6. AVERAGES, ALLIGATION & MIXTURES

Introduction to the Topic

Average, one of the most fundamental concept in Mathematics, is used almost everyday by an individual. The concept is restated in many forms and finds its application in Mixtures, Ratios and can even be used to solve questions quickly in Data Interpretation (DI). Once done thoroughly, a student can master the technique of solving questions efficiently without putting in much effort.

Relevance in CAT

Average and its applications is an important topic for CAT exam. Though the number of questions asked from this topic has reduced in the last couple of years, the concept of averages is still relevant in aptitude as it is carried forward in Alligation & Mixtures, and is also used in questions based on Ages, Ratios and many more.

Fundamentals

Average is the central value of a given set of numbers, which provides an indicative way of interpreting the given set of data points, it is equal to the sum of data points divided by the number of data points.

Average is the mean value of set of numbers or values. Therefore average of a set of numbers is,

Average = $\frac{x_1 + x_2 + x_3 + ... + x_n}{n}$ or in other words,

Average of some observations = $\frac{\text{Sum of all observations}}{\text{Number of all observations}}$

Average is also called the **Arithmetic Mean.**

Also,

Sum of all observations

= Average × Number of observations

Number of observations = $\frac{\text{Sum of all observations}}{\text{Average}}$

Some Important Points

- If all the given quantities have the same value, then the number in itself is the average.
- If all the given quantities are not same, then the average of the given quantities is always greater then the smallest number and always less than the largest number. Equivalently, atleast one of the numbers is less than the average and atleast one is greater than the average.
- If each of the observation is increased/decreased/ multiplied/divided by a constant p then their average is also increased/decreased/multiplied/divided by p.
- Whenever the given quantities form an arithmetic sequence and if the given quantities are odd terms, then the average is the middle term in the sequence and if the given quantities are even terms, then the average of the sequence is the average of the middle two terms.
- In order to calculate the weighted average of a set of numbers, multiply each number in the set by the number of times it appears, add all the products and divide by the total number of numbers in the set.
- Average of consecutive numbers
  $= \frac{\text{First number + Last number}}{2}$
- Average of 'first n' odd numbers

$= \frac{\text{Last odd number} + 1}{2}$

- Average of 'first n' even numbers

$= \frac{\text{Last even number} + 2}{2}$

Example 1: There are five electronic shops in the Naza market, which have 40, 60, 120, 160 and 100 T.V. sets with them respectively, then find the average number of T.V. sets in each shop.

Solution:

Average number of T.V. sets

$= \frac{40 + 60 + 120 + 160 + 100}{5} = \frac{480}{5} = 96$

Example 2: The average income of 12 employees of Vodafone is Rs. 18,000 per month and 16 employees of Airtel is Rs. 32,000 month. The average income of all the 28 employees is:

Solution:

Required average income

$= \frac{12 \times 18,000 + 16 \times 32,000}{12 + 16} = \frac{7,28,000}{28} = \text{Rs. } 26,000$

Example 3: The average age of 9 members of Sharma's family is 32 years. The average age of the same family 4 years ago would be?

Solution:

Present average age of family = 32 years

4 years ago average age of family = 32 − 4 = 28 years

Example 4: The average salary of 60 employees in a company is Rs. 26,000 per month. If the number of executive is twice the number of non-executive employees and average salary of non-executive is $\frac{3}{5}$ of executive's average salary, find the average salary of all the non-executive employees.

Solution:

$\frac{\text{Number of executives}}{\text{Number of non-executives}} = \frac{2}{1}$

Let the average salary of executives be x.

And average salary of non-executives = $\frac{3}{5}x$

So, number of executive = 40

And number non-executive employees = 20

Total salary = 40 × salary of executive + 20 × salary of non-executive

$60 \times 26000 = 40 \times x + 20 \times x$

On solving we get,

$x = 30,000$

$\therefore$ Average Salary of non-executive employees = $\frac{3}{5}x$

$\Rightarrow 18,000$

Example 5: The average weight of 10 men in a boat is increased by 2.2 kg when one of the crew, who weighs 58 kg, is replaced by a new man. Find the weight of the new man.

Solution:

Total weight increase = (2.2 × 10) = 22 kg.

∴ Weight of the new man = (58 + 22) = 80 kg.

Example 6: The average age of 24 girls and one teacher is 18 years. When the teacher's age is excluded, the average decreases by 2. What is the age of the teacher?

Solution:

Total age of initial group = (25 × 18) years = 450 years.

Total age of group (excluding the teacher) = 24 × 16 = 384 years.

∴ Age of the teacher = 450 − 384 = 66 years.

Example 7: Five friends went to a restaurant. Four of them spent Rs. 24 each on their meals and the fifth spent Rs. 8 more than the average expenditure of all the five. What was the total money spent by them?

Solution:

Let the total expenditure be x.

$$\therefore \quad 4 \times 24 + \left(\frac{x}{5} + 8\right) = x$$

$$\text{or} \qquad x - \frac{x}{5} = 104 \Rightarrow \frac{4x}{5} = 104$$

$x = 130$

Hence, the total money spent is 130.

Example 8: The average of 11 numbers is 40 ; that of the 1st five is 33 and that the last five is 30. Find the value of the 6th number.

Solution:

Average of 11 numbers = 40

∴ Total of 11 numbers = 11 × 40 = 440,.

Total of the first 5 = 5 × 33 = 165

Total of the last 5 = 5 × 30 = 150

∴ Value of the sixth number = 440 − (165 + 150)

= 440 − 315 = 125

Example 9: A batsman in his 17th innings makes a score of 68 and thereby increases his average by 2. What is his average after 17 innings?

Solution:

Let his average score in 16 innings be 'x'.

∴ Total runs scored in 16 innings = $16x$

∴ Total runs after 17 innings = $16x + 68$

$$\therefore \quad \text{Average} = \frac{16x + 68}{17}$$

Now, average is 2 more than the earlier average.

$$\therefore \quad \frac{16x + 68}{17} = x + 2$$

or, $16x + 68 = 17x + 34$

or, $x = 34$

∴ Average after 17 innings = 34 + 2 = 36

Mixtures

Mixing of two or more quantities of different things produces a mixture. When two items of varying qualities and prices are mixed, the quality and price of the resultant mixture lies between the qualities and prices of the original constituent items.

There are two types of mixtures:

Simple Mixture

When two different ingredients are mixed together, it is know as a Simple Mixture.

Compound Mixture

When two or more simple mixtures are mixed together, it is known as a Compound Mixture.

Alligation is an arithmetic method of solving similar problems. The concept of alligation can be used to solve similar problems in various other areas as well. Problems of Profit and Loss, Time, Speed & Distance can also be solved through alligation.

Rule **of Alligation**

When we mix a cheaper (lesser cost price) sample and a dearer (more cost price) sample, the cost price of the mixture lies between the cost prices of the two. This cost price is called the mean price. All these quantities are related as in the following formula:

$$= \frac{\text{Quantity of Cheaper}}{\text{Quantity of Dearer}} = \frac{\text{C.P. of Dearer} - \text{Mean Price}}{\text{Mean Price} - \text{C.P. of Cheaper}}$$

Though, alligation appears 'magical', it is nothing but a rearranged form of weighted average.
Let us show this with the help of some equation.

Let the quantity of cheaper quality be Q_C and quantity of dearer quality be Q_D.
Let C be the price of cheaper quality and D be the price of dearer quality.
Let M be the mean price which we get after mixing the two qualities.

So, $M = \dfrac{C \times Q_C + D \times Q_D}{Q_C + Q_D}$

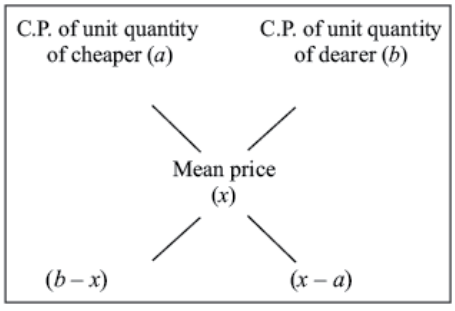
(which is nothing but the weighted average)

$M \cdot (Q_C + Q_D) = C \cdot Q_C + D \cdot Q_D$

$Q_C (M - C) = Q_D (D - M)$

$$\boxed{\frac{Q_C}{Q_D} = \frac{D - M}{M - C}}$$

It can also be represented as:



(Cheaper quantity) : (Dearer quantity) = $(b - x) : (x - a)$

This is the Alligation formula.

Note: Thus please get it crystal clear that wherever Weighted Average can be used, Alligation can also be used and wherever Alligation can be used, Weighted Average can also be used, as basically both are the same.

It is just that at places alligation can be slightly faster and at other instances, weighted average can be faster. A simple benchmark to follow is; if the weighted average is given and the ratio of weights is to be found out, Alligation can prove to be faster and if the weights are given and the weighted average is to be found out, the weighted average formula can be faster.

Example 10: In what ratio must 30% milk solution be mixed with 80% milk solution to result in a 60% milk solution?

Solution:

Let the 30% milk solution and the 80% milk solution be mixed in the ratio of $m : n$. Thus using the formula of weighted average we have,

$$= \frac{(30\% \times m) + (80\% \times n)}{m + n} = 60\%$$

Solving this,

$(30\% \times m) + (80\% \times n) = (60\% \times m) + (60\% \times n)$

i.e. $20\% \times n$

$= 30\% \times m$

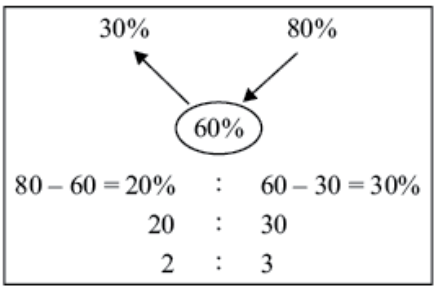
and we have $m : n = 2 : 3$.

However, in the above solution, we have introduced variables and then we solve the equation. A procedure called "Alligation" also simplifies this type of problems.

Write the two average in a straight line and slightly apart and the weighted average in the center slightly below the straight line as follows:

30%		80%
	60%	

Now, the ratio of mixing can be found by just subtracting the figures as follows:



Note that $80 - 60$ *i.e.* 20 is written on the diagonally opposite end and similarly $60 - 30 = 30$ is written on diagonally opposite end.

(2 parts corresponds to 30% as it is written below it and 3 parts corresponds to 80% as it is written below it.)

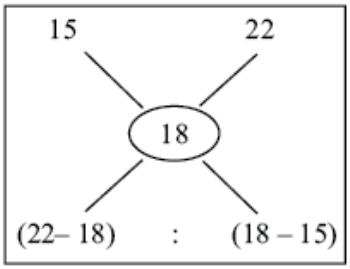
Thus, visually we can solve this type of problem without the introduction of any variable.

Example 11: A tea seller buys two varieties of sugar costing Rs. 15 per kilogram and Rs. 22 per kilogram. He mixes these two varieties in a certain ratio that cost him Rs. 18 per kilogram. Find the ratio of the cheaper quantity to that of the dearer quantity in the mixture.

Solution:

Using alligation,

Rs. 18 per kg is the mean cost price.

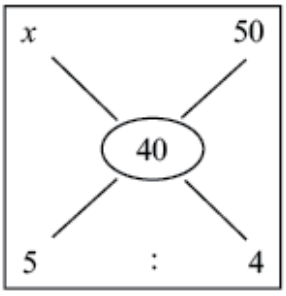


Thus, ratio of cheaper quantity to dearer quantity is
= (22− 18) : (18 − 15) = 4 : 3

Example 12: Ramit buys a certain variety of rice and mixes it with another variety of rice costing Rs. 50 per kg in the ratio of 5 : 4. The mixture costs Rs. 40 per kg. What is the cost price of the cheaper variety?

Solution:

Using alligation



$= \frac{50 - 40}{40 - x} = \frac{10}{40 - x} = \frac{5}{4}$

$\Rightarrow 40 - x = 8$

Or, $x = 32$

$\therefore$ Price is Rs. 32 per kg.

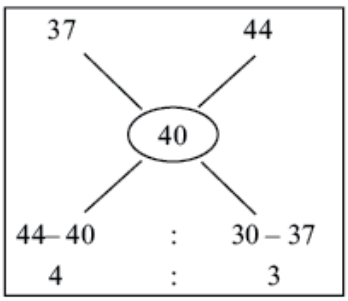
Example 13: A fruit seller mixes two varieties of apples, costing Rs. 37 per dozen and Rs. 44 per dozen and sells them at Rs. 44 per dozen, there by gaining 10% on the transaction. Find out the ratio in which he mixes these two varieties?

Solution:

S.P. of the mixture = $\frac{11}{10}$ C.P. of the mixture

C.P. of the mixture is = $\frac{10}{11} \times$ SP = $\frac{10}{11} \times 44$ per dozen

Using alligation,



Ratio of the mixture is = $\frac{44 - 40}{40 - 37} = \frac{4}{3} = 4 : 3$

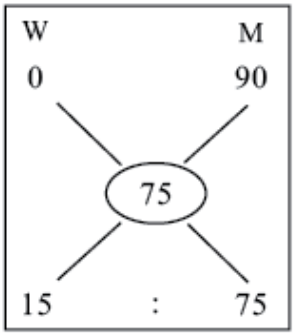
Example 14: A mixture of certain quantity of milk with 15 litres of water is worth 75 paise per litre. If pure milk cost 90 paise per litre, what is the amount of milk in the mixture? (Assume that water does not cost anything.)

Solution:

Price of milk per litre = 90 paise ;

Price of water per litre = 0 paisa

Applying the principle of alligation, we have



$= \frac{90 - 75}{75 - 0} = \frac{15}{75} = \frac{1}{5}$

Ratio of milk to water in the mixture is 5 : 1.

Quantity of milk in the mixture

= 5 × 15 = 75 litres.

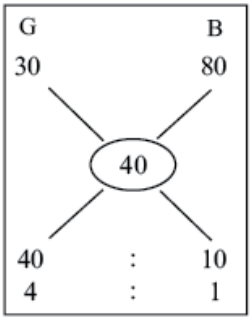
Example 15: There are 65 students in a class. Among them, Rs. 26 is distributed so that each boy gets 80 paise and each girl gets 30 paise. Find the number of boys and girls in that class.

Solution:

Alligation is applicable for 'money per boy or girl'.

Average money per student $= \frac{2600}{65} = 40$ paise .

Applying the alligation rule, $\frac{80 - 40}{40 - 30} = \frac{4}{1}$



Girls : Boys = 4 : 1

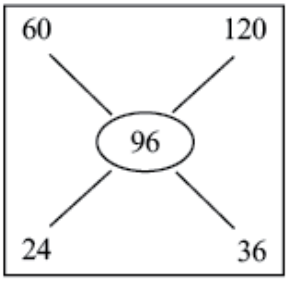
Number of boys = $\frac{65 \times 1}{5} = 13$

Number of girls = 65 − 13 = 52

Example 16: In a farm there are goats and ducks. If you count the heads, there are 30; if you count the legs, there are 96. How many of each kind are there?

Solution:

Obviously, there are 30 animals. Now, if all were to be ducks, there would be (30 2) = 60 legs; and if all to be goats, there would be 120 legs. Now, use alligation:



∴ Ducks : Goats = 24 : 36 = 2 : 3

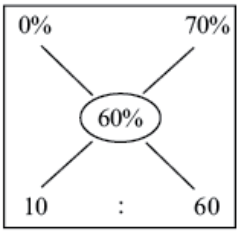
∴ There are $\left(\frac{2}{2+3}\right) \times 30 = 12$ ducks, and (30 − 12) = 18 Goats.

Example 17: Shikha removed a certain quantity from a solution of 70% milk and replaced it by pure water. The concentration of milk in the resulting mixture is now 60%. What fraction of milk did Shikha remove?

Solution:

Pure water is 0% milk solution:

∴ Using alligation



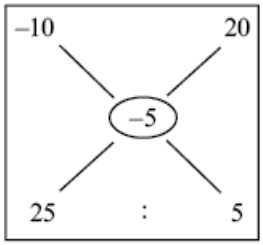
Thus, the ratio of water to that original solution is = 1 : 6

Thus, fraction removed is = $\frac{1}{7}$

Example 18: A property dealer purchases two flats for Rs. 80 lakhs. He sells one at a loss of 10% and other at a gain of 20%. He losses 5% in the entire transaction. What is the cost of each flat?

Solution:

Using alligation,

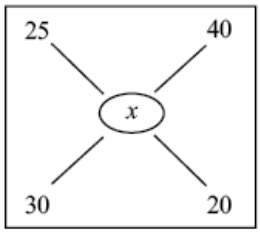


C_1 and C_2 are the cost of each flat.

C_1 = × 80,00,000 = 66.66 lakhs and C_2 = 13.33 lakhs.

Example 19: Nandini travels 30 minutes at the speed of 25 km/hr. Further she travels 20 minutes at the speed of 40 km/hr. Find his average speed.

Solution:



Since the actual ratio is 3 : 2, so reverse it, *i.e.*, the required ratio is 2 : 3.

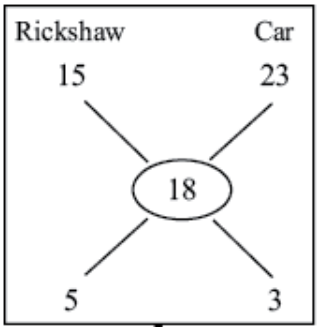
$\frac{x-25}{40-x}=\frac{2}{3}$ Solving for x, we get $x = 31$

Thus, average speed is 31 km/hr.

Example 20: Nakul covered 180 km distance in 10 hours. The first part of his journey he covered by car, then he hired a rickshaw. The speed of car and rickshaw is 23 km/hr and 15 km/hr respectively. The ratio of distance covered by car and the rickshaw respectively are:

Solution:

The average speed of Avinash = $\frac{180}{10}$ = 18 km/hr



It means the rickshaw took $\frac{5}{8}$ and car took $\frac{3}{8}$ of the total time *i.e.*, the ratio of time taken by rickshaw to car is 5 : 3.

So, the ratio of distances covered by rickshaw to car is

$= 5 \times 15 : 3 \times 23 = 75 : 69$

$\Rightarrow$ 25 : 23

Example 21: A person takes a loan of Rs. 20,000, partly from AIOB bank at 16% per annum and remaining from ABOM bank at 20% per annum. He pays a total interest of Rs. 3600 per annum. What amount of loan is taken from AIOB bank?

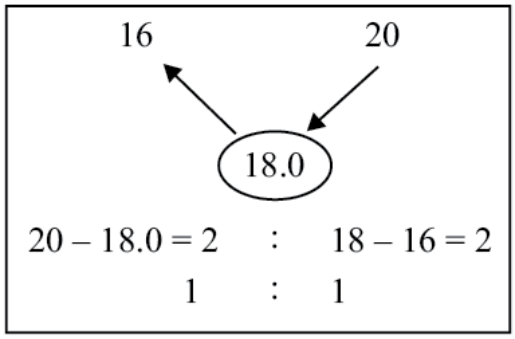
Solution:

Conventionally, the problem can be solved by assuming a loan of Rs. x from AIOB bank.

Thus, $0.16x + 0.2\ (20000 - x) = 3600$

$4000 - 0.04x = 3600$

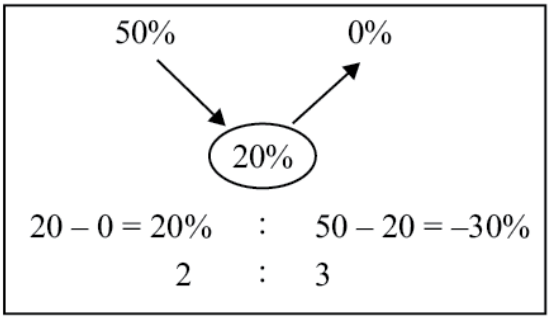
However if we consider the total loan as a mixture of two loans one at 16% and other at 20% and the overall rate on both the loans given together is 18% *i.*e. $\frac{3600}{20000}\times 100 = 18\%$, we can easily apply alligation to get to the ratio of the loan amount as:



Thus amount of loan taken at 16% is $\frac{1}{2}$th of 20000 *i.e.* 10000.

Example 22: How many litres of water should be added to 40 litres of 50% milk solution to make it a 20% milk solution?

Solution:



Thus, the 50% milk solution and water should be added in ratio 2 : 3. Since we have 40 litres of 50% milk solution, water to be added will be 60 litres.

Practice Exercise – Easy

1. The average income of Sonika & Rakhi is Rs. 5000 and that of Rakhi & Priya is Rs. 2000. What is the overall average income?
   a. 2800 b. 4600 c. 3500 d. 3200

2. In a class, there are 20 boys whose average age is decreased by 2 months, when one boy age 18 years is replaced by a new boy. The age of the new boy is?
   a. 14 years 8 months b. 16 years 4 months
   c. 15 years d. 17 years 10 months

3. 164 typists typed 984 papers in $\frac{1}{20}$ hours. The number of paper typed per minute by an average typist is:
   a. 5 b. 2 c. 4 d. 3

4. If in a final examination consisting of 10 papers Anna scored 97, 96, 98, 85, 94, 95, 85, 91, 92, 96 respectively, find her average score.
   a. 92 b. 94 c. 92.9 d. 91.5

5. The average of 30 numbers is calculated as 72. It is discovered later that while calculating the average, one number, 28, was misread as 88. Find the correct average.
   a. 72.5 b. 68 c. 65 d. 70

6. There was one mess for 30 boarders in a certain hostel. If the number of boarders was increased by 10, the expenses of the mess increased by Rs. 40 per month, while the average expenditure per head diminished by Rs. 2. Find the original monthly expenses?
   a. Rs. 390 b. Rs. 360 c. Rs. 410 d. Rs. 480

7. The mean of 25 observations was found to be 78.4. But later on it was found that 96 was misread as 69. The correct mean is?
   a. 79.48 b. 76.54 c. 81.32 d. 78.40

8. The average monthly salary of employees, consisting of officers and workers of an organization is Rs. 3000. The average salary of an officer is Rs. 10000 while that of a worker is Rs. 2000 per month. If there are total 400 employees in the organization, find the number of officers and workers separately.
   a. 50, 350 b. 350, 450 c. 50, 275 d. 325, 350

9. The average weight of 10 men increased by 1.8 kg when one weighing 65 kg was replaced by a new man. What is the weight of the new man?
   a. 73 b. 65 c. 83 d. 82

10. The average temperature from Monday to Thursday is 48° and from Tuesday to Friday is 52°. If the temperature on Monday is 42°,
    what was it on Friday?
    a. 55° b. 52° c. 58° d. 51°

11. The average weight of 20 teachers of a school is 55. If the weight of a student is included, the average weight reduces by 2 kg. Find the weight of the student?
    a. 13 b. 16
    c. 11 d. Cannot be determined

12. The average of five numbers is 42 & that of the first 4 is 40. Find the value of the fifth numbers.
    a. 36 b. 40 c. 50 d. 48

13. The average weight of boys in a class is 43 kg. Four more boys whose weights are 42 kg, 34.5 kg, 44.5 kg and 39 kg respectively join them. The average now becomes 42.5 kg. Find the original number of boys in the class.
    a. 20 b. 28 c. 32 d. 26

14. The average age of the students of three classes with 45, 60 & 75 students is 12, 11 & 8 years respectively. Find the average age of all students?
    a. 10 b. 11 c. 14 d. 16

15. Nine students of a class contribute a certain sum. Seven of them give Rs. 5 each and the other two give Rs. 5 and Rs. 9 more than the average contribution of all the 9 students. The average contribution of the class of 9 students is:
    a. 9 b. 12 c. 7 d. 14

16. The average of 5 consecutive odd numbers *A, B, C, D* and *E* is 41. What is the product of *A* and *E*?
    a. 1677 b. 1517 c. 1665 d. 1591

17. The average age of a woman and her daughter is 42 years. The ratio of their ages is 2 : 1 respectively. What is the daughter's age?
    a. 14 years b. 21 years c. 28 years d. 32 years

18. The average of marks obtained by 120 candidates was 35. If the average of the passed candidates was 39 and that of the failed candidates was 15, then the number of candidates who passed the examination was?
    a. 100 b. 110 c. 120 d. 150

19. In the first 10 overs of a cricket game, the run rate was only 3.2. What should be the run rate in the remaining 40 overs to reach the target of 282 runs?
    a. 6.25 b. 6.50 c. 6.75 d. 7

20. There are 30 students in a class. The average age of the first 10 students is 12.5 years. The average age of the next 20 students is 13.1 years. The average age of the whole class is?
    a. 12.5 years b. 12.7 years
    c. 12.8 years d. 12.9 years

21. If the average weight of a class of students is 18 and the average weight of another class of students is 39, then find the ratio of the students in both the classes when the average weight of both the classes taken together is 25:
    a. 1 : 4 b. 2 : 1 c. 1 : 2 d. 3 : 2

22. Three varieties of premium basmati rice costing Rs. 60 per kg, Rs. 70 per kg and Rs. 90 per kg are mixed together in the ratio of 2 : 3 : 1 respectively. Find the cost of the resultant mixture.
    a. Rs. 72 b. Rs. 70 c. Rs. 65 d. Rs. 68

23. A shopkeeper mixes two varieties of pulses to get a mixture. He uses 1 kg and 5 kg of pulses costing Rs. 10 and Rs. 20 per kg respectively. What is the cost of the resultant mixture (in Rs. per kg)?
    a. 16 b. 22 c. 18.33 d. 25

24. Three types of rice whose rates are Rs. 35, Rs. 42 and Rs. 45 per kg are blended together to make a 15 kg of new blend of rice in which there are 8 kgs, 4 kgs 3 kgs of the respective types of rice. The average price of the new blend of rice is:
    a. 38.87 b. 42 c. 41 d. 39.5

25. A solution containing 18% of water is mixed with another solution containing 40% of water. In what proportions should the two liquids be mixed to get a solution containing 30% of water?
    a. 2 : 1 b. 5 : 6 c. 3 : 2 d. 4 : 3

26. The cost of the Green, Blue and Red colours per kg is Rs. 20, Rs. 15 and Rs. 18 respectively. Sheesh Mahal is a renowned building in which these three colours are being used in the ratio of 3 : 2 : 4. The average cost of all the three colours used per kg is:
    a. 18 b. 17.33 c. 20 d. 22

27. In which proportion must a grocer mix sugar at Rs. 1.02/kg and Rs. 1.44/kg so as to make a mixture worth Rs. 1.26/kg?
    a. 3 : 4 b. 3 : 2 c. 2 : 1 d. 1 : 4

28. In what proportion must potato at Rs. 4.20 per kg be mixed with potato at Rs. 4.80 per kg, so that the mixture be worth Rs. 4.40 a kg?
    a. 2 : 3 b. 3 : 7 c. 3 : 1 d. 2 : 1

29. In what ratio must rice at Rs. 8.40 per kg be mixed with rice at Rs. 11.70 per kg so that the mixture be worth Rs. 10.20 per kg.
    a. 3 : 2 b. 2 : 5 c. 5 : 6 d. 6 : 1

30. In what proportion must a person mix pulses Rs. 11.7 per kg and Rs. 14.40 per kg so as to make a mixture worth Rs. 12.60 per kg.
    a. 3 : 2 b. 2 : 3 c. 2 : 1 d. 1 : 4

31. In what ratio must a grocer mix two varieties of tea costing Rs. 15 and Rs. 20 per kg respectively so as to get a mixture worth Rs. 17.50 per kg?
    a. 3 : 4 b. 3 : 7 c. 1 : 1 d. 1 : 3

32. In what ratio must rice at Rs. 17.20 per kg be mixed with rice at Rs. 22.80 per kg, so that the mixture be worth Rs. 20.80 per kg?

a. 2 : 1 b. 3 : 2 c. 7 : 2 d. 5 : 9

33. A goldsmith has two qualities of gold, one of 22 carats and another of 36 carats purity. In what proportion should he mix both to make an ornament of 30 carats purity?
a. 3 : 4 b. 1 : 2 c. 4 : 5 d. 2 : 3

34. In what ratio must a grocer mix two types of sugar costing Rs. 7.50 per kg and Rs. 10 per kg respectively. So as to get a mixture worth Rs. 8.5 per kg?
a. 5 : 3 b. 3 : 2 c. 4 : 1 d. 2 : 3

35. Peanuts cost Rs. 30 per kilogram while cashews cost Rs. 60 per kilogram. How many kilograms of cashews should be mixed with 14 kg of peanuts to obtain a mixture that costs Rs. 45 per kilogram?
a. 6 b. 7 c. 14 d. 9

36. A chemist has 6 L of a 25% wine solution. How much wine must he add so that the resulting solution contains 60% wine?
a. 9 b. 5.25 c. 6 d. 8

37. Suman combines 12 L of a 10% acid solution with 34 L of a 20% acid solution. What is the strength (in percentage) of the acid in this mixture?
a. 18.28% b. 9.15% c. 17.4% d. 30%

38. 40 kg of a 13% titanium alloy and 68 kg of a 60% titanium alloy are melted and mixed together to form a new material. What is concentration of titanium in the resulting alloy?
a. 46.2% b. 42.6% c. 55.8% d. 52.2%

39. A gardener wants to make a new blend of grass seeds by using 200 kg of Rs. 55 per kilogram seed and some quantity of Rs. 75 per kilogram seed. What quantity of Rs. 75 per kilogram seed will he need to make a blend of Rs. 65 per kilogram?
a. 180 b. 200 c. 120 d. 400

40. How many kilograms of Basmati rice costing Rs. 42/kg should a shopkeeper mix with 45 kg of ordinary rice costing Rs. 24/kg so as to make a profit of 25% by selling the mixture at Rs. 40/kg?
a. 20 b. 27 c. 36 d. 24

41. A mixture of a certain quantity of milk with 28 litres of water is worth Rs. 15 per litre. If pure milk be worth Rs. 21 per litre, how much milk is there in the mixture?
a. 82 *l* b. 75 *l* c. 70 *l* d. 84 *l*

42. A grocer buys two kinds of rice at Rs. 19 and Rs. 10 per kg respectively. In what proportion should these be mixed so that by selling the mixture at Rs. 17.50 per kg, 25% may be gained?
a. 2 : 3 b. 1 : 2 c. 3 : 5 d. 4 : 3

43. In what amount sugar costing Rs. 12. 20 per kg must be mixed with 252 kg of sugar costing Rs. 5.70 per kg, so that 20% may be gained by selling the mixture at Rs. 9.6 per kg.
a. 69 kg b. 138 kg
c. 460 kg d. None of these

44. A merchant has 2100 kg of rice, part of which he sells at 36% profit and the rest at 16% profit. He gains 30% on the whole. Find the quantity sold at 16%?
a. 690 kg b. 560 kg c. 750 kg d. 630 kg

45. A trader has 80 kg of pulses, part of which the sells at 8% profit and rest at 18% profit. He gains 16% on the whole. What is the quantity sold at 18% profit?
a. 64 kg b. 72 kg c. 58 kg d. 80 kg

46. A shopkeeper purchased 4 quintal tea at the rate of Rs. 110 per kg, 2 quintal tea at the rate of Rs. 140 per kg and 4 quintal tea at the rate of Rs. 120 per kg. He mixed the three varieties of tea. At what selling price should he sell the final mixture of tea to get a profit of 25%?
a. Rs. 120 per kg b. Rs. 144 per kg
c. Rs. 150 per kg d. Rs. 160 per kg

47. In what ratio must wheat at Rs. 7.40 per kg be mixed with wheat at Rs. 7.10 per kg so that the mixture be worth Rs. 7.28 per kg?
a. 3 : 4 b. 2 : 3 c. 3 : 2 d. 4 : 3

48. In what proportion must a juice at Rs. 60 per kg be mixed with an another juice at Rs. 30 per kg so that the mixture be worth Rs. 39 per kg?
    a. 7 : 3 b. 5 : 3 c. 3 : 5 d. 3 : 7

49. In what ratio must coffee at Rs. 82 per kg be mixed with tea at Rs. 92 per kg so that the mixture must be worth Rs. 84.50 per kg?
    a. 3 : 2 b. 3 : 1 c. 2 : 3 d. 1 : 3

50. The ratio in which the price at Rs. 7.10 a kg be mixed with rice at Rs. 5.70 a kg to produce a mixture worth Rs. 5.60 a kg, is:
    a. 2 : 1 b. 3 : 4
    c. 4 : 3 d. None of these

Practice Exercise – Medium

1. Milk and water in two vessels V_1 and V_2 are in the ratio 4 : 3 and 2 : 3 respectively. In what ratio the liquids in both the vessels should be mixed to obtain a new mixture in vessel V_3 containing half milk and half water?
    a. 2 : 1 b. 3 : 2 c. 3 : 4 d. 7 : 5

2. The average weight of 29 students in a class is 48 kg. If the weight of the teacher is included, the average weight rises by 500 g. Find the weight of the teacher?
    a. 57 kg b. 60 kg c. 65 kg d. 63 kg

3. The batting average of 40 innings of a cricket player is 50 runs. His highest score exceeds his lowest score by 172 runs. If these two innings are excluded the average of the remaining 38 innings is 48. His highest score was?
    a. 172 b. 173 c. 174 d. 176

4. In three numbers, the first is twice the second and thrice the third. If the average of these three numbers is 44, then the first number is?
    a. 72 b. 24 c. 36 d. 44

5. The mean monthly salary paid to 75 workers in a factory is Rs. 5680. The mean salary of 25 of them is Rs. 5400 and that of 30 others is Rs. 5700. The mean salary of the remaining workers is?
    a. Rs. 5000 b. Rs. 7000 c. Rs. 6000 d. Rs. 8000

6. The average monthly expenditure of a family was Rs. 2200 during the first 3 months; Rs. 2250 during the next 4 months and Rs. 3120 during the last 5 months of a year. If the total savings during the year were Rs. 1260, then the average monthly income was?
    a. Rs. 2605 b. Rs. 2805 c. Rs. 2705 d. Rs. 2905

7. There are four friends. The average score in unit test of the first three is 15 and that of the last three is 16. If the score of the last friend is 19, then first friend's score is what percent of sum of the last three?
    a. $66\frac{2}{3}\%$ b. 300%
    c. $33\frac{5}{6}\%$ d. None of these

8. The average marks of a student in 8 subjects is 87. Of these, the highest marks is 2 more than the one next in value. If these two subjects are eliminated, the average marks of the remaining subjects is 85. What is the highest marks obtained by him?
    a. 94 b. 91 c. 89 d. 96

9. The average of 3 children in a family is 20% of the average age of the father and the eldest child. The total age of the mother and the youngest child is 39 years. If the father's age is 26 years, what is the age of the second child?
    a. 20 years b. 18 years
    c. 15 years d. Cannot be determined

10. The average score of boys in an examination in a school is 71 and that of the girls is 73. The average score of the school is 71.8. The ratio of the number of boys to that of the girls that appeared in the examination is?
    a. 1 : 2 b. 3 : 2 c. 2 : 3 d. 4 : 2

11. The average age of a husband, his wife and son 3 years ago was 27 years and that of his wife and son 5 years ago was 20 years. What is the husband's present age?

a. 35 years b. 32 years c. 37 years d. 40 years

12. The average weight of 45 students in a class is 52 kg. 5 of them whose average weight is 48 kg leave this class and other 5 students whose average weight is 54 kg join the class. What is the new average weight (in kg) of the class?

    a. 52.6 b. $52\frac{2}{3}$

    c. $52\frac{1}{3}$ d. None of these

13. Nine persons went to a hotel for taking their meals. Eight of them spent Rs. 12 each over their meals and the ninth spent Rs. 8 more than the average expending of all the nine. Total money spent by them was?
    a. Rs. 104 b. Rs. 105 c. Rs. 116 d. Rs. 117

14. Two varieties of sugar are mixed in the ratio 2 : 3. The price of the mixture is Rs. 12 per kg and the price of the variety having lower weight is Rs. 10 per kg. Find the price of the other variety?
    a. 11 per kg b. 12.45 per kg
    c. 13.33 per kg d. 11.33 per kg

15. A class of 15 students got an average of 64 marks in an exam, while another class of 60 students got an average of 44 marks in the same exam. If all the students are combined into one class, then what will be the average marks of the class in the exam?
    a. 52 b. 44 c. 48 d. 46

16. 6 kg of fine quality of sugar is mixed with 30 kg of inferior quality sugar. The price of fine quality and inferior quality sugar is Rs. 18 and Rs. 12 respectively The average price per kg of the mixture is:
    a. Rs. 17 b. Rs. 13 c. Rs. 20 d. Rs. 18

17. Rashmi purchases two flats for Rs. 80 lakhs. She sells one at a loss of 10% and the other at a gain 15%. She looses 5% in the entire transaction. The cost of each flat is?
    a. 64 *l*, 16 *l* b. 30 *l*, 50 *l*
    c. 25 *l*, 55 *l* d. 20 *l*, 60 *l*

18. In what ratio should water and milk be mixed so that after selling the mixture at the cost price a profit of 16.67% is made?
    a. 1 : 2 b. 1 : 4 c. 1 : 6 d. 7 : 3

19. How many kg of mangoes at Rs. 42 per kg must a seller mix with 25 kg of mangoes at Rs. 24 per kg so that he may, on selling the mixture at Rs. 40 per kg, gain 25% on the outlay?
    a. 28 kg b. 20 kg c. 24 kg d. 25 kg

20. In a 80 litre mixture of water and milk, water is only 20%. The milkman gives 20 litres 'of this' mixture to a customer and then he adds up 20 litres of pure water in the remaining mixture. The percentage of water in the final mixture is:
    a. 60% b. 52% c. 48% d. 40%

21. Two vessels *A* and *B* contain alcohol and water in the ratios of 5 : 2 and 7 : 6, respectively. Find the ratio in which these mixtures are to be mixed to get a new mixture containing alcohol and water in the ratio of 8 : 5.
    a. 5 : 2 b. 7 : 9 c. 3 : 5 d. 4 : 3

22. A mixture of rice is sold at Rs. 3.00 per kg. This mixture is formed by mixing the rice of Rs. 2.10 and Rs. 2.85 per kg. What is the ratio of price of cheaper to the costlier quality in the mixture if the profit of 10% on S.P. is being earned.
    a. 4 : 1 b. 2 : 7 c. 2 : 3 d. 1 : 4

23. 32 litres of milk and water solution contains 94% milk. How much water should be added to this solution to reduce its concentration to 64%?
    a. 18 *l* b. 15 *l* c. 21 *l* d. 30 *l*

24. A milkman has 40 litres of milk. He mixes 8 litres of water, which is freely available, in 40 litres of pure milk. If the cost of pure milk is Rs. 22 per litre, then the profit of the milkman, if he sells all the mixture at cost price, is:
    a. 25% b. 20% c. 33.33% d. 9.09%

25. Rakhi travels 60 minutes at the speed of 25 km/hr. Further she travels 40 minutes at the speed of 40 km/hr. Find his average speed.
    a. 31 km/hr. b. 30 km/hr.

c. 28 km/hr. d. 26 km/hr.

26. How many litres of water must be added to 20 litres of 24% solution of wine in water to make it a 15% solution of wine in water?
a. 24 b. 12 c. 22 d. 18

27. A mixture of water and wine contains 80% wine. In 60 litres of such a mixture, how many litres of water is required to increase the percentage of water to, 60%?
a. 25 b. 40
c. 48 d. None of these

28. In what ratio should freely available water be mixed with the wine worth Rs. 70 per litre so that after selling the mixture at Rs. 50 per litre, the profit will be 25%?
a. 2 : 1 b. 3 : 5 c. 3 : 4 d. 1 : 5

29. Two solutions contain petrol and diesel in the ratio 3 : 2 and 3 : 7. In what ratio should the two solutions be mixed so that the ratio of the petrol and the diesel in the final mixture is 9 : 11?
a. 3 : 7 b. 3 : 1 c. 1 : 1 d. 2 : 5

30. How much of sugar costing Rs. 36.60 per kg be mixed with 65 kg of sugar costing Rs. 17.10 per kg so that the mixture may cost Rs. 24 per kg?
a. 32.5 kg b. 35.6 kg c. 38.5 kg d. 44.5 kg

31. Two alloys containing nickel and zinc in the ratio of 2 : 3 and 7 : 3 are melted and mixed in the ratio of 2 : 1 to get a new alloy. Find the ratio of nickel to zinc in the new alloy.
a. 4 : 5 b. 1 : 4 c. 1 : 2 d. 2 : 3

32. A mixture of a certain quantity of milk with 9 litres of water is worth Rs. 9 per litre. If pure milk is worth Rs. 10.80 per litre, how much milk is there in the mixture?
a. 25 litres b. 45 litres c. 70 litres d. 50 litres

33. A butler stole wine from a butt of sherry which contained 30% of spirit and he replaced what he had stolen by wine containing 12% of spirit. The butt was then of 15% strength only. How much of the butt did he steal?
a. $\frac{1}{6}$th b. $\frac{5}{6}$th c. $\frac{1}{3}$rd d. $\frac{1}{2}$nd

34. Three mixtures containing water and alcohol in the ratio of 5 : 2, 3 : 4 and 1 : 6 are mixed in equal quantities. The ratio of water to alcohol in the resulting mixture is?
a. 3 : 4 b. 2 : 5 c. 5 : 3 d. 7 : 4

35. Some amount of Rs. 6000 was lent out at 10% per annum and the rest amount at 20% per annum and thus in 4 years the total interest from both the amounts collected was Rs. 4200. What is the amount which was lent out at 10% per annum?
a. Rs. 2800 b. Rs. 3500 c. Rs. 4500 d. Rs. 1500

36. A milkman has two types of milk. In the first container the percentage of milk is 40% and in the second container the percentage of milk is 30%. If he mixes 28 litres of milk of the first container to the 32 litres of milk of the second container, then the percentage of milk in the mixture is:
a. 33.99 b. 34.66 c. 30.28 d. 38.75

37. When 7 litres of milk at Rs. 30 per litre is mixed with 4 litres of another brand of milk, the resultant mixture costs Rs. 23 per litre. What is the cost (per litre) of the 3 litre milk brand?
a. 9.33 b. 6.67 c. 10.75 d. 11.25

38. There are 70 students in a class, Rs. 84 are distributed among them so that each boy gets Rs. 1.6 and each girl gets Rs. 0.60. Find the numbers of boys in the class?
a. 28 b. 30 c. 35 d. 42

39. Of three numbers, the average of the first and the second is greater than the average of the second and the third by 30. What is the difference between the first and the third numbers?
a. 15 b. 45
c. 60 d. Cannot be determined

40. The milk and water in two vessels *A* and *B* are in the ratio 2 : 5 and 1 : 4 respectively. In what ratio the liquids in both the vessels be mixed to obtain a new mixture in vessel *C* consisting milk and water in the ration 1 : 3 ?
    a. 7 : 5 b. 8 : 3 c. 4 : 3 d. 3 : 2

41. 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 gain of 10% by selling the mixture at Rs.9.24 per kg?
    a. 50 kg b. 77 kg c. 60 kg d. 63 kg

42. One quantity of rice at Rs. 9.30 per kg is mixed with another quality at a certain rate in the ratio 8 : 7. If the mixture so formed be worth Rs. 10 per kg, what is the rate per kg of the second quality of rice?
    a. Rs. 10.80 b. Rs. 12.87
    c. Rs. 15.15 d. Rs. 47.63

43. 8 litres are drawn from a cask filled with 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 total solution is 16 : 81. How much wine did the cask hold originally?
    a. 72 litres b. 48 litres c. 24 litres d. 16 litres

44. A vessel is filled with liquid, 5 parts of which are water and 7 parts 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. $\frac{12}{7}$ b. $\frac{1}{5}$ c. $\frac{2}{5}$ d. $\frac{1}{7}$

45. Coffee worth Rs. 128 per kg and Rs. 133 per kg are mixed with a third variety in the ratio 1 : 1 : 2. If the mixture is worth Rs. 153 per kg, the price of the third variety per kg will be:
    a. Rs. 173.50 b. Rs. 175.50
    c. Rs. 170 d. Rs. 169.50

46. 800 gm spirit solution has 40 % spirit in it, how many grams of spirit should be added to make it 60 % in the solution?
    a. 400 b. 560 c. 480 d. 320

47. Milk and water are mixed in a vessel *A* in the ratio 5 : 3 and in vessel *B* in ratio 9 : 7. In what ratio should quantities be taken from the two vessels so as to form a mixture in which milk and water will be in the proportion of 7 : 5?
    a. 3 : 2 b. 3 : 1 c. 4 : 1 d. 2 : 1

48. In what proportion must water be mixed with wine to gain 20 % by selling it at cost price?
    a. 1 : 5 b. 1 : 4 c. 1 : 3 d. 2 : 5

49. A vessel is filled with liquid, 3 parts of which are water and 5 parts milk. How much of the mixture must be drawn off and replaced with water so that the mixture may be half water and half milk?
    a. $\frac{1}{3}$ b. $\frac{1}{4}$ c. $\frac{1}{5}$ d. $\frac{1}{7}$

50. Two vessles of equal capacity are full of a mixture of syrup and water. In the first, the ratio of syrup to water is 4 : 7 and in the second it is 7 : 11. Now both the mixtures are mixed in a bigger container. What is the resulting ratio of syrup and water?
    a. 241 : 143 b. 149 : 247
    c. 143 : 241 d. 247 : 149

Practice Exercise – Difficult

1. 20% of the employees in a factory are workers. All the remaining employees are executives. The annual income of each worker is Rs. 390. The annual income of each executive is Rs. 420. What is the average annual income of all the employees in the factory together?
    a. 410 b. 416 c. 418 d. 424

2. The average price of 10 books is Rs.12 while the average price of 8 of these books is Rs.11.75. Of the remaining two books, if the price of one book is 60% more than the price of the other, what is the price of each of these two books?
    a. Rs. 10, Rs.16 b. Rs. 12, Rs. 14
    c. Rs. 8, Rs. 18 d. Rs. 6, Rs. 20

3. In a set of three numbers, the average of first two numbers is 4, the average of the last two numbers is 5, and the average of the first and the last numbers is 9. What is the average of three numbers?
   a. 6 b. 6.5 c. 7 d. 7.5

4. In 2013, the arithmetic mean of the annual incomes of Ram and Shyam was Rs. 3800. The arithmetic mean of the annual incomes of Shyam and Pratap was Rs. 4800, and the arithmetic mean of the annual incomes of Pratap and Ram was Rs. 5800. What is the arithmetic mean of the incomes of the three?
   a. Rs. 4800 b. Rs. 5600
   c. Rs. 4200 d. Rs. 5000

5. The average of 5 consecutive numbers is 21. What will be the 8^{th} number?
   a. 24 b. 25 c. 26 d. 27

6. The average age of husband, wife and their child 3 years ago was 27 years and that of husband and the child 5 years ago was 20 years. What is the present age of the wife?
   a. 28 b. 30 c. 32 d. 40

7. 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 water is 16 : 65. How much wine did the cask hold originally?
   a. 48 litres b. 24 litres c. 36 litres d. 56 litres

8. In what ratio must a person mix three kinds of coffee costing Rs.60/kg, Rs.75/kg and Rs.100 /kg so that the resultant mixture when sold at Rs.96/kg yields a profit of 20%?
   a. 1 : 4 : 2 b. 1 : 3 : 2
   c. 3 : 9 : 7 d. None of these

9. From a tank of petrol, which contains 400 litres of petrol, the seller replaces each time with kerosene when he sells 80 litres of petrol(or its mixture). Everytime he sells out only 80 litres of petrol(pure or impure). After replacing the petrol with kerosene 4th time, the total amount of kerosene in the mixture is:
   a. 156.64 b. 236.16
   c. 273.72 d. None of these

10. From a container of wine, a thief has stolen 15 litres of wine and replaced it with same quantity of water. He again repeated the same process. Thus, in three attempts the ratio of wine and water became 729 : 271. The initial amount of wine in the container was:
   a. 75 litres b. 100 litres
   c. 150 litres d. 120 litres

11. After the results of an examination, when the scores of the top four students are deleted the average score of the remaining 66 students falls by 6 marks. Assume that it is possible for two or more students to have the same net score. What is the minimum score possible for the fourth ranking student if no student got a net score of more then 352?
   a. 308 b. 280 c. 300 d. 320

12. From a 3 : 5 solution of milk and water, 20% is taken out and replaced by milk. How many times should this process be done to make the ratio of milk to water as 17 : 8?
   a. Four times b. Thrice
   c. Twice d. Once

13. 4 kg of a metal contains $\frac{1}{5}$ iron and rest is copper. Another 5 kg of metal contains $\frac{1}{6}$ iron and rest is copper. The ratio of iron and copper into the mixture of these two metals:
   a. 94 : 181 b. 49 : 231
   c. 49 : 221 d. None of these

14. In a mixture of milk and water, there is only 48% water. After replacing the mixture with 7 litres of pure milk. The percentage of milk in the mixture becomes 64%. The quantity of mixture is:
   a. 91 litres b. 28 litres
   c. 42 litres d. None of these

15. The diluted wine contains only 6 litres of wine and the rest is water. A new mixture whose concentration is 50% is to be formed by replacing wine. How many litres of mixture be replaced with pure wine of there are initially 18 litres of water in the mixture?
    a. 5 litres b. 6 litres c. 8 litres d. 12 litres

16. Rahim sells two types of coffees viz. Desi Coffee and Videshi Coffee. He sells Desi Coffee at Rs. 18 per kg and incurs a loss of 10% whereas on selling the Videshi Coffee at Rs. 30 per kg, he gains 20%. In what proportion should the Desi Coffee and Videshi Coffee be mixed such that he can gain a profit of 25% by selling the mixture at Rs. 27.5 per kg?
    a. 5 : 3 b. 3 : 2 c. 2 : 3 d. 7 : 4

17. A litre of glycerine was poured out of a vessle filled up with pure glycerine to the brim and a litre of water was poured in. After the solution was mixed up, a litre of the mixture was poured out again and a litre of water was added. As a result of these operations, there was three time as much water in the vessel (by volume) as the remaining glycerine. How many litres of glycerine remains in the vessel as a result of the operations performed?
    a. .25 litres b. .50 litres
    c. .75 litres d. 1.5 litres

18. From a 10 litres flask full of milk, 2 litres is emptied and refilled with water. Now from the mixture, the same amount is removed and the flask is refilled with water. How many times should the process be repeated so that the flask has less than 50% milk?
    a. 6 b. 3 c. 5 d. 4

19. One vessel contains syrup and water in the ratio $a : b$, while another vessel contains syrup and water in the ratio $b : a$. In what ratio must the contents of the first vessel be mixed with the contents of the second, so that in the final sample, syrup and water may be as 2 : 1?
    a. $(2a + b) : (a + 2b)$ b. $(2a - b) : (a + b)$
    c. $(a + b) : (a - b)$ d. $(a - b) : (a + b)$

20. There are two identical vessels A and B. B is filled with water to the brim and A is empty. There are two pails X and Y, such that Y can hold half as much water as X. One operation is said to be executed when water is transferred from B to A using X once and water is transferred to B from A using Y once. If X can hold $\frac{1}{2}$ 1/2 a litre of water and it takes 40 operations to equate the water level in A and B, what is the total volume of water in the system?
    a. 10 litres b. 20 litres
    c. 40 litres d. $20\frac{3}{4}$ litres

21. A 10 litres cylinder contains a mixture of water and sugar, the volume of sugar being 15% of total volume. A few litres of the mixture is released and an equal amount of water is added. Then the same amount of the mixture as before is released and replaced with water for a second time. As a result, the sugar content becomes 10% of total volume. What is the approximate quantity of mixture released each time?
    a. 1 litre b. 1.2 litres c. 1.5 litres d. 2 litres

22. A manufacturer has 200 litres of acid solution which has 15% acid content. How many litres of acid solution with 30% acid content may be added so that acid content in the resulting mixture will be more than 20% but less than 25% ?
    a. More than 100 litres but less than 300 litres.
    b. More than 120 litres but less than 400 litres.
    c. More than 100 litres but less than 400 litres.
    d. None of the above

23. In a certain vessel water to milk ratio is 2 : 1. In another vessel water to milk ratio is 7 : 1. they are mixed in a ratio 9 : 16 to form 100 litres of new mixture. Now, from the mixture, 20 litres is taken out and 10 litres of milk added to it. then 9 litres of mixture is taken out and 5 litres of milk is added to it. Now what is the percentage of milk in the mixture?
    a. 25% b. 40% c. 33% d. 45%

24. Four gallons is drawn from a cask full of petrol. It is then filled with water. Four gallons of mixture is again drawn and the cask is again filled with water. The ratio of quantity of petrol now left in the cask to that of the mixture in it is 36 : 49. How much does the cask hold?
    a. 25 gallons b. 28 gallons
    c. 30 gallons d. 35 gallons

25. A grocer sells one kind of tea at Rs. 2.70 per kg., and loses 10% and another at Rs. 4.50 per kg, and gains $12\frac{1}{2}$ %. How should the two quantities of tea be mixed so that the mixture may be sold at Rs. 3.95 kg at a profit of 25%.

a. 7 : 3 b. 11 : 7 c. 21 : 4 d. 13 : 9