 50wt 100g = 150wg 80g
= 170g.
The specific latent heat of vaporization of water = 170wg.



Extract 13.1 shows a sample of a response of a candidate who could not write the definitions of temperature, heat, latent heat and specific heat capacity. He/she also failed to recognise the correct formula to calculate the quantity of heat, time required to boil water and the value for specific latent heat of vaporisation.

The candidates who scored from 0.5 to 10 marks had the following strengths and weaknesses; some of them (47.6%) failed the question by scoring less than 6 marks and these only managed to either differentiate between temperature and heat or give the difference between latent heat and specific heat capacity of a substance and identified the formulas used to calculate the quantity heat. However, those who scored above 6 marks managed to differentiate on either between temperature and heat or/and between latent heat and specific heat capacity of a substance and identified the formulas used to calculate the quantity of heat.

The candidates who scored from 10 to 20 marks were those who calculated time it would take for the water to boil and the value for the specific latent heat of vaporisation of water they also identified the formula and used it to calculate the quantity heat required to change 2 g of ice at -6^{o}C into steam at 100^{o}C, but failed either to differentiate between temperature and heat or to give the difference between latent heat and specific heat capacity of a

substance. Those who scored 20 marks were able to differentiate between temperature and heat, gave the difference between latent heat and specific heat capacity of a substance and could calculate; time it would take for the water to boil, the value for the specific heat latent heat of vaporisation of water and they also managed to identify the formula and used it to calculate the quantity of heat required to change 2 g of ice at -6°C into steam at 100°C as shown in Extract 13.2.

Extract 13.2

13 Temperature is a degree of hotness or coldness of a body compared to some other temperature taken as standard.

Heat is the degree of coldness or hot

Heat is the form of energy which is transfered from one object to another due to their temperature difference.

b. Solution
Power (P) = 50W
Mass (m_1) = 100g = 0.1 kg.
Mass of remained water (m_2) = 80g = 0.08 kg
Initial temperature (θ_1) = 20°C
Final temperature (θ_2) = 100°C
Time taken
Specific heat capacity of water = 4200J/kg.
From
Heat energy supplied = Electrical energy supplied
$Q = mc\theta_2 - \theta_1 = P \times t$

$Pt = mc(\theta_2 - \theta_1)$

$50W \times t = 0.1\ kg \times 4200J/kg \times (100 - 20)$.

$50W\ t = 420J \times 80$.

$\frac{50W\ t}{50W} = \frac{33600}{50W}$.

$t = 672$ seconds.

Extract 13.2 shows sample of a response of a candidate who differentiated between temperature and heat and latent heat and specific heat capacity. He/she also managed to recognise the correct formula to calculate the

quantity of heat, time required to boil water and the value for specific latent heat of vaporization.

2.3.3 Question 14: Work, Energy and Power

This question consisted of three parts (a), (b), and (c).
Part (a) required the candidates to define the concepts of
(i) inertia of a body,
(ii) Momentum of a body and
(iii) Kinetic energy as used in engineering science.

Part (b) required the candidates to compute
(i) the car's initial momentum,
(ii) (ii) its initial kinetic energy and
(iii) (iii) the average braking force required, when a motor car of mass1000kg travelling at 90 km per hour is brought to rest by brakes in 100 m.

In part (c), candidates were required to
(i) define 'linear expansivity of a substance',

(ii) differentiate between pressure law and charle's law with reagard to gas law and

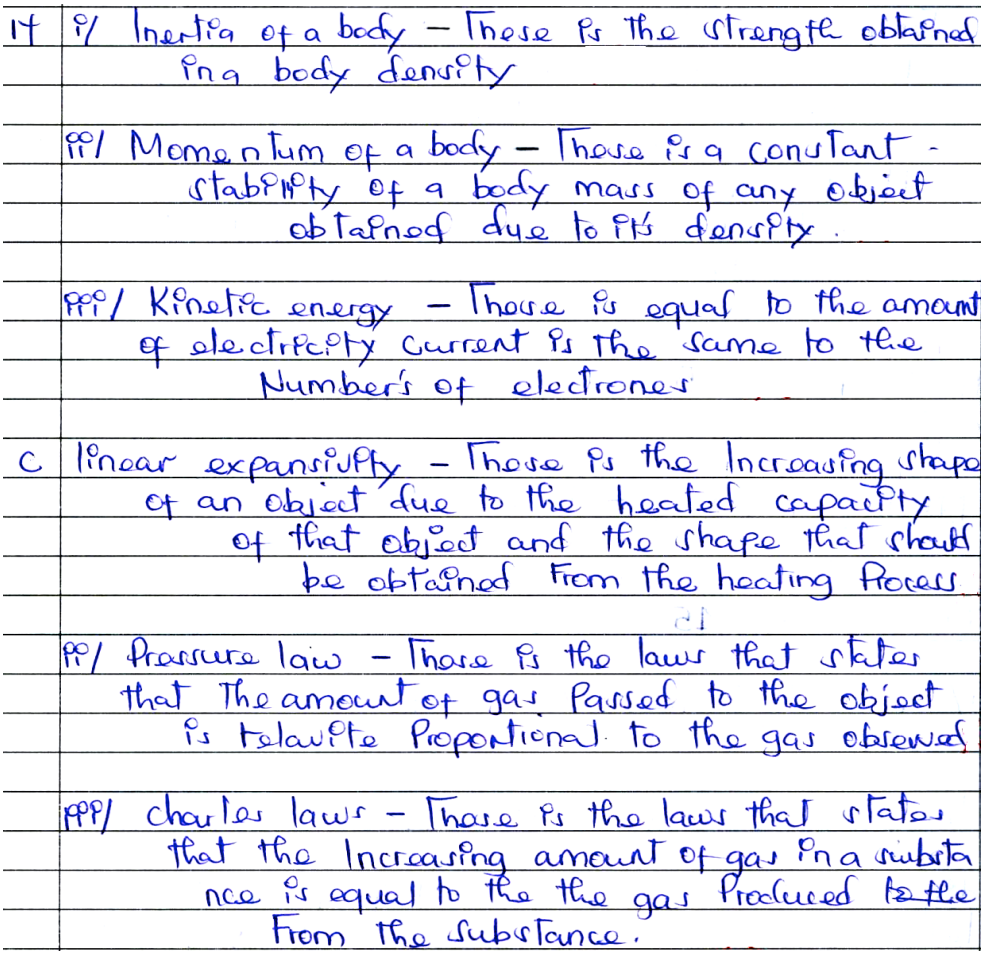
(iii) the candidates were required to attempt the following problem: *The difference in length between a brass and an iron rod is 14 at 10^oC. What must be the length of the iron for this difference to remain at 14 cm when both rods are heated to 100^oC? (Linear expansivity of brass = 19 x 10-6/K, of iron = 12 x 10-6/K).*

The question was opted for by 68.8 percent of all the candidates, whereby 9.8 percent scored a 0 mark, 69.1 percent scored from 0.5 to 10 marks and 21.1 percent scored from 10 to 20 marks.

The candidates who scored a 0 mark failed to (a) define the concepts of (i) inertia of a body, (ii) Momentum of a body and (iii) Kinetic energy as used in engineering science. Moreover, the candidates could not compute (i) the car's initial momentum, (ii) initial kinetic energy and (iii) the average braking force required as demanded by the question in Part (b). These candidates also failed to; (i) define 'linear expansivity of a substance', (ii) differentiate between pressure law and charle's law with reagard to gas law and could not calculate the length of the iron in part (c) as shown in Extract14.1. These candidates lacked the knowledge of inertia that is the

reluctance of a body to move or stop when in motion. They lacked the knowledge of concerning the topic of work, energy, power and expansivity of materials when heated.

Extract 14.1



Extract 14.1 shows a sample of a response of a candidate who failed to define inertial of a body, momentum of a body, kinetic energy and linear expansivity of a substance. He/she could not write the formula used to calculate the momentum of a body, kinetic energy, braking force and length of the iron.

The candidates who scored from 0.5 to 06 marks could not recall the formula for (i) the car's initial momentum, (ii) initial kinetic energy and (iii) the average braking force required or defined the concepts of (i) inertia of a body and (ii) Momentum of a body. Those who scored more than six

marks managed to define the concepts of inertia of a body, Momentum of a body and Kinetic energy but failed to; define 'linear expansivity of a substance', differentiate between pressure law and charle's law with regard to gas law and to calculate the length of the iron.

Candidates who scored from 10 to 20 marks failed to answer some parts of the question and thus scored less than 20 marks. Others managed to define the concepts of inertia of a body, momentum of a body and kinetic energy. They computed the car's initial momentum, initial kinetic energy of a car and the average braking force which was required. They wrote the formula for linear expansivity and used it to calculate the length of the iron as shown in Extract 14.2.

Extract14.2.

3(a). i/ Inertia of a body; Is the property of a body to remain in uniform motion in a straight line or in a rest unless acted upon by an external force.

ii/ Momentum of a body; Is the product of its mass and its velocity.

iii/ Kinetic energy; Is the energy that is ~~stored~~ possessed by the body which is moving or is in a state of motion.

3b. Data.

Mass (m) = 1000kg, Initial velocity (u) = 25m/s

speed (v) = 90 Km/h. Final velocity (v) = 0m/s.

distance (s) = 100m.

i/ Solution.

36 Km/h = 10m/s

90 Km/h = x.

$$x = \frac{90\,Km/h \times 10\,m/s}{36\,Km/h}$$

$$x = 25\,m/s$$

Momentum (P) = mass × velocity.

$= mv$

$= (1000 \times 25)\,kgm/s$

∴ Momentum (P) = 25000 kgm/s.

14b. ii/ Solution.

Initial K.E $= \frac{1}{2}mv^2$

$= \frac{1}{2} \times 1000 \times 25^2$

$= \frac{1}{2} \times 1000 \times 625$.

$= 500 \times 625$

$= 312500\ J$.

∴ Kinetic energy (KE) $= 312500\ J$.

iii/ Solution

~~u = m/s~~ v =

$u = 25\ m/s$, $v = m/s$ $s = 100\ m$.

From 3rd eqn of Linear motion.

$v^2 = u^2 + 2as$

$-u^2 = 2as$.

$-\frac{(25 \times 25)}{2 \times 100} = \frac{2 \times 100 \times a}{2 \times 100}$.

$a = \frac{625}{200} = 3.125\ m/s^2$

∴ Acceleration (a) $= 3.125\ m/s^2$

Force = mass × Acceleration

$= 1000\ kg \times 3.125\ m/s^2$

Average breaking force (F) $= 3125\ N$

Extract 14.2 is the part of a sample of a response of a candidate who managed to; define inertial of a body, momentum of a body, kinetic energy and linear expansivity of a substance. He/she also used the correct formula to calculate momentum of a body, kinetic energy, braking force and length of the iron.

2.3.4 Question 15: Electricity and Magnetism

This question had three parts (a), (b) and (c).
In part (a) candidates were required to
(i) state ohm's law and
(ii) state the Fleming's left-hand rule.

In part (b) candidates were given an electric circuit and were required to find
(i) Total current of the circuit,
(ii) voltages of V_1 and V_2 and
(iii) an electric current in ammeters A_1 and A_2.

While in part (c) the question was as follows: *A medium house with a main supply at 250V has two 2kW electric heaters and six 100 W lamps. The power and lighting circuit are entirely separate, and each has its own main fuse. What current passes through each of the fuses when both heaters and all lamps are in use? Calculate the total resistance.*

The question was opted for by 55.7 percent of all the candidates whereby 11.2 percent scored a 0 mark, 55.9 percent scored from 0.5 to 10 marks and 32.9 percent scored from 10.5 to 20 marks.

The candidates, who scored a 0 mark failed to state laws, identify the formula in order to find a total current of the circuit, voltages of V_1 and V_2 and an electric current in ammeters A_1 and A_2. They also failed to identify the formula in calculating current which passes through each of the fuses when both heaters and all lamps are in use and eventually failed to calculate the total resistance as can be depicted in extract 15.1. The candidate here lacked the concept of ohm's law which could lead them to calculate electric current and voltages.

Extract 15.1

15

(a) ohm's law –
Fleming's left hand rule –

(b)

(i) 5Ω + 1Ω + 4Ω + 5Ω + 6Ω + 3Ω + 2Ω + 3Ω + 1Ω
20Ω ÷ 10V = ~~70Ω / 10V~~ = ~~10~~ 70 Ω

(ii) Voltage V_1 and V_2 =
(a) V_2 = 1Ω + 4Ω + 5Ω = 10 ~~10V~~ 100V
(b) V_1 = 6Ω + 3Ω = 9V

(c) Data given
Main supply voltage 250
Electric heaters 2 kw
Watt 100
6 lamp
Soln.
Change kilowatt in to watt
1kw = 100 watt
2kw = watt ?

$$\frac{2kw \times 100}{1} = 200$$

= 200 watt

$\frac{200 \text{ watt}}{100 \text{ watt}} = 2V$

Current flow in each fuse 2V
2V × 6 = 12
Total Voltage = 12Ω

Extract 15.1 shows a sample of a response of a candidate who failed to state ohm's law and Fleming's left hand rule. This candidate failed to apply the formula. He/she did not manage to reduce the electric circuit to correct answers.

The candidates who scored from 0.5 to 05 marks only managed to state laws and identified part of the formula and others stated the laws and managed to write some parts of the formula. Those who scored from 6 to 9 marks managed to state the law and calculated the total current but could not identify the formula in calculating current which passes through each of the fuse.

The candidates who scored from 10 to 20 marks, only managed to state ohm's law, Fleming's left-hand rule and calculated the total current of the circuit, voltages of V_1 and V_2 and an electric current in ammeters A_1 and A_2. Those who scored twenty marks managed to state laws, identified the formula to find the total current of the circuit, voltages of V_1 and V_2 and an electric current in ammeters A_1 and A_2. They were able to find the current which passes through each of the fuses when both heaters and all lamps are in use and calculated the total resistance as shown in Extract 15.2.

Extract 15.2

15b. Total resistance for R_4 R_5 and R_6.

$$\frac{1}{r_T} = \frac{1}{r_4} + \frac{1}{r_5} + \frac{1}{r_6}.$$

$$= \frac{1}{2} + \frac{1}{3} + \frac{1}{1} = \frac{3+2+6}{6}$$

$$\frac{1}{r_T} = \frac{11}{6}.$$

$$r_T = \frac{6}{11} = 0.55\Omega$$

Total resistance for R_7, R_8 and R_9.

$$\frac{1}{r_T} = \frac{1}{r_7} + \frac{1}{r_8} + \frac{1}{r_9}$$

$$= \frac{1}{5} + \frac{1}{4} + \frac{1}{1} \quad \frac{4+5+20}{20}$$

$$\frac{1}{r_T} = \frac{29}{20}$$

$$r_T = \frac{20}{29} = 0.69\Omega$$

Total resistance of the circuit = $25\Omega + 20\Omega + 0.55\Omega + 0.69\Omega + 75\Omega$

$= 48.24\Omega$

∴ Total resistance = 48.24Ω.

$$\text{Total current} = \frac{\text{Total voltage}}{\text{Total resistance}}.$$

$$= \frac{10}{48.24} = 0.2077$$

∴ Total current $[I] = 0.21A$.

15c. Data.

Voltage (V) = 250V

Electric heaters = (2kw x 2) = 4kw.

Lamp = 6 x 100w = 600w

Solution

Power = voltage x current.

$\frac{P}{V} = \frac{VI}{V}$

$I = \frac{4000}{250}$

$I = 16A$.

∴ current through fuse of electric heater = 16A.

Power = voltage x current.

$\frac{P}{V} = \frac{VI}{V}$

$I = \frac{600}{250} = 2.4A$.

current through fuse of Lamp = 2.4A.

Total current = 16A + 2.4A.

= 18.4A.

Total resistance = $\frac{\text{Total voltage}}{\text{Total current}} = \frac{250}{18.4}$

= 13.58Ω

∴ Total resistance (R_T) = 13.58Ω.

Extract 15.2 shows sample of a response of a candidate who was able to; state ohm's law and Fleming's left hand rule and applied the ohm's law and reduced the electric circuit.

2.3.5 Question 16: Force

The question had three parts (a), (b) and (c). In part (a), the candidates were required to

(i) define resultant forces,
(ii) differentiate scalar and vector quantities and
(iii) state the principle of parallelogram of forces.

In part (b) candidates were required to calculate the resultant force with the aid of sketch(es) resolving the following forces of 250N, 200N and 150N acting at 60^{o}, 120^{o} and 330^{o} respectively to the horizontal into their horizontal and vertical components.

In part (c), the questions were as follows: *A uniform wooden lath AB, 150 cm long and weighting 1.5 N rests on two sharp-edged support C and D placed 20 cm from each end of the lath respectively. A 0.4 N weight hangs from a loop of thread 40 cm from A and a 0.9 N weight hangs similarly 50 cm from B. Draw a clear-diagram of the arrangement and calculate the reactions at the supports.*.

The question was opted for by 37.3 percent of all the candidates whereby 8.5 percent scored a 0 mark, 64.3 percent scored from 0.5 to 10 marks and 27.2 percent scored from 10.5 to 20 marks.

The candidates who scored a 0 mark failed to define resultant forces, differentiate scalar and vector quantities and could not state the principle of parallelogram of forces. Moreover the candidate failed to calculate the resultant force with the aid of a sketch they failed to draw a clear-diagram of the arrangement of uniform wooden lath and to calculate the reactions at the support as shown in Extract 16.1. These candidates lacked the concept of forces acting on an object and seesaw of force on a beam.

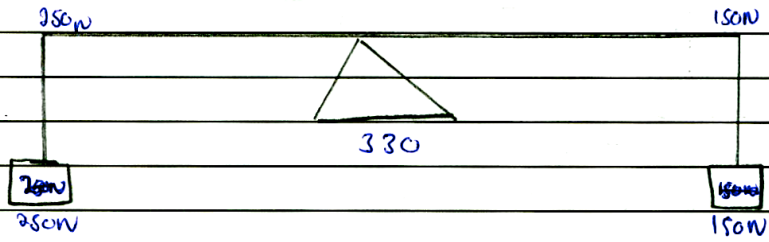
Extract 16.1

16 (i) Force - Is the power per unit time.

(ii) Scalar and vector quantities. Is the rate of change in power is friction.

(iii) (i) time
(ii) weight.
(iii) mass.

(b)



Soln

$$\frac{250N \times 200N \times 150N}{60 \times 120 \times 330} = \frac{7500000}{2376000}$$

$$\frac{7500}{2376} = 3.1$$

The force is 3.1N

(c) AB, 150cm weighing = 1.5N
Card D, 20cm
A 0.4N

Extract 16.1 shows a sample of a response of a candidate who was not able to define resultant force, differentiate between scalar and vector quantities and could not state the principle of parallelogram of forces. He/she failed to apply the principle of moments to calculate reactions on supports.

The candidates who scored from 0.5 to 05 marks only managed to either define resultant forces or differentiated scalar and vector quantities but could not state the principle of parallelogram of forces and failed all the other parts of the question thus scored less than 6 marks. Others who scored more than 6 marks were able to define resultant forces and differentiated between scalar and vector quantities and managed to state the principle of parallelogram of forces. They also failed to resolve the forces into their horizontal and vertical components. Some of the candidates in this group managed to state the principle of moments but failed to sketch the parallel force-diagram in order to calculate the reactions at the supports.

The candidate who scored from 06 to 11 marks calculated the resultant force with the aid of sketch (es) by resolving the forces into their horizontal and vertical components and therefore scored less than 12 marks, but failed to differentiate scalar and vector quantities. Others from this group scored from 12 to 20 marks because they were able to define resultant forces and managed to differentiate between Scalar and Vector quantities. They calculated the resultant force and calculated the reactions forces by stating the correct principle of moment with aid of sketch as shown in Extract 16.2.

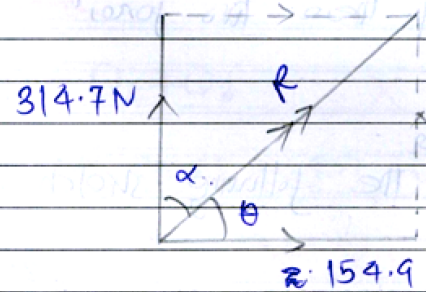
Extract 16.2

from Resolution of forces

FORCE (N)	VERTICAL COMPONENT V.C (N)	HORIZONTAL COMPONENT, H.C (N)
250	$250\sin 60^\circ = 216.5$	$250\cos 60^\circ = 125$
200	$200\sin 60^\circ = 173.2$	$-200\cos 60^\circ = -100$
150	$-150\sin 30^\circ = -75.0$	$150\cos 30^\circ = 129.9$
Resultant force.	314.7	154.9

V.C of 250N is 216.5 N

Then, Consider the following figure below.



from, Resultant,

$$R = \sqrt{(V.C)^2 + (H.C)^2}$$

$$R = \sqrt{(314.7)^2 + (154.9)^2}$$

$$R = \left(\sqrt{99040 + 24000}\right) N$$

$R = (\sqrt{123040})\,N$

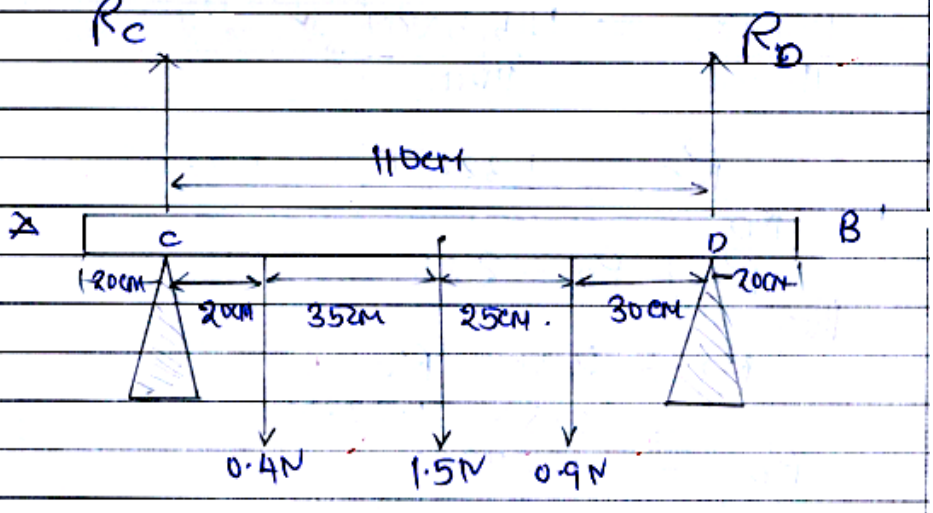
$R = \sqrt{12.304 \times 10^4} = 3.507 \times 10^2$

$= \cancel{357}\ 350.7N$

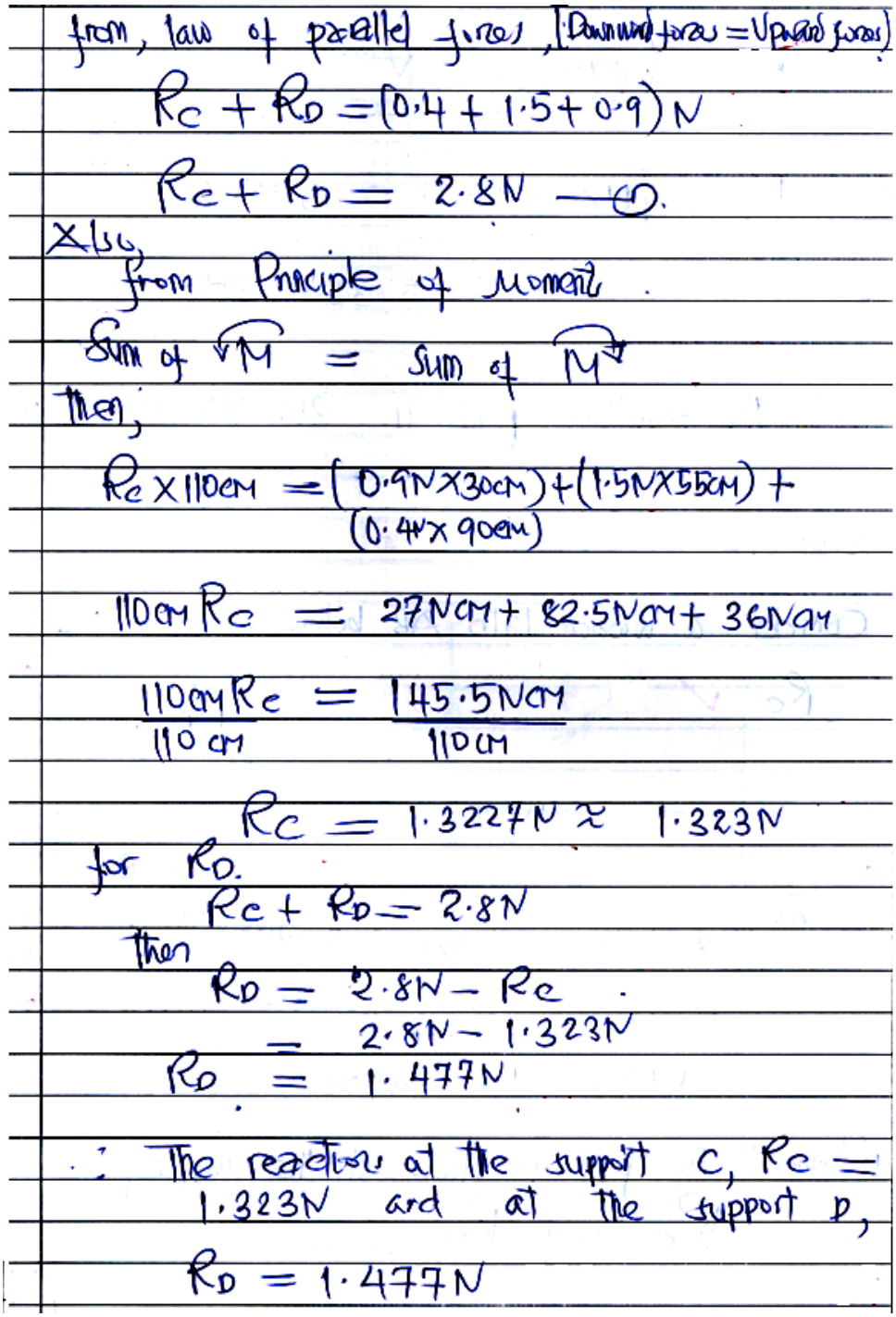
∴ The resultant force is 350.7N

Solution;

Consider a wooden lath AB below.



Required: To find reactions at the support, R_C and R_D.



Extract 16.2 shows a sample of a response of a candidate who managed to define resultant force, differentiate between scalar and vector quantities and stated the principle of parallelogram of forces. He/she applied the principle of moments to calculate reactions on support.

3.0 CONCLUSION

This report has given the analysis of candidates' performance on individual questions. It has indicated some of the strengths and weaknesses that the candidates encountered in answering questions in Engineering Science subject, CSEE 2014. The most notable strengths shown include candidates' ability to identify the task of the question, ability to recall some laws and principles related to Engineering Science subject. However some of the candidates performed poorly due to lack of knowledge of the subject matter, failure to identify the task of the question and poor writing skills whereby some candidates failed to express themselves well. It is evident from the report that some candidates lacked knowledge in various Engineering Science concepts, laws and principles, and therefore failed to apply scientific laws and principles in answering the questions.

Further analysis on the candidates' performance in different topics indicates that the general performance was good because most of the topic were performed well. The topic with the highest performance is "*Simple Machine*" in which 85.4 percent of the candidates scored 30 percent or above. The topic with the lowest performance is from the topic of "*Angular velocity*" in which 43.4 percent of the candidates scored 30 percent and above. As seen in the appendix.

4.0 RECOMMENDATIONS

(a) The candidates should be guided to acquire reading skills by reading a variety of books which will enable them to read and understand the demand of the questions when doing examinations.

(b) The candidates should be guided to acquire mathematical skills by giving them enough class exercises to improve their learning skills and thus be able to solve problems which involve calculations.

(c) Candidates should be helped to practice drawing as this will help them acquire skills to draw/sketch neatly labelled diagrams and graphs.

APPENDIX

Analysis of Candidates' Performance Question-wise in Engineering Science subject

S/N	Topic	Question Number	Percentage of candidates who scored 30 percent or more.	Recommendation
1	Simple Machine	11	85.4	Good
2	Force	7	84.5	Good
3	Fluid Mechanics	9	84.4	Good
4	Units and Measurements	10	77.2	Good
5	Optics (Light)	6	73.4	Good
6	Fluid Mechanics	4	72.9	Good
7	Forces Linear Motion Heat Fluid Mechanics, Sound Electricity and Magnetism	1	70.4	Good

S/N	Topic	Question Number	Percentage of candidates who scored 30 percent or more.	Recommendation
8	Sound	5	66.1	Good
9	Linear Motion	12	55.5	Good
10	Electricity and Magnetism	3	54.7	Good
11	Electricity and Magnetism	15	54.3	Good
12	Simple Machine	8	52.9	Good
13	Work, Energy and Power	14	51.2	Good
14	Force	16	50.5	Good
15	Heat	13	45.9	Average
16	Angular Velocity	2	43.4	Average