Mixture and Alligation

QUANTITATIVE APTITUDE

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Mixture and Alligation

In this chapter we are going to learn a concept called Mixture and Alligation, which is used to solve various types of mixture problems.

Mixture of two things

In these type of questions we make a mixture of two things.

Q. A vessel contains a mixture of P and Q in the ratio of 5 : 3. 16 liters of this mixture is taken out and 5 liters of P is poured in. The new mixture has ratio of P to Q as 11 : 6. Find the total original quantity of mixture.

A. Detailed Solution:

P = 5x, Q = 3x

The quantity of P and Q in 16 liters of the mixture:

Quantity of P = (16 × 5x)/8x = 10

Quantity of Q = (16 × 3x)/8x = 6

Now, 5 liters of P poured in and then ratio becomes 11 : 6

(5x - 10 + 5) / (3x - 6) = 11/6

(5x - 5) / (3x - 6) = 11/6

Therefore, x = 12

So total mixture originally = 8x = 8 × 12 = 96 liters

⚡Testbook Trick

For the above question, this is the shorter way to analyse the problem statement:

Total original quantity of mixture = 80 + 16 = 96 liters

Q. The ratio of milk and water in a solution is 20 : 7 and after adding 5 liters of water in it the ratio of milk and water becomes 5 : 3, then find the final amount of water in the final solution.

A. Let the initial amount of milk be 20x and of water 7x.

Ratio of milk and water after adding 5 litres = 20x/ (7x + 5) = 5/3

⇒ 60x = 35x + 25

⇒ 25x = 25

⇒ x = 1.

∴ Final amount of water in solution = 7x + 5 = 7 + 5 = 12 litres.

Smart approach

Initial ratio of milk and water = 20/7   ---(1)

Final ratio of milk and water = 5/3   ---(2)

Multiplying equation 2 with 4 (to make amount of milk equal), we get

Final ratio of milk and water = 20/12   ---(3)

∴ Amount of water in final solution = 12 litres.

When two mixtures are mixed to form a new mixture

Q. Two vessels of equal capacity contain juice and water in the ratio of 7 : 2 and 11 : 7 respectively. The mixture of both the vessels is mixed and transferred into a bigger vessel. What is the ratio of juice and water in the new mixture?

A. Detailed Solution:

The ratio of juice and water in the first vessel = 7 : 2   ---(1)

Total capacity of first vessel = 7 + 2 = 9 units

The ratio of juice and water in the second vessel = 11 : 7   ---(2)

Total capacity of second vessel = 11 + 7 = 18 units

We will have to equal the total capacity of both vessels, so multiply by 2 in equation (1).

The ratio of juice and water in the first vessel = 14 : 4   ---(3)

The ratio of juice and water in the second vessel = 11 : 7   ---(4)

Ratio of juice and water in bigger vessel = (14 + 11) : (4 + 7) = 25 : 11

⚡ Testbook Trick

For the above question, this is the shorter way to analyse the problem statement:

```
                    Juice  :  Water
1ˢᵗ vessel ────▶  7   :    2
                          └──▶ 9×2
2ⁿᵈ vessel ────▶  11  :    7
                          └──▶ 18
                            ⇓
1ˢᵗ vessel ────▶  14  :    4
2ⁿᵈ vessel ────▶  11  :    7
Bigger vessel      25  :    11
```
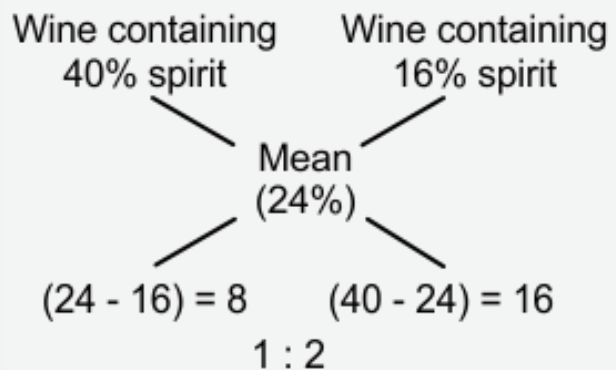
Q. A butler stole wine from a butt of Rony which contained 40% of spirit and he replaced what he had stolen by wine containing only 16% spirit. The butt was then 24% strength only. How much of the butt did he steal?

A. Part of 40% of spirit which is use to make 24% spirit = 1/3

Part of 16% of spirit which is use to make 24% spirit = 1 - 1/3 = 2/3

Since 16% of spirit is replaced by the butler after stealing 40% of spirit.

∴ Part of 40% of spirit which is stolen by the Butler = 2/3

```
Wine containing          Wine containing
  40% spirit               16% spirit

            Mean
            (24%)

(24 - 16) = 8      (40 - 24) = 16
            1 : 2
```

Selling of Mixtures

In these type of questions we make a mixture of two things and sell the resultant mixture.

Q. A shopkeeper mixed low-quality vegetable oil costing Rs. 40 per litre with sunflower refined oil costing Rs. 80 per litre in the ratio of 2 : 3 respectively. If he sold the mixture at Rs. 100 per litre, find his profit percentage.

A. Solution:

Let the total quantity of the mixture be 10 ltr.

10 litres of mixture contains,

$\Rightarrow$ (2/5) × 10 = 4 litres of low quality vegetable oil

$\Rightarrow$ (3/5) × 10 = 6 litres of sunflower refined oil

The cost price of 10 litres mixture = 4 × 40 + 6 × 80 = 160 + 480 = Rs. 640

The cost price of 1 litre mixture = 640/10 = Rs. 64

Profit earned = 100 − 64 = Rs. 36

∴ Profit percentage = (36/64) × 100 = 56.25%

Alternate Solution:
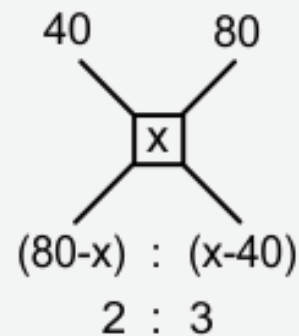
Let the cost price of the mixture be Rs. x per litre.

$\Rightarrow$ (80 - x) / (x - 40) = 2/3

$\Rightarrow$ 240 - 3x = 2x - 80

$\Rightarrow$ x = Rs. 64 per litre.
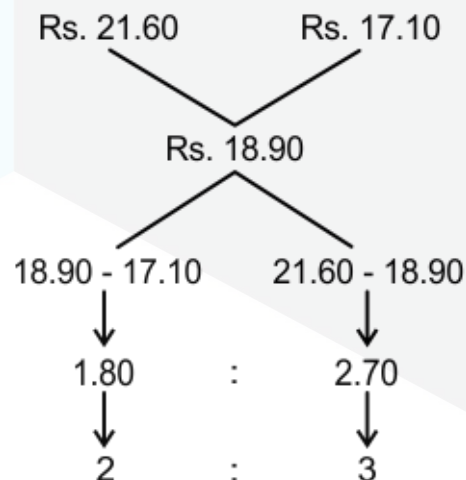
The selling price of the mixture = Rs. 100 per litre.

∴ Profit percentage = {(100 - 64) / 64} × 100 = 56.25%

$$40 \qquad 80$$
$$\boxed{x}$$
$$(80\text{-}x) : (x\text{-}40)$$
$$2 : 3$$

Q. In what ratio must wheat costing Rs. 21.60 per kg be mixed with wheat costing Rs. 17.10 per kg such that it produces a mixture worth Rs. 18.90?

A. By Mixture and Allegation Method:

Required ratio = 2 : 3

Rs. 21.60   Rs. 17.10

Rs. 18.90

18.90 - 17.10   21.60 - 18.90

1.80   :   2.70

2   :   3

Miscellaneous Questions

Q. A bucket contains 64 liters of petrol. 16 liters of petrol is removed and replaced with kerosene. 16 liters of this mixture is removed and replaced with kerosene. How much kerosene (in liters) is present now?

A. We know the formula:

$X = A(1 - R/C)^n$

Here X = Liquid remaining after replacement

A = Total quantity of liquid before replacement

R = Quantity of replaced liquid

C = Total Capacity

n = No. of times the liquid was replaced

$\Rightarrow$ A = 64, R = 16, C = 64 and n = 2

Putting these values in the formula,

$\Rightarrow X = 64 \times (1 - 1/4)^2$

$\Rightarrow X = 64 \times 9/16$

$\Rightarrow X = 36$ liters

$\Rightarrow$ Amount of petrol present after replacement = 36 liters

$\therefore$ Amount of kerosene present after replacement = 64 – 36 = 28 liters

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Q. A vessel is full of Petrol. 1/4th of the Petrol is taken out and replaced with kerosene oil. If the process is repeated 3 more time, 81 litres of Petrol is finally left in the vessel. Find the capacity of vessel.

A. We know the formula,

[Petrol left/Total capacity] = $[1 - 1/4]^4$

Since 81 litres of Petrol is finally left in the vessel

$\Rightarrow$ 81/Total capacity = 81/256

$\therefore$ Total capacity = 256 L

Q. 8L Cold drink was added to a 20L mixture of water and alcohol such that the ratio of alcohol to that of cold drink and water is 1 : 3. Find the amount of alcohol in the solution.

A. Detailed solution:

We have a 20L mixture of alcohol and water.

$\Rightarrow$ A + W = 20   ---- (1)

Let the cold drink be denoted by C

According to question, A : (W + C) = 1 : 3

$\Rightarrow$ A/ (W + 8) = 1/3

$\Rightarrow$ 3A = W + 8

$\Rightarrow$ W = 3A – 8   ----(2)

From (1) and (2)

$\Rightarrow$ 4A = 28

$\Rightarrow$ A = 7

Hence 7L of alcohol is present in the mixture.

Short trick:

Alcohol : (Cold drink + Water) = 1 : 3

$\therefore$ Amount of Alcohol = 1/4 × 28 = 7 L

Q. Rice worth Rs. 128 per kg and Rs. 130 per kg are mixed with third variety in ratio 1 : 1 : 3. If the mixture is worth Rs. 138 per kg find the price of third variety per kg.

A. Since the two varieties are mixed in equal proportion

So, their average price = (128 + 130) /2 = Rs. 129 per kg

Now, let the variety 3 to be mixed worth Rs. X per kg in ratio 2 : 3 .

Cost of
(1st two kinds)
Rs. 129

Cost of
(3rd variety)
Rs. x

Rs. 138
(Mean Price)

(x-138)

9
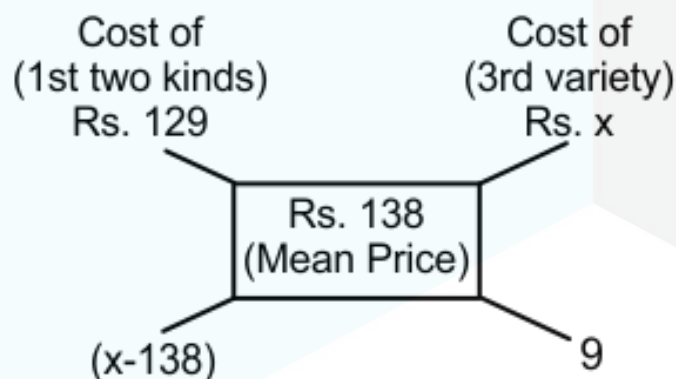
By using alligation,

Given, $\dfrac{x-138}{9} = \dfrac{2}{3}$

Or, x = Rs. 144 per kg

Topper's approach:

Let the price of the third variety be x.

According to the question,

128 × 1 + 130 × 1 + 3x = 138 × (1 + 1 + 3)

$\Rightarrow$ x = Rs. 144

Q. **The average marks obtained in an examination by two groups of students were found to be 45 and 70. If average marks of all the students were 60, then the ratio of the number of students in two groups is:**

A. Using Alligation method:

Group (First)   Group (second)

       45   70

                  60

       10   :   15

Required ratio of the first group to the second group = 10 : 15 = 2 : 3