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# MIXTURES

## ALLIGATIONS AND



**Alligation:** Rule of alligation enables us to find the ratio in which two or more ingredients at a given price must be mixed to produce a resultant mixture of desired price.

**Mean Price:** It is the cost of unit quantity of a mixture.

**Mixture:** Mixture is formed by mixing two or more quantities. It can be expressed in the form of percentage or ratio.

- 10 % of sugar in water
- A solution of water and sugar is 12 : 20, which means water : sugar = 12 : 20

1. **According to the rule of alligation:** When two ingredients are mixed,

$$\frac{\text{Cheaper Quantity (X)}}{(\text{Quantity of Y})} = \frac{(\text{C.P. of Y}) - (\text{Mean Price})}{(\text{Mean Price}) - (\text{C.P. of X})}$$

# INTRODUCTION

2. If a vessel contains A liters of milk and if B litres of milk is withdrawn and replaced by water, and again if B litres of mixture is withdrawn and replaced by water and this operation is repeated n times in all, then

$$\frac{\text{(Quantity of milk left after } n^{\text{th}} \text{ operation)}}{\text{(Initial quantity of milk)}} = \left[ \frac{(A - B)}{A} \right]^n$$

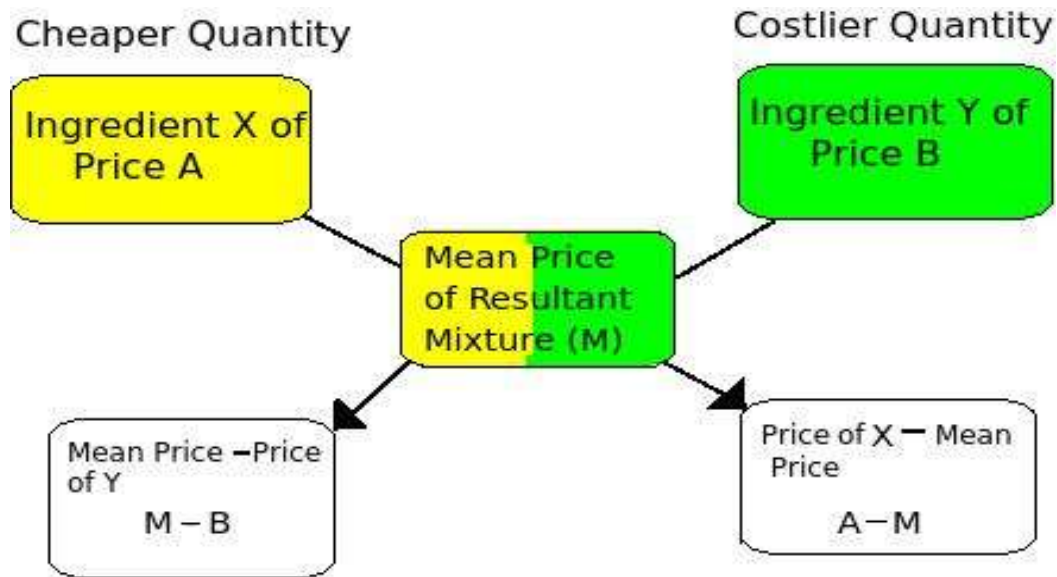
$$\text{Quantity of milk left after } n^{\text{th}} \text{ operation} = A \times \frac{[A(1 - (B/A))^n]}{A}$$

$$\text{Simplified formula to calculate quantity of milk left after } n^{\text{th}} \text{ operation} = [A(1 - (B/A))^n]$$



# INTRODUCTION

## Rule of Alligation:



$$\text{Ratio} = \frac{(M - B)}{(A - M)} = \frac{(B - M)}{(M - A)}$$

## Question: 01

In what ratio must wheat A at Rs. 10.50 per kg be mixed with wheat B at Rs. 12.30 per kg, so that the mixture be worth of Rs. 11 per kg?

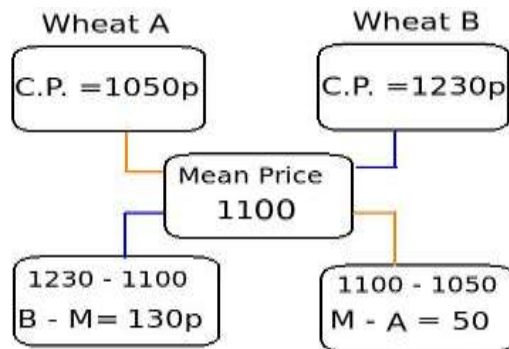
- A. 13 : 5
- B. 18 : 3
- C. 17 : 5
- D. 11 : 5

**Answer: A**



## Explanation:

Convert Rs into paise, to make the calculation easy



$$\text{Ratio} = \frac{(M - B)}{(A - M)} = \frac{(B - M)}{(M - A)}$$

The required ratio = 130 : 50 = 13 : 5

## Question: 02

In what ratio must a shopkeeper mix Peas and Soybean of Rs. 16 and Rs. 25 per kg respectively, so as to obtain a mixture of Rs. 19.50 ?

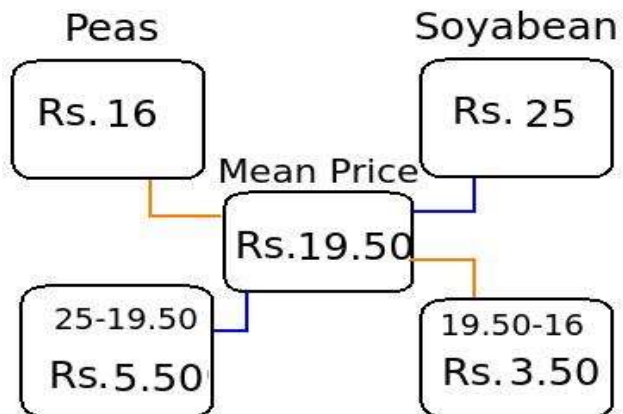
- A. 9 : 5
- B. 7 : 5
- C. 11 : 7
- D. 12 : 8

**Answer: C**



## Explanation:

Use rule of alligation, to determine the ratio



The required ratio of Soybean and Peas =  $5.50 : 3.50 = 11 : 7$

## Question: 03

10 gallons are drawn from a container full of alcohol and filled with water again. 10 gallons of mixture are again drawn and the container is filled with water again. If the ratio of alcohol and water left in the container is 49 : 32, then find how much quantity does the container hold?

- A. 35
- B. 45
- C. 55
- D. 60

**Answer: B**

## Explanation:



Initially the container contains only wine. 10 gallons of alcohol was removed and same quantity of water was added.

This process is again repeated by replacing the mixture( alcohol + water) of 10 gallons with same quantity of water. Hence, the initial quantity of wine and the final quantity of water and alcohol is the same.

- 1) First assume that the initial quantity of alcohol is 'A' .
- 2) We are given that, the ratio of alcohol and water is 49 : 32
- 3) Assume initial quantity of alcohol in the container =  $49 + 32 = 81$  ----- (This is because we have assumed that initial quantity of alcohol = final quantity of water and alcohol)
- 4) Subtract the quantity of alcohol replaced by water from the initial quantity of alcohol  $(A - B)$ . As this operation is repeated n times, therefore  $(A - B)^n$

Therefore,

$$\frac{\text{(Quantity of alcohol left after } n^{\text{th}} \text{ operation)}}{\text{(Initial quantity of alcohol) or (Volume of flask)}} = \left[ \frac{(A - B)^n}{A} \right]$$
$$\frac{49}{81} = \frac{(A - 10)^2}{A}$$

A=45 Gallons

## Question: 04

A container is filled with a mixture of water and milk in the ratio of 3 : 5. Find the quantity of mixture to be drawn off and replaced with water, in order to get the mixture as half milk and half water.

- A. 2 : 3
- B. 1 : 1
- C. 1 : 5
- D. 1 : 4

**Answer: C**

## Explanation:

A container contains milk and water in the ratio of 3 : 5. This means that the vessel contains 8 litres of mixture. Assume that  $x$  litres of this mixture is replaced with water.

From the mixture containing water and milk of 3 : 5,  $x$  quantity of mixture is withdrawn and is replaced by water of the same quantity in the mixture. From the mixture  $(3x)/(8)$  part of water is removed and  $x$  quantity of water is added.

1) Quantity of water in the newly formed mixture =  $[3-(3X/8)+X]$ -----> (3 is the quantity of water,  $x$  is the quantity of mixture replaced by water)

2) Similarly, quantity of milk in the newly formed mixture =  $[5-(5X/8)]$ ----> (Here  $x$  is not added because only water was added in the mixture and not the syrup)

$$[3-(3X/8)+X] = [5-(5X/8)]$$

$$5X + 24 = 40 - 5X$$

$$X = 8/5$$

So the part of mixture replaced from 8 litres =  $8/5 * 1/8 = 1/5$



## Question: 05

A shopkeeper has 100 kg of salt. He sells part of the total quantity A at 7% profit and the rest B at 17 % profit. If he gains 10 % profit on the whole quantity, then find how much is sold at 7 % profit?

- A. 30 kg
- B. 35 kg
- C. 40 kg
- D. 45 kg

**Answer: A**

## Explanation:

Assume that A and B are two parts of the mixture. To determine the quantity A and B, first calculate ratio of A : B.

Given:

- 1) Selling price of mixture with 10% profit = Rs. 110
- 2) With 17 % profit, the selling price of A = Rs. 117
- 3) With 7 % profit, the selling price of B = Rs. 107

Now, this question can be easily solved by using the rule of alligation

Now, the ratio of A : B = 3 : 7

Let the quantity of part A be  $3x$  and part B be  $7x$  in the total quantity of

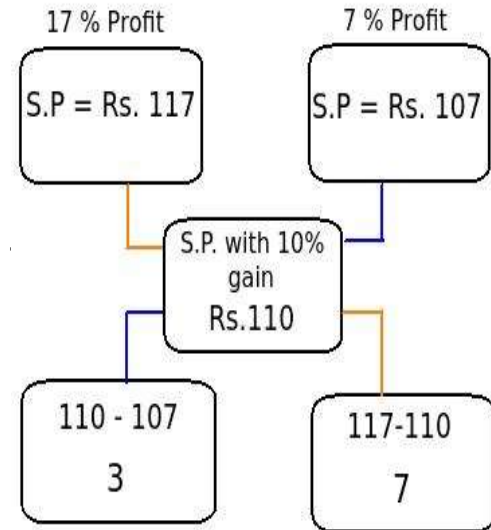
Therefore,  $3x + 7x = 100$

$$10x = 100$$

$$x = 10$$

Quantity of part A =  $3x = 3 \times 10 = 30$  kg

Quantity of part B =  $7x = 7 \times 10 = 70$  kg



## Question: 06

Sugar A worth Rs. 130/kg and B of Rs. 120/kg are mixed with a third variety C in the ratio of 1 : 1 : 2. If the mixture is worth Rs. 160, then find the price of third variety of sugar.

- A. Rs. 195
- B. Rs. 200
- C. Rs. 225
- D. Rs. 230

**Answer: A**



## Explanation:

1) First calculate the average of A and B variety of sugar:  $(120 + 130)/2 = \text{Rs.}125$

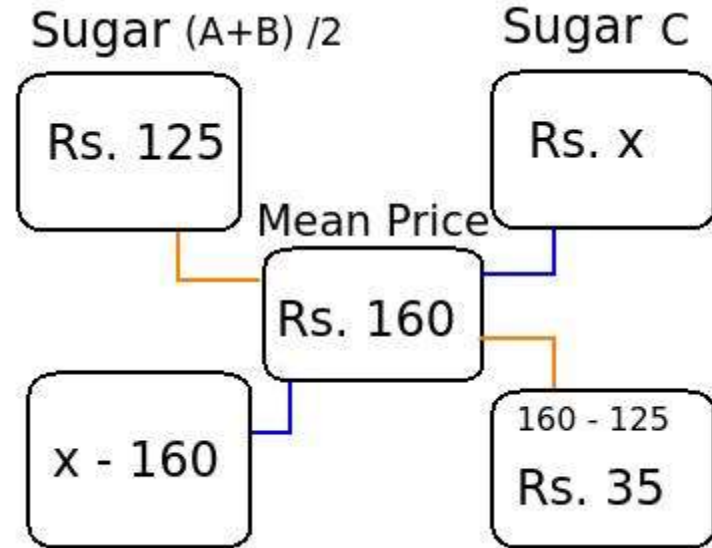
2) Now, the mixture is formed by two varieties of sugar, one at Rs. 125 /kg and assume the cost of type C Rs. x. It is formed in the ratio of 2 : 2, i.e 1 : 1

Use the rule of alligation, to easily determine the unknown quantity.

$$(X - 160)/35 = 1$$

$$X = 35 + 160 = \text{Rs.}195$$

The cost of third variety of sugar C = Rs. 195



## Question: 07

Two containers P and Q contain milk and water in the ratio of 5 : 2 and 7 : 6 respectively. Find the ratio in which these two mixtures can be mixed so that a new mixture formed in the container R is in the ratio of 8 : 5.

- A. 5 : 6
- B. 4 : 9
- C. 7 : 9
- D. 9 : 7

**Answer: C**



## Explanation: 07

Let the cost price of milk be **Re. 1 per litre.**

Therefore, **cost of milk in 1 litre of mixture in**

Container A (Milk : Water = 5 : 2) =  $(5/7) \times \text{Re. 1} = \text{Re. } 5/7$

Container B (Milk : Water = 7 : 6) =  $(7/13) \times \text{Re. 1} = \text{Re. } 7/13$

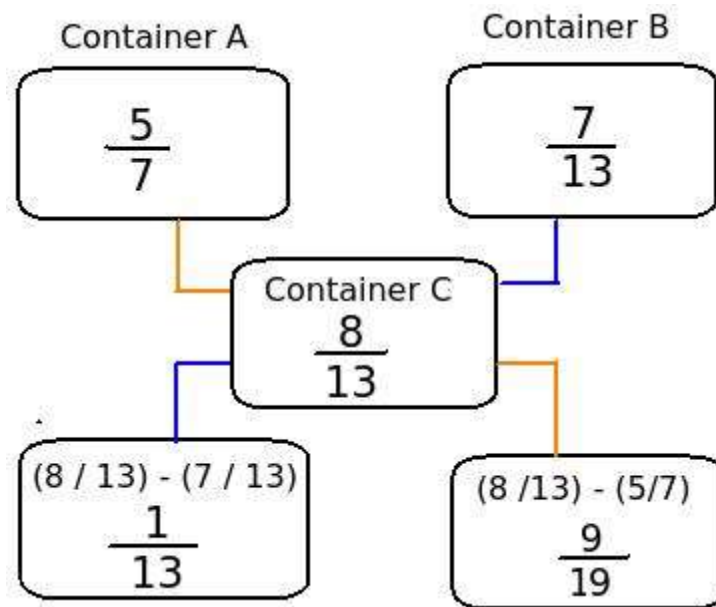
Container C (Milk : Water = 8 : 5) =  $(8/14) \times \text{Re. 1} = \text{Re. } 8/14$

Now use the rule of alligation, to find the required ratio

The required ratio of milk and water:

1/13 : 9/91

Simplifying, we get 7 : 9



## Question: 08

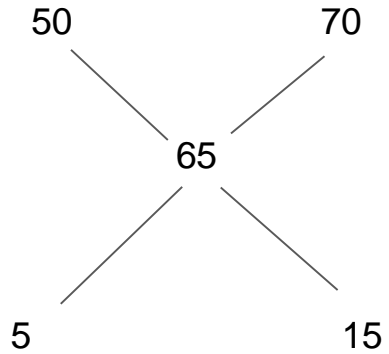
In what ratio must a shopkeeper mix two types of rice worth Rs. 50 kg and Rs. 70 kg, so that the average cost of the mixture is Rs. 65 kg?

- A. 2:1
- B. 1:2
- C. 3:1
- D. 1:3

**Answer: C**



## Explanation: 08



$$5:15 = 1:3$$



## Question: 09

A container contains 50 litres of milk. From this container, 10 litres of milk was taken out and replaced by water. This process is repeated one more time. How much milk is now left in the container?

- A. 24
- B. 32
- C. 30
- D. 36

**Answer: B**



## Explanation:

$$\begin{aligned}\text{Amount of milk after 2 operations} &= [50(1-(10/50))^2] \\ &= 50 * 4/5 * 4/5 \\ &= 32 \text{ litres}\end{aligned}$$



## Question: 10

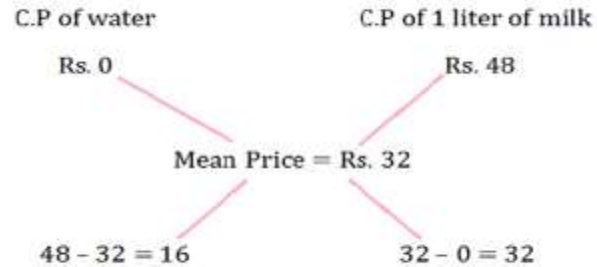
In what ratio water must be mixed with milk costing Rs. 48 per liter to get a mixture worth Rs. 32 per liter ?

- A. 2:3
- B. 3:2
- C. 3:4
- D. 1:2

**Answer: D**



## Explanation:



$$\text{Water/Milk} = 16/32 = 1/2$$

Required ratio; water:milk = 1:2

## Question: 11

8 litres are drawn from a cask full of wine and is then filled with water. This operation is performed three more times. The ratio of the quantity of wine now left in cask to that of the water is 16 : 65. How much wine the cask hold originally?

- A. 18 litres
- B. 24 litres
- C. 32 litres
- D. 42 litres

**Answer: B**



## Explanation: 11

Let the quantity of the wine in the cask originally be  $x$  litres

Then, quantity of wine left in cask after 4 operations =  $\left[ x \left( 1 - \frac{8}{x} \right)^4 \right]$  litres

$$\therefore \left[ \frac{x \left( 1 - \frac{8}{x} \right)^4}{x} \right] = \frac{16}{81}$$

$$\Rightarrow \left[ 1 - \frac{8}{x} \right]^4 = \left( \frac{2}{3} \right)^4$$

$$\Rightarrow x = 24$$



## Question: 12

A mixture of 150 liters of wine and water contains 20% water. How much more water should be added so that water becomes 25% of the new mixture?

- A. 10 litres
- B. 20 litres
- C. 30 litres
- D. 40 litres

**Answer: A**



## Explanation:

Number of liters of water in 125 liters of the mixture = 20% of 150 =  $\frac{1}{5}$  of 150 = 30 liters

Let us Assume that another 'P' liters of water are added to the mixture to make water 25% of the new mixture. So, the total amount of water becomes  $(30 + P)$  and the total volume of the mixture becomes  $(150 + P)$

Thus,  $(30 + P) = 25\% \text{ of } (150 + P)$

Solving, we get  $P = 10$  liters



## Question: 13

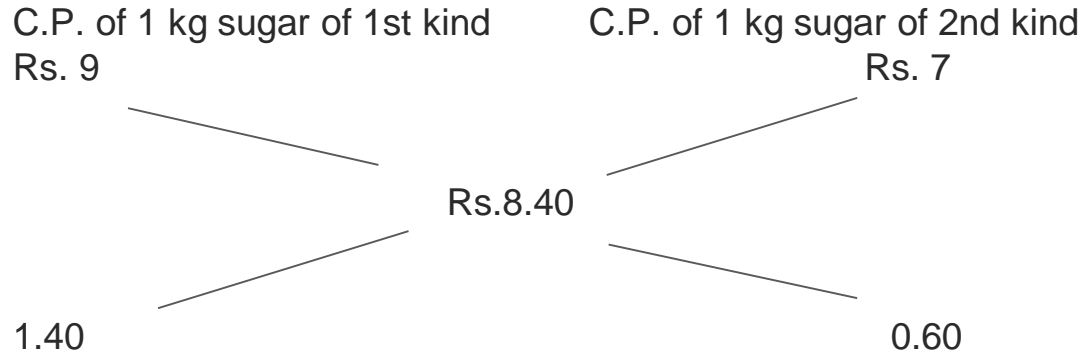
How many kilograms of sugar costing Rs. 9 per kg must be mixed with 27 kg of sugar costing Rs. 7 per Kg so that there may be a gain of 10 % by selling the mixture at Rs. 9.24 per Kg ?

- A. 36 Kg
- B. 42 Kg
- C. 54 Kg
- D. 63 Kg

**Answer: D**



## Explanation:



Therefore, Ratio of quantities of 1st and 2nd kind =  $14 : 6 = 7 : 3$ .

Let  $x$  kg of sugar of 1st kind be mixed with 27 kg of 2nd kind.

Then,  $7 : 3 = x : 27$  or  $x = (7 \times 27 / 3) = 63$  kg.



## Question: 14

The ratio of expenditure and savings is 3 : 2 . If the income increases by 15% and the savings increases by 6% , then by how much percent should his expenditure increases?

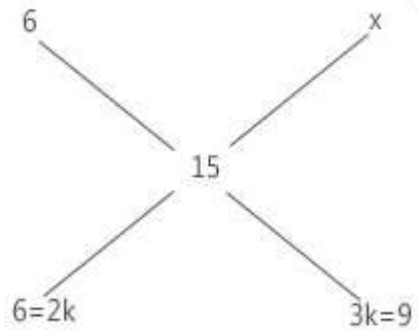
- A. 25
- B. 21
- C. 12
- D. 24

**Answer: 21**





## Explanation:



Therefore  $x = 21\%$



## Question: 15

A vessel is filled with liquid, 3 parts of which are water and 5 parts of syrup. How much of the mixture must be drawn off and replaced with water so that the mixture may be half water and half syrup?

- A.  $\frac{1}{3}$
- B.  $\frac{1}{4}$
- C.  $\frac{1}{5}$
- D.  $\frac{1}{7}$

**Answer: C**



## Explanation:

Suppose the vessel initially contains 8 litres of liquid.

Let  $x$  litres of this liquid be replaced with water.

Quantity of water in new mixture  $= (3 - (3x/8) + x)$  litres

Quantity of syrup in new mixture  $= (5 - (5x/8))$  litres

$$(3 - (3x/8) + x) = (5 - (5x/8))$$

$$\Rightarrow 5x + 24 = 40 - 5x$$

$$\Rightarrow 10x = 16 \Rightarrow x = 8/5$$

So, part of the mixture replaced  $= (8/5 * 1/8) = 1/5$



*THANK YOU*

