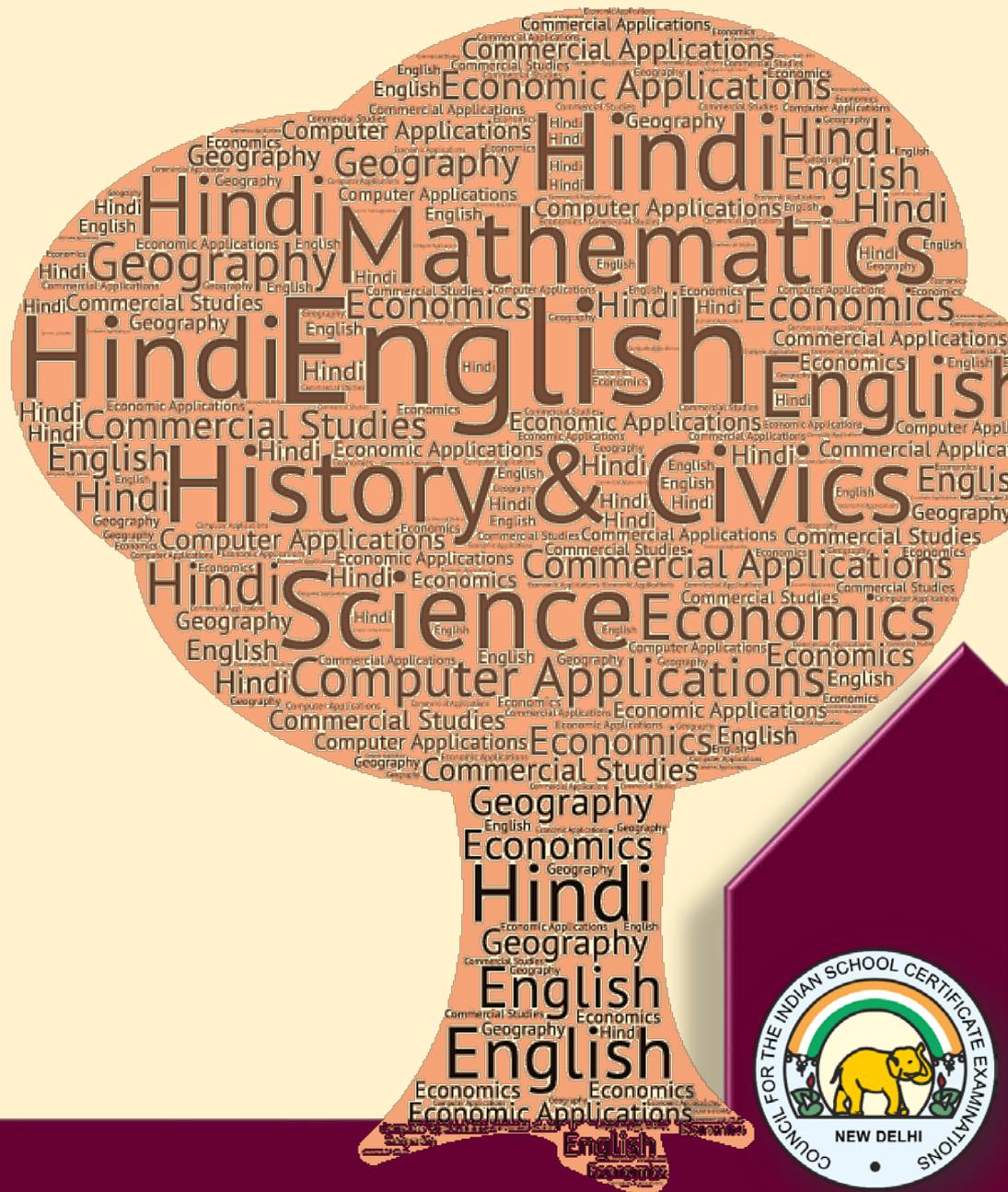


Analysis of Pupil Performance

Year 2017 Examination

ICSE

MATHEMATICS



Research Development and Consultancy Division

**Council for the Indian School Certificate Examinations
New Delhi**

Year 2017

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FOREWORD

This document of the Analysis of Pupils' Performance at the ISC Year 12 and ICSE Year 10 Examination is one of its kind. It has grown and evolved over the years to provide feedback to schools in terms of the strengths and weaknesses of the candidates in handling the examinations.

We commend the work of Mrs. Shilpi Gupta (Deputy Head) and the Research Development and Consultancy Division (RDCD) of the Council who have painstakingly prepared this analysis. We are grateful to the examiners who have contributed through their comments on the performance of the candidates under examination as well as for their suggestions to teachers and students for the effective transaction of the syllabus.

We hope the schools will find this document useful. We invite comments from schools on its utility and quality.

November 2017

**Gerry Arathoon
Chief Executive & Secretary**

The Council has been involved in the preparation of the ICSE and ISC Analysis of Pupil Performance documents since the year 1994. Over these years, these documents have facilitated the teaching-learning process by providing subject/ paper wise feedback to teachers regarding performance of students at the ICSE and ISC Examinations. With the aim of ensuring wider accessibility to all stakeholders, from the year 2014, the ICSE and the ISC documents have been made available on the Council's website www.cisce.org.

The document includes a detailed qualitative analysis of the performance of students in different subjects which comprises of examiners' comments on common errors made by candidates, topics found difficult or confusing, marking scheme for each answer and suggestions for teachers/ candidates.

In addition to a detailed qualitative analysis, the Analysis of Pupil Performance documents for the Examination Year 2017 have a new component of a detailed quantitative analysis. For each subject dealt with in the document, both at the ICSE and the ISC levels, a detailed statistical analysis has been done, which has been presented in a simple user-friendly manner.

It is hoped that this document will not only enable teachers to understand how their students have performed with respect to other students who appeared for the ICSE/ISC Year 2017 Examinations, how they have performed within the Region or State, their performance as compared to other Regions or States, etc., it will also help develop a better understanding of the assessment/ evaluation process. This will help them in guiding their students more effectively and comprehensively so that students prepare for the ICSE/ ISC Examinations, with a better understanding of what is required from them.

The Analysis of Pupil Performance document for ICSE for the Examination Year 2017 covers the following subjects: English (English Language, Literature in English), Hindi, History, Civics and Geography (History & Civics, Geography), Mathematics, Science (Physics, Chemistry, Biology), Commercial Studies, Economics, Computer Applications, Economics Applications, Commercial Applications.

Subjects covered in the ISC Analysis of Pupil Performance document for the Year 2017 include English (English Language and Literature in English), Hindi, Elective English, Physics (Theory and Practical), Chemistry (Theory and Practical), Biology (Theory and Practical), Mathematics, Computer Science, History, Political Science, Geography, Sociology, Psychology, Economics, Commerce, Accounts and Business Studies.

I would like to acknowledge the contribution of all the ICSE and the ISC examiners who have been an integral part of this exercise, whose valuable inputs have helped put this document together.

I would also like to thank the RDCD team of Dr. Manika Sharma, Dr. M.K. Gandhi, Ms. Mansi Guleria and Mrs. Roshni George, who have done a commendable job in preparing this document. The statistical data pertaining to the ICSE and the ISC Year 2017 Examinations has been provided by the IT section of the Council for which I would like to thank Col. R. Sreejeth (Deputy Secretary - IT), Mr. M.R. Felix, Education Officer (IT) – ICSE and Mr. Samir Kumar, Education Officer (IT) - ISC.

November 2017

Shilpi Gupta
Deputy Head - RDCD

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INTRODUCTION

This document aims to provide a comprehensive picture of the performance of candidates in the subject. It comprises of two sections, which provide Quantitative and Qualitative analysis results in terms of performance of candidates in the subject for the ICSE Year 2017 Examination. The details of the Quantitative and the Qualitative analysis are given below.

Quantitative Analysis

This section provides a detailed statistical analysis of the following:

- Overall Performance of candidates in the subject (Statistics at a Glance)
- State wise Performance of Candidates
- Gender wise comparison of Overall Performance
- Region wise comparison of Performance
- Comparison of Region wise performance on the basis of Gender
- Comparison of performance in different Mark Ranges and comparison on the basis of Gender for the top and bottom ranges
- Comparison of performance in different Grade categories and comparison on the basis of Gender for the top and bottom grades

The data has been presented in the form of means, frequencies and bar graphs.

Understanding the tables

Each of the comparison tables shows N (Number of candidates), Mean Marks obtained, Standard Errors and t-values with the level of significance. For t-test, mean values compared with their standard errors indicate whether an observed difference is likely to be a true difference or whether it has occurred by chance. The t-test has been applied using a confidence level of 95%, which means that if a difference is marked as 'statistically significant' (with * mark, refer to t-value column of the table), the probability of the difference occurring by chance is less than 5%. In other words, we are 95% confident that the difference between the two values is true.

t-test has been used to observe significant differences in the performance of boys and girls, gender wise differences within regions (North, East, South and West), gender wise differences within marks ranges (Top and bottom ranges) and gender wise differences within grades awarded (Grade 1 and Grade 9) at the ICSE Year 2017 Examination.

The analysed data has been depicted in a simple and user-friendly manner.

Given below is an example showing the comparison tables used in this section and the manner in which they should be interpreted.

Comparison on the basis of Gender

Gender	N	Mean	SE	t-value
Girls	2,538	66.1	0.29	11.91*
Boys	1,051	60.1	0.42	

*Significant at 0.05 level

Girls performed significantly better than boys.



The results have also been depicted pictographically. In this case, the girls performed significantly better than the boys. This is depicted by the girl with a medal.

The table shows comparison between the performances of boys and girls in a particular subject. The t-value of 11.91 is significant at 0.05 level (mentioned below the table) with a mean of girls as 66.1 and that of boys as 60.1. It means that there is significant difference between the performance of boys and girls in the subject. The probability of this difference occurring by chance is less than 5%. The mean value of girls is higher than that of boys. It can be interpreted that girls are performing significantly better than boys.

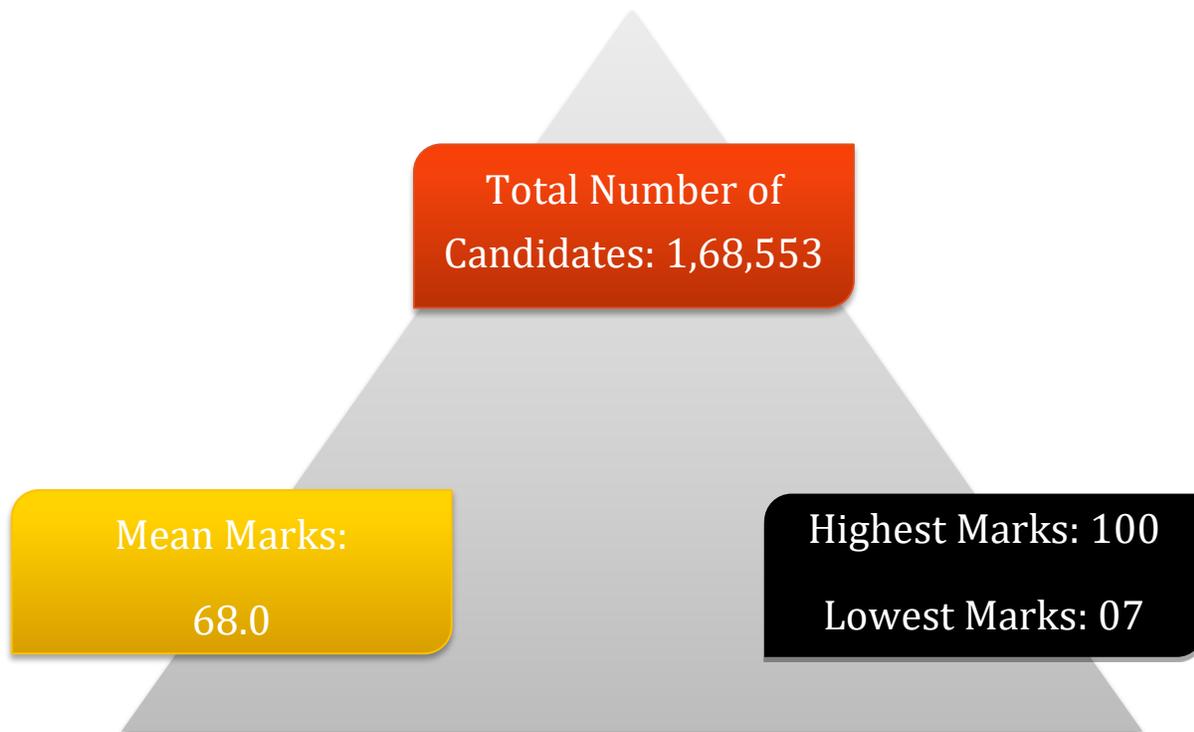
Qualitative Analysis

The purpose of the qualitative analysis is to provide insights into how candidates have performed in individual questions set in the question paper. This section is based on inputs provided by examiners from examination centres across the country. It comprises of question wise feedback on the performance of candidates in the form of *Comments of Examiners* on the common errors made by candidates along with *Suggestions for Teachers* to rectify/ reduce these errors. The *Marking Scheme* for each question has also been provided to help teachers understand the criteria used for marking. Topics in the question paper that were generally found to be difficult or confusing by candidates, have also been listed down, along with general suggestions for candidates on how to prepare for the examination/ perform better in the examination.

QUANTITATIVE ANALYSIS

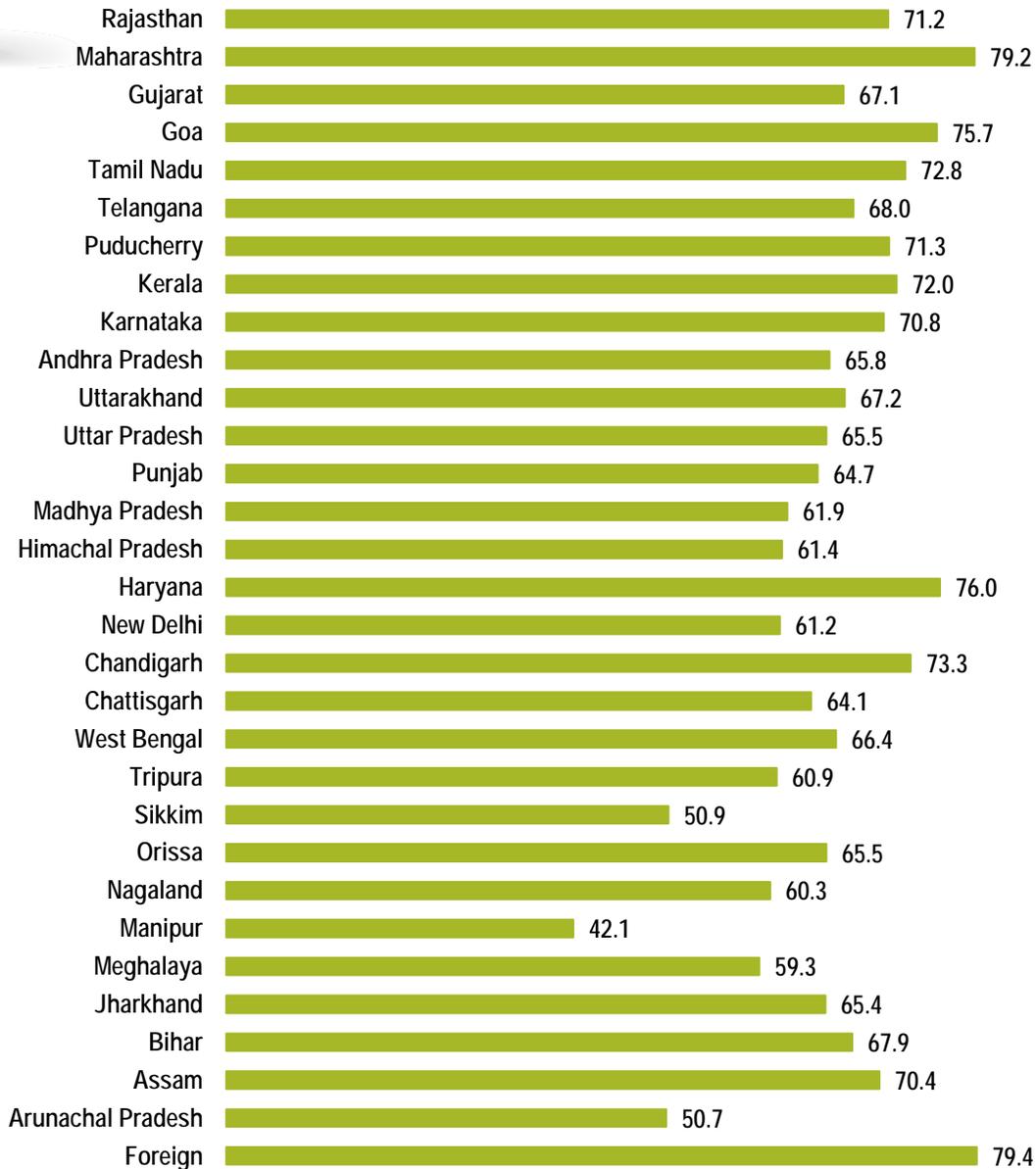


STATISTICS AT A GLANCE





PERFORMANCE (STATE-WISE & FOREIGN)



The States of Maharashtra, Haryana and Goa secured highest mean marks. Mean marks secured by candidates studying in schools abroad were 79.4.



GENDER-WISE COMPARISON



GIRLS

Mean Marks: 68.8

Number of
Candidates: 75,128



BOYS

Mean Marks: 67.3

Number of
Candidates: 93,425

Comparison on the basis of Gender

Gender	N	Mean	SE	t-value
Girls	75,128	68.8	0.07	14.89*
Boys	93,425	67.3	0.07	

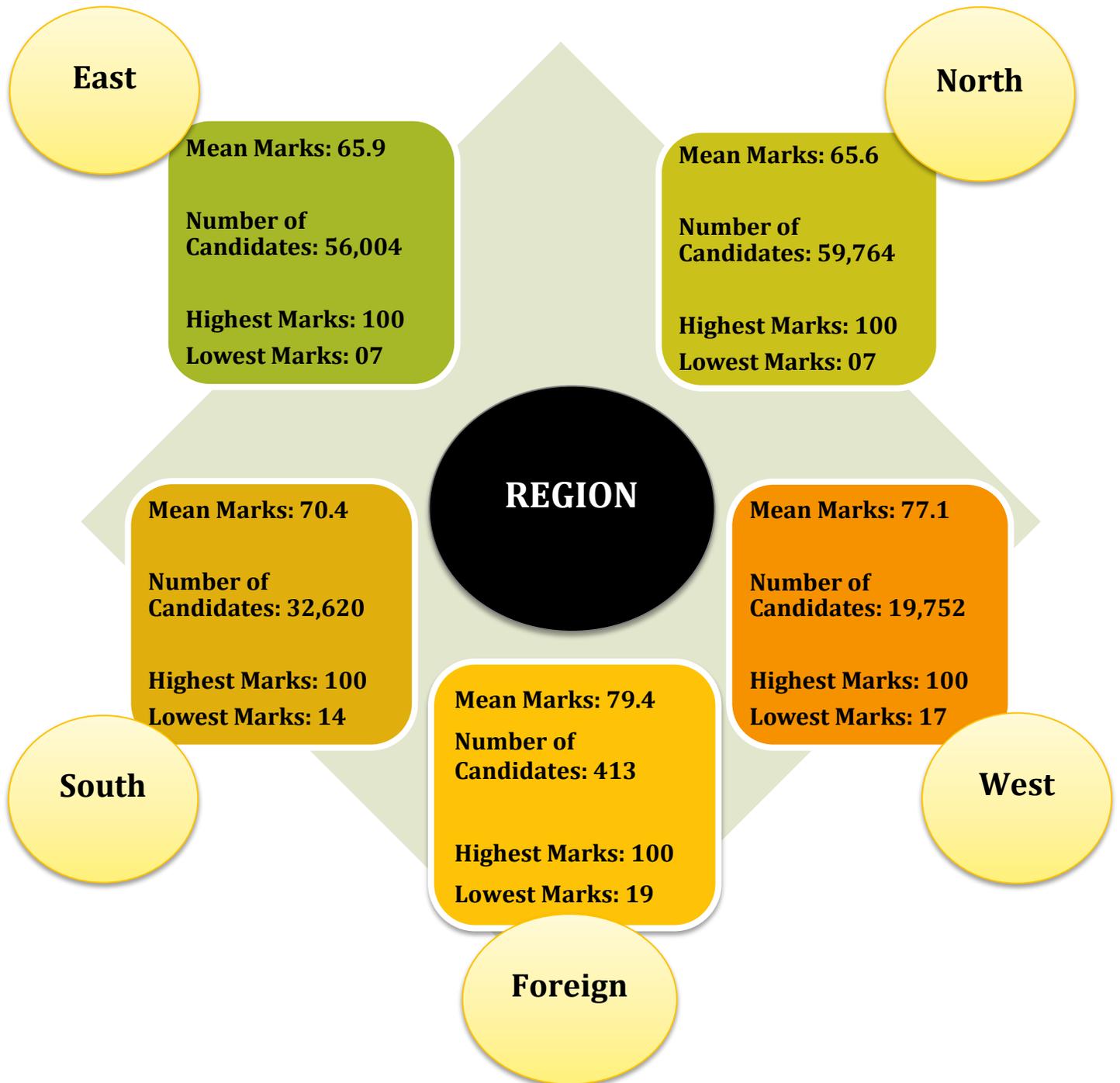
*Significant at 0.05 level

**Girls performed
significantly better than
boys.**

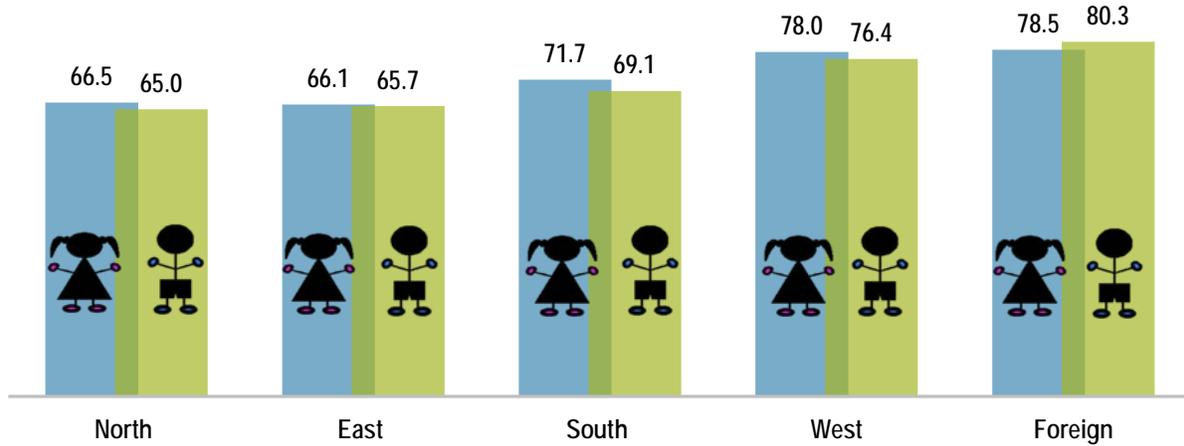




REGION-WISE COMPARISON



Mean Marks obtained by Boys and Girls-Region wise



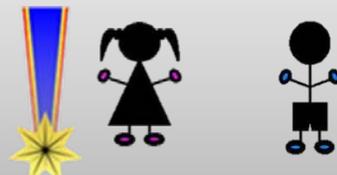
Comparison on the basis of Gender within Region

Region	Gender	N	Mean	SE	t-value
North (N)	Girls	25,270	66.5	0.13	9.05*
	Boys	34,494	65.0	0.11	
East (E)	Girls	24,850	66.1	0.13	1.78
	Boys	31,154	65.7	0.12	
South (S)	Girls	16,088	71.7	0.15	12.56*
	Boys	16,532	69.1	0.15	
West (W)	Girls	8,722	78.0	0.19	6.29*
	Boys	11,030	76.4	0.18	
Foreign (F)	Girls	198	78.5	1.28	-1.04
	Boys	215	80.3	1.16	

*Significant at 0.05 level

The performance of girls was significantly better than that of boys in the northern, southern and western regions. In other regions no significant difference was observed.

REGION (N, S, W)



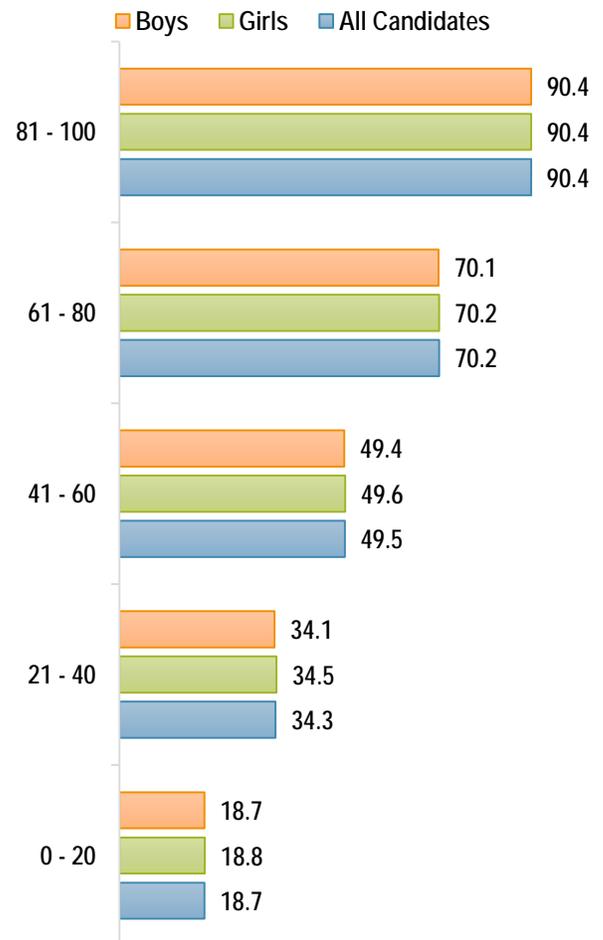


MARK RANGES : COMPARISON GENDER-WISE

Comparison on the basis of gender in top and bottom mark ranges

Marks Range	Gender	N	Mean	SE	t-value
Top Range (81-100)	Girls	26,835	90.4	0.03	0.92
	Boys	32,063	90.4	0.03	
Bottom Range (0-20)	Girls	722	18.8	0.06	1.38
	Boys	1,435	18.7	0.04	

No significant difference was found in the performance of girls and boys in the top and bottom marks range.





GRADES AWARDED : COMPARISON GENDER-WISE

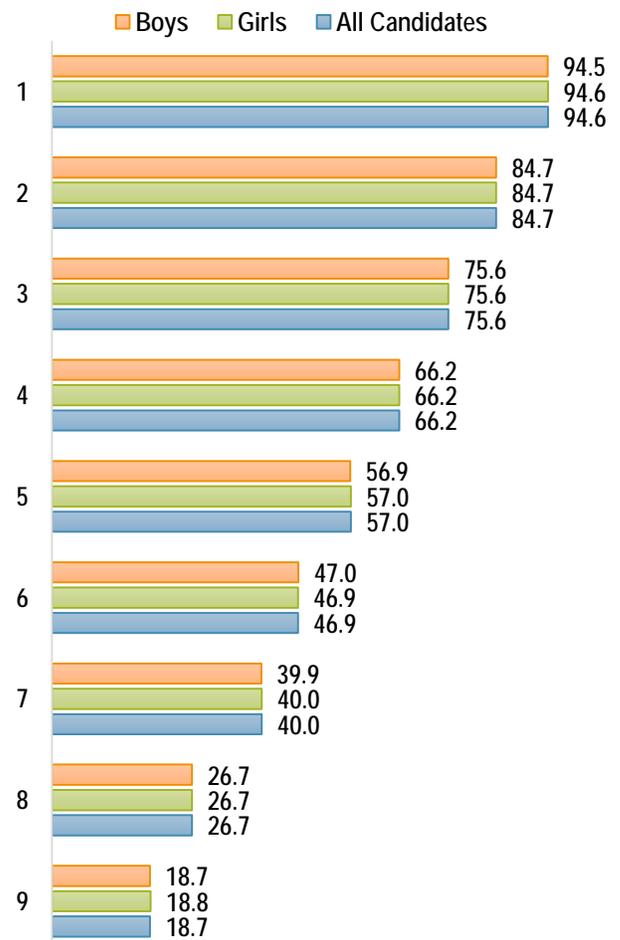
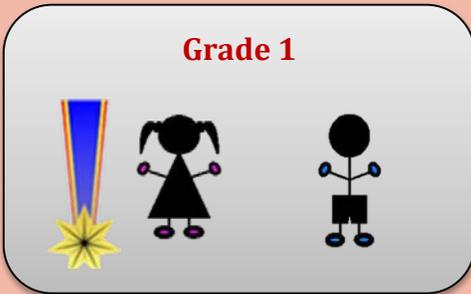
Comparison on the basis of gender in Grade 1 and Grade 9

Grades	Gender	N	Mean	SE	t-value
Grade 1	Girls	14,983	94.6	0.02	2.00*
	Boys	17,829	94.5	0.02	
Grade 9	Girls	722	18.8	0.06	1.38
	Boys	1,435	18.7	0.04	

*Significant at 0.05 level

In Grade 1, performance of girls was significantly better than the performance of boys. However, no significant difference was observed between the average performance of girls and boys in Grade 9.

Grade 1



QUALITATIVE ANALYSIS

SECTION A (80 Marks)

Attempt all questions from this Section.

Question 1

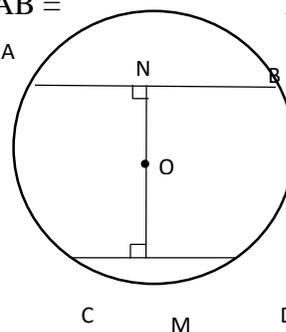
- (a) If b is the mean proportion between a and c , show that: [3]

$$\frac{a^4 + a^2b^2 + b^4}{b^4 + b^2c^2 + c^4} = \frac{a^2}{c^2}$$

[4]

- (b) Solve the equation $4x^2 - 5x - 3 = 0$ and give your answer correct to two decimal places.

- (c) AB and CD are two parallel chords of a circle such that AB = 24 cm and CD = 10 cm. If the radius of the circle is 13 cm, find the distance between the two chords. [3]



Comments of Examiners

- (a) Some candidates were not aware of the basic concepts of ratio and proportion, hence were unable to write mean proportion. They failed to prove the given condition.
- (b) Common errors made by candidates were:
- (i) used incorrect formula.
 - (ii) made mistakes in calculation.
 - (iii) made errors in finding square root of $\sqrt{73}$.
 - (iv) failed to give the answer correct up to two decimal places or did not round off at all.
- (c) Most candidates calculated the distance between the two chords correctly. Some wrote the equation using

Suggestions for teachers

- The concept of proportion and its properties needs thorough drilling. Teach different methods of solving problems on proportion through various examples.
- Drilling is necessary for solving quadratic equations. Extensive teaching and practice is necessary on approximation of numbers. Encourage students to use Mathematical tables to find square roots of numbers.
- Sufficient practice on sums related to chords and other properties of circle should be given.

Pythagoras theorem incorrectly. Several candidates got incorrect answers as they did not add the distances of OM and ON to get MN.

MARKING SCHEME

Question 1

(a)	$a : b : c$ $\frac{a}{b} = \frac{b}{c} \therefore b^2 = ac$ $\frac{a^4 + a^2b^2 + b^4}{b^4 + b^2c^2 + c^4} = \frac{a^4 + a^2ac + a^2c^2}{a^2c^2 + ac^3 + c^4}$ $= \frac{a^2(a^2+ac+c^2)}{c^2(a^2+ac+c^2)} = \frac{a^2}{c^2}$
(b)	$4x^2 - 5x - 3 = 0$ $x = \frac{5 \pm \sqrt{25 - 4 \times 4 \times (-3)}}{2 \times 4}$ $x = \frac{5 \pm \sqrt{73}}{8}$ $x = \frac{5 \pm 8.544}{8}$ $x = 1.693 \qquad x = -0.443$ $x = 1.69 \qquad x = -0.44$
(c)	$ON = \sqrt{OA^2 - AN^2}$ $OM = \sqrt{OC^2 - CM^2}$ $\therefore ON = \sqrt{13^2 - 12^2}, = \sqrt{25} = 5cm$ $OM = \sqrt{13^2 - 5^2} = \sqrt{144} = 12cm$ $\therefore \text{Distance } MN = ON + OM = 5 + 12 = 17cm$

Question 2

- (a) Evaluate without using trigonometric tables, [3]

$$\sin^2 28^\circ + \sin^2 62^\circ + \tan^2 38^\circ - \cot^2 52^\circ + \frac{1}{4} \sec^2 30^\circ$$

- (b) If $A = \begin{bmatrix} 1 & 3 \\ 3 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} -2 & 1 \\ -3 & 2 \end{bmatrix}$ and $A^2 - 5B^2 = 5C$. Find matrix C where C is a 2 by 2 matrix. [4]

- (c) Jaya borrowed ₹ 50,000 for 2 years. The rates of interest for two successive years are 12% and 15% respectively. She repays ₹33,000 at the end of the first year. Find the amount she must pay at the end of the second year to clear her debt. [3]

Comments of Examiners

- (a) Errors in application of complementary angles was very common among candidates. Some candidates wrote $\sin^2 28^\circ = \sin^2(90^\circ - 28^\circ)$ instead of $\cos^2(90^\circ - 28^\circ)$ or $\sin^2(90^\circ - 62^\circ)$ etc. Candidates substituted incorrect values for $\sec 30^\circ$. A few candidates applied complementary angles directly without showing any working or giving any reasons.

- (b) Some candidates made mistakes in matrix multiplication

e.g. If $A = \begin{bmatrix} 1 & 3 \\ 3 & 4 \end{bmatrix}$,

$$A^2 = \begin{bmatrix} 1^2 & 3^2 \\ 3^2 & 4^2 \end{bmatrix}$$

A few candidates skipped major steps of working.

- (c) Some candidates missed out the word 'successive' and found the amount directly for two years and subtracted the repayment amount ₹33000. A few candidates made calculation errors.

Suggestions for teachers

- Thorough drilling of complementary angles and their properties is necessary.
- Teach students to deduce the values of special angles e.g., $0^\circ, 30^\circ, 45^\circ, 60^\circ$ and 90° .
- Advise students to show all essential steps of working.
- Clarify basic operations with Matrices. Adequate practice should be given in Multiplication of a Matrix by a Matrix.
- Give students different types of questions on compound interest for practice. Advise them to practise the sums both with and without formula. This would help them to handle sums with successive rates.

MARKING SCHEME

Question 2

(a)
$$\sin^2 28^\circ + \sin^2 62^\circ + \tan^2 38^\circ - \cot^2 52^\circ + \frac{1}{4} \sec^2 30^\circ$$

$$\sin^2 28^\circ + \sin^2 (90^\circ - 28^\circ) + \tan^2 38^\circ - \cot^2 (90^\circ - 38^\circ) + \frac{1}{4} \left(\frac{2}{\sqrt{3}} \right)^2$$

$$(\sin^2 28^\circ + \cos^2 28^\circ) + (\tan^2 38^\circ - \tan^2 38^\circ) + 1/3$$

$$1 + 0 + \frac{1}{3} = 1\frac{1}{3}$$

(b) $A^2 - 5B^2 = 5C$

$$\begin{bmatrix} 1 & 3 \\ 3 & 4 \end{bmatrix} \begin{bmatrix} 1 & 3 \\ 3 & 4 \end{bmatrix} - 5 \begin{bmatrix} -2 & 1 \\ -3 & 2 \end{bmatrix} \begin{bmatrix} -2 & 1 \\ -3 & 2 \end{bmatrix}$$

$$\begin{bmatrix} 1 \times 1 + 3 \times 3 & 1 \times 3 + 3 \times 4 \\ 3 \times 1 + 4 \times 3 & 3 \times 3 + 4 \times 4 \end{bmatrix} - 5 \begin{bmatrix} 4 - 3 & -2 + 2 \\ 6 - 6 & -3 + 4 \end{bmatrix}$$

$$\begin{bmatrix} 10 & 15 \\ 15 & 25 \end{bmatrix} - 5 \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 10 & 15 \\ 15 & 25 \end{bmatrix} - \begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix} = \begin{bmatrix} 5 & 15 \\ 15 & 20 \end{bmatrix} = 5C$$

$$C = \begin{bmatrix} 1 & 3 \\ 3 & 4 \end{bmatrix}$$

(c)
$$I_1 = \frac{50,000 \times 1 \times 12}{100} = ₹ 6,000$$

Amount = 50,000 + 6000 = ₹ 56,000

$P = 56,000 - 33,000 = ₹ 23,000$

$$I_2 = \frac{23,000 \times 1 \times 15}{100} = ₹ 3,450$$

Outstanding amount = 23,000 + 3,450 = ₹ 26,450

Question 3

- (a) The catalogue price of a computer set is ₹ 42000. The shopkeeper gives a discount of 10% on the listed price. He further gives an off-season discount of 5% on the discounted price. However, sales tax at 8% is charged on the remaining price after the two successive discounts. Find: [3]
- (i) the amount of sales tax a customer has to pay
- (ii) the total price to be paid by the customer for the computer set.
- (b) P(1,-2) is a point on the line segment A(3,-6) and B(x, y) such that AP : PB is equal to 2 : 3. [4]
Find the coordinates of B.
- (c) The marks of 10 students of a class in an examination arranged in ascending order is as follows: [3]
- 13, 35, 43, 46, x, x+4, 55, 61, 71, 80

If the median marks is 48, find the value of x. Hence find the mode of the given data.

Comments of Examiners

- (a) Many candidates were not clear about the concept of successive discount. They added the two discounts 10% and 5% and found discount as 15% of ₹42000 followed by 8% tax. Most of them left their answer as ₹38782.8 instead of ₹38782.80.
- (b) Some candidates applied incorrect Section formula and a few made errors in substituting the values in the formula. In some cases, candidates considered B dividing AP instead of P dividing AB. The coordinates of B were written as -2 and 4 instead of writing in coordinate form i.e. (-2, 4).
- (c) In the question, the given data was arranged in ascending order but some candidates could not identify the middle term to get the value of x. A few candidates used the formula for mean to solve for x.

Suggestions for teachers

- Sales tax needs to be taught with sufficient examples. Concepts related to MP, CP and SP require thorough drilling. Train students to differentiate between list price, sale price and sale tax. Advise students to express answers related to rupees and paise up to two decimal places.
- Instruct students to write all coordinates enclosed within the bracket.
- Drill students with method of finding median of even and odd non grouped distribution.

MARKING SCHEME

Question 3

(a) Sales price = $(1 - \frac{10}{100})(1 - \frac{5}{100})42000$
 $= ₹ 35910$
 Sales tax = $\frac{8}{100} \times 35910 = ₹ 2872.80$
 Final price = $₹ 35910 + ₹ 2872.80 = ₹ 38782.80$

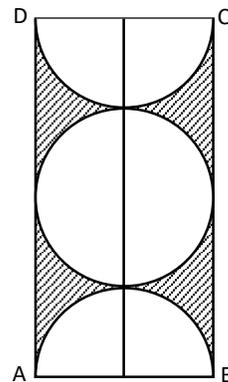
(b) $x = \frac{mx_2 + nx_1}{m + n}, y = \frac{my_2 + ny_1}{m + n}$
 $1 = \frac{2 \times x + 3 \times 3}{2 + 3}$
 $\therefore 5 = 2x + 9$
 $\therefore 2x = -4$
 $x = -2$
 $-2 = \frac{2 \times y + 3 \times -6}{2 + 3}$
 $-10 = 2y - 18$
 $8 = 2y$
 $\therefore y = 4$
 $\therefore B(-2, 4)$

(c) 13, 35, 43, 46, x, (x+4), 55, 61, 71, 80
 No. of terms is 10 which is even.
 \therefore Median is average of $(\frac{n}{2})^{th}$ and $(\frac{n}{2} + 1)^{th}$ term.
 $\rightarrow \frac{10}{2}, \frac{10}{2} + 1$ i.e. 5th and 6th term
 Median = $\frac{x+x+4}{2} = 48$
 $\frac{2x+4}{2} = 48$
 $x + 2 = 48$
 $\therefore x = 48 - 2$
 $x = 46$
 \therefore 13, 35, 43, 46, 46, 50, 55, 61, 71, 80
 \therefore Mode is 46

Question 4

(a) What must be subtracted from $16x^3 - 8x^2 + 4x + 7$ so that the resulting expression has $2x + 1$ as a factor? [3]

(b) In the given figure ABCD is a rectangle. It consists of a circle and two semi circles each of which are of radius 5 cm. Find the area of the shaded region. Give your answer correct to three significant figures. [4]



(c) Solve the following inequation and represent the solution set on a number line. [3]

$$-8\frac{1}{2} < -\frac{1}{2} - 4x \leq 7\frac{1}{2}, x \in I$$

Comments of Examiners

(a) Some candidates made calculation errors in solving the problem e.g. $(-\frac{1}{2})^2$ as $-\frac{1}{4}$. Some failed to use Remainder and Factor theorem and instead, used long division. Many candidates did not equate $f(-\frac{1}{2})$ to zero. A few candidates did not draw conclusion that 1 must be subtracted to have $2x + 1$ as a factor of the given expression.

(b) Some candidates were unable to identify the length or breadth of the rectangle using the radius of the given circle and semi circles. A few candidates made calculation errors. Many candidates approximated their values initially hence were unable to give their answers correct to three significant digits.

(c) Transposition of like terms to the same side of the inequation was incorrect in several cases. Errors were mostly of sign e.g. $-4x > -8\frac{1}{2} + \frac{1}{2} \therefore x > 2$

Suggestions for teachers

- Insist that students should strictly follow the instructions given in all questions.
- Give practice in the method to solve the problems based on Remainder and Factor Theorem.
- Give extensive practice in problems on mensuration and instruct students to give answers correct to the required number of significant digits/decimal places/ nearest whole number.
- Tell students that while solving an inequation, all the points given in the comments are essential and must be followed. Further, extensive drilling is necessary on concepts of positive and negative signs.

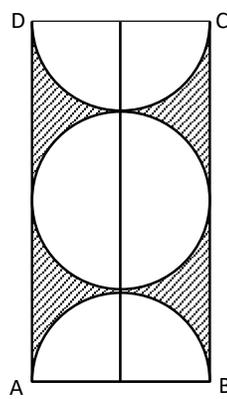
instead of writing $x < 2$. Other common errors made by candidates were:

- (i) Some candidates did not represent the solution in set form;
- (ii) A number of candidates did not put arrow marks on both ends of the number line;
- (iii) Some candidates did not have extra digits marked on the number line beyond the solution set.

MARKING SCHEME

Question 4

(a)	<p>Let A be subtracted</p> $f(x) = 16x^3 - 8x^2 + 4x + 7 - A$ $f\left(\frac{-1}{2}\right) = 16\left(\frac{-1}{2}\right)^3 - 8\left(\frac{-1}{2}\right)^2 + 4\left(\frac{-1}{2}\right) + 7 - A = 0$ $-2 - 2 - 2 + 3 - A = 0$ <p style="margin-left: 20px;">➔ $A = 1$</p> <p>∴ 1 must be subtracted.</p>
(b)	<p>Area of shaded part = Area of rectangle – (Area of circle + area of two semi circles)</p> <p>Side of rectangle ➔ $L = 5 + 5 + 5 + 5 = 20 \text{ cm}$ $B = 5 + 5 = 10 \text{ cm}$</p> <p>∴ Area =</p> $20 \times 10 - \left(2 \times \frac{1}{2} \pi \times 5^2 + \pi \times 5^2\right)$ $= 200 - 2 \times \frac{22}{7} \times 25$ $= 200 - \frac{1100}{7}$ $= \frac{1400 - 1100}{7} = \frac{300}{7}$ $= 42 \frac{6}{7} = 42.857 = 42.9 \text{ cm}^2$
(c)	$-8 \frac{1}{2} < -\frac{1}{2} - 4x \leq 7 \frac{1}{2}, \quad x \in I$ $-4x \leq 7 \frac{1}{2} + \frac{1}{2} \qquad -8 \frac{1}{2} + \frac{1}{2} < -4x$ $x \geq -2 \qquad x < 2$ <p>$\{-2 \leq x < 2, x \in I\}$ or $\{-2, -1, 0, 1\}$</p> <div style="text-align: center;"> </div>



Question 5

- (a) Given matrix $B = \begin{bmatrix} 1 & 1 \\ 8 & 3 \end{bmatrix}$. Find the matrix X if, $X = B^2 - 4B$. [4]

Hence solve for a and b given $X \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} 5 \\ 50 \end{bmatrix}$

- (b) How much should a man invest in ₹ 50 shares selling at ₹60 to obtain an income of ₹ 450, if the rate of dividend declared is 10%. Also find his yield percent, to the nearest whole number. [3]
- (c) Sixteen cards are labelled as $a, b, c, \dots, m, n, o, p$. They are put in a box and shuffled. [3]
A boy is asked to draw a card from the box. What is the probability that the card drawn is:
- a vowel.
 - a consonant.
 - none of the letters of the word *median*.

Comments of Examiners

- (a) Many candidates found matrix B^2 by squaring each element of matrix B instead of finding $B \times B$. A few candidates found the matrix $X = B^2 - 4B$ but did not find the values of 'a' and 'b'. Some made calculation errors.
- (b) Many candidates were unable to find the number of shares purchased. A few candidates made calculation errors. A common error made by candidates was that of expressing the answer correct to the nearest whole number.
- (c) Common errors detected in this problem were the following:
- total outcome of event was incorrect, or
 - favourable outcome was incorrect or
 - the result was not given in the simplest form. e.g.

$$\frac{4}{16} = \frac{1}{4}$$

Suggestions for teachers

- Emphasis must be given on showing all essential steps of working so as to avoid errors.
- Sufficient drilling is necessary on product of matrices, specially to find square of a matrix.
- Give sufficient practice on commercial mathematics.
- Terms like NV, MV, dividend, etc must be thoroughly drilled.
- Advise candidates that all necessary outcomes must be listed before finding probability and all answers must be given in the simplest form.

MARKING SCHEME

Question 5

(a)

$$B^2 = \begin{bmatrix} 1 & 1 \\ 8 & 3 \end{bmatrix} \times \begin{bmatrix} 1 & 1 \\ 8 & 3 \end{bmatrix} = \begin{bmatrix} 1+8 & 1+3 \\ 8+24 & 8+9 \end{bmatrix}$$

$$= \begin{bmatrix} 9 & 4 \\ 32 & 17 \end{bmatrix}$$

$$B^2 - 4B = \begin{bmatrix} 9 & 4 \\ 32 & 17 \end{bmatrix} - \begin{bmatrix} 4 & 4 \\ 32 & 12 \end{bmatrix} = \begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$$

$$\begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix} \times \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} 5 \\ 50 \end{bmatrix}$$

$$\begin{bmatrix} 5a \\ 5b \end{bmatrix} = \begin{bmatrix} 5 \\ 50 \end{bmatrix}$$

$$5a = 5 \quad 5b = 50$$

$$a = 1 \quad b = 10$$

(b)

$$\text{Income} = ₹ 450$$

$$\frac{10 \times 50 \times N}{100} = 450$$

$$N = 90$$

$$\text{Investment} = ₹ 60 \times 90 = ₹ 5400$$

$$\text{Yield \%} = \frac{10 \times 50}{60}$$

$$= 8.33\%$$

$$= 8\% \text{ (nearest whole number)}$$

(c)

a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p

$$(i) \quad \frac{4}{16} = \frac{1}{4}$$

$$(ii) \quad \frac{12}{16} = \frac{3}{4}$$

$$(iii) \quad \frac{10}{16} = \frac{5}{8}$$

Question 6

- (a) Using a ruler and a compass construct a triangle ABC in which $AB = 7\text{cm}$, $\angle CAB = 60^\circ$ [4] and $AC = 5\text{cm}$. Construct the locus of:

- (i) points equidistant from AB and AC.
(ii) points equidistant from BA and BC.

Hence construct a circle touching the three sides of the triangle internally.

- (b) A conical tent is to accommodate 77 persons. Each person must have 16m^3 of air to breathe. Given the radius of the tent as 7m find the height of the tent and also its curved surface area. [3]

- (c) If $\frac{7m+2n}{7m-2n} = \frac{5}{3}$, use properties of proportion to find [3]

- (i) $m : n$

- (ii) $\frac{m^2 + n^2}{m^2 - n^2}$

Comments of Examiners

- (a) Some candidates bisected two sides instead of two angles for locating the in-centre. A number of candidates identified the centre correctly but did not drop a perpendicular from the centre to any one side of the triangle so as to find the length of radius of required in-circle.

- (b) In solving this mensuration problem most of the errors were due to incorrect calculation or formula. Answer was not expressed correct to the nearest whole number.

- (c) Some candidates did not use properties of proportion to solve the problem, instead tried to solve by cross-multiplication. Some made errors in signs, while applying componendo and dividendo theorem.

- (i) Many did not give the answer in the correct form, e.g. $m:n = 8 : 7$

- (ii) Some candidates did not apply $m:n = 8 : 7$ and instead tried to apply componendo and dividendo theorem to find $\frac{m^2 + n^2}{m^2 - n^2}$.

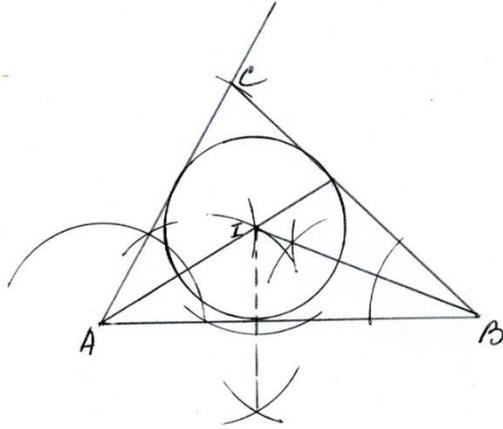
Suggestions for teachers

- Instruct students that for all geometry constructions it is essential to show all traces of construction. Sums on locus require more practice.
- Give ample practice on questions based on mensuration.
- Sufficient practice of problems on proportion is necessary.

MARKING SCHEME

Question 6

- (a) Triangle
- (i) Bisector of $\angle A$
 - (ii) Bisector of $\angle B$
 - (iii) Incircle with perpendicular constructed to find radius



- (b) Volume = 77×16
 $\frac{1}{3} \pi \times 7 \times 7 \times h = 77 \times 16$
 $h = 77 \times 16 \times \frac{7}{22} \times \frac{3}{7 \times 7}$
 $h = 24m$
- $r = 7m, \quad h = 24m, \quad l = 25m$
- Curved Surface Area = $\pi r l = \frac{22}{7} \times 7 \times 25 = 550 m^2$

- (c) $\frac{7m + 2n}{7m - 2n} = \frac{5}{3}$,
- Using componendo and dividendo theorem, $\frac{7m + 2n + 7m - 2n}{7m + 2n - 7m + 2n} = \frac{5 + 3}{5 - 3}$
- $\frac{7m}{2n} = \frac{8}{2} = 4 \quad \longrightarrow \quad m : n = 8 : 7$
- $\frac{m^2}{n^2} = \frac{64}{49}$
- $\frac{m^2 + n^2}{m^2 - n^2} = \frac{64 + 49}{64 - 49} = \frac{113}{15}$

Question 7

(a) A page from a savings bank account passbook is given below:

[5]

Date	Particulars	Amount Withdrawn (₹)	Amount Deposited (₹)	Balance (₹)
Jan. 7, 2016	B/F			3000.00
Jan 10, 2016	By Cheque		2600.00	5600.0
Feb. 8, 2016	To Self	1500.00		4100.00
Apr. 6, 2016	By Cheque	2100.00		2000.00
May 4, 2016	By cash		6500.00	8500.00
May 27, 2016	By Cheque		1500.00	10000.00

(i) Calculate the interest for the 6 months from January to June 2016, at 6% per annum.

(ii) If the account is closed on 1st July 2016, find the amount received by the account holder.

(b) Use a graph paper for this question (Take 2 cm = 1 unit on both x and y axis)

[5]

(i) Plot the following points:

A(0,4), B(2,3), C(1,1) and D(2,0).

(ii) Reflect points B, C, D on the y -axis and write down their coordinates. Name the images as B', C', D' respectively.

(iii) Join the points A, B, C, D, D', C', B' and A in order, so as to form a closed figure. Write down the equation of the line of symmetry of the figure formed.

Comments of Examiners

- (a) Candidates made different types of errors in this question. A few are given below:
- Some took the balance of the month of June as '0' instead of ₹10000.
 - Some took time as $\frac{6}{12}$ instead of $\frac{1}{12}$ as interest is calculated per month.
 - To calculate the amount many candidates added the interest to the total qualifying balance ₹34300 instead of the last balance ₹10000.
 - Most candidates left the answers as ₹171.5, ₹10171.5 instead of ₹171.50, ₹10171.50.
- (b) Some candidates plotted the points incorrectly or did not complete the figure by joining the points. Most candidates made mistakes in identifying the line of symmetry or writing down its equation. Some did not follow the instructions given in the question and thus used incorrect scale for the graph.

Suggestions for teachers

- Adequate practice should be given in building up concepts. Teach students why time is taken $\frac{1}{12}$ for calculation of interest for one month. . Emphasis must be given on expressing answer to two decimal places, especially in banking system.
- Instruct students to read the question carefully.
- Sufficient practice is required in plotting numerous points on the

MARKING SCHEME

Question 7

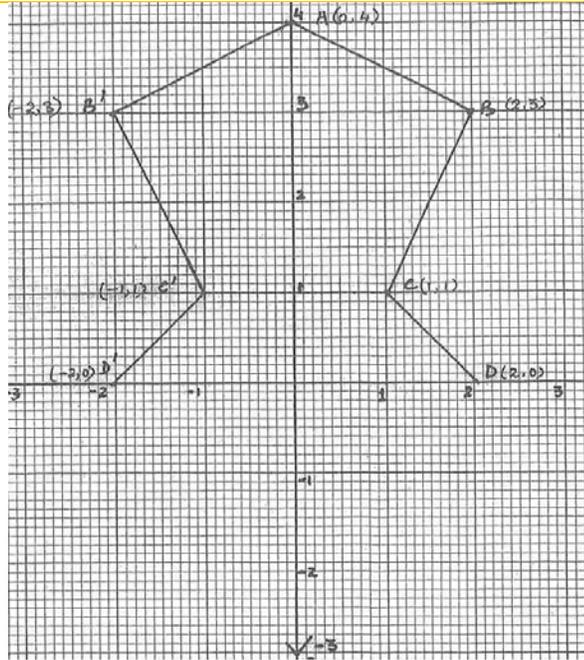
(a)	Qualifying sum for	(₹)
	Jan	5600.00
	Feb	4100.00
	Mar	4100.00
	Apr	2000.00
	May	8500.00
	June	10000.00
	Total	34300.00

$$(i) \text{ Interest} = \frac{34300 \times 6 \times 1}{100 \times 12} = ₹ 171.50$$

$$(ii) \text{ Amount received} = ₹ (10,000 + 11.50) = ₹ 10,171.50$$

(b)

Coordinates of images of B, C and D are B'(-2,3), C'(-1,1) and D'(-2,0).
Figure



Equation of line of symmetry is $x = 0$

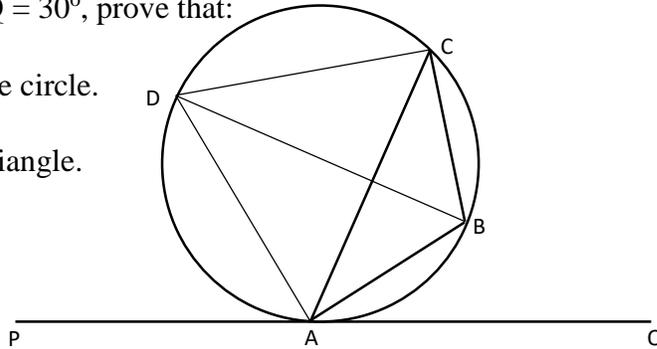
Question 8

- (a) Calculate the mean of the following distribution using step deviation method. [4]

Marks	0 – 10	10 – 20	20 – 30	30 – 40	40 – 50	50 – 60
Number of Students	10	9	25	30	16	10

- (b) In the given figure PQ is a tangent to the circle at A. AB and AD are bisectors of $\angle CAQ$ and $\angle PAC$. If $\angle BAQ = 30^\circ$, prove that: [3]

- (i) BD is a diameter of the circle.
 (ii) ABC is an isosceles triangle.



- (c) The printed price of an air conditioner is ₹ 45,000/-. The wholesaler allows a discount of 10% to the shopkeeper. The shopkeeper sells the article to the customer at a [3]

discount of 5% of the marked price. Sales tax (under VAT) is charged at the rate of 12% at every stage. Find:

- (i) VAT paid by the shopkeeper to the government.
- (ii) The total amount paid by the customer inclusive of tax.

Comments of Examiners

- (a) Some candidates did not use step deviation method to find mean as specified in the question. Other common errors observed were:
 - (i) Incorrect class mark;
 - (ii) Incorrect class interval, e.g. 5 instead of 10.
 - (iii) Incorrect formula used or calculation errors.
- (b) Many candidates were unable to identify $\angle CAB = 30^\circ$ or $\angle CAD = 60^\circ$ and were unable to prove BD, a diameter. Some could not use the property of alternate segment theorem to prove $\angle BAQ = \angle BCA = 30^\circ$. A few candidates did not write the answer with proper reasons.
- (c) Some candidates found the amount paid by the customer correctly but VAT paid by shopkeeper was incorrect. Many made calculation errors.

Suggestions for teachers

- Give equal stress to all three methods of finding mean. Care must be taken while identifying the length of class interval and the class mark. Repeated drilling could help in rectifying such errors.
- Sufficient drilling is necessary on properties of circles. Emphasis must be given in answering the geometry based problems with logical reasons. Stress must be given on alternate segment theorem tangents and intersecting chords.
- Adequate practise is required for VAT based problems. Ask students to read the question carefully and note down what is the given data and what is required to be found so as to make the problem easier to

MARKING SCHEME

Question 8

(a)	Marks	Number of students	X	$t = \frac{X - A}{i}$	ft
	0 – 10	10	5	-3	-30
	10 – 20	9	15	-2	-18
	20 – 30	25	25	-1	-25
	30 – 40	30	35	← 0	0
	40 – 50	16	45	1	16
	50 – 60	10	55	2	20
		$\Sigma f = 100$			$\Sigma ft = -37$

Let $A = 35$

$$\text{Mean} = A + \frac{\Sigma ft}{\Sigma f} \times i$$

$$= 35 + \frac{-37}{100} \times 10$$

$$= 35 - 3.7$$

$$= 31.3$$

(b) (i) AB is the bisector of $\angle CAQ$.

$$\therefore \angle CAB = \angle BAQ = 30^\circ$$

AD is the bisector of $\angle PAC$

$$\therefore \angle CAD = \angle PAD = \frac{180^\circ - 60^\circ}{2} = \frac{120}{2} = 60^\circ$$

$$\therefore \angle BAD = \angle BAC + \angle CAD = 30 + 60^\circ = 90^\circ$$

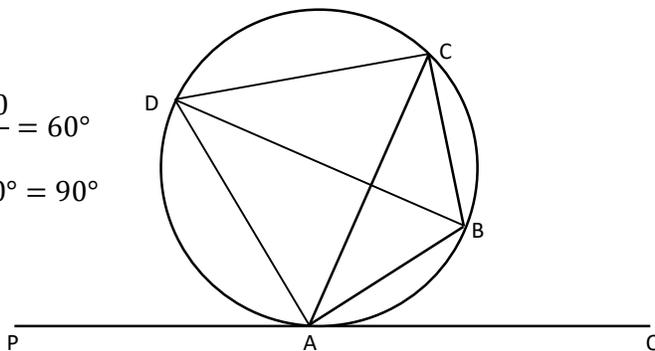
\therefore BD is a diameter of the circle.

(ii) $\angle BAQ = \angle BCA = 30^\circ$

\because AB is a chord and PQ tangent

\therefore angle in the alternate segment are equal

$\therefore \triangle ABC$ is an isosceles triangle.

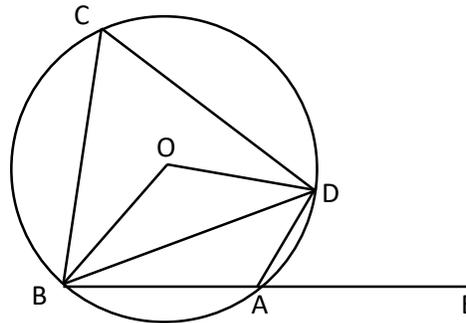


(c)	<p>MP = 45,000</p> <p>Discount amount to the shopkeeper = $\frac{10}{100} \times 45,000 = ₹ 4,500$</p> <p>SP = 45,000 – 4,500 = 40,500</p> <p>Sales tax for the shopkeeper = $\frac{12}{100} \times 40,500 = ₹ 4,860$</p> <p>Discount amount to the customer = $\frac{5}{100} \times 45,000 = ₹ 2,250$</p> <p>SP = 45,000 – 2,250 = 42,750</p> <p>Sales tax for the customer = $\frac{12}{100} \times 42,750 = ₹ 5,130$</p> <p>(i) VAT paid by the shopkeeper = 5,130</p> $\begin{array}{r} -4,860 \\ \hline ₹ 270 \end{array}$ <p>(ii) Amount paid by customer = 42,750 + 5130</p> $= ₹ 47,880$
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Question 9

(a) In the figure given, O is the centre of the circle. $\angle DAE = 70^\circ$. Find giving suitable reasons, the measure of: [4]

- (i) $\angle BCD$
- (ii) $\angle BOD$
- (iii) $\angle OBD$



(b) A(-1, 3), B(4, 2) and C(3, -2) are the vertices of a triangle. [3]

- (i) Find the coordinates of the centroid G of the triangle.
- (ii) Find the equation of the line through G and parallel to AC.

(c) Prove that

[3]

$$\frac{\sin \theta - 2\sin^3 \theta}{2\cos^3 \theta - \cos \theta} = \tan \theta$$

Comments of Examiners

- (a) Many candidates did not write the reasons in support of their answers. Some candidates were not versed with the circle properties, e.g. could not identify $\angle BCD = 70^\circ$ by using alternate segment theorem. Many wrote $\angle BCD = 55^\circ$ due to incorrect use of circle properties.
- (b) Most candidates found the coordinates of the centroid G correctly but could not find the equation of the line through G and parallel to AC.
- (c) Many candidates were unable to identify the term $\sin \theta$ and $\cos \theta$ common to numerator and denominator respectively. Some went wrong in simplification.

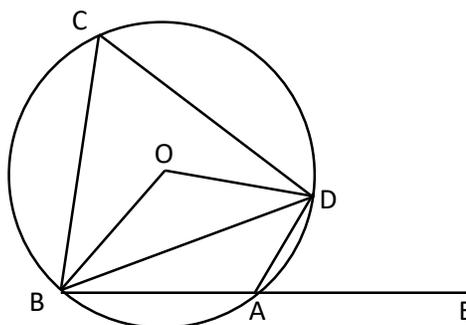
Suggestions for teachers

- Train students to:
 - (i) Name angles correctly e.g. $\angle BAD$ cannot be written as $\angle A$.
 - (ii) give essential working,
 - (iii) state reasons clearly.
- Sufficient practice is necessary to find slope of parallel lines and equation of lines with given conditions.
- Ensure adequate practice of sums based on identities. Instruct students not to cross multiply and change the form of the identity.

MARKING SCHEME

Question 9

(a)



$\angle DAE = \angle BCD$ (ext. \angle of a cyclic quad. is equal to interior opp. \angle)

(i) $\angle DAE = \angle BCD = 70^\circ$

(ii) $\angle BOD = 2 \angle BCD = 140^\circ$ (angle at centre is twice the angle on other segment)

	<p>(iii) In $\triangle OBD$, $OB = OD$ (radii of circle)</p> <p>$\therefore \angle OBD = \angle ODB = x^\circ$ (say) (at least 2 correct reasons)</p> <p>$x^\circ + x^\circ + 140^\circ = 180^\circ$ (sum of angles of a triangle = 180°)</p> <p>$\therefore \angle OBD = x^\circ = 20^\circ$</p>
(b)	<p>Centroid $G = \left(\frac{-1+4+3}{3}, \frac{3+2-2}{3} \right) = G(2, 1)$</p> <p>Slope of AC = $\frac{-2-3}{3+1} = \frac{-5}{4}$</p> <p>Equation of line through G and parallel to AC: $y - 1 = \frac{-5}{4}(x - 2)$</p> <p>$5x + 4y = 14$</p>
(c)	$\frac{\sin\theta(1 - 2\sin^2\theta)}{\cos\theta(2\cos^2\theta - 1)}$ $= \frac{\sin\theta(\sin^2\theta + \cos^2\theta - 2\sin^2\theta)}{\cos\theta[2\cos^2\theta - (\sin^2\theta + \cos^2\theta)]}$ $= \frac{\sin\theta(\cos^2\theta - \sin^2\theta)}{\cos\theta[\cos^2\theta - \sin^2\theta]}$ $= \tan\theta$

Question 10

- (a) The sum of the ages of Vivek and his younger brother Amit is 47 years. The product of their ages in years is 550. Find their ages. [4]
- (b) The daily wages of 80 workers in a project are given below. [6]

Wages (in ₹)	400-450	450-500	500-550	550-600	600-650	650-700	700-750
No. of workers	2	6	12	18	24	13	5

Use a graph paper to draw an ogive for the above distribution. (Use a scale of 2 cm = ₹ 50 on x -axis and 2 cm = 10 workers on y -axis). Use your ogive to estimate:

- the median wage of the workers.
- the lower quartile wage of workers.
- the number of workers who earn more than ₹ 625 daily.

Comments of Examiners

- (a) Many candidates took the two ages as x and $x - 47$ or x and $x + 47$ instead of x and $47 - x$. Some could not form the correct equation. Some candidates did not write the final answer Vivek's and Amit's ages as 25 years and 22 years respectively. Some wrote the quadratic expression $x^2 - 47x + 550$ correct but did not equate to zero to form the required equation.
- (b) Majority of candidates did not write correct scale. Some made mistake in finding the cumulative frequency. Some candidates did not drop perpendiculars to locate medians, quartiles etc.

Suggestions for teachers

- Lot of practice is required to form quadratic equation from the conditions given in the question. Working must be clearly shown with all necessary steps. Instruct the students to conclude the answer found.
- Many students did not write scale chosen to plot the graph, put a kink on the X-axis. Explain students the use and importance of scale chosen, kink and method of estimating some quantity from the graph plotted.

MARKING SCHEME

Question 10

- | | |
|-----|--|
| (a) | Let age of Vivek be x years
And of Amit $47 - x$ years
$\therefore x(47 - x) = 550$
$47x - x^2 = 550$
Or $x^2 - 47x + 550 = 0$
$(x - 25)(x - 22) = 0$
$\therefore x = 25$ or age = 22 (not possible)
\therefore Vivek's age is $x = 25$ years, and Amit's age is $47 - 25 = 22$ years |
|-----|--|

b)

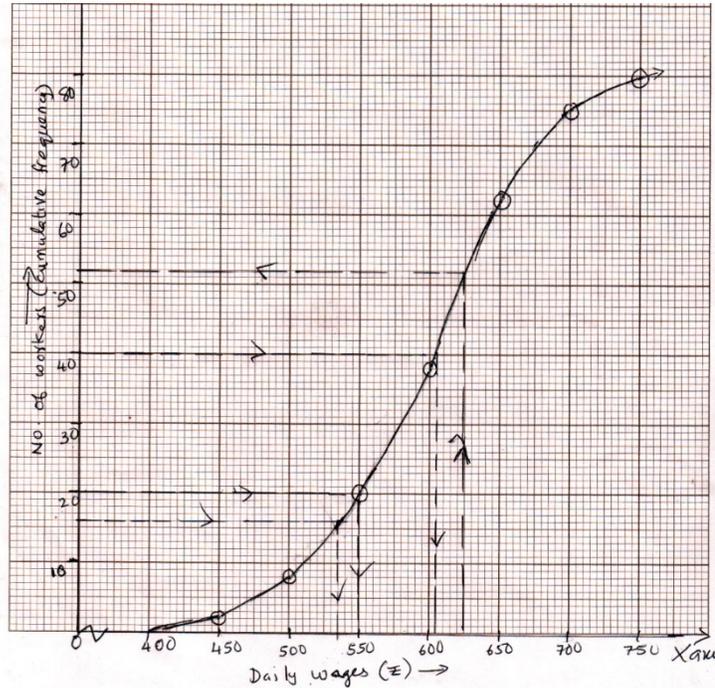
c.f: 2, 8, 20, 38, 62, 75, 80

(For smooth S curve plotted with upper boundaries)

(i) Median = $\frac{N}{2}$ term. = 40th term = ` 605

(ii) $Q_1 = \frac{N}{4}$ th term = 20th term = ` 550

(iii) No. of workers who earn more than ` 625 = 80 - 52 = 28 (± 3)



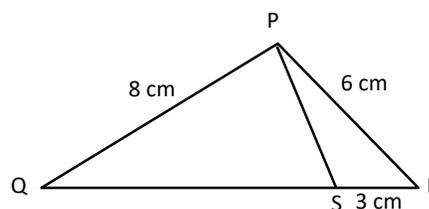
Question 11

- (a) The angles of depression of two ships A and B as observed from the top of a light house 60 m high are 60° and 45° respectively. If the two ships are on the opposite sides of the light house, find the distance between the two ships. Give your answer correct to the nearest whole number. [4]

- (b) PQR is a triangle. S is a point on the side QR of ΔPQR such that $\angle PSR = \angle QPR$. [3]

Given $QP = 8$ cm, $PR = 6$ cm and $SR = 3$ cm

- (i) Prove $\Delta PQR \sim \Delta SPR$
 (ii) Find the length of QR and PS
 (iii) $\frac{\text{area of } \Delta PQR}{\text{area of } \Delta SPR}$



- (c) Mr. Richard has a recurring deposit account in a bank for 3 years at 7.5% p. a. simple interest. If he gets ₹ 8325 as interest at the time of maturity, find: [3]

- (i) The monthly deposit
 (ii) The maturity value.

Comments of Examiners

(a) Many candidates could not draw the diagram on heights and distance as per the given conditions. Their concept of angle of depression was not clear. Some took both ships on the same side of the light house. Calculation errors were also common. Many candidates did not give the final answer to the nearest whole number.

(b) Many candidates were not able to prove $\Delta PQR \sim \Delta SPR$. Many candidates were not able to write the corresponding proportional sides, $\frac{QR}{PR} = \frac{PQ}{PS} = \frac{PR}{SR}$.

The following were the common errors observed in the answer books: Incorrect formula used for calculation of interest; incorrect substitution; Interest = ₹ 8325 taken as maturity value. Some candidates took $n = 3$ instead of 36.

Suggestions for teachers

- Advise students that all rounding off must be done at the end while calculating the final answer. More drilling is necessary on problems related to heights and distances, especially where the diagram needs to be drawn. The concept of angle of depression and angle of elevation could be made clearer through various class activities.
- Sufficient practice with similar triangles is necessary for students. They must be drilled to write the corresponding proportional sides.
- While solving a recurring deposit sum it is necessary to analyse and note down what is given and what is required to find.

MARKING SCHEME

Question 11

(a)

$$\tan 60 = \frac{60}{AD}$$

$$\therefore AD = \frac{60}{\tan 60}$$

$$= \frac{60}{\sqrt{3}} = \frac{60 \times \sqrt{3}}{3}$$

$$= 20\sqrt{3}$$

$$= 20 \times 1.732$$

$$= 34.640 \text{ m}$$

$$\tan 45 = \frac{CD}{DB} \therefore 1 = \frac{CD}{DB}$$

$$CD = DB = 60 \text{ m}$$

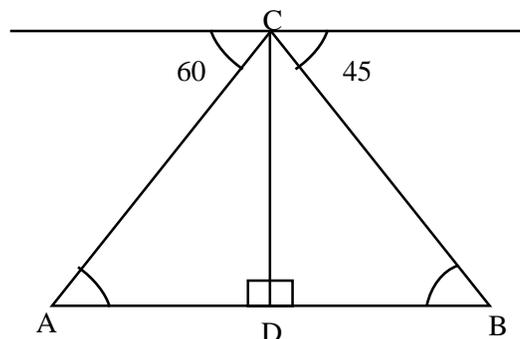
$$\therefore AB = AD + DB$$

$$= 34.640 + 60$$

$$= 94.640 = 95 \text{ m}$$

$$\tan 60 = \sqrt{3}$$

$$\tan 45 = 1$$



(b)

(i) In $\triangle PQR$ and $\triangle SPR$

$$\angle PSR = \angle QPR$$

$\angle R$ is common to both

$\therefore 3^{\text{rd}}$ angles are equal

$\therefore \triangle PQR \sim \triangle SPR$ (AAA)

Hence sides are proportional.

(ii)
$$\therefore \frac{QR}{PR} = \frac{PQ}{PS} = \frac{PR}{SR}$$

$$\frac{QR}{6} = \frac{8}{PS} = \frac{6^2}{3}$$

$$\therefore QR = 6 \times 2$$

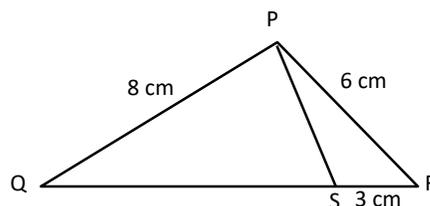
$$QR = 12 \text{ cm}$$

$$PS = \frac{8}{2} = 4$$

$$\therefore PS = 4 \text{ cm}$$

(iii)
$$\frac{\Delta PQR}{\Delta SPR} = \frac{6^2}{3^2}$$

$$\frac{\Delta PQR}{\Delta SPR} = \frac{2^2}{1} = \frac{4}{1}$$



(c)	<p>Let monthly deposit be ₹ x</p> <p>Qualifying sum = $\frac{(x)(36)(36+1)}{2}$</p> <p>Interest = $\frac{(x)(36)(37)(7.5)}{2(100)(12)}$</p> <p>₹ 8325 = $\frac{(x)(9)(37)}{80}$</p> <p>$x = ₹ 2000$</p> <p>Maturity Value = $2000 \times 36 + 8325 = ₹ 80,325$</p>
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GENERAL COMMENTS

**Topics
found
difficult/
confusing**

- Value Added Tax (VAT).
- Shares and Dividend.
- Use of Remainder and Factor Theorem.
- Inequation solving and representing solution.
- Geometry: Constructions and solving problems using properties of circle and similar triangles.
- Application of Circle Theorems.
- Finding out minimum balance in a month of a Savings Bank account.
- Coordinate geometry: Section formula.
- Trigonometry, complementary angles and Heights and Distances.
- Properties of Ratio and Proportion.
- Approximation to given significant figures or to nearest whole number.
- Statistics: finding mean by using step-deviation Method.
- Representing solutions on number line.
- Probability.
- Problems based on graph. Choosing correct axis and scale.



Suggestions for candidates

- Reading time must be utilised to make the right choice of question and to be thorough with the given data.
- Round off the answers where asked.
- Choose the correct scale while drawing graphs and special care must be taken while marking the axes and plotting points.
- Use mathematical tables to find square roots.
- Show all steps of working including rough work on the same answer page.
- While solving geometry problems reasons must be given.
- Show clearly all traces of constructions.
- To avoid calculation errors, all calculations must be rechecked.
- Make wise choices from the options available in the question paper and manage time wisely.
- Study the entire syllabus thoroughly and revise from time to time. Concepts of Class IX must be revised and integrated with the Class X syllabus.
- Develop logical and reasoning skills to have a clear understanding.
- Revise all topics and formulae involved and make a chapter wise or topic-wise list of these.
- Be methodical and neat in working.