Class XI Session 2024-25
Subject - Mathematics
Sample Question Paper - 1

Time Allowed: 3 hours **Maximum Marks: 80**

General Instructions:

1. This Question paper contains - five sections A, B, C, D and E. Each section is compulsory. However, there are internal choices in some questions.
2. Section A has 18 MCQ's and 02 Assertion-Reason based questions of 1 mark each.
3. Section B has 5 Very Short Answer (VSA)-type questions of 2 marks each.
4. Section C has 6 Short Answer (SA)-type questions of 3 marks each.
5. Section D has 4 Long Answer (LA)-type questions of 5 marks each.
6. Section E has 3 source based/case based/passage based/integrated units of assessment (4 marks each) with sub parts.

Section A

1. If $\sin\theta + \text{cosec}\theta = 2$, then $\sin^2\theta + \cos ec^2\theta$ is equal to **[1]**

a) 2 b) 1

c) 3 d) 4

2. Domain of definition of the function f(x) = $\frac{3}{4-x^2} + \log_{10}\left(x^3 - x\right)$ is **[1]**

a) $(-1, 0) \cup (1, 2) \cup (2, \infty)$ b) $(1, 2) \cup (2, \infty)$

c) $(-1, 0) \cup (1, 2)$ d) $(1, 2)$

3. Two cards are drawn successively without replacement from a well-shuffled pack of 52 cards. The probability of drawing two aces is **[1]**

a) $\frac{1}{221}$ b) $\frac{1}{26}$

c) $\frac{1}{13}$ d) $\frac{4}{223}$

4. $\lim\limits_{x\to0} \frac{\tan 2x - x}{3x - \sin x}$ is equal to **[1]**

a) $\frac{1}{2}$ b) 2

c) $\frac{1}{4}$ d) $-\frac{1}{2}$

5. The centroid of a triangle is (2, 7) and two of its vertices are (4, 8) and (-2, 6). The third vertex is **[1]**

a) (0, 0) b) (4, 7)

c) (7, 7) d) (7, 4)

6. Let A = {a, b, c}, B = {a, b}, C = {a, b, d}, D = {c, d} and E = {d}. Then which of the following statement is not correct? **[1]**

a) D ⊇ E

b) C - B = E

c) B ∪ E = C

d) C - D = E

7. If $z = \left(\frac{1+i}{1-i}\right)$, then z^4 equals. **[1]**

a) 0

b) - 1

c) 2

d) 1

8. Let R be a relation on N defined by x + 2y = 8. The domain of R is **[1]**

a) {1, 2, 3, 4}

b) {2, 4, 8}

c) {2, 4, 6, 8}

d) {2, 4, 6}

9. The solution set for (x + 3) + 4 > -2x + 5: **[1]**

a) (- ∞, 2)

b) $\left(\frac{-2}{3}, \infty\right)$

c) (- ∞, - 2)

d) (2, ∞)

10. The radian measure of 50° 37' 30'' is **[1]**

a) $\left(\frac{5\pi}{16}\right)^c$

b) $\left(\frac{9\pi}{32}\right)^c$

c) $\left(\frac{7\pi}{18}\right)^c$

d) $\left(\frac{11\pi}{36}\right)^c$

11. If a set A has n elements then the total number of subsets of A is **[1]**

a) 2n

b) n

c) 2^n

d) n^2

12. (3 + 6 + 12+ ... +1536) = ? **[1]**

a) 1023

b) 3069

c) 2046

d) 4092

13. $\{C_0 + 2C_1 + 3C_2 + ...+ (n + 1)C_n\} = ?$ **[1]**

a) $(n +1) . 2^n$

b) $(n + 2) . 2^{n+1}$

c) $(n + 2) . 2^{n-1}$

d) $n . 2^{n-1}$

14. If $x < 5$, then **[1]**

a) $-x > -5$

b) none of these .

c) $-x < 5$

d) $x > -5$

15. For any two sets A and B, $A \cap (A \cup B) = \ldots$ **[1]**

a) $\neq \phi$

b) B

c) ϕ

d) A

16. $\frac{1-\cos 2x+\sin x}{\sin 2x+\cos x}$ = ? **[1]**

a) cosec x

b) sec x

c) cot x

d) tan x

17. Mark the correct answer for (2 - 3i)(-3 + 4i) = ? **[1]**

a) (6 + 17i)

b) (-6 + 17i)

c) (6 - 15i)

d) (6 - 17i)

18. $^{36}C_{34}$ = ? **[1]**

a) 610

b) 630

c) 1224

d) 612

19. **Assertion (A):** The expansion of $(1 + x)^n = n_{c_0} + n_{c_1}x + n_{c_2}x^2 \ldots + n_{c_n}x^n$. **[1]**

Reason (R): If x = -1, then the above expansion is zero.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

20. **Assertion (A):** The mean deviation about the mean for the data 4, 7, 8, 9, 10, 12, 13, 17 is 3. **[1]**

Reason (R): The mean deviation about the mean for the data 38, 70, 48, 40, 42, 55, 63, 46, 54, 44 is 8.5.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

Section B

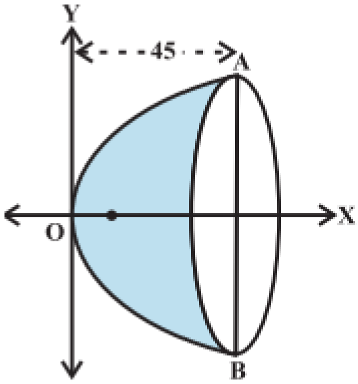
21. Write the domain of the real function $f(x) = \frac{1}{\sqrt{|x| - x}}$ **[2]**

OR

Find the domain and range of the real function $f(x) = \sqrt{9 - x^2}$.

22. Differentiate $\frac{x}{\sin x}$ respect to x. **[2]**

23. The focus of a parabolic mirror as shown in is at a distance of 5 cm from its vertex. If the mirror is 45 cm deep, find the distance AB **[2]**



OR

Find the vertex, focus, axis, directrix and latus-rectum of the following parabolas $4x^2 + y = 0$.

24. Two sets A and B are, such that n(A ∪ B) = 21, n(A) = 10, n(B) = 15, find n(A ∩ B) and n(A - B). **[2]**

25. Find the angles between the pairs of straight lines x - 4y = 3 and 6x - y = 11. **[2]**

Section C

26. Find the domain and range of the function $f(x) = \frac{x^2 - 9}{x - 3}$ **[3]**

27. To receive Grade **A**, in a mathematics course, one must obtain an average of 90 marks or more in five examinations (each of 100 marks). If Ragini's marks in first four examinations are 87, 92, 94 and 95, find minimum marks that Ragini must obtain in fifth examination to get Grade **A** in the course. **[3]**

28. Find the point on the y-axis which is equidistant from the points A(3, 1, 2) and B(5, 5, 2). **[3]**

OR

Find the lengths of the medians of the triangle with vertices A (0, 0, 6), B (0, 4, 0) and C (6, 0, 0).

29. Using binomial theorem, expand: $\left(\frac{2x}{3}-\frac{3}{2x}\right)^6$ **[3]**

OR

Find $(a + b)^4 - (a - b)^4$. Hence, evaluate $(\sqrt{3}+\sqrt{2})^4-(\sqrt{3}-\sqrt{2})^4$

30. Express the complex number $\left(-2-\frac{1}{3}i\right)^3$ in the form of a + ib. **[3]**

OR

Find the square root of 3 - 4i

31. There are 200 individuals with a skin disorder, 120 had been exposed to the chemical C_1, 50 to chemical C_2 and 30 to both the chemicals C_1 and C_2. Find the number of individuals exposed to (i) chemical C_1 but not chemical C_2 (ii) Chemical C_2 but not chemical C_1 (iii) Chemical C_2 or chemical C_1. **[3]**

Section D

32. A bag contains 6 red, 4 white and 8 blue balls. If three balls are drawn at random, find the probability that: **[5]**

i. one is red and two are white
ii. two are blue and one is red
iii. one is red.

33. Evaluate: $\lim_{x\to 2}\frac{x^3+3x^2-9x-2}{x^3-x-6}$. **[5]**

OR

Differentiate $x^2 \sin x$ from first principle.

34. In an increasing GP, the sum of the first and last terms is 66, the product of the second and the last but one is 128 and the sum of the terms is 126. How many terms are there in this GP? **[5]**

35. Prove that: $\sin 6^o \sin 42^o \sin 66^o \sin 78^o = \frac{1}{16}$. **[5]**

OR

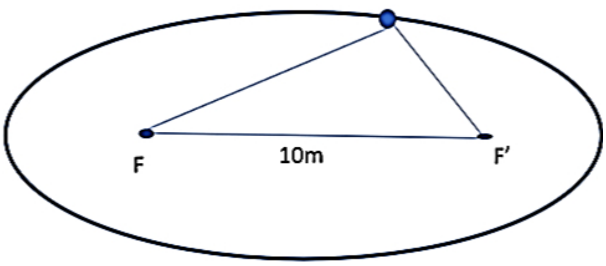
Prove that $\cos\frac{2\pi}{15}\cdot\cos\frac{4\pi}{15}\cdot\cos\frac{8\pi}{15}\cdot\cos\frac{16\pi}{15}=\frac{1}{16}$

Section E

36. **Read the following text carefully and answer the questions that follow:** **[4]**

A farmer wishes to install 2 handpumps in his field for watering.

The farmer moves in the field while watering in such a way that the sum of distances between the farmer and each handpump is always 26m. Also, the distance between the hand pumps is 10 m.



i. Name the curve traced by farmer and hence find the foci of curve. (1)

ii. Find the equation of curve traced by farmer. (1)

iii. Find the length of major axis, minor axis and eccentricity of curve along which farmer moves. (2)

OR

iv. Find the length of latus rectum. (2)

37. **Read the following text carefully and answer the questions that follow:** **[4]**

Consider the data.

Class	Frequency
0-10	6
10-20	7
20-30	15
30-40	16
40-50	4
50-60	2

i. Find the mean deviation about median. (1)

ii. Find the Median. (1)

iii. Write the formula to calculate the Mean deviation about median? (2)

OR

Write the formula to calculate median? (2)

38. **Read the following text carefully and answer the questions that follow:** **[4]**

The purpose of the student council is to give students an opportunity to develop leadership by organizing and carrying out school activities and service projects. Create an environment where every student can voice out their concern or need. Raju, Ravi Joseph, Sangeeta, Priya, Meena and Aman are members of student's council. There is a photo session in a school these 7 students are to be seated in a row for photo session.

i. Find the total number of arrangements so that Raju and Ravi are at extreme positions? (1)

ii. Find the number of arrangements so that Joseph is sitting in the middle. (1)

iii. Find the number of arrangements so that three girls are together. (2)

OR

Find the number of arrangements so that Aman and Ravi are not together? (2)

Solution

Section A

1. **(a)** 2

Explanation: Given $\sin\theta + cosec\theta = 2$

Squaring on both sides, we get

$\sin^2\theta + \csc^2\theta + 2\sin\theta\csc\theta = 4$ [$\because \sin\theta cosec\theta = 1$]

$\Rightarrow$ $\sin^2\theta + cosec^2\theta$ = 4 - 2 = 2

2. **(a)** (- 1, 0) $\cup$ (1, 2) $\cup$ (2, ∞)

Explanation: For f(x) to be real, we must have

4 - $x^2 \neq 0$ and x^3 - x > 0

$\Rightarrow$ $x^2 \neq 4$ and $x(x^2 - 1) > 0$

$\Rightarrow$ x $\neq$ 2, -2 and x(x - 1)(x + 1) > 0

$\Rightarrow$ x $\neq$ 2, -2 and -1 < x < 0, 1 < x < ∞

$\therefore$ Domain = (-1, 0) $\cup$ (1, 2) $\cup$ (2, ∞)

3. **(a)** $\frac{1}{221}$

Explanation: Total number of ways drawing 2 cards successively without replacement

= ${}^{52}C_1 \times {}^{51}C_1$ and number of ways 2 aces without replacement = ${}^{4}C_1 \times {}^{3}C_1$

$\therefore$ Required probability = $\frac{{}^4C_1 \times {}^3C_1}{{}^{52}C_1 \times {}^{51}C_1} = \frac{4\times3}{52\times51}$

$= \frac{1}{13\times17} = \frac{1}{221}$

4. **(a)** $\frac{1}{2}$

Explanation: Given, $\lim\limits_{x\to0} \frac{\tan 2x - x}{3x - \sin x} = \lim\limits_{x\to0} \frac{x\left[\frac{\tan 2x}{x} - 1\right]}{x\left[3 - \frac{\sin x}{x}\right]}$

$\lim\limits_{x\to0} \frac{\frac{\tan 2x}{2x}\times2-1}{3-\frac{sinx}{x}} = \frac{1.2-1}{3-1} = \frac{2-1}{2} = \frac{1}{2}$

5.

(b) (4, 7)

Explanation: Let A (4, 78) and B (-2, 6) be the given vertex. Let C(h, k) be the third vertex.

The centroid of $\triangle$ ABC is $\left(\frac{4-2+h}{3}, \frac{8+6+k}{3}\right)$

It is given that the centroid of triangle ABC is (2, 7) as obtained from above formula,

$\therefore$ $\frac{4-2+h}{3} = 2$, $\frac{8+6+k}{3} = 7$

$\Rightarrow$ h = 4, k = 7

Thus, the third vertex is (4, 7)

6.

(d) C - D = E

Explanation: C - D = {a, b, c} - {c, d} = {a, b}

But E = {d}

Hence C - D $\neq$ E

7.

(d) 1

Explanation: 1

Let z $= \frac{1+i}{1-i}$

$z = \frac{1+i}{1-i} \times \frac{1+i}{1+i}$

$\Rightarrow z = \frac{1+i^2+2i}{1-i^2}$

$\Rightarrow z = \frac{2i}{2}$

$\Rightarrow$ z = i

$\Rightarrow$ $z^4 = i^4$

Since i2 = -1, we have:

$\Rightarrow z^4 = i^2 \times i^2$

$\Rightarrow$ $z^4 = 1$

8.

(d) {2, 4, 6}

Explanation: We have , x + 2y = 8

y = $\frac{8-x}{2}$

since, x and y are Natural numbers, So x must be an even number.

if x = 2, y = 3;

if x = 4, y = 2;

if x = 6, y = 1.

So, relation R = {(2, 3), (4, 2), (6, 1)}

Hence, the domain of R is {2, 4, 6}.

9.

(b) $\left(\frac{-2}{3}, \infty\right)$

Explanation: (x + 3) + 4 > -2x + 5

$\Rightarrow$ x + 7 > -2x + 5

$\Rightarrow$ x + 7 + 2x > -2x + 5 + 2x

$\Rightarrow$ 3x + 7 > 5

$\Rightarrow$ 3x + 7 - 7 > 5 - 7

$\Rightarrow$ 3x > -2

$\Rightarrow$ x > $\frac{-2}{3}$

$\Rightarrow x \in \left(\frac{-2}{3}, \infty\right)$

10.

(b) $\left(\frac{9\pi}{32}\right)^c$

Explanation: 50°37'30" = 50° + $\left(37\frac{30}{60}\right)' = 50^\circ + \left(\frac{75}{2}\right)' = 50^\circ + \left(\frac{75}{2\times 60}\right)^\circ = \left(50\frac{5}{8}\right)^\circ = \left(\frac{405}{8}\right)^\circ$

$180^\circ = \pi^c \Rightarrow 1^\circ = \left(\frac{\pi}{180}\right)^c \Rightarrow \left(\frac{405}{8}\right)^\circ = \left(\frac{\pi}{180} \times \frac{405}{8}\right)^c = \left(\frac{9\pi}{32}\right)^c$

11.

(c) 2^n

Explanation: The total no of subsets = 2^n

12.

(b) 3069

Explanation: This is a GP in which a = 3, r = $\frac{6}{3}$ = 2 and l = 1536

$\therefore$ required sum = $\frac{(lr-a)}{(r-1)} = \frac{(1536\times 2-3)}{(2-1)}$ = (3072 - 3) = 3069.

13.

(c) (n + 2) . 2^{n-1}

Explanation: Here, $C_0 + 2C_1 + 3C_2 + ...+ (n + 1)C_n$

$= (C_0 + C_1 + C_2 + ... + C_n) + (C_1 + 2C_2 + 3C_3 + ... + nC_n)$

$= 2^n + n \cdot 2^{n-1} = (n + 2) \cdot 2^{n-1}$

14. **(a)** $-x > -5$

Explanation: Given $x < 5$

Multiplying both sides of the above inequality by -1,we get

$-x > -5$ [The sign of the inequality is to be reversed if both sides of an inequality are multiplied by the same negative real number]

15.

(d) A

Explanation: Common between set A and $(A \cup B)$is set A itself

16.

(d) tan x

Explanation: $\frac{1-\cos 2x+\sin x}{\sin 2x+\cos x} = \frac{2\sin^2 x+\sin x}{2\sin x\cos x+\cos x} = \frac{\sin x(2\sin x+1)}{\cos x(2\sin x+1)}$ = tan x

17. **(a)** (6 + 17i)

Explanation: (2 - 3i)(-3 + 4i) = (-6 + 8i + 9i - 12i^2) = (-6 + 17i + 12) = (6 + 17i)

18.

(b) 630

Explanation: $^{36}C_{34}$ = $^{36}C_{(36 - 34)}$ = $^{36}C_2 = \frac{36\times35}{2}$ = 630.

19.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation: Assertion:

$(1 + x)^n = n_{c_0} + n_{c_1}x + n_{c_2}x^2 \ldots + n_{c_n}x^n$

Reason:

$(1 + (-1))^n = n_{c_0}1^n + n_{c_1}(1)^{n-1}(-1)^1 + n_{c_2}(1)^{n-2}(-1)^2$ +... + $^nc_n(1)^{n-n}(-1)^n$

$= n_{c_8} - n_{c_1} + n_{c_2} - n_{c_3}$ + ... $(-1)^n n_{c_n}$

Each term will cancel each other

$\therefore (1 + (-1))^n = 0$

Reason is also the but not the correct explanation of Assertion.

20.

(c) A is true but R is false.

Explanation: Assertion Mean of the given series

$\bar{x} = \frac{\text{Sum of terms}}{\text{Number of terms}} = \frac{\sum x_i}{n}$

$= \frac{4+7+8+9+10+12+13+17}{8}$ = 10

xi	$\|$xi - $\bar{x}\|$
4	$|$4 - 10$|$ = 6
7	$|$7 - 10$|$ = 3
8	$|$8 - 10$|$ = 2
9	$|$9 - 10$|$ = 1
10	$|$10 - 10$|$ = 0
12	$|$12 - 10$|$ = 2
13	$|$13 - 10$|$ = 3
17	$|$17 - 10$|$ = 7
$\sum x_i$ = 80	$\sum \|x_i - \bar{x}\|$ = 24

$\therefore$ Mean deviation about mean

$= \frac{\Sigma|x_i - \bar{x}|}{n} = \frac{24}{8}$ = 3

Reason Mean of the given series

$\bar{x} = \frac{\text{Sum of terms}}{\text{Number of terms}} = \frac{\sum x_i}{n}$

$= \frac{38+70+48+40+42+55}{+63+46+54+44}$ = 50

$\therefore$ Mean deviation about mean

$= \frac{\Sigma|x_i - \bar{x}|}{n}$

$= \frac{84}{10}$ = 8.4

Hence, Assertion is true and Reason is false.

Section B

21. Case I : When x > 0.Then,we have,

$|x| = x$

$\Rightarrow \frac{1}{\sqrt{|x|-x}} = \frac{1}{\sqrt{x-x}} = \frac{1}{0} = \infty$

Case II : When x < 0

$|x| = -x$

$\Rightarrow \frac{1}{\sqrt{|x|-x}} = \frac{1}{\sqrt{-x-x}} = \frac{1}{\sqrt{-2x}}$ (exists because when x < 0, -2x > 0)

$\Rightarrow$ f(x) is defined when x < 0

Therefore, domain = $(-\infty, 0)$

OR

It is clear that, f(x) = $\sqrt{9-x^2}$ is not defined when $(9 - x^2) < 0$, i.e.

When $x^2 > 9$ i,.e when x > 3 or x < -3

dom (f) = $|x \in R : -3 \leq x \leq 3|$

Also, y = $\sqrt{9-x^2} \Rightarrow y^2 = (9-x^2)$

$\Rightarrow x = \sqrt{9-y^2}$

clearly, x is not defined when $(9-y^2) < 0$

but $(9-y^2) < 0 \Rightarrow y^2 > 9$

$\Rightarrow y > 3$ or $y < -3$

range $(f) = \{y \in R : -3 \leq y \leq 3\}$.

22. Let f(x) = $\frac{x}{\sin x}$

$\therefore$ f(x) = $\frac{d}{dx}\left(\frac{x}{\sin x}\right)$

= $\frac{\sin x \frac{d}{dx} x - x \frac{d}{dx} \sin x}{(\sin x)^2}$

= $\frac{\sin x \cdot 1 - x \cdot \cos x}{\sin^2 x}$

= cosec x - x cot x cosec x

= (1 - x cot x)$\cdot$cosec x

23. Since the distance from the focus to the vertex is 5 cm. We have, a = 5. If the origin is taken at the vertex and the axis of the mirror lies along the positive x-axis, the equation of the parabolic section is

$y^2 = 4 (5) x = 20 x$ ==> required eqution of parabola $y^2 = 20x$

Note that x = 45. Thus

$y^2 = 900$

Therefore y = $\pm$ 30

Hence AB = 2y = 2 $\times$ 30 = 60 cm

OR

We are given that:

$4x^2 + y = 0$

$\Rightarrow \frac{-y}{4} = x^2$

Comparing the given equation with $x^2 = -4ay$

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

$\therefore$ Vertex = (0, 0)

Focus = (0, -a) = $\left(0, \frac{-1}{16}\right)$

Equation of the directrix:

y = a

i.e. y = $\frac{1}{16}$

Axis = x = 0

Therefore, length of the latus rectum = 4a = $\frac{1}{4}$

24. Using identity,

$n(A \cup B) = n(A) + n(B) - n(A \cap B)$

21 = 10 + 15 - n(A ∩ B)

∴ n(A ∩ B) = (10 + 15) - 21

= 25 - 21 = 4

∴ n(A - B) = n(A ∩ B')

= n(A) - n(A ∩ B)

= 10 - 4

= 6

25. Given that equations of the lines are,

x - 4y = 3 .... (i)

6x - y = 11 .... (ii)

Let m_1 and m_2 be the slopes of these lines.

Here, $m_1 = \frac{1}{4}$, $m_2 = 6$

Let θ be the angle between the lines.

Then,

$\tan\theta = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right|$

$= \left|\frac{\frac{1}{4} - 6}{1 + \frac{3}{2}}\right|$

$= \frac{23}{10}$

$\Rightarrow \theta = \tan^{-1}\left(\frac{23}{10}\right)$

Therefore, the acute angle between the lines is $\tan^{-1}\left(\frac{23}{10}\right)$

Section C

26. Here $f(x) = \frac{x^2 - 9}{x - 3}$

f (x) assume real values for all real values of x except for x - 3 = 0 i.e .x = 3

Thus domain of f (x) = R - {3}

Let f (x) = y

$\therefore y = \frac{x^2 - 9}{x - 3} = \frac{(x+3)(x-3)}{(x-3)}$

⇒ y = x + 3

y takes all real values except 6 as domain =R-{3}

Thus range of f (x) = R - {6}.

27. Let the marks obtained by Ragini in fifth examination be x.

Then average of five examinations $= \frac{87+92+94+95+x}{5}$

Now $\frac{87+92+94+95+x}{5} \geq 90 \Rightarrow \frac{368+x}{5} \geq 90$

Multiplying both sides by 5, we have

$368 + x \geq 450$

$\Rightarrow x \geq 450 - 368$

$\Rightarrow x \geq 82$

Thus the minimum marks needed to be obtained by Ragini = 82.

28. Consider, C(0, y, 0) point which lies on the y-axis and is equidistant from points A(3, 1, 2) and B(5, 5, 2).

∴ AC = BC

$\sqrt{(0-3)^2 + (y-1)^2 + (0-2)^2} = \sqrt{(0-5)^2 + (y-5)^2 + (0-2)^2}$

Squaring both sides,

$\Rightarrow (0 - 3)^2 + (y - 1)^2 + (0 - 2)^2 = (0 - 5)^2 + (y - 5)^2 + (0 - 2)^2$

$\Rightarrow 9 + y^2 - 2y + 1 + 4 = 25 + y^2 - 10y + 25 + 4$

⇒ 8y = 40

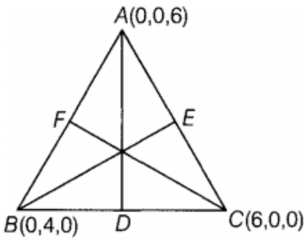
⇒ y = 5

The coordinate of C is (0, 5, 0).

OR

ABC is a triangle with vertices A (0, 0, 6), (0, 4, 0) and C (6, 0, 0).

Let points D, E and F are the mid-points of BC, AC and AB, respectively. So, AD, BE and CF will be the medians of the triangle.



Coordinates of point $D=\left(\frac{0+6}{2},\frac{4+0}{2},\frac{0+0}{2}\right)$ = (3, 2, 0)

$\left[\because \text{ coordinates of mid-point } \left(\frac{x_1+x_2}{2},\frac{y_1+y_2}{2},\frac{z_1+z_2}{2}\right)\right]$

Coordinates of point $E=\left(\frac{0+6}{2},\frac{0+0}{2},\frac{6+0}{2}\right)$ = (3, 0, 3)

and coordinates of point$F=\left(\frac{0+0}{2},\frac{0+4}{2},\frac{6+0}{2}\right)=(0,2,3)$

Now, length of median

AD = Distance between point A and D

$AD=\sqrt{(0-3)^2+(0-2)^2+(6-0)^2}$

$[\because \text{distance} =\sqrt{(x_1-x_2)^2+(y_1-y_2)^2+(z_1-z_2)^2}]$

$=\sqrt{9+4+36}$

$=\sqrt{49}=7$

Similarly, $BE=\sqrt{(0-3)^2+(4-0)^2+(0-3)^2}$

$=\sqrt{9+16+9}=\sqrt{34}$

and $CF=\sqrt{(6-0)^2+(0-2)^2+(0-3)^2}$

$=\sqrt{36+4+9}=\sqrt{49}=7$

Hence, length of the medians are 7, $\sqrt{34}$ and 7.

29. To find: Expansion of $\left(\frac{2x}{3}-\frac{3}{2x}\right)^6$ by means of binomial theorem

Formula used: ${}^nC_r=\frac{n!}{(n-r)!(r)!}$

$(a+b)^n={}^nC_0a^n+{}^nC_1a^{n-1}b+{}^nC_2a^{n-2}b^2+\ldots\ldots+{}^nC_{n-1}ab^{n-1}+nC_nb^n$

Now here We have, $\left(\frac{2x}{3}-\frac{3}{2x}\right)^6$

$=\left[6c_0\left(\frac{2x}{3}\right)^{6-0}\right]+\left[6c_1\left(\frac{2x}{3}\right)^{6-1}\left(-\frac{3}{2x}\right)^1\right]+\left[6c_2\left(\frac{2x}{3}\right)^{6-2}\left(-\frac{3}{2x}\right)^2\right]$

$+\left[6c_3\left(\frac{2x}{3}\right)^{6-3}\left(-\frac{3}{2x}\right)^3\right]+\left[6\mathrm{C}_4\left(\frac{2\mathrm{x}}{3}\right)^{6-4}\left(-\frac{3}{2\mathrm{x}}\right)^4\right]$

$+\left[6c_5\left(\frac{2x}{3}\right)^{6-5}\left(-\frac{3}{2x}\right)^5\right]+\left[6c_6\left(-\frac{3}{2x}\right)^6\right]$

$=\left[\frac{6!}{0!(6-0)!}\left(\frac{2x}{3}\right)^6\right]-\left[\frac{6!}{1!(6-1)!}\left(\frac{2x}{3}\right)^5\left(\frac{3}{2x}\right)\right]+\left[\frac{6!}{2!(6-2)!}\left(\frac{2x}{3}\right)^4\left(\frac{9}{4x^2}\right)\right]-\left[\frac{6!}{3!(6-3)!}\left(\frac{2x}{3}\right)^3\left(\frac{27}{8x^3}\right)\right]$

$+\left[\frac{6!}{4!(6-4)!}\left(\frac{2x}{3}\right)^2\left(\frac{81}{16x^4}\right)\right]-\left[\frac{6!}{5!(6-5)!}\left(\frac{2x}{3}\right)^1\left(\frac{243}{32x^5}\right)\right]+\left[\frac{6!}{6!(6-6)!}\left(\frac{729}{64x^6}\right)\right]$

$=\left[1\left(\frac{64x^6}{729}\right)\right]-\left[6\left(\frac{32x^5}{243}\right)\left(\frac{3}{2x}\right)\right]+\left[15\left(\frac{16x^4}{81}\right)\left(\frac{9}{4x^2}\right)\right]-\left[20\left(\frac{8x^3}{27}\right)\right.$

$\left.\left(\frac{27}{8x^3}\right)\right]+\left[15\left(\frac{4x^2}{9}\right)\left(\frac{81}{16x^4}\right)\right]-\left[6\left(\frac{2x}{3}\right)\left(\frac{243}{32x^5}\right)\right]+\left[1\left(\frac{729}{64x^6}\right)\right]$

$=\frac{64}{729}x^6-\frac{32}{27}x^4+\frac{20}{3}x^2-20+\frac{135}{4}\frac{1}{x^2}-\frac{243}{8}\frac{1}{x^4}+\frac{729}{64}\frac{1}{x^6}$

OR

$(a+b)^4=[{}^4C_0a^4+{}^4C_1a^3b+{}^4C_2a^2b^2+{}^4C_3ab^3+{}^4C_4b^4]$

and $(a-b)^4=[{}^4C_0a^4-{}^4C_1a^3b+{}^4C_2a^2b^2-{}^4C_3ab^3+{}^4C_4b^4]$

$\therefore(a+b)^4-(a-b)^4=2\left[{}^4C_1a^3b+{}^4C_3ab^3\right]$

$=2\left[4a^3b+4ab^3\right]=8ab\left[a^2+b^2\right]$

$\therefore(\sqrt{3}+\sqrt{2})^4-(\sqrt{3}-\sqrt{2})^4=8\cdot\sqrt{3}\cdot\sqrt{2}\left[(\sqrt{3})^2+(\sqrt{2})^2\right]$

$=8\cdot\sqrt{3}\cdot\sqrt{2}[3+2]=40\cdot\sqrt{3}\cdot\sqrt{2}=40\sqrt{6}$

30. $\left(-2-\frac{1}{3}i\right)^3=-\left(2+\frac{1}{3}i\right)^3$

$=-\left[(2)^3+\left(\frac{1}{3}i\right)^3+3\times(2)^2\times\frac{1}{3}i+3\times 2\times\left(\frac{1}{3}i\right)^2\right]$

$= -\left[8 + \frac{1}{27}i^3 + 4i + \frac{2}{3}i^2\right] = -\left[8 - \frac{1}{27}i + 4i - \frac{2}{3}\right] \begin{bmatrix} \because i^3 = -i \\ i^2 = -1 \end{bmatrix}$

$= \left[\left(8 - \frac{2}{3}\right) + \left(4 - \frac{1}{27}\right)i\right.$

$= -\left[\frac{22}{3} + \frac{107}{27}i\right] = \frac{-22}{3} - \frac{107}{27}i$

OR

Let x + yi = $\sqrt{3 - 4i}$

Squaring both sides, we get

$x^2 - y^2 + 2xyi = 3 - 4i$

Equating the real and imaginary parts

$x^2 - y^2 = 3$ .... (i)

and $2xy = -4 \Rightarrow xy = -2$

Now from the identity, we know

$(x^2 + y^2) = (x^2 - y^2)^2 + 4x^2y^2$

$(x^2 + y^2)^2 = (3)^2 + 4(-2)^2$

= 9 + 16 = 25

$\therefore x^2 + y^2 = 5$ .... (ii) [Neglecting (-) sign as $x^2 + y^2 > 0$]

Solving (i) and (ii) we get

$x^2 = 4$ and $y^2 = 1$

$x = \pm 2$ and $y = \pm 1$

Since the sign of xy is negative

$\therefore$ if, x = 2, y = -1

and if x = -2, y = 1

$\therefore \sqrt{-5 + 12i} = \pm(2 - i)$

31. Let S denote the universal set consisting of individuals suffering from the skin disorder, A denote the set of individuals exposed to chemical C_1 and B denote the set of individuals exposed to chemical C_2.

Now,

n(S) = 200

n(A) = 120

n(B) = 50

and n $(A \cap B)$ = 30

i. Chemical C_1 but not chemical C_2

Number of individuals exposed to chemical C_1 but not chemical C_2 is

= $n(A \cap B')$

= n(A) - $n(A \cap B)$

= 120 - 30 = 90

ii. Number of individuals exposed to chemical C_2 but not chemical C_1

= $n(A' \cap B)$

= n(B) - $n(A \cap B)$

= 50 - 30 = 20

iii. Number of individuals exposed to chemical C_1 or chemical C_2

= $n(A \cup B)$

= n(A) + n(B) - $n(A \cap B)$

= 120 + 50 - 30

= 140

Section D

32. Bag contains:

6 -Red balls

4 -White balls

8 -Blue balls

Since three ball are drawn,

$\therefore n(S) = {}^{18}C_3$

i. Let E be the event that one red and two white balls are drawn.

$\therefore n(E) = {}^{6}C_1 \times {}^{4}C_2$

$\therefore P(E) = \frac{{}^{6}C_1 \times {}^{4}C_2}{{}^{18}C_3} = \frac{6\times4\times3}{2} \times \frac{3\times2}{18\times17\times16}$

$P(E) = \frac{3}{68}$

ii. Let E be the event that two blue balls and one red ball was drawn.

$\therefore n(E) = {}^{8}C_2 \times {}^{6}C_1$

$\therefore P(E) = \frac{{}^{8}C_2 \times {}^{6}C_1}{{}^{18}C_3} = \frac{8\times7}{2} \times 6 \times \frac{3\times2\times1}{18\times17\times16} = \frac{7}{34}$

$P(E) = \frac{7}{34}$

iii. Let E be the event that one of the ball must be red.

$\therefore$ E = {(R,W,B) or (R,W,W) or (R,B,B)}

$\therefore n(E) = {}^{6}C_1 \times {}^{4}C_1 \times {}^{8}C_1 + {}^{6}C_1 \times {}^{4}C_2 + {}^{6}C_1 \times {}^{8}C_2$

$$\therefore P(E) = \frac{{}^{6}C_1 \times {}^{4}C_1 \times {}^{8}C_1 + {}^{6}C_1 \times {}^{4}C_2 + {}^{6}C_1 \times {}^{8}C_2}{{}^{18}C_3} = \frac{6\times4\times8+\frac{6\times4\times3}{2\times1}+\frac{6\times8\times7}{2\times1}}{\frac{18\times17\times16}{3\times2\times1}}$$

$= \frac{396}{816} = \frac{33}{68}$

33. We have to find the value of $\lim\limits_{x\to2}\frac{x^3+3x^2-9x-2}{x^3-x-6}$

We have

$\lim\limits_{x\to2}\frac{x^3+3x^2-9x-2}{x^3-x-6}$

Divide $x^3 + 3x^2 - 9x - 2$ by $x^3 - x - 6$

$$\begin{array}{r|l} & 1 \\ x^3-x-6 & x^3+3x^2-9x-2 \\ & \underline{\overset{-}{+x^3} \quad \overset{+}{-x} \quad \overset{+}{-6}} \\ & 3x^2-8x+4 \end{array}$$

$\Rightarrow \lim\limits_{x\to2}\frac{x^3+3x^2-9x-2}{x^3-x-6} = \lim\limits_{x\to2}1 + \lim\limits_{x\to2}\frac{3x^2-8x+4}{x^3-x-6}$

$= 1 + \lim\limits_{x\to2}\frac{3x^2-2x-6x+4}{x^3-x-6}$

$= 1 + \lim\limits_{x\to2}\frac{3x^2-2x-6x+4}{x^3-x-6}$

$\Rightarrow \lim\limits_{x\to2}\frac{x^3+3x^2-9x-2}{x^3-x-6} = 1 + \lim\limits_{x\to2}\frac{(3x-2)(x-2)}{x^3-x-6}$

Divide $x^3 - x - 6$ by $x - 2$

$$\begin{array}{r|l} & x^2+2x+3 \\ x-2 & x^3-x-6 \\ & \underline{\pm x^3 \overset{}{\underset{+}{-2x^2}}} \\ & 2x^2-x-6 \\ & \underline{2x^2 \mp 4x} \\ & 3x-6 \\ & \underline{3x-6} \\ & \times \end{array}$$

$\Rightarrow \lim\limits_{x\to2}\frac{x^3+3x^2-9x-2}{x^3-x-6} = 1 + \lim\limits_{x\to2}\frac{(3x-2)(x-2)}{(x-2)(x^2+2x+3)}$

$= 1 + \lim\limits_{x\to2}\frac{(3x-2)}{(x^2+2x+3)}$

$= 1 + \frac{3\times2-2}{2^2+2\times2+3}$

$=1 + \frac{4}{11}$
$= \frac{15}{11}$

OR

We have to find derivative of f(x) = x^2 sin x

Derivative of a function f(x) is given by f'(x) = $\lim_{h \to 0} = \frac{f(x+h)-f(x)}{h}$ {where h is a very small positive number}

∴ Derivative of f(x) = x^2 sin x is given as f'(x) = $\lim_{h \to 0} = \frac{f(x+h)-f(x)}{h}$

$\Rightarrow f(x) = \lim_{h \to 0} \frac{(x+h)^2 \sin(x+h) - x^2 \sin x}{h}$

Using $(a + b)^2 = a^2 + 2ab + b^2$, we get

$\Rightarrow f(x) = \lim_{h \to 0} \frac{h^2 \sin(x+h) + x^2 \sin(x+h) + 2hx \sin(x+h) - x^2 \sin x}{h}$

Using the algebra of limits, we have

$\Rightarrow f(x) = \lim_{h \to 0} \frac{h^2 \sin(x+h)}{h} + \lim_{h \to 0} \frac{x^2 \sin(x+h) - x^2 \sin x}{h} + \lim_{h \to 0} \frac{2hx \sin(x+h)}{h}$

$\Rightarrow f(x) = \lim_{h \to 0}$ h sin (x + h) + $\lim_{h \to 0} \frac{x^2(\sin(x+h) - \sin x)}{h}$ +$\lim_{h \to 0}$ 2x sin (x + h)

⇒ f'(x) = 0 × sin (x + 0) + 2x sin(x + 0) + $x^2 \lim_{h \to 0} \frac{(\sin(x+h) - \sin x)}{h}$

⇒ f'(x) =2x sin + $x^2 \lim_{h \to 0} \frac{(\sin(x+h) - \sin x)}{h}$

Using the algebra of limits we have

∴ f'(x) = 2x sin x + $x^2 \lim_{h \to 0} \frac{(\sin(x+h) - \sin x)}{h}$

We can't evaluate the limits at this stage only as on putting value it will take $\frac{0}{0}$ form. So, we need to do little modifications.

Use: sin A – sin B = 2 cos($\frac{(A-B)}{2}$) sin ($\frac{(A-B)}{2}$)

∴ f'(x) = 2x sin x + $x^2 \lim_{h \to 0} \frac{2 \cos\left(\frac{2x+h}{2}\right) \sin\left(\frac{h}{2}\right)}{h}$

⇒ f'(x) = 2x sin x + $x^2 \lim_{h \to 0} \frac{\cos\left(x + \frac{h}{2}\right) \sin\left(\frac{h}{2}\right)}{\frac{h}{2}}$

Using the algebra of limits:

⇒ f'(x) = 2x sin x + $x^2 \lim_{h \to 0} \frac{\sin\left(\frac{h}{2}\right)}{\frac{h}{2}} \times \lim_{h \to 0} \cos\left(x + \frac{h}{2}\right)$

By using the formula we get – $\lim_{x \to 0} \frac{\sin x}{x} = 1$

∴ f'(x) = 2x sin x + $x^2 \lim_{h \to 0} \cos\left(x + \frac{h}{2}\right)$

substuite the value of h to evaluate the limit:

Therefore, f'(x) = 2x sin x + x^2 cos(x + 0) = 2x sin x + x^2 cos x

Hence,

Derivative of f(x) = (x^2 sin x) is (2x sin x + x^2 cos x)

34. Let the given GP contain n terms. Let abe the first term and r be the common ratio of this GP.

Since the given GP is increasing, we have r > 1

Now, $T_1 + T_n$ = 66 ⇒ a + $ar^{(n-1)}$ = 66 ...(i)

And, $T_2 \times T_{n-1}$ = 128 ⇒ ar × $ar^{(n-2)}$ = 128

⇒ $a^2r^{(n-1)}$ = 128 ⇒ $ar^{(n-1)} = \frac{128}{a}$ ...(ii)

Using (ii) and (i), we get

a + $\frac{128}{a}$ = 66 ⇒ a^2 - 66a + 128 = 0

⇒ a^2 - 2a - 64a + 128 = 0

⇒ a(a - 2) - 64(a - 2) = 0

⇒ (a - 2) (a - 64) = 0

⇒ a = 2 or a = 64

Putting a = 2 in (ii), we get

$r^{(n-1)} = \frac{128}{a^2} = \frac{128}{4}$ = 32 ...(iii)

Putting a = 64 in (ii), we get

$r^{(n-1)} = \frac{128}{a^2} = \frac{128}{64\times64} = \frac{1}{32}$, which is rejected, since r > 1.

Thus, a = 2 and $r^{(n-1)}$ = 32

Now, S_n = 126 ⇒ $\frac{a(r^n-1)}{(r-1)}$ = 126

⇒ $2\left(\frac{r^n-1}{r-1}\right)$ = 126 ⇒ $\frac{r^n-1}{r-1}$ = 63

⇒ $\frac{r^{(n-1)}\times r-1}{r-1}$ = 63 ⇒ $\frac{32r-1}{r-1}$ = 63

⇒ 32r - 1 = 63r - 63 ⇒ 31r = 62 ⇒ r = 2

∴ $r^{(n-1)}$ = 32 = 25 ⇒ n - 1 = 5 ⇒ n = 6

Hence, there are 6 terms in the given GP

35. We have to prove that sin 6° sin 42° sin 66° sin 78° = $\frac{1}{16}$.

LHS = sin 6° sin 42° sin 66° sin 78°

By regrouping the LHS and multiplying and dividing by 4 we get,

= $\frac{1}{4}$(2 sin 66° sin 6°)(2 sin 78° sin 42°)

But 2 sin A sin B = cos (A - B) - cos (A + B)

Then the above equation becomes,

=$\frac{1}{4}$(cos(66° - 6°) - cos(66° + 6°)) (cos(78° - 42°) - cos(78° + 42°))

=$\frac{1}{4}$(cos(60°) - cos(72°)) (cos(36°) - cos(120°))

=$\frac{1}{4}$(cos(60°) - cos(90° - 18°)) (cos(36°) - cos(180° - 120°))

But cos(90° - θ) = sin θ and cos(180° - θ) = -cos(θ).

Then the above equation becomes,

= $\frac{1}{4}$(cos(60°) - cos(18°)) (cos(36°) + cos(60°))

Now, cos(36°) = $\frac{\sqrt{5}+1}{4}$

sin(18°) = $\frac{\sqrt{5}-1}{4}$

cos(60°) = $\frac{1}{2}$

Substituting the corresponding values, we get

$=\frac{1}{4}\left(\frac{1}{2}-\frac{\sqrt{5}-1}{4}\right)\left(\frac{\sqrt{5}+1}{4}+\frac{1}{2}\right)$

$=\frac{1}{4}\left(\frac{2-\sqrt{5}+1}{4}\right)\left(\frac{\sqrt{5}+1}{4}+\frac{1}{2}\right)$

$=\frac{1}{4}\left(\frac{3-\sqrt{5}}{4}\right)\left(\frac{3+\sqrt{5}}{4}\right)$

$=\frac{1}{4}\left(\frac{3^2-(\sqrt{5})^2}{4\times4}\right)$

$=\frac{1}{4}\left(\frac{9-5}{16}\right)$

$=\frac{1}{16}$

LHS = RHS

Hence proved.

OR

LHS = $\cos\frac{2\pi}{15}\cdot\cos\frac{4\pi}{15}\cdot\cos\frac{8\pi}{15}\cdot\cos\frac{16\pi}{15}$

$= cos\ \frac{2\pi}{15}\ cos2\ \left(\frac{2\pi}{15}\right)cos4\ \left(\frac{2\pi}{15}\right)\ cos8\ \left(\frac{2\pi}{15}\right)$

Put $\frac{2\pi}{15} = \alpha$

⇒LHS = $\cos\alpha\cdot\cos2\alpha\cdot\cos4\alpha\cdot\cos8\alpha$

$= \frac{2\sin\alpha[\cos\alpha\cdot\cos2\alpha\cdot\cos4\alpha\cdot\cos8\alpha]}{2\sin\alpha}$ [multiplying numerator and denominator by $2sin\ \alpha$]

$= \frac{(2\sin\alpha\cdot\cos\alpha)\cdot\cos2\alpha\cdot\cos4\alpha\cdot\cos8\alpha}{2\sin\alpha}$

$= \frac{2(\sin2\alpha\cdot\cos2\alpha\cdot\cos4\alpha\cdot\cos8\alpha)}{2(2\sin\alpha)}$ [$\because 2sin\alpha\ cos\alpha = sin2\alpha$ and multiplying numerator and denominator by 2]

$= \frac{(2\sin2\alpha\cdot\cos2\alpha)\cdot\cos4\alpha\cdot\cos8\alpha}{4\sin\alpha}$

$= \frac{2(\sin4\alpha\cdot\cos4\alpha)\cos8\alpha}{2(4\sin\alpha)}$ [$\because 2sin\alpha\ cos\alpha = sin2\alpha$ and multiplying numerator and denominator by 2]

$= \frac{2(\sin 8\alpha \cdot \cos 8\alpha)}{2(8 \sin \alpha)}$

$= \frac{\sin 16\alpha}{16 \sin \alpha} = \frac{\sin(15\alpha+\alpha)}{16 \sin \alpha}$

Now, $15\alpha = 2\pi$,

$= \frac{\sin(2\pi+\alpha)}{16 \sin \alpha} = \frac{\sin \alpha}{16 \sin \alpha}$ $= \frac{1}{16}$ = RHS

$\therefore$ **LHS = RHS**

Hence proved.

Section E

36. i. The curve traced by farmer is ellipse. Because An ellipse is the set of all points in a plane, the sum of whose distances from two fixed points in the plane is a constant.

Two positions of hand pumps are foci Distance between two foci = 2c = 10 Hence c = 5 Here foci lie on x axis & coordinates of foci = $(\pm c, 0)$

Hence coordinates of foci =$(\pm 5, 0)$

ii. $\frac{x^2}{169} + \frac{y^2}{144} = 1$

Sum of distances from the foci = 2a

Sum of distances between the farmer and each hand pump is = 26 = 2a

$\Rightarrow$ 2a = 26 $\Rightarrow$ a = 13 m

Distance between the handpump = 10m = 2c

$\Rightarrow$ c = 5 m

$c^2 = a^2 - b^2$

$\Rightarrow 25 = 169 - b^2$

$\Rightarrow b^2 = 144$

Equation is $\frac{x^2}{169} + \frac{y^2}{144} = 1$

iii. Equation of ellipse is $\frac{x^2}{169} + \frac{y^2}{144} = 1$ comparing with standard equation of ellipse a=13, b= 12 and c= 5 (given)

Length of major axis = 2a = 2 $\times$ 13 = 26

Length of minor axis = 2b = 2 $\times$ 12 = 24

eccentricity $e = \frac{c}{a} = \frac{5}{13}$

OR

Equation of the ellipse is $\frac{x^2}{169} + \frac{y^2}{144} = 1$ hence a = 13 and b = 12

length of latus rectum of ellipse is given by $\frac{2\,b^2}{a} = \frac{2\times144}{13}$

37. i. We make the table from the given data.

Class	f_i	cf	Mid-point(x_i)	$\|x_i - M\|$	$f_i\|x_i - M\|$
0-10	6	6	5	23	138
10-20	7	13	15	13	91
20-30	15	28	25	3	45
30-40	16	44	35	7	112
40-50	4	48	45	17	68
50-60	2	50	55	27	54
	50				508

Here, $\frac{N}{2}$ = $\frac{50}{2}$ = 25

Here, 25th item lies in the class 20-30. Therefore, 20-30 is the median class.

Here, l = 20, cf = 13, f = 15, b = 10 and N = 50

$\because$ Median, M = $l + \frac{\frac{N}{2} - cf}{f} \times b$

$\Rightarrow$ M = 20 + $\frac{25-13}{15}$ $\times$ 10 = 20 + 8 = 28

Thus, mean deviation about median is given by

MD (M) = $\frac{1}{N}\sum_{i=1}^{6} f_i\left|x_i - M\right|$ = $\frac{1}{50}$ $\times$ 508 = 10.16

Hence, mean deviation about median is 10.16.

ii. Here, l = 20, cf = 13, f = 15, b = 10 and N = 50

$\because$ Median, M = $l + \frac{\frac{N}{2} - cf}{f} \times b$

$\Rightarrow$ M = 20 + $\frac{25-13}{15}$ $\times$ 10 = 20 + 8 = 28

iii. MD = $\frac{\Sigma f_i|x_i - M|}{N}$

OR

M = 1 $+ \frac{\frac{N}{2} - cf}{f} \times h$

38. i. Given Raju and Ravi are at the extreme positions

Case 1 Raju ______ ______ ______ ______ ______ Ravi

Case 2 Ravi ______ ______ ______ ______ ______ Raju

So remaining 5 places are filled in 5! Ways in both cases

5! = 5 $\times$ 4 $\times$ 3 $\times$ 2 $\times$ 1 = 120

Hence total number of arrangements = 120 $\times$ 2 = 240 ways

ii. ______ ______ ______ **Joseph** ______ ______ ______

So here middle place is occupied by Joseph remaining 6 places are filled by remaining 6 students in 6! Ways

6! = 6 $\times$ 5 $\times$ 4 $\times$ 3 $\times$ 2 $\times$ 1 = 720 ways

iii. When all girls are together let's consider them as a single unit. So four 4 boys with single group of girls can be arranged in 4 + 1 = 5! Ways

______ ______ ______ ______ | Sangeeta Priya Meena |

5! = 5 $\times$ 4 $\times$ 3 $\times$ 2 $\times$ 1 = 120

But all the tree girls can be arranged in themselves in 3! Ways = 3 $\times$ 2 $\times$ 1 = 6

Hence total number of ways = 5! $\times$ 3! = 120 $\times$ 6 = 720

OR

When Aman and Ravi are together let's consider them as a single unit. So remaining 5 students with single group of Aman and Ravi can be arranged in 5 + 1 = 6! Ways

______ ______ ______ ______ | Aman Ravi |

6! = 6 $\times$ 5 $\times$ 4 $\times$ 3 $\times$ 2 $\times$ 1 = 720

But Aman and Ravi can be arranged in themselves in 2! Ways = 2 $\times$ 1 = 2

Hence total number of ways = 6! $\times$ 2! = 720 $\times$ 2 = 1440 ways ...(i)

Total number of sitting arrangements of all 7 students without restriction

______ ______ ______ ______ ______ ______ ______

All seven students can fill seven seats in 7! Ways

7! = 7 $\times$ 6 $\times$ 5 $\times$ 4 $\times$ 3 $\times$ 2 $\times$ 1 = 5040 ways ...(ii)

But here we need the number of arrangements so that Aman and Ravi are not together = Total number of sitting arrangements of all 7 students without restriction - Number of arrangements so that Aman and Ravi are together.

From (i) and (ii) we have

The number of arrangements so that Aman and Ravi are not together = 5040 - 1440 = 3600