

MIXTURE AND ALLIGATION

Complete SSC CGL Mathematics Notes

Comprehensive Guide with Formulas & Examples • Created by GovtExamPrep

1. BASIC CONCEPTS OF MIXTURE AND ALLIGATION

Definitions and Terminology

Mixture: A combination of two or more ingredients mixed together.

Alligation: A rule that helps us to find the ratio in which two or more ingredients at given prices must be mixed to produce a mixture of desired price.

Key Terms:

- **Cost Price (C.P.):** Price of individual ingredients
- **Mean Price (M.P.):** Cost price of mixture
- **Alligation Rule:** Formula to find mixing ratio
- **Quantity:** Amount of each ingredient

Element	Description	Example
Cheaper Quantity	Ingredient with lower price	Rice @ ₹20/kg
Dearer Quantity	Ingredient with higher price	Rice @ ₹30/kg
Mean Price	Desired mixture price	Rice @ ₹25/kg
Alligation Rule	Finds mixing ratio	Cheaper : Dearer = 1:1

Fundamental Alligation Rule

Alligation Rule Formula:

$$\text{Quantity of Cheaper} / \text{Quantity of Dearer} = (\text{Price of Dearer} - \text{Mean Price}) / (\text{Mean Price} - \text{Price of Cheaper})$$

Graphical Representation:

$$\begin{array}{c} \text{Dearer Price} \text{ --- } (\text{Mean Price} - \text{Cheaper Price}) \\ \text{Mean Price} \\ \text{Cheaper Price} \text{ --- } (\text{Dearer Price} - \text{Mean Price}) \end{array}$$

Alligation Rule in Simple Terms:

$$(\text{Dearer} - \text{Mean}) : (\text{Mean} - \text{Cheaper}) = \text{Quantity of Cheaper} : \text{Quantity of Dearer}$$

2. BASIC ALLIGATION PROBLEMS

Two Ingredient Mixtures

Example 1: In what ratio must rice costing ₹20/kg be mixed with rice costing ₹30/kg to get mixture costing ₹25/kg?

Solution using Alligation Rule:

- Cheaper price = ₹20, Dearer price = ₹30, Mean price = ₹25
- Quantity of Cheaper / Quantity of Dearer = $(30-25)/(25-20) = 5/5 = 1/1$
- Ratio = **1:1**

Alligation Diagram:

₹30 --- $(25-20)=5$

₹25

₹20 --- $(30-25)=5$

Ratio = 5:5 = 1:1

Example 2: In what ratio must tea costing ₹240/kg be mixed with tea costing ₹300/kg to get mixture costing ₹270/kg?

Solution:

- Cheaper = ₹240, Dearer = ₹300, Mean = ₹270
- Cheaper/Dearer = $(300-270)/(270-240) = 30/30 = 1/1$
- Ratio = **1:1**

Finding Mean Price

Example: 5kg of rice @ ₹20/kg mixed with 10kg of rice @ ₹30/kg. Find cost price of mixture.

Solution:

- Total cost = $(5 \times 20) + (10 \times 30) = 100 + 300 = ₹400$
- Total quantity = $5 + 10 = 15\text{kg}$
- Mean price = $400/15 = ₹26.67/\text{kg}$

Example using Alligation: Find mean price when rice @ ₹20/kg and ₹30/kg mixed in ratio 2:3

Solution:

- Let mean price = x
- Using alligation: $2/3 = (30-x)/(x-20)$
- $2(x-20) = 3(30-x)$
- $2x - 40 = 90 - 3x$
- $5x = 130$
- $x = \text{₹26/kg}$

3. REPLACEMENT AND REMOVAL PROBLEMS

Mixture Replacement

Replacement Concept: When part of mixture is removed and replaced with another ingredient, the composition changes.

Example: 40 litres of milk and water mixture contains 25% water. How much milk should be replaced with water to make water 40%?

Solution:

- Initial water = 25% of 40 = 10 litres
- Let x litres of mixture be replaced
- Water removed = 25% of x = $0.25x$
- Water added = x litres
- Final water = $10 - 0.25x + x = 10 + 0.75x$
- Final water should be 40% of 40 = 16 litres
- $10 + 0.75x = 16$
- $0.75x = 6$
- $x = 8$ litres

Successive Replacement

Example: A container has 60 litres of milk. 6 litres replaced with water, then 6 litres of mixture replaced with water. Find milk quantity.

Solution:

- After first replacement: Milk = $60 \times (54/60) = 54$ litres
- After second replacement: Milk = $54 \times (54/60) = 48.6$ litres
- Formula: Final = Initial $\times (1 - r/n)^2$ where r=replaced, n=total
- Final milk = $60 \times (54/60)^2 = 60 \times (0.9)^2 = 60 \times 0.81 = 48.6$ litres

4. THREE INGREDIENT MIXTURES

Multiple Alligation

For Three Ingredients:

Use alligation twice - first between two ingredients, then with third.

Example: In what ratio must rice @ ₹10, ₹12, ₹15 per kg be mixed to get mixture @ ₹13 per kg?

Solution:

Step 1: Mix ₹10 and ₹12 to get ₹13

- $(12-13):(13-10) = (-1):3$ (not possible as negative)

Step 2: Mix ₹10 and ₹15 to get ₹13

- $(15-13):(13-10) = 2:3$

Step 3: Mix ₹12 and ₹15 to get ₹13

- $(15-13):(13-12) = 2:1$

Final: Use weighted average or trial

- Let quantities be a, b, c for ₹10, ₹12, ₹15 respectively
- $(10a + 12b + 15c)/(a+b+c) = 13$
- $10a + 12b + 15c = 13a + 13b + 13c$
- $3a + b = 2c$
- Try $a=1, b=1 \Rightarrow 3+1=2c \Rightarrow c=2$
- Ratio = **1:1:2**

5. PROFIT AND LOSS IN MIXTURES

Selling Price Calculations

Example: A shopkeeper mixes 20kg rice @ ₹15/kg with 30kg rice @ ₹20/kg and sells at ₹22/kg. Find profit percentage.

Solution:

- Cost price = $(20 \times 15) + (30 \times 20) = 300 + 600 = ₹900$
- Total quantity = $20 + 30 = 50\text{kg}$
- Selling price = $50 \times 22 = ₹1100$
- Profit = $1100 - 900 = ₹200$
- Profit % = $(200/900) \times 100 = \mathbf{22.22\%}$

Desired Profit Percentage

Example: In what ratio must tea @ ₹160/kg be mixed with tea @ ₹200/kg to gain 20% by selling @ ₹216/kg?

Solution:

- Selling price = ₹216, Profit = 20%
- Cost price = $216/1.20 = ₹180/\text{kg}$
- Now use alligation with mean price ₹180
- Cheaper/Dearer = $(200-180)/(180-160) = 20/20 = 1/1$
- Ratio = **1:1**

6. SSC CGL PRACTICE PROBLEMS

Previous Year Question Types

Problem 1: In what ratio must water be mixed with milk costing ₹15/litre to get mixture worth ₹10/litre?

Solution:

- Water cost = ₹0/litre, Milk cost = ₹15/litre, Mean = ₹10
- Water/Milk = $(15-10)/(10-0) = 5/10 = 1/2$
- Ratio = **1:2**

Problem 2: 40 litres of mixture contains 20% alcohol. How much alcohol to add to make it 50%?

Solution:

- Initial alcohol = 20% of 40 = 8 litres
- Let x litres alcohol added
- Final alcohol = 8 + x
- Total mixture = 40 + x
- $(8+x)/(40+x) = 50/100 = 1/2$
- $16 + 2x = 40 + x$
- $x = 24$ litres

Problem 3: Two varieties of rice costing ₹30/kg and ₹40/kg mixed in ratio 3:2. Find cost price of mixture.

Solution:

- Let quantities be 3kg and 2kg
- Total cost = $(3 \times 30) + (2 \times 40) = 90 + 80 = ₹170$
- Total quantity = 5kg
- Mean price = $170/5 = ₹34/\text{kg}$

Problem 4: A vessel has 60 litres milk. 12 litres taken out and replaced with water. Then 12 litres mixture taken out and replaced with water. Find

final milk.

Solution:

- Using formula: $\text{Final} = \text{Initial} \times (1 - r/n)^2$
- Final milk = $60 \times (1 - 12/60)^2 = 60 \times (0.8)^2$
- = $60 \times 0.64 = \mathbf{38.4 \text{ litres}}$

7. QUICK METHODS & SHORTCUTS

Memory Tips and Tricks

Alligation Rule Shortcut:

"Dearer minus Mean : Mean minus Cheaper"
= "Quantity of Cheaper : Quantity of Dearer"

Replacement Formula:

$$\text{Final} = \text{Initial} \times (1 - r/n)^n$$

Where r=replaced quantity, n=total quantity, n=number of operations

Water and Milk Problems:

- When adding water: Use alligation with water cost = 0
- When removing mixture: Use replacement formula
- For successive operations: Use power formula

Common Ratio Patterns

Situation	Ratio Pattern	Example
Equal mean from extremes	1:1	₹20 & ₹30 → ₹25
Mean closer to cheaper	More dearer	₹20 & ₹30 → ₹28 (1:4)
Mean closer to dearer	More cheaper	₹20 & ₹30 → ₹22 (4:1)
Water added	Water : Liquid = (C2-M): (M-C1)	Milk ₹15 → ₹10, Water: Milk=1:2

8. SSC CGL PREPARATION STRATEGY

Expected Marks Distribution

Topic	Frequency	Difficulty	Marks Weightage
Basic Alligation	High	Easy	1-2 marks
Replacement Problems	Medium	Medium	1-2 marks
Three Ingredients	Low	Hard	1 mark
Profit/Loss in Mixture	Medium	Medium	1-2 marks
Mixed Problems	High	Hard	2-3 marks

15-Day Study Plan

Week 1: Foundation Building

- Days 1-3: Basic alligation rule and two ingredient problems
- Days 4-5: Replacement and removal problems
- Days 6-7: Three ingredient mixtures

Week 2: Advanced Topics & Practice

- Days 8-9: Profit and loss in mixtures
- Days 10-11: Water and milk specific problems
- Days 12-13: Mixed and complex problems
- Days 14-15: Previous year papers and revision

Daily Practice Routine:

- 10 basic alligation problems
- 5 replacement problems
- 3 profit/loss mixture problems
- Learn all formulas and shortcuts

Exam Tips

Time Management:

- Basic alligation: 1-2 minutes
- Replacement problems: 2-3 minutes

- Three ingredients: 3-4 minutes
- Complex problems: 4-5 minutes

Common Mistakes to Avoid:

- Wrong application of alligation rule
- Incorrect mean price calculation
- Forgetting to consider total quantity
- Calculation errors in ratios

Mixture and Alligation - SSC CGL Master Notes

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