LF LearnFrenzy

QUANTITATIVE APTITUDE · FREE STUDY MATERIAL

Alligation or Mixture

Formulas & Shortcut Tricks

Every important formula, shortcut and exam trick for Alligation or Mixture in one place – with solved examples, common mistakes and a one-page revision sheet.

WHAT'S INSIDE

1. Topic introduction
2. Important formulas
3. Shortcut tricks & smart techniques
4. Solved examples
5. Important exam tips
6. Quick revision sheet
7. A message from LearnFrenzy

USEFUL FOR

- Bank PO & Clerk (IBPS, SBI, RBI)
- SSC CGL / CHSL
- Railways (RRB NTPC)
- Campus placements (TCS, Infosys, Wipro, Accenture)
- UPSC CSAT & state PSC exams

Practise **Alligation or Mixture** free on LearnFrenzy – questions with instant explanations →

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1 Topic introduction

What it is, why it matters and how it is asked

Alligation is a quick rule for finding the ratio in which two ingredients at different prices (or strengths) must be mixed to get a mixture at a given mean price. It is a shortcut for weighted averages.

Exams use it for grains, milk and water, acid solutions, alloys and even averages of marks, speeds and interest rates. Mixture questions also ask about adding or evaporating a liquid and about repeatedly drawing off part of a mixture and replacing it with water.

Why it matters in exams

- Bank papers ask 1–3 questions, often in a set.
- The same rule solves averages, profit and interest questions.
- Replacement questions have a one-line formula.

Where it is used

- Blending tea, coffee, grains and spices.
- Diluting chemicals and medicines.
- Making alloys and jewellery.

Common question patterns

Ratio of mixing
Cheaper : dearer for a mean price.

Mean price
Price of a mixture.

Mixing for profit
Find the cost price of the mixture first.

Adding or evaporating
Change a ratio or strength.

Replacement
Draw off and replace, n times.

Alloys and carats
Gold purity mixtures.

Mixtures of mixtures
Combine two mixed vessels.

Averages, speeds, interest
Alligation beyond mixtures.

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2 Important formulas

Cards marked MOST USED are the ones to revise first

Rule of alligation

Rule of alligation

MOST USED

Quantity of cheaper : quantity of dearer = (d − m) : (m − c)

Each side takes the difference from the other side.

c – cheaper price **d** – dearer price **m** – mean price

EXAMPLE Rice at ₹40 and ₹55 for a mean of ₹45 → 10 : 5 = **2 : 1**.

Mean price

MOST USED

$m = (c \cdot x + d \cdot y)/(x + y)$

A weighted average of the two prices.

EXAMPLE 3 kg at ₹40 and 2 kg at ₹55 → 230/5 = **₹46**.

Mixing for a profit

Mean cost price = selling price × 100/(100 + profit%); then alligate

Alligation works on cost prices, not selling prices.

EXAMPLE Sold at ₹60 with 20% profit → mean cost = **₹50**.

Solutions: adding and evaporating

Adding water

MOST USED

The amount of the other substance stays the same; only the total changes

Track the quantity that does not change.

EXAMPLE 40 L of 25% acid + 10 L water → 10/50 = **20%**.

Changing a ratio

Keep the unchanged part fixed and scale the other to the new ratio

Find each part in litres first.

EXAMPLE 40 L of milk : water 5 : 3 (25 : 15); for 1 : 1 add **10 L** water.

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Evaporation

Dissolved amount fixed → new total = dissolved ÷ new strength

Only water leaves.

EXAMPLE 30 L of 20% salt solution to 30% → salt 6 → total 20 → **10 L** evaporated.

Replacement and alligation beyond mixtures

Repeated replacement

MOST USED

Liquid left = $V\left(1 - x/V\right)^n$

Each draw removes the same fraction, not the same amount of milk.

V – volume of vessel **x** – amount drawn each time **n** – number of times

EXAMPLE 40 L milk, 4 L replaced twice → 40×0.9^2 = **32.4 L**.

Averages, interest and speeds

Any weighted average: the two “prices” are the two rates; the mean is the overall rate

For speeds, alligation gives the ratio of times.

EXAMPLE ₹10,000 at 8% and 12%, overall 9.2% → 2.8 : 1.2 = 7 : 3 → **₹7,000** at 8%.

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3 Shortcut tricks & smart techniques

Each trick says when to use it – that matters as much as the trick

The alligation cross

MOST USED

USE WHEN Two ingredients and a mean.

1. Write c and d on top, m in the middle.
2. Cross-subtract: under c write d – m, under d write m – c.

EXAMPLE 20% and 45% solutions for 30% → 15 : 10 = **3 : 2**.

Replacement as a fraction

MOST USED

USE WHEN Draw-and-replace questions.

Drawn each time	Left after 2	Left after 3
1/10	81/100	729/1000
1/5	16/25	64/125
1/4	9/16	27/64
1/2	1/4	1/8

EXAMPLE ¼ drawn 3 times → $(\frac{3}{4})^3$ = **27/64** left.

Water costs nothing

USE WHEN Milk or juice diluted with water and sold at cost price for a profit.

1. Water is an ingredient priced at ₹0.
2. Alligate water (₹0) with milk at its cost price.

EXAMPLE Milk ₹50/L, sold at ₹50 for 25% profit → cost 40 → water : milk = 10 : 40 = **1 : 4**.

Mixtures of mixtures

USE WHEN Two vessels with different ratios are combined.

1. Turn each ratio into a fraction of milk.
2. Average the fractions by the amounts taken.

EXAMPLE 3 : 1 and 5 : 3 in equal amounts → $(\frac{3}{4} + \frac{5}{8})/2 = 11/16$ → **11 : 5**.

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4 Solved examples

The full method on the left, the exam shortcut on the right

1 RATIO OF MIXING

In what ratio must tea at ₹120 per kg be mixed with tea at ₹160 per kg to get a mixture worth ₹135 per kg?

STEP BY STEP

1. Cheaper : dearer = (160 − 135) : (135 − 120).
2. = 25 : 15 = 5 : 3.

SHORTCUT

Cross-subtract.

Why it works: Trap: 3 : 5 – reversing the ratio.

Answer: 5 : 3

2 PROFIT

A grocer mixes sugar at ₹36 per kg with sugar at ₹48 per kg and sells the mixture at ₹49.50 per kg, making a 10% profit. In what ratio did he mix them?

STEP BY STEP

1. Mean cost = 49.50 × 100/110 = ₹45.
2. (48 − 45) : (45 − 36) = 3 : 9.
3. = 1 : 3.

SHORTCUT

Remove the profit first, then alligate.

Why it works: Trap: alligating with ₹49.50, the selling price.

Answer: 1 : 3

3 WATER AND PROFIT

A milkman buys milk at ₹60 per litre, adds water and sells the mixture at ₹60 per litre, gaining 20%. Find the ratio of water to milk.

STEP BY STEP

1. Cost of 1 L mixture = 60 × 100/120 = ₹50.
2. Water ₹0, milk ₹60: (60 − 50) : (50 − 0) = 10 : 50.
3. = 1 : 5.

SHORTCUT

Profit % = water : milk → 20% = 1 : 5.

Why it works: The profit comes only from the free water.

Answer: 1 : 5

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4 CHANGING A RATIO

60 litres of a mixture has milk and water in the ratio 7 : 3. How much water must be added to make the ratio 7 : 5?

STEP BY STEP

1. Milk 42 L, water 18 L.
2. For 7 : 5, water = 42 × 5/7 = 30 L.
3. Add 30 − 18 = 12 L.

SHORTCUT

Milk stays 42 → 6 per part → water 3 → 5 parts: +2 parts = 12 L.

Why it works: Trap: 20 L – the final water, not the water added.

Answer: 12 litres

5 DRYING

Fresh grapes contain 90% water and dry grapes 20% water. How many kilograms of dry grapes are obtained from 50 kg of fresh grapes?

STEP BY STEP

1. Pulp in fresh grapes = 10% of 50 = 5 kg.
2. In dry grapes pulp is 80%.
3. Dry grapes = 5 ÷ 0.8 = 6.25 kg.

SHORTCUT

50 × 10/80.

Why it works: Only water is lost; the pulp is unchanged.

Answer: 6.25 kg

6 REPLACEMENT

A vessel holds 80 litres of pure milk. 8 litres are taken out and replaced with water. This is done three times in all. How much milk is left?

STEP BY STEP

1. Each time 1/10 of the liquid is removed.
2. Milk left = $80 \times (9/10)^3$.
3. = 80 × 0.729 = 58.32 L.

SHORTCUT

$V(1 - x/V)^n$.

Why it works: Trap: 56 L – taking away 8 L of milk each time.

Answer: 58.32 litres

7 FIND THE AMOUNT DRAWN

From 50 litres of pure wine, x litres are drawn and replaced with water, twice. Wine and water are now in the ratio 16 : 9. Find x.

STEP BY STEP

1. Wine left = 16/25 of 50.
2. $(1 - x/50)^2 = 16/25 \rightarrow 1 - x/50 = 4/5$.
3. x = 10.

SHORTCUT

$\sqrt{(16/25)} = 4/5 \rightarrow 1/5$ drawn each time.

Why it works: The fraction left is the square of the fraction kept each time.

Answer: 10 litres

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8 ALLOY

In what ratio must 14-carat gold be mixed with 22-carat gold to get 20-carat gold?

STEP BY STEP

1. (22 – 20) : (20 – 14).
2. = 2 : 6 = 1 : 3.

SHORTCUT

Carats work like prices.

Why it works: Purity is the "price" here.

Answer: 1 : 3

9 INTEREST

₹12,000 is lent partly at 6% and the rest at 10% simple interest. The total interest for a year is ₹1,000. How much was lent at 6%?

STEP BY STEP

1. Overall rate = 1,000/12,000 = 8⅓%.
2. (10 – 8⅓) : (8⅓ – 6) = 5/3 : 7/3 = 5 : 7.
3. At 6% = 5/12 × 12,000 = ₹5,000.

SHORTCUT

0.06a + 0.10(12,000 – a) = 1,000 → a = 5,000.

Why it works: Rates are alligated like prices.

Answer: ₹5,000

10 SPEEDS

A car travels 300 km in 5 hours, partly at 50 km/h and partly at 70 km/h. How far did it travel at 50 km/h?

STEP BY STEP

1. Average speed = 60 km/h.
2. Time ratio = (70 – 60) : (60 – 50) = 1 : 1 → 2.5 h each.
3. Distance at 50 km/h = 125 km.

SHORTCUT

Alligation on speeds gives times.

Why it works: Trap: 150 km – applying the time ratio to distances.

Answer: 125 km

11 MIXTURES OF MIXTURES

Vessel A has milk and water in the ratio 3 : 1 and vessel B in the ratio 5 : 3. Equal quantities are mixed. Find the new ratio of milk to water.

STEP BY STEP

1. Milk in A = 3/4, in B = 5/8.
2. Equal amounts → milk = (6/8 + 5/8)/2 = 11/16.
3. Milk : water = 11 : 5.

SHORTCUT

Make both out of 8 parts: 6 + 5 milk, 2 + 3 water.

Why it works: Trap: 8 : 4 – adding the ratio terms directly.

Answer: 11 : 5

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5 Important exam tips

Patterns, traps and habits that save marks

Frequently asked question patterns

- Ratio of mixing for a mean price.
- Mixing for a profit.
- Water and milk with profit.
- Adding liquid to change a ratio.
- Evaporation and drying.
- Repeated replacement.
- Alligation on interest and speeds.

Common mistakes to avoid

- Reversing the alligation ratio.
- Alligating selling prices instead of cost prices.
- Taking the simple average of two prices.
- Subtracting the same amount of milk at every draw.
- Applying a time ratio to distances.
- Giving the final quantity instead of the amount added.

Points to remember

- c : d = (d − m) : (m − c).
- Mean = weighted average.
- Left = $V(1 - x/V)^n$.
- Water costs ₹0.
- Speeds → ratio of times.

Speed and accuracy

- Draw the alligation cross.
- Track the part that does not change.
- Use fractions for replacement.
- Give two mixtures a common total of parts.

Preparation strategy

- Learn the cross until it is automatic.
- Practise on LearnFrenzy in order: Easy → Medium → Hard → Exam Pattern Mix → Data Sufficiency.
- Aim for 40–50 seconds per question.
- Use alligation as a check in average and profit questions.
- Read the Quick Revision Sheet (next page) the night before the exam.

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6 Quick revision sheet

Everything on one page for the night before the exam

Formulas

Alligation	**c : d = (d − m) : (m − c)**	Mean price	**(cx + dy)/(x + y)**
For profit	**mean CP = SP × 100/(100 + P%)**	Adding water	**other part fixed**
Evaporation	**new total = dissolved ÷ new %**	Replacement	**V(1 − x/V)ⁿ**
Water and profit	**water : milk = profit %**	Speeds	**alligation → time ratio**
Interest	**alligate the rates**		

Shortcut tricks

- Cross-subtract.
- Water = ₹0.
- ¼ drawn 3 times → 27/64 left.
- Mixtures: common parts.
- Remove profit before alligating.
- Carats behave like prices.

Must-know numbers

Powers	$0.9^2 = 0.81 \cdot 0.9^3 = 0.729 \cdot 0.8^2 = 0.64 \cdot 0.8^3 = 0.512 \cdot 0.75^2 = 0.5625$
Percent	$1/6 = 16\frac{2}{3}\% \cdot 1/8 = 12.5\% \cdot 1/5 = 20\% \cdot 1/4 = 25\%$

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7 A message from LearnFrenzy

For everyone preparing for placements, competitive and government exams

Keep going – you are closer than you think

Success in examinations is not just about how many hours you study. It is about how effectively you understand concepts, practise questions, and improve yourself every day.

Every formula you learn, every problem you solve, and every mistake you correct brings you one step closer to your goal.

Whether you are preparing for campus placements, competitive examinations, or government jobs, remember that consistency, confidence, and smart preparation make a real difference.

Don’t just memorize formulas. Understand the concepts, practise smart techniques, and develop the confidence to solve problems independently.

Your hard work today can create the opportunities you dream of tomorrow.

— Team LearnFrenzy

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