GATE फरें

DATA SCIENCE & ARTIFIACL INTELLIGENCE (DA)

GENERAL APTITUDE

SHORT NOTES

ENROLL NOW

TO EXCEL IN GATE AND ACHIEVE YOUR DREAM IIT OR PSU!

ENROLL NOW

- Percentage is a number or ratio expressed as a fraction of 100 .

- It tells how many parts out of **100**.
$$\text{Percentage} = \left(\frac{\text{Part}}{\text{Whole}}\right) \times 100$$

- **Basic Formulas:**

1. To convert Fraction to Percentage:
$$\text{Fraction} \times 100 = \text{Percentage}$$

2. To convert Percentage to Fraction:
$$\frac{\text{Percentage}}{100} = \text{Fraction}$$

3. To find $X\%$ of Y :
$$\frac{X}{100} \times Y$$

4. Percentage Increase:
$$\frac{\text{Increase}}{\text{Original Value}} \times 100$$

5. Percentage Decrease:
$$\frac{\text{Decrease}}{\text{Original Value}} \times 100$$

6. Final Value after Percentage Increase:
$$\text{New Value} = \text{Original} \times \left(1 + \frac{\text{Percentage}}{100}\right)$$

7. Final Value after Percentage Decrease:
$$\text{New Value} = \text{Original} \times \left(1 - \frac{\text{Percentage}}{100}\right)$$

8. Successive Percentage Change:
$$\text{Net Change} = x + y + \frac{xy}{100}$$
Where $x\%$ and $y\%$ are two successive changes (positive for increase, negative for decrease)

9. Population Growth/Depreciation Formula:
$$\text{Final Population} = P \times \left(1 \pm \frac{r}{100}\right)^n$$
Where r = rate, n = number of years

10. % Error in Calculation:
$$\frac{\text{Correct Value} - \text{Incorrect Value}}{\text{Correct Value}} \times 100$$

- **Important Equivalents:**

Fraction	Percentage
1/2	50%
1/3	33.33%
1/4	25%
1/5	20%
1/6	16.67%
1/8	12.5%
1/10	10%

Conversion when an amount is increased by a% and then decreased by the same a% :

- Net decrease in percentage:
$$\frac{a^2}{100}\%$$
If A is $x\%$ more than B, then B is less than A by:
$$\frac{R \times 100}{100 + R}\%$$
If two numbers are $x\%$ and $y\%$ more than a third number, then percentage of the first with respect to the second is:
$$\frac{100 + x}{100 + y} \times 100\%$$

PROFIT&LOSS

Important Definitions

- Cost Price (CP): The price at which an article is purchased.
- Selling Price (SP): The price at which an article is sold.
- Profit (Gain): When the selling price is greater than the cost price.
$$\text{Profit} = SP - CP$$
- Loss: When the cost price is greater than the selling price.
$$\text{Loss} = CP - SP$$
- Marked Price (MP): The price marked as the selling price on an article, before any discount.
- Discount: The reduction given on the marked price.

Important Formulas
- Profit Percentage:
$$\text{Profit \%} = \left(\frac{\text{Profit}}{CP}\right) \times 100$$
- Loss Percentage:
$$\text{Loss\%} = \left(\frac{\text{Loss}}{CP}\right) \times 100$$

- Selling Price (in terms of Profit):
$$SP = CP + \text{Profit}$$
Or,
$$SP = CP\left(1 + \frac{\text{Profit \%}}{100}\right)$$

- Selling Price (in terms of Loss):
$$SP = CP - \text{Loss}$$
Or,
$$SP = CP\left(1 - \frac{\text{Loss\%}}{100}\right)$$
- Cost Price (in terms of Profit):
$$CP = \frac{SP}{1 + (\text{Profit \%}/100)}$$
- Cost Price (in terms of Loss):
$$CP = \frac{SP}{1 - (\text{Loss\%}/100)}$$
- Discount Percentage:
$$\text{Discount \%} = \left(\frac{\text{Discount}}{MP}\right) \times 100$$

- Selling Price after Discount:

$$SP = MP - \text{Discount}$$

Formula and concept based on Discount:

1. **Relationship Between Two Profit/Loss Percentages**
If an article is sold at two different prices and the percentage profit at the first price equals the percentage loss at the second price (with respect to CP):
$$CP = \sqrt{SP_1 \times SP_2}$$
Where:
- SP_1 = Selling price at profit
- SP_2 = Selling price at loss

2. **Equal Profit and Loss**
If a trader sells an article at $x\%$ profit and at $x\%$ loss, the loss on the whole transaction is:
Overall Loss % = $\frac{x^2}{100}$

3. **Successive Profit or Loss (Multiple Transactions)**
If an article is sold at a profit of $a\%$ and then sold again at a profit of $b\%$, then the total profit percentage is:
Net Profit % = $a + b + \frac{ab}{100}$
Replace 'profit' with 'loss' (negative values) for successive losses.

4. Profit or Loss when Parts are Sold at Different Rates
If a trader sells two parts of goods, each costing the same, one at a profit of $x\%$ and the other at a loss of $x\%$, then:
Net Loss % = $\frac{x^2}{100}$

5. False Weighing
If a shopkeeper uses weights that are $y\%$ less than the correct weight and sells at CP:
$$\text{Illegal Profit \%} = \frac{y}{100 - y} \times 100$$

6. Dishonest Dealer (Mixing Cheaper with Costlier)
If a dealer mixes two kinds of goods costing x and y per kg in the ratio $a:b$ and sells the mixture at z per kg , the profit % is:

$$\text{Total Cost Price} = (a \times x) + (b \times y)$$
$$\text{Total Selling Price} = (a + b) \times z$$
$$\text{Profit \%} = \left[\frac{(a + b)z - (ax + by)}{ax + by}\right] \times 100$$

7. Marked Price and Discount
If an article is marked at M rupees, a discount of $d\%$ is given, and still there is a profit of $p\%$, then:
$$\text{CP} = \frac{M \times (100 - d)}{100 \times \left(1 + \frac{p}{100}\right)}$$

Simple Interest
Definitions:
- Simple Interest (SI): Interest calculated only on the original principal amount for the entire period.
- Principal (P): The initial amount of money lent or invested.
- Rate of Interest (R): The percentage of the principal charged as interest per year.
- Time (T): The duration for which the money is lent or invested, usually in years.

Formulas:
1. Simple Interest (SI):
$$\text{SI} = \frac{P \times R \times T}{100}$$

2. Total Amount (A):
(Principal + Interest)
$$A = P + \text{SI} = P + \frac{P \times R \times T}{100} = P \times \left(1 + \frac{R \times T}{100}\right)$$

3. Principal (P) when SI, R, and T are given:
$$P = \frac{100 \times \text{SI}}{R \times T}$$

4. Rate (R) when SI, P, and T are given:
$$R = \frac{100 \times \text{SI}}{P \times T}$$

5. Interest for Different Time Periods
When the time is given in months or days instead of years:
$$\text{SI} = \frac{P \times R \times T}{100}$$
Where time T in months $= \frac{\text{number of months}}{12}$
Or time T in days $= \frac{\text{number of days}}{365}$

6. Principal for Compound Periods Under Simple Interest
If interest is added multiple times under simple interest, the principal is:
$$P = \frac{A}{1 + \frac{R \times T}{100}}$$
Where A = amount after interest, R = rate, and T = time.

7. Difference Between Two Simple Interests
If two different amounts P_1 and P_2 are lent at the same rate R for the same time T :
$$\text{Difference in SI} = \frac{R \times T}{100} \times (P_1 - P_2)$$

8. Time Period Calculation Using Two Interests
If interest on a sum for x years is I_1, and for y years is I_2, then:
$$\frac{I_1}{I_2} = \frac{x}{y}$$

9. Rate Calculation When Interest Doubles the Principal
If the simple interest earned is equal to the principal itself:
$$\frac{P \times R \times T}{100} = P \implies R \times T = 100$$

10. Finding Rate or Time from Amount
If amount A and principal P are given, then:
$$R \times T = \frac{(A - P) \times 100}{P}$$

11. Interest on Part of the Year
When interest is charged for part of a year or fraction of a year, multiply the time by the appropriate fraction:
$T =$ fraction of year (e.g. months/ 12 or days /365)

COMPOUND INTEREST

Definitions:

- Compound Interest (CI): Interest calculated on the principal amount and also on the accumulated interest of previous periods.
- Principal (P): The initial amount of money invested or lent.
- Rate of Interest (R): The percentage of the principal charged as interest per period (usually per year).
- Time (T): The duration for which the money is invested or borrowed, typically in years.
- Amount (A): The total sum after interest is added to the principal.

Formulas:

1. Amount (A) after compound interest:
$$A = P \times \left(1 + \frac{R}{100}\right)^T$$

2. Compound Interest (CI):
$$CI = A - P = P \times \left(1 + \frac{R}{100}\right)^T - P$$

3. Compound Interest when compounded n times a year:
$$A = P \times \left(1 + \frac{R}{100n}\right)^{nT}$$

4. Conversion between Compound Interest and Simple Interest (Approximate):

   For small interest rates and time periods,
$$CI \approx SI + \frac{SI^2}{100}$$

5. Time period to double the investment (Rule of 72):
$$T \approx \frac{72}{R}$$

6. Compound Interest for Fractional/Non-Annual Periods
$$A = P \times \left(1 + \frac{R}{100n}\right)^{nT}$$

Where:
P = Principal,
R = Annual interest rate (%),

n = Number of compounding periods per year,
T = Number of years.

7. Continuous Compounding
$$A = P \times e^{\frac{R \times T}{100}}$$
Where $e \approx 2.71828$.

8. Finding Principal or Rate
- Principal:
$$P = \frac{A}{\left(1 + \frac{R}{100}\right)^T}$$

- Rate:
$$R = \left[\left(\frac{A}{P}\right)^{\frac{1}{T}} - 1\right] \times 100$$

9. Difference Between Compound Interest and Simple Interest (for 2 Years)
$$\text{Difference} = CI - SI = P \times \left(\frac{R}{100}\right)^2$$

10. Population or Value Growth Problems
$$\text{Future Value} = \text{Present Value} \times \left(1 + \frac{R}{100}\right)^T$$
(Use for growth or decay; replace R with negative rate for decay.)

11. Rule to Find Time When Amount Doubles or Triples
$$T = \frac{\log(k)}{\log\left(1 + \frac{R}{100}\right)}$$
Where k is the multiplier (e.g., 2 for doubling, 3 for tripling).

RATIO AND PROPORTION

- Ratio: A ratio compares two quantities of the same kind by division. It is expressed as $a : b$ or $\frac{a}{b}$, where a and b are positive numbers, and $b \neq 0$. The order matters (antecedent:consequent).
- Equivalent ratios: Ratios that simplify to the same value, e.g., $2 : 4 = 1 : 2$.
- Simplest form: Divide both terms by their GCD (Greatest Common Divisor).
- Compound ratio: Product of two or more ratios, e.g., $(a : b) \times (c : d) = (a \times c) : (b \times d)$.
- Types:
- Duplicate ratio: Square of a ratio, e.g., duplicate of $a : b$ is $a^2 : b^2$.
- Sub-duplicate ratio: Square root, e.g., $\sqrt{a} : \sqrt{b}$.
- Triplicate ratio: Cube, e.g., $a^3 : b^3$.
- Inverse ratio: Reciprocal, e.g., b:a.
- Proportion: An equality of two ratios. If $\frac{a}{b} = \frac{c}{d}$, then a, b, c, d are in proportion (a and d are extremes; b and c are means).
- Properties:
- Cross-multiplication: If $a : b = c : d$, then $a \times d = b \times c$.
- Componendo: $\frac{a+b}{b} = \frac{c+d}{d}$.
- Dividendo: $\frac{a-b}{b} = \frac{c-d}{d}$.
- Componendo-Dividendo: $\frac{a+b}{a-b} = \frac{c+d}{c-d}$.
- Alternendo: $\frac{a}{c} = \frac{b}{d}$.
- Invertendo: $\frac{b}{a} = \frac{d}{c}$.

Types:
- Direct proportion: If one quantity increases, the other increases (or decreases together). E.g., $y \propto x$ means $y = kx$ (k is constant).
- Inverse proportion: If one increases, the other decreases. E.g., $y \propto \frac{1}{x}$ means $y = \frac{k}{x}$.
- Continued proportion: Three quantities where $a : b = b : c$; b is the mean proportional ($b^2 = a \times c$).
- Mean proportional: For two numbers a and c , it's $\sqrt{a \times c}$.
- Fourth proportional: If a: b = c: d, d is the fourth proportional $\left(d = \frac{b \times c}{a} \right)$.

- Third proportional: For a and b , it's c where $a : b = b : c \left(c = \frac{b^2}{a} \right)$.
- Variations:
- Combined: $z \propto x \times y$ or other combinations.
- Applications: Dividing quantities in ratio (e.g., divide X in a:b as $\frac{a}{a+b} X : \frac{b}{a+b} X$), mixtures, partnerships, work-time problems.
- Alligation Rule: For mixtures of two ingredients at different prices/qualities to find ratio for a mean price.
- Ratio = (Quantity of cheaper : Quantity of dearer) = (Dearer - Mean) : (Mean - Cheaper).
- Compounded Ratio of multiple ratios: $(a_1 : b_1), (a_2 : b_2), \ldots \Rightarrow (a_1 \times a_2 \times \cdots) : (b_1 \times b_2 \times \cdots)$
- Combined Proportion: $a : b : : c : d : : e : f \Rightarrow a : c : e = b : d : f$
- Extended Componendo and Dividendo (three terms): $\frac{a+b+c}{a-b-c} = \frac{x+y+z}{x-y-z}$ if $\frac{a}{x} = \frac{b}{y} = \frac{c}{z}$
- Direct Proportion: $\frac{x_1}{y_1} = \frac{x_2}{y_2}$
- Inverse Proportion: $x_1 \times y_1 = x_2 \times y_2$
- Split Amount in ratio $a : b : c$:
- First share: $\frac{a}{a+b+c} \times S$
- Second share: $\frac{b}{a+b+c} \times S$, etc.
- Shortcut combining two ratios $A : B = a : b$ and $B : C = c : d$:
- $A : B : C = a \times c : b \times c : b \times d$

AVERAGE

- **Definition:** The average (arithmetic mean) is the central value of a set, calculated by dividing the sum of all values by the number of values.
- **Symbol:** Usually denoted as "Avg" or a bar over a variable (e.g., $\bar{x}$).
- **Key Usage:** Measures central tendency; widely used in quantitative comparisons, statistics, and aptitude problems 112234.

- **General Average:**

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

For values $x_1, x_2, \ldots, x_n$:

$$\text{Average} = \frac{x_1 + x_2 + \cdots + x_n}{n}$$

- **Weighted Average:**

$$\text{Weighted Average} = \frac{\sum w_i x_i}{\sum w_i}$$

Where w_i are the weights, x_i the values.

- **Combined Average (of groups):**

$$\text{Combined Average} = \frac{p_1 q_1 + p_2 q_2 + \cdots + p_n q_n}{q_1 + q_2 + \cdots + q_n}$$

Where p_i are group averages, q_i the group sizes 5 .

- **Effect of Adding/Removing a Value:**

If a new value x is added to a group of n values (average A):

$$\text{New Average} = \frac{nA + x}{n + 1}$$

If a value y is replaced by x :

$$\text{New Average} = A + \frac{x - y}{n}$$

- Average of first n natural numbers: $\frac{n+1}{2}$
- Average of first n even numbers: $n + 1$
- Average of first n odd numbers: n
- Average of squares of first n naturals: $\frac{(n+1)(2n+1)}{6}$
- Average of cubes of first n naturals: $\frac{n(n+1)^2}{4}$ 647.
- **Average Speed for Equal Distances** (x at speed a, y at speed b):

$$\text{Average Speed} = \frac{2ab}{a + b}$$

For three speeds for equal distances (a, b, c) :

$$\text{Average Speed} = \frac{3abc}{ab + bc + ca}$$

- **Age Problems:**
- If a new person's age replaces another and changes the average:

Age of new person = Age of removed person $\pm$ (Number of persons $\times$ Change in a

- **Increase/Decrease All Values by k :**

The average also increases/decreases by k.

- **Mixture/Replacement Shortcut:**

If part of a solution is removed and replaced:

Remaining original part $=$ Initial quantity $\times$

$$\left(1 - \frac{\text{Quantity removed}}{\text{Total quantity}}\right)^n$$

- **Finding number of members in a group with changed average:**

$$n = \frac{\text{Total increase or decrease}}{\text{Increase or decrease in average}}$$

- **When a number is added/removed and average changes:**

New number = New average $\times n -$ Sum of previous (n-1) terms

- **Change in average due to addition/removal:**

Change in sum = Change in average $\times$ Total number

- **Weighted Average:**

$$\text{Average} = \frac{w_1 x_1 + w_2 x_2 + \cdots + w_n x_n}{w_1 + w_2 + \cdots + w_n}$$

- **Alligation Rule for Averages:**

$$\frac{\text{Quantity 1}}{\text{Quantity 2}} = \frac{\text{Average of group 2} - \text{Overall Average}}{\text{Overall Average} - \text{Average of group 1}}$$

- **Average of squares of first n natural numbers:**

$$\text{Average} = \frac{(n)(n + 1)(2n + 1)}{6n}$$

- **Average of cubes of first n natural numbers:**

$$\text{Average} = \frac{(n^2)(n + 1)^2}{4n}$$

SPEED, TIME AND DISTANCE.

Fundamental Formulas
- Speed $= \frac{\text{Distance}}{\text{Time}}$
- Time $= \frac{\text{Distance}}{\text{Speed}}$
- Distance $=$ Speed $\times$ Time

Unit Conversions
- 1 km/hr $= \frac{5}{18}$ m/s
- 1 m/s $= \frac{18}{5}$ km/hr

- Average Speed:
- If equal distances are covered at two different speeds x and y :
- Average Speed $= \frac{2xy}{x+y}$
- For overall journey:
- Average Speed $= \frac{\text{Total Distance}}{\text{Total Time}}$
- Relative Speed:
- Moving in the same direction: Relative Speed $= |v_1 - v_2|$
- Moving in opposite direction: Relative Speed $= v_1 + v_2$
- Ratio of Speeds and Times (same distance):
- If two speeds are in ratio $a:b$, times taken are in ratio $b:a$
- Conversions in Train Problems:

- Train crosses pole: Speed $= \frac{\text{Length of train}}{\text{Time to cross pole}}$
- Train crosses platform/bridge: Length of train + platform $=$ Speed $\times$ Time
- Two trains crossing each other:
- Opposite Direction: Time $= \frac{L_1 + L_2}{S_1 + S_2}$
- Same Direction: Time $= \frac{L_1 + L_2}{|S_1 - S_2|}$
- Average of Different Speeds (Three Equal Segments):
- Average Speed $= \frac{3abc}{ab+bc+ca}$ for speeds a, b, c
- Relative Speed-Persons Moving Toward Each Other:
- If after meeting, they take times t_1 and t_2 to finish:
- $\frac{\text{Speed of A}}{\text{Speed of B}} = \sqrt{\frac{t_2}{t_1}}$
- Boat and Stream:
- Upstream speed $=$ Speed in still water - Current speed

- Downstream speed $=$ Speed in still water + Current speed
- Finding Distance (Change in Speed):
- When speed changes by ΔS and time changes by Δt :

- Distance $= \frac{(\text{ Original Speed } \times \text{ New Speed })}{|\Delta S|} \times |\Delta t|$ [see advanced application]
- Average Speed for Unequal Distances:
- Average Speed $= \frac{\text{Total Distance}}{\text{Total Time}}$
- Relative Speed for Objects Moving Towards/Away Each Other:
- Relative Speed $= S_1 + S_2$ (opposite), $|S_1 - S_2|$ (same)
- Ratio of Times for Same Distance:
- $\frac{T_1}{T_2} = \frac{S_2}{S_1}$
- Meeting Point (Trains):
- If A and B start at same time from two points and after meeting take times t_1 and t_2 to finish:
- $\frac{\text{Speed of A}}{\text{Speed of B}} = \sqrt{\frac{t_2}{t_1}} 23$
- Train Passing Point Objects:
- Speed $= \frac{\text{Length of Train}}{\text{Time to Pass Object}}$

- Train Passing Platform:
- Speed $= \frac{\text{Length of Train + Length of Platform}}{\text{Time to Pass}}$

Short Tricks
- If speed doubles, time halves for same distance (and vice versa).
- If two objects start at same time from A and B , meet at P : Distance AP:PB $=$ Speed A: Speed B .
- For average speed over equal distances: Use harmonic mean, e.g., for n speeds: n / (1/S1 + 1/S2 + … +1/Sn).
- Train crossing pole: Treat pole as zero length.
- Boat trick: If time downstream $=$ time upstream, impossible unless R=0.
- Race: If A gives B a head start of X, then $A:B$ speed $= (D):(D-X)$.
- Convert units quickly: km/h to m/s multiply by 5/18; reverse multiply by 18/5.
- Relative speed zero: Objects moving at same speed in same direction.

Mensuration
Formula List for Common 2D Shapes

Shape	Perimeter/Circumference Formula	Area Formula
Square	$4 \times$ side	side ^{2}
Rectangle	$2 \times$ (length + breadth)	length $\times$ breadth
Triangle	Sum of all sides (a + b + c)	$(1/2) \times$ base $\times$ height
Right-Angled Triangle	Sum of sides ($a + b + \sqrt{(a^2 + b^2)}$)	$(1/2) \times$ leg1 $\times$ leg2
Equilateral Triangle	$3 \times$ side	$(\sqrt{3/4}) \times$ side ^{2}
Isosceles Triangle	$2 \times$ equal side + base	$(1/2) \times$ base $\times$ height
Parallelogram	$2 \times$ (adjacent side1 + adjacent side2)	base $\times$ height
Rhombus	$4 \times$ side	(diagonal1 $\times$ diagonal2)/2
Trapezium	Sum of all sides	$(1/2) \times$ (sum of parallel sides) $\times$ height
Circle	2mr (circumference)	πr^2
Semicircle	$\pi r + 2r$	$(1/2)\pi r^2$

Sector of Circle	$(\theta/360) \times 2\pi r + 2r$ (arc length + radii)	$(\theta/360) \times \pi r^2$
Ring (Annulus)	$-$(not applicable)	$\pi(R^2 - r^2)(R =$ outer radius, $r =$ inner)

Additional Basic Formulas:
- Heron's Formula for Triangle Area:
$\sqrt{[s(s - a)(s - b)(s - c)]}$, where $s = (a + b + c)/2$(semi-perimeter).

- Area of Scalene Triangle: Use (1/2)ab sin C for two sides and included angle.
- Perimeter of Regular Polygon: n × side (n = number of sides).

Formula List for Common 3D Solids

Solid	Lateral/Curved Surface Area Formula	Total Surface Area Formula	Volume Formula
Cube	$4 \times$ side ^{2}	$6 \times$ side ^{2}	side ^{3}
Cuboid	$2 \times$ height $\times$ (length + breadth)	$2(lb + bh + hl)$	length $\times$ breadth $\times$ height
Cylinder	$2\pi rh$	$2\pi r(h + r)$	$\pi r^2 h$
Hollow Cylinder	$2\pi h(R + r)$	$2\pi h(R + r) + 2\pi(R^2 - r^2)$	$\pi h(R^2 - r^2)$
Cone	$\pi r l$ (l = slant height)	$\pi(l + r)$	$(1/3)\pi r^2 h$
Frustum of Cone	$\pi l(R + r)$	$\pi l(R + r) + \pi(R^2 + r^2)$	$(1/3)\pi h(R^2 + r^2 + Rr)$
Sphere	- (curved = total)	$4\pi r^2$	$(4/3)\pi r^3$
Hemisphere	$2\pi r^2$ (curved)	$3\pi r^2$ (total) or $2\pi r^2 + \pi r^2$ (with base)	$(2/3)\pi r^3$
Hollow Sphere	-	$4\pi(R^2 + r^2)$ (inner + outer)	$(4/3)\pi(R^3 - r^3)$
Pyramid	$(1/2) \times$ perimeter of base $\times$ slant height	Lateral SA + base area	$(1/3) \times$ base area $\times$ height

	Perimeter of base $\times$ height	Lateral SA + 2 $\times$ base area	Base area $\times$ height
Prism	Perimeter of base $\times$ height	Lateral SA + 2 $\times$ base area	Base area $\times$ height
Tetrahedron	-	$\sqrt{3} \times$ side ^{2}	(/2/12) $\times$ side ^{3}

Additional Basic Formulas:

- **Slant Height of Cone:** $\sqrt{(r^2 + h^2)}$.

- **Diagonal of Cuboid:** $\sqrt{(1^2 + b^2 + h^2)}$.

- **Euler's Formula for Polyhedra:** $V - E + F = 2$ (V = vertices, E = edges, F = faces).

2D Tricks:
- For equilateral triangle: Height = $(\sqrt{3/2}) \times$ side; use for quick area calculation.
- Circle inscribed in square: Diameter = side of square; area ratio = $\pi/4$.
- Triangle area trick: If coordinates given $(x1, y1), (x2, y2), (x3, y3)$: $(1/2) | x1(y2 - y3) + x2(y3 - y1) + x3(y1 - y2) |$.
- Perimeter to area ratio: For similar figures, scales with $1/k$ (k = scale factor).

3D Tricks:
- Cube volume from surface area: If $SA = 6a^2$, then $V = a^3 = (SA/6)^{3/2}$.
- Cylinder vs. Cone: Cone volume = (1/3) cylinder volume for same base and height.
- Sphere from cylinder: Volume of sphere = (2/3) volume of circumscribed cylinder.
- Frustum trick: Average radius = (R + r)/2 for approximate calculations, but use exact formula.
- Scaling solids: If linear dimensions scale by k , area by k^2, volume by k^3.
- Quick diagonal: For cube, diagonal = side $\sqrt{3}$; for cuboid, as above.

GATE CSE BATCH

KEY HIGHLIGHTS:

- 300+ HOURS OF RECORDED CONTENT
- 900+ HOURS OF LIVE CONTENT
- SKILL ASSESSMENT CONTESTS
- 6 MONTHS OF 24/7 ONE-ON-ONE AI DOUBT ASSISTANCE
- SUPPORTING NOTES/DOCUMENTATION AND DPPS FOR EVERY LECTURE

COURSE COVERAGE:

- ENGINEERING MATHEMATICS
- GENERAL APTITUDE
- DISCRETE MATHEMATICS
- DIGITAL LOGIC
- COMPUTER ORGANIZATION AND ARCHITECTURE
- C PROGRAMMING
- DATA STRUCTURES
- ALGORITHMS
- THEORY OF COMPUTATION
- COMPILER DESIGN
- OPERATING SYSTEM
- DATABASE MANAGEMENT SYSTEM
- COMPUTER NETWORKS

LEARNING BENEFIT:

- GUIDANCE FROM EXPERT MENTORS
- COMPREHENSIVE GATE SYLLABUS COVERAGE
- EXCLUSIVE ACCESS TO E-STUDY MATERIALS
- ONLINE DOUBT-SOLVING WITH AI
- QUIZZES, DPPS AND PREVIOUS YEAR QUESTIONS SOLUTIONS

ENROLL NOW

TO EXCEL IN GATE AND ACHIEVE YOUR DREAM IIT OR PSU!

ENROLL NOW

Advanced 2D Formulas

- Area of Ellipse: $\pi \times a \times b (a, b$ = semi-major, semi-minor axes).
- Area of Cyclic Quadrilateral (Brahmagupta's Formula): $\sqrt{[(s-a)(s-b)(s-c)(s-d)]}, s = (a + b + c + d)/2$.
- Area between Two Concentric Circles: $\pi(R^2 - r^2)$.
- Length of Chord in Circle: $2\sqrt{(r^2 - d^2)} (d$ = distance from center).
- Area of Segment of Circle: $(r^2/2)(\theta - \sin\theta)(\theta$ in radians).
- Apothem of Regular Polygon: (side)/(2 $\tan(\pi/n)$).

Advanced 3D Formulas

- Volume of Torus: $2\pi^2 Rr^2 (R$ = major radius, r = minor radius).
- Surface Area of Torus: $4\pi^2 Rr$.
- Volume of Ellipsoid: $(4/3)\pi abc (a, b, c$ = semi-axes).
- Lateral Surface Area of Frustum of Pyramid: $(1/2) \times$ (perimeter 1 + perimeter 2) $\times$ slant height.
- Volume of Combined Shapes (e.g., Cylinder + Cone): Sum individual volumes, subtract overlaps if any.

Centroid Distance in Cone: (3/4)h from base.

Moment of Inertia for Sphere: (2/5) M r^2 (about diameter).

Volume of Paraboloid: $(1/2)\pi r^2 h$.

Surface Area of Capsule (Cylinder + Hemispheres): $2\pi r(2r + h)$.

PROBABILITY

Basic Concepts of Probability

Probability in general aptitude measures the likelihood of an event occurring, expressed as a value between 0 (impossible) and 1 (certain). It involves analyzing outcomes in uncertain situations, often in games of chance, decision-making, or risk assessment.

Key principles:

Experiment: Any process with observable outcomes (e.g., rolling a die).

Sample Space (S): The set of all possible outcomes of an experiment.

Event (E): A subset of the sample space; can be simple (single outcome) or compound (multiple outcomes).

- Favorable Outcomes: Outcomes that satisfy the event.
- Mutually Exclusive Events: Events that cannot occur simultaneously.
- Independent Events: Occurrence of one does not affect the other.
- Dependent Events: Occurrence of one affects the probability of the other.
- Complementary Event: The event that does not occur (1-P(E)).
- Exhaustive Events: Events that cover the entire sample space.
- A Priori Probability: Based on reasoning (classical approach).
- Empirical Probability: Based on observed data (frequency approach).
- Subjective Probability: Based on personal judgment.

Common types of probability problems include:

- Coin tosses, dice rolls, card draws.
- Combinations and permutations for counting outcomes.
- Conditional scenarios (given that something has happened).
- Bayes' applications for updating probabilities with new information.
- Distributions for repeated trials (binomial, Poisson).

Formula List for Probability

1. Probability of an Event: P(E) = Number of Favorable Outcomes / Total Number of Possible Outcomes
2. Probability of Complementary Event: $P(E') = 1 - P(E)$
3. Addition Rule (Mutually Exclusive): $P(A \cup B) = P(A) + P(B)$
4. Addition Rule (General): $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
5. Multiplication Rule (Independent): $P(A \cap B) = P(A) \times P(B)$

6. Multiplication Rule (Dependent): $P(A \cap B) = P(A) \times P(B \mid A)$
7. Conditional Probability: $P(B \mid A) = P(A \cap B)/P(A)$
8. Total Probability (Partition): $P(B) = P(B \mid A1)P(A1) + P(B \mid A2)P(A2) + \cdots + P(B \mid An)P(An)$
9. Odds in Favor: $Odds = P(E)/(1 - P(E))$
10. Odds Against: $Odds = (1 - P(E))/P(E)$

Short Tricks for Solving Probability Problems

- Count Total Outcomes First: Always determine the sample space size using permutations (order matters) or combinations (order doesn't).
- Use Tree Diagrams: For conditional or multi-stage events, sketch branches to visualize probabilities.
- Check Independence: If events are independent, multiply directly; otherwise, use conditional formula.
- Complementary Counting: For "at least one" problems, calculate 1 minus probability of none.

- Mutually Exclusive Check: If no overlap, add probabilities; subtract intersection if overlap exists.
- Bayes' Quick Flip: For reversing conditions, remember to use total probability in denominator.
- Fraction Simplification: Reduce fractions early to avoid calculation errors.
- Venn Diagram Aid: For unions and intersections, draw circles to see overlaps visually.
- Permutation vs Combination: Use nPr for arrangements, nCr for selections.
- Avoid Double Counting: In card/dice problems, ensure outcomes aren't repeated.

1. Bayes' Theorem: $P(A \mid B) = [P(B \mid A) \times P(A)]/P(B)$
2. Binomial Probability: $P(X = k) = nCk \times p^{\wedge}k \times (1 - p)^{\wedge}(n - k)$
3. Binomial Mean: $\mu = n \times p$
4. Binomial Variance: $\sigma^2 = n \times p \times (1 - p)$
5. Poisson Probability: $P(X = k) = (e^{\wedge}(-\lambda) \times \lambda^{\wedge}k)/k!$
6. Poisson Mean and Variance: $\mu = \sigma^2 = \lambda$
7. Normal Distribution (Z-Score): $Z = (X - \mu)/\sigma$
8. Expected Value: $E(X) = \Sigma[\ x\_i \times P(\ x\_i\ )]$
9. Variance: $Var(X) = E(X^2) - [E(X)]^2$
10. ovariance: $Cov(X, Y) = E(XY) - E(X)E(Y)$

11. Correlation Coefficient: $\rho = Cov(X, Y)/(\sigma\_X \times \sigma\_Y)$
12. Geometric Probability: $P(X = k) = (1 - p)^{\wedge}(k - 1) \times p$
13. Hypergeometric Probability: $P(X = k) = [KCk \times (N - K)C(n - k)]/NCn$
14. Continuous Uniform Distribution: $f(x) = 1/(b - a)$ for $a \leq x \leq b$
15. Exponential Distribution: $f(x) = \lambda e^{\wedge}(-\lambda x)$ for $x \geq 0$

PERMUTATION AND COMBINATION

Basic Concepts

- Permutation: An arrangement of objects where order matters.
- Combination: A selection of objects where order does not matter.

Basic Formula List

1. Factorial:
- $n! = n \times (n - 1) \times (n - 2) \times \ldots \times 1$
- By convention, $0! = 1$

2. Permutations:
- Number of permutations of n distinct items taken r at a time:
$$P(n, r) = {}^nP_r = \frac{n!}{(n - r)!}$$
- Permutations of n items with some identical items:
If a are alike, b are alike, $\ldots$, then: $\frac{n!}{a! \times b! \times \ldots}$

3. Circular Permutation:
- Arrangement around a circle:
$$(n - 1)!$$

- If clockwise and anticlockwise arrangements are same:
$$\frac{(n - 1)!}{2}$$

4. Combinations:
- Number of ways to choose r from n :
$$C(n, r) = {}^nC_r = \frac{n!}{r!\,(n - r)!}$$
- Key property:
$${}^nC_r = {}^nC_{n-r}$$

- Permutations with repetition (selection with replacement):
$$n^r$$
- Combinations with repetition (selection with replacement):
$$^{n+r-1}C_r$$
- Number of ways to distribute r identical objects into n distinct groups:
$$^{n+r-1}C_r$$
- Number of ways to divide n distinct objects into r groups:
$$n!/(n_1! \, n_2! \ldots n_r!)$$
(where $n_1 + n_2 + \cdots + n_r = n$)

Short Tricks
- When order doesn't matter: Use combinations (^nC_r)
- When order matters: Use permutations (^nP_r)
- Arrangements in a circle: Use $(n-1)$!

MIRRORING:

Basic Concepts
Mirroring involves reflecting an object or figure over a line (mirror line) to create a symmetric image. Common types include horizontal mirroring (over x -axis), vertical mirroring (over y -axis), and water images (reflection over a horizontal line simulating water). The mirror image is congruent but reversed in direction.

Basic Formula List
- Reflection over x-axis: $(x, y) \rightarrow (x, -y)$
- Reflection over y-axis: $(x, y) \rightarrow (-x, y)$
- Reflection over origin: $(x, y) \rightarrow (-x, -y)$
- Reflection over line $y = x$: $(x, y) \rightarrow (y, x)$
- Reflection over line $y = -x$: $(x, y) \rightarrow (-y, -x)$

Short Tricks
- For letters/numbers: Reverse left-right for vertical mirror; top-bottom for horizontal.
- Clock hands: In mirror, hour and minute hands swap positions relative to 12.
- Identify unchanged elements: Symmetric shapes like circles remain the same.

ROTATION:

Basic Concepts
Rotation is turning a figure around a fixed point (center of rotation) by a specific angle, either clockwise or counterclockwise. Common angles in aptitude are $90°, 180°, 270°$. The shape and size remain the same, but orientation changes.

Basic Formula List
- Rotation by θ around origin (2D):
$$x' = x\cos\theta - y\sin\theta$$
$$y' = x\sin\theta + y\cos\theta$$
- For 90° clockwise: $(x, y) \rightarrow (y, -x)$
- For 90° counterclockwise: $(x, y) \rightarrow (-y, x)$
- For 180°: $(x, y) \rightarrow (-x, -y)$
- For 270° clockwise: $(x, y) \rightarrow (-y, x)$

Short Tricks
- Cycle method: For 90° rotations, track point positions in quadrants.
- Overlay trick: Imagine superimposing rotated figure; count mismatches for identification.
- For cubes/dice: Opposite faces don't change relative positions after rotation.

TRANSALTION:

Basic Concepts
Translation is sliding a figure from one position to another without rotating or flipping, along a straight path defined by a vector. All points move by the same distance and direction; shape and orientation remain unchanged.

Basic Formula List
- Translation by vector (a, b): $(x, y) \rightarrow (x + a, y + b)$
- In 3D: $(x, y, z) \rightarrow (x + a, y + b, z + c)$
- Composition of translations: Sum of vectors (a1+a2, b1+b2)

Short Tricks
- Vector addition: Treat as shifting grid positions; count horizontal/vertical moves.
- For patterns: Identify repeated motifs by subtracting positions.

- In sequences: Look for constant differences in coordinates.

PAPER FOLDING & 2-D AND 3-D PATTERNS:

Basic Concepts

Paper folding involves creasing paper and cutting to create symmetric patterns when unfolded. 2-D patterns focus on flat shapes like nets or embedded figures; 3-D patterns involve visualizing solids like cubes, prisms from views or nets. Symmetry and hole positions are key.

Basic Formula List

- For folds: Number of symmetric parts = 2^n where n is number of folds.
- Hole positions after unfolding: Mirror across each fold line.
- Net validity for cube: 11 possible nets; ensure no more than 6 faces, opposite faces don't touch.
- 3-D views: Orthographic projections (front, top, side).

Short Tricks

- Fold symmetry: Count creases; patterns repeat across lines.
- Punch holes: Double for single fold, quadruple for double.
- Cube rotations: Max 3 faces visible; opposite colors/faces hidden.
- Embedded figures: Trace outlines ignoring distractions.

ASSEMBLING

Basic Concepts

Assembling involves combining parts or fragments to form a complete figure, like puzzles, figure formation from pieces, or constructing 3-D models from 2-D nets. Focus on fitting shapes without overlaps or gaps.

Basic Formula List

- Area conservation: Total area of parts = area of assembled figure.

- Perimeter matching: Edges must align; internal edges cancel.
- For tangrams: 7 pieces form square; dissect into known shapes.
- Net assembly: Fold along edges; ensure adjacency.

Short Tricks

- Edge counting: Match boundaries; look for unique curves.
- Symmetry check: Assemble symmetric parts first.
- Trial fit: Rotate/flip pieces mentally; eliminate mismatches.
- For dice assembly: Sum of opposite faces = 7 .

SCALING:

- Concept: Changing the size (not shape) of a figure.
- Formula: If scale factor = k :
- New length = $k \times$ original length
- New area = $k^2 \times$ original area
- New volume = $k^3 \times$ original volume

REASONING:

BLOOD RELATION:

Introduction to Blood Relations

Blood relations is a reasoning topic in aptitude tests that involves understanding and decoding family relationships based on given statements. It tests logical deduction of kinship ties like parent-child, siblings, in-laws, etc.

Key concepts:

- Direct Relations: Immediate family (e.g., parents, children, siblings).
- Indirect Relations: Extended family (e.g., grandparents, uncles, cousins).
- Paternal Side: Father's family.
- Maternal Side: Mother's family.
- Generations: Levels in family tree (e.g., +1 for parents, -1 for children, 0 for self/siblings).
- In-Laws: Relations through marriage (e.g., brother-in-law).

- Common assumptions: Relations are blood unless specified as in-law; no multiple marriages unless stated; gender-neutral unless specified.

Basic Relation List (Common Kinship Terms)

Relation	Description/Definition
Father	Male parent
Mother	Female parent
Son	Male child
Daughter	Female child
Brother	Male sibling
Sister	Female sibling
Grandfather	Father's father or Mother's father
Grandmother	Father's mother or Mother's mother
Grandson	Son's son or Daughter's son
Granddaughter	Son's daughter or Daughter's daughter
Uncle (Paternal)	Father's brother
Aunt (Paternal)	Father's sister

Uncle (Maternal)	Mother's brother
Aunt (Maternal)	Mother's sister
Nephew	Brother's son or Sister's son
Niece	Brother's daughter or Sister's daughter
Cousin	Uncle/Aunt's child
Father-in-Law	Spouse's father
Mother-in-Law	Spouse's mother
Brother-in-Law	Spouse's brother or Sister's husband
Sister-in-Law	Spouse's sister or Brother's wife
Son-in-Law	Daughter's husband
Daughter-in-Law	Son's wife

Advanced Kinship Terms

Advanced Relation	Description/Definition
Great Grandfather	Grandfather's father
Great Grandmother	Grandfather's mother
Great Grandson	Grandson's son
Great Granddaughter	Grandson's daughter
Second Cousin	Children of first cousins
Cousin Once Removed	Cousin's child or parent's cousin
Paternal Great Uncle	Grandfather's brother
Maternal Great Aunt	Grandmother's sister
Co-Brother-in-Law	Wife's sister's husband
Co-Sister-in-Law	Husband's brother's wife
Stepfather	Mother's husband (not biological father)
Stepmother	Father's wife (not biological mother)
Stepbrother	Stepparent's son

Stepsister
Half-Brother
Half-Sister
Uncle-in-Law
Aunt-in-Law
Additional Advanced Relations:
- Father's brother's only son's father: Father (self-reference trick).
- Mother's father's only daughter: Mother.
- Son's wife's mother: Daughter-in-Law's mother (co-mother-in-law).
- Brother's son's wife: Nephew's wife (niece-in-law).
- Sister's husband's father: Brother-in-Law's father (co-father-in-law).

DIRECTION AND SENSE.

Direction sense is a reasoning topic in aptitude tests that evaluates the ability to determine orientations, positions, and directions based on movements, turns, and environmental cues like shadows or maps. It involves visualizing paths and relative positions.

Key concepts:

- Cardinal Directions: North (N), South (S), East (E), West (W).
- Intermediate Directions: Northeast (NE), Northwest (NW), Southeast (SE), Southwest (SW).
- Turns: Left (anticlockwise), Right (clockwise); measured in degrees (90°, 180°, etc.).
- Facing Direction: Reference point for turns; opposite directions are 180° apart.
- Displacement: Net movement from start to end point, often using vectors or Pythagoras.

- **Shadow Sense:** Based on sun's position (rises in East, sets in West); morning shadows point West, evening point East.
- **Common assumptions:** Flat plane; no obstacles; starting direction often North unless specified.

Aspect	Formula/Rule
Right Turn	+90 ° clockwise from current facing
Left Turn	-90 ° anticlockwise from current facing
U-Turn/Back Turn	180° reversal of direction
Net Direction After Turns	Sum of turn angles modulo 360°
Opposite Direction	Current direction + 180°
Shortest Distance (Straight Line)	$\sqrt{(x^2 + y^2)}$ where x = East-West displacement, y = North-South displacement
Direction Angle	$\tan^{-1}(y/x)$ for angle from East (use quadrants)
Shadow in Morning	Person facing South → Shadow to left (East-facing shadow West)
Shadow in Evening	Person facing North → Shadow to left (West-facing shadow East)
At Noon	Shadow towards North (in Northern Hemisphere)
Clockwise Sequence	North → East → South → West → North
Anticlockwise Sequence	North → West → South → East → North

INEQUALITIES

Basic Concepts
- **Definition:** An inequality is a mathematical statement that compares two expressions using symbols like < (less than), > (greater than), ≤ (less than or equal to), ≥ (greater than or equal to), or ≠ (not equal to).
- **Types of Inequalities:**
- **Linear Inequalities:** Involve linear expressions (e.g., $ax + b > c$).
- **Quadratic Inequalities:** Involve quadratic expressions (e.g., $ax^2 + bx + c < 0$).
- **Rational Inequalities:** Involve fractions with variables (e.g., $(x + 1)/(x - 2) > 0$).
- **Absolute Value Inequalities:** Involve absolute values (e.g., $|x - a| < b$).
- **Properties:**
- If a > b, then a + c > b + c (addition property).
- If a > b and c > 0, then ac > bc (multiplication by positive constant).
- If a > b and c < 0, then ac < bc (multiplication by negative constant reverses inequality).
- If a > b, then $-a < -b$ (negation reverses inequality).

Basic Formula List

1. Linear Inequalities:
- $ax + b > c \rightarrow x > (c - b)/a$ (if a > 0)
- $ax + b < c \rightarrow x < (c - b)/a$ (if a > 0)
- $ax + b > c \rightarrow x < (c - b)/a$ (if a < 0, reverse inequality)
- $ax + b < c \rightarrow x > (c - b)/a$ (if a < 0, reverse inequality)

2. Quadratic Inequalities
  ($ax^2 + bx + c > 0$ or $ax^2 + bx + c < 0$):
- Solve $ax^2 + bx + c = 0$ to find roots (x_1, x_2) using quadratic formula: $x = [-b \pm \sqrt{(b^2 - 4ac)}]/(2a)$.
- Determine intervals based on roots and test points to find where the expression is positive or negative.

VERBAL

TENSES

Basic Concepts
- Tenses indicate the time of an action: past, present, or future.
- Divided into three main categories: Past, Present, Future, each with four sub-types: Simple, Continuous, Perfect, Perfect Continuous.
- Helps in expressing when an action happens, is happening, has happened, or will happen.

Formula List (Basic Rules/Structures)
- Simple Present: Subject + Verb (base form/s/es) + Object.
- Present Continuous: Subject + is/am/are + Verb-ing + Object.
- Present Perfect: Subject + has/have + Past Participle + Object.
- Present Perfect Continuous: Subject + has/have been + Verb-ing + Object.
- Simple Past: Subject + Verb (past form) + Object.
- Past Continuous: Subject + was/were + Verb-ing + Object.
- Past Perfect: Subject + had + Past Participle + Object.
- Past Perfect Continuous: Subject + had been + Verb-ing + Object.
- Simple Future: Subject + will/shall + Verb (base form) + Object.
- Future Continuous: Subject + will/shall be + Verb-ing + Object.
- Future Perfect: Subject + will/shall have + Past Participle + Object.

- Future Perfect Continuous: Subject + will/shall have been + Verb-ing + Object.

Short Tricks
- Use "since/for" with Perfect tenses: "since" for point of time, "for" for period of time.
- In narratives, use Past Perfect for earlier past actions.

- "Will" for spontaneous decisions; "going to" for planned future.

Advanced Formula List (Advanced Rules/Structures)
- Conditional Tenses: Zero (If + Present Simple, Present Simple); First (If + Present Simple, will + base); Second (If + Past Simple, would + base); Third (If + Past Perfect, would have + Past Participle).
- Mixed Conditionals: If + Past Perfect, would + base (for unreal past affecting present).
- Sequence of Tenses in Reported Speech: Present changes to Past; Past to Past Perfect; Future to Conditional.
- Passive Voice Tenses: Object + Auxiliary (as per tense) + Past Participle + by + Subject.

ARTICLES

Basic Concepts
- Articles are words ("a", "an", "the") that define nouns as specific or general.
- "A/An" for indefinite (non-specific); "The" for definite (specific).
- "An" before vowel sounds; "A" before consonant sounds.
- No article for plural/general nouns, proper nouns, or abstract ideas.

Formula List (Basic Rules/Structures)
- Indefinite Article: A/An + Singular Countable Noun (e.g., a book, an apple).
- Definite Article: The + Noun (specific, e.g., the sun).
- Zero Article: No article before plural nouns (e.g., books), uncountable nouns (e.g., water), proper nouns (e.g., London).

Short Tricks
- "An" for words starting with vowel sound (e.g., an hour, but a university).
- Use "the" for unique items (e.g., the moon), superlatives (e.g., the best), and ordinal numbers (e.g., the first).

- Omit articles before meals (e.g., have breakfast), sports (e.g., play cricket), or languages (e.g., speak English).

- Articles with Adjectives: A/An/The + Adjective + Noun (e.g., a beautiful day).
- With Geographical Names: The + Rivers/Deserts/Seas (e.g., the Nile); No article for single mountains/countries (e.g., Mount Everest, India).
- In Idiomatic Expressions: By the dozen (definite); At a loss (indefinite).
- With Abstract Nouns: The + Abstract Noun (when specific, e.g., the honesty in him); No article for general (e.g., honesty is best).

CONJUCTIONS:

Basic Concepts
- Conjunctions are words that connect words, phrases, clauses, or sentences (e.g., and, but, or).
- Types: Coordinating (connect equals, e.g., and), Subordinating (connect dependent clauses, e.g., because), Correlative (pairs like either...or).

Formula List (Basic Rules/Structures)
- Coordinating: Word/Phrase/Clause + Conjunction + Word/Phrase/Clause (e.g., tea and coffee).
- Subordinating: Main Clause + Subordinating Conjunction + Dependent Clause (e.g., I run because I am fit).
- Correlative: Correlative Pair + Elements (e.g., either...or, neither...nor).

Short Tricks
- "And" for addition; "But" for contrast; "Or" for choice; "So" for result.
- Avoid starting sentences with "and/but" in formal writing unless for emphasis.
- Use "although" for unexpected contrast; "unless" for negative conditions.
- Conjunctions in Complex Sentences: Although/Though + Contrast Clause, Main Clause.
- Paired Conjunctions: Not only...but also; Hardly...when; No sooner...than.

- Conjunctions for Time: As soon as/While/Until + Action.
- In Conditional Clauses: If/Unless + Condition, Result.

ADJECTIVES

Basic Concepts
- Adjectives describe or modify nouns/pronouns (e.g., big, happy).
- Types: Descriptive (quality, e.g., red), Quantitative (number, e.g., five), Demonstrative (pointing, e.g., this), Possessive (ownership, e.g., my).
- Position: Usually before nouns or after linking verbs.

Formula List (Basic Rules/Structures)
- Attributive: Adjective + Noun (e.g., tall man).
- Predicative: Subject + Linking Verb + Adjective (e.g., he is tall).
- Degrees: Positive (base, e.g., big); Comparative (+er/more, e.g., bigger); Superlative (+est/most, e.g., biggest).

PARTS OF SPEECH:

Basic Concepts
- Parts of speech are categories of words based on function: Noun (person/place/thing), Verb (action/state), Adjective (describes noun), Adverb (modifies verb/adjective), Pronoun (replaces noun), Preposition (shows relation), Conjunction (connects), Interjection (emotion).

Formula List (Basic Rules/Structures)
- Noun: Subject/Object (e.g., dog runs).
- Verb: Action/State (e.g., runs, is).
- Adjective: Modifier of Noun (e.g., fast dog).
- Adverb: Modifier of Verb/Adjective/Adverb (e.g., runs quickly).
- Pronoun: Replaces Noun (e.g., it runs).
- Preposition: Relation Word + Object (e.g., on the table).
- Conjunction: Connector (e.g., and/or).
- Interjection: Exclamation (e.g., wowl).

- Noun Types: Proper/Common/Collective/Abstract/Concrete + Usage.
- Verb Forms: Base/Infinitive (to + base); Gerund (verb-ing as noun); Participle (verb-ing/ed as adjective).
- Adverb Clauses: Adverb + Clause (e.g., when it rains).
- Pronoun Agreement: Pronoun + Antecedent (match number/gender, e.g., he for singular male).

PREPOSITIONS:

- Prepositions show relationships between nouns/pronouns and other words (time, place, direction, e.g., in, on, at).
- Types: Time (at/on/in), Place (in/at/on), Direction (to/from/through), Manner (with/by).
Formula List (Basic Rules/Structures)
- Preposition of Time: At (specific time), On (days/dates), In (months/years/periods).
- Preposition of Place: At (specific point), In (enclosed space), On (surface).
- Preposition of Direction: To (movement towards), From (origin), Into (entering).
- Preposition of Agent/Manner: By (agent), With (instrument).

Short Tricks
- "At" for exact time/place (at 5 PM, at home); "In" for larger areas/times (in India, in summer); "On" for surfaces/days (on table, on Monday).
- Avoid double prepositions (e.g., not "discuss about", just "discuss").
- "Between" for two; "Among" for more than two.

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