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Quantitative Aptitude Important Formulas Revision

Introduction to Quantitative Aptitude:

Quantitative Aptitude is an important section in the employment-related competitive exams in India. Quantitative **Aptitude** Section is one of the key sections in recruitment exams in India including but not limited to **Banking, Railways, and Staff Selection Commission, Insurance, Teaching, UPSC** and many others. The Quantitative Aptitude section has questions related to **Profit and Loss, Percentage and Discount, Simple Equations, Time and Work and Quadratic Equations, Mensuration etc.**

Simplification

One of the most common topic in quantitative aptitude section is simplification.

1. **'BODMAS' Rule:** This rule depicts the correct sequence in which the operations are to be executed, so as to find out the value of given expression.

    B - Bracket,
    O - of,
    D - Division,
    M - Multiplication,
    A - Addition and
    S - Subtraction

Thus, in simplifying an expression, first of all the brackets must be removed, strictly in the order (), {} and ||.

After removing the brackets, one must use the following operations strictly in the order:

    i.   Of
    ii.   Division
    iii.   Multiplication
    iv.   Addition
    v.   Subtraction.

1. **Modulus of a Real Number:** Modulus of a real number a is defined as

$$|a| = \begin{cases} a, & \text{if } a > 0 \\ -a, & \text{if } a < 0 \end{cases}$$

Thus, $|5| = 5$ and $|-5| = -(-5) = 5$.

2. **Virnaculum (or Bar):** When an expression contains Virnaculum, before applying the 'BODMAS' rule, we simplify the expression under the Virnaculum.

Profit and Loss

Cost Price (C.P.) is the price at which a buyer buys an article. Selling Price (S.P.) is the price at which a seller sells the article. If the S.P. is greater than the C.P., the seller will have profit. Alternatively, if the S.P. is less than C.P., the seller will incur loss. Loss or gain is always reckoned on C.P.

The following formula are essential to support the **concept of profit and loss**.

1. **Gain** = (S.P.) - (C.P.)

2. **Loss** = (C.P.) - (S.P.)

3. **Gain Percentage:** (Gain %)

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

4. **Loss Percentage:** (Loss %)

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

5. **Selling Price:** (S.P.)

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

6. **Selling Price:** (S.P.)

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

7. **Cost Price:** (C.P.)

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

8. **Cost Price:** (C.P.)

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

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

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

11. When a person sells two similar items, one at a gain of say $x\%$, and the other at a loss of $x\%$, then the seller always incurs a loss given by:

$$\textbf{Loss \%} = \left(\frac{\text{Common Loss and Gain \%}}{10}\right)^2 = \left(\frac{x}{10}\right)^2.$$

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

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

Mixtures & Alligations

1. **Alligation:** It is the rule that enables us to find the ratio in which two or more ingredients at the given price must be mixed to produce a mixture of desired price.

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

3. **Rule of Alligation:** If two ingredients are mixed, then

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

We present as under:

C.P. of a unit quantity of cheaper   C.P. of a unit quantity of dearer

(c)   (d)

Mean Price
(m)
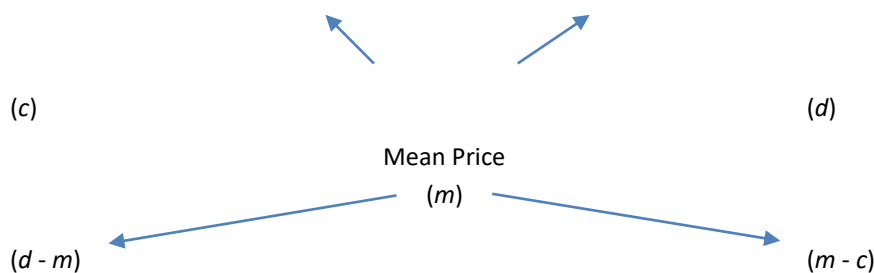
(d - m)   (m - c)

∴ (Cheaper quantity) : (Dearer quantity) = (d - m) : (m - c).

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

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

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Computation of Interest: Simple & Compound

The money that someone borrows or lents out for a certain period is known as the principal amount. The extra money that the borrower pays the lender for using that money is known as the interest. This interest can be in the form of simple or compound interest.

Simple interest is the interest on the sum borrowed for a certain period that is reckoned uniformly.

Let Principal = P, Rate = R% per annum (p.a.) and Time = T years. Then

1. **Simple Interest** = $\left(\dfrac{P \times R \times T}{100} \right)$

2. $P = \left(\dfrac{100 \times S.I.}{R \times T} \right)$; $R = \left(\dfrac{100 \times S.I.}{P \times T} \right)$ and $T = \left(\dfrac{100 \times S.I.}{P \times R} \right)$.

Compound Interest is the addition of the interest to the principal sum. Therefore, if **Principal = P, Rate = R% per annum, Time = n years**, then:

1. **When interest is compound Annually:**

   $\text{Amount} = P \left(1 + \dfrac{R}{100} \right)^{n}$

2. **When interest is compounded Half-yearly:**

   $\text{Amount} = P \left[1 + \dfrac{(R/2)}{100} \right]^{2n}$

3. **When interest is compounded Quarterly:**

   $\text{Amount} = P \left[1 + \dfrac{(R/4)}{100} \right]^{4n}$

4. **When interest is compounded Annually but time is in fraction, say $3\frac{2}{5}$ years.**

   $\text{Amount} = P \left(1 + \dfrac{R}{100} \right)^{3} \times \left(1 + \dfrac{\frac{2}{5}R}{100} \right)$

5. **When Rates are different for different years**, say R_1%, R_2%, R_3% for 1st, 2nd and 3rd year respectively.

Then, Amount = P $\left(1 + \dfrac{R_1}{100}\right)\left(1 + \dfrac{R_2}{100}\right)\left(1 + \dfrac{R_3}{100}\right)$.

6. **Present worth of Rs. _x_ due _n_ years hence is given by:**

Present Worth = $\dfrac{x}{\left(1 + \dfrac{R}{100}\right)^n}$

Surds & Indices

Laws of Indices:

i. $a^m \times a^n = a^{m+n}$

ii.

$\dfrac{a^m}{a^n} = a^{m-n}$

iii. $(a^m)^n = a^{mn}$

iv. $(ab)^n = a^n b^n$

v.

$\left(\dfrac{a}{b}\right)^n = \dfrac{a^n}{b^n}$

vi. $a^0 = 1$

Laws of Surds:

Let _a_ be rational number and _n_ be a positive integer such that $a^{(1/n)} = a$. Then, _a_ is called a surd of order _n_.

vii. $a = a^{(1/n)}$

viii. $ab = a \times b$

ix.

$\sqrt[n]{\dfrac{a}{b}} = \dfrac{a}{b}$

x. $(a)^n = a$

xi. $\sqrt[m]{\sqrt[n]{a}} = \sqrt[mn]{a}$

xii. $(a)^m = a^m$

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Work & Time

1. **Work from Days:**

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

2. **Days from Work:**

   If A's 1 day's work = $\dfrac{1}{n}$, then A can finish the work in n days.

3. **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.

Time & Distance

1. **Speed, Time and Distance:**

   Speed = $\left(\dfrac{\text{Distance}}{\text{Time}}\right)$, Time = $\left(\dfrac{\text{Distance}}{\text{Speed}}\right)$, Distance = (Speed x Time).

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

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

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

   x m/sec = $\left(x \times \dfrac{18}{5}\right)$ 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 then to cover the same distance is $\dfrac{1}{a} : \dfrac{1}{b}$ or $b : a$.

Note: 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 $\dfrac{2xy}{}$ km/hr.

$$\left(x + y \right)$$

Ratio & Proportion

1. **Ratio:** The ratio of two quantities a and b in the same units, is the fraction $\frac{a}{b}$ and we write it as $a : b$. In the ratio $a: b$, a is the first term or **antecedent** and b, is the second term or **consequent**.

   Example: The ratio 5 : 9 represents $\frac{5}{9}$ 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.

   Example: 4: 5 = 8: 10 = 12: 15. Also, 4: 6 = 2: 3.

2. **Proportion:** The equality of two ratios is called proportion. If $a: b = c: d$, then write $a: b :: c : d$ and a, b, c, d shall be 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. **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.

4. **Comparison of Ratios:**

   $(a : b) > (c : d) \Leftrightarrow \dfrac{a}{b} > \dfrac{c}{d}$.

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

6. **Duplicate Ratios:**
   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 $(a^{1/3} : b^{1/3})$.

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

7. **Variations:** x is directly proportional to y, if $x = ky$ for some constant k and we write, $x \propto y$.
   Also, x is inversely proportional to y, if $xy =$ k for some constant k and

we write, $x \propto \dfrac{1}{y}$.

Permutation, Combination

1. **Factorial Notation:**
   Let n be a positive integer. Then, factorial n, denoted $n!$ is defined as:

   n! = n (n - 1) (n - 2) … 3.2.1.

   Examples:

   i.   We define **0! = 1**.

   ii. $4! = (4 \times 3 \times 2 \times 1) = 24$.

   iii. $5! = (5 \times 4 \times 3 \times 2 \times 1) = 120$.

2. **Permutations:** The different arrangements of a given number of things by taking some or all at a time, are called permutations.

   Examples:

   i.   All permutations (or arrangements) made with the letters a, b, c by taking two at a time are
         (**ab, ba, ac, ca, bc, cb**).

   ii.   All permutations made with the letters a, b, c taking all at a time are:
         (**abc, acb, bac, bca, cab, cba**).

3. **Number of Permutations:** Number of all permutations of n things, taken r at a time, is given by:

   $$^{n}P_r = n(n - 1)(n - 2) \ldots (n - r + 1) = \dfrac{n!}{(n - r)!}$$

   Examples:

   i. $^{6}P_2 = (6 \times 5) = 30$.

   ii. $^{7}P_3 = (7 \times 6 \times 5) = 210$.

   iii. **Cor. number of all permutations of n things, taken all at a time = $n!$**

4. **An Important Result:** If there are n subjects of which p_1 are alike of one kind; p_2 are alike of another kind; p_3 are alike of third kind and so on and p_r are alike of rth kind, such that $(p_1 + p_2 + \ldots p_r) = n$.

   Then, number of permutations of these n objects is = $\dfrac{n!}{(p_1!).(p_2)!.....(p_r!)}$

5. **Combinations:** Each of the different groups or selections which can be formed by taking some or all of a number of objects is called a **combination**.

   Examples:

   i.   Suppose we want to select two out of three boys A, B, C. Then, possible selections are AB, BC and CA.

ii.   Note: AB and BA represent the same selection.
   a.   All the combinations formed by *a*, *b*, *c* taking **ab, bc, ca**.
   b.   The only combination that can be formed of three letters *a*, *b*, *c* taken all at a time is **abc**.

   c.   Various groups of 2 out of four persons A, B, C, D are: **AB, AC, AD, BC, BD, CD**.
   d.   Note that *ab ba* are two different permutations but they represent the same combination.

Number of Combinations: The number of all combinations of *n* things, taken *r* at a time is:

$$^nC_r = \frac{n!}{(r!)(n-r)!} = \frac{n(n-1)(n-2) \dots \text{to } r \text{ factors}}{r!}.$$

Note: $^nC_n = 1$ and $^nC_0 = 1$. $^nC_r = {}^nC_{(n-r)}$

Examples:

i. $^{11}C_4 = \dfrac{(11 \times 10 \times 9 \times 8)}{(4 \times 3 \times 2 \times 1)} = 330.$

ii. $^{16}C_{13} = {}^{16}C_{(16-13)} = {}^{16}C_3 = \dfrac{16 \times 15 \times 14}{3!} = \dfrac{16 \times 15 \times 14}{3 \times 2 \times 1} = 560.$

Probability

1.   **Experiment:** An operation which can produce some well-defined outcomes is called an experiment.

2.   **Random Experiment:** An experiment in which all possible outcomes are know and the exact output cannot be predicted in advance, is called a random experiment.

Examples:

i.   Rolling an unbiased dice.

ii.   Tossing a fair coin.

iii.   Drawing a card from a pack of well-shuffled cards.

iv.   Picking up a ball of certain color from a bag containing balls of different colors.

Details:

a)   When we throw a coin, then either a Head (H) or a Tail (T) appears.

b)   A dice is a solid cube, having 6 faces, marked 1, 2, 3, 4, 5, 6 respectively. When we throw a die, the outcome is the number that appears on its upper face.

c)   A pack of cards has 52 cards. It has 13 cards of each suit, name **Spades, Clubs, Hearts and Diamonds**. Cards of spades and clubs are **black cards**. Cards of hearts and diamonds are **red cards**. There are 4 honors of each unit. There are **Kings, Queens and Jacks**. These are all called **face cards**.

3. **Sample Space:** When we perform an experiment, then the set S of all possible outcomes is called the **sample space**.

    Examples:

    a. In tossing a coin, S = {H, T}

    b. If two coins are tossed, the S = {HH, HT, TH, TT}.

    c. In rolling a dice, we have, S = {1, 2, 3, 4, 5, 6}.

    Event: Any subset of a sample space is called an **event**.

    Probability of Occurrence of an Event: Let S be the sample and let E be an event.

Then, E $\subseteq$ S.

$$\therefore \quad P(E) = \frac{n(E)}{n(S)}.$$

   Results on Probability:

i. $P(S) = 1$

ii. $0 \leq P(E) \leq 1$

iii. $P(\phi) = 0$

iv. For any events A and B we have : $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
v. If A denotes (not-A), then $P(A) = 1 - P(A)$.

Mensuration

1. **CUBOID**: Let length = l, breadth = b and height = h units. Then,

    Volume = $(l \times b \times h)$ cubic units.
    Surface area = $2(lb + bh + lh)$ sq. units.
    Diagonal = $l^2 + b^2 + h^2$ units.

2. **CUBE**: Let each edge of a cube be of length a. Then,

    Volume = a^3 cubic units.
    Surface area = $6a^2$ sq. units.
    Diagonal = $3a$ units.

3. **CYLINDER**: Let radius of base = r and Height (or length) = h. Then,

    Volume = $(\Pi r^2 h)$ cubic units.
    Curved surface area = $(2\Pi rh)$ sq. units.
    Total surface area = $2\Pi r(h + r)$ sq. units.

4. **CONE**: Let radius of base = r and Height = h. Then,

      Slant height, $l = h^2 + r^2$ units.

      Volume = $[\frac{1}{3}\pi r^2 h]$ cubic units.

      Curved surface area = (πrl) sq. units.

      Total surface area = $(\pi rl + \pi r^2)$ sq. units.

5. **SPHERE**: Let the radius of the sphere be r. Then,

      Volume = $[\frac{4}{3}\pi r^3]$ cubic units.

      Surface area = $(4\pi r^2)$ sq. units.

6. **HEMISPHERE**: Let the radius of a hemisphere be r. Then,

      Volume = $[\frac{2}{3}\pi r^3]$ cubic units.

      Curved surface area = $(2\pi r^2)$ sq. units.

      Total surface area = $(3\pi r^2)$ sq. units.

      Note: 1 liter = 1000 cm^3.

Number Series

Some Basic Formulae:

1. $(a + b)(a - b) = (a^2 - b^2)$

2. $(a + b)^2 = (a^2 + b^2 + 2ab)$

3. $(a - b)^2 = (a^2 + b^2 - 2ab)$

4. $(a + b + c)^2 = a^2 + b^2 + c^2 + 2(ab + bc + ca)$

5. $(a^3 + b^3) = (a + b)(a^2 - ab + b^2)$

6. $(a^3 - b^3) = (a - b)(a^2 + ab + b^2)$

7. $(a^3 + b^3 + c^3 - 3abc) = (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ac)$

8. When $a + b + c = 0$, then $a^3 + b^3 + c^3 = 3abc$.

Partnership

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

2. **Ratio of Divisions of Gains:**

    I. 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.

II.   When investments are for different time periods, then equivalent capitals are calculated for a unit of time by taking (capital x 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*.

3.   **Working and Sleeping Partners:** A partner who manages the the business is known as a **working partner** and the one who simply invests the money is a **sleeping partner**.

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