Golden Notes

Math & Physics

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Parabola $e=1$

$y^2=4ax$

Tangent at $\left(\frac{a}{m^2},\frac{2a}{m}\right)$

$y = mx + a/m$ } Evertangent

Tangent at $(at^2, 2at)$

$ty = x + at^2$

Normal at $(at^2, 2at)$

$tx+y = 2at+at^3$

Chord joining t_1 & t_2

$y(t_1+t_2) = 2x+2at_1t_2$

It passes through focus iff $t_1t_2=-1$

For a line $lx+my+n=0$ to be a tangent

$ln = m^2a$

For $y=mx+c$ to be tangent, $c=a/m$

t_1 & t_2 intersect at.

$[2a(GM), 2a(AM)]$

i.e $\left[2a\left(\frac{t_1t_2}{2}\right), 2a\left(\frac{t_1+t_2}{2}\right)\right]$

Ellipse $(0<e<1)$

$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$

$b^2=a^2(1-e^2)$

Focus $(\pm ae, 0)$

Vertices $(\pm a,0)$ & $(0,\pm b)$

Directrix $x=\pm\frac{a}{e}$

Length of LR = $\frac{2b^2}{a}$

Coordinates of end of LR: $\left(ae, \pm\frac{b^2}{a}\right)$ & $\left(-ae,\pm\frac{b^2}{a}\right)$

Tangent at $(a\cos\theta, b\sin\theta)$

$\frac{x}{a}\cos\theta+\frac{y}{b}\sin\theta=1$

Eqⁿ of normal

$ax\sec\theta - by\,\mathrm{cosec}\,\theta = a^2-b^2$

Tangent (evertangent)

$y=mx\pm\sqrt{a^2m^2+b^2}$

Line $lx+my+n=0$ is tangent iff $l^2a^2+m^2b^2=n^2$

Line $y=mx+c$ is tangent iff $c^2=a^2m^2+b^2$

Chord joining θ_1 & θ_2

$\frac{x}{a}\cos\left(\frac{\theta_1+\theta_2}{2}\right)+\frac{y}{b}\sin\left(\frac{\theta_1+\theta_2}{2}\right) = \cos\left(\frac{\theta_1-\theta_2}{2}\right)$

Director circle eqⁿ: $x^2+y^2=a^2+b^2$

Hyperbola $(e>1)$

$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$

$b^2=a^2(e^2-1)$

Vertices $(\pm a,0)$

Directrix $x=\pm a/e$

Length of LR = $2b^2/a$

Coordinates of LR = $\left(ae, \frac{\pm b^2}{a}\right)$

Tangent at $(a\sec\theta, b\tan\theta)$

$= \frac{x}{a}\sec\theta - \frac{y}{b}\tan\theta = 1$

Normal at 'θ' =

$ax\cos\theta + by\cot\theta = a^2+b^2$

Evertangent

$y=mx\pm\sqrt{a^2m^2-b^2}$

line $lx+my+n$ is tangent iff $l^2a^2-m^2b^2=n^2$

line $y=mx+c$ is tangent iff $\cancel{y=mx}$ $c^2=a^2m^2-b^2$

Chord joining θ_1 & θ_2 =

$\frac{x}{a}\cos\left(\frac{\theta_1-\theta_2}{2}\right)-\frac{y}{b}\sin\left(\frac{\theta_1+\theta_2}{2}\right)=\cos\left(\frac{\theta_1+\theta_2}{2}\right)$

If $S=0$ is eqⁿ of hyperbola & (x_1,y_1) an external pt., then, $S_{11}<0$

Director circle eqⁿ $x^2+y^2=a^2-b^2$

General notations:

$S= ax^2+by^2+2gx+2fy+c$

$S_1= axx_1+byy_1+g(x+x_1)+f(y+y_1)+c$

$S_{11}= ax_1^2+by_1^2+2gx_1+2fy_1+c$

$S_{12}= ax_1x_2+by_1y_2+g(x_1+x_2)+f(y_1+y_2)+c$

- If $S=0$ is a conic & $A(x_1,y_1)$ & $B(x_2,y_2)$ are 2 pts. on it. If $S_1=0$ & $S_2=0$ are not ∥, then eqⁿ of chord $\overline{AB} = S_1+S_2=S_{12}$
- Combined eqⁿ of pair of tangents drawn from an ext. pt. (x_1,y_1) to conic $S=0$ is $S_1^2=SS_{11}$
- In any conic, two tangents or 2 lines are ⊥ to each other iff coeff. of x^2 + coeff of $y^2=0$
- Angle b/w $ax^2+2hxy+by^2+2gx+2fy+c=0$ or $ax^2+2hxy+by^2=0$ is given as $\theta=\tan^{-1}\left(\frac{2\sqrt{h^2-ab}}{a+b}\right)$

- For $S=ax^2+by^2+2hxy+2gx+2fy+c=0$, $\Delta=h^2-ab$, $\theta=\begin{vmatrix} a & h & g\\ h & b & f\\ g & f & c\end{vmatrix}$

Now,

- ✓ For S to represent intersecting lines, $\Delta>0$ & $\theta=0$
- ✓ For S to represent ∥ lines, $\Delta=0$, $\theta=0$ & $bg^2=af^2$
- Pts. from which 2 tangents to a given conic $S=0$ are ⊥ lie on
  (i) directrix if $S=0$ is parabola
  (ii) circle (director circle) if $S=0$ is ellipse or hyperbola with transverse axis > conjugate axis.
- Eqⁿ of chord of contact for any conic: $S_1=0$

* MATHS

- N arithmetic means b/w x & y, $C.D(d) = \left(\frac{y-x}{N+1}\right)$
- N geometric means b/w x & y, common ratio $(r) = \left(\frac{y}{x}\right)^{1/n+1}$
- N harmonic means b/w x & y, common diff. $(d) = \frac{x-y}{xy(n+1)}$
- Sum of ∞ terms of an AGP :- $S_\infty = \frac{ab}{1-r} + \frac{dbr}{(1-r)^2}$
- ~~If~~ Sum of N terms of AGP :-

$$S_n = \frac{ab}{1-r} + \frac{dbr(1-r^{n-1})}{(1-r)^2} - \frac{[a+(n-1)d]br^n}{1-r}$$

- $$2\sum_{i<j} a_i a_j = (a_1+a_2+\dots+a_n)^2 - (a_1^2+a_2^2+\dots+a_n^2)$$
- If α & β are roots of a quad. eq^n $ax^2+bx+c=0$, $\alpha - \beta = \frac{\sqrt{D}}{a}$
- Coeff. of x^r in $(1-x)^{-n}$ $= {}^{n+r-1}C_r$
- No. of dearray $n!\left[1 - \frac{1}{1!} + \frac{1}{2!} - \frac{1}{3!} + \dots (-1)^n \frac{1}{n!}\right]$
- Greatest term in expansion $(a+x)^n$:- $\alpha : \frac{n+1}{1+\left|\frac{a}{x}\right|}$; $r = [\alpha]$; $\alpha \notin Z$

& $r = \alpha - 1$ & α if $\alpha \in Z$.

- If $(\sqrt{A}+B)^n = I + f$

n = odd, then, $(I+f) \cdot f = K^n$

where $A - B^2 = K > 0$ & $\sqrt{A} - B < 1$.

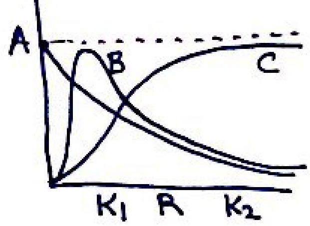
n = even, $(I+f)(1-f) = K^n$

- $e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \dots$; $e = \lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n$
- $a^x = 1 + \frac{x \ln a}{1!} + \frac{x^2(\ln a)^2}{2!} + \dots$
- $\log(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \dots$
- Periodic matrix :- $A^{K+1} = A$; K : Period
- Ht. of cappilary tube rise $(h) = \frac{2S\cos\theta}{\rho g r}$
- For a plane progressive wave, amplitude(A) doesn't change.
- $F_{viscous} = 6\pi\eta r v$
- $F_{viscous} = \eta A \frac{dv}{dx}$
- Poisson's Ratio :- $\left|-\Delta d/d \,//\, \Delta l/l\right| = \left|\frac{\text{Transverse strain}}{\text{Longitudinal strain}}\right|$
- Thermal stress $(\sigma) = Y\alpha(\Delta\theta)$
- Speed of efflux $(v) = \frac{\sqrt{2gh}}{\sqrt{1-\frac{a^2}{A^2}}}$
- Both closed/Both open $\rightarrow$ ν or $f = n\left(\frac{v}{2l}\right)$ $n \in Z^+$
- One closed, one open ; ν or $f = n\left(\frac{v}{4l}\right)$; n = odd
- Degree of freedom $(f) = 3N - R$
  N: no. of particles ; R: no. of bonds (relations)
- $C_v = \left(\frac{f}{2}\right)R$
- $P_{avg} = 2\pi^2\nu^2 A^2 v\mu$; $I = \frac{P}{A} = \frac{E}{At}$; A: Area
  $A \rightarrow$ Amplitude
- L: Level of soundness : $10\log\frac{I}{I_0}$; $I_0 = 10^{-12}\ \text{Wb m}^{-2}$
- Particle vel: $A\omega$, Wave vel: $\nu\lambda$
- $\mu = \frac{m}{l} = \rho A$
- Energy (, say $\frac{1}{2}mv^2$) ; $v = A\omega \Rightarrow E = \frac{1}{2}mA^2\omega^2$
  $\Rightarrow E \propto (\text{Amplitude})^2(\text{Frequency})^2$
- For sonometer, $n \propto \frac{1}{\sqrt{m}}$; m: mass, n: no. of antinodes
- $V_{particle} = -V_{wave}\frac{\partial y}{\partial t}$
- Beat frequency $(\nu_2 - \nu_1)$: No. of times max. intensity occurs in 1 sec. or no. of maximas in 1 sec.
- For an expression to describe wave motion, $\frac{\partial^2 y}{\partial x^2} = (\text{constant})\frac{\partial^2 y}{\partial t^2}$
- Distance b/w 2 consecutive nodes or antinodes is $\frac{\lambda}{2}$ and distance b/w a node and an antinode is $\lambda/4$.
- For sonometer, $\nu = \frac{nv}{2l}$

* $F = 32 + \frac{9}{5}C$
- Multiply a complex no. by i rotates it anti clockwise by $\frac{\pi}{2}$ i.e, argument increases by $\frac{\pi}{2}$.
- During compression, ↑ in P is more in adiabatic than isothermal.
- During expansion, the ↓ in P is more in adiabatic than isothermal.
- Hydration energy $\propto$ ~~size~~ charge
  & Lattice energy $\propto \frac{1}{\text{size}}$
- Among isoelectronic species,
  ✓ ionic size $\propto \frac{1}{\text{At. no.}}$
  ✓ cation < neutral < anion.
- Hyperconjug^n involves overlap of $\sigma - \pi$ orbitals.
- If algebraic sum ($\perp$ distance) of n points to the fixed line is zero, then, line passes through a fixed pt. having coordinates (AM_x, AM_y) : AM: Arithmetic Mean.
- For $a_1x + b_1y + c_1 = 0$ & $a_2x + b_2y + c_2 = 0$ cuts coordinate axis at concyclic points, then,
  $a_1a_2 = b_1b_2$; or ; $a_1b_2 + a_2b_1 = 0$
- Projection of $\vec{b}$ on $\vec{a}$
  Scalar :- $|\hat{a} \cdot \vec{b}|$
  Vector :- $|\vec{b}|\hat{a} \cdot \frac{(\vec{a} \cdot \vec{b})}{|\vec{a}||\vec{b}|}$ or $|\vec{b}|\,\hat{a}\cos\theta$
- Projection of normal to $\vec{b}$ (given vector) of $\vec{a}$
  Scalar :- $|\vec{a} - (\vec{a} \cdot \hat{b})\hat{b}|$
  Vector :- $\vec{a} - |\vec{a}| \cdot \hat{b}\cos\theta$
- Volume of tetrahedron $= \frac{1}{6}$ STP
- Vol. of ~~trigonal~~ triangular prism $= \frac{1}{2}$ STP
- Reciprocal sys of vectors :-
  $(\vec{a})^{-1} = \frac{\vec{b} \times \vec{c}}{STP}$
- ${}^{n+1}C_{r+1} = \left(\frac{n+1}{r+1}\right){}^{n}C_r = \left(\frac{n+1}{r+1}\right)\left(\frac{n}{r}\right){}^{n-1}C_{r-1} \ldots\ldots$

- $\frac{{}^nC_r}{{}^nC_{r-1}} = \frac{n-r+1}{r}$; $\frac{{}^nC_{r+1}}{{}^nC_r} = \frac{n-r}{r+1}$; ${}^nC_r \cdot {}^rC_s = {}^nC_s \cdot {}^{n-s}C_{r-s}$
- To find sum of binomial coeff. of the expansion $(1+x)^n$ with 'k' no. of missing terms ; substitute $(k+1)$ roots of unity in place of x on both sides of equation. Then, add the $(K+1)$ terms obtained. The result is answer.
- $\frac{N}{M} = \frac{\text{Normality}}{\text{Molarity}} = \frac{W}{EW} = n\text{-factor}$
- $PV = \frac{1}{3}mN(\bar{c})^2$; $\bar{c}$: μ_{rms}
- $E = \frac{3}{2}K_bT$; $K_b = \frac{R}{N_0}$
- $Z = \frac{V_m}{V_{ideal}} = \frac{PV_m}{RT} = \frac{P_{real}}{P_{ideal}}$

  • Cond^n for ideality
  $P \to 0$
  $T \to \infty$
  $V \to \infty$
- $\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$
- $Z = \frac{1}{V_m}\left(b - \frac{a}{RT}\right) + 1$: Solving Virial eq^n under approxim^n
- $T_B = \frac{a}{Rb}$; T_B: Boyle Temp.
- $T_{critical} = \frac{8a}{27Rb}$; $P_{critical} = \frac{a}{27b^2}$; $V_{critical} = 3b$
- No. of spectral lines $= \frac{n(n-1)}{2}$
- $mvr = \frac{\sqrt{l(l+1)}\,h}{2\pi} = \left(\sqrt{l(l+1)}\right)\frac{h}{2\pi}$
- For Parallel Rxn $A \xrightarrow{K_1} B$, $A \xrightarrow{K_2} C$
  $K_{eq} = k_1 + k_2$; $\frac{[B]}{[C]} = \frac{k_1}{k_2}$
- For Consecutive reaction,
  $A \xrightarrow{K_1} B \xrightarrow{K_2} C$
  $t_{max} = \frac{1}{K_1 - K_2}\ln\left(\frac{K_1}{K_2}\right)$
  $[B]_{max} = A_0\left(\frac{K_2}{K_1}\right)^{K_2/K_1 - K_2}$



- For Opposing reactions,
  $\underset{t=t \quad (a_0)}{A} \underset{K_2 \text{ or } K_{-1}}{\overset{K_1}{\rightleftharpoons}} \underset{(x)}{Z}$; $K = \frac{k_1}{k_2 \text{ or } K_{-1}}$
  $\frac{dx}{dt}$ = Rate of form^n of $Z = k_1(a_0 - x) - k_{-1}(x)$
- $K_b = \frac{M_1RT_b^{\circ}}{\Delta H^{\circ}_{1mv}}$; $K_f = \frac{M_1RT_f^{\circ}}{\Delta H^{\circ}_{1mf}}$

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- $2\sum_{i<j} a_i a_j = (a_1+a_2+\dots+a_n)^2 - (a_1^2+a_2^2+\dots+a_n^2)$
- If α & β are roots of a quad. eq^n $ax^2+bx+c=0$,
  $\alpha-\beta = \frac{\sqrt{D}}{a}$
- Coeff. of x^r in $(1-x)^{-n}$
  $= {}^{n+r-1}C_r$
- No. of dearray
  $n!\left[1-\frac{1}{1!}+\frac{1}{2!}-\frac{1}{3!}+\dots\frac{(-1)^n 1}{n!}\right]$
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  & $r = \alpha-1$ & α if $\alpha \in Z$.
- If $(\sqrt{A}+B)^n = I+f$
  $n=$ odd, then, $(I+f)\cdot f = K^n$
  where $A-B^2 = K>0$ & $\sqrt{A}-B<1$.
  $n=$ even, $(I+f)(1-f) = K^n$
- $e^x = 1+\frac{x}{1!}+\frac{x^2}{2!}+\dots$; $e = \lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n$
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- Degree of freedom $(f) = 3N-R$
  N: no. of particles ; R: no. of bonds (relations)
- $C_v = \frac{f}{2}R$

• 1 AU - Astronomical unit = Distance b/w centre of earth and centre of Sun $= 1.496 \times 10^{11}\, m \approx 1.5 \times 10^{11}\, m$

• 1 Par Sec = 1 Parallactic Second = It is distance from an arc of 1 AU that subtends 1″ angle.
1 Par Sec $= 3 \times 10^{16}$ m.

• Angular fringe separation $(\theta) = \frac{\lambda}{d}$

• Variation of g :-
On surface $= g_0 = \frac{G M_e}{R_e^2}$
At a ht. (h) $= \frac{g_0 R_e^2}{(R_e+h)^2} \approx g_0\left(1 - \frac{2h}{R_e}\right)$
At a depth (d) $= g_0\left(1 - \frac{d}{R_e}\right)$
Due to rot^n :- $= g_0 - (\omega^2 \cos^2\theta) R_e$

• Power of radiation received by a surface at temp (T_0) by any other surface at temp. $(T > T_0)$ and distance d is given as $P \propto \frac{T^4}{d^2}$

• Acc. to Rayleigh's scattering law, Intensity of light scattered (I) $\propto \frac{1}{\lambda^4}$

• If $(N+1)$ polaroids are placed, so that their axes are equally spaced, then, intensity of light after passing through all polaroids :-
$I = I_0\left(\cos\frac{\pi}{2N}\right)^{2N}$

• If a vehicle is overtaking a car (fitted with convex mirror - driving mirror) of focal length f), then speed of image of vehicle (V_i) formed by the mirror (as seen by person in the car is :-
$V_i = \frac{-f^2}{(u-f)^2} \times$ (rel. speed of vehicle w.r.t car)
u: distance of vehicle from car.

• Acidic character $\propto$ E_N of central atom ⟵ In period

• For bond to be covalent :-
Large size of anion
Small size of cation
highly charged cation or anion or both.

* When particles are falling in a viscous fluid under gravity, they attain a terminal velocity (V_s) s.t their f_v combined with buoyancy balances wt. (gravit^{nal} force).
Then, $V_s = \frac{2}{9} \frac{(\rho_{particle} - \rho_{fluid})\, g R^2}{\eta}$ ⟶ viscosity

$V \Delta\rho g = 6\pi\eta R V_s$; $V = \frac{4}{3}\pi R^3$

· The terminal velocity is attained
Vertically upwards : $\rho_{particle} < \rho_{fluid}$
Vertically downwards : $\rho_{particle} > \rho_{fluid}$.

	Electron (e^-, β^-)	Proton	α-particle $(\alpha, \alpha^{2+}, He^{2+})$
q:	$-1e$ -1.6×10^{-19} C -4.8×10^{-10} esu	$+1e$ $+1.6 \times 10^{-19}$ C	$2e$
m:	5.48×10^{-4} u 9.1×10^{-31} Kg	$1u$ 1.6×10^{-27} Kg	$4u$

* Lateral shift in a glass prism :-
$d = \frac{t}{\cos r} \sin(i - r)$; t: thickness of slab

* Units of activity of radioactive sample :-
SI = Becquerel (Bq) or disintegs^{ns} per sec (dps)
1 Curie (Ci) $= 3.7 \times 10^{10}$ Bq $= 3.7 \times 10^{10}$ dps
1 Rutherford (Rd) $= 10^6$ Bq $= 10^6$ dps

* Wein's Displacement law
$\lambda_{max} T = b = 2.89 \times 10^{-3}$ mK

* Newton's Law of Cooling
$+\frac{dQ}{dt} = +ms\frac{dT}{dt} = \frac{-\Delta T}{l/KA} = \frac{-\Delta T}{1/hA} = e\sigma A(4T_0^3)(\Delta T)$
$= hA(-\Delta T) = \frac{KA}{l}(\Delta T)$

* Time taken for cooling
$t = \frac{l}{KA} \ln \frac{\theta_1 - \theta_0}{\theta_2 - \theta_0}$; θ = Temp.

* TP of simple pendulum of length comparable to radius of earth
$T = 2\pi \sqrt{\frac{1}{g\left(\frac{1}{l} + \frac{1}{R}\right)}}$

* For n^{th} order rxn,
$kt = \frac{1}{n-1}\left[\frac{1}{[A]^{n-1}} - \frac{1}{[A_0]^{n-1}}\right]$; $k = \left(\frac{1}{[conc]}\right)^{n-1}\left(\frac{1}{t}\right)$

* $K_p = K_c (RT)^{\Delta n}$

* E_N of central atom $\propto$ Bond angle of compd.

* Acidic character $\propto$ size : In group.

* Σ of all the r digit nos. that can be formed from n distinct digits (non zero)
$=$ (Sum of all digits)$(n^{r-1})(1 + 10 + 10^2 + \cdots 10^{r-1})$

* For ungrouped data

Mean = $\dfrac{\sum x_i}{n} = \bar{x}$; Mean deviation = $\dfrac{\sum |x_i - \bar{x}|}{n}$

Median :- M, say , Mean deviation = $\dfrac{\sum |x_i - M|}{n}$

* For discrete frequency distribution

Mean = $\dfrac{\sum f_i x_i}{\sum f_i} = \bar{x}$, Mean deviation = $\dfrac{\sum f_i |(x_i - \bar{x})|}{\sum f_i \text{ i.e total frequency (N)}}$

Median = M, say , Mean deviation = $\dfrac{\sum f_i (|x_i - M|)}{\sum f_i}$,

* For continuous frequency distribution

x_i = Mid pt. of interval given.. Rest is same.

* Variance :- Replace $|x_i - \bar{x}|$ or $|x_i - M|$ by $(x_i - \bar{x})^2$ or $(x_i - M)^2$ in every formula given above.
(σ^2)

* Standard deviation = σ = $\sqrt{\text{Variance}}$

* Another formula for std. deviation =

ungrouped : $\dfrac{\sum x_i^2}{n} - \left(\dfrac{\sum x_i}{n}\right)^2$

discrete : $\dfrac{\sum f_i (x_i)^2}{n} - \left(\dfrac{\sum f_i x_i}{n}\right)^2$

* Coeff. of variation = $\dfrac{\sigma}{\bar{x}} \times 100$ = C.V. [σ : std. deviation, $\bar{x}$: Mean]