CBSE Class XI Mathematics
Sample Paper 03
As per pattern issued by CBSE for (2023-24)

Maximum Marks : 80 **Time : 3 hrs.**

General Instructions :

1. This Question Paper has 5 Sections A-E.
2. Section A has 20 MCQs carrying 1 mark each
3. Section B has 5 questions carrying 02 marks each.
4. Section C has 6 questions carrying 03 marks each.
5. Section D has 3 case based integrated units of assessment (04 marks each) with subparts of the values of 1, 1 and 2 marks each respectively.
6. Section E has 4 questions carrying 05 marks each.
7. All Questions are compulsory. However, an internal choice in 2 Qs of 5 marks, 2 Qs of 3 marks and 2 Questions of 2 marks has been provided. An internal choice has been provided in the 2marks questions of Section E
8. Draw neat figures wherever required. Take π =22/7 wherever required if not stated.

SECTION A
(Question 1 to 20 carry 1 mark)

Q.1 The set A = {14, 21, 28, 35, 42,..., 98} in set-builder form is

a)$A = \{x: x = 7n, n \in N and\ 1 \le n \le 15\}$	b)$A = \{x: x = 7n, n \in N and\ 2 \le n \le 14\}$
c)$= \{x: x = 7n, n \in N and\ 3 \le n \le 13\}$	d)$A = \{x: x = 7n, n \in N and\ 4 \le n \le 12\}$

Q2.The greatest value of sinx cosx is

a)1	b)2
c)$\sqrt{2}$	d) 1/2

Q3.If the set A has p elements, B has q elements, then the number of elements in A × B is

a)p+q	b) p+q-1
c)pq	d)pq-1

Q4. If A = {1, 2, 3}, B = {1, 4, 6, 9} and R is a relation from A to B defined by 'x is greater than y'. The range of R is :

a){1,4,6,9}	b) {1}
c){4,6,9}	d){1,9}

Q5.Mean of 10 items is 17. If an observation 21 is replaced with 12, then new mean is

a)17	b) 26
c)8	d)16.1

Q6. The value of $(i^5 + i^6 + i^7 + i^8 + i^9)\ /\ (1 + i)$ is

a)$\frac{i+1}{2}$	b) $\frac{i-1}{2}$
c) $i - 1$	d) $i - 1$

Q7. In a group of students, 100 students know Hindi, 50 know English and 25 know both. Each of the students knows either Hindi or English. The number of students in the group is

a)50	b) 125
c)75	d)175

Q8. The eccentricity of the ellipse $9x^2 + 25y^2 = 225$ is 'e' then the value of '5e' is

a)3	b) -3
c)both (a) and (b)	d)neither (a) nor (b)

Q9. A line passes through the point (2, 2) and is perpendicular to the line 3x + y = 3. Its y intercept is

a)1/3	b) 2/3
c)1	d)4/3

Q10. The x-intercept and the y-intercept of the line 5x – 7 = 6y, respectively are

a)$\frac{7}{5}\, an\, d\, \frac{7}{6}$	b) $\frac{7}{5}\, an\, d\, \frac{-7}{6}$
c)$\frac{5}{7}\, an\, d\, \frac{6}{7}$	d)$\frac{-5}{7}\, an\, d\, \frac{6}{7}$

Q11. Solution set for inequality $|x – 1| \leq 5$ is

a)[-6,4]	b) [-4,0]
c)[-4,6]	d)[0,6]

Q12. If the 10th term of a G.P. is 9th and 4th term is 4, then what is its 7 th term

a)6	b) 14
c)27/14	d)56/15

Q13. What is the number of ways of arrangement of letters of word 'BANANA' so that no two N's are together

a)40	b) 60
c)80	d)100

Q14. If pth, qth and rth terms of an A.P. are in G.P., then the common ratio of this G.P. is

a)$\frac{p-q}{q-\gamma}$	b) none of these
c)pqr	d)$\frac{q-\gamma}{p-q}$

Q15. If the lines 3x + 4y + 1 = 0, 5x + λy + 3 = 0 and 2x + y – 1 = 0 are concurrent, then λ is equal to

a)-8	b)8
c)4	d)-4

Q16. What is the number of signals that can be sent by 6 flags of different colours taking one or more at a time?

a)45	b) 63
c)720	d)1956

Q17. For all n ∈ N, 2^{4m} – 15n – 1 is divisible by

a)125	b) 225
c)450	d)625

Q18.Three unbiased coins are tossed. If the probability of getting at least 2 tails is p, Then the value of 8p:

a)0	b) 1
c)3	d)4

Q19.Assertion (A) The domain of the relation R = {(x + 2, x + 4): x∈ N , x < 8} is {3, 4, 5, 6, 7, 8, 9}.
Reason (R) The range of the relation R = {(x + 2, x + 4): x ∈N , x < 8} is {1, 2, 3, 4, 5, 6, 7}.

a)Both assertion and reason are true and reason is the correct explanation of assertion	b)Both assertion and reason are true but reason is not the correct explanation of assertion
c)Assertion is true but reason is false.	d) Assertion is false but reason is true.

Q20. Assertion (A) $\lim_{x\to 0}\frac{\sin ax+bx}{ax+\sin bx}=-2$

Reason (R) $\lim_{x\to 1}5x^3+5x+1$ is equal to 11.

a)Both assertion and reason are true and reason is the correct explanation of assertion	b)Both assertion and reason are true but reason is not the correct explanation of assertion
c)Assertion is true but reason is false.	d) Assertion is false but reason is true.

SECTION B
(Question 21 to 25 carry 2 mark)

Q21.Using binomial theorem, find the remainder when 5^{103} is divided by 13.

Q22.Prove that $\sqrt{2+\sqrt{2+2\cos 4\theta}}=2\cos\theta$

Or

Prove that $\frac{\cos x}{1-\sin x}=\tan\left(\frac{\pi}{4}+\frac{x}{2}\right)$

Q23.Evaluate $\lim_{x\to 9}\frac{x^{\frac{3}{2}}-27}{x^2-81}$

Q24.Find the coordinate of the point P which is three-fourth of the way from A(–1, 0, 2) to B (5, –7, –10).

Or

A point R with x-coordinate 4 lies on the line segment joining the points P(2, –3, 4) and Q (8, 0, 10). Find the coordinates of the point R.

Q25.Find the Standard deviation for the following data: 10, 20, 30, 40, 50, 50, 60, 70, 80, 90

SECTION C
(Question 26 to 31 carry 3 mark)

Q26. Find the domain and range of $f(x)=|2x-3|-3$

Q27. Find the equation of the lines which cut-off intercepts on the axes whose sum and product are 1 and –6 respectively.

Or

If the image of the point (2, 1) in a line is (4, 3) then find the equation of line.

Q28.If x + iy = $\sqrt{\frac{1+i}{1-i}}$ prove that $x^2 + y^2 = 1$

Q29.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)

Or

Two sets A and B are such that n(A ∪ B) = 21, n(A′ ∩ B′) = 9, n(A ∩ B) = 7 find n(A ∩ B)′.

Q30. If the eccentricity of the ellipse is $\frac{5}{8}$ and distance between its foci is 10. Find the equation of ellipse.

Q31.Find the value of $\sqrt{3}\, cosec\, 20^0 - sec\, 20^0$

SECTION D
(Question 32 to 35 carry 4 mark)

Q32. Read the Information given carefully:
An urn contains twenty white slips of paper numbered from 1 to 20 , ten red slips of paper numbered from 1 to 10 , forty yellow slips of paper numbered 1 to 40 , and ten blue slips of paper numbered 1 to 10 .In total there are 80 slips of paper which are mixed thoroughly and well shuffled so that each slip has the same probability of being drawn .
Based on the above information answer the following :
(i) A slip is drawn at random from the urn .What is the probability that it is blue or a white slip.
(ii) A slip drawn at random from the urn .What is the probability that the slip is numbered 1,2,3,4 or 5?
(iii) A slip is drawn at random from the urn. What is the probability that it is a red or a yellow slip numbered 1,2,3 or 4?

OR

A slip is drawn at random from the urn. What is the probability that it is a red or a yellow slip numbered 20, 30 or 40 ?

Q33. If A and B are two persons sitting at the positions (2,-3) and (6,-5). If C is a third person who is sitting between A and B such that it divides the line AB in 1: 3 ratio.

Based on the above information, answer the following questions
(i)Find distance between A and B.
(ii)Find the equation of AB.
(iii)Find the coordinate of C and an equation of line passing through A and C.

OR

Find the coordinate of C and an equation of line passing through B and C.

Q34. In a library, 25 students read physics, chemistry and mathematics books. It was found that 15 students read mathematics, 12 students read physics while 11 students read chemistry. 5 students read both mathematics and chemistry, 9 students read physics and mathematics. 4 students read physics and chemistry and 3 students read all three subject books.

Based on the above information, answer the following questions.

(i)Find the number of students who reading only chemistry

(ii)Find the number of student who read only Maths.

(iii)Find the number of student who read atleast one of the subject

Or

Find the number of students who read atleast one of the subject.

SECTION E
(Question 35 to 32 carry 3 mark)

Q35. Prove that the line 5x-2y − 1= 0 is mid-parallel to the lines 5 x - 2y − 9= 0 and 5 x - 2y + 7 =0 .

Or

Prove that the perpendicular distance of the line joining the points A(cos θ , sin θ), B(cos ϕ , sin ϕ) from the origin is $cos\left|\frac{\theta-\phi}{2}\right|$

Q36.Prove that $2\,sin^2\beta + 4\,cos(\alpha+\beta)\,sin\,\alpha\,sin\,\beta + cos\,2(\alpha+\beta) = cos\,2\alpha$

Or

Prove that $cos\,A\,cos\,2A\,cos\,4A\,cos\,8A = \frac{sin\,16A}{16\,sin\,A}$

Q37. Find the values of a and b if $\lim_{x\to 2} f(x)$ and $\lim_{x\to 4} f(x)$ exists where

$$f(x) = \begin{cases} x^2 + ax + b, 0 \le x < 2 \\ 3x + 2, 2 \le x \le 4 \\ 2ax + 5b, 4 < x < 8 \end{cases}$$

Q38. Calculate the mean, variance, and standard deviation for the following distribution

Class Interval	30-40	40-50	50-60	60-70	70-80	80-90	90-100
frequency	3	7	12	15	8	3	2

________________________**End**________________________

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CBSE Class XI Mathematics Sample Paper 03 Answer key

SECTION – A

(Question number **1 to 20** carry **1 marks** each)

Q1.	**B**
Q2.	**D**
Q3.	**C**
Q4.	**B**
Q5.	**D**
Q6.	**A**
Q7.	**B**
Q8.	**D**
Q9.	**D**
Q10.	**B**
Q11.	**C**
Q12.	**A**
Q13.	**A**
Q14.	**D**
Q15.	**B**
Q16.	**D**
Q17.	**B**
Q18.	**D**
Q19.	**C**
Q20.	**D**

SECTION – B

(Question number **21 to 25** carry **2 marks** each)

Q21.Using binomial theorem, find the remainder when 5^{103} is divided by 13.

We have, 5^{103}

$= 5.5^{102} = 5(26 - 1)^{51}$

Now expanding the above by binomial theorem we get,

$= [\,^{51}C_0\,(26)^{51}\,1^0 - {}^{51}C_1\,(26)^{50}\,1^1 + \ldots + {}^{51}C_{51}\,(26)^0\,1^{51}]$

In the above expansion, all terms except the constant (last) term will contain 26, which is divisible by 13

Hence the remainder is

$5(-1)^{51} = -5$

Which is the same as remainder being 8.

Q22.Prove that $\sqrt{2+\sqrt{2+2\cos 4\theta}} = 2\cos\theta$

$$LHS = \sqrt{2+\sqrt{2+2\cos 4x}}$$

$$= \sqrt{2+\sqrt{2(1+\cos 4x)}}$$

$$= \sqrt{2+\sqrt{2\times 2\cos^2 2x}}\,(\because 2\cos^2 2x = 1+\cos 4x)$$

$$= \sqrt{2+2\cos 2x}$$

$$= \sqrt{2(1+\cos 2x)}$$

$$= \sqrt{2.2\cos^2 x}\,(\because 2\cos^2 x = 1+\cos 2x)$$

$$= 2\cos x = RHS$$

Hence proved .

Or

Prove that $\frac{\cos x}{1-\sin x} = \tan\left(\frac{\pi}{4}+\frac{x}{2}\right)$

$$LHS = \frac{\cos x}{1-\sin x}$$

$$= \frac{\cos^2\frac{x}{2}-\sin^2\frac{x}{2}}{\sin^2\frac{x}{2}+\cos^2\frac{x}{2}-2\sin\frac{x}{2}\times\cos\frac{x}{2}}\left[\because \cos x = \cos^2\frac{x}{2}-\sin^2\frac{x}{2}\right.$$

$$= \frac{\left(\cos\frac{x}{2}-\sin\frac{x}{2}\right)\left(\cos\frac{x}{2}+\sin\frac{x}{2}\right)}{\left(\cos\frac{x}{2}-\sin\frac{x}{2}\right)^2}$$

$$= \frac{\cos\frac{x}{2}+\sin\frac{x}{2}}{\cos\frac{x}{2}-\sin\frac{x}{2}}$$

On dividing the numerator and denominator by

$$\cos\frac{x}{2}$$

, we get

$$= \frac{1+\tan\frac{x}{2}}{1-\tan\frac{x}{2}}$$

$$= \tan\left(\frac{\pi}{4}+\frac{x}{2}\right) = RHS$$

Hence proved .

Q23.Evaluate $\lim_{x\to 9}\frac{x^{\frac{3}{2}}-27}{x^2-81}$

$$=\lim_{x\to 9}\frac{x^{\frac{3}{2}}-\left(9^{\frac{3}{2}}\right)}{x-9}$$

$$=\frac{3}{2}\left(9^{\frac{3}{2}-1}\right)=\frac{3}{2}\left(9^{\frac{1}{2}}\right)$$

$$=\frac{9}{2}$$

Q24.Find the coordinate of the point P which is three-fourth of the way from A(–1, 0, 2) to B (5, –7, –10).

Let P be the point which is three-fourth of the way from A(3,1) to B(-2,5).
AP/AB = 3/ 4
AB = AP+PB
AP/AB = AP/(AP+PB) = 3/4
4AP = 3AP+3PB
4AP-3AP = 3PB
AP = 3PB
AP/PB = 3/1
The ratio m:n = 3:1
$x_1 = 3$, $y_1 = 1$, $x_2 = -2$, $y_2 = 5$
By Section formula $x = (mx_2+nx_1)/(m+n)$
$x = (3\times-2+1\times3)/(3+1)$
$x = (-6+3)/4$
$x = -3/4$
By Section formula $y = (my_2+ny_1)/(m+n)$
$y = (3\times5+1\times1)/(3+1)$
$y = (15+1)/4$
$y = 16/4$
$y = 4$
Hence the co-ordinates of P are (-3/4, 4).

Q25.Find the Standard deviation for the following data: 10, 20, 30, 40, 50, 50, 60, 70, 80, 90

Mean $= \frac{10+20+30+\dots+90}{9} = 50$

$SD = \sqrt{\frac{1}{n}\sum(x_i-\bar{x})^2} = \sqrt{\frac{1}{9}\left((-40)^2+(-30)^2+\dots+(40)^2\right)}$

$= \sqrt{\frac{1}{9}\times 6000} = \frac{20\sqrt{15}}{3}$

SECTION – C

(Question number **26 to 31** carry **3 marks** each)

Q26.Find the domain and range of $f(x) = |2x - 3| - 3$

Domain of f = (– ∞, ∞) = R

Range of f = [–3, ∞] or {y/y ≥ – 3}

Q27.Find the equation of the lines which cut-off intercepts on the axes whose sum and product are 1 and –6 respectively.

Let the intercepts cut by the given lines on the axes be *a* and *b*.

It is given that

$a + b = 1$ ... (1)

$ab = -6$ ... (2)

On solving equations (1) and (2), we obtain

$a = 3$ and $b = -2$ or $a = -2$ and $b = 3$

It is known that the equation of the line whose intercepts on the axes are *a* and *b* is

$\frac{x}{a} + \frac{y}{b} = 1$ or $bx + ay - ab = 0$

Case I: $a = 3$ and $b = -2$

In this case, the equation of the line is $-2x + 3y + 6 = 0$, i.e., $2x - 3y = 6$.

Case II: $a = -2$ and $b = 3$

In this case, the equation of the line is $3x - 2y + 6 = 0$, i.e., $-3x + 2y = 6$.

Thus, the required equation of the lines are $2x - 3y = 6$ and $-3x + 2y = 6$.

Or

If the image of the point (2, 1) in a line is (4, 3) then find the equation of line.

Ans: x+y=5

Q28.If x + iy = $\sqrt{\frac{1+i}{1-i}}$ prove that $x^2 + y^2 = 1$

Q29.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)

Ans)n(A ∪ B) = n(A) + n(B) - n(A ∩ 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

Or

Two sets A and B are such that $n(A \cup B) = 21$, $n(A' \cap B') = 9$, $n(A \cap B) = 7$ find $n(A \cap B)'$.

Ans)U = $n(A \cup B)' + n(A \cup B)$

$= 9 + 21 = 31$

$\therefore n(A \cap B)' = u - n(A \cup B) = 30 - 7 = 23$

Q30. If the eccentricity of the ellipse is $\frac{5}{8}$ and distance between its foci is 10. Find the equation of ellipse.

Sol^n: here $e = \frac{5}{8}$ & distance between foci is given by, $2ae = 10$

so, $ae = 5$

& $a = 5/e = 5/5 \times 8 = 8$

From given data we get, $a = 8$ & $e = 5/8$

Now, eccentricity $e = \sqrt{1 - \left(\frac{b}{a}\right)^2}$

$$e^2 = 1 - \left(\frac{b}{a}\right)^2 \longrightarrow ①$$

Now, length of Latus rectum is

$$l = \frac{2b^2}{a} \longrightarrow ②$$

From eq^n ①, $e^2 = 1 - \frac{b^2}{a^2}$

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

$$b^2 = a^2(1 - e^2)$$

From eq^n ② $l = \frac{2a^2(1-e^2)}{a}$

$$l = 2a(1 - e^2) = 2(8)(1 - (\tfrac{5}{8})^2)$$

$$= 16\left(1 - \frac{25}{64}\right)$$

$$l = \frac{16 \times 39}{64}$$

$$l = \frac{39}{4}$$

$$\boxed{l = 9\frac{3}{4}}$$

Q31.Find the value of $\sqrt{3}\, cosec\, 20^0 - sec\, 20^0$

$\sqrt{3}$ cosec20° - sec20°

$$= \frac{\sqrt{3}}{\sin 20^o} - \frac{1}{\cos 20^o}$$

$$= \frac{\sqrt{3}\cos 20^o - \sin 20^o}{\sin 20^o \cos 20^o}$$

$$= 4\left(\frac{\frac{\sqrt{3}}{2}\cos 20^o - \frac{1}{2}\sin 20^o}{2\sin 20^o \cos 20^o}\right)$$

$$= 4\left(\frac{\sin 60^o \cos 20^o - \cos 60^o \sin 20^o}{\sin 40^o}\right)$$

$$= 4\left(\frac{\sin(60^o - 20^o)}{\sin 40^o}\right) = 4$$

SECTION – D

(Question number **32 to 34** carry **4 marks** each)

Q32.

(a) P (Blue or White) = P (Blue) + P (White)

$$= \frac{10}{80} + \frac{20}{80} = \frac{30}{80} = \frac{3}{8}$$

(b) P (numbered 1, 2, 3, 4 or 5)

= P (1 of any colour) + P (2 of any colour) + P (3 of any colour) + P (4 of any colour) + P (5 of any colour)

$$= \frac{4}{80} + \frac{4}{80} + \frac{4}{80} + \frac{4}{80} + \frac{4}{80} = \frac{20}{80} = \frac{2}{8} = \frac{1}{4}$$

c)

P (Red or yellow and numbered 1, 2, 3 or 4)

= P (Red numbered 1, 2, 3 or 4) + P (yellow numbered 1, 2, 3 or 4)

$$= \frac{4}{80} + \frac{4}{80} = \frac{8}{80} = \frac{1}{10}$$

Q33.

a)Find distance between A and B.(Ans: $\sqrt{20}$)

b)Find the equation of AB.(Ans: 2y= -x -2)

c)Find the coordinate of C and an equation of line passing through A and C.(Ans: C($3, -\frac{7}{2}$) ,Equation :y= -12x+21)
or

Find the coordinate of C and an equation of line passing through B and C.(Ans:)

Q34.

a)Find the number of students who reading only chemistry.(Ans: 5)

b)Find the number of student who read only Maths..(Ans: 4)

c)Find the number of student who read atleast one of the subject .(Ans: 23)

Or
Find the number of students who read atleast one of the subject..(Ans:)

SECTION – E
Question number **35 to 38** carry **5 marks** each)

Q35. Prove that the line 5x-2y – 1= 0 is mid-parallel to the lines 5 x - 2y – 9= 0 and 5 x - 2y + 7 =0 .

Converting each of the given equations to the form y=mx+C,

We get $5x-2y-1=0 \Rightarrow y=\frac{5}{2}x-\frac{1}{2}\ldots\ldots.(i)$

$5x-2y-9=0 \Rightarrow y=\frac{5}{2}x-\frac{9}{2}\ldots\ldots.(ii)$

$5x-2y+7=0 \Rightarrow y=\frac{5}{2}x+\frac{7}{2}\ldots\ldots.(iii)$

Clearly, the slope of (i) is equal to the slope of each of (ii) and (iii), So, the line (i) is parallel to each of the given line (ii) and (iii). Let the given line be $y=mx+C, y=mx+C_1$ and $y=mx+C_2$ respectively. Then,

$m=\frac{5}{2}, C=-\frac{1}{2}=-\frac{1}{2}, C_1=-\frac{9}{2}$ and $C_2=\frac{7}{2}$

Let d_1 and d_2 be the distance of (i) from (ii) and (iii) respectively.

Then, $d_1=\frac{|C_1-C|}{\sqrt{1+m^2}}=\frac{-\frac{9}{2}+\frac{1}{2}}{\sqrt{1+\frac{25}{4}}}=|-4|=\frac{4\times 2}{\sqrt{29}}=\frac{8}{\sqrt{29}}$ units

$$\text{and } d_2 = \frac{|C_2 - C|}{\sqrt{1+m^2}} = \frac{\frac{7}{2}+\frac{1}{2}}{\sqrt{1+\frac{25}{4}}} = \left(4 \times \frac{2}{\sqrt{29}}\right) = \frac{8}{\sqrt{29}}\text{units}$$

Thus, $d_1 = d_2$

This shows that (i) is equidistant from (ii) and (iii).

Hence, 5x-2y-1=0 is mid-parallel to the lines 5x-2y-9=0 and 5x-2y+7=0

Or

Prove that the perpendicular distance of the line joining the points A(cos θ , sin θ) , B(cos ϕ , sin ϕ) from the origin is $cos\left|\frac{\theta-\phi}{2}\right|$

The equation of the line joining the points (cos θ, sin θ) and (cos ϕ, sin ϕ) is given below:

$$y - sin\theta = \frac{sin\phi - sin\theta}{cos\phi - cos\theta}(x - cos\theta)$$

$$\Rightarrow (cos\phi - cos\theta)y - sin\theta\,(cos\phi - cos\theta) = (sin\phi - sin\theta)x - (sin\phi - sin\theta)cos\theta$$

$$\Rightarrow (sin\phi - sin\theta)x - (cos\phi - cos\theta)y + sin\theta\; cos\phi - sin\phi\; cos\theta = 0$$

Let d be the perpendicular distance from the origin to the line

$(sin\phi - sin\theta)x - (cos\phi - cos\theta)y + sin\theta\; cos\phi - sin\phi\; cos\theta = 0$

$$\therefore d = \left|\frac{sin\theta cos\phi - sin\phi cos\theta}{\sqrt{(sin\phi - sin\theta)^2 + (cos\phi - cos\theta)^2}}\right|$$

$$\Rightarrow d = \left|\frac{\sin(\theta-\phi)}{\sqrt{\sin^2\phi + \sin^2\theta - 2sin\phi sin\theta + \cos^2\phi + \cos^2\theta - 2\cos\phi cos\theta}}\right|$$

$$\Rightarrow d = \left|\frac{\sin(\theta-\phi)}{\sqrt{\sin^2\phi + \cos^2\phi + \sin^2\theta + \cos^2\theta - 2\cos(\theta-\phi)}}\right|$$

$$\Rightarrow d = \frac{1}{\sqrt{2}}\left|\frac{\sin(\theta-\phi)}{\sqrt{1-\cos(\theta-\phi)}}\right|$$

$$\Rightarrow d = \frac{1}{\sqrt{2}}\left|\frac{\sin(\theta-\phi)}{\sqrt{2\sin^2\left(\frac{\theta-\phi}{2}\right)}}\right|$$

$$\Rightarrow d = \frac{1}{\sqrt{2}\times\sqrt{2}}\left|\frac{\sin(\theta-\phi)}{\sin\left(\frac{\theta-\phi}{2}\right)}\right| = \frac{1}{2}\left|\frac{2\sin\left(\frac{\theta-\phi}{2}\right)\cos\left(\frac{\theta-\phi}{2}\right)}{\sin\left(\frac{\theta-\phi}{2}\right)}\right|$$

$$\Rightarrow d = \cos\left(\frac{\theta-\phi}{2}\right)$$

Hence, the required distance is $\cos\left(\frac{\theta-\phi}{2}\right)$.

Q36.Prove that $2\sin^2\beta + 4\cos(\alpha+\beta)\sin\alpha\sin\beta + 2\cos(\alpha+\beta) = \cos 2\alpha$

$\cos 2(\alpha+\beta) = 2\cos^2(\alpha+\beta) - 1,\ 2\sin^2\beta = 1 - \cos 2\beta$

L.H.S.

$= -\cos 2\beta + 2\cos(\alpha+\beta)[2\sin\alpha\sin\beta + \cos(\alpha+\beta)]$

$= -\cos 2\beta + 2\cos(\alpha+\beta)\cos(\alpha+\beta)$

$= -\cos 2\beta + (\cos 2\alpha + \cos 2\beta) = \cos 2\alpha.$

Or

Prove that $\cos A\cos 2A\cos 4A\cos 8A = \frac{\sin 16A}{16\sin A}$

LHS=(2sinAcosAcos2Acos4Acos8A)/2sinA

=(2×sin2Acos2Acos4Acos8A)/2x 2sinA

=(2×sin4Acos4Acos8A)/2x4sinA

=(2×sin8Acos8A)/2x8sinA

=(sin16A)/16sinA =RHS

Q37. Find the values of a and b if $\lim\limits_{x\to 2} f(x)$ **and** $\lim\limits_{x\to 4} f(x)$**exists where**

$$f(x) = \begin{cases} x^2 + ax + b, 0 \le x < 2 \\ 3x + 2, 2 \le x \le 4 \\ 2ax + 5b, 4 < x < 8 \end{cases}$$

Given,

$$f(x) = \begin{cases} x^2 + as + b & ,0 \le x < 2 \\ 3x + 2, & ,2 \le x \le 4 \\ 2ax + 5b & ,4 < x \le 8 \end{cases}$$

To find $\lim\limits_{x\to 2} f(x)$

L.H.L

$= \lim\limits_{x\to 2^-} f(x)$

$= \lim\limits_{x\to 2^-} (x^2 + ax + b)$

$= 2^2 + a\cdot 2 + b$

$= 2a + b + 4$

R.H.L

$= \lim\limits_{x \to 2^+} f(x)$

$= \lim\limits_{x \to 2^+} (3x + 2)$

= 3 · 2 + 2 = 8

Since $\lim\limits_{x \to 2} f(x)$ **exists,**

$\therefore \lim\limits_{x \to 2^-} f(x) = \lim\limits_{x \to 2^+} f(x)$

⇒ 2a + b + 4 = 8

⇒ 2a + b = 4 **... (1)**

L.H.L

$= \lim\limits_{x \to 4^-} f(x)$

$= \lim\limits_{x \to 4^-} (3x + 2)$

= 3 · 4 + 2 = 14

R.H.L

$= \lim\limits_{x \to 4^+} f(x)$

$= \lim\limits_{x \to 4^+} (2ax + 5b)$

= 2a. 4 + 5b

= 8a + 5b

Since $\lim\limits_{x \to 4} f(x)$ **exists.**

$\therefore \lim\limits_{x \to 4^-} f(x) = \lim\limits_{x \to 4^+} f(x)$

⇒ 8a + 5b = 14 **... (2)**

From (1) and (2), a = 3 and b = -2.

Q38. Calculate the mean, variance, and standard deviation for the following distribution

Class Interval	30-40	40-50	50-60	60-70	70-80	80-90	90-100
frequency	3	7	12	15	8	3	2

Step 1: Finding mean

30 − 40	3	$\frac{30+40}{2} = 35$	$35 \times 3 = 105$
40 − 50	7	$\frac{40+50}{2} = 45$	$45 \times 7 = 315$
50 − 60	12	$\frac{50+60}{2} = 55$	$55 \times 12 = 660$
60 − 70	15	$\frac{60+70}{2} = 65$	$65 \times 15 = 975$
70 − 80	8	$\frac{70+80}{2} = 75$	$75 \times 8 = 600$
80 − 90	3	$\frac{80+90}{2} = 85$	$85 \times 3 = 255$
90 − 100	2	$\frac{90+100}{2} = 95$	$95 \times 2 = 190$
	$\sum f_i = 50$		$\sum f_i x_i = 3100$

Mean $\bar{x} = \frac{\sum x_i f_i}{\sum f_i}$

$\Rightarrow \bar{x} = \frac{3100}{50}$

$\Rightarrow \bar{x} = 62$

Step 2: Finding variance and standard deviation

Frequency	Mid - point	$(x_i - \bar{x})^2$	$f_i(x_i - \bar{x})^2$
3	35	$(35-62)^2 = (27)^2 = 729$	$3 \times 729 = 2187$
7	45	$(45-62)^2 = (17)^2 = 289$	$7 \times 289 = 2023$
12	55	$(55-62)^2 = (7)^2 = 49$	$12 \times 49 = 588$
15	65	$(65-62)^2 = 3^2 = 9$	$15 \times 9 = 135$
8	75	$(75-62)^2 = (13)^2 = 169$	$8 \times 169 = 1352$
3	85	$(85-62)^2 = (23)^2 = 529$	$3 \times 529 = 1587$
2	95	$(95-62)^2 = (33)^2 = 1089$	$2 \times 1089 = 2178$
$\sum f_i = 50$		$\sum f_i(x_i - \bar{x})^2 = 10050$	

Variance $(\sigma^2) = \frac{1}{N}\sum f_i(x_i - \bar{x})^2$

$= \frac{1}{50} \times 10050 \quad [\because N = \sum f_i = 50]$

$= 201$

Standard deviation $(\sigma) = \sqrt{201} = 14.17$

hence, the mean is 62, variance is 201 and the standard deviation is 14.17

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