4 Mixtures and Alligations

Introduction

The questions on mixtures and alligation are repeatedly tested in CAT, XAT and other management exams. One can expect one or two questions from this topic. Generally, the questions are not asked directly from these concepts, but the application of mixtures and alligation can be utilised to solve difficult problems in a simple way. One must consider the concepts of mixtures and alligation as a tool to ease the problem solving.

Weighted Average and its relation with the structure of alligation:

When two groups of items are combined together, then we can talk about the average of the entire group. This average of the entire group is called weighted average. The weighted average is simply the more generalized form of average.

Let us understand weightage average and its linkage to alligation:

Let the average of group 1 be 'A' and the number of people in group 1 be x and the average of group 2 be 'B' and the number of people in group 2 be y.

Here, we make an assumption that the average of group 2 is more than the average of group 1, i.e., B > A.

The weighted average is given by

$$\Rightarrow \quad Aw = \frac{Ax + By}{x + y}$$

By cross multiplication we get,

$\Rightarrow$ $x \times Aw + y \times Aw = Ax + By$

$\Rightarrow$ $x \times Aw - Ax = By - y \times Aw$

$\Rightarrow$ $x(Aw - A) = y(B - Aw)$

$$\Rightarrow \quad \frac{x}{y} = \frac{B - Aw}{Aw - A}$$

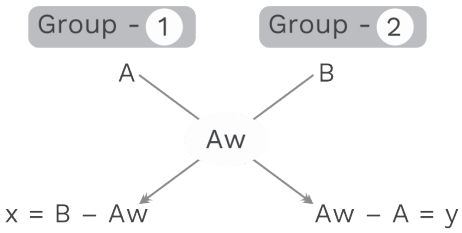
[Known as Alligation equation]

Key Points

The structure of alligation can be used to find the ratio of the weights associated with two groups.

Note: Weighted average (Aw) of the two groups lies between A and B, i.e., $A \leq Aw \leq B$.

Diagrammatically this can be represented as below:



Note: Here A and B are the averages and x and y are the weights associated with A and B respectively.

Let us see how can we ease the calculation while dealing with the structure of alligation.

If x = mp and y = np

If there is any common factor among 'x' and 'y', then let's see the final outcome associated with this.

$$Aw = \left(\frac{A \times x + B \times y}{x + y}\right) = \left(\frac{A \times mp + B \times np}{mp + np}\right)$$

$$\Rightarrow \left(\frac{p(A \times m + B \times n)}{p(m + n)}\right)$$

$$\Rightarrow \left(\frac{Am + Bn}{m + n}\right)$$

As one can see that ultimately the common factor among x and y gets cancelled so we can utilize this concept to make the calculation faster.

Let us understand a basic example to ease our calculation based on the above learning.

For Example:

If the average weight of class A of 24 students is 25 kg and that of class B of 36 students is 30 kg. Find the average of both the classes when combined.

A = 25 kg, B = 30 kg, x = 24 students and

y = 36 students.

x : y = 24 : 36 = 2 : 3

$$Aw = \left(\frac{A \times x + B \times y}{x + y}\right)$$

$$\Rightarrow \frac{25 \times 2 + 30 \times 3}{2 + 3}$$

$$\Rightarrow \frac{140}{5} = 28$$

Example 1:

The average weight of girls in a class is 10 kg and the average weight of boys of the same class is 20 kg. The average weight of the whole class is 15 kg. If the number of boys are 20, then the number of girls are:

(A) 5 (B) 10

(C) 15 (D) 20

Solution: (D)

By using weighted average: $Aw = \frac{Ax + By}{x + y}$

Where,

Aw = Weighted Average = 15

A = Average Weight of girls = 10

B = Average Weight of boys = 20

x = Number of girls = a

y = Number of boys = 20

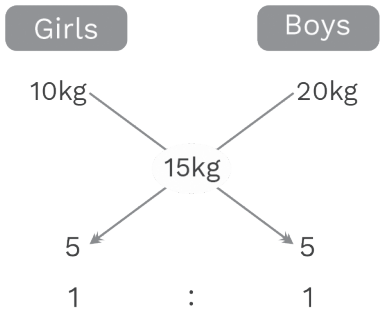
$$\Rightarrow 15 = \frac{10 \times a + 20 \times 20}{a + 20}$$

$$\Rightarrow 15a + 300 = 10a + 400$$

$$\Rightarrow 5a = 100$$

$$a = 20$$

Number of girls = 20



$$\frac{\text{Number of girls}}{\text{Number of boys}} = \frac{1}{1}$$

$$\frac{a}{20} = 1 \quad \Rightarrow a = 20$$

Example 2:

If 20 kg of rice costing Rs. 16/kg is mixed with 16 kg of the second variety of rice costing Rs. 25/kg, then what is the average cost per kg of the resulting mixture?

Solution: 20/kg

By using weighted average.

$$Aw = \frac{Ax + By}{x + y}$$

Where,

A = Cost of first variety rice = 16/kg

B = Cost of second variety rice = 25/kg

x = Quantity of first variety rice = 20 kg

y = Quantity of second variety rice = 16 kg

$$Aw = \frac{16 \times 20 + 25 \times 16}{20 + 16}$$

$$Aw \Rightarrow \frac{320 + 400}{36}$$

$$Aw \Rightarrow \frac{720}{36}$$

Aw = Rs. 20/kg

Alternate Solution:

By using the Alligation equation $\frac{x}{y} = \frac{B - Aw}{Aw - A}$

$$\Rightarrow \frac{20}{16} = \frac{25 - Aw}{Aw - 16}$$

$$20\ Aw - 320 = 400 - 16\ Aw$$

$$36\ Aw = 720$$

$$Aw = \frac{720}{36}$$

Aw = 20/kg

Alligation

Alligation is a method or a rule for the solution of problems concerning the compounding or mixing of ingredients differing in price or quality. Recently we have learned the association of weightage average with respect to alligation.

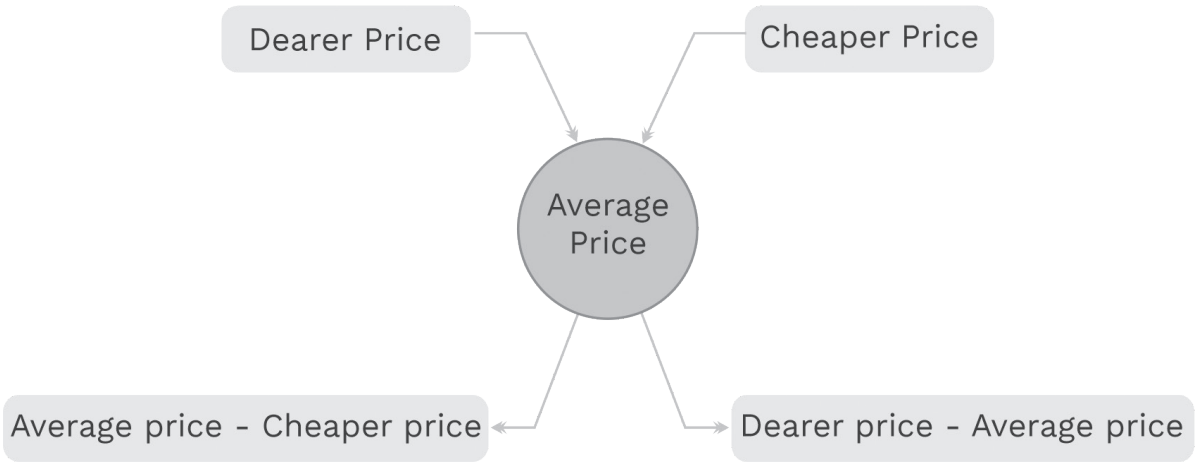
This rule connects quantities and prices in a mixture.

$$\frac{x}{y} = \frac{B - Aw}{Aw - A}$$ [structure of Alligation]

The representation of the structure of Alligation as follows:

$$\frac{\text{Quantity of cheaper}}{\text{Quantity of Dearer}} = \frac{\text{Dearer price} - \text{Average price}}{\text{Average price} - \text{Cheaper price}}$$

Pictorially this can be represented as below,



Lets understand how the alligation can be applied using some examples:

Example 3:

How many kilograms of coffee costing Rs. 20/kg must be mixed with 20 kg of coffee costing Rs. 15/kg, so that the resulting mixture cost Rs. 18/kg?

Solution: 30 kg

By using the rule of Alligation,

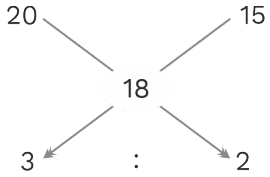
$$\frac{\text{Quantity of cheaper}}{\text{Quantity of Dearer}} = \frac{\text{Dearer price} - \text{Average price}}{\text{Average price} - \text{Cheaper price}}$$

$$\frac{20}{x} = \frac{20-18}{18-15}$$

$\therefore \quad x = 30$ kg

Alternate Solution:

"By using the rule of alligation".



The ratio of the quantity of Dearer to the quantity of Cheaper = 3 : 2

Rack Your Brain

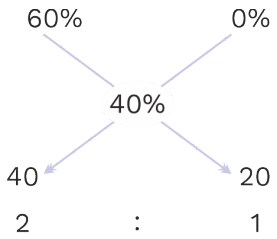
Two solution of acid (Acid + Water) with concentration of 70% and 80% respectively are mixed in a certain ratio to get a 64% acid solution. This solution is mixed with 10L of water to get back 50% acid solution. How much of the 80% solution has been used in the entire process?

Example 4:

There is a 100-litre solution of milk and water in which milk forms 60%. How much water must be added to this solution to make it a solution in which milk forms 40%?

Solution: 50 litres

We will apply the alligation rule here, taking 60% concentration solution (of milk) mixed with a 0% concentration solution of pure water (100% water) to give 40% concentration solution.



Let the quantity of water added be x units

The ratio of the quantity of initial solution to the quantity of water = 2 : 1

$$\frac{100}{x} = \frac{2}{1} \Rightarrow x = 50 \text{ litres}$$

Application of Alligation

Alligation and its application are extensively applied in solving the problem of ratio-proportion, S.I - C.I., Profit-Loss, Time-Speed-Distance and some miscellaneous topics as well.

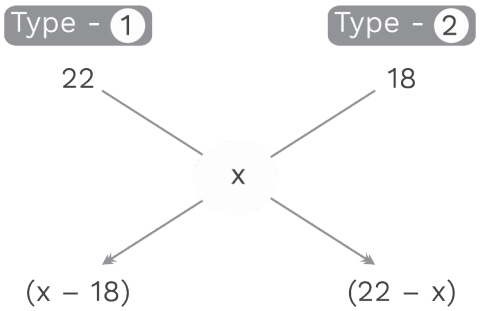
1. Alligation in Ratio

Example 5:

The cost of type 1 rice is Rs. 22 per kg and type 2 rice is Rs. 18 per kg. If both type 1 and type 2 are mixed in the ratio of 3 : 1, then the price (in Rs.) per kg of the mixed variety of rice is?

Solution: 21

Let the average price per kg be ₹x.



Ratio of quantities of Type 1 and Type 2 = 3 : 1

$$\frac{x-18}{22-x}=\frac{3}{1}$$

$\Rightarrow$ x – 18 = 66 – 3x

$\Rightarrow$ 4x = 84

$\Rightarrow$ x = 21

Average price = Rs. 21 per kg.

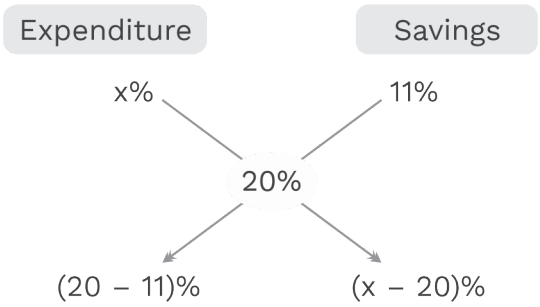
Example 6:

The ratio of expenditure and savings is 9 : 11. If the income increases by 20% and the savings increase by 11%, then by how much percent does the expenditure increase?

Solution: 31%

Let the % increase in expenditure is x%

By using the rule of alligation.



The ratio of expenditure and saving = 9 : 11.

So, $\frac{9\%}{(x-20)\%}=\frac{9}{11}$

$\therefore$ x = 31 %

Previous Years' Question

There are two drums, each containing a mixture of paints A and B. In drum 1, A and B are in the ratio 18 : 7. The mixtures from drum 1 and 2 are mixed in the ratio 3 : 4 and in this final mixture, A and B are in the ratio 13 : 7. In drum 2, then 'A' and 'B' were in the ratio?

(A) 239 : 161 (B) 251 : 166

(C) 273 : 167 (D) 239 : 157

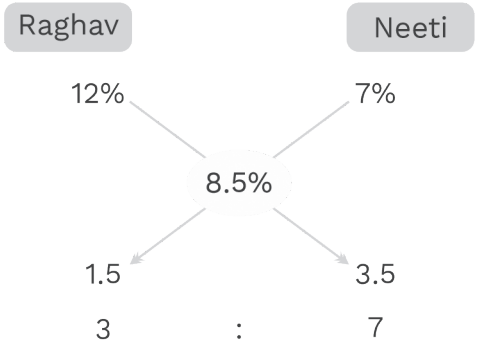
2. Alligation in Compound Interest and Simple Interest

Example 7:

Ashwani lent a certain sum of money to Raghav at 12% p.a. S.I. and lent the remaining amount to Neeti at 7% p.a. S.I. overall he gets the interest of 8.5% p.a. Find the amount of money Ashwani lent to Raghav, if Ashwani has a total of Rs. 50,000.

Solution: Rs. 15,000

By using the rule of Alligation



The ratio of the amount lent to Raghav and Neeti = (3 : 7).

Let the amount lent to Raghav and Neeti be 3K and 7K respectively, then

3K + 7K = 50000

K = 5,000

Amount lent to Raghav = 3K

$\Rightarrow$ 3 × 5000

$\Rightarrow$ Rs. 15,000

3. Alligation in Profit and Loss

Example 8:

Anil sold 40% of the book at a profit of 40% and 60% of the book at 20% profit. Find the average profit percent, if Anil sells only these two kinds of books.

Solution: 28%

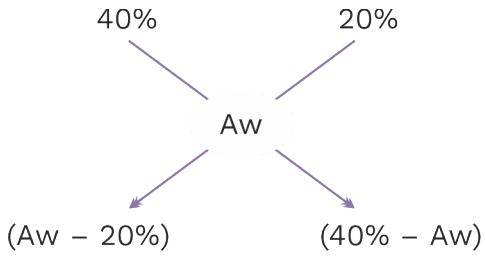
The ratio of the number of books sold at 40% profit and 20% profit is:

$\Rightarrow$ 40% : 60%

$\Rightarrow$ 2 : 3

Let Aw be the average profit percentage.

By using the rule of Alligation.



$$\frac{Aw - 20\%}{40\% - Aw} = \frac{2}{3}$$

3Aw – 60% = 80% – 2Aw

5Aw = 140%

Aw = 28%

Previous Years' Question

Two alcohol solutions 'A' and 'B' are mixed in proportions 1 : 3 by volume. The volume of the mixture is then doubled by adding solution 'A' such that the resulting mixture has 72% alcohol. If solution 'A' has 60% alcohol, then the percentage of alcohol in solution 'B' is?

(A) 92% (B) 83%

(C) 62% (D) 74%

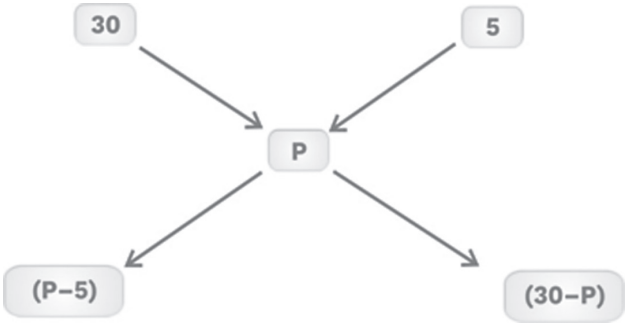
Example 9:

Simba purchased a table for ₹13,000 and sold it at 30% profit. He again purchased a chair at ₹4,000 and sold it at 5% profit, then find the overall profit percent earned by him.

Solution: 24.12%

Let overall profit percent earned = P%

By using the rule of alligation we get,



$$\Rightarrow \frac{13000}{4000} = \frac{P - 5}{30 - P}$$

$\Rightarrow$ 17P = 410

$\Rightarrow$ P = 24.12%

4. Alligation in Time , Speed and Distance

Example 10:

Keerti usually takes 10 hours to ride from Agra to New Delhi. One day her car had a technical issue at Greater Noida, so she has to stop for 20 minutes to resolve the issue. After that, she increases her speed by 25% and reaches New Delhi 20 minutes before her scheduled time. What is the ratio of the distance between Agra to Greater Noida to Greater Noida to New Delhi?

Solution: 2 : 1

25% means = $\frac{1}{4}$ (increase of 1 unit over 4 unit).

Let the usual speed = 4x

Increased speed = 5x

Total distance = speed × time = 4x × 10 = 40x

Time is taken by Keerti if she travels the whole distance at increased speed

$$\text{Time} = \frac{\text{distance}}{\text{speed}} = \frac{40x}{5x} = 8 \text{ hours}$$

Now, the average time is taken by her to cover the whole distance

Rack Your Brain

A solution of volume 40 litre, has dye and water in the proportion 2 : 3. Water is added to the solution to change this proportion to 2 : 5. If one-fourth of this diluted solution is taken out, how many litres of dye must be added to the remaining solution to bring the proportion back to 2 : 3?

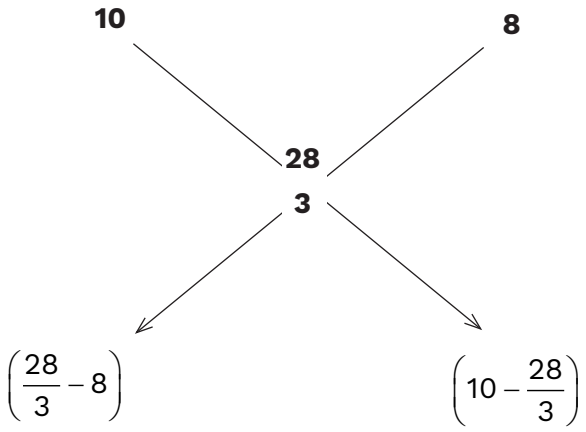
(A) 8 litres (B) 6 litres

(C) 7.5 litres (D) 9 litres

= 10 hours + 40 min

$= 9 + \frac{1}{3} = \frac{28}{3}$ hours

By using the rule of alligation we get,



$$\frac{\text{Distance from agra to Greater Noida}}{\text{Distance from Greater Noida to New delhi}}$$

$$= \frac{\frac{28}{3} - 8}{10 - \frac{28}{3}}$$

$$= \frac{\frac{4}{3}}{\frac{2}{3}} = \frac{4}{2}$$

Hence, the required ratio will be

4 : 2 or 2 : 1

5. Alligation in Compound Mixtures

Example 11:

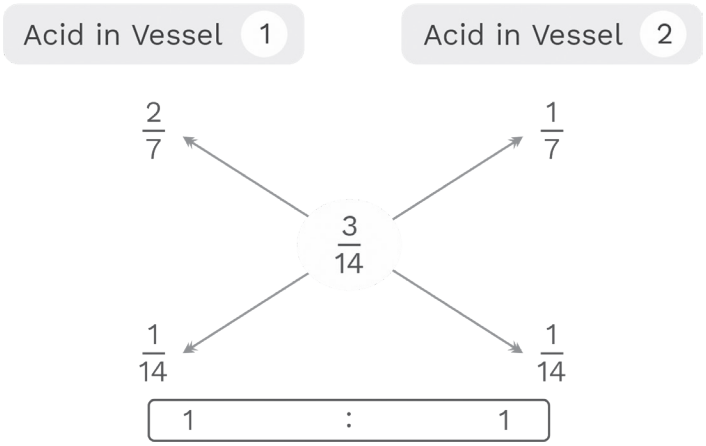
In a vessel, the ratio of acid and water is 2 : 5. In another vessel, the ratio of water and acid is 6 : 1. In what ratio the contents from both vessels should be mixed, so that the ratio of acid and water becomes 3 : 11?

(A) 3 : 2 (B) 1 : 1

(C) 4 : 3 (D) 5 : 2

Solution: (B)

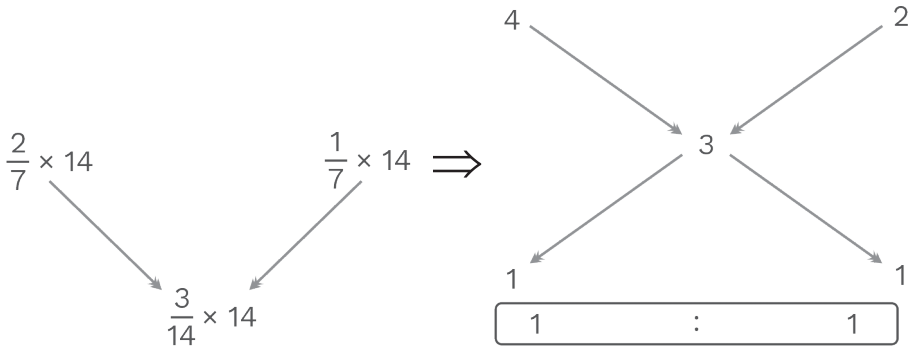
We can solve such a by applying the method of alligation either on acid or on water



TIP:

As the fraction involved are $\frac{2}{7}, \frac{1}{7}, \frac{3}{14}$

To get rid of fraction, take the L.C.M of (7, 7, 14) = 14



Mixture

When two or more than two pure substances/mixtures are mixed, then a mixture is formed.

When two items of different concentrations are mixed, the concentration of the resultant mixture lies in between the concentrations of the other two.

Type of Mixture:

There are two types of mixtures:

1. **Simple Mixture:** When two or more than two different things are mixed together, a simple mixture is formed.
2. **Compound Mixture:** When two or more than two simple mixtures are mixed together, a compound mixture is formed.

Mixing without Replacement

In this type of mixing, two or more than two substances are mixed without any part of any mixture being replaced.

Let's understand this concept with the help of some examples.

Example 12:

In a mixture of 600 litres, the ratio of milk and water is 7 : 8 respectively. Now, 120 litres

of water is added to the mixture. What is the ratio of milk and water in the final mixture?

Solution: 7 : 11

Let the volume of milk and water in the solution be 7K and 8K.

$15K = 600$

$K = 40$

Volume of milk = 7 × 40 = 280 litres

Volume of water = 8 × 40 = 320 litres

When 120 L of water is added.

Volume of water = 320 + 120 = 440 litres

Hence, the ratio of milk and water

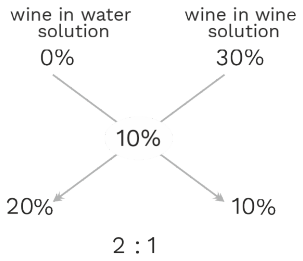
= 280 : 440 = 7 : 11

Example 13:

How many litres of water should be mixed with 50 litres of 30% wine solution so that the resultant solution is a 10% wine solution?

Solution: x = 100 litres

By using the rule of Alligation with respect to wine,



$$\frac{\text{Volume of solution of 30\% wine}}{\text{Volume of solution of water}} = \frac{1}{2}$$

$$\frac{50}{x} = \frac{1}{2}$$

x = 100 litres

100 litres of water added to make the resultant solution, 10% wine solution.

Alternate Solution: (Rule of Constant)

When the quantity of one element in the mixture does not change while adding another element to the first mixture.

15 litres = 30% of first solution = 10% of the new solution

10% of the new solution = 15 litres

The total quantity of new solution

$$= \frac{15}{10\%} \times 100\% = 150 \text{ litres}$$

Quantity of fresh water added

= 150 – 50 = 100 litres

Mixing with Replacement

It is a type of mixing when two substances are mixed by replacing some part of a mixture. In this type of mixing total volume may or may not be the same.

In this type of mixing, three types of questions can be asked.

Type 1:

In this case, the quantity withdrawn and quantity replaced are of the same volume and this process can be repeated 'n' times.

Suppose from 'V' litres of pure milk (or any pure thing), 'A' litres of milk is replaced by A litres of water, then the volume of the milk in the final solution after 'n' such operation is given by, $V' = V\left[1 - \frac{A}{V}\right]^n$

Example 14:

A person has 90 litres of pure alcohol solution and 9 litres of alcohol is replaced with 9 litres of water. This operation is performed two more times. Find the quantity of alcohol left.

Solution: 65.61 litres

Here, initial volume V = 90 litres

Volume of alcohol replaced by water A = 9 litres

n = 3 times

$$V' = 90 \times \left[1 - \frac{9}{90}\right]^3$$

$$V' = 90 \times \frac{729}{1000} \qquad V' \Rightarrow 65.61 \text{ litres}$$

Rack Your Brain

Two glass P and Q were partially filled with water. 70% of the water in P was transferred to Q. After that, 50% of the water in Q was transferred to P. At this stage, the volume of water in glass P and Q are in the ratio of 5 : 3. Find the ratio of the initial volume of water in P and Q.

Type 2:

In this case, the quantity withdrawn and the quantity replaced are of the same volume, but the withdrawn quantity and replace quantity may vary subsequently.

Suppose from 'V' litres of pure milk (or any liquid), 'A' litres of pure milk is replaced by A litres of water, again 'B' litres of mixture is replaced by 'B' litres of water and so on.

The final volume of milk is given by,

$$V' = V\left(1 - \frac{A}{V}\right)\left(1 - \frac{B}{V}\right)\left(1 - \frac{C}{V}\right)\ldots$$

Example 15:

A milkman has 90 litres of milk and 9 litres of milk is taken out and replaced by 9 litres of water. Again, 10 litres of mixture is taken out and replaced by 10 litres of water. Find the volume of milk in the final solution.

Solution: 72 litres

Here, V = 90 litres; A = 9 litres; B = 10 litres

$$V' = V\left(1 - \frac{A}{V}\right)\left(1 - \frac{B}{V}\right)$$

$$V' = 90 \times \frac{9}{10} \times \frac{8}{9}$$

$$V' = 72 \text{ litres}$$

Previous Years' Question

Each of 3 vessels A, B, C contains 500 ml of salt solution of strengths 10%, 22% and 32% respectively. Now, 100 ml of the solution in vessel 'A' is transferred to vessel 'B'. Then 100 ml of the solution in vessel 'B' is transferred to vessel 'C'. Finally, 100 ml of the solution in vessel 'C' is transferred to vessel 'A'. The strength, in percentage of the resulting solution in vessel 'A' is.

(A) 14% (B) 12%

(C) 86% (D) 72%

Rack Your Brain

A sample of 'a' litres from a tank having 60 litres mixture of alcohol and water containing alcohol and water in the ratio of 2 : 3 is replaced with pure alcohol, so that the tank will have alcohol and water in equal proportion. What is the value of a?

Type 3:

In this case, the quantity withdrawn and the quantity replaced are not of the same volume.

Let's understand this concept with examples.

Some Miscellaneous Examples

Example 16:

8 litres of alcohol solution contains 60% alcohol. 3 litres of water is added to this solution. What is the percentage of alcohol in the new solution?

Solution: 43.63%

The volume of alcohol in a solution

$= 8 \times \frac{60}{100} = 4.8$ litres

The volume of water in a solution = 8 – 4.8

$\Rightarrow$ 3.2 litres

3 litres of water added to this solution

Volume of water in a new solution = 3.2 + 3

$\Rightarrow$ 6.2 litres

Total volume of a new solution

= 8 + 3 = 11 litres

% of alcohol in a solution

$= \frac{4.8}{11} \times 100 = 43.63\%$

Example 17:

The wine and water in a mixture are in the ratio of 5 : 7 respectively. If 44 litres of water is added to it, then the ratio of wine and water in the new mixture becomes 2 : 5. What is the total quantity (in litres) of the wine in the new mixture?

Solution: 40 litres

Here, the quantity of wine in the mixture remains constant. So, the value of the quantity of wine in both the ratio must be same.

	Wine	**:**	**Water**
Before	5	:	7) × 2
After	2	:	5) × 5

Multiply first ratio by (2) and second by (5) we get,

Wine	**:**	**Water**
10	:	14
10	:	25

Amount of water poured = 44 litres

25K – 14K = 44

K = 4

Quantity of wine

$\Rightarrow$ 10K $\Rightarrow$ 10 × 4 = 40 litres

Rack Your Brain

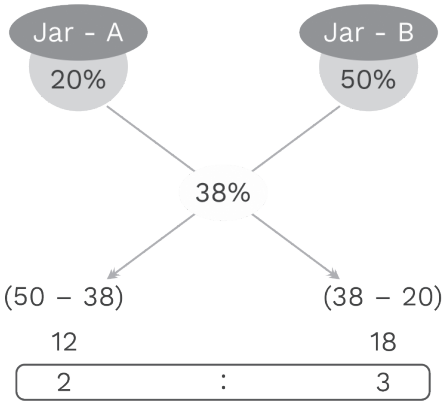
There is 40 litres of milk in the container four litres of milk is taken out and replaced with 5L of water. After this 6L of mixture is replaced with 7 litres of water and finally 8 litres of mixture is replaced with 9 litres of water. How much of the milk is there in the vessel now?

Example 18:

Jar A contains 20% acid and Jar B contains 50% acid. In what ratio should Jar A be mixed with Jar B to obtain a mixture of 38% acid?

Solution: 2 : 3

By using rule of alligation with respect to acid.



Hence, Jar A and Jar B must be mixed in the ratio of 2 : 3.

Example 19:

Sharad Chand has 50 litres of alcohol in a cask. He drinks 5 litres of alcohol and replaced it with 5 litres of water. He performed this operation 2 more times. Find the amount of alcohol left after third operation.

Solution: 36.45 litres

Traditional Method:

Initially, there are 50 litres of alcohol, and 5 litres of alcohol is replaced with 5 litres of water.

Now, there will be 45 litres of alcohol and 5 litres of water.

The quantity of Alcohol and water being withdrawn here will be in the ratio of

(45 : 5) = 9 : 1

So, the quantity of alcohol withdrawn

$= \frac{9}{10} \times 5 = 4.5$ litres

So, the volume of alcohol

= 45 – 4.5 = 40.5 litres

And the volume of water = 5 + 4.5 = 9.5 litres

Now, again 5 litres of mixture is replaced with 5 litres of water.

The quantity of Alcohol and water being withdrawn here will be in the ratio of

(40.5 : 9.5) = 81 : 19.

The quantity of alcohol withdrawn

$$= \frac{81}{100} \times 5 \Rightarrow 4.05 \text{ litres}$$

The volume of alcohol

$$= 40.5 - 4.05 = 36.45 \text{ litres}$$

Alternate Solution:

Formula Based:

The initial volume of Alcohol V = 50 litres

Replaced volume A = 5 litres

Number of times operation performed

(n) = 3

The volume of alcohol left = V′

$$V' = V \times \left(1 - \frac{A}{V}\right)^n$$

$$V' = 50 \times \left(1 - \frac{5}{50}\right)^3$$

$\Rightarrow$ 36.45 litres

Previous Years' Question

The strength of salt solution is P% if 100 ml of the solution contains 'P' grams of salt. If 3 salt solutions A, B, C are mixed in the proportion 1 : 2 : 3, then the resulting solution has strength 20%. If instead the proportion is 3 : 2 : 1., then the resulting solution has strength 30%. A fourth solution, D, is produced by mixing B and C in the ratio 2 : 7. The ratio of the strength of 'D' to that of 'A' is:

(A) 1 : 2 (B) 1 : 3

(C) 1 : 4 (D) 1 : 5

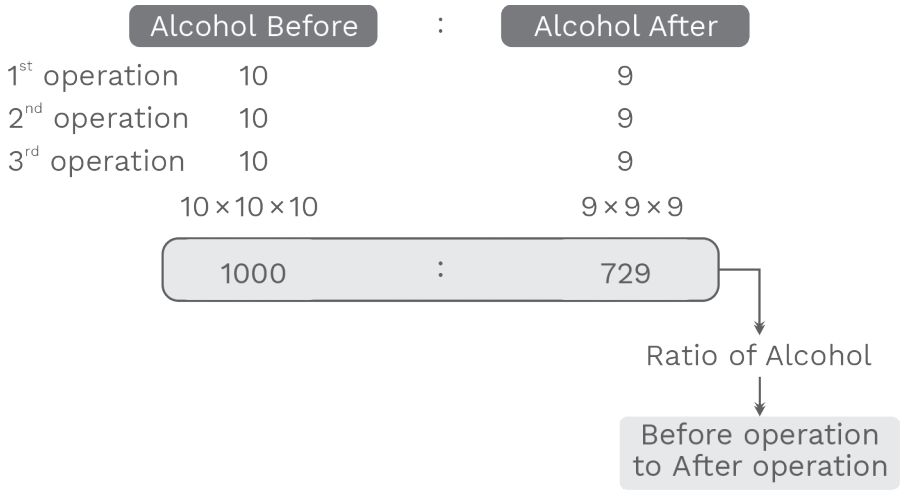
Alternate Solution:

Percentage Change Method:

% of alcohol withdrawn

$$= \frac{5}{50} \times 100 \Rightarrow 10\% \text{ (each time)}$$

10% decrement means decrement of 1 over 10.



$$\frac{\text{Alcohol before operation}}{\text{Alcohol after operation}} = \frac{1000}{729}$$

$$\frac{50}{x} = \frac{1000}{729}$$

$\Rightarrow$ x = 36.45 litres

Example 20:

When 12 litres of water is added to the vessel having milk and water in the ratio of 2 : 3, the ratio changes to 4 : 7. Find the new volume of the water in the vessel if 22 litres of solution is removed from the same vessel.

(A) 63 (B) 56

(C) 70 (D) 84

Solution: (C)

Let the initial milk and water in the vessel be 2x and 3x

So, when 12 litre water is added

$\frac{2x}{(3x+12)} = \frac{4}{7}$; Solving it we get x = 24

So, new volume of the water in the vessel now is (3x + 12)

= 3 × 24 + 12 = 84 litres

So, now when 22 litres solution is removed, the solution will be removed in the ratio of 4 : 7.

Water removed = $\frac{7}{11} \times 22 = 14$ litre

So, new volume of water = 84 – 14 = 70 litre

Alternate Solution:

M : W

(2 : 3)×2

OR

Milk is same $\begin{cases} 4 : 6 \\ 4 : 7 \end{cases}$ Water is increasing by 1 part

1 part = 12 litres

7 part = 84 litres (after adding water)

22 litres mixture is removed

Water quantity removed = $\frac{7}{11} \times 22 = 14$ litres

New volume of water = 84 – 14 = 70 litres

Practice Exercise – 1

Level of Difficulty – 1

1. A mixture of 100 litres of Mango juice and water contains 15% water. How many litres of water should be added to the mixture, so that the mixture contains 25% water?

(A) 15 litres

(B) 13.33 litres

(C) 14 litres

(D) 12 litres

2. A Juice seller claim to sell Juice at a cost price, still he is making a profit of 37.5%, since he has mixed some amount of water in the Juice. What is the percentage of Juice in the mixture?

(A) 62.5%

(B) 66.66%

(C) 72.72%

(D) 87.5%

3. Two solutions of hydrochloric acid are mixed in the ratio of 1 : 9. The concentration of hydrochloric acid in the first and second solutions are 10% and 20% respectively. What is the concentration of hydrochloric acid in the resulting solution?

(A) 19%

(B) 17%

(C) 18%

(D) 20%

4. The Milk and Water in two vessels A and B are in the ratio of 6 : 7 and 11 : 2 respectively. In what ratio the liquid in both the vessels be mixed to obtain a new mixture in vessels C consisting of half Milk and half Water?

(A) 9 : 1

(B) 7 : 3

(C) 15 : 8

(D) 8 : 5

5. If a woman buys 1 litres of vinegar for Rs. 12, mixes it with 300ml water and sells it for Rs. 15, then what is her profit percentage?

(A) 26%

(B) 27%

(C) 25%

(D) 22%

Level of Difficulty – 2

6. Raghav bought 3 kg grapes. The ratio of water to pulp was 3 : 2. When his mother crushed these grapes, then some amount of water gets wasted. Now, the ratio of water is to pulp is 1 : 4. What is the quantity of crushed grapes?

(A) 1.5 kg

(B) 2.5 kg

(C) 2.75 kg

(D) 1.75 kg

7. Two chocolate powders costing Rs. 300/kg and Rs. 180/kg were blended in different ratios to get chocolate blends P and Q. P and Q were mixed in the ratio 1 : 1 to form blend R. R was sold at a price of Rs. 294/kg at 20% profit. If P costs Rs. 210/kg. Find the ratio in which the two powders were mixed to form Q.

(A) 5 : 2
(B) 5 : 1
(C) 5 : 4
(D) 5 : 7

8. Two alloys are made up of gold and silver. The ratio of gold and silver in the first alloy is 1 : 4 and in the second alloy, it is 2 : 3. In what ratio the two alloys should be mixed to obtain a new alloy in which the ratio of silver and gold be 9 : 5?
(A) 4 : 11
(B) 3 : 9
(C) 3 : 11
(D) 3 : 15

9. In two alloys, the ratio of silver and tin is 5 : 7 and 9 : 4. How many kilograms of the first alloy and the second alloys, respectively, should be melted together to obtained 1333 kg of a new alloy with equal silver and tin?
(A) 900 kg and 433 kg
(B) 910 kg and 423 kg
(C) 920 kg and 413 kg
(D) 930 kg and 403 kg

10. Two varieties of rice are mixed in the ratio 2 : 3. The cost price of each kg of the first variety of rice is Rs. 5 more than the cost price of each kg of the second variety of rice. The mixture is sold at 20% profit at Rs. 30/kg. Find the CP of the first variety in Rs./kg
(A) Rs. 28.5/kg
(B) Rs. 28.75/kg
(C) Rs. 28/kg
(D) Rs. 20/kg

Level of Difficulty – 3

11. Dye and Urea are two fertilizers. Dye is consists of N, P and K and Urea consists of only N and P. A mixture of Dye and Urea is prepared in which the ratio of N, P and K is 27%, 65% and 8% respectively. The ratio of N, P and K in Dye is 30%, 55% and 15% respectively. What is the ratio of N and P in the Urea?
(A) 33 : 107
(B) 33 : 105
(C) 34 : 107
(D) 33 : 109

12. There is 120 litres of Gastrol and 180 litres of Mastrol oil. The price of Gastrol is Rs. 90/litre and price of Mastrol is Rs. 70/litre. Equal amount of Gastrol and Mastrol is taken out and poured in Mastrol and Gastrol respectively. Now, the price of both the mixture becomes the same. What is the amount of oil taken out form each vessel?
(A) 90 litres
(B) 84 litres
(C) 80 litres
(D) 72 litres

13. Milk and water are mixed in the ratio 7 : 4 to form a solution. From the solution, 22 litres is taken out and 4ℓ of water is added in the solution, which result in ratio of milk and water in the final mixture as 12 : 7. Find the quantity of milk (in litres) in the initial solution.
(A) 320
(B) 334
(C) 350
(D) 360

14. There are three vessels filled to their capacities with a mixture of water and alcohol in the ratio of 3 : 5, 5 : 9 and 7 : 11 respectively. These are all poured into a big vessel. What proportion of the mixture in the big vessels should be replaced by water, so that the alcohol forms 50% of the resulting mixture?

(A) 193 : 947

(B) 191 : 947

(C) 189 : 947

(D) 185 : 947

15. Shubham sits for a drink and adds 20ml water to 60 of alcohol in a glass. He takes a sip of 4ml of the resulting mixture and finds it bitter in taste. He then adds 8ml of water more to the same mixture and still finds it bitter after taking a sip of 28ml. He adds 20 ml of water more and finally gets a perfect peg. Find the ratio of alcohol and water in the resulting mixture peg.

(A) 1 : 1

(B) 1 : 2

(C) 2 : 1

(D) 3 : 4

Solutions

1. (B)

Method 1:

Traditional Method = (Rule of constant)

Quantity of fruit juice in the mixture

$= 100 - \left(100 \times \frac{15}{100}\right) = 85$ Litres

After adding water, Juice would form 75% of the mixture.

75% of mixture = 85

1% of mixture $= \frac{85}{75}$

100% of mixture

$\Rightarrow \frac{85}{75} \times 100$

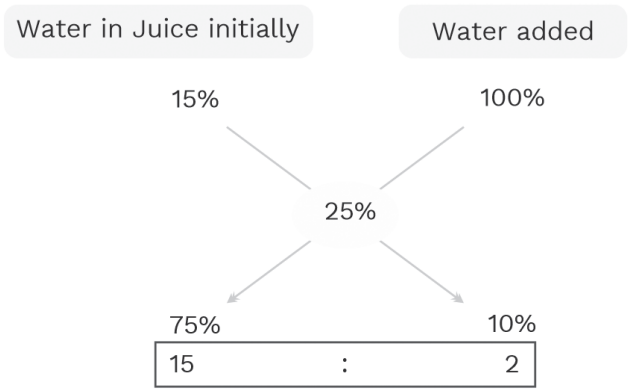
$\Rightarrow$ 113.33 litres

Quantity of water added = 113.33 – 100 = 13.33 litres

Method 2:

By rule of alligation

On applying the rule of alligation with respect to water.



Quantity of mixture : Water added = 15 : 2

$\frac{100}{\text{Water added}} = \frac{15}{2}$

Water added = 13.33 litres

2. (C)

Let the Juice he bought is 1000 ml.

Let C.P. of 1000 ml is Rs. 100

Juice seller sells the mixture of Juice and water at CP.

So, we can conclude that he sells the water, which is freely available at the price of milk.

So, the overall profit the Juice seller gains because of the amount of water he mixed.

37.5% profit in fraction = $\frac{3}{8}\begin{matrix}\rightarrow \text{WATER}\\ \rightarrow \text{JUICE}\end{matrix}$

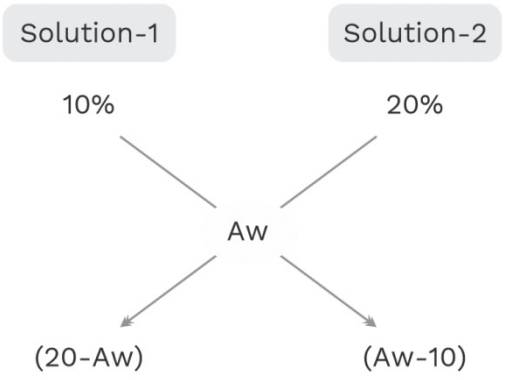
Juice	:	Water
8	:	3

Percentage of Juice = $\frac{8}{11} \times 100 = 72.72\%$

3. (A)

By using the rule of alligation with respect to hydrochloric acid.

Let the average percentage of hydrochloric acid in the solution is Aw.



Given that,

Quantity of solution 1 : Quantity of solution 2 = 1 : 9.

$\frac{20 - Aw}{Aw - 10} = \frac{1}{9}$

180 – 9Aw = Aw – 10

10 Aw = 190

Aw = 19%

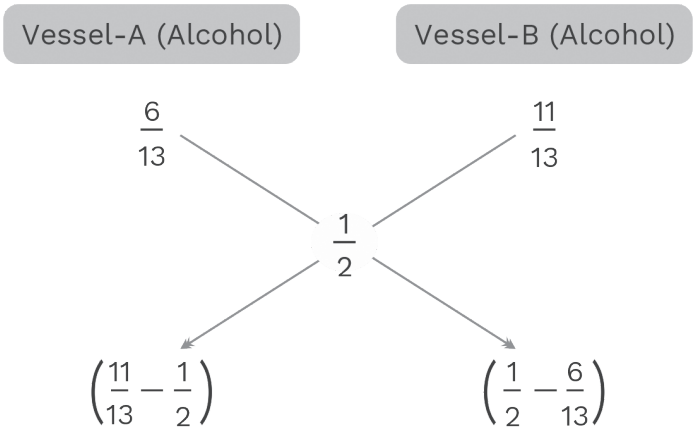
4. (A)

Concentration of Milk in mixture A = $\frac{6}{13}$

Concentration of Milk in mixture B = $\frac{11}{13}$

Concentration of Milk in resultant mixture = $\frac{1}{2}$

By using rule of allegation with respect to Milk.



The required ratio of the quantity of vessel A and vessel B.

Vessel A : Vessel B = $\frac{9}{26} : \frac{1}{26} = 9 : 1$

5. (C)

Here, it is not directly given but we can conclude from the statement that she sells whole quantity of vinegar for Rs. 15.

CP of vinegar = Rs. 12

SP of vinegar = Rs. 15

Profit = SP – CP = Rs. 3

Profit% = $\frac{\text{Profit}}{\text{CP}} \times 100 = \frac{3}{12} \times 100 = 25\%$

6. (A)

	Water	Pulp
Initial	3x	2x
Final	y	4y

But 2x = 4y since the quantity of pulp remains the same.

	Water	Pulp
Initial	6y	4y
Final	y	4y

Given that initially, Raghav bought 3 kg grapes.

6y + 4y = 3 kg

y = $\frac{3}{10}$kg

Final amount of crushed grapes = y + 4y

= 5y = 5 × $\frac{3}{10}$kg = 1.5 kg

7. (B)

(Traditional Method)

Let the two blends be mixed in the ratio of x : y.

Let Q's cost be q Rs/kg.

Given R was sold at 20% profit at 294/kg

CP of R = $\frac{294}{1.2}$

CP of R = 245/kg

P and Q mixed in 1 : 1

Weighted Average $\Rightarrow \frac{210\times1+1\times q}{2} = 245$

210 + q = 490

q = 280/kg.

Now, again using weighted average among two types of powder with respect to Q we get,

$\text{WeightedAverage} = \frac{300\times x+180\times y}{x+y} = 280$

300x + 180y = 280x + 280y

20x = 100y

$\frac{x}{y} = \frac{5}{1}$

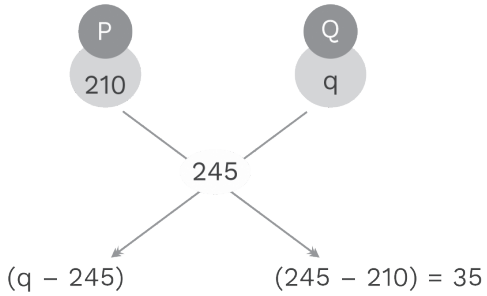
Two blends were mixed in the ratio of 5 : 1 to produce 'Q'.

Alternate Method:

CP of

R = $\frac{294}{1.2} = \text{Rs. } 245/\text{kg}$ $(\because 20\%\ \text{profit})$

By using Alligation in P, Q, R.



$\frac{\text{Quantity of P}}{\text{Quantity of Q}} = \frac{1}{1}$

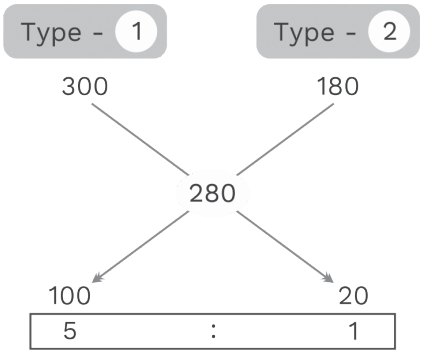
$\frac{q-245}{35} = \frac{1}{1}$

q – 245 = 35

q = 280/kg

CP of 'Q' = 280 Rs/kg.

Now, again using alligation among two types of powder with respect to Q.



The two blends were mixed in 5 : 1 to produced Q.

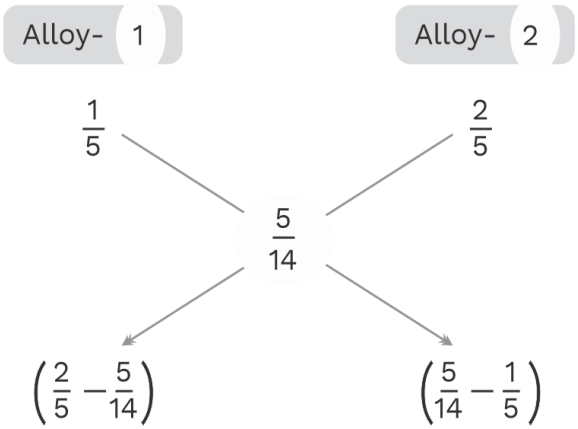
8. (C)

Concentration of gold in alloy 1 = $\frac{1}{5}$

Concentration of gold in alloy 2 = $\frac{2}{5}$

Concentration of gold in final alloy = $\frac{5}{14}$

By using alligation with respect to gold.



The ratio of the quantity of Alloy 1 : Alloy 2 = $\frac{3}{70} : \frac{11}{70} \Rightarrow 3 : 11$

Hence, the two alloys must be mixed in the ratio of 3 : 11

9. (D)

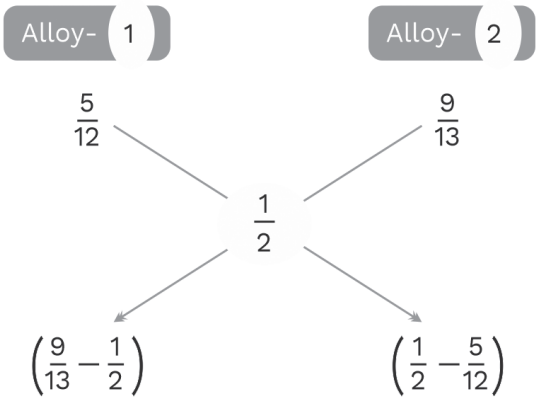
Let x and y kg of the first alloy and the second alloy are taken.

The concentration of silver is Alloy 1 = $\frac{5}{12}$

The concentration of silver is Alloy 2 = $\frac{9}{13}$

The concentration of silver in final Alloy = $\frac{1}{2}$

By using the rule of alligation.



$\frac{x}{y} = \frac{5/26}{1/12}$

x : y = 30 : 13

Amount of Alloy 1 in mixture

$= \frac{30}{43} \times 1333 = 930\,kg$

Amount of Alloy 2 in mixture

$= \frac{13}{43} \times 1333 = 403\,kg$

(930 kg, 403 kg)

10. (C)

Let the quantities of two varieties of rice be 2x and 3x kg respectively.

Let the CP of the second variety of rice be Rs. y/kg.

So, CP of the first variety of rice

= (y + 5)/kg

CP of the 1 kg mixture = $\frac{2x \times (y+5) + 3x \times y}{2x + 3x}$

$= \frac{2xy + 10x + 3xy}{5x} = (y + 2).$

CP of 1 kg of mixture

$= \frac{30}{1.2} = 25 / kg$ (∵ 20% profit)

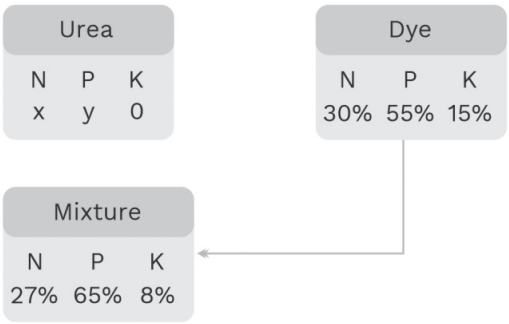
y + 2 = 25

y = 23

CP of first variety of rice

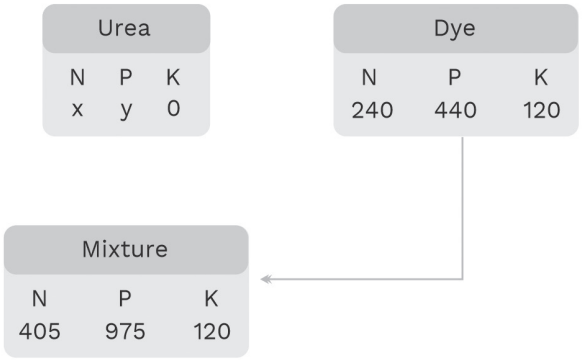
= y + 5 = 23 + 5 = Rs. 28/kg

11. (A)



This 8% of K is obtained only from Dye.

To make the concentration of k the same in both Dye and Mixture, multiply the quantity of Dye by 8 and mixture by 15 we get,



∴ Urea + Dye = Mixture

$N_{Urea} + N_{Dye} = N_{Mixture}$

x + 240 = 405

x = 165

Similarly, $P_{Urea} + P_{Dye} = P_{Mixture}$

$y + 440 = 975$

$y = 535$

Ratio of N : P in urea = 165 : 535

33 : 107

12. (D)

Traditional Method:

Let the amount of oil withdrawal be x.

Gastrol = 120 litre at Rs. 90/litres

Mastrol = 180 litre at Rs. 70/litres

After withdrawal and pouring.

Gastrol	Mastrol
(120 – x)	x
Mastrol	**Gastrol**
(180 – x)	x

Price of Gastrol = Price of Mastrol.

$$\frac{(120-x)\times 90 + x\times 70}{120} = \frac{(180-x)\times 70 + x\times 90}{180}$$

$$\frac{10,800 - 90x + 70x}{2} = \frac{12,600 - 70x + 90x}{3}$$

$$\Rightarrow (10,800 - 20x)\times 3 = 2\times(12,600 + 20x)$$

$$\Rightarrow 32,400 - 60x = 25,200 + 40x$$

$\Rightarrow$ 100x = 7,200

$\Rightarrow$ x = 72

Hence, 72 of oil was taken out from the vessel.

13. (C)

Since the mixture of milk and water is a homogeneous mixture, therefore ratio will remain same if we withdraw some solution from it.

This implies, after removal of 22 litres solution,

Ratio of milk and water = 7 : 4

Now, m : w $\xrightarrow{\text{water added}}$ m : w

7 : 4 12 : 7

We can solve this by making same value of milk as it quantity is not changing.

Therefore, m : w $\xrightarrow{+4\text{l water}}$ m : w

84 : 48 84 : 49

+1 part of water

Now, 1 part of water = 4ℓ.

$\therefore$ total solution (84 + 48 parts)

= 132 parts = 132 × 4 = 528ℓ.

total solution before removal (in starting)

= (528 + 22) litres = 550 litres

Now, quantity of milk in the solution at this stage = $\frac{7}{11}\times 550 = 350$ litres

14. (B)

In the new vessel water and alcohol are in the ratio

$$\left(\frac{3}{8}+\frac{5}{14}+\frac{7}{18}\right):\left(\frac{5}{8}+\frac{9}{14}+\frac{11}{18}\right)$$

$$= \frac{189+180+196}{504} : \frac{315+324+308}{504}$$

$= 565 : 947$

Let's assume the quantity of water, alcohal be 565 k and 947 k respectively.

Thus, total solution

= 565 k + 947 k = 1512 k

Let's assume the fraction of mixture withdrawn and replaced with water = x

Alcohal = 947 × (1 – x) = 50% of total

$= \frac{1}{2}\times 1512 = 756$

$$\Rightarrow \quad x = 1 - \frac{756}{947} = \frac{191}{947}$$

15. (A)

Shubham adds 20 ml water to 60ml of alcohol when he sits for drink

Alcohol	**:**	**Water**	
60ml	**:**	**20ml**	
Ratio → **3**	**:**	**1**	
Qty left. → $\frac{3}{4}$ **×76**	**&**	$\frac{1}{4}$ **×76**	**(Takes 4ml sip)**
57ml	**&**	**19ml**	
57	**&**	**(19+8)**	**(Adds 8ml water)**
57ml	**&**	**27ml**	
Ratio → **19**	**:**	**9**	
Qty. Removed → $\frac{19}{28}$ **×28**	**&**	$\frac{9}{28}$ **×28**	**(Takes 28ml sip)**
Qty. left → **(57–19)**	**&**	**(27–9)**	
38ml	**&**	**18ml**	
38ml	**&**	**(18+20)ml**	**(Addition of 20ml water)**
38ml	**&**	**38ml**	
(Alcohol)	**:**	**(Water)**	

Therefore, Required ratio = 38 : 38 = 1 : 1

Hence, Option (A) is the correct.

Practice Exercise – 2

Level of Difficulty – 1

1. In a cooking competition, Team A and Team B (First two winners) made mocktails. Mocktail of Team A contains a mixture of orange juice and blueberry juice in the ratio 11 : 3 and Team B's mocktail contains a mixture of orange juice and blueberry juice in the ratio 7 : 4. What should be the ratio of volumes of mocktails of Team A and Team B be taken so as to obtain a mocktail of Orange juice and blueberry juice in the ratio 5 : 2?

(A) 6 : 11
(B) 1 : 14
(C) 3 : 7
(D) 12 : 11

2. The ratio of copper and zinc by weight in two alloys x and y is 2 : 7 and 5 : 4. How many kilograms of the alloy x and y are required to make 42 kg of new alloy z in which the ratio of copper and zinc is the same?

(A) 6 kg and 36 kg
(B) 10 kg and 32 kg
(C) 7 kg and 35 kg
(D) None of these

3. A, B, C are 3 containers, which contain Milk, Sugar, and Water in varying proportions. Container 'A' contains x% milk and y% sugar. Container 'B' contains y% milk and y% water. Container 'C' contains x% sugar and y% water. When A, B, C are mixed in the ratio 2 : 3 : 5, then the final mixture has 18% milk and 23% sugar. Find the product of x and y.

(A) 1500
(B) 1200
(C) 1000
(D) 900

4. From a vessel containing 750 ml of pure milk, 160 ml pure milk was drawn out and distributed equally between two beakers P and Q. The milk in both the beakers was diluted by adding water in different proportions. After that, the contents of P and Q were added back to the vessel. The concentration of milk in the vessel now is 75%. Had the contents of beakers P and Q been mixed with each other instead of adding it into the vessel, what would be the approximate concentration of milk in the mixture?

(A) 42%
(B) 39%
(C) 35%
(D) 36%

5. Shreyas took pure milk and started to dilute it with water. He first replaced 14 litres from the beaker full of pure milk with 14 litres of water. He performed this process three more times. Finally, the ratio of milk left in the beaker to that of water became 81 : 544. Find out how much pure milk (in litres) was there in the beaker initially.

(A) 21
(B) 28
(C) 35
(D) 42

6. In what ratio should water which costs Rs. 10 per litre be mixed with a concentrated acid costing Rs 25/litre to make a profit of 30% by selling the resultant

liquid at Rs 18/litre? Given that any acid should have at least 50% acid content or else it will be rejected.

(A) 1.2
(B) 1.3
(C) 2.9
(D) Not possible

7. Two alloys 'P' and 'Q' of Tin and lead are prepared by mixing the respective metals in the proportion of 5: 2 and 5 : 11 respectively. If the two alloys are melted and mixed to form a 3rd alloy 'R', having 1 : 1 proportion of Tin and Lead, what is the ratio of alloys 'P' and 'Q' in the mixture?

(A) 7 : 8
(B) 8 : 7
(C) 5 : 7
(D) 7 : 5

8. In 320 litres of the mixture, the ratio of milk and water is 5 : 3. If 80 litres of the mixture is taken out and some quantity of water is added to the mixture, then the ratio between milk and water becomes 5 : 4 respectively. Find the amount of water that is added to the mixture.

(A) 30 litres
(B) 50 litres
(C) 80 litres
(D) 20 litres

9. If 40 litres of milk solution having 36 % of milk and remaining water is given, then how many litres of water (in litres) must be added to this solution to make it a 30% solution of milk?

(A) 4
(B) 6
(C) 8
(D) 10

10. A vessel is filled with milk. 12 litres of milk is withdrawn and replaced with water. Next, from the same vessel, 12 litres of the mixture is withdrawn and replaced with water. If the volumes of milk and water in the vessel are now in the ratio of 81 : 19, then the capacity of the vessel (in litres) is:

(A) 40
(B) 80
(C) 90
(D) 120

Level of Difficulty – 2

11. In what ratio should two varieties of tea costing Rs. 600 per kg and Rs. 900 per kg respectively be mixed so that the resulting mixture when mixed with another variety of tea costing Rs. 1000 per kg in the ratio 5 : 4, would yield a mixture costing Rs. 800/kg?

(A) 2 : 13
(B) 13 : 2
(C) 5 : 13
(D) 9 : 17

12. Two types of spirits solutions 'P' and 'Q' are mixed in the proportion 3: 5 by volume. The volume of the mixture is then doubled by adding solution 'P' such that the resulting mixture has 60% spirit. If solution 'P' has 70% spirit, then find the % of spirit in solution 'Q' ?

(A) 36%
(B) 38%
(C) 40%
(D) 42%

13. When 20 litres of milk is added to 60 litres of a milk and water solution, the

new concentration of milk in the solution formed is the same as the new concentration of water, when 30 litres of water is added to the same 60 litres of initial milk and water solution. What is the ratio of milk and water in the original milk-water solution?

(A) 3:2
(B) 8:9
(C) 9:8
(D) 5:3

14. A jar contains 40 litres of pure milk, 20% of this is taken out and replaced with water in the first cycle. In the 2nd cycle, 30% of the resultant mixture is taken out and replaced with water and finally in the third cycle 20% of the mixture is taken out and replaced with water. Find the ratio of milk and water in the final mixture.

(A) 56 : 69
(B) 71 : 79
(C) 38 : 43
(D) 45 : 56

15. Mixture 'x' has been formed by two types of raw elements A and B by mixing them in the ratio of 3 : 5. Similarly, mixture 'y' has been formed by mixing two raw elements 'A' and 'C' in the ratio of 3: 2. In what ratio should both the mixtures be mixed to obtain a solution which has a concentration of 'B' as 40%?

(A) 9 : 1
(B) 13 : 2
(C) 16 : 9
(D) 5 : 9

16. A milk distribution tanker contains 320 litres mixture of milk and water with 70% of milk. In order to increase the purity, the distributor decided to add more milk to the mixture. Find the quantity of milk (in litres) that should be added to the mixture so that the percentage of milk is increased to 80%.

(A) 120
(B) 130
(C) 140
(D) 160

17. A 30% ethanol solution is mixed with another ethanol solution, say, K of unknown concentration in the proportion 3 : 5 by volume. This mixture is then mixed with an equal volume of 12.5 % ethanol solution. If the resultant mixture is an 18.75% ethanol solution, then the unknown concentration of K is:

(A) 20%
(B) 22%
(C) 24%
(D) 18%

18. Three vessels of equal capacities contain the three liquids L, M & N in the ratio 1 : 2 : 3, 3 : 4 : 5 & 5 : 6 : 7 respectively. The mixtures from these vessels are taken in the ratio 1 : 2 : 3 and poured into a fourth vessel with a capacity equal to the capacity of the given three vessels. The ratio of the liquids L, M and N in the resulting mixture is:

(A) 16 : 21 : 26
(B) 3 : 4 : 5
(C) 1 : 2 : 3
(D) None of these

19. A 20 kg alloy made up of copper and zinc in the ratio 4 : 1 is mixed with 12 kg of another alloy of copper and zinc, such that in the resultant alloy, the ratio of copper and zinc becomes 5 : 3. Find the ratio of copper and zinc in the 2nd alloy.

(A) 1 : 2
(B) 2 : 1
(C) 3 : 2
(D) 2 : 3

20. Two vessels whose volumes are in the ratio of 3: 4 contain milk and water mixtures. If 40% of the first mixture, which is of 60% milk concentration, is mixed with 60% of the 2nd mixture, which is of 50% milk concentration, then find the milk concentration of the final mixture or the resultant mixture.

(A) 53.33%
(B) 42.28%
(C) 19.75%
(D) 80%

Level of Difficulty – 3

21. If a certain weight of an alloy of copper and gold is mixed with 6 kg of pure gold, the resulting alloy will have 90% gold by weight. If the same weight of the initial alloy is mixed with 4 kg of another alloy which has 90% gold by weight, the resulting alloy will have 80% gold by weight. Then, the weight of the initial alloy, in kg is.

(A) 0.82 kg
(B) 5/13 kg
(C) 8/13 kg
(D) 2 kg

22. A can contains a solution of milk and water. After adding 50 litres of water into the can, the concentration of the milk in the can becomes 40%. Now if further 60 litres of more water is added to the can, the concentration of the milk in the can reduces by 10 percentage points. How much more water (in litres) must be added to the can so that the concentration of milk in the can becomes 15%?

(A) 80
(B) 120
(C) 240
(D) 360

23. A mixture 'P' is produced by mixing the chemical 'A' and 'B' in the ratio of 3 : 5. Chemical 'A' is prepared by mixing two raw materials 'm' and 'n' in the ratio of 2 : 3. Chemical 'B' is prepared by mixing raw materials 'n' and 'K' in the ratio of 3 : 2. Then the final mixture is prepared by mixing 128 litres of 'P' with some litres of water. If the concentration of the raw material 'n' in the final mixture is 40%, how much water (in litres) has been added to the mixture 'P'?

24. A vessel contains 240 litres of milk and water solution in the ratio 1 : 5 respectively. 60 litres of the contents of the vessel are taken out and 'x' litres of pure milk is added to the vessel. Due to this, the ratio of milk and water in it gets reversed. Then, 'y' litre of water is added to the vessel due to which the ratio of milk and water once again gets reversed. The value of (y + x) is equal to (in litres):

(A) 4200
(B) 4230
(C) 4320
(D) None of these

25. A vessel has a 900-litre mixture of spirit and water which has 40% spirit in it. How many litres of another mixture with 60% spirit content may be added so that spirit content in the resulting mixture will be more than 45% but less than 50% ?

(A) More than 300 litres but less than 900 litres

(B) More than 800 litres but less than 1200 litres

(C) More than 500 litres but less than 900 litres

(D) More than 200 litres but less than 600 litres

26. Ganpat was an alcoholic. One day, he mixed alcohol and water in equal proportions to get 300ml of solution. He tasted 30ml of the solution and felt that he should mix some water. He mixed 30ml of water and tasted the solution again. He kept on doing it until the concentration of alcohol was at most 30%. How much alcohol (in millilitres) did he consume in the process ?

Mark the answer to the closest integral value.

(A) 61

(B) 62

(C) 88

(D) 89

27. Two solutions P and Q made up of alcohol and soda water have different percentages of alcohol in it. The total volume of P and Q are 40 and 16 litres respectively. Equal volume of solutions of P and Q are taken. Solution taken from P was mixed with Q and the solution taken from Q was mixed with P. If the final percentage of alcohol in both the solutions is equal, then find the amount of solution (in litres) that was taken out and mixed with the other solution.

(A) 11.42

(B) 12.33

(C) 11.60

(D) 12.2

28. A mixture, of volume 120 litres, has milk and water in the proportion 2 : 3. When water is added to this mixture, the ratio of milk and water changes to 2 : 5. If 1/5th part of this mixture is taken out, then how many litres of milk must be added to the remaining mixture so that the ratio of milk and water again becomes 2: 3?

(A) 28.7 litres

(B) 24.5 litres

(C) 25.6 litres

(D) 26.7 litres

29. The profit is 20% when two types of pulses, 'x' and 'y' are mixed in the ratio 3 : 2 and then sold at Rs. 60/kg. The profit is 5%, when the same two types of pulses 'x' and 'y' are mixed in the ratio 2 : 3 and then sold at Rs. 60/kg. The cost prices, per kg, of x and y, are in the ratio:

(A) 41 : 43

(B) 5 : 3

(C) 1 : 2

(D) 2 : 3

30. A milkman has a 100L tank of milk. He removes 5 L from the container and replaces it with water. He keeps on repeating it till the content of milk is a maximum of 80%.

Statement 1: The milkman has the desired proportion when he has added 20 L of water.

Statement 2: The milkman has the desired proportion when he has added 25 L of water.

(A) Both statements are correct

(B) Only statement 1 is correct

(C) Only statement 2 is correct

(D) Both statements are false

Solutions

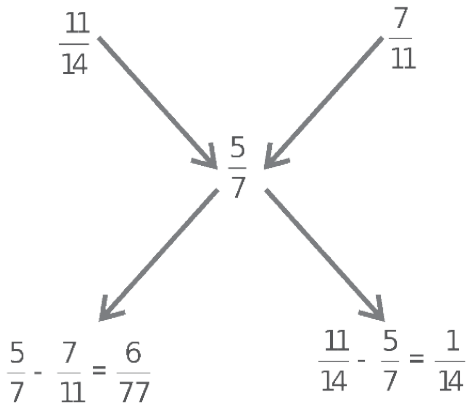
1. (D)

Fraction of Orange juice in mocktail of Team A = 11/4

Fraction of Orange juice in mocktail of Team B = 7/11

Fraction of orange juice in resultant mixture =5/7

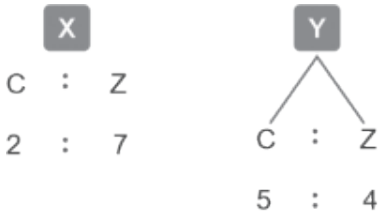
Using alligation rule:



Required ratio = (6/77 : 1/14) = 12 : 11

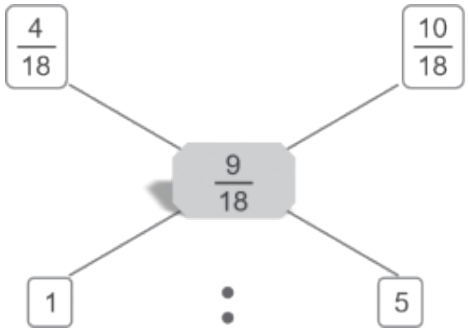
Hence, option (D) is the correct answer.

2. (C)



Copper = 2/9 = 4/18 Copper = 5/9 = 10/18

Now use alligation:



∴ amount of X = (1/6) × 42 = 7 kg

and Amount of Y = (5/6) × 42 = 35 Kg

Hence, option (C) is the correct answer.

3. (B)

Let's assume the quantity of A, B and C are 200 litres, 300 litres and 500 litres respectively.

Container 'A' contains x% milk and y% sugar.

Container 'B' contains y% milk and y% water.

Container 'C' contains x% sugar and y% water.

It is given that the concentration of milk in the final mixture is 18%.

2x + 3y = 18% of 1000 = 180 ...(1)

Also the concentration of sugar in the final mixture is 23%.

2y + 5x = 230 ...(2)

On solving (1) and (2) we get

x = 30 and y = 40

$x \times y = 30 \times 40 = 1200$

Hence, option (B) is the correct answer.

4. (B)

According to the question, when diluted contents (milk + water) of both the beakers P as well as Q are added back to the vessel, the milk volume will be equal to 750 ml and this 750 ml represents 75% milk concentration

So, 750 ml of pure milk corresponds to 75% concentration.

100% = 1000 ml

Volume of water in the vessel = 250 ml

If the contents of beaker P and Q are mixed then there would be 160 ml of pure milk and 250 ml water will be present.

% of milk = (161/410) x 100 = 39% approximately

Hence, option (C) is the correct answer.

5. (C)

If a vessel contains 'q' amount of solution and 'p' amount of solution is replaced for 'n' times by another solution, then

$$\frac{\text{final amount left}}{\text{Initial amount}} = \left(1 - \frac{p}{q}\right)^n$$

So, $\frac{81}{625} = \left(1 - \frac{14}{q}\right)^4$

$\Rightarrow 1 - \frac{14}{q} = \frac{3}{5}$

$\Rightarrow \frac{14}{q} = \frac{2}{5}$

$\Rightarrow q = 35$

Hence, option (C) is the correct answer.

6. (D)

Let the quantity of acid be x L and the quantity of water be y L.

Cost of acid: 25x

Cost of water: 10y

Total Cost: 25x + 10y

Total SP = Cost + Profit

= (25x + 10y) + 30% of (25x + 10y)

= 1.3 (25x + 10y) = 32.5x + 13y = 18 (x + y)

14.5x = 5y

$\frac{y}{x} = \frac{14.5}{5} = \frac{29}{10}$

But since the content of water in the final mixture cannot be above 50%, the ratio of water to acid should be less than 1.

But 2.9 is not less than 1.

Thus, our answer will be not possible

Hence, option (D) is the correct answer.

7. (A)

Let's assume x kg of alloy 'P' and y kg of alloy 'Q' are mixed to form 3rd alloy 'R'.

Now, given that the ratio of tin and lead in the mixture 'R' is 1 : 1

Solving which, we will get x/y = 7 : 8

Hence, option (A) is the correct answer.

8. (A)

When 80 litres of the mixture is removed, then the remaining mixture

= (320 – 80) = 240 litres

When the mixture is removed from the given mixture then the ratio will not change.

Therefore, the quantity of milk, when 80 litres of the mixture is removed

= (5/8) x 240 = 150 litres

Also, Quantity of water

= 240 – 150 = 90 litres

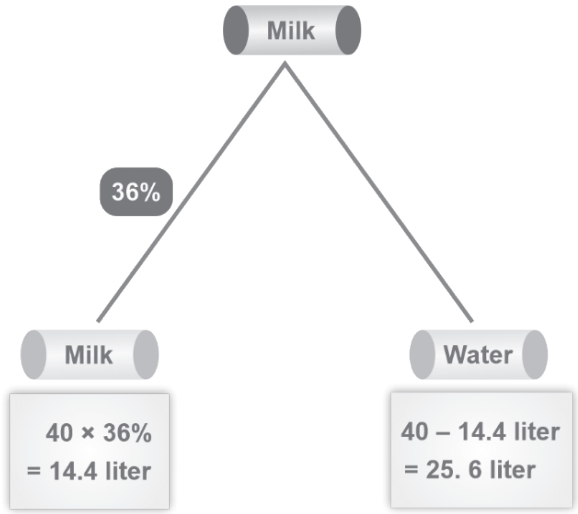
Let 'x' litres of water is added to the mixture after that ratio becomes 5 : 4

150/(90 + x) = 5/4

x = 30 litres

Hence, option (A) is the correct answer.

9. (C)



Let 'x' litres of water is added in the solution.

Then, $\frac{14.4}{25.6+x} = \frac{30}{70}$

$7 \times 1.44 = 3x\ 25.6 + 3x$

$100.8 = 76.8 + 3x$

$3x = 24$

$x = 8$ litres

Thus, 8 litres of water is added

Hence, option (C) is the correct answer.

10. (D)

Since we know the formula:

$$FQ = IQ\left[1-\frac{U}{I_Q}\right]^n$$

Where, FQ = Final quantity of the milk.

IQ = Initial quantity of the milk.

U = Amount of substance taken out.

n = Number of times the process is repeated.

$$\frac{F_Q}{I_Q} = \left[1-\frac{U}{I_Q}\right]^n$$

$$\frac{81}{100} = \left[1-\frac{12}{I_Q}\right]^2$$

$$\frac{9}{10} = 1-\frac{12}{I_Q}$$

$$\frac{12}{I_Q} = 1-\frac{9}{10}$$

$$\frac{12}{I_Q} = \frac{1}{10}$$

IQ = 120 litres

Hence, option (D) is the correct answer.

11. (B)

Let the price of the resulting mixture be Rs. x/kg and this resulting mixture is mixed with another variety of tea costing Rs. 1,000/kg in the ratio 5 : 4. The price of the mixture is:

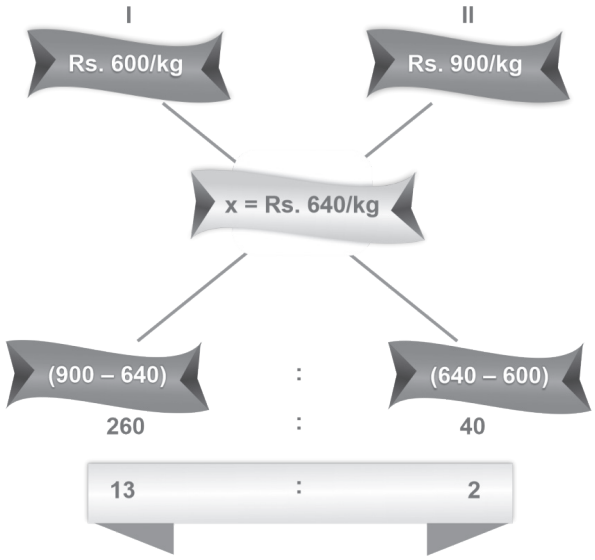
$x \times 5 + 1000 \times 45 + 4 = 800$

$5x + 4000 = 7200$

$5x = 3200$

x = Rs. 640/kg

Now, apply the allegation method in the first given statement:



Hence the two varieties of tea cost Rs. 600/kg and Rs. 900/kg are mixed in the

ratio of 13 : 2, so that desired mixture can be obtained.

Hence, Option (B) is the correct answer.

12. (B)

Let solution 'P' has 3x volume and solution 'Q' has 5x volume.

Since solution 'P' is only added not solution 'Q' therefore, the volume of solution 'Q' will remain the same from start to end.

Original quantity of mixture = 8x

Quantity of mixture after volume doubled = 16x

Amount of P in this mixture = 3x + 8x

= 11x and amount of Q would be 5x

Let solution 'Q' have a% spirit in it.

∴ P	Q
11x :	5x ⇒ 16x
70%	a% 60%

Therefore, 11x × 70% + 5x × a% = 16x × 60%

11x × 70 + 5a = 16 × 60

770 + 5a = 960

5a = 190

a = 38%

Hence, solution 'Q' has 38% spirit in it.

Hence, option (B) is the correct answer.

13. (C)

Let's initial quantity of Milk and water in the 60 litres of milk-water solution be M and W respectively.

According to the question

$$\frac{M+20}{80}=\frac{W+30}{90}$$

⇒ 9M + 180 = 8W + 240

⇒ 9M − 8W = 60 ...(1)

Also, M + W = 60

So, 8M + 8W = 480 ...(2)

Adding (1) and (2), 17M = 540

M = 540/17 so W = 60 − 540/17 = 480/17

Thus, the initial Ratio of M and W = 540/17 : 480/17 = 9 : 8

Hence, Option (C) is the correct answer.

14. (A)

The volume of milk in the final mixture = 40 (1 − 0.2) (1 − 0.3) (1 − 0.4) = 17.92 litres

Therefore, volume of water

= 40 litres − 17.92 litres = 22.08 litres

Now, find the ratio of milk and water in final mixture.

Milk : Water = 17.92 : 22.08 = 56 : 69

Hence, option (A) is the final answer

15. (C)

Let the amount of mixture 'x' be 'P' units and the amount of mixture 'y' be 'Q' units.

Amount of 'B' in mixture 'x' = 5/8 x P units

Also, amount of 'B' in mixture 'y' = 0 units.

Concentration of

'B' = (5P/8)/(P + Q) = 40%

5P/8 = 0.4(P + Q)

0.625 P = 0.4P + 0.4Q

0.225 P = 0.4 Q

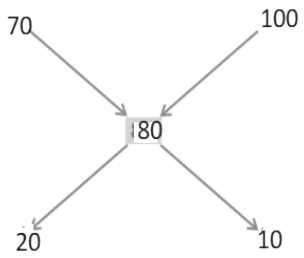
P/Q = 16/9

Hence, option (C) is the correct answer.

16. (D)

In 320 litres, 70% is milk. But in pure milk, there will be 100% milk only.

Using alligation:



Ratio = 20 : 10 = 2 : 1

Milk that should be added to 320 litres of mixture = 320/2 = 160 litres

Alternate Method:

In 320 litres 30% is water.

That is 30/100 x 320 = 96 litres.

So, if we add some amount of pure milk (say, x), that won't change the amount of water. It will still be 96 litres but these 96 litres will now be 20% of the new total quantity.

20% of (320 + x) = 96 litres

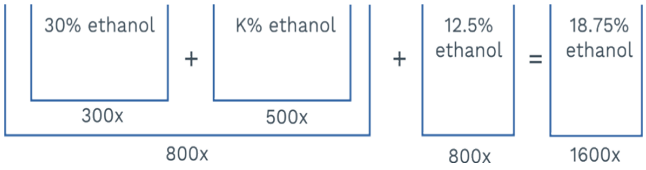
20/100 (320 + x) = 96

(320 + x) = 480

Therefore, x = 160 litres

Hence, Option (D) is the correct answer.

17. (B)



Equate ethanol on both sides

(90x + 5xK) + 100x = 18.75% of 1600x

90 + 5K + 100 = (3/16) x 1600 = 300

5K = 110

K = 22

Hence, Option (B) is the correct answer.

18. (B) 3: 4: 5

Let the capacities of the four casks be 36 litres each.

Then,

Amount of Liquid L in first vessel

= (1/6) × 36 = 6 litres

Amount of Liquid M in first vessel

= (1/6) × 36 = 12 litres

Amount of Liquid N in first vessel

= (1/6) × 36 = 18 litres

Similarly, the amount of liquid L, M, N in the second vessel is 9, 12 and 15 litres respectively.

And the amount of liquid L, M, N in the third vessel is 10, 12 and 14 litres respectively.

Now, the mixtures are taken out in the ratio 1 : 2 : 3; 6 litres, 12 litres and 18 litres mixture are drawn from the three casks respectively and poured in the fourth vessel.

Therefore,

Amount of Liquid L in fourth vessel

= 1 + 3 + 5 = 9

Amount of liquid M in fourth vessel

= 2 + 4 + 6 = 12

Amount of liquid N in fourth vessel

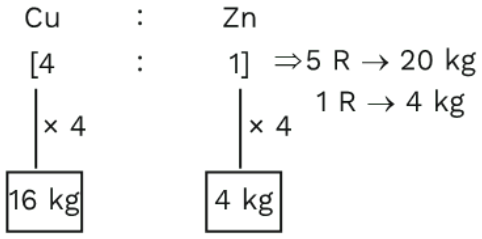
= 3 + 5 + 7 = 15

Hence, the ratio of the liquids in the resulting mixture

= 9 : 12 : 15 = 3 : 4 : 5

Hence, Option (B) is the correct answer.

19. (A)



The total amount of final mixture when 20 kg of 1st alloy is mixed with

12 kg, of 2nd alloy = 20 + 12 = 32 kg

∴ Amount of copper (Cu) in resultant alloy

$= \frac{5}{8} \times 32 = 20$ kg

Also, the amount of Zinc (Zn) in the resultant alloy

$= \frac{3}{8} \times 32 = 12$ kg

Now, the amount of copper in the 2nd alloy = 20 kg – 16kg = 4 kg.

Also, amount of Zinc in 2nd alloy = 12 – 4 = 8 kg

$\Rightarrow$ The ratio of copper (Cu) and Zinc in 2nd alloy is

Cu	:	Zinc
4	:	8
1	:	2

Hence, option (A) is the correct answer.

20. (A)

Since, concentration

$$= \frac{\text{Total amount of milk}}{\text{Total quantity of mixture}} \times 100$$

$$= \frac{3 \times 40\% \times 60\% + 4 \times 60\% \times 50\%}{3 \times 40\% + 4 \times 60\%}$$

$$= \frac{3 \times 0.4 \times 0.6 + 4 \times 0.6 \times 0.50}{3 \times 0.40 + 4 \times 0.60}$$

$$= \frac{1.92}{1.2 + 2.4} \times 10 \ = \frac{1.92}{3.6} \times 100 \ = 53.33\%$$

Therefore, concentration of the final mixture is 53.33%

Hence, Option (A) is the correct answer.

21. (D)

Let the alloy initially contain 'a' kg gold and 'b' kg copper.

When it is mixed with 'b' kg pure gold.

Then, $\frac{(a+6)}{(a+b+6)} = \frac{90}{100}$

10a + 60 = 9a + 9b + 54

a – 9b = –6

9b – a = 6 ...(1)

Now, again according to the 2nd condition given in the question-

Gold in 4kg alloy = 90% × 4 kg = 3.6 kg

Thus, $\frac{(a+3.6)}{(a+b+4)} = \frac{80}{100}$

$\frac{a+3.6}{a+b+4} = \frac{4}{5}$

5a + 18 = 4a + 4b + 16

a – 4b = –2

4b – a = 2 ...(2)

If we solve (1) and (2) equation we well get b = 4/5

Also, 4b – a = 2

(16/5) – a = 2

a = (16/5) – 2

a = 6/5

Therefore, the weight of the initial alloy = (a + b) kg = (4/5) + (6/5) = 2

Hence, option (D) is the correct answer.

22. (C)

Let the initial quantity of milk and water be P and Q litres respectively

After adding 50 litres of water, milk will be P litres but water will be Q + 50 litres and according to the question milk concentration becomes 40 %, which means milk to water ratio would be 40 : 60 or 2 : 3

So, P/(Q + 50) = 2/3 ...(1)

After adding 60 litres of more water, milk will be P litres but water will be Q + 110 litres and according to the question milk concentration becomes 30%, which means milk to water ratio would be 30 : 70 or 3 : 7

So, P/(Q + 110) = 3/7 ...(2)

Solving I and II we will get Q = 58 and P = 72

Now we have 72 litres of milk, 168 (58 + 110) litres of water and total solutions of 240 (168 + 72) litres

Now according to the question, suppose y litres of more water is added so that the milk concentration becomes 15% or milk to water ratio becomes 15 : 85 or 3 : 17

So, 72/(168 + y) = 3/17 solving which we will get y = 240 litres

Hence, 240 litres of water must be added to make the milk concentration 15%

Hence, Option (C) is the correct answer.

23. 64

Let the amount of chemical 'A' in mixture 'P' = 3x units

Also, the amount of chemical 'B' in mixture 'P' = 5x units

Since chemical 'A' is prepared by mixing two raw materials 'm' and 'n' in the ratio of 2 : 3.

Quantity of 'n' raw material in chemical 'A' = 3/5 x (3x) = 1.8x units

Similarly, chemical 'B' is prepared by mixing raw materials 'n' and 'K' in the ratio of 3 : 2.

Quantity of 'n' in chemical 'B' =3/5 x (5x) = 5x units

The quantity of 'n' in mixture 'P' = (1.8x + 3x) units = 4.8 x units

Now, according to the question, 128 litres of mixture 'P' is mixed with water to prepare the final mixture.

Total quantity of 'P' = (3x + 5x) units

8x = 128 litres

x = 16 litres

Also, it is given in the question that, if the concentration of raw material 'n' in the final mixture is 40%.

Quantity of n = Quantity of final mixture × 40% = 4.8x

Quantity of final mixture × (2/5) = 4.8 × 16 litres

Quantity of final mixture = 192 litres

Therefore, the quantity of water added = 192 – 128 = 64 litres.

24. (C)

Ratio of milk and water in the vessel = 1: 5.

After 60 litres of solution is taken out, the remaining would have 30 litres of milk and 150 litres of water.

Now, x litres of milk is added and the ratio becomes M : W = 5 : 1

(30 + x) : 150 = 5 : 1

i.e. 30 + x = 750

i.e. x = 720

So, milk = 750 and water = 150

Now, y litres water is added and ratio again gets reversed

750 : (150 + y) = 1 : 5

i.e. y = 3600

Therefore, y + x = 3600 + 720 = 4320

Hence, option (C) is the correct answer.

25. (A)

Amount of spirit content in the first mixture = 40% of 900 = 360 litres

Let the amount of another mixture be 'a' litres will be added with the first mixture.

Therefore, The proportion of spirit content in the mixture now

$$= \frac{360 + 60\% \text{ of } a}{900 + a} = \frac{360 + 0.60a}{900 + a}$$

Since the spirit contained in the resulting mixture is 45%.

$$\therefore \quad \frac{360 + 0.6a}{900 + a} = \frac{45}{100}$$

$$\Rightarrow \frac{360 + 0.6a}{900 + a} = \frac{9}{20}$$

7200 + 12a = 8100 + 9a

3a = 900

a = 300 litres

Again, when spirit content will be 50% in the resulting mixture, then the amount of 2nd mixture will be:

$$\frac{360 + 0.6a}{900 + a} = \frac{1}{2}$$

720 + 1.2 a = 900 + a

0.2 a = 180

a = 900 litres

Hence, the quantity of the 2nd mixture to be added should be more than 300 litres but less than 900 litres.

Hence, Option (A) is the correct answer.

26. (A)

As the alcohol and water are in the same proportion, the amount of alcohol would be 150 ml.

Let n be the number of replacements.

$$150\left(1-\frac{30}{100}\right)^{n} \leq 30\% \text{ of } 300$$

$$\Rightarrow \left(1-\frac{1}{10}\right)^{n} \leq \frac{90}{150}$$

$$\Rightarrow 150\left(1-\frac{1}{10}\right)^{n} \leq \frac{90}{150}$$

$\Rightarrow (0.9)^n \leq 0.6$

As we know that

$\Rightarrow (0.9)^2 = 0.81$

$\Rightarrow (0.9)^4 = (0.81)^2 = 0.6561$

Four replacements have already been done.

Now, if we multiply 0.6561 with 0.9, the product would be 0.59049 (which is less than 0.6)

The remaining quantity of alcohol = 150 × $(0.9)^5$ = 88.57 ml (approx.)

So, Ganpat must have consumed 150 – 88.57 = 61.42 ml ~ 61 ml of alcohol.

Hence, option (A) is the correct answer.

27. (A)

Let the % of alcohol in solutions P and Q are x% and y% respectively. Let the volume taken from both the solutions be 'k' litres. Equating the % of alcohol from both P and Q

(x% of (40 – k) + y% of k)/40 = (y% of (16 –k) + x% of k)/16

2x (40 – k) + 2yk = 5y (16 – k) + 5xk

80x – 2xk + 2yk = 80y – 5yk + 5xk

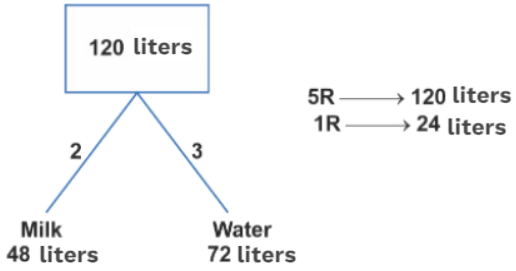
80 (x – y) = 7k (x – y)

80 = 7k ..... as (x is not equal to y)

k = 80/7 = 11.42

Hence, Option (A) is the correct answer.

28. (C)



M : W		⇒	**5R → 120 litres**
2 : 3	]	**+ 2R**	**1R → 24 litres**
2 : 5			**2R → 24 × 2 = 48 litres**

M : W ⇒

2 : 3] +2R

2 : 5

5R ⟶ 120 litre

1R ⟶ 24 litre

2R ⟶ 24 × 2 = 48 litre

Therefore, water added in the mixture is 48 litres.

Now, the total mixture becomes = 120 litre + 48 litres = 168 litres

Since 1/5th part of this mixture is taken out, then the remaining mixture

= 168 x (4/5) = 134.4 litres

Again, some quantity of milk is added to the remaining mixture.

Then,

M : W

2 : 5 ⇒ 3 × [2 : 5]

2 : 3 ⇒ 5 × [2 : 3]

	M	:	W
+4R	6	:	15
	10	:	15

$\Rightarrow$ 21R → 134.4 litre

1R → $\frac{134.4}{21}$ litre = 6.4 litre

$\therefore$ 4R → 4 × 6.4 = 25.6 litre

Hence, 25.6 litres of milk is added to the mixture, so that ratio of milk and water becomes 2: 3.

Hence, option (C) is the correct answer.

29. (C)

Let 'a' be the price of 1 kg of pulse 'x' is the mixture and 'b' be the price per kg of pulse 'y'.

Case-1

Since the selling price of the mixture is Rs. 60/kg and a profit of 20% is given.

Let the cost price of the mixture is CP.

$CP_{mix_1} \times 120\% = 60$

$CP_{mix_1} = \frac{60}{120} = \text{Rs. } 50 / \text{kg}$

Price per kg of the mixture when pulses are mixed in the ratio 3 : 2.

$\Rightarrow \frac{3 \times a + 2 \times b}{5} = 50$

3a + 2b = 250 ...(1)

Case-2

The profit is 5% if the two vertices of pulses are mixed in 2 : 3.

$CP_{mix_2} \times 105\% = 60$

$CP_{mix_2} = \frac{60}{105}$

$\therefore$ Price per kg of the mixture when pulses are mixed in the ratio 2 : 3.

$\frac{2a + 3b}{5} = \frac{60}{105}$

2.1a + 3.15b = 300 ...(2)

Now, solving equation 1 and 2.

3a + 2b = 250

2.1a + 3.15b = 300

6.3a + 4.2b = 525

$\Rightarrow$ 6.3a + 9.45b = 900

−5.25b = −375

b = 500/7

Put the value of b = 500/7 in equation (1), we will get a = 250/7

Therefore, the cost prices, per kg of x and y are in the ratio

x : y = 250/7 : 500/7 = 1 : 2

Hence, option (C) is the correct answer.

Statement 1: The milkman has the desired proportion when he has added 20 L of water.

Statement 2: The milkman has the desired proportion when he has added 25 L of water.

30. (C)

For a content, less than 80 % of 100 litres, the quantity of milk should be below 80 litres

After 1st time: Tank has 95 litres milk and 5 litres water

For, 2nd time, when 5 litres mixture is removed and 5 litres water is added

Milk: 95% of previous: 95% of 95 litres milk = 90.25L milk

Remaining 100 – 90.25 litres = 9.75 litres is water

For, 3rd time, when 5 litres mixture is removed and 5 litres water is added

Milk: 95% of previous: 95% of 90.25 litres milk = 85.7375 litres milk

Remaining 100 – 85.7375.25 litres = 14.2625 litres is water

For, 4th time, when 5 litres mixture is removed and 5 litres water is added

Milk: 95% of previous: 95% of 85.7375
litres milk = 81.45 litres milk
Remaining 100 – 81.45 litres = 18.55 litres is water
For, 5th time, when 5 litres mixture is removed and 5 litres water is added
Milk: 95% of previous: 95% of 81.45L milk = 77.37 litres milk
Remaining 100 – 77.37 litres = 22.63 litres is water
Thus, it needs at least 5 steps to reach the desired concentration.
Any further step will lower milk content which also lies in the range i.e. less than 80%.
Thus, he needs to add water at least 5 times i.e. 5 × 5 = 25 litres
Hence, statement 1 is false and statement 2 is true.
Hence, option (C) is the correct answer.