Aga Khan University Examination Board

Notes from E-Marking Centre on SSC-I Mathematics Examination May 2017

Introduction

This document has been produced for the teachers and candidates of Secondary School Certificate (SSC-I) Mathematics. It contains comments on candidates' responses to the 2017 SSC-I Examination indicating the quality of the responses and highlighting their relative strengths and weaknesses.

E-Marking Notes

This includes overall comments on students' performance on every question and *some* specific examples of students' responses which support the mentioned comments. Please note that the descriptive comments represent an overall perception of the better and weaker responses as gathered from the e-marking session. However, the candidates' responses shared in this document represent some specific example(s) of the mentioned comments.

Teachers and candidates should be aware that examiners may ask questions that address the Student Learning Outcomes (SLOs) in a manner that require candidates to respond by integrating knowledge, understanding and application skills they have developed during the course of study. Candidates are advised to read and comprehend each question carefully before writing the response to fulfil the demand of the question.

Candidates need to be aware that the marks allocated to the questions are related to the answer space provided on the examination paper as a guide to the length of the required response. A longer response will not in itself lead to higher marks. Candidates need to be familiar with the command words in the SLOs which contain terms commonly used in examination questions. However, candidates should also be aware that not all questions will start with or contain one of the command words. Words such as 'how', 'why' or 'what' may also be used.

Key observations:

This year candidates did not perform well in questions based on properties of similar triangles, parallelogram, angle bisectors and perpendicular. Candidates had problems with application of reminder and factor theorems (zero of a polynomial) and logarithms. Candidates performed well on questions related to complex numbers, algebraic manipulation, variations, matrices, and construction of medians of a triangle.

Detailed Comments:

Question 1:

This question offered a choice between part a and b. Part a was attempted by candidates more as compared to part b. Both parts were well attempted.

Question 1a:

If $z = -2-3i$ and $\bar{z} = -2+3i$, then find $\frac{\bar{z}}{z}$, giving your answer in the form $a+ib$.

Better responses rationalized $\frac{\bar{z}}{z}$ using the correct conjugate. Correct algebraic formulae were applied on $(-2+3i)^2$ and $(-2)^2-(3i)^2$ to find the answer which was expressed in the required form. Many candidates preferred to expand $(-2+3i)^2$ without using formula.

Example:

$\bar{z} = -2+3i,\ z = -2-3i$

$\frac{\bar{z}}{z} = \frac{-2+3i}{-2-3i} \times \frac{-2+3i}{-2+3i}$

$\frac{\bar{z}}{z} = \frac{-2(-2+3i)+3i(-2+3i)}{(-2)^2-(3i)^2}$

$\frac{\bar{z}}{z} = \frac{4-6i-6i+9i^2}{4-9i^2}$

$\frac{\bar{z}}{z} = \frac{4-12i+9(-1)}{4-9(-1)}$

$\frac{\bar{z}}{z} = \frac{4-9-12i}{4+9}$

$\frac{\bar{z}}{z} = \frac{-5-12i}{13}$

$\frac{\bar{z}}{z} = \frac{-5}{13} - \frac{12}{13}i$

Weaker responses reflected candidates' confusion in conjugates. The most frequently used incorrect conjugates were $2+3i$ and $2-3i$. Minor errors were frequent in simplification after application of formulae.

Example:

Sol

$z = -2-3i$

$\bar{z} = -2-3i$

$\dfrac{\bar{z}}{z} = ?$

$\dfrac{\bar{z}}{z} = \dfrac{-2+3i}{-2-3i} \times \dfrac{+2+3i}{+2+3i}$

$\dfrac{\bar{z}}{z} = \dfrac{-2(2+3i)+3i(+2+3i)}{-2(+2+3i)-3i(+2+3i)}$

$\dfrac{\bar{z}}{z} = \dfrac{-4-\cancel{6i}+\cancel{6i}+9i^2}{(-2)^2-(3i)^2}$

$\dfrac{\bar{z}}{z} = \dfrac{-4+9i^2}{4-9i^2}$

$\dfrac{\bar{z}}{z} = \dfrac{-4+9(-1)}{4-9(-1)}$

$\dfrac{\bar{z}}{z} = \dfrac{-4-9}{4-9}$

$\dfrac{\bar{z}}{z} = 0$

Question 1b:

Express $\dfrac{m^{\frac{7}{3}}n}{\sqrt{m^{-4}n^{-2}}}$ in its simplest form.

Better responses correctly applied the laws of exponents and expressed the answer in the simplest form. Most of the responses expressed square root as a power and simplified the denominator as $m^{-2}n^{-1}$. The final answer was found by correct conversion of signs when $m^{-2}n^{-1}$ was taken in numerator.

Example:

Q1: b $\dfrac{m^{7/3}\, n}{\sqrt{m^{-4} n^{-2}}}$

$= \dfrac{m^{7/3}\, n}{m^{-4\times 1/2}\, n^{-2\times 1/2}}$

$= \dfrac{m^{7/3}\, n}{m^{-2}\, n^{-1}} = m^{7/3+2}\, n^{1+1}$

$= m^{\frac{7+6}{3}}\, n^{2}$

$= m^{13/3}\, n^{2}$

$\boxed{= m^{13/3}\, n^{2}}$ Ans

Weaker responses failed to exhibit the law of exponents in division; there was a vague understanding of change of sign rule but it could not be applied correctly resulting in loss of marks. In some of the responses, the square root was converted to exponent correctly but due to minor mistakes the numerator $m^{-2}n^{-1}$ was not found. Minor errors in simplification were frequent.

Example:

$$= \frac{m^{7/3} n}{\sqrt{m^{-4} n^{-2}}}$$

$$= m^{7/3} n \times \frac{1}{\sqrt{m^{-4} n^{-2}}}$$

$$= m^{7/3} n \times \sqrt{m^{+4} n^{+2}}$$

$$= m^{7/3} n \times m^{4 \times 1/2} n^{\cancel{2} \times 1/\cancel{2}}$$

$$= m^{7/3} n \times m^{2} n$$

$$= m^{9/3} n^{2}$$

$$= m^{3} n^{2}$$

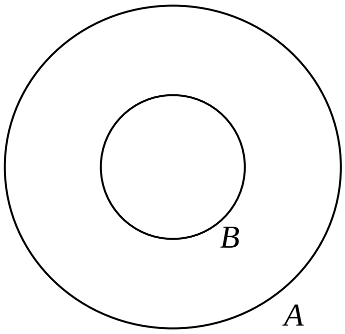
Question 2:

This question offered a choice between part a and b. Part a was attempted more as compared to part b and was also attempted well.

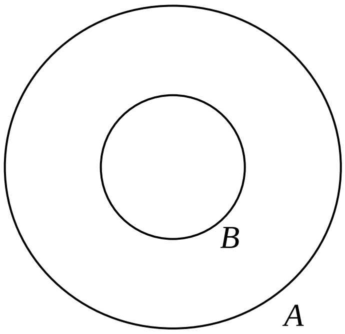
Question 2a:

If A and B are two non-empty sets, shade each of the following set operations in the corresponding Venn diagrams.

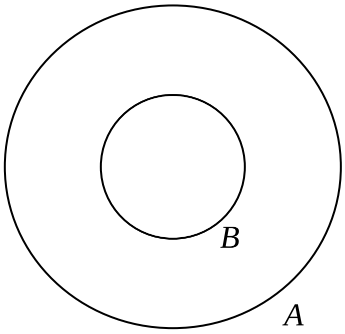
i. $A \cup B$



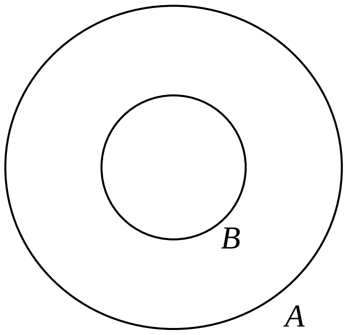
ii. $A \cap B$



iii. $(A \cup B) - (A \cap B)$

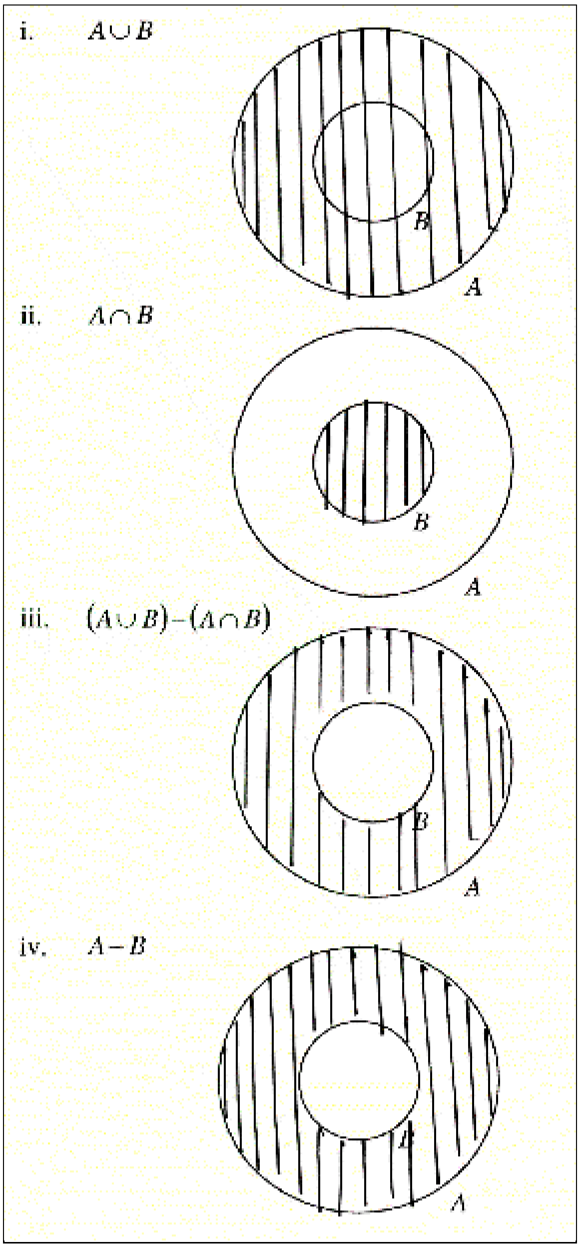


iv. $A - B$



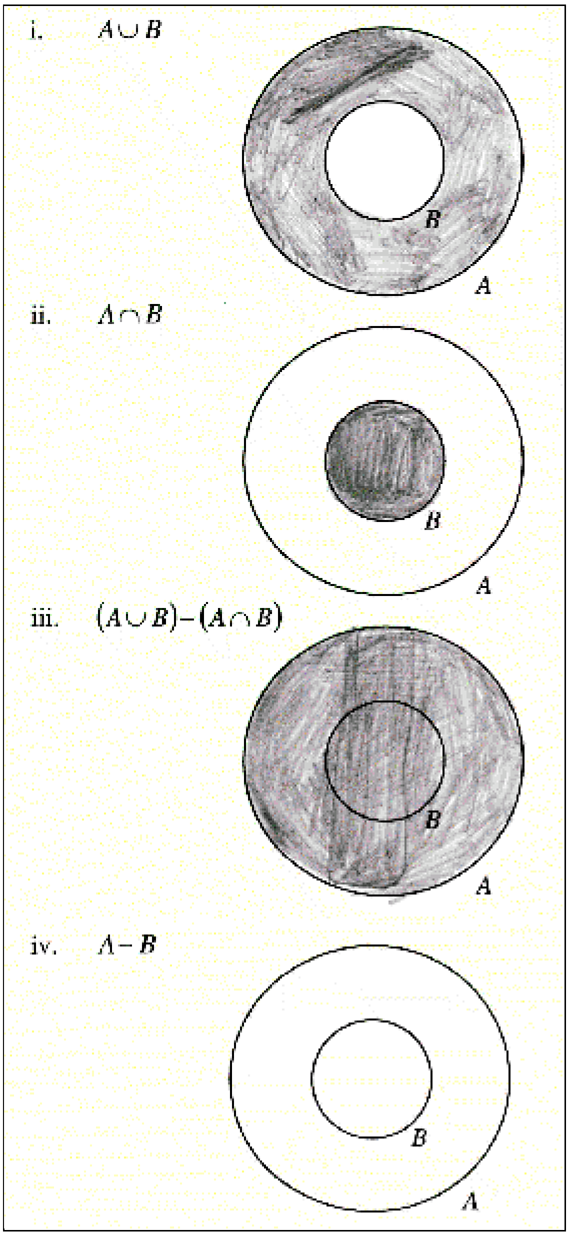
Better responses exhibited clear understanding of operations of union and intersection on sets in the Venn diagrams which was evident from correct shading. A large number of candidates used different patterns to shade $A \cup B$ and $A \cap B$ which visually aided them to find the answer.

Example:



Weaker responses reflected that candidates failed to exhibit the operations of union and intersection in Venn diagram or confused the two. Many candidates shaded part i and ii correctly but were unable to shade the more complex part iii $(A \cup B) - (A \cap B)$. They were also not able to connect iii and iv and shaded these two differently even though they are equal.

Example:



Question 2b:

For two non-empty sets *A* and *B*, an **onto function** from *A* to *B* is defined as $f_1 = \{(p, 10), (q, 10), (r, 25), (s, 30)\}$. Answer the following.

i. Find the domain of f_1.

ii. Find the set *A*.

iii. Select and write down the possible set *B* from the given two choices.

Choice I: {10, 25, 30}
Choice II: {10, 15, 20, 25, 30}

iv. Write down a function f_2 from *A* to *B*.

(**Note:** f_2 should not be the same as f_1)

Better responses reflected that candidates were able to understand the flow of the question. In part i and ii, candidates showed understanding that since f_1 is a function from *A* to *B*, the domain of f_1 should also be set *A*. In part iii, the candidates were able to differentiate between into and onto set by choosing the correct set *B*. A variety of responses were given in part iv, which included into, onto and one-one functions. A large number of candidates used mapping diagrams to find their answers and got full credit for it.

Example:

i. Find the domain of f_1.

{p, q, r, s} is the domain of f_1

ii. Find the set *A*.

A = {p, q, r, s}

iii. Select and write down the possible set *B* from the given two choices.

Choice I: {10, 25, 30}
Choice II: {10, 15, 20, 25, 30}

Choice I is the possible set B.

iv. Write down a function f_2 from *A* to *B*.

(**Note:** f_2 should not be the same as f_1)

$f_2 = \{(p, 10), (q, 25), (r, 30), (s, 10)\}$

Weaker responses reflected weak understanding of functions in general. Candidates were able to find set *A* in part ii but found range, instead of domain, in part i. Many candidates lost marks in part iii due to incorrect selection of set which reflects their confusion between into and onto functions. In part iv, there was a lot of guess-work observed in forming functions.

Example:

i. Find the domain of f_1.

$f_1 = \{10, 10, 25, 30\}$

ii. Find the set A.

$A = \{p, q, r, s\}$

iii. Select and write down the possible set B from the given two choices.

Choice I: $\{10, 25, 30\}$
Choice II: $\{10, 15, 20, 25, 30\}$

$\{10, 25, 30\}$

iv. Write down a function f_2 from A to B.

(**Note:** f_2 should not be the same as f_1)

$f_2 = \{(10, p), (10, q), (25 r), (s, 30)\}$

Question 3:

Given that $\log_3 x = m$, find the value of the following in terms of *m*.

i. x

ii. $\log_3 \frac{x}{3}$

This was not a well attempted question.

Better responses of part i converted the given logarithmic term into exponential form. In part ii, candidates exhibited correct application of quotient law $\log_3 \frac{x}{3} = \log_3 x - \log_3 3$. This was followed by application of laws of logarithm to get the answer $m-1$. Many candidates substituted the value of *x* found in part i, i.e. $\log_3 \frac{x}{3} = \log_3 x - \log_3 3$ or $\log_3 \frac{x}{3}$. Candidates also converted part ii into exponential form, supposing it as a variable, and found the answer by working with the exponents. One such response is shown below.

Example:

$\log_3 x = m$

$\boxed{3^m = x}$

$\log_3 \frac{x}{3}$

$\log_3 x - \log_3 3$

Substituting

$m - \log_3 3$

Weaker responses reflected that candidates had a weak understanding of laws of logarithm. In part I, candidates merely guessed the exponential form. In part ii, most of the candidates did not use quotient rule. Those who did use it correctly, could not extend it to get the answer.

Example:

$$\log_3 x = m$$

$$\cancel{3}^m = x^{\cancel{3}}$$

$$m = x$$

$$\log_3 \frac{x}{3} = x$$

$$\log \cancel{3}^x = \frac{x}{\cancel{3}}$$

$$\log x = x$$

Question 4:

This question offered a choice between part a and b. Majority of students chose part b. Both parts were well attempted.

Question 4a:

Show that $\dfrac{a^3-b^3}{a^2+ab+b^2}+\dfrac{1}{a+b}=\dfrac{a^2-b^2+1}{(a+b)}$.

Better responses exhibited algebraic manipulation skills in candidates. Some candidates took L.C.M. of the L.H.S. $\dfrac{(a^3-b^3)(a+b)+(a^2+ab+b^2)}{(a^2+ab+b^2)(a+b)}$ while others simplified it to $\dfrac{(a-b)}{1}+\dfrac{1}{a+b}$ before taking L.C.M. $\dfrac{(a-b)(a+b)+1}{a+b}$.

Example:

a. $\dfrac{a^3-b^3}{a^2+ab+b^2}+\dfrac{1}{a+b}=\dfrac{a^2-b^2+1}{a+b}$

$\because a^3-b^3=(a-b)(a^2+ab+b^2)$

$=\dfrac{(a-b)\cancel{(a^2+ab+b^2)}}{\cancel{a^2+ab+b^2}}+\dfrac{1}{a+b}=\dfrac{a^2-b^2+1}{(a+b)}$

$=\dfrac{(a-b)}{1}+\dfrac{1}{a+b}=\dfrac{a^2-b^2+1}{(a+b)}$

$=\dfrac{(a-b)(a+b)+1}{(a+b)}=\dfrac{a^2-b^2+1}{(a+b)}$

$\because (a-b)(a+b)=a^2-b^2$, $=\dfrac{a^2-b^2+1}{(a+b)}=\dfrac{a^2-b^2+1}{(a+b)}$

Proved that L.H.S = R.H.S.

Weaker responses reflected that candidates did not know algebraic formulae. The expression $(a^3 - b^3)$ was not expanded correctly. There were also many errors in cancellation after expansion. Minor errors of sign were also frequently observed.

Example:

$$\frac{(a^3-b^3)}{a^2+\cancel{ab}+b^2} - 3\cancel{ab}(a-b) + \frac{1}{(a+b)} = \frac{a^2-b^2+1}{a+b}$$

$$\frac{(a-b)^2-3(a+b)}{a^2+b^2} + \frac{1}{a+b} = \frac{a^2-b^2+1}{a+b}$$

$$\frac{a^2-2ab+b^2-3\cancel{(a+b)}}{(a-b)\cancel{(a+b)}} + \frac{1}{a+b} = \frac{a^2-b^2+1}{a+b}$$

$$\frac{a^2-2ab+b^2-2}{(a-b)(a+b)} = \frac{a^2-b^2+1}{a+b}$$

Question 4b:

Find the value of $a^2 + b^2 + c^2$, when $a + b + c = 7$ and $ab + bc + ca = 18$.

Better responses used the given data $a + b + c = 7$ and squared it on both sides, i.e. $(a + b + c)^2 = 7^2$ which was further expanded to get $a^2 + b^2 + c^2 + 2(ab + bc + ca) = 49$. After correct substitution, the answer as found.

Example:

$(a+b+c)^2 = a^2+b^2+c^2+2ab+bc+ca$

Puting values in eq

$(7)^2 = a^2+b^2+c^2+2(18)$

$49 = a^2+b^2+c^2+36$

$49-36 = a^2+b^2+c^2$

$\therefore a^2+b^2+c^2 = 13$

Weaker responses exhibited that candidates made mistakes in stating the formula $(a+b+c)^2 = a^2+b^2+c^2+2(ab+bc+ac)$ correctly. The most frequently used incorrect formulae were $a^2+b^2+c^2 = a^2+b^2+c^2+2(ab+bc+ac)$ and $(a+b+c)^2 = a^2+b^2+c^2+ab+bc+ac$.

Example:

b. $a^2+b^2+c^2 = (a+b+c)^2 + 2ab + 2bc + 2ca$

$a^2+b^2+c^2 = (7)^2 + 2(18)$

$a^2+b^2+c^2 = 14 + 36$

$a^2+b^2+c^2 = 50$ Ans

Question 5:

This question offered a choice between part a and b. Majority of the candidates chose part b which was attempted better than part a.

Question 5a:

Find the zeros of the polynomial y^2-5y+6. Hence, find the remainder when y^2-5y+6 is divisible by $y-3$.

Better responses exhibited clear understanding of zeros of a polynomial which were found using the trial and error method. Some candidates factorised the given polynomial to find factors and stated zeros. The reminder of y^2-5y+6 was found by candidates mostly by using division method and, at times, factor theorem.

Example:

a. y^2-5y+6	$P(3) = (3)^2-5(3)+6$	$P(2) = (2)^2-5(2)+6$
$= y^2-2y-3y+6$	$= 9-15+6$	$= 4-10+6$
$= y(y-2)-3(y-2)$	$= -6+6$	$= 4-4$
$= (y-3)(y-2)$	$= 0$ (Proved)	$= 0$ (Proved

$\therefore$ The zeroes of the polynomial y^2-5y+6 are 3 and 2.

$\Rightarrow$ When y^2-5y+6 is divisible by $(y-3)$

$P(3) = (3)^2-5(3)+6$

$= 9-15+6$

$= -6+6$

$= 0$

The remainder when y^2-5y+6 is divisble by $y-3$ is 0

Weaker responses reflected that candidates did not know what zeros of polynomial are and/ or how many were to be found for the given polynomial (A quadratic polynomial will have two zeros). Candidates did use trial and error but did not extend it to finding factors and or/ zeros. Many candidates did not find the remainder when $y^2 - 5y + 6$ was divided by $y - 3$.

Example:

(a) $y^2 - 5y + 6$

$\Rightarrow y^2 - 2y - 3y + 6$

$= y(y - 2) - 3(y + 2)$

solution:- 1^{st} condition: $p(x) = y^2 - 5y + 6$

$= p(3) = (3)^2 - 5(3) + 6$

$= 27 - 15 + 6$

$= 18$

2^{nd} condition: $y^2 - 5y + 6$

$p(1) = (1)^2 - 5(1) + 6$

$= 1 - 5 + 6 = 0$

factor is $(x - 1)$

$p(-1) = (-1)^2 - 5(-1) + 6$

$\Rightarrow 1 - (-5) + 6$

$\Rightarrow 1 + 5 + 6$

$\Rightarrow 12$

$(x + 1)$ is not factor

Question 5b:

Factorise $(z^2 - z - 3)(z^2 - z + 1) + 4$ completely.

Better responses substituted $z^2 - z$ with a variable, e.g. y, hence forming the equation $(y-3)(y+1) + 4$ which was simplified to $y^2 - 2y + 1$ and then factorised. The variable y was substituted back again to get the factors $(z^2 - z - 1)^2$.

Example:

Let $z^2 - z = t$

$\Rightarrow (t-3)(t+1) + 4$

$= t(t+1) - 3(t+1) + 4$

$= t^2 + t - 3t - 3 + 4$

$= t^2 - 2t + 1$

$= (t)^2 - 2(t)(1) + (1)^2$

$\because (a-b)^2 = a^2 - 2ab + b^2$

$= (t-1)^2$

$= (t-1)(t-1)$

putting value of t in above expression.

$= (z^2 - z - 1)(z^2 - z - 1)$ Ans.

Weaker responses expanded the given equation and got stuck when they found that the equation could not be simplified any further. Candidates that were able to do substitution made mistakes in factorisation of $y^2 - 2y + 1$ which lead them to incorrect answers.

Example:

$= (z^2 - z - 3)(z^2 - z + 1) + 4$

$= z^2(z^2 - z + 1) - z(z^2 - z + 1) - 3(z^2 - z + 1) + 4$

$= z^4 - z^3 + z^2 - z^3 + z^2 - z - 3z^2 + 3z - 3 + 4$

$= z^4 - z^3 - z^3 + z^2 + z^2 - 3z^2 - z + 3z - 3 + 4$

$= z^4 - 2z^3 + 2z^2 - 3z^2 + 2z + 1$

$= z^4 - 2z^3 - z^2 + 2z + 1$ an.

Question 6:

This question offered a choice between part a and b. Candidates chose both parts equally. Both parts were attempted well.

Question 6a:

If $\frac{m}{n} = \frac{l}{p} = \frac{q}{r} = k$, then using K-method verify $\frac{mlq}{npr} = \frac{m^3 + l^3 + q^3}{n^3 + p^3 + r^3}$.

Better responses used $\frac{m}{n} = \frac{l}{p} = \frac{q}{r} = k$ to substitute *m, l*, and *q* as $m = nk$; $l = pk$; $q = rk$ in the given equation $\frac{mlq}{npr} = \frac{m^3 + l^3 + q^3}{n^3 + p^3 + r^3}$ to show that both sides become equal to k^3.

Example:

$\frac{m}{n} = k \quad \frac{L}{p} = k \quad \frac{q}{r} = k \longrightarrow$

$= m = nk \quad L = pk \quad q = rk$

$\frac{m}{n} \times \frac{L}{p} \times \frac{q}{r} = k \times k \times k$

$\frac{mLq}{npr} = k^3$

Substituting the values of m, L, q

$\frac{n^3k^3 + p^3k^3 + r^3k^3}{n^3 + p^3 + r^3}$

$= k^3 \frac{(\cancel{n^3} + \cancel{p^3} + \cancel{r^3})}{(\cancel{n^3} + \cancel{p^3} + \cancel{r^3})} = k^3(1) = k^3$

Thus verified $\boxed{k^3 = \frac{mLq}{npr}}$

Weaker responses reflected that candidates did not have difficulty in making the substitution but they could not simplify the right hand side of the equation

$\dfrac{(nk)(pk)(rk)}{npr} = \dfrac{(nk)^3 + (pk)^3 + (rk)^3}{n^3 + p^3 + r^3}$. Many candidates did incorrect cancellation, e.g. without taking k^3 common in the numerator. Some also tried to use cubic expansion.

Example:

a) $\dfrac{m}{n} = k \quad \dfrac{L}{p} = k \quad \dfrac{q}{r} = k.$

$m = nk \quad L = pk \quad q = rk$

$\dfrac{mlq}{npr} = \dfrac{m^3 + l^3 + q^3}{n^3 + p^3 + r^3}$

$\dfrac{mlq}{npr} = \dfrac{nk^3 + pk^3 + rk^3}{n^3 + p^3 + r^3}$

$\dfrac{mlq}{npr} = (k^3)^{\cancel{3}}$

$\dfrac{mlq}{npr} = k$ Therefore $k = k$ Verified.

Question 6b:

Given that p varies inversely as the square root of q. If $q = 100$ when $p = \dfrac{1}{5}$, find p when $q = 144$.

Better responses reflected clear understanding of inverse proportion. Candidates formed the equation $p = \frac{k}{\sqrt{q}}$ successfully. The data given in the question was correctly used to find the value of k which was substituted back in the equation to find p when q = 144. A few candidates solved the question without using a constant of proportionality k as is the common practice. One such response is shown below.

Example:

$P \propto \frac{1}{\sqrt{q}}$

if $\frac{1}{5} \propto \frac{1}{\sqrt{100}}$

then find p when $q = 144$

by simplifying

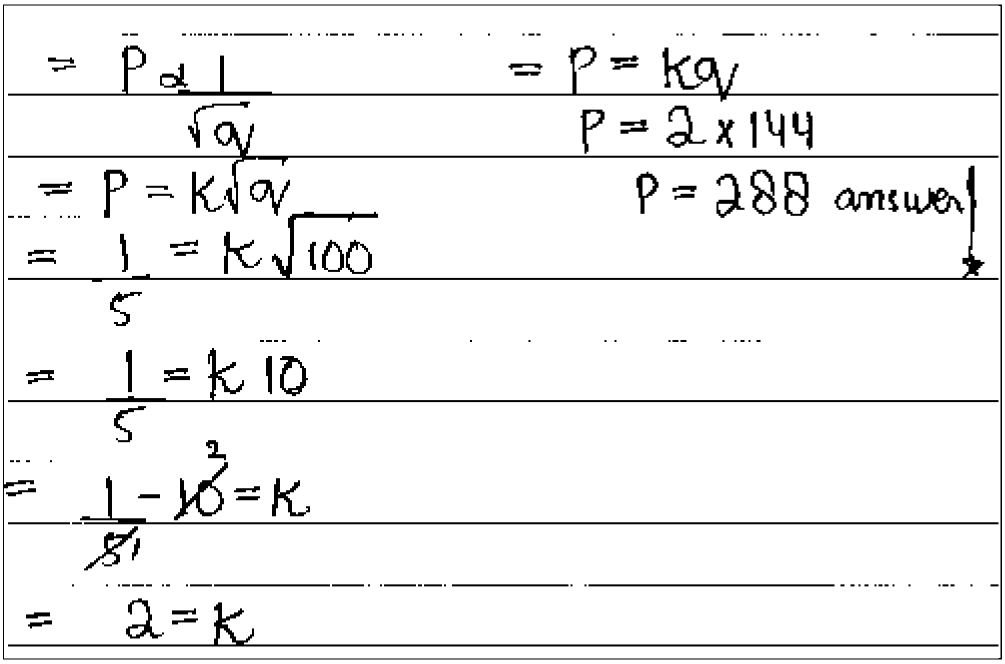
$P \propto \frac{1}{\sqrt{144}}$

$= P \propto \frac{1}{\sqrt{(12)^2}}$

$= P \propto \frac{1}{12}$ $\therefore$ $\frac{1}{5} \propto \frac{1}{10}$ so $P \propto 1/12 = P = 1/6$

Weaker responses reflected that candidates could not translate '*p* varies inversely as the square root of *q'* numerically. The most frequent incorrect responses were $p \propto \sqrt{q}$ and $p \propto \frac{1}{q^2}$. Some candidates did not use the given data correctly and made minor mistakes in finding the answer.

Example:



$= P \propto \frac{1}{\sqrt{q}}$

$= P = k\sqrt{q}$

$= \frac{1}{5} = k\sqrt{100}$

$= \frac{1}{5} = k\,10$

$= \frac{1}{\cancel{5}_{1}} - \cancel{10}^{2} = k$

$= 2 = k$

$= P = kq$

$P = 2 \times 144$

$P = 288$ answer

Question 7:

Find the value of *x* and *y* in the following matrix equation.

$$2\begin{bmatrix} 3 & x \\ 4 & 5 \end{bmatrix} + \begin{bmatrix} 6x & -2x \\ 0 & 6y \end{bmatrix} = \begin{bmatrix} 6 & 0 \\ 8 & 3 \end{bmatrix}$$

This question was attempted well by majority of the candidates.

Better responses reflected strong understanding of matrix operations. Candidates correctly applied scalar multiplication which was followed by addition of matrices. The concept of equality of matrices was used to form equations $6+6x=6$ and $10+6y=3$ which were simplified to find the answer.

Example:

$$\begin{bmatrix} 6 & 2x \\ 8 & 10 \end{bmatrix} + \begin{bmatrix} 6x & -2x \\ 0 & 6y \end{bmatrix} = \begin{bmatrix} 6 & 0 \\ 8 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 6+6x & 2x-2x \\ 8+0 & 10+6y \end{bmatrix} = \begin{bmatrix} 6 & 0 \\ 8 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 6+6x & 0 \\ 8 & 10+6y \end{bmatrix} = \begin{bmatrix} 6 & 0 \\ 8 & 3 \end{bmatrix}$$

$6+6x=6$ $\qquad$ $10+6y=3$

$6x=6-6$ $\qquad$ $6y=3-10$

$x=0/6$ $\qquad$ $y=-7/6$

$\boxed{x=0}$ $\qquad$ $\boxed{y=-7/6}$

Weaker responses showed a variety of misconceptions in matrices. While most candidates were able to do the scalar multiplication in matrices, the same was not observed in addition of matrices. The candidates who managed to add the matrices got stuck at $\begin{bmatrix} 6+6x & 0 \\ 8 & 10+6y \end{bmatrix} = \begin{bmatrix} 6 & 0 \\ 8 & 3 \end{bmatrix}$ and could not solve any further which showed that they could not use the concept of equality of matrices.

Example:

$$\Rightarrow \begin{bmatrix} 6 & 2x \\ 8 & 10 \end{bmatrix} + \begin{bmatrix} 6x & -2x \\ 0 & 6y \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 12x & -4x \\ 0 & +60y \end{bmatrix} = \begin{bmatrix} 6 & 0 \\ 8 & 3 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 8x \\ 60y \end{bmatrix} = \begin{bmatrix} 6 & 0 \\ 8 & 3 \end{bmatrix}$$

$$\Rightarrow 8x = 6$$

$$\Rightarrow \frac{8}{6} = x$$

$$\Rightarrow 1.33 = x$$

$$\Rightarrow 8x = 0.$$

$$\Rightarrow \frac{8}{0} = x$$

$$= 0 = x.$$

$$\Rightarrow 60y = 8$$

$$\frac{60}{8} = y$$

$$7.5 = y$$

$$\Rightarrow 60y = 3$$

$$\Rightarrow \frac{60}{3} = y.$$

$$\Rightarrow 20 = y$$

Question 8:

The given data shows the height (in centimetres) of 27 plants. Complete the given table and use it to construct a cumulative frequency curve.

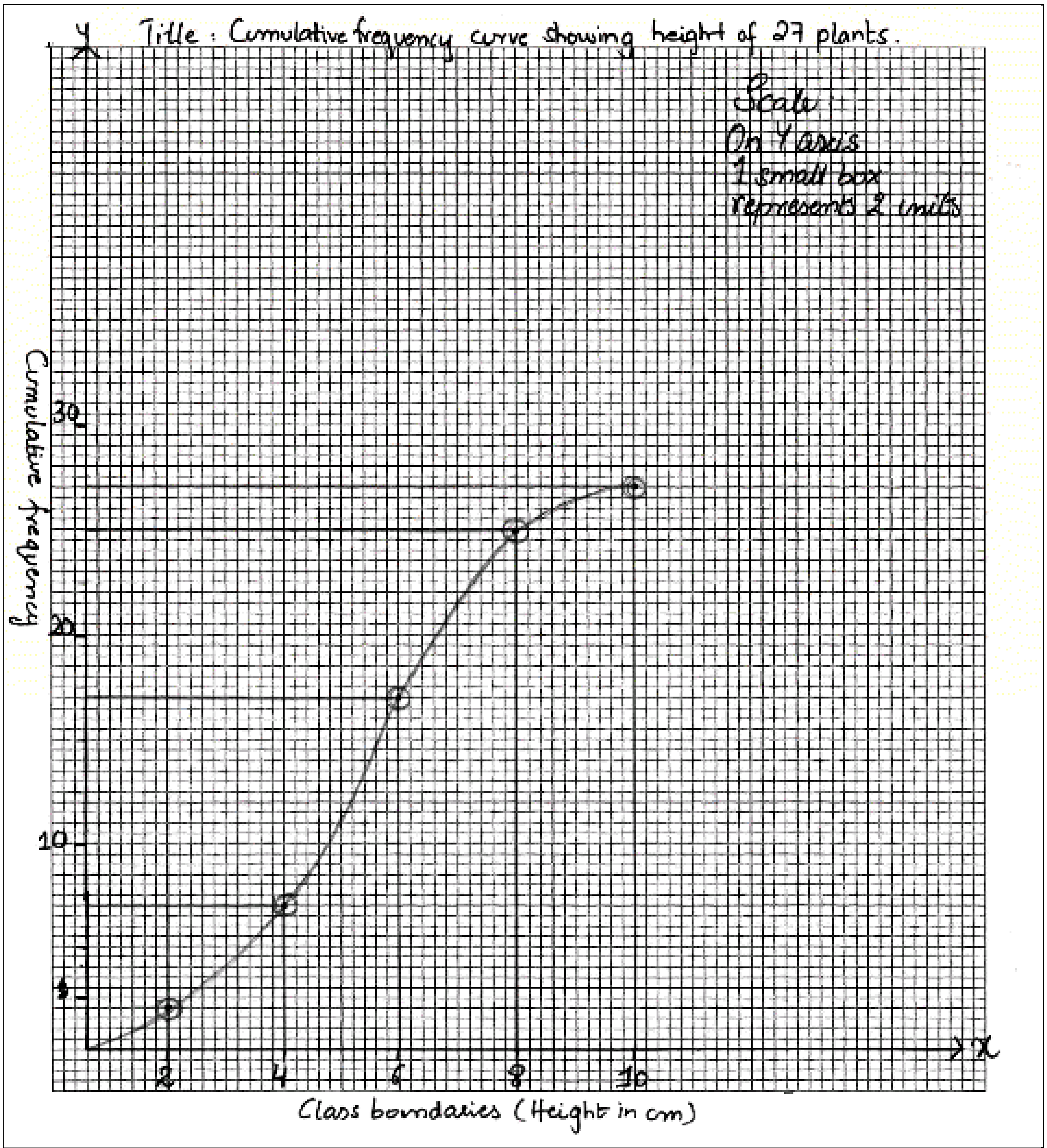
Height (cm)	0 – 2	2 – 4	4 – 6	6 – 8	8 – 10
Frequency	2	5	10	8	2
Cumulative Frequency					

Candidates showed average performance on this question.

Better responses displayed correct drawing of cumulative frequency curve. Candidates took class intervals on *x*-axis and cumulative frequency on *y*-axis to plot the cumulative frequency that they found from the given data.

Example:

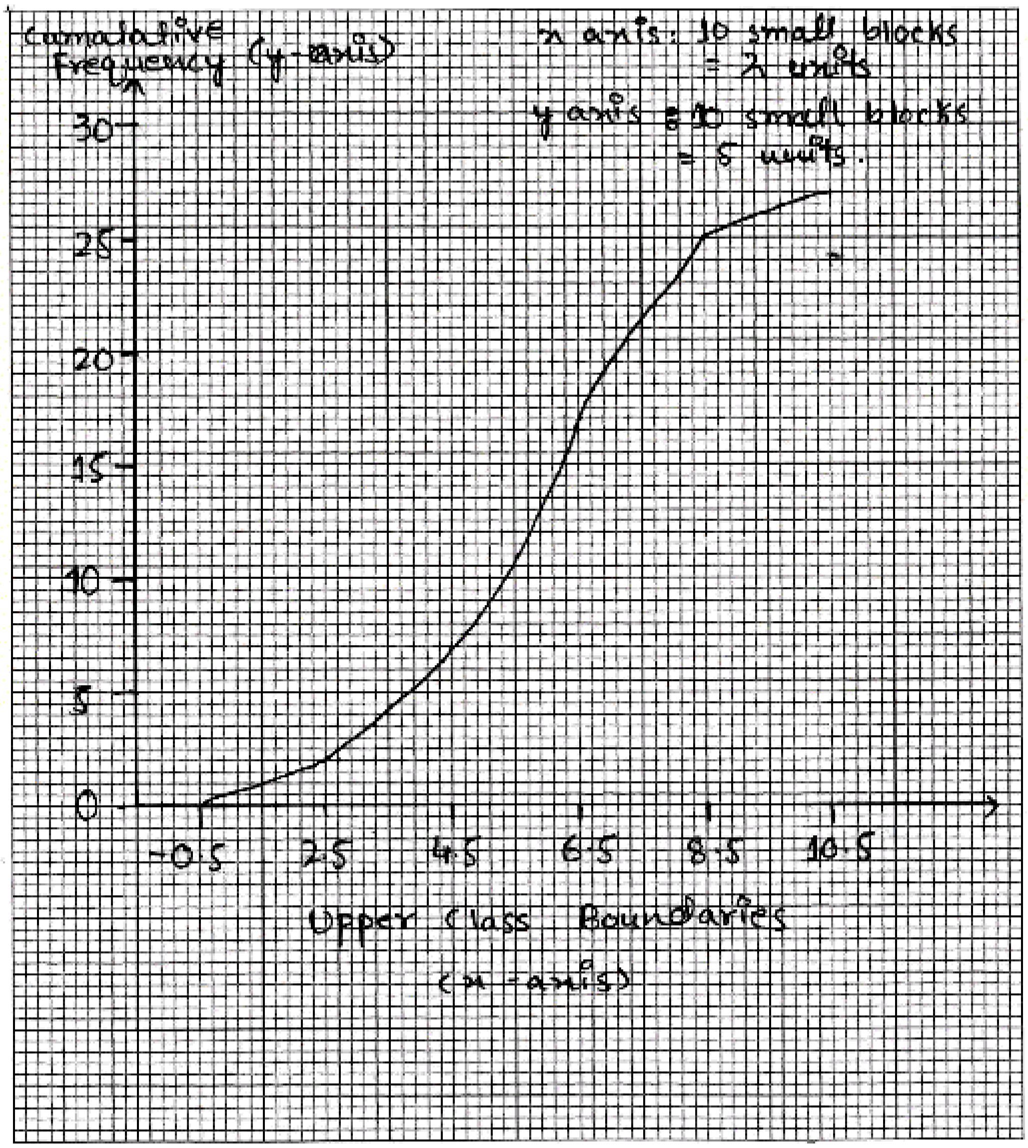
Height (cm)	0 – 2	2 – 4	4 – 6	6 – 8	8 – 10
Frequency	2	5	10	8	2
Cumulative Frequency	2	7	17	25	27



Weaker responses reflected the misconception among candidates that class boundaries were required to draw the cumulative frequency curve (Since the classes intervals are continuous, class boundaries are not required). There were errors in scaling of graph such as taking cumulative frequency no *x*-axis and class intervals on *y*-axis. Another common mistake was that after plotting the point and drawing the curve, it was not traced back to 0 on *x*-axis. Many candidates plotted frequency curve, frequency polygon and cumulative frequency polygon instead of the required cumulative frequency curve.

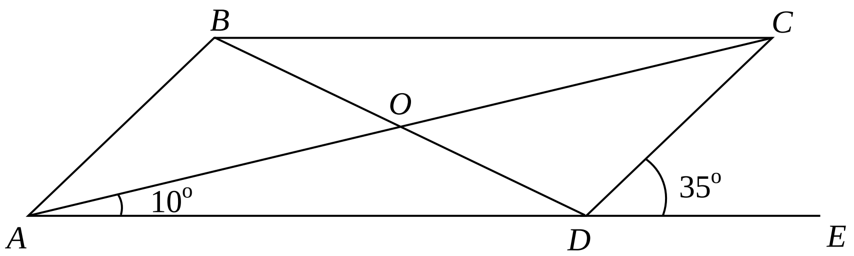
Example:

Height (cm)	0 – 2	2 – 4	4 – 6	6 – 8	8 – 10
Frequency	2	5	10	8	2
Cumulative Frequency	2	7	17	25	27



Question 9:

A parallelogram $ABCD$ is given. Find



NOT TO SCALE

i. $\angle ABC$

ii. $\angle BAO$

iii. $\angle OCD$

iv. $\angle BCA$

This was not a well attempted question.

Better responses displayed knowledge that opposite angles are congruent in a parallelogram and applied this knowledge to find solutions for all parts.

Example:

i. $\angle ABC$ (1 Mark)

$\angle ABC = \angle ADC$

$= 180° - 35° = 145°$. $m\angle ABC = 145°$

ii. $\angle BAO$ (1 Mark)

$\angle BAO = 180° - 145° - 10° = 25°$

$\angle BAO = 25°$

iii. $\angle OCD$ (1 Mark)

$\angle OCD = \angle BAO$

$\angle OCD = 25°$

iv. $\angle BCA$ (1 Mark)

$\angle BCA = m\angle CAD$

$\angle BCA = 10°$

Weaker responses reflected lack of knowledge of angles formed on a straight line which is also included in middle school syllabus. The candidates could not work out how to use the given angles in the diagram and properties of parallelogram to find the answer.

Example:

i. $\angle ABC$ (1 Mark)

$m\angle ABC = m\angle ADC$

$m\angle ABC = 150^\circ$ Ans.

ii. $\angle BAO$ (1 Mark)

$m\angle BAO = +150^\circ + 10^\circ - 180^\circ$

$m\angle BAO = 20^\circ$ Ans.

iii. $\angle OCD$ (1 Mark)

~~mLO~~ $m\angle OCD = m\angle OAB$

$m\angle OCD = 20^\circ$ Ans.

iv. $\angle BCA$ (1 Mark)

$m\angle BCA = m\angle CAD$

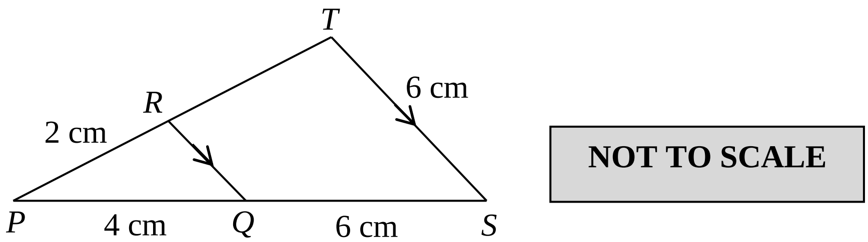
$m\angle BCA = 10^\circ$ Ans.

Question 10:

This question offered a choice between part a and b. Candidates attempted part a more than b. Both parts were not attempted well.

Question 10a:

In the given triangle *PST*, *PS* = 10 cm, *ST* = 6 cm, and *PR* = 2 cm. Find the length of



i. *PT*
ii. *QR*

Better responses exhibited strong understanding of similar triangles and the ratios derived from them. In part i, the ratios $\frac{PT}{PR} = \frac{PS}{PQ}$ and $\frac{PR}{RT} = \frac{PQ}{QS}$ were used equally by candidates. Likewise in part ii, the ratios $\frac{ST}{QR} = \frac{PS}{PQ}$ and $\frac{QR}{ST} = \frac{PR}{PT}$ were used equally. Using the ratios, correct substitution from diagram led candidates to correct answers. A large number of candidates solved part ii before i. After finding the value of *QR* in part ii, this value was substituted in ratio of part i.

Example:

$\frac{PR}{RT} = \frac{PQ}{QS}$ | $4x = 2 \times 6$

$4x = 12$

$\frac{2}{x} = \frac{4}{6}$ | $x = 3$ (RT)

$PT = PR + RT = 2 + 3 = 5cm$

$\frac{\overline{QR}}{\overline{TS}} = \frac{\overline{PQ}}{\overline{PS}}$ | $\overline{QR} \times 10 = 6 \times 4$

$QR \times 10 = 24$

$\frac{QR}{6} = \frac{4}{10}$ | $\boxed{\overline{QR} = 2.4\ cm}$

Weaker responses showed that while candidates had some understanding of similar triangles, they could not effectively find the relation between ratios of sides of similar triangles. Many candidates did random guess work and used addition and subtraction to find the length.

Example:

If $PRQ \sim PTS \Rightarrow \frac{PR}{PT} : \frac{PQ}{PS}$

$\frac{2}{PT} : \frac{4}{6} \Rightarrow PT = 6 \times 2 / 4 \Rightarrow 12/4$

$\boxed{PT = 3\ cm}$

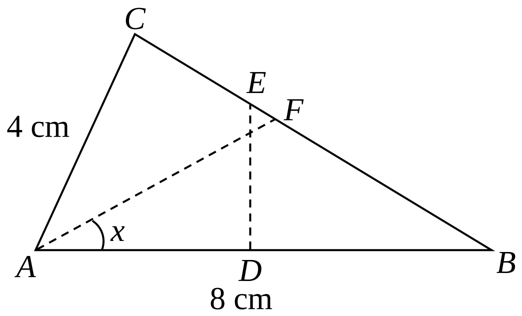
$QR \parallel ST$ | $QR = 3cm.$

$QR = \frac{1}{2} ST$

$QR = \frac{1}{\cancel{2}_1} \times \cancel{6}^3$

Question 10b:

In the given triangle ABC, $AB = 8$ cm and $AC = 4$ cm. Also, DE is the perpendicular bisector of AB and AF is the angle bisector of $\angle BAC$.



NOT TO SCALE

i. Find $\angle CAB$ in terms of x.

ii. Find the length of DB.

iii. If $BF = 6$ cm, find the length of FC.

Better responses reflected clear understanding of perpendicular bisector and angle bisector in part i and ii. Candidates were able to understand the given diagram, and used it to find their answers. For part iii, multiple responses were observed. Most of the candidates used the theorem of ratio and proportion 'the internal bisector of an angle of a triangle divides the side opposite to it in the ratio of the length of the sides containing the angle' while some candidates used direct proportion between sides.

Example:

As we know that AF is the angle bisector, Hence it divides $\angle CAB$ into two equal halves. Therefore $\angle CAB = 2x$

ii. Find the length of DB. (1 Mark)

As we know that DE is the perpendicular bisector, Hence it divides AB into two equal halves. Therefore $AD = DB = 4$cm

iii. If $BF = 6$ cm, find the length of FC. (2 Marks)

$\frac{AB}{CA} = \frac{BF}{FC}$

$\Rightarrow \frac{8}{4} = \frac{6}{x}$

$\Rightarrow 4 \times 6 = 8 \times x$

$\Rightarrow 24 = 8x$

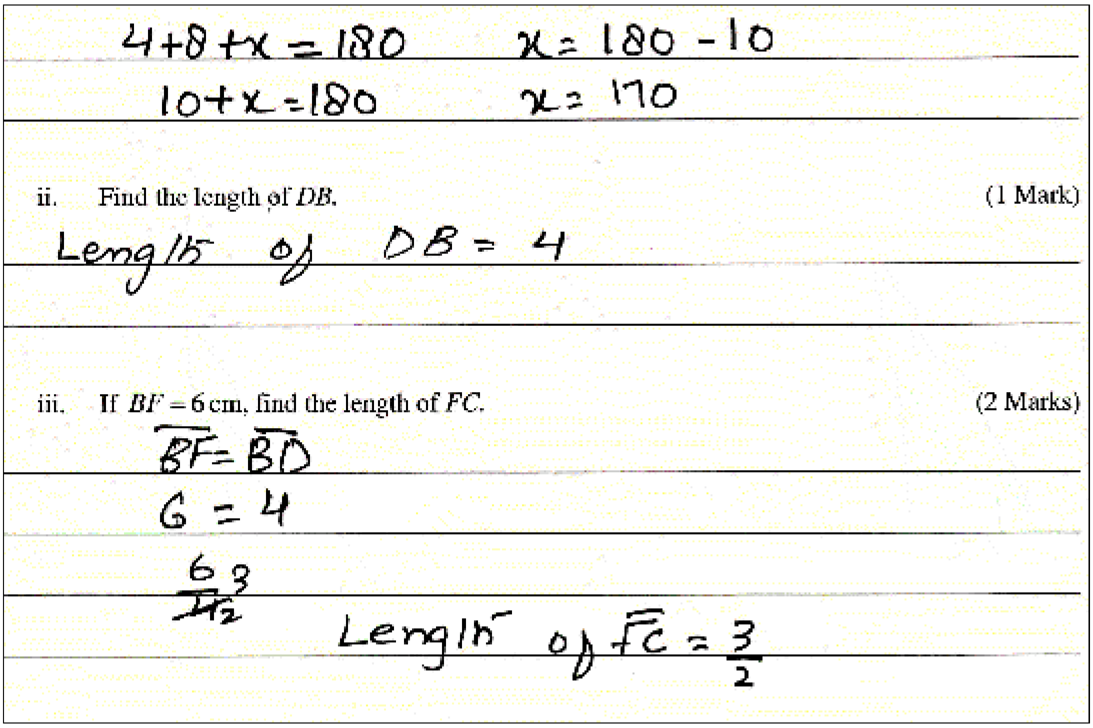
$\Rightarrow x = \frac{24}{8}$

$x = 3$

$\therefore FC = 3$cm

Weaker responses reflected that candidates were doing guess-work in part i and ii. They could not understand how to use the given diagram to find the answers. Candidates had difficulty solving part iii. They tried to develop various relations between the lengths of sides of triangles but due to unclear concepts of ratio and proportion in triangle, they could not succeed.

Example:



$4+8+x=180$ $x=180-10$

$10+x=180$ $x=170$

ii. Find the length of DB. (1 Mark)

Length of $DB = 4$

iii. If $BF = 6$ cm, find the length of FC. (2 Marks)

$\overline{BF} = \overline{BD}$

$6 = 4$

$\frac{\cancel{6}^{3}}{\cancel{4}_{2}}$

Length of $\overline{FC} = \frac{3}{2}$

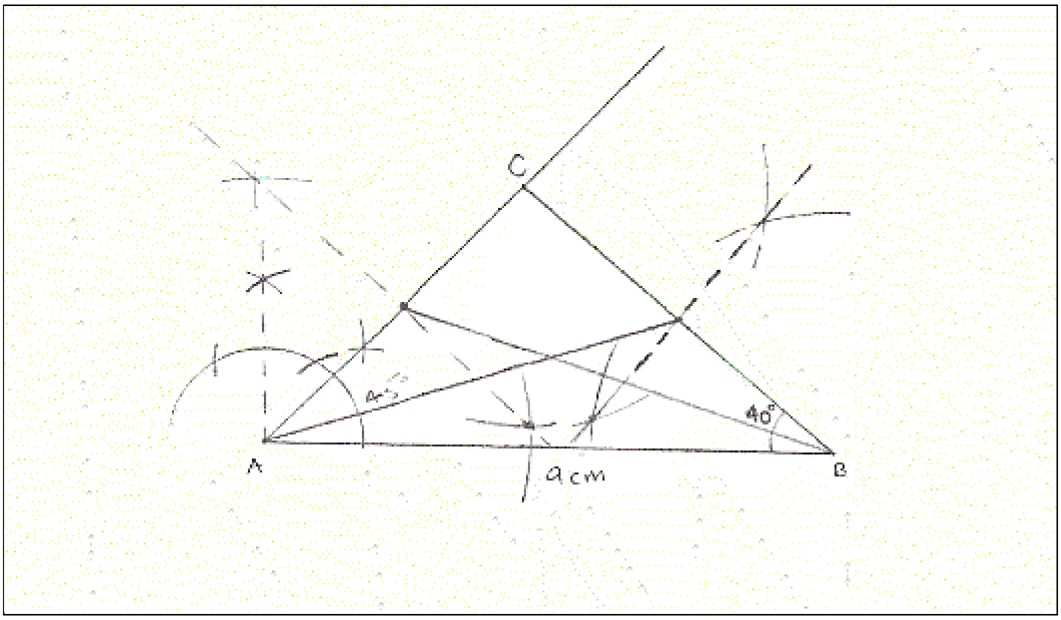
Question 11:

Draw a triangle ABC such that $AB = 9$ cm, $\angle A = 45°$ and $\angle B = 40°$. Also draw any TWO medians of the triangle.

This was a well attempted question.

Better responses constructed the triangle *ABC* and displayed various methods of drawing medians. While most of the candidates used side bisector to find the midpoint, there were some that found it by measuring half length of the side using a ruler. The medians were constructed by joining the mid points to the vertices.

Example:



Weaker responses displayed that candidates are confused between median and altitude. Many candidates did not use perpendicular bisector to find midpoint. Instead, they aimlessly constructed angle bisectors. The candidates who managed to construct perpendicular bisectors did not complete the solution further. They did not use the midpoints found to make medians, thus, they could not achieve more than 2 marks.

Example: