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CAT Ratio & Proportion Formulas

- Ratio and Proportions is one of the easiest concepts in CAT. Questions from this concept are mostly asked in conjunction with other concepts like similar triangles, mixtures and alligations.
- Hence fundamentals of this concept are important not just from a stand-alone perspective, but also to answer questions from other concepts
- A ratio can be represented as fraction a/b or using the notation a:b. In each of these representations ′a′ is called the antecedent and ′b′ is called the consequent.
- For a ratio to be defined, the quantities of the items should be of the same nature. We can not compare the length of the rod to the area of a square.
- However if these quantities are represented in

square is ‘b’ sq.km, we can still define the ratio of these numbers as a:b

- The Ratio of the number a to the number b (b$\neq$ 0) is also expressed as $\frac{a}{b}$
- Example: As mentioned, a Ratio can be expressed or represented in a variety of ways. For instance, the ratio of 2 to 3 can be expressed as 2:3 or $\frac{2}{3}$
- The order in which the terms of a ratio are written is important. For example, The ratio of the number of months having precisely 30 days to the number of months with exactly 31 days, is $\frac{4}{7}$, not $\frac{7}{4}$

Properties of Ratios:

- It is not necessary for a ratio to be positive. When dealing with quantities of objects, however, the ratios will be positive. Only positive ratios will be considered in this notion.

- A ratio remains the same if both antecedent and consequent are multiplied or divided by the same non-zero number, i.e.,

$$\frac{a}{b}=\frac{pa}{pb}=\frac{qa}{qb},\ p,q\neq 0$$

$$\frac{a}{b}=\frac{a/p}{b/p}=\frac{a/q}{b/q},\ p,q\neq 0$$

- Two ratios in fraction notation can be compared in the same way that actual numbers can.

$$\frac{a}{b}=\frac{p}{q}\Leftrightarrow aq = bp$$

$$\frac{a}{b}> \frac{p}{q}\Leftrightarrow aq > bp$$

$$\frac{a}{b}< \frac{p}{q}\Leftrightarrow aq < bp$$

- If antecedent > consequent, the ratio is said to be

- If antecedent < consequent, the ratio is said to be the ratio of lesser inequality.
- If the antecedent = consequent, the ratio is said to be the ratio of equality.

If a, b, x are positive, then

If a > b, then $\frac{a+x}{b+x} < \frac{a}{b}$

If a < b, then $\frac{a+x}{b+x} > \frac{a}{b}$

If a > b, then $\frac{a-x}{b-x} > \frac{a}{b}$

If a < b, then $\frac{a-x}{b-x} < \frac{a}{b}$

If $\frac{a}{p} = \frac{b}{q} = \frac{c}{r} = \frac{d}{s} = \ldots$,

then a:b:c:d:... = p:q:r:s:...

If two ratios $\frac{a}{b}$ and $\frac{c}{d}$ are equal

1. **Invertendo:** $\frac{a}{b} = \frac{c}{d} \Rightarrow \frac{b}{a} = \frac{d}{c}$

2. **Alternendo:** $\frac{a}{b} = \frac{c}{d} \Rightarrow \frac{a}{c} = \frac{b}{d}$

3. **Componendo:** $\frac{a}{b} = \frac{c}{d} \Rightarrow \frac{a+b}{b} = \frac{c+d}{d}$

4. **Dividendo:** $\frac{a}{b} = \frac{c}{d} \Rightarrow \frac{a-b}{b} = \frac{c-d}{d}$

5. **Componendo-Dividendo:** $\frac{a}{b} = \frac{c}{d} \Rightarrow \frac{a+b}{a-b} = \frac{c+d}{c-d}$

6. $\frac{a}{b} = \frac{c}{d} \Rightarrow \frac{pa+qb}{ra+sb} = \frac{pc+qd}{rc+sd}$,

   for all real p, q, r, s such that $pa+qb \neq 0$ and

   $rc+sd \neq 0$

Other Properties:

- If a, b, c, d, e, f, p, q, r are constants and are not equal to zero and $\frac{a}{b} = \frac{c}{d} = \frac{e}{f} = \ldots$ then each of these ratios is equal to $\frac{a+c+e\ldots}{b+d+f\ldots}$
- If a, b, c, d, e, f, p, q, r are constants and are not equal to zero and $\frac{a}{b} = \frac{c}{d} = \frac{e}{f} = \ldots$ then each of these ratios is equal to $\frac{pa+qc+re\ldots}{pb+qd+rf\ldots}$
- If a, b, c, d, e, f, p, q, r are constants and are not equal to zero and $\frac{a}{b} = \frac{c}{d} = \frac{e}{f} = \ldots$ then each of these ratios is equal to $\left(\frac{pa^n+qc^n+re^n+\ldots}{pb^n+qd^n+rf^n+\ldots}\right)^{1/n}$

➔ Duplicate Ratio of a : b is $a^2 : b^2$

➔ Sub-duplicate ratio of a : b is $a : b$

➔ Triplicate Ratio of a : b is $a^3 : b^3$

➔ Sub-triplicate ratio of a : b is $\sqrt[3]{a} : \sqrt[3]{b}$

Proportions :

- A proportion is defined as an equalisation of ratios.
- As a result, if a:b = c:d is a ratio, the first and last terms are referred to as extremes, whereas the middle two phrases are referred to as means.
- When four terms a, b, c, and d are considered to be proportionate, a:b = c:d is the result. When three terms a, b, and c are considered to be proportionate, a:b = b:c is the result.
- A proportion is a statement that two ratios are equal; for example $\frac{2}{3} = \frac{8}{12}$ is a proportion.

- One way to solve a proportion involving an unknown is to cross multiply, obtaining a new equality.
- For example, to solve for n in the proportion $\frac{2}{3}=\frac{n}{12}$, cross multiply, obtaining 24=3n, then divide both sides by 3, to get n=8

Properties of proportions :

- If a:b = c:d is a proportion, then Product of extremes = product of means i.e., ad = bc
- Denominator addition/subtraction: a:a+b = c:c+d and a:a-b = c:c-d
- a, b, c, d,.... are in continued proportion means, a:b = b:c = c:d = ...
- a:b = b:c then b is called mean proportional and b^2= ac
- The third proportional of two numbers, a and b, is c, such that, a:b = b:c.
- ‘d’ is fourth proportional to numbers a, b, c if a:b = c:d

Variations :

- If x varies directly to y, then x is said to be in directly proportional with y and is written as $x \propto y$

➔ $x = ky$ (where k is direct proportionality constant)

➔ $x = ky + C$ (If x depends upon some other fixed constant C)

- If x varies inversely to y, then x is said to be in inversely proportional with y and is written as $x \propto \frac{1}{y}$

➔ $x = k\frac{1}{y}$

(where k is indirect proportionality constant)

➔ $x = k\frac{1}{y} + C$

(If x depends upon some other fixed constant C)

- If $x \propto y$ and $y \propto z$ then $x \propto z$
- If $x \propto y$ and $x \propto z$ then $x \propto (y \pm z)$
- If $a \propto b$ and $x \propto y$ then $ax \propto by$