

## 12. RATIO AND PROPORTION

### IMPORTANT FACTS AND FORMULAE

**I. 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**.

**Ex.** The ratio  $5:9$  represents  $5/9$  with 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.

**Ex.**  $4:5 = 8:10 = 12:15$  etc. Also,  $4:6 = 2:3$ .

**2. 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,  $a:b::c:d \Leftrightarrow (b \times c) = (a \times d)$ .

3. (i) Fourth Proportional: If  $a:b = c:d$ , then  $d$  is called the fourth proportional to  $a, b, c$ .

(ii) Third Proportional: If  $a:b = b:c$ , then  $c$  is called the third proportional to  $a$  and  $b$ .

(iii) Mean Proportional: Mean proportional between  $a$  and  $b$  is *square root of  $ab$*

4. (i) COMPARISON OF RATIOS:

We say that  $(a:b) > (c:d) \Leftrightarrow (a/b) > (c/d)$ .

(ii) COMPOUNDED RATIO:

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

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

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

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

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

(v) If  $(a/b) = (c/d)$ , then  $((a+b)/(a-b)) = ((c+d)/(c-d))$  (**Componendo and dividendo**)

6. VARIATION:

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

(ii) We say that  $x$  is inversely proportional to  $y$ , if  $xy = k$  for some constant  $k$  and we write,  $x \propto (1/y)$

## SOLVED PROBLEMS

**Ex. 1. If  $a : b = 5 : 9$  and  $b : c = 4 : 7$ , find  $a : b : c$ .**

**Sol.**  $a:b=5:9$  and  $b:c=4:7=(4 \times 9/4):(7 \times 9/4) = 9:63/4$   
 $a:b:c = 5:9:63/4 = 20:36:63$ .

**Ex. 2. Find:**

- (i) the fourth proportional to 4, 9, 12;
- (ii) the third proportional to 16 and 36;
- iii) the mean proportional between 0.08 and 0.18.

**Sol.**

i) Let the fourth proportional to 4, 9, 12 be x.

Then,  $4 : 9 :: 12 : x \Leftrightarrow 4x = 9 \times 12 \Leftrightarrow x = (9 \times 12)/4 = 27$ ;  
Fourth proportional to 4, 9, 12 is 27.

(ii) Let the third proportional to 16 and 36 be x.

Then,  $16 : 36 :: 36 : x \Leftrightarrow 16x = 36 \times 36 \Leftrightarrow x = (36 \times 36)/16 = 81$   
Third proportional to 16 and 36 is 81.

(iii) Mean proportional between 0.08 and 0.18

$\sqrt{0.08 \times 0.18} = \sqrt{8/100 \times 18/100} = \sqrt{144/(100 \times 100)} = 12/100 = 0.12$

**Ex. 3. If  $x : y = 3 : 4$ , find  $(4x + 5y) : (5x - 2y)$ .**

**Sol.**  $X/Y=3/4 \Leftrightarrow (4x+5y)/(5x+2y) = (4(x/y)+5)/(5(x/y)-2) = (4(3/4)+5)/(5(3/4)-2)$   
 $= (3+5)/(7/4) = 32/7$

**Ex. 4. Divide Rs. 672 in the ratio 5 : 3.**

**Sol.** Sum of ratio terms =  $(5 + 3) = 8$ .

First part = Rs.  $(672 \times (5/8)) =$  Rs. 420; Second part = Rs.  $(672 \times (3/8)) =$  Rs. 252.

**Ex. 5. Divide Rs. 1162 among A, B, C in the ratio 35 : 28 : 20.**

**Sol.** Sum of ratio terms =  $(35 + 28 + 20) = 83$ .

A's share = Rs.  $(1162 \times (35/83)) =$  Rs. 490; B's share = Rs.  $(1162 \times (28/83)) =$  Rs. 392;

C's share = Rs.  $(1162 \times (20/83)) =$  Rs. 280.

**Ex. 6. A bag contains 50 p, 25 P and 10 p coins in the ratio 5: 9: 4, amounting to Rs. 206. Find the number of coins of each type.**

**Sol.** Let the number of 50 p, 25 P and 10 p coins be  $5x$ ,  $9x$  and  $4x$  respectively.

$$(5x/2) + (9x/4) + (4x/10) = 206 \Leftrightarrow 50x + 45x + 8x = 4120 \Leftrightarrow 103x = 4120 \Leftrightarrow x = 40.$$

Number of 50 p coins =  $(5 \times 40) = 200$ ; Number of 25 p coins =  $(9 \times 40) = 360$ ;

Number of 10 p coins =  $(4 \times 40) = 160$ .

**Ex. 7. A mixture contains alcohol and water in the ratio 4 : 3. If 5 litres of water is added to the mixture, the ratio becomes 4: 5. Find the quantity of alcohol in the given mixture**

**Sol.** Let the quantity of alcohol and water be  $4x$  litres and  $3x$  litres respectively

$$4x/(3x+5) = 4/5 \Leftrightarrow 20x = 4(3x+5) \Leftrightarrow 8x = 20 \Leftrightarrow x = 2.5$$

Quantity of alcohol =  $(4 \times 2.5)$  litres = 10 litres.

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