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## ALLIGATION OR MIXTURE

**Alligation:** - It is the rule that enable us to find the ratio in which two or more ingredients at given price must be mixed of desired price.

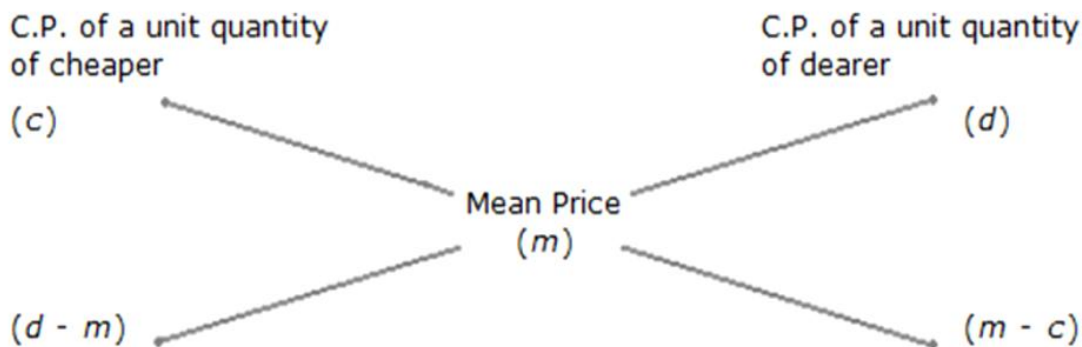
**Mean Price:** - The cost of a unit quantity is called the mean price.

### Rule of Alligation:

If two ingredients are mixed, then

$$\left( \frac{\text{Quantity of cheaper}}{\text{Quantity of dearer}} \right) = \left( \frac{\text{C.P. of dearer} - \text{Mean Price}}{\text{Mean price} - \text{C.P. of cheaper}} \right)$$

We present as under:



$$\therefore (\text{Cheaper quantity}) : (\text{Dearer quantity}) = (d - m) : (m - c).$$

Suppose a container contains  $x$  of liquid from which  $y$  units are taken out and replaced by water.

$$\text{After } n \text{ operations, the quantity of pure liquid} = \left[ x \left( 1 - \frac{y}{x} \right)^n \right] \text{ units.}$$

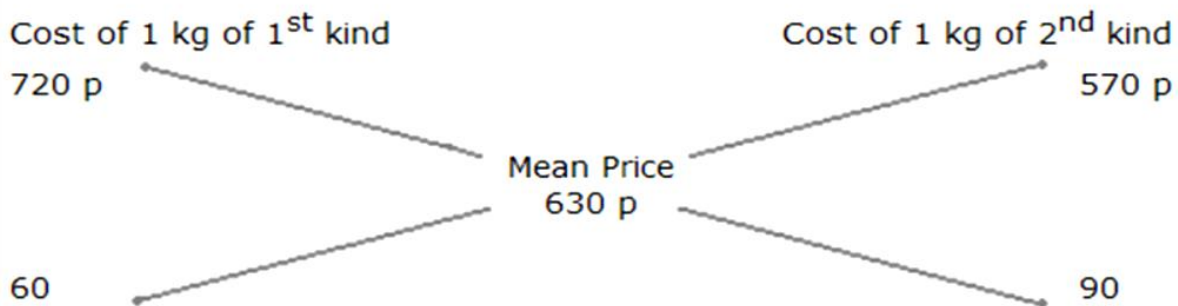
**Question:** - Find the ratio in which rice at Rs. 7.20 a kg be mixed with rice at Rs. 5.70 a kg to produce a mixture worth Rs. 6.30 a kg.

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

**Answer:** Option B

**Explanation:**

By the rule of alligation:



∴ Required ratio = 60 : 90 = 2 : 3.

**Question:** - A container contains 40 litres of milk. From this container 4 litres of milk was taken out and replaced by water. This process was repeated further two times. How much milk is now contained by the container?

- A. 26.34 litres
- B. 27.36 litres
- C. 28 litres
- D. 29.16 litres

**Answer:** Option D

**Explanation:**

$$\text{Amount of milk left after 3 operations} = \left[ 40 \left( 1 - \frac{4}{40} \right)^3 \right] \text{ litres}$$

$$= \left( 40 \times \frac{9}{10} \times \frac{9}{10} \times \frac{9}{10} \right) = 29.16 \text{ litres.}$$

**Question:** - How many kilogram 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

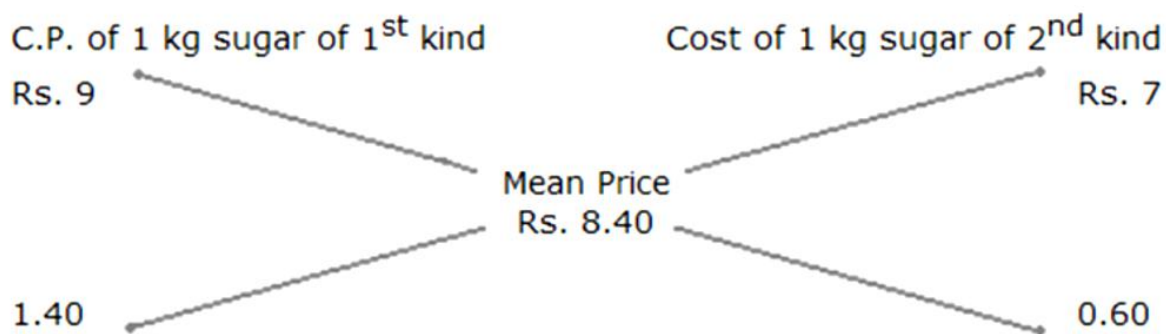
**Answer:** Option D

**Explanation:**

S.P. of 1 kg of mixture = Rs. 9.24, Gain 10%.

$$\therefore \text{C.P. of 1 kg of mixture} = \text{Rs.} \left( \frac{100}{110} \times 9.24 \right) = \text{Rs.} 8.40$$

By the rule of alligation, we have:



$\therefore$  Ratio of quantities of 1<sup>st</sup> and 2<sup>nd</sup> kind = 14 : 6 = 7 : 3.

Let x kg of sugar of 1<sup>st</sup> be mixed with 27 kg of 2<sup>nd</sup> kind.

Then, 7 : 3 = x : 27

$$\Rightarrow x = \left( \frac{7 \times 27}{3} \right) = 63 \text{ kg.}$$

**Question:** - A dishonest milkman professes to sell his milk at cost price but he mixes it with water and thereby gains 25%. The percentage of water in the mixture is:

- A. 4%
- B. 6%
- C. 20%
- D. 25%

**Answer:** Option C

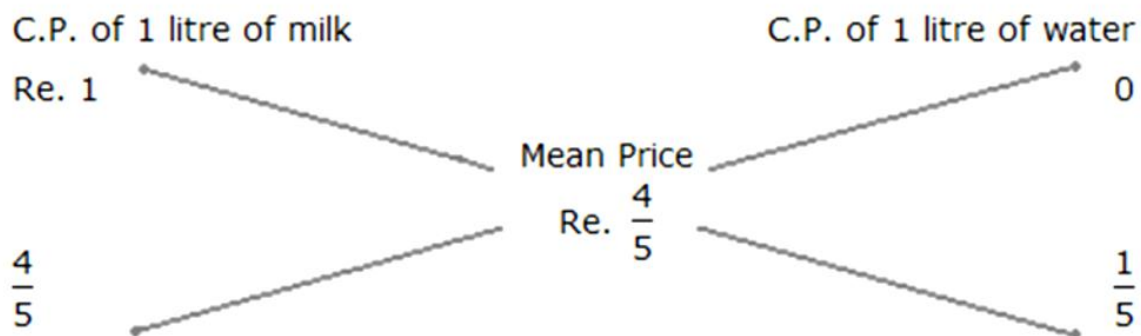
**Explanation:**

Let C.P. of 1 litre milk be Re. 1

Then, S.P. of 1 litre of mixture = Re. 1, Gain = 25%.

$$\text{C.P. of 1 litre mixture} = \text{Re.} \left( \frac{100}{125} \times 1 \right) = \frac{4}{5}$$

By the rule of alligation, we have:



$$\therefore \text{Ratio of milk to water} = \frac{4}{5} : \frac{1}{5} = 4 : 1.$$

$$\text{Hence, percentage of water in the mixture} = \left( \frac{1}{5} \times 100 \right) \% = 20\%.$$

## CHAIN RULE

### Direct Proportion

- Two quantities are said to be directly proportional, if on the increase (or decrease) of the one, the other increases (or decreases) to the same extent.

Eg. Cost is directly proportional to the number of articles. (More Articles, More Cost)

### Indirect Proportion

- Two quantities are said to be indirectly proportional, if on the increase of the one, the other decreases to the same extent and vice-versa.

Eg. The time taken by a car is covering a certain distance is inversely proportional to the speed of the car. (More speed, Less is the time taken to cover a distance.)

- Note: In solving problems by chain rule, we compare every item with the term to be found out.

**Question:** - If 15 toys cost Rs 234, what do 35 toys cost?

- A. Rs. 540
- B. Rs. 546
- C. Rs. 548
- D. Rs. 556

**Answer:** Option B

**Explanation:**

- Let the required cost be Rs  $x$ . Then More toys, More Cost (Direct Proportion)  
»  $15 : 35 :: 234 : x$   
»  $(15x) = (35 \times 234)$   
»  $X = 546$

**Question:** - If 36 men can do a piece of work in 25 hours, in how many hours will 15 men do it?

- A. 60 hours
- B. 50 hours
- C. 66 hours
- D. 70 hours

**Answer:** Option A

**Explanation:**

- Let the required number of hours be Rs  $x$ . Then Less men, More hours (Indirect Proportion)  
»  $15 : 36 :: 25 : x$   
»  $(15x) = (36 \times 25)$   
»  $X = 60$

**Question:** - If the wages of 6 men for 15 days be Rs2100, then find the wages of 9 men for 12 days.

- A. Rs 2520
- B. Rs 2560
- C. Rs 2620
- D. Rs 2650

**Answer:** Option A

**Explanation:**

• Let the required wages be Rs x. Then More men, More wages (Direct Proportion) Less days, Less wages (Direct Proportion)

» Men 6 : 9

» Days 15 : 12 :: 2100 : x

»  $6 * 15 * x = 9 * 12 * 2100$

»  $X = 2520$

## TIME AND WORK

### Work from Days

If A can do a piece of work in  $n$  days, then A's 1 day's work =  $1/n$ .

### Days from Work:

If A's 1 day's work =  $1/n$ , then A can finish the work in  $n$  days.

### Ratio

• If A is thrice as good a workman as B, then:

Ratio of work done by A and B = 3 : 1.

Ratio of times taken by A and B to finish a work = 1 : 3.

**Question:** - Worker A takes 8 hours to do a job. Worker B takes 10 hours to do the same job. How long should it take both A and B, working together, to do the same job?

- A.  $4 \frac{2}{9}$  days
- B.  $4 \frac{4}{9}$  days
- C.  $4 \frac{5}{9}$  days
- D.  $4 \frac{7}{9}$  days

**Answer:** Option B

### Explanation:

A's 1 hour's work =  $1/8$

B's 1 hour's work =  $1/10$

(A+B)'s 1 hour's work =  $(1/8+1/10) = 9/40$

Both A and B will finish the work in  $40/9 = 4 \frac{4}{9}$  days

**Question:** - A and B together can complete a piece of work in 4 days. If A alone can complete the same work in 12 days, in how many days can B alone complete that work?

- A. 6 days
- B. 4 days
- C. 8 days
- D. 9 days

**Answer:** Option A

### Explanation:

(A+B)'s 1 day's work =  $\frac{1}{4}$

A's 1 day's work =  $1/12$

B's 1 day's work =  $\frac{1}{4} - 1/12 = 1/6$

B alone can complete the work in 6 days.

**Question:** - A is twice as good a workman as B and together they finish a piece of work in 18 days. In how many days will A alone finish the work?

- A. 27 days
- B. 24 days
- C. 28 days
- D. 29 days



**Answer:** Option A

**Explanation:**

(A's 1 day's work) : (B's 1 day's work) = 2 : 1

(A+B)'s 1 day's work =  $1/18$

Divide  $1/18$  in the ratio 2 : 1

A's 1 days work =  $1/18 \times 2/3 = 1/27$

So, A alone can finish the work in 27 days.

**Question:** - A and B working separately can do a piece of work in 9 and 12 days respectively. If they work for a day alternately, A beginning, in how many days, the work will be completed?

- A.  $10 \frac{1}{4}$  days
- B.  $10 \frac{1}{2}$  days
- C.  $8 \frac{1}{4}$  days
- D.  $8 \frac{1}{2}$  days

**Answer:** Option A

**Explanation:**

(A+B)'s 2 day's work =  $1/9 + 1/12 = 7/36$

Work done in 5 pairs of days =  $5 \times 7/36 = 35/36$

Remaining work =  $1 - 35/36 = 1/36$

On 11th day, it is A's turn.

$1/9$  work done by him in 1 day.

$1/36$  work done by him in  $(9 \times 1/36) = 1/4$  days.

Total time taken =  $10 + 1/4 = 10 \frac{1}{4}$  days.

**Question:** - 45 men can complete a work in 16 days. Six days after they started working, 30 more men joined them. How many days will they now take to complete the remaining work?

- A. 6 days
- B. 4 days
- C. 8 days
- D. 9 days

**Answer:** Option A

**Explanation:**

45 men can complete the work in 16 days.

(45x16) men can complete the work in 1 day.

1 man's 1 day's work =  $1/720$

45 men's 6 day's work =  $45/720 \times 6 = 3/8$

Remaining work =  $1 - 3/8 = 5/8$

75 men's 1 day's work =  $75/720 = 5/48$ .

Now,  $5/48$  work is done by them in 1 day.

So,  $5/8$  work is done by them in  $48/5 \times 5/8 = 6$  days

## PIPES AND CISTERNS

### Inlet

- A pipe connected with a tank or a cistern or a reservoir, that fills it, is known as an inlet.

### Outlet

- A pipe connected with a tank or cistern or reservoir, emptying it, is known as an outlet.

- If a pipe can fill a tank in  $x$  hours, then part filled in 1 hour =  $1/x$
- If a pipe can empty a tank in  $y$  hours, then part emptied in 1 hour =  $1/y$
- If a pipe can fill a tank in  $x$  hours and another pipe can empty the full tank in  $y$  hours (where  $y > x$ ), then on opening both the pipes, the net part filled in 1 hour =  $(1/x) - (1/y)$ .
- If a pipe can fill a tank in  $x$  hours and another pipe can empty the full tank in  $y$  hours (where  $x > y$ ), then on opening both the pipes, the net part emptied in 1 hour =  $(1/y) - (1/x)$ .

**Question:** - A tank is filled in 5 hours by three pipes A, B and C. The pipe C is twice as fast as B and B is twice as fast as A. How much time will pipe A alone take to fill the tank?

- A. 20 hours
- B. 25 hours
- C. 35 hours
- D. Cannot be determined
- E. None of these

**Answer:** Option C

### Explanation:

Suppose pipe A alone takes  $x$  hours to fill the tank.

Then, pipes B and C will take  $\frac{x}{2}$  and  $\frac{x}{4}$  hours respectively to fill the tank.

$$\therefore \frac{1}{x} + \frac{2}{x} + \frac{4}{x} = \frac{1}{5}$$

$$\Rightarrow \frac{7}{x} = \frac{1}{5}$$

$$\Rightarrow x = 35 \text{ hrs.}$$

**Question:** - Two pipes A and B together can fill a cistern in 4 hours. Had they been opened separately, then B would have taken 6 hours more than A to fill the cistern. How much time will be taken by A to fill the cistern separately?

- A. 1 hour
- B. 2 hours
- C. 6 hours
- D. 8 hours

**Answer:** Option C

**Explanation:**

Let the cistern be filled by pipe A alone in  $x$  hours.

Then, pipe B will fill it in  $(x + 6)$  hours.

$$\therefore \frac{1}{x} + \frac{1}{(x + 6)} = \frac{1}{4}$$

$$\Rightarrow \frac{x + 6 + x}{x(x + 6)} = \frac{1}{4}$$

$$\Rightarrow x^2 - 2x - 24 = 0$$

$$\Rightarrow (x - 6)(x + 4) = 0$$

$$\Rightarrow x = 6. \quad [\text{neglecting the negative value of } x]$$

**Question:** - Two pipes A and B can fill a tank in 15 minutes and 20 minutes respectively. Both the pipes are opened together but after 4 minutes, pipe A is turned off. What is the total time required to fill the tank?

- A. 10 min. 20 sec.
- B. 11 min. 45 sec.
- C. 12 min. 30 sec.
- D. 14 min. 40 sec.

**Answer:** Option D

**Explanation:**

$$\text{Part filled in 4 minutes} = 4 \left( \frac{1}{15} + \frac{1}{20} \right) = \frac{7}{15}.$$

$$\text{Remaining part} = \left( 1 - \frac{7}{15} \right) = \frac{8}{15}.$$

$$\text{Part filled by B in 1 minute} = \frac{1}{20}$$

$$\therefore \frac{1}{20} : \frac{8}{15} :: 1 : x$$

$$x = \left( \frac{8}{15} \times 1 \times 20 \right) = 10\frac{2}{3} \text{ min} = 10 \text{ min. } 40 \text{ sec.}$$

$\therefore$  The tank will be full in  $(4 \text{ min.} + 10 \text{ min.} + 40 \text{ sec.}) = 14 \text{ min. } 40 \text{ sec.}$

## TIME AND DISTANCE

### 1. Speed, Time and Distance:

$$\text{Speed} = \left( \frac{\text{Distance}}{\text{Time}} \right), \text{ Time} = \left( \frac{\text{Distance}}{\text{Speed}} \right), \text{ Distance} = (\text{Speed} \times \text{Time}).$$

### 2. km/hr to m/sec conversion:

$$x \text{ km/hr} = \left( x \times \frac{5}{18} \right) \text{ m/sec.}$$

### 3. m/sec to km/hr conversion:

$$x \text{ m/sec} = \left( x \times \frac{18}{5} \right) \text{ km/hr.}$$

4. If the ratio of the speeds of A and B is  $a : b$ , then the ratio of the

the times taken by them to cover the same distance is  $\frac{1}{a} : \frac{1}{b}$  or  $b : a$ .

5. Suppose a man covers a certain distance at  $x$  km/hr and an equal distance at  $y$  km/hr. Then,

the average speed during the whole journey is  $\left( \frac{2xy}{x+y} \right)$  km/hr.

**Question:** - A person crosses a 600 m long street in 5 minutes. What is his speed in km per hour?

- A. 3.6
- B. 7.2
- C. 8.4
- D. 10

**Answer:** Option B

**Explanation**

$$\text{Speed} = \left( \frac{600}{5 \times 60} \right) \text{m/sec.}$$

$$= 2 \text{ m/sec.}$$

Converting m/sec to km/hr

$$= \left( 2 \times \frac{18}{5} \right) \text{km/hr}$$

$$= 7.2 \text{ km/hr.}$$

**Question:** - If a person walks at 14 km/hr instead of 10 km/hr, he would have walked 20 km more. The actual distance travelled by him is:

- A. 50 km
- B. 56 km
- C. 70 km
- D. 80 km

**Answer:** Option A

**Explanation**

Let the actual distance travelled be  $x$  km.

$$\text{Then, } \frac{x}{10} = \frac{x + 20}{14}$$

$$\Rightarrow 14x = 10x + 200$$

$$\Rightarrow 4x = 200$$

$$\Rightarrow x = 50 \text{ km.}$$

**Question:** - Excluding stoppages, the speed of a bus is 54 kmph and including stoppages, it is 45 kmph. For how many minutes does the bus stop per hour?

- A. 9
- B. 10
- C. 12
- D. 20

**Answer:** Option B

**Explanation**

Due to stoppages, it covers 9 km less.

$$\text{Time taken to cover 9 km} = \left( \frac{9}{54} \times 60 \right) \text{min} = 10 \text{ min.}$$

**Question:** - A train can travel 50% faster than a car. Both start from point A at the same time and reach point B 75 kms away from A at the same time. On the way, however, the train lost about 12.5 minutes while stopping at the stations. The speed of the car is:

- A. 100 kmph
- B. 110 kmph
- C. 120 kmph
- D. 130 kmph

**Answer:** Option C

**Explanation**

Let speed of the car be  $x$  kmph.

$$\text{Then, speed of the train} = \frac{150}{100}x = \left( \frac{3}{2}x \right) \text{ kmph.}$$

$$\therefore \frac{75}{x} - \frac{75}{(3/2)x} = \frac{125}{10 \times 60}$$

$$\Rightarrow \frac{75}{x} - \frac{50}{x} = \frac{5}{24}$$

$$\Rightarrow x = \left( \frac{25 \times 24}{5} \right) = 120 \text{ kmph.}$$

**Question:** - A man complete a journey in 10 hours. He travels first half of the journey at the rate of 21 km/hr and second half at the rate of 24 km/hr. Find the total journey in km.

- A. 220 km
- B. 224 km
- C. 230 km
- D. 234 km

**Answer:** Option B

**Explanation**

$$\frac{(1/2)x}{21} + \frac{(1/2)x}{24} = 10$$
$$\Rightarrow \frac{x}{21} + \frac{x}{24} = 20$$
$$\Rightarrow 15x = 168 \times 20$$
$$\Rightarrow x = \left( \frac{168 \times 20}{15} \right) = 224 \text{ km.}$$

**Question:** - A man on tour travels first 160 km at 64 km/hr and the next 160 km at 80 km/hr. The average speed for the first 320 km of the tour is:

- A. 35.55 km/hr
- B. 36 km/hr
- C. 71.11 km/hr
- D. 71 km/hr

**Answer:** Option C

**Explanation**

$$\text{Total time taken} = \left( \frac{160}{64} + \frac{160}{80} \right) \text{hrs.} = \frac{9}{2} \text{ hrs.}$$
$$\therefore \text{Average speed} = \left( 320 \times \frac{2}{9} \right) \text{km/hr} = 71.11 \text{ km/hr.}$$

**Question:** - In covering a distance of 30 km, Abhay takes 2 hours more than Sameer. If Abhay doubles his speed, then he would take 1 hour less than Sameer. Abhay's speed is:

- A. 5 kmph
- B. 6 kmph
- C. 6.25 kmph
- D. 7.5 kmph

**Answer:** Option A

**Explanation**

Let Abhay's speed be  $x$  km/hr.

$$\text{Then, } \frac{30}{x} - \frac{30}{2x} = 3$$

$$\Rightarrow 6x = 30$$

$$\Rightarrow x = 5 \text{ km/hr.}$$



## PERCENTAGE

### Percentage

• A fraction whose denominator is 100 is called a percentage, and the numerator of fraction is called the rate percent.

To express  $x\%$  as a fraction: We have,  $x\% = \frac{x}{100}$ .

$$\text{Thus, } 20\% = \frac{20}{100} = \frac{1}{5}.$$

To express  $\frac{a}{b}$  as a percent: We have,  $\frac{a}{b} = \left(\frac{a}{b} \times 100\right)\%$ .

$$\text{Thus, } \frac{1}{4} = \left(\frac{1}{4} \times 100\right)\% = 25\%.$$

### Percentage Increase / Decrease

If the price of a commodity increases by  $R\%$ , then the reduction in consumption so as not to increase the expenditure is:

$$\left[\frac{R}{(100 + R)} \times 100\right]\%$$

If the price of a commodity decreases by  $R\%$ , then the increase in consumption so as not to decrease the expenditure is:

$$\left[\frac{R}{(100 - R)} \times 100\right]\%$$

If A is  $R\%$  more than B, then B is less than A by  $\left[\frac{R}{(100 + R)} \times 100\right]\%$ .

If A is  $R\%$  less than B, then B is more than A by  $\left[\frac{R}{(100 - R)} \times 100\right]\%$ .

## Results on Population

Let the population of a town be  $P$  now and suppose it increases at the rate of  $R\%$  per annum, then:

1. Population after  $n$  years =  $P \left( 1 + \frac{R}{100} \right)^n$

2. Population  $n$  years ago =  $\frac{P}{\left( 1 + \frac{R}{100} \right)^n}$

## Results on Depreciation

Let the present value of a machine be  $P$ . Suppose it depreciates at the rate of  $R\%$  per annum. Then:

Value of the machine after  $n$  years =  $P \left( 1 - \frac{R}{100} \right)^n$

Value of the machine  $n$  years ago =  $\frac{P}{\left( 1 - \frac{R}{100} \right)^n}$

**Question:** - A batsman scored 110 runs which included 3 boundaries and 8 sixes. What percent of his total score did he make by running between the wickets?

- A. 45%
- B. 45 5/11 %
- C. 54 6/11 %
- D. 55%

**Answer:** Option B

**Explanation:**

$$\begin{aligned}\text{Number of runs made by running} &= 110 (3 \times 4 + 8 \times 6) \\ &= 110 - (60) \\ &= 50.\end{aligned}$$

$$\text{Required percentage} = 50/110 \times 100 \% = 45 \frac{5}{11} \%$$

**Question:** - Two students appeared at an examination. One of them secured 9 marks more than the other and his marks was 56% of the sum of their marks. The marks obtained by them are:

- A. 39, 30
- B. 41, 32
- C. 42, 33
- D. 43, 34

**Answer:** Option C

**Explanation:**

Let their marks be  $(x + 9)$  and  $x$ .

$$\text{Then, } (x + 9) / (x + 9 + x) * 100 = 56$$

$$x = 33$$

So, their marks are 42 and 33.

**Question:** - A fruit seller had some apples. He sells 40% apples and still has 420 apples. Originally, he had:

- A. 588 apples
- B. 600 apples
- C. 672 apples
- D. 700 apples

**Answer:** Option D

**Explanation:**

Suppose originally he had  $x$  apples.

$$\text{Then, } (100 - 40)\% \text{ of } x = 420.$$

$$60 / 100 * x = 420$$

$$x = 420 * 100 / 60 = 700$$

**Question:** - If  $A = x\%$  of  $y$  and  $B = y\%$  of  $x$ , then which of the following is true?

- A. A is smaller than B.
- B. A is greater than B
- C. Relationship between A and B cannot be determined.
- D. If  $x$  is smaller than  $y$ , then A is greater than B.
- E. None of these

**Answer:** Option E

**Explanation:**

$$x\% \text{ of } y = (x/100) \times y = (y/100) \times x = y\% \text{ of } x$$

$$A = B.$$

**Question:** - If  $20\%$  of  $a = b$ , then  $b\%$  of  $20$  is the same as:

- A.  $4\%$  of  $a$
- B.  $5\%$  of  $a$
- C.  $20\%$  of  $a$
- D. None of these

**Answer:** Option A

**Explanation:**

$$20\% \text{ of } a = b \text{ So, } 20 a / 100 = b.$$

$$\text{Now } b\% \text{ of } 20 = b / 100 \times 20$$

By putting value of  $b$

$$\begin{aligned} b\% \text{ of } 20 &= (20 a \times 1 \times 20) / (100 * 100) \\ &= 4/100 * a = 4\% \text{ of } a. \end{aligned}$$

**Question:** - In an election between two candidates, one got  $55\%$  of the total valid votes,  $20\%$  of the votes were invalid. If the total number of votes was  $7500$ , the number of valid votes that the other candidate got, was:

- A.  $2700$
- B.  $2900$
- C.  $3000$
- D.  $3100$

**Answer:** Option A

**Explanation:**

$$\text{Number of valid votes} = 80\% \text{ of } 7500 = 6000.$$

$$\text{Valid votes polled by other candidate} = 45\% \text{ of } 6000$$

$$= 45/100 * 6000 = 2700.$$

**Question:** - Gauri went to the stationers and bought things worth Rs. 25, out of which 30 paise went on sales tax on taxable purchases. If the tax rate was 6%, then what was the cost of the tax free items?

- A. Rs. 15
- B. Rs. 15.70
- C. Rs. 19.70
- D. Rs. 20

**Answer:** Option C

**Explanation:**

Let the amount taxable purchases be Rs.  $x$ .

Then, 6% of  $x = 30 / 100$

$$x = (30/100) * (100/6) = 5.$$

$$\text{Cost of tax free items} = \text{Rs. } [25 - (5 + 0.30)] = \text{Rs. } 19.70$$

**Question:** - Rajeev buys good worth Rs. 6650. He gets a rebate of 6% on it. After getting the rebate, he pays sales tax @ 10%. Find the amount he will have to pay for the goods.

- A. Rs. 6876.10
- B. Rs. 6999.20
- C. Rs. 6654
- D. Rs. 7000

**Answer:** Option A

**Explanation:**

$$\text{Rebate} = 6\% \text{ of Rs. } 6650 = \text{Rs. } 6/100 * 6650 = \text{Rs. } 399.$$

$$\text{Sales tax} = 10\% \text{ of Rs. } (6650 - 399) = \text{Rs. } 625.10$$

$$\text{Final amount} = \text{Rs. } (6251 + 625.10) = \text{Rs. } 6876.10$$

## PROFIT AND LOSS

- **Cost Price:** The price, at which an article is purchased, is called its cost price, abbreviated as C.P.
- **Selling Price:** The price, at which an article is sold, is called its selling prices, abbreviated as S.P.
- **Profit or Gain:**
  - If S.P. is greater than C.P., the seller is said to have a profit or gain.
  - If S.P. is less than C.P., the seller is said to have incurred a loss.

### Important Formulae

1.  $\text{Gain} = (\text{S.P.}) - (\text{C.P.})$

2.  $\text{Loss} = (\text{C.P.}) - (\text{S.P.})$

3. Loss or gain is always reckoned on C.P.

4. Gain Percentage: (Gain %)

$$\text{Gain \%} = \left( \frac{\text{Gain} \times 100}{\text{C.P.}} \right)$$

5. Loss Percentage: (Loss %)

$$\text{Loss \%} = \left( \frac{\text{Loss} \times 100}{\text{C.P.}} \right)$$

6. Selling Price: (S.P.)

$$\text{SP} = \left[ \frac{(100 + \text{Gain \%})}{100} \times \text{C.P.} \right]$$

7. Selling Price: (S.P.)

$$\text{SP} = \left[ \frac{(100 - \text{Loss \%})}{100} \times \text{C.P.} \right]$$

8. Cost Price: (C.P.)

$$\text{C.P.} = \left[ \frac{100}{(100 + \text{Gain \%})} \times \text{S.P.} \right]$$

9. Cost Price: (C.P.)

$$\text{C.P.} = \left[ \frac{100}{(100 - \text{Loss \%})} \times \text{S.P.} \right]$$

10. If an article is sold at a gain of say 35%, then S.P. = 135% of C.P.

11. If an article is sold at a loss of say, 35% then S.P. = 65% of C.P.

12. If a trader professes to sell his goods at cost price, but uses false weights, then

$$\text{Gain \%} = \left[ \frac{\text{Error}}{(\text{True Value}) - (\text{Error})} \times 100 \right] \%$$

**Question:** - Alfred buys an old scooter for Rs. 4700 and spends Rs. 800 on its repairs. If he sells the scooter for Rs. 5800, his gain percent is:

- A.  $4\frac{4}{7}\%$
- B.  $5\frac{5}{11}\%$
- C. 10%
- D. 12%

**Answer:** Option B

**Explanation:**

Cost Price (C.P.) = Rs. (4700 + 800) = Rs. 5500.

Selling Price (S.P.) = Rs. 5800.

Gain = (S.P.) - (C.P.) = Rs.(5800 -5500) = Rs. 300.

Gain % =  $300 / 5500 \times 100\% = 5\frac{5}{11}\%$

**Question:** - The cost price of 20 articles is the same as the selling price of x articles. If the profit is 25%, then the value of x is:

- A. 15
- B. 16
- C. 18
- D. 25

**Answer:** Option B

**Explanation:**

Let C.P. of each article be Re. 1

C.P. of x articles = Rs. x.

S.P. of x articles = Rs. 20.

Profit = Rs. (20 -x).

$$20 - x / x * 100 = 25$$

$$2000 - 100x = 25x$$

$$125x = 2000$$

$$x = 16.$$

## RATIO AND PROPORTION

### Ratio

- The ratio of two quantities a and b in the same units, is the fraction  $a/b$  and we write it as  $a : b$ .
- In the ratio  $a : b$ , we call a as the first term or antecedent and b, the second term or consequent.

Eg. The ratio  $5 : 9$  represents antecedent = 5, consequent = 9.

Rule: The multiplication or division of each term of a ratio by the same non-zero number does not affect the ratio.

- Eg.  $4 : 5 = 8 : 10 = 12 : 15$ . Also,  $4 : 6 = 2 : 3$ .

### Proportion

- The equality of two ratios is called proportion.
- If  $a : b = c : d$ , we write  $a : b :: c : d$  and we say that a, b, c, d are in proportion.
- Here a and d are called extremes, while b and c are called mean terms.
- Product of means = Product of extremes.
- Thus, if  $a : b :: c : d$  then  $(b \times c) = (a \times d)$ .

Fourth Proportional:

- If  $a : b = c : d$ , then d is called the fourth proportional to a, b, c.

Third Proportional:

- $a : b = c : d$ , then c is called the third proportion to a and b.

Mean Proportional:

- Mean proportional between a and b is  $(ab)^{1/2}$



## Duplicate Ratio

Duplicate ratio of  $(a : b)$  is  $(a^2 : b^2)$ .

Sub-duplicate ratio of  $(a : b)$  is  $(\sqrt{a} : \sqrt{b})$ .

Triplicate ratio of  $(a : b)$  is  $(a^3 : b^3)$ .

Sub-triplicate ratio of  $(a : b)$  is  $(a^{1/3} : b^{1/3})$ .

If  $\frac{a}{b} = \frac{c}{d}$ , then  $\frac{a+b}{a-b} = \frac{c+d}{c-d}$ . [componendo and dividendo]

### Comparison of Ratios:

We say that  $(a : b) > (c : d) \Leftrightarrow \frac{a}{b} > \frac{c}{d}$ .

### Compounded Ratio:

The compounded ratio of the ratios:  $(a : b)$ ,  $(c : d)$ ,  $(e : f)$  is  $(ace : bdf)$ .

### Variations:

We say that  $x$  is directly proportional to  $y$ , if  $x = ky$  for some constant  $k$  and we write,  $x \propto y$ .

We say that  $x$  is inversely proportional to  $y$ , if  $xy = k$  for some constant  $k$  and we write,  $x \propto \frac{1}{y}$ .

**Question:** - Two numbers are respectively 20% and 50% more than a third number. The ratio of the two numbers is:

- A. 2 : 5
- B. 3 : 5
- C. 4 : 5
- D. 6 : 7

**Answer:** Option C

**Explanation:**

Let the third number be  $x$ .

Then, first number = 120% of  $x = 120x/100 = 6x/5$

Second number = 150% of  $x = 150x/100 = 3x/2$

Ratio of first two numbers =  $6x/5 : 3x/2 = 4 : 5$ .

**Question:** - A sum of money is to be distributed among A, B, C, D in the proportion of 5 : 2 : 4 : 3. If C gets Rs. 1000 more than D, what is B's share?

- A. Rs. 500
- B. Rs. 1500
- C. Rs. 2000
- D. None of these

**Answer:** Option C

**Explanation:**

Let the shares of A, B, C and D be Rs.  $5x$ , Rs.  $2x$ , Rs.  $4x$  and Rs.  $3x$  respectively.

Then,  $4x - 3x = 1000$

$x = 1000$ .

B's share = Rs.  $2x = \text{Rs. } (2 \times 1000) = \text{Rs. } 2000$ .

**Question:** - Seats for Mathematics, Physics and Biology in a school are in the ratio 5 : 7 : 8. There is a proposal to increase these seats by 40%, 50% and 75% respectively. What will be the ratio of increased seats?

- A. 2 : 3 : 4
- B. 6 : 7 : 8
- C. 6 : 8 : 9
- D. None of these

**Answer:** Option A

**Explanation:**

Originally, let the number of seats for Mathematics, Physics and Biology be  $5x$ ,  $7x$  and  $8x$  respectively.

Number of increased seats are (140% of  $5x$ ), (150% of  $7x$ ) and (175% of  $8x$ ).

$140/100 * 5x$ ,  $150/100 * 7x$  and  $175/100 * 8x$

$7x$ ,  $21x/2$  and  $14x$ .

The required ratio =  $7x : 21x/2 : 14x$

$14x : 21x : 28x$

$2 : 3 : 4$ .

**Question:** - If 40% of a number is equal to two-third of another number, what is the ratio of first number to the second number?

- A. 2 : 5
- B. 3 : 7
- C. 5 : 3
- D. 7 : 3

**Answer:** Option C

**Explanation:**

Let 40% of A =  $\frac{2}{3}$  B

Then,  $\frac{40}{100}$  A =  $\frac{2}{3}$  B

$\frac{2}{5}$  A =  $\frac{2}{3}$  B

$A/B = \frac{2}{3} * \frac{5}{2} = \frac{5}{3}$

A : B = 5 : 3.

**Question:** - Two number are in the ratio 3 : 5. If 9 is subtracted from each, the new numbers are in the ratio 12 : 23. The smaller number is:

- A. 27
- B. 33
- C. 49
- D. 55

**Answer:** Option B

**Explanation:**

Let the numbers be 3x and 5x.

Then,  $3x - 9/5x - 9 = 12/23$

$23(3x - 9) = 12(5x - 9)$

$9x = 99$

$x = 11.$

The smaller number =  $(3 \times 11) = 33.$

**Question:** - In a bag, there are coins of 25 p, 10 p and 5 p in the ratio of 1 : 2 : 3. If there is Rs. 30 in all, how many 5 p coins are there?

- A. 50
- B. 100
- C. 150
- D. 200

**Answer:** Option C

**Explanation:**

Let the number of 25 p, 10 p and 5 p coins be x, 2x, 3x respectively.

Then, sum of their values = Rs.  $\frac{25x}{100} + 10 \times \frac{2x}{100} + 5 \times \frac{3x}{100} = \text{Rs.}30$

$\frac{60x}{100} = 30$

$x = 50.$

Hence, the number of 5 p coins =  $(3 \times 50) = 150.$

## PARTNERSHIP

### Partnership

• When two or more than two persons run a business jointly, they are called partners and the deal is known as partnership.

### Working and Sleeping Partners

• A partner who manages the business is known as a working partner and the one who simply invests the money is a sleeping partner.

### Ratio of Division of Gains

• When investments of all the partners are for the same time, the gain or loss is distributed among the partners in the ratio of their investments.

Suppose A and B invest Rs.  $x$  and Rs.  $y$  respectively for a year in a business, then at the end of the year: (A's share of profit) : (B's share of profit) =  $x : y$ .

• When investments are for different time periods, then equivalent capitals are calculated for a unit of time by taking (capital  $\times$  number of units of time). Now gain or loss is divided in the ratio of these capitals.

Suppose A invests Rs.  $x$  for  $p$  months and B invests Rs.  $y$  for  $q$  months then,  
(A's share of profit) : (B's share of profit) =  $xp : yq$ .

**Question:** - A and B invest in a business in the ratio 3 : 2. If 5% of the total profit goes to charity and A's share is Rs. 855, the total profit is:

- A. Rs. 1425
- B. Rs. 1500
- C. Rs. 1537.50
- D. Rs. 1576

**Answer:** Option B

### Explanation:

Let the total profit be Rs. 100.

After paying to charity, A's share = Rs.  $95 \times \frac{3}{5} = \text{Rs. } 57$ .

If A's share is Rs. 57, total profit = Rs. 100.

If A's share Rs. 855, total profit =  $100/57 \times 855 = 1500$ .

**Question:** - Simran started a software business by investing Rs. 50,000. After six months, Nanda joined her with a capital of Rs. 80,000. After 3 years, they earned a profit of Rs. 24,500. What was Simran's share in the profit?

- A. Rs. 9,423
- B. Rs. 10,250
- C. Rs. 12,500
- D. Rs. 10,500

**Answer:** Option D

### Explanation:

Simran : Nanda =  $(50000 \times 36) : (80000 \times 30) = 3 : 4$ .

Simran's share = Rs.  $24500 \times \frac{3}{7} = \text{Rs. } 10,500$ .

**Question:** - Arun, Kamal and Vinay invested Rs. 8000, Rs. 4000 and Rs. 8000 respectively in a business. Arun left after six months. If after eight months, there was a gain of Rs. 4005, then what will be the share of Kamal?

- A. Rs. 890
- B. Rs. 1335
- C. Rs. 1602
- D. Rs. 1780

**Answer:** Option A

**Explanation:**

$$\text{Arun : Kamal : Vinay} = (8,000 \times 6) : (4,000 \times 8) : (8,000 \times 8) = 48 : 32 : 64 = 3 : 2 : 4.$$

$$\text{Kamal's share} = \text{Rs. } 4005 \times \frac{2}{9} = \text{Rs. } 890.9$$

**Question:** - A, B, C subscribe Rs. 50,000 for a business. A subscribes Rs. 4000 more than B and B Rs. 5000 more than C. Out of a total profit of Rs. 35,000, A receives:

- A. Rs. 8400
- B. Rs. 11,900
- C. Rs. 13,600
- D. Rs. 14,700

**Answer:** Option D

**Explanation:**

$$\text{Let } C = x.$$

$$\text{Then, } B = x + 5000 \text{ and } A = x + 5000 + 4000 = x + 9000.$$

$$\text{So, } x + x + 5000 + x + 9000 = 50000$$

$$3x = 36000$$

$$x = 12000$$

$$A : B : C = 21000 : 17000 : 12000 = 21 : 17 : 12.$$

$$\text{A's share} = \text{Rs. } 35000 \times \frac{21}{50} = \text{Rs. } 14,700.$$

**Question:** - Three partners shared the profit in a business in the ratio 5 : 7 : 8. They had partnered for 14 months, 8 months and 7 months respectively. What was the ratio of their investments?

- A. 5 : 7 : 8
- B. 20 : 49 : 64
- C. 38 : 28 : 21
- D. None of these