Science & Technology since Vedic Times

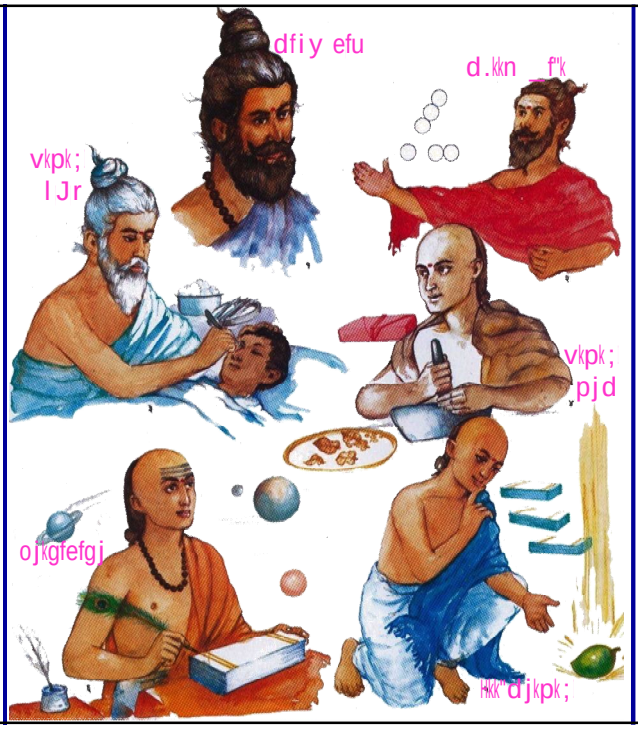
ik- d".k fcgkjh ik.Mk;
dyifr(Ex)

egkRek xka/kh fp=dwV xkekn; fo'ofo|ky; fp=dwV ¼e-i-½

- ekuo lH;rk d fodkl dk Øe gh foKku d fodkl dk Øe gA
- ikphu dky e ekuo lH;rk d fodkl dh rhu lekukUrj /kkjk; ekuh tkrh g& 1.Hkkjr 2.phu 3.if'pe ,f'k;k ,o fudVorh n'k ¼tl& feJ] xhl rFkk cchyku½A
- bue l Hkkjr e foKku d fodkl dh /kkjk ikphure ekuh tkrh g] ftldk ikjEHk ikxfrgkfld dky ¼ik"kk.k&;x½ l gA
- ik'pkR; xUFkk e feJ] ;uku rFkk cchyku dh gh mifC/k;k dk o.ku ,o ;'kkxku g] Hkkjr rFkk phu d ;kxnkuk dh vogyuk dh xb gA
- foKku dk ikjEHk Ýkfll cdu] ju&M&dkV] xyhfy;k] dkijfudl rFkk U;Vu vkfn l gh ekuk x;k g] tcfd dfiy] d.kkn] lJr] pjd] Hkj}kt] vk;HkVV rFkk Hkk"djkpk; vkfn oKkfud cgr igy d gA
- ;gh iLrr 0;k[;ku dh fo"k;&oLr gA

oKkfudk'p dfiy% d.kkn% lJrLrFkkA
pjdk HkkLdjkpk;k ojkgfefgj% l/kh%AA

ukxktuk Hkj}kt vk;HkÍk olc/k%A
/;;k odVjke'p foKk jkekutkn;%AA



1- dfiy
¼~3000 b-i-½

2- d.kkn
¼~600 b-i-½

3- lJr
¼~600 b-i-½

4- pjd
¼~600 b-i-½

5- Hkk"djkpk;
¼1114&1183 b-½

6- ojkgfefgj
¼499&587 b-½

7. ukxk t u
½~100&200 b-½

8. Hkj}kt
½=rk;x½

9. vk;HkVV
½476&550 b-½

10. t xnh'kpUn c l
½1858&1937 b-½

11. pUn'k[kj odVjkeu
½1888&1970 b-½

12. jkeku t e
½1887&1920 b-½

I have travelled across the length and breadth of India and I have not seen one person who is a beggar, who is a thief. Such wealth I have seen in this country, such high moral values, people of such caliber, that I do not think we would ever conquer this country, unless we break the very backbone of this nation, which is her spiritual and cultural heritage, and, therefore, I propose that we replace her old and ancient education system, her culture, for if the Indians think that all that is foreign and English is good and greater than their own, they will lose their self-esteem, their native self culture and they will become what we want them, a truly dominated nation.

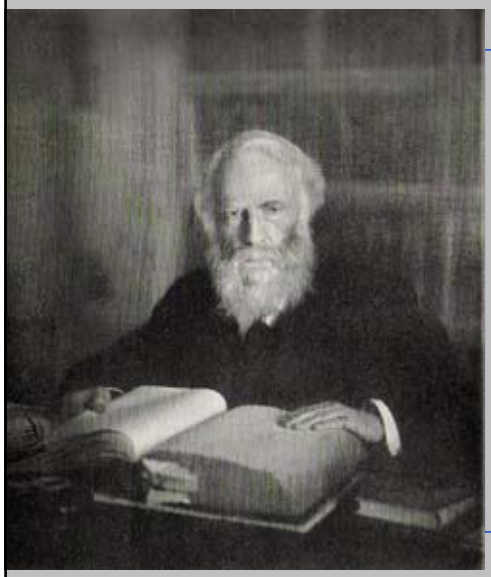
-Lord McCauley (speech of Feb. 2, 1835) British Parliament.

It is therefore with some misgiving that today I find myself dealing with Indians, many of whom do not feel proud of their Indianness. Indians are recognized throughout America as technically superior. Since the day Indians learn pride, India will rapidly move out of its third world status to become one of the world's industrial powers.

-Adam Osborne, Apple Computers
(Dataquest magazine)

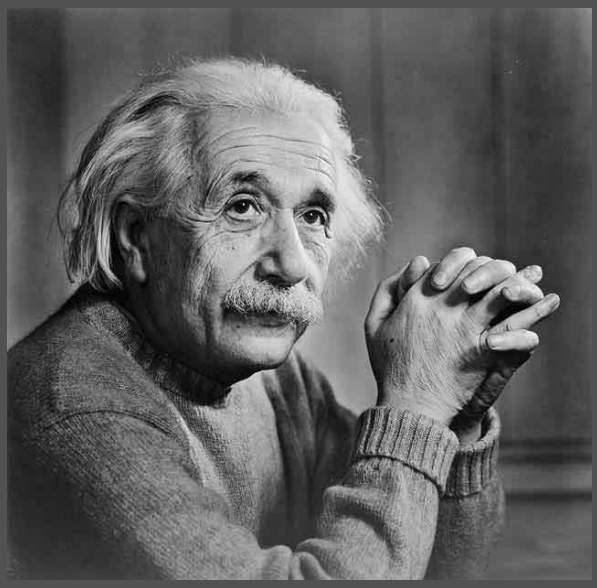
How can we lament lack of national pride in Indians without first acquainting them with the country's phenomenal scientific achievements in the dim distant past?

-D.S. Kothari
(Lecture on "Science and Values" delivered at the Indian National Science Academy)



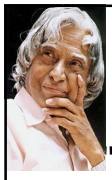
"Many of the advances in the sciences that we consider today to have been made in Europe were in fact **made in India centuries ago**"

- Grant Duff
British Historian of India



"We owe a lot to the **Indians,** who taught us **how to count**, without which no worthwhile scientific discovery could have been made"

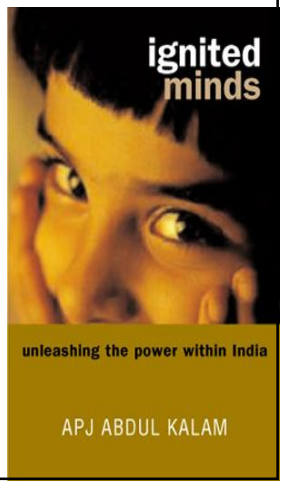
-Albert Einstein



'The work of these three mathematicians of India (Aryabhata, Brahmgupta and Bhaskaracharya) provides the context of Albert Einstein's remark that 'We owe a lot to the Indians who taught us how to count, without which no worthwhile scientific discovery could have been made.'

Then comes to my mind the greatest of all geniuses ever known and acknowledged, and who lived within our present memory - Srinivasa Ramanujan."

- APJ Abdul Kalam (*Ignited Minds, p. 43-44*)



- foKku vkj ik|kfxdh nkuk {k=k e Hkkjr ekuo lH;rk d m"kdky l gh vx.kh jgk gA
- Hkkjr d bl mRd"V oKkfud Kku d ikphure miyC/k lkr g& onA
- ofnd _f"k gh Hkkjr d iFke oKkfud FkA mudh ;K'kkyk; gh ikjfEHkd i;kx'kkyk; FkhA
- mifu"kn dky rd ;g foKku jkf'k fofHkUu 'kk[kkvk e oxhdr gk pdh Fkh& xf.kr] T;kfr"k] inkFk foKku] lU; foKku] fpfdRlk foKku ,o tho foKkuA

ofnd dky l e/; ;x rd oKkfud lkfgR; rhu :ik e miyC/k g&

Lor= oKkfud xUFk

- fpfdRlk foKku& pjd lfgrkj] lJr lfgrkA
- [kxky vkj xf.kr& vk;HkVVh;e] ogRlfgrkA
- vfHk;kf=dh vkj okLr'kkL=& lejkx.k l=/kkj] ;=loLoA
- ouLifr foKku& Hkko idk'k vkfnA

vu"kkfxd 'kkL=h; xFk

- vFkoon e fpfdRlk foKku lc/kh lDrA
- dkfVY; vFk'kkL= e df"k foKku] [kfut] vfHk;kf=dh vkfnA

fo'k) lkfgfR;d dfr;k

- jkek;.k] egkHkkjr] e?knre vkfnA

ASTRONOMY & MATHEMATICS

ikphu Hkkjr e [kxky'kkL=

dky&[k.M	[kxky'kkL=h	jpuk;
1500 BC	yx/k	onkx T;kfr"k
476 AD	vk;HkVV&1 ¼dleijk] fcgkj] ukyUnk d fudV½	vk;HkVV fl)kr] vk;HkVVh;e
505 AD	ojkgfefgj ¼mTtu½	ipfl)kfrdk] ogRlfgrk
600 AD	Hkk"djkpk;&1 ¼oYyHkh] xtjkr½	egkHkk"djh;e] y?kHkk"djh;e
600 AD	ogexlr ¼fHkYyekyk] jktLFkku½	cgeLQV fl)kr] [k.M&[kkd
700 AD	yYyk ¼nklijk] e-i-½	f'k";&/kh&of)nk
889 AD	oV'oj ¼okruxj] xtjkr½	oV'oj fl)kr
932 AD	ety ¼idk'kiRru½	y?kekul] ogr&ekul
953 AD	vk;HkVV&2	egkfl)kr
999 AD	Jhifr	T;kfr"k jRuekyk] fl)kr 'k[kj
1000 AD	jktk Hkkt ¼mTtu½	fo}TtuoYyHk] jktekr.M
1114 AD	Hkk"djkpk;&2	fl)kr f'kjkef.k] yhykorh] chtxf.kre] dj.kdrgy
1227 AD	Jhvkjkpk;	y?k dpjflf)
1376 AD	ije'oj ¼djy½	nXxxf.kr] xkynhfidk] xg.kenkj

ikphu Hkkjr e xf.kr

dky&[k.M	xf.kr ,o xf.krK
3000 - 1500 BC	bMl Ldy] yEckb rFkk Hkkj ekiu rFkk ekudhdj.kA
1500 - 500 BC	on] onkx rFkk 'kYc l=] 'kCn&vd] [kxky'kkL= dk ikjHk] vd xf.krh; fØ;k;] ofnd T;kfefr xf.krK& ckWk;u] vkiLrEHk] dkR;k;u
500 - 200 BC	tu xf.kr dk iknHkko] vd&fl)kUr] ijE;V'ku&dkEchu'ku] ckbukfe;y fl)kr] fixy&pnk l=] e#&iLrj
200 BC - 400 AD	c{kyh eU;fLdlV] xf.krh; fØ;kvk d fu;e] 'kU; dk iFke i;kx] ljy chtxf.kr] vKkr jkf'k ifrfuf/kRo] _.k&fpUg ldYiuk
400 - 1200 AD	Hkkjrh; xf.kr dk mRd"V dky xf.krK& vk;HkVV ¼vk;HkVVh;e½] ojkgfefgj ¼ipfl)kfrdk½] Hkk"djkpk;&1] cgexlr] Jh/kj] egkohj] Hkk"djkpk;&2 ¼fl)krf'kjkef.k] vk;HkVVh; Hkk";rFkk egkHkk";½

l;| dh fdj.kk e lkr jx gA

vL; okeL;ifyrL; gkrLrL; Hkkrk e/;ek vLR;'u¼A
rrh;k Hkkrk ?kri"Bk vL;k=ki'; fo'ifr lIri=eAA

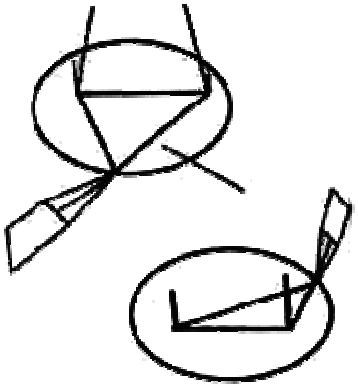
¼_xon 1-164-1½

bu lUnj ,o txikyd gkrk ¼l;no½ dk geu lkr i=k ¼llro.kh fdj.kk½ lfgr n[kk gA bu ¼l;no½ d e/;e ¼e/;&vUrfj{k e gju oky k½ Hkkb lo0;kih ok;no gA mud rhlj Hkkb rtLoh ihBoky gA

[kxkyh; fi.Mk d xfr dk iFk f=ukfHkpØh; (nh?koRrh;] Elliptical) gA

llr ;tfUr jFkedpØedk v'ok ogfr llrukekA
f=ukfHkpØetjeuo ;=ek fo'ok Hkoukfu rLFkkA

¼_xon 1-164-2½



,d pØ ¼lfork d ik"k.k pØ½ oky jFk l ; lkrk tM gA lkr ukek ¼jxk½ okyk ,d ¼fdj.k :ih½ v'o bl pd dk pykrk gA rhu ukfHk;k ¼dUnd½ vFkok /kfj;k okyk pg dkypd lrr xfr'khy vfouk'kh vkj f'kfFkyrk jfgr gA blh pØ d vUnj leLr ykd fo|eku gA

dkijfudl ¼1473&1543½ d dky rd [kxkyh; fi.Mk dh xfr dk iFk oRrh; ekur FkA
t- diyj ¼1571&1630 b-½ u iFke ckj 1609 b- e nh?koRrh; iFk gkuk crk;kA

cgek.M dk dUn l;g

uokLreuedL; ukn;% lonk lr%A mn;kLreuk[; fg n'kukn'ku jo%A
¼fo".k ijk.k] 2-8-15] egf"k 0;kl] on&vuUrj dky½
okLro e l; u rk mxrk g vkj u vLr gkrk gA ;g ik;% ogh jgrk g] ek= mifLFkfr vkj vuifLFkfr inf'kr gkrh gA

nk/kFk ifFkohefHkrk e;[k%A ¼;tj&vj.;de 1-8-3] ofnd dky½
l; iFoh dk viuh vkj vkdf"kr djd j[krk gA

fe=k nk/kkj ifFkoher|keA fe=% d"Vh%A
¼;ton] rfRrjh; lfgrk 3-4-10-34] ofnd dky½
l; iFoh dk rFkk vU; [kxkyh; fi.Mk dk viuh vkj vkdf"kr djd j[krk gA

iky.M d [kxkyfon dkijfudl ¼1473&1543½ u lu 1543 b- e crk;k fd l; cgek.M dk dUn g rFkk iFoh vkj vU; xg bld pkjk vkj pDdj yxkr gA if'peh foKku d bfrgkl e bl fo'k"k fcUn ekuk x;k gA

'kU; D;k g & lf"V dk vkfn vkj vUr

¼vkdk'k] bfUn;] fjDr LFkku] fNn] }kj] vUrfj{k] Lox ;k noykd½

[k jFkL;A _x0 8-91-7
d% llr [kkfu fo rrn 'kh"kf.kA vFko0 10-2-6
vfX/k [keA _x0 10-156-3
fo"kkfg --- x.kr--- [keA _x0 4-11-2
vk [k cgeA ; t0 40-17

vd"k 'kU;foU;kl kn of)% L;kr r n'kkf/kdkA
rLekn K;k fo'k"k.k] vdkuk okeuk xfr%AA & i|jRuekfydk

'kU; vkj vuUr

vk [k cgeA ; t0 40-17

o/kknk fo;r [kL; [k [ku ?kkrA
[kgkjk Hkor [ku HkDr'p jkf'k%A
v;euUrk jkf'k% [kgj bR;P;rA & chtxf.kr 'ykd 3

vfLeu fodkj% [kgj u jk'kk &
vfi ifo"V"ofi fu%lr"kA
cg"ofi L;kn y;&lf"V&dky·&
uUr·P;r Hkrx.k"k ;norA & chtxf.kr 'ykd 4
¼Hkk"djkpk;] f}rh; 1150 bLoh½

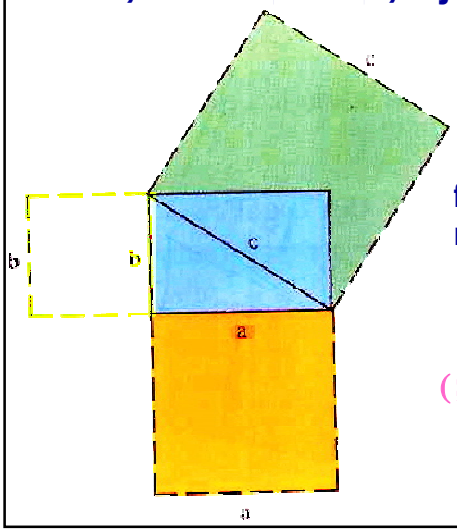
n'keyo i.kkyh

n'kkofuH;k n'kd{;H;k
n'k;kD=kH;k n'k;ktuH;kA
n'kkHkh'kH;k vprktjH;kA
n'k /kjk n'k ;Drk ognH;kAA
r vn;k n'k;U=kl vk'ko&
Lr"kkek/kku i;fr g;reAA &

_x0 10-94-7 vkj 8

'kYc&l=e vFkkr ck/kk;u ie;&

nh?kkprjJL;k{.k;k jTtk ik'oekuh fr;ZekuhA
;RiFkXHkr d#rLrnHk; djkfrA



¼'kYc&l=e 1-48 ck/kk;u 800 ch-lh-½
¼vkiLrEc 1-4 rFkk dkR;k;u 2-11½

fdlh vk;r dh yEckb rFkk pkMkb d oxk dk ;kx mldh fod.k d ox d cjkcj gkrk gA $a^2 + b^2 = c^2$

(;ukuh xf.krK ikbFkkxkjl u ck/kk;u l yxHkx 200 o"k i'pkr ;gh ie; fn;k)

vk;HkVV&1 ¼476&550 AD½

xUFk& vk;HkVVh;e rFkk vk;HkVV fl)krA

^iFoh l; d pkjk vkj ?kerh g* dk ifriknuA

Aryabhatta

(~476-550 AD)

vuykexfrukLFk% i';R;py foykex ;}rA

vpykfu Hkkfu r}r leif'pexkfu ydk;keAA

vFkkr tl xfr'khy ukdk e cB g, O;fDr dk fdukj d fLFkj o{k vkfn oLr, ihN dh vkj Hkkxrh gb fn[krh g] mlh idkj xfr'khy iFoh ¼ydk vFkkr Hkke/; j[kk½ ij fLFkr O;fDr dk vpy l; vkfn u{k= if'pe dh vkj xfr djr g, irhr gkr gA vFkkr l; fLFkj g] iFoh mld pkjk vkj xfr djrh gA

¼yxHkx 1000 o"k ckn dkijfudl]1473&1542½

xgk dh xfr d fu;e ¼vk;HkVV½

d{;k ifre.Myxk HkefUr lo xgk% Lopkj.kA

eUnkPpknuykse ifrykepo 'kh?kkPpkrAA

&vk;HkVVh;e] dykfØ;kikn% 3-17] vk;HkVV 499 ,-Mh-

e/;e xg viuh d{kk ij rFkk e[; xg viu oRr e ?ker gA

teu [kxkyfon t- diyj u xgk dh xfr d fu;e dk ifriknu 1609 ,-Mh- e fd;kA

ikb (π) dk eku&

prjkf/kd 'kre"Vx.k }k"kf"VLrFkk lgl k.kkeA
v;r};fo"dkEHkL;k lUuk oRrifj.kkg%AA

¼vk;HkVVh;e xf.krin% 2-10] vk;HkVV 499 ,-Mh-½

tc 100 $ 4 dk 8 l x.kk djd 62000 e tkMk tkrk g rk 20000 0;k l oky oRr dh ifjf/k ikIr gkrh gA

C = [(100 + 4) × 8] + 62000 = 62832

rFkk d = 20000

blfy,] π = C / d

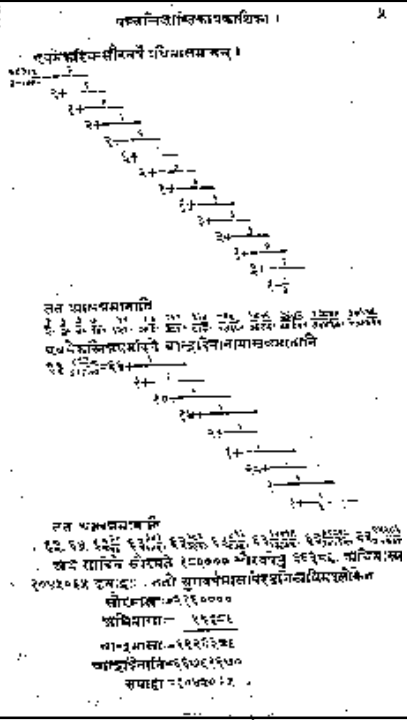
= 3.1416

ikb (π) dk eku&

xf.krK	dky	ikb dk eku
egkohj	850 AD	$(10)^{1/2}$
Hkk"djkpk;&2	1150 AD	3927 / 1250
uhyd.B lkek;kth (r= lxg%)	1444-1545 AD	28,27,43,33,88,233 / 9 × $(10)^{11}$ (ek/kokpk;] Infinite series for π)
'kdj okfj;kj	1500-1560 AD	104348 / 33215
John Wallis	1655 AD	Infinite series for π
Abraham Sharp	1717 AD	Infinite series for π
ireu lkek;kth	1732 AD	31,415,926,536 / $(10)^{10}$
'kdj oeu	1823 AD	314,159,265,358,979,324 / $(10)^{17}$
jkekute	1887-1920 AD	vud foy{k.k l= fn;] ftul π d eku 3]7]8]14] -----] 31 n'keyo LFkku rd ikIr g,A

ojkgfefgj ¼6Bh 'krkCnh AD½

- ifl) T;kfr"kkpk;A
- foØekfnR; d njckj d uk&jRuk eA
- ifl) jpuk % ogRlfgrk] ipfl)kfrdkA



Method of graduated calculation.

ip&fl)kfrdk ¼505 ,-Mh½

e of.krA

;g rduhd ofnddky dh gA

This fascimile is from the Pancha-siddhantika (Five Principles) of Varahmihir dated around early 6th century. This text graphically shows how eclipses are to be calculated. Thus this text foreshadows what Westeren Astronomers propounded nearly one thousand years later

HkkLdjkpk;& &2

½1114&1185 AD, foTtkfnr] tyxko] egkjk"V½

- U;Vu l 550 o"k igy x#Rokd"k.k d fu;e dk ifriknuA
- xUFk& fl)kf'kjkef.k] ftld nk Hkkx g&
  - (i) xkyk&v/;k; ¼[kxky'kkL=½
  - (ii) xg&xf.krA

Bhaskaracharaya-II
(1114-1185 CE)

Hkk"djkpk; ¼ x#Rokd"k.k

U;Vu\

vkdf"V'kfDr'p egh r;k ;r
[kLFk x# LokfHke[k Lo'kDR;kA
vkd";r rRirrho Hkkfr
le leUrkr Do irfRo; [kAA

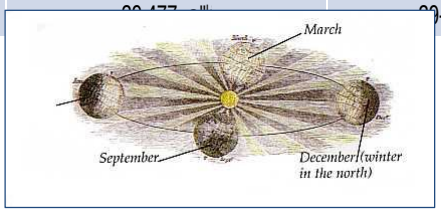
& fl)krf'kjkef.k] xkyk/;k;] Hkoudk'k 6 ¼Hkk"djkpk;&2] 1150 ,-Mh-½

iFoh e vkd"k.k 'kfDr g] vr% og Åij dh gj Hkkjh oLr dk viuh vkj [khprh gA og oLr iFoh ij fxjrh gb lh yxrh gA iFoh Lo; l; vkfn d vkd"k.k l :dh gb gA vr% og fujk/kj vkdk'k e fLFkr g rFkk viu LFkku l u gVrh g vkj u fxjrh g] cfYd viuh dhyh ij ?kerh gA

U;Vu ¼1642&1728 ,-Mh-½ u Hkk"djkpk;&2 l yxHkx 550 o"kk ckn x#Rokd"k.k d fu;e dk ifriknu fd;kA

xgk }kjk l; dh ifjØek dk dky ¼Hkk"djkpk;½

xg	Hkk"djkpk; dk eku	vk/kfud eku
iFoh	365-259 fnu	365-256 fnu
pUnek	27-322 fnu	27-322 fnu
ekl	1-881 o"k	1-881 o"k
tfiVj	11-861 o"k	11-862 o"k
lVu		-458 o"k



Hkk"djkpk; u viu xUFk fl)kUr f'kjkef.k ¼12oh 'krkCnh½ e iFoh }kjk l; dh ifjØek e yxu oky le; dh x.kuk 365-25756484 fnu dhA if'peh [kxkyfon LekV u ;g x.kuk yxHkx 500 o"k i'pkr dhA

${}^nP_r$ dk eku&

LFkkukUredkfnp;kd?kkr% l[;kfoHknk fu;rL;jd%A
HkDrk-³dfeR;kdlekl fu?u% LFkku"k ;Drk fefrl;fr% L;krAA

;koRLFkku"k rY;kdkLrnHknLr iFkd dr%A
ikXHknk fogrk HknkLR l[;D; p ioorAA
yhykorh] vdik'kj] 33-1] 3-4 ½Hkk"djkpk;&2] 1150 ,-Mh-½

(i) n fHkUu&fHkUu oLrvk dk n LFkkuk e fdru idkj l j[kk tk ldrk g& $1 \times 2 \times 3 \times 4 \times 5 \times \ldots\ldots\ldots\ldots \times n$

(ii) n oLrvk e ,d oLr r ckj vkrh g rk dy Permutations vFkkr ${}^nP_r$ dk eku g&
$(1 \times 2 \times 3 \times 4 \times \ldots. \times n) / (1 \times 2 \times 3 \times 4 \times \ldots.. \times r)$

- Hkkjrh; bfrgkl d e/;dky e HkkLdjkpk; dh i=h yhykorh dk mYy[k vkrk g] ftl firk HkkLdjkpk; u ^ikVh xf.kr* i<k;k rFkk viuh iLrd d ^ikVh xf.kr* Hkkx dk uke Hkh ^yhykorh* j[kkA
- fo}kuk dk ,lk Hkh er g fd firk l ^ikVh xf.kr* i<dj yhykorh u ^fl)kr f'kjkef.k* dk yhykorh Hkkx Lo; fy[kkA
- Hkk"djkpk; dh pkj ihf<;k d xf.kr'kkL= dk mikld gku dk mYy[k feyrk g& firk ekg'oj] i= y{eh/kj rFkk ik= pxnoA
- lu 1587 b-e vdcj d njckjh dfo Qth u yhykorh dk Qkjlh e vuokn fd;kA
- yhykorh dk vxth e vuokn 1816 e tVyj u rFkk 1817 b-e gujh Fkkel dkycd u fd;kA

${}^{n}C_{r}$ dk eku&

,dk|dkRrjr% ine/o/k;r% ØekRØe'kkA
LFkkI; ifryke?u ifryke?uu Hkkftr lkjeAA

½xf.kr&lkj&lxg] 6-218] egkohjkpk; 850 ,-Mh-½

n nh gb oLrvk e l r oLrvk d p;u d idkj] vFkkr ${}^{n}C_{r}$ dk eku&

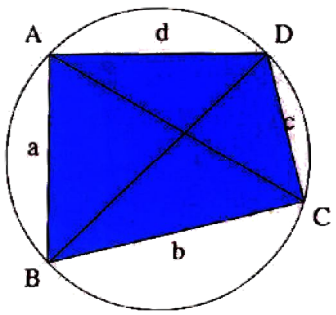
$$\frac{n(n-1)\,(n-2)\,(n-3)\,\ldots\ldots\ldots\,(n-r+1)}{1\times 2\times 3\times 4\times \ldots\ldots\ldots\ldots\ldots\times r}$$

(;gh l= ik'pkR; xf.krK Herigone u lu 1634 b- e fn;k)

cãxlr ie;&

d.kkfJrHkt?kkrD;eHkoFkkU;kU;Hkkftr x.korA
;kxu Hkt ifrHkto/k;kh d.kk in fo"keAA

½cã&LQV&fl)kUr% 12-28 cãxlr 628 ,-Mh-½



fo"ke prHkt d fod.kk dh yEckb dk eku fuEu l=k d vulkj gkrk g&

$$(AC) = \sqrt{\frac{ad + bc}{ab + cd} \times (ac + bd)}$$

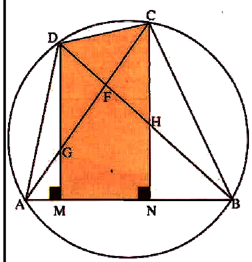
$$(BD) = \sqrt{\frac{ab + cd}{ad + bc} \times (ac + bd)}$$

yxHkx 1000 o"k ckn ;jkih; xf.krK W. Snell (1619 ,-Mh-) u blh ie; dk iuifriknu fd;kA

cãxlr prHkt&

tkR;};dkfVHktkš ijd.kx.kkš Hktk'prfo"keA
vf/kdk Hke[k ghuk ckgf}r; HktkoU;kAA

½cã&LQV&fl)kUr½ 12-38 cãxlr 628 ,-Mh-½



nk ledk.k f=Hktk d vk/kkj rFkk Åpkb dk ,d&nlj d d.k l x.kk dju ij pdh; prHkt dh vleku Hktk, iklr gkrh gA mnkgj.k d fy, fp= d vulkj nk ledk.k f=Hkt ftudh Hktk, 3] 4] 5 rFkk 5] 12] 13 g] mud pdh; prHkt dh Hktk, gkxh 5 × 5 = 25] 5 × 12 = 60] 13 × 3 = 39 rFkk 13 × 4 = 52- ,l prHkt dk cgexlr prHkt dgr gA

yxHkx 1100 o"k ckn ;jksi; xf.krK Eular (1707&1783 ,-Mh-) u ,l prHkt dk o.ku fd;kA

pØh; prHkt rFkk f=Hkt dk {k=Qy&

LFkyQy f=prHktckgifrckg;kxny?kkr%A
Hkt;kxk/kpr"V;Hktku?kkrkr in l{eeAA

½cã&LQV&fl)kUr½ 12-21 cãxlr 628 ,-Mh-½

fdlh pdh; prHkt rFkk f=Hkt d {k=Qy d l= fuEuku lkj g&

1- prHkt d fy, ¼ {k=Qy = [(s-a) (s-b) (s-c) (s-d)]$^{1/2}$

tgk 2 s = (a + b + c + d)

2- fdlh f=Hkt d fy, ¼ {k=Qy = [s(s-a) (s-b) (s-c)]$^{1/2}$

tgk 2 s = (a + b + c)

;|fi cgexlr u pdh; prHkt dk mYy[k ugh fd;k Fkk] fdUr lUnHk l ;g Li"V gA egkohjkpk; (850 ,-Mh-½ dk bldk Kku FkkA

1- ek/ko dh T;k (sine) rFkk dkT;k (cosine) Jf.k;k

¼;fDrHkk"kh 6-12&13] T;"Bno¼ 1500&1610 ,-Mh-½
¼U;Vu 1642&1728 ,-Mh-½
¼cd Vyj 1685&1731 ,-Mh-½

2- ek/ko dh Li'kT;k (tangent) Jf.k;k

¼fd;kdedkjh 2-40 ireu lkek;kth 1350&1410 ,-Mh-½
¼tEl xxkjh 1638 ,-Mh-½
¼th-MCY;- yhfCuRt 1644 ,-Mh-½

AYURVEDA

- Ayurveda is the earliest school of medicine known to humans.
- Charaka, the father of medicine, consolidated Ayurveda 2500 years ago.

pjd lfgrk e xHkfu/kj.k

xHkLFk pRokfj prfo/kkfu Hkrkfu ekrkfirlEHkokfuA
vkgkj tU;kRedrkfu po loL; lokf.k HkofUr ngAA

pjd lfgrk & 'kjhjLFkkue 2-26 ½500 b-i-½

xHkL; f'k'k d fu/kkj.k e pkj i/kku dkjd gkr g &

1- ekrk 2- firk 3- vkgkj 4- Lo;

fof'k"Vx.k ;Dr lUrku

Reproduction & heredity beliefs of the Hindus based on their sacred books.

(Alain F Corcus)

The Journal of Heridity (American Genetic Association) 75:152-154 (1984)

euLefr] cgR lfgrk ¼ojkfefgj½ ,o cgnkj.;d mifu"kn

1- xkjo.k i.kk;] ,d on tkuu oky i=ikflr gr n/k pkoy vkj ?kh d lkFk iRuh lfgr Lo; [kk;A
2- dfiy o.k nk on dk tkudkj i.kk; i= ikflr gr ngh pkoy&?kh d lkFk iRuh lfgr [kk;
3- ';keo.k rhu on dk tkudkj i.kk; i= ikflr gr ty e pkoy&?kh d lkFk iRuh lfgr [kk;A
4- tk pkgr g fd i.k vk;"; okyh fon"kh dU;k gk rk fry pkoy dh f[kpMh cukdj iRuh dk f[kykuk pkfg;A
5- tk pkgr gk fd ejk i= ifl) fo}ku pkjk onk dk tkudkj cu] rk mMn] pkoy dh f[kpMh cukdj _"kHk uked vk"kf/k feykdj ?kh d lkFk iRuh lfgr [kk;A

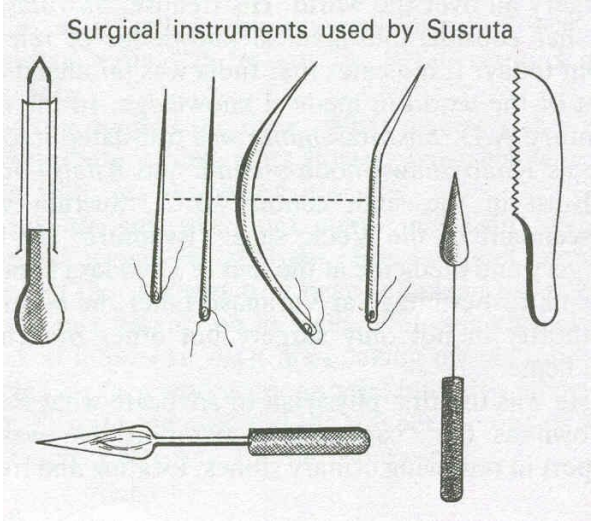
Qkl rFkk dukMk d MkDVjk u mijkDr ij i;kx djd mUg lR; ik;k gA

LVkyokLdh ¼Qkl½ 36 i;kxk e 31 lQy ¼86 ifr'kr½
ykju ¼teuh½ 234 i;kxk e 181 lQy ¼81 ifr'kr½

egRoi.k & fyx fu/kkj.k e eXuhf'k;e] ikVf'k;e] dfY'k;e vkj lkfM;e dh Hkfedk gA ikVf'k;e ,o lkfM;e dh vf/kdrk rFkk dfY'k;e dh deh l i= bld foijhr i=h

- सुश्रुत शल्यक्रिया के पिता थे।
- उनके काल में निम्न शल्य क्रियाएं की जाती थीं – cesareans, cataract, artificial limbs, fractures, urinary stones and even plastic surgery and brain surgery.
- भारत में प्राचीन काल में निश्चेतक का प्रयोग किया जाता था।

- jktk Hkkt dk mud diky dh 'kY;fd;k d io lEekfguh uke dk p.k l?kkdj vpr fd;k x;k FkkA & Hkkticl/k ¼927b-½



- महर्षि सुश्रुत द्वारा शल्य क्रिया हेतु 125 प्रकार के उपकरणों के उपयोग का वर्णन है।
- महर्षि सुश्रुत के काल के चिकित्सकों को निम्न विधाओं का सम्यक ज्ञान होने का वर्णन है – **anatomy, physiology, etiology, embryology, digestion, metabolism, genetics and immunity**

lJr lfgrk e vkr dh 'kY;fØ;k

c)xn ifjlkfof.k p fLuX/kfLoUuL;kH;DrL;k/kk ukHkoke'prj³xyeigk; jkejkT;k mnj ikVf;Rok prj³xyiek.kU;L=kf.k fu"d"; fujh{; c)xnL;kU=ifrjk/kdj'eku cky ok·ikg; eytkr ok rrk e/klfiH;keH;T;kU=kf.k ;FkkLFkku LFkkif;Rok ckg; o.kenjL; lh0;rA ifjlkfo.;l;oeo 'kY;en/kR;kU=lkoku l'kk/;] rfPNnek=k lek/kk; dkyfiihfydkfHkn'k;r] n"V p rklk dk;kuigjUu f'kjkfl] rr¼ ioor lh0;r] lU/kku p ;FkkDr dkj;r] ;"Vhe/kdfeJ;k p d".kenk·ofyl; cU/kukipjr] rrk fuokrekxkj io';kpkfjdeifn'k}kl;Ppu rynk.;k lfink.;k ok i;kofÙkfefrAA17AA

lJr lfgrk & fpfdRlkLFkkue 14-17 ¼500 b-i-½

c)knj vkj ifjlkoh mnj dh fpfdRlk e 'kY;de (Laparotomy for intestinal obstruction and perforation) – c)knj l ihfMr jkxh vkj ifjlkoh&mnjh 0;fDr (Case of intestinal obstruction and intestinal perforation) dk Lugu (Oleation) Lonu (Sudation) vkj vH;x (Annointed) dju d mijkU;r ukfHk l uhp jkejkft (Hairy line, midline) l ckb vkj pkj vxy NkMdj mnj dk ikVu de dj (Abdomen should incised) pkj vxy yEch vU= dk ckgj fudky y vkj ml dk fujh{k.k djA vU= e #dkoV ink dju oky iRFkj] cky vkfn ;k eykfn tk Hkh gk ml nj dj vU= dk e/k&?kr l vH;x dj iuh ;FkkLFkku LFkkfir dj n vkj mnjckg; o.k (External abdominal wound) dk lhou dj nA

ifjlkoh mnj dk 'kY;de & ifjlkoh (Perforation) mnj e Hkh 'kL=kde blh idkj dj vkj 'kY; dk fudky dj vU=lkok (Intestinal discharges) dk lkQ dj nA rnuUrj vkrk d fNn dk lek/kk; vFkkr ikl&ikl feykdj d".k o.k dh phfV;k l dVok; ¼^edkVn'k;r fNne* & ok-fp-15A110½ vkj mUg xbok ij l dkV n ¼^yXu"k pk·gjr dk;e* &ok-½ rFkk f'kjk dk ogh yxk jgu nA rRi'pkr o.k dk ioor lhou de dj n rFkk vU; lU/kku dk; (Reparative measures) Hkh io of.kr d vulkj djA fQj o.k dk eygBh p.kfefJr dkyh feVVh l yi dj n vkj iVVh ck/k nA rnuUrj jkxh dk rt gok jfgr Hkou e j[k vkj i'pkr de l lEcfU/kr vkn'k nA jkxh dk rynk.kh ;k ?krnk.kh e j[k rFkk nX/k&vkgkj nAA17AA

lJr lfgrk e oDd iFkjh dh 'kY;fØ;k

rr% l0; ik'o louh ;oek=.k eDrk·opkj;PNL='ejhiek.k nf{k.krk ok fØ;klkd;grkfjR;d] ;Fkk lk u fHk|r p.;r ok rFkk i;rr] p.keYiel;ofLFkr fg iu% ifjof)efr] rLekr leLrkexoD=.kknnhr(L=h.kk r cfLrik'oxrk xHkk'k;% lfUud"V%] rLekr rklkeRlxoPNL= ikr;r] vrk·U;Fkk [kYoklk e=lkoh o.kk Hkor(i#"kL; ok e=ild{k.kukUe={kj.ke(v'ejho.kknr fHkUuk cfLrjdk/kk·fi u Hkofr] f}/kk fHkUucfLr jk'efjdk u fl/;fr] v'ejho.kfufeÙked/kkfHkUucfLr thofr] fØ;kH;klkPNL=fofgrPNnkr fu%L;Unifjo)RokPp 'kY;L;frA mn/kr'kY; r".kkndnk.;keoxkg; Lon;r] rFkk fg cfLrjltk u i;r] i.k ok {khjo{kd"kk; i"iu=.k fon/;krAA3AA

lJr lfgrk & fpfdRlkLFkue 7-33 %500 b-i-%

i/kku de (Operative procedure) & bld i'pkr louh l ckb vkj ;oek= (Barley width) NkMdj v'ejh d iek.k d cjkcj Hknu (Incision) djA dN dh lEefr l ;g Hknu nkfguh vkj vFkok ft/kj lfo/kk gk djuk pkfg,A ,lk i;Ru dj fd v'ejh u rk VdM&VdM gk vkj u mldk pjk gh gk] D;kfd p.k FkkMk Hkh e=k'k; e jg tk; rk v'ejh iuh gk tkrh gA vr% vxoØ (Scoope like instrumet) l leLr v'ejh dk fudkyA

fL=;k e 'kL=&i;kx e lko/kkuh & fL=;k e e=k'k; d lehi gh xHkk'k; gkrk gA vr% mue 'kL=i;kx Åij dh vkj (Upwards) dk dj %ihN dh vkj dk@Posteriorly ugh% vU;Fkk fL=;k e e=lkoh o.k (Urine discharging ulcers) gk tkrk gA i#"kk e Hkh e=ild (Trigone of the bladder) d Hknu l e={kj.k (Leakage of urine) gkrk jgrk gA v'ejh dk fudkyu d fy, fd; x; Hknu d vfrfjDr ;fn e=k'k; dk Hknu gkrk g rk ;g ?kkrd gA blh idkj nk LFkkuk ij fHkUu cfLr %cfLr dk Hknu% gk rk o.k Bhd ugh gkrk gA

lJr lfgrk e lykfLVd ltjh

fo'yf"krk;kLRoFk ukfldk;k o{;kfe l/kkufof/k ;FkkorA uklkiek.ke ifFkoh#gk.kk] i= xghRok RooyfEc rL;AA ru iek.ku fg x.Mik'oknRdR; c) RoFk ukfldkxeA fofy[; pk'k ifrlUn/khr rr lk/kcU/kfHk"kxier%AA llfgr lE;xrk ;FkoUukMh};ukfHkleh{; cn/okA ikUuE; pukeop.k;Ùk irx;"Vhe/kdktu'pAA lNk| lE;d fipuk flru ryu flpnldfÙkykukeA ?krp ik,;% l uj% lth.k fLuX/kk fojP;% l ;Fkkin'keAA :< p lU/kueikxr L;kr rn/k"k"k r iufudUrrA ghuk iuo/kf;r ;rr lek p d;knfro)eklkeAA

lJr lfgrk & l=LFkue 16-28&32 %500 b-i-%

fNn ukfldk dh lU/kku&fof/k & vc ukfldk dV tku d ckn mldh lU/kku&fof/k dk o.ku djxA uklk d dV Hkkx d cjkcj dk iM dk iÙkk ydj mlh d vkdkj&idkj dk ekl xky (Cheek) ij l bl idkj dk dkV fd og ,d vkj xky l tMk jg vkj nljh vkj d Hkkx dk uklk d lV Hkkx ij] uklkx dk dN [kjpdj (Making the nose raw) d'ky 'kY;fpfdRld lko/kkuhiod lhou de dj tkM nA tc bl idkj uklk dk ikdr :i ndj rFkk fLFkj dj fn;k tkrk g rk nk ukfM;k %ufydkv% dk uklkjU/kk e ifo"V dj rFkk Åij mBkdj ck/k fn;k tkrk g vkj Åij l jDrpUnu] eygBh vkj jlktu dk p.k fNMddj rFkk lQn diM l <ddj fryry l fujUrj fip l flpu djA jkxh dk ?kr fiyko vkj th.k gk tku ij fof/kiod fojpu djkoA tc bl idkj tkMk x;k Hkkx Hkyh idkj jkfgr (Healed) gk tk; rk xky l tM Hkkx dk dkV fn;k tkrk gA bl idkj lU/kku dju ij ;fn uklk NkVh vFkok cMh gk x;h gk rk vko';drkulkj NkVh dk c<kdj vkj cMh dk ?kVkdj uklk dk LokHkkfod :i noAA

रक्त संचरण

(सुश्रुत संहिता सूत्रस्थानम् १४.३)

आहारस्य सम्यक्परिणतस्य यस्तेजोभूतः सारः परमसूक्ष्मः स रस इत्युच्यते; तस्य हृदयं स्थानं; शरीरमहरहस्तर्पयति वर्धयति धारयति यापयति चादृहेतुकेन कर्मणा। तस्य शरीरमनुसरतोऽनुमानाद् गतिरुपलक्षयितव्या क्षयवृद्धिवैकृते। तस्मिन् सर्वशरीरावयवदोषधातुमलाशयानुसारिणि रसे जिज्ञासा-किमयं सौम्यस्तेजसः? इति। अत्रोच्यते – स खलु द्रवानुसारी स्नेहनजीवनतर्पणधारणादिभिर्विशेषैः सौम्य इत्यवगम्यते।।३।।

आहार का जो तेजोमय तथा विडादि मलरहित परम सूक्ष्म (Extremely fine, the end products of digestion, probably in the molecular stage) **भाग है उसे रस कहते हैं।**
उस रस का स्थान हृदय है। वह हृदय से ऊपर को जाने वाली दस, नीचे को जाने वाली दस और तिरछी जाने वाली चार धमनियों में प्रविष्ट होकर सारे शरीर का किसी अज्ञातकर्म (Inscrutable) **द्वारा अहर्निश** (Functioning constantly) **तर्पण करता है** (Nourishes)**, वृद्धि करता है** (Develops) **धारण करता है** (Maintains) **और यापन (शक्ति को बनाये रखता) करता है। सारे शरीर में सञ्चरण करते हुए उस रस की गति को उसके क्षयविकारों एवं वृद्धिविकारों (क्षयविकार जैसे रसक्षय में हृत्पीड़ाकम्प तथा वृद्धिविकार जैसे हृदयोत्क्लेशादि) से अनुमान द्वारा जानना चाहिए। सारे शरीर, अवयव, दोष, धातु, मल, आशय में तर्पणादि कार्य करने वाले उस रस के सम्बन्ध में यह जानने की इच्छा होती है कि वह सौम्य है या तैजस। इस सम्बन्ध में कहा जाता है कि द्रव रूप इस रस को स्नेहन, जीवन, तर्पण और धारण आदि विशेषताओं के कारण सौम्य जानना चाहिए।।**

हृदयम्· हृ + द + यम्· हरति + ददाति + यति।

1. माइकल सर्वितस – स्पेन – 1553 ईस्वी (चर्च में हत्या करा दी) २. विलियम हार्वे – इग्लैण्ड 1628 ईस्वी

egkHkkjr e Dykfux

¼Mk- ckyd".k x.kifr ekrkijdj½

Xokfy;j e 1941 e tUeA
xtjkjkt efMdy dkyt l ,e-,l·
ekykuk vktkn efMdy dkyt fnYyh e dk;
1991 e 'kjhj d vUnj gh u;k xHkk'k;@fdMuh r;kj dju ij y[k idkf'kr
1996 e vefjdh iVUV d fy; vkonu
;g 'kk/k cht dkf'kdk ¼LVe ly½ ij vk/kkfjr g bldk [kykl 1999 e fd;k
1996 e vefjdh iVUV d fy, mud vkonu d ckn vefjdk e LVe ly ij
dk; 'k# gvkA

Mk- ekrkijdj dk dguk g fd bl 'kk/k d fy, mUg egkHkkjr d vkfnio e of.kr
xkU/kkjh d 100 i=k d tUe dh dFkk l ij.kk feyhA

BOTANY

वृक्षवनस्पतियों के माता-पिता
(अ.१.२१)

विद्मा शरस्य पितरं पर्जन्यं भूरिधायसम् ।
विद्मो ष्वस्य मातरं पृथिवींभूरिवर्पसम् ।।

अनेक प्रकार से (चराचर) धारक एवं पोषक पर्जन्य को हम इस 'शर' के पिता के रूप में जानते हैं। अनेक प्रकार के स्वरूप देने वाली पृथ्वीको भी हम भली प्रकार जानते हैं।।

वृक्षवनस्पतियों के पाँच पिता
(अ.१.३.१-५)

विद्मा शरस्य पितरं पर्जन्यं शतवृष्ण्यम् ।
तेन ते तन्वेऽशं करं पृथिव्यांते निषेचनं बहिष्टे
अस्तु बालिति।।१।।
(ऋषि कहते हैं) इस शरीर के जनक शतवृष्ण पर्जन्य
से हम भली-भाँति परिचित हैं। उससे तुमहारे (शर
की) कल्याण की कामना है। उनसे तुम्हारा विशेष
सेचन हो और शत्रु (विकार) बाहर निकल जाएँ।
विद्मा शरस्य पितरं मित्रं शतवृष्ण्यम् ।
विद्मा शरस्य पितरं वरुणं शतवृष्ण्यम् ।
विद्मा शरस्य पितरं चन्द्रं शतवृष्ण्यम् ।
विद्मा शरस्य पितरं सूर्यं शतवृष्ण्यम् ।

प्रकाश-संश्लेषण

$$6CO_2 + 12H_2O \xrightarrow[\text{पर्णहरिम}]{\text{प्रकाश}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

प्रथम वैज्ञानिक वॉन हेल्मॉन्ट (1577 **से** 1664) **प्रयोग** 1648 **में थे परन्तु उनकी मृत्यु के पश्चात** 1740 **में प्रकाशित हुए।**

(**पृष्टले** 1772) **इन्जेन हौज**, **लैवोज़िए** 1785, **इयूट्रोचेट** 1837, **लीबिग** 1845, **हुबेर मिचेल डिजेन होपेअर** 1985 (**नोबेल पुरस्कार** 1988)

ऋग्वेद तथा यजुर्वेद में प्रकाश-संश्लेषण का वर्णन

अधुक्षत् पिप्युषीमिषम् ऊर्जं.।
सूर्यस्य सप्त रश्मिभि:।। - ऋग्. 8.72.16
स ओषधी: पचति विश्वरूपा:। - ऋग्. 8.72.16
देवस्त्वा सविता मध्वाऽनत्तुâ
सुपिप्पलाभ्यस्त्वौषधीभ्य:। - यजु. 6.2

वृक्ष-वनस्पतियों पर सूर्य का बहुत प्रभाव पड़ता है। ऋग्वेद के एक मंत्र में सूर्य की किरणों से प्रकाश-संश्लेषण-प्रक्रिया (Photo-synthesis) **का संकेत मिलता है। मंत्र का कथन है कि वृक्ष सूर्य की सात रंग की किरणों से शक्तिप्रद ऊर्जा प्राप्त करते हैं। अन्य मन्त्र में कहा गया है कि सूर्य के कारण ही सभी प्रकार के वृक्ष-वनस्पतियों में पाक क्रिया होती है। इसी से सब फल और अन्न आदि पकते हैं। सूर्य ही फल-फूल वाली सभी ओषधियों को शक्ति प्रदान करता है। सूर्य ही अपनी ऊष्मा से फलों आदि में मधुरता उत्पन्न करता है और फल-फूल की वृद्धि करता है।**

वृक्ष ऑक्सीजन देते हैं

(- ऋग्. १०.९१.६।)

तमोषधीर्दधिरे गर्भमृत्वियं
तमापो अग्निं जनयन्त मातर:।
तमित् समानं वनिनश्च वीरुधो-
अन्तर्वतीश्च सुवते च विश्वहा।।

ऋग्वेद और सामवेद का कथन है कि वृक्षों के अन्दर अग्नि (Oxygen) **है। वृक्ष अपनी ज़ड़ से जो जल खीचते हैं, उस जल से यह अग्नि** (Oxygen) **तैयार होती है। सभी वृक्ष, लता और वनस्पतियाँ इस गर्भस्थ अग्नि** (Oxygen) **को बाहर फेंकती है। इस मंत्र में प्रकाश-संश्लेषण-प्रक्रिया** (Photosynthesis) **का संकेत है। इस मंत्र में आक्सीजन को 'समानवायु' नाम दिया गया है। अश्वत्थ (पीपल) में ऑक्सीजन की मात्रा बहुत अधिक है, अत: उसे 'देवसदन' अर्थात् देवों का निवास या ऊर्जा का भंडार कहा गया है।**

ऋतु के अनुरूप उत्पन्न उस अग्नि (ऊर्जा) को ओषधियाँ गर्भ में धारण करती हैं। जल धाराएँ माता की तरह उसे पैदा करती हैं। वनस्पतियाँ और ओषधियाँ उसे गर्भरूप में धारण करके प्रकट करती हैं।

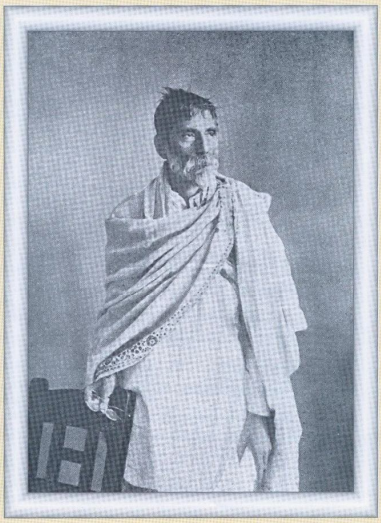
वृक्ष वनस्पतियों में जीवन है

(महाभारत, शान्तिपर्व अध्याय 184, **श्लोक** 11-18)

(भरद्वाज-भृगु वार्ता : विशेष सन्दर्भ आचार्य जगदीश चन्द्र बसु)

अष्मतो म्लायते पर्णं त्वचः फलं पुण्यमेव च।
म्लायते शीर्यते चापि स्पर्शस्तेनात्र विद्यते।।
वाय्वग्न्यशनिनिर्घोषैः फलं पुष्पं विशीर्यते।
श्रोत्रेण गृह्यतेशब्दस्तस्माच्छृण्वन्ति पादपाः।।
वल्ली वेष्टयते वृक्षंसर्वतश्चैव गच्छति।
न ह्यदृष्टेश्च मार्गोऽस्ति तस्मात् पश्यन्ति पादपाः।।
पुण्यापुण्यैस्तथागन्धैर्धूपैश्च विविधैरपि।
अरोगाः पुष्पिताः सन्ति तस्माज्जिघ्रन्ति पादपाः।।
पादैः सलिलपानाच्च व्याधीनां च दर्शनात् ।
व्याधिप्रतिक्रियत्वाच्च विद्यते रसनं द्रुमे।।
सुखदुःखयोश्च ग्रहणाच्छिन्नस्य च विरोहणात् ।
जीवं पश्यामि वृक्षाणामचैतन्यंन विद्यते।।
तेन तज्जलमादत्तं जरयत्यग्निमरुतौ।
आहारपरिणामाच्च स्नेहो वृद्धिश्चजायते।।
वक्त्रेणोत्पलनालेन यथोर्ध्वं जलमाददेत् ।
तथा पवनसंयुक्तः पादैः पिबति पादपः।।

CHEMISTRY



2.8.1861 — 16.6.1944

Prafulla Chandra Ray

"Her (India's) elevation will not come in Sir Prafulla Chandra Ray's time. A small spare man, in feeble health, and a confirmed dyspeptic, he will be spent in her service. But the memory of these services will survive".

-Sir Edward Thorpe, *Nature* (1919).

"While we shall never be able to repay our debt to him, we must try to emulate and propagate his ideals and this would be the fittest way to offer our homage to him".

-D. Banerjea, *J. Indian Chem. Soc. (2011),*

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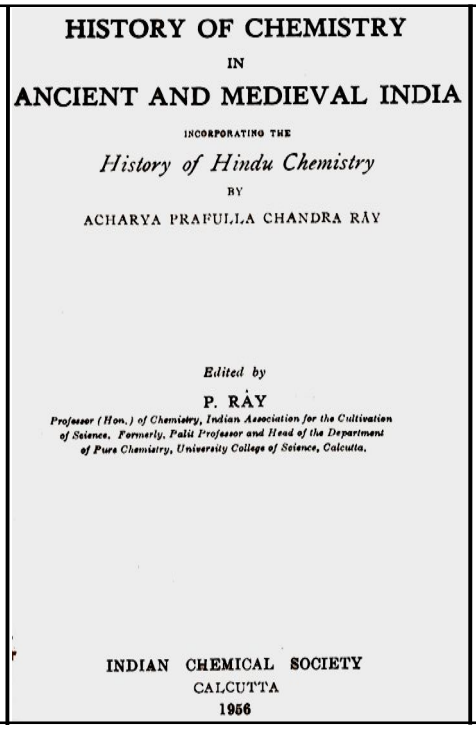

HISTORY OF CHEMISTRY

IN

ANCIENT AND MEDIEVAL INDIA

INCORPORATING THE

History of Hindu Chemistry

BY

ACHARYA PRAFULLA CHANDRA RAY

Edited by

P. RAY

Professor (Hon.) of Chemistry, Indian Association for the Cultivation of Science. Formerly, Palit Professor and Head of the Department of Pure Chemistry, University College of Science, Calcutta.

INDIAN CHEMICAL SOCIETY

CALCUTTA

1956

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ikphu Hkkjr esa jlk;u foKku dk fodkl

2500BC l 2000BC	: Gold, silver, copper, lead, bronze, electrum (Au-Ag), Some minerals, glazed potteries, porcelain, terrracota, *faience*, art of dyeing (with extract of madder root (alizarin), mortar.
1500BC l 800BC	: Tin, iron, glass, fermentation (for alcoholic dirnks and curds), tanning. Emergence of medicinal chemistry (*Ayurveda*).
600BC l 400BC	: Brass, steal, colorued glasses, solder (Pb-Sn), ink, vegetabel dies, amalgams, diamond and gem stones. Atomic theory and concept of compound formation.
100AD l 400AD	: Theory of chemical combination, preparation of alkalis, use of minerals in medicine. Relation between heat and chemical change.
400AD l 600AD	: Iron pillar (Delhi, pure wrought iron), statue of Gautam Buddha (pure copper 99.7%, Sultanganj).
800AD l 900AD	: Extraction of zinc from calamine (first in the world), use of murcury sulphide (red and black) in medicine, gemstones.
1000AD	: Paper making.
1100AD l 1200AD	: Soap indelible ink, sulphuric acid, antimony from stibnite.
1300AD l 1600AD	: Medicinal uses of calomel, blended perfume, aquaregia, gun powder, pyrotechny, essential oils, tinctures, opium etc. in medicine, *bidery* (Cu-Pb-Zn-Sn).

;wjki esa ¼,oa vU;½ jlk;u foKku dk fodkl

Discovery	Period
Glass	12th century AD (2000 BC in Egypt, 2600 BC in Mesopotamia)
Alchemy	13th century AD (2nd century BC in China, 1st to 7th century AD in Egypt and Arabia)
Arsenic	13th century AD
Iron	14th century AD
Antimony	1492 AD
Sulphuric Acid	15th century AD
Zinc	1695 AD (Hamburg), 1740 AD (Bristol)
Dyeing	18th century AD (France)

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- 15oh&16oh 'krkCnh e ijkl yl ¼1493&1541 A.D.½ u vk"kf/k jlk;u d {k= e dk;l fd;kA
- 16oh&17oh 'krkCnh e Ýkfll cdu ¼1561&1636 A.D.½ u vk/kfud foKku dh vk/kkjf'kyk j[khA
- 17oh 'krkCnh e jkcVl Cok;y ¼1627&1691 A.D.½ u xlk d fl)kr dk ifriknu fd;kA
- ifl) Ýkslhlh jlk;u oKkfud yokft;l ¼1733&1804 A.D.½ u Toyu e vkDlhtu dh Hkfedk crkbA

gMlik&iod dky
(4000-2000 B.C.)

Polychrome Nal wares (Piggott, *Prehistoric India*).

Indian Paints Association (IPA) Award (2010)

Technical Excellence in Coatings and Allied Field Research

K.V.S.N. Raju
Ramanuj Naryan
Kishore K. Jena

ATTENTION!

Painted potteries from Harappa (Piggot, *Prehistoric India*, 1950).

gMlik dky

flU/k ?kkVh dh lH;rk

(2500-1800 B.C.)

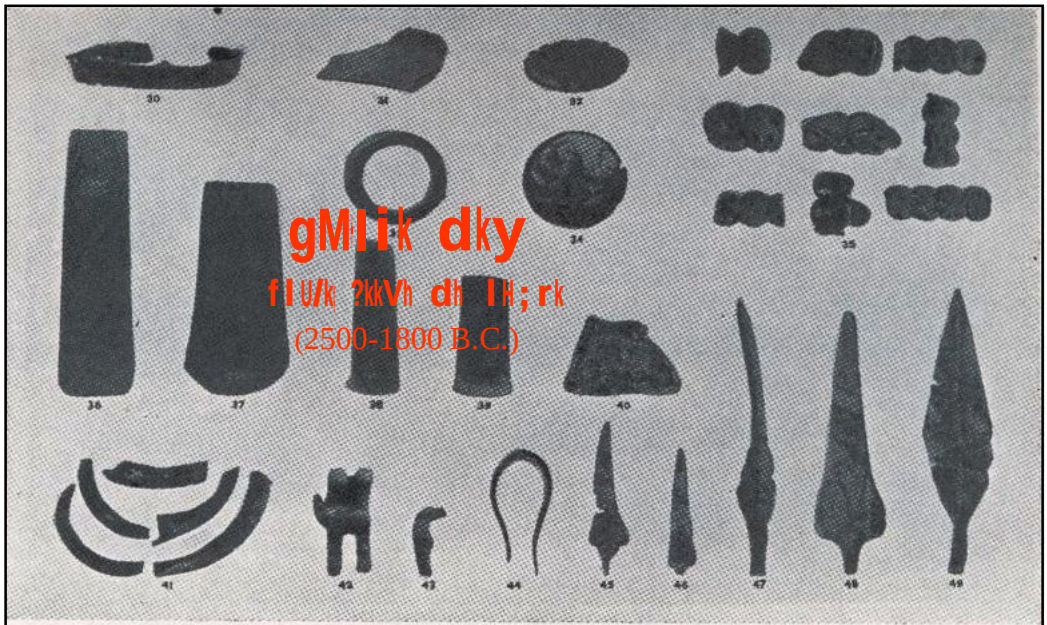


Fig. 11*b*. Copper and bronze articles from Harappa (Vats, *Excavations at Harappa*, 1940).

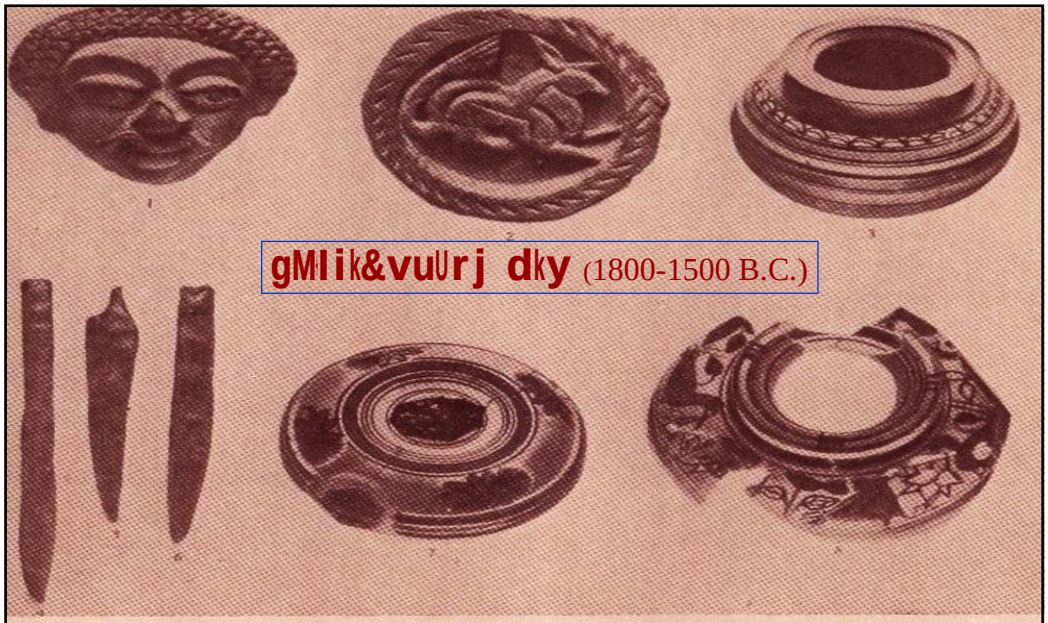
gMlik dky

flU/k ?kkVh dh lH;rk

(2500-1800 B.C.)

Copper axes, pins and potteries from Jhukar
(Mackay, *Further Excavations at Mohenjodaro*, 1938).

gMlik&vuUrj dky
(1800-1500 B.C.)
rke fufer oLrq;s



gMlik&vuUrj dky (1800-1500 B.C.)

Fig. 14. Potteries and iron implements from Jhukar (Majumdar, *Explorations in Sind, Memoirs, Archæological Survey of India*, No. 48).

onk e&&&

onk e ty dh mRifÙk] ty dk egÙo] ty d x.k] ty d Hkn] ty l lf"V] fofo/k /kkr,a] mudk feJ.k] mud fofo/k mi;kx] yo.k] ty vkj jRuk dk vk"kf/k d #i e mi;kx vkfn dk o.ku ikIr gkrk gA

vkDlhtu ¾ vfXu] fe=] o'okuj vfXu] ekrfjý k vkfnA gkbMkstu ¾ lke] ty] vki%] lfyy] o#.k vkfnA

- vXuh"kkek foHkfr&vki br rk%A vFko- 3-13-5
  ty e vfXu ¼vkDlhtu½ rFkk lke ¼gkbMkstu½ nkuk gA
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- oý kujk ;kl&vfXu% ifo"V%] rk vki%A _x-7-49-4
  ty e vfXu ¼vkDlhtu½ rFkk lke ¼gkbMkstu½ nkuk dk ,d= yr gA
- fe= go irn{k o#.k p fj'kknleA
  f/k; ?krkph lk/kUrkA _x-1-2-7
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- fo|rk T;kfr% ifj lftgku fe=ko#.kk ;ni';rk RokA
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vfpl & rikuk] jxM l fo|r mRiknu vkj mÙktuk nukA
'kkfpl & idk'k nuk] nkgdRo vkj 'kk/kdRoA
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- vki% ---- foýL; LFkkr txrk tfu=h%A _x- 6-50-7

  ty lHkh pj vkj vpj txr dk tUe nu okyk gA

- vkik g ;n cgrhfoýek;u xHk n/kkuk tu;UrhjfXueA ;t- 27-25

  ty e loiFke lf"V dk cht iMkA vkj ml vfXu dh mRifÙk gbA

ty l vfXu dh mRifÙk

- vik uikn ;k olfHk% lg fi;%A _x- 1-141-1
  vfXu dk ^vik uikr vFkkr ty dk i= dgk x;k gA*
  ;g Hkh fd ;g olvk ¼iFoh vkfn½ d lkFk jgrk gA
- re vkik vfXu tu;Ur ekrj%A _x- 10-91-7
  ekrk #i ty u vfXu dk tUe fn;kA
- vXu fiÙke vike vflA v- 18-3-5
  vfXu dk ty dk fiÙk ¼Å"ek½ dgk x;k gA
- RokeXu i"djknf/k& vFkok fujeUFkrA _x- 6-16-13
  vFkok Rok iFkek fujeUFknXuA ; t- 11-32
  o.ku g ?k"k.k vFkok eFku l ty l vfXu mRié gkrh gA vFkok igy _f"k Fk] ftUgku rkykc d ty l eFku }kjk vfXu mRié dhA

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  o.ku g fd l; dh Åtk dk lkr lke ¼gkbMktu½ gA
- vik jle mno;l l; lUr lekfgreA
  vik jlL; ;k jlLr ok xg.kkE;ÙkeeAA ; t-9-3
  o.ku g fd l; e gkMktu vkj ghfy;e xl gA gkbMktu d fy, ^vik jl% ¼ty dk lkj Hkkx½ 'kCn vk;k g rFkk ghfy;e d fy, ^vik jlL; ;k jl%* 'kCn vk;k gA vFkkr ghfy;e ty d lkj&Hkkx gkMktu dk Hkh lkj&Hkkx gA ^l; lUr lekfgre* vFkkr nkuk xl l; e fo|eku gA*

$$_1H^1 + {}_1H^1 + {}_1H^1 + {}_1H^1 \rightarrow {}_2He^4 + 2\,{}_{+1}\beta^0 + 2\nu + \gamma$$

+ Åtk (24.82 MeV)

Hans Albrecht Bethe ¼1906&2005] German Scientist in America)1938

/kkr foKku&1

v'ek p e efRrdk p e fxj;'p e iork'p e fldrk'p e ouLir;'p e fgj.; p e·;'p e ';ke p e ykg p e lhl p e =i p e ;Ku dYiUrkeA

¼d-;t-4-7-5½

ej iRFkj] feVVh] ior] fxfj] cky] ouLifr] lo.k] ykgk] yky ykgk] rke] lhlk vkj Vhu ;K l c<A

/kkr foKku&2

- gfjr =hf.k] jtr =hf.k] v;fl =hf.k rilkfo"BrkfuA
  ¼lku] pknh rFkk ykg d ¼rhu&rhu½ /kkxk l ;Kkiohr cuku dk o.ku g½
  vFko- 5-28-1
- =;% ik"kk% f=ofr J;UrkeA ¼vFko-5-28-3½
  ¼rhu /kkrvk ¼;k nC;k½ d feJ.k dk f=or dgr g½
- ;k foHkfr nk{kk;.k fgj.;
  l tho"k d.kr nh?kek;%A ¼vFko-1-35-2½
  /kkrvk dk 'k) dju dh ifØ;k dk n{k dgk x;k gA 'k) fd; g, lku dk ^nk{kk;.k fgj.;* dgk x;k gA ;ton vkj vFkoon e 'k) lku dh tthj iguu ;k rkcht ck/ku l nh?kk; o opfLork vkj cyof) dk o.ku gA

- v;Le;ku fo prk cU/kik'kkuA vFko- 6-63-2
- v;Le; nin---A vFko- 6-63-3

  ykg dh cuh t thj ¼c/kik'k½ rFkk ykg d cu [kV ¼nin½ dk o.ku gA
- _"Vhj;Le;h%A vFko- 4-37-8
- _"Vhfgj.;;h%A vFko- 4-37-9
- fgj.;fuf.kxijk u _f"V%A _x- 1-167-3

  ykg vkj lku d cu cjN@Hkky ¼_f"V½ dk o.ku gA
- r Rok lhlu fo/;kek ;Fkk uk·lk vohjgkA vFko- 1-16-2 l 4

  vFkoon d bl ij lä e lhl /kkr dk o.ku gA lhl d cu Nj ¼xkfy;k½ l 'k=vk dk ekju dk mYy[k gA
- v;Le;ukdu f}"kr Rok ltkeflA vFko- 7-115-1

  ykg dh dhy ¼v;Le; vd½ d i;kx l 'k= dk Hkxku dk i;kx gA

HkLe fuek.k

- eDrk HkLe& 'k) fd; g, ekfr;k dk [kjy e xk&nX/k d lkFk ?kkVdj l[kk yA p.k dk ,d lEiV e cUn djd miyk dh gYdh vkp e Qd nA bl idkj ekrh dh lQn HkLe r;kj gk tkrh gA ¼jlrjfx.kh½
- ikjn HkLe& 'k) ikjn 4 rkyk] 'k) x/kd 4 rkyk [kjy e ?kkVdj dTtyh cukdj cM d n/k d lkFk ?kkVdj feVVh d pkM ik= e dM e Mkydj pYg ij p<k n vkj uhp l eUn&eUn vfXu nA cM dh xhyh ydMh d MM l pykr jgA bl idkj fnu Hkj en vfXu e idku l ikjn&HkLe r;kj gk tkrh gA ¼;kxfpUrkef.k½

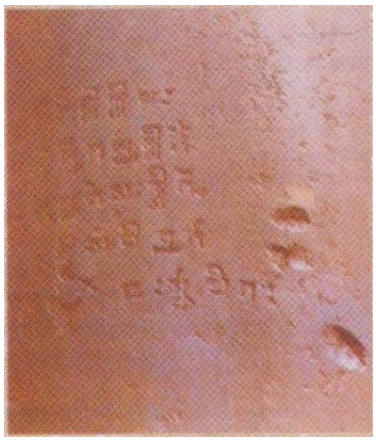
  lkuk] pknh rFkk rkck dh HkLe Hkh blh idkj r;kj dh tkrh gA
- =i HkLeA

  jkx dh HkLe ¼ox HkLe ;k =i HkLe½ dk o.ku gA¼vFko- 11-3-8½

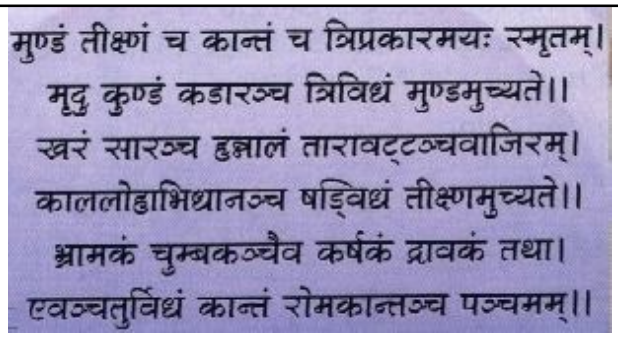
HISTORY OF METALLURGY IN ANCIENT INDIA

SN	Period	Item	Location
1.	2500-1800 B.C.	Copper-Bronze Technology Cire-perduce process Copper mines found	North West India Rajasthan Many parts of India
2.	1800-1000 B.C.	Use of Copper tools Copper - hoards	Some parts throughout India
3.	1400 B.C.	Discovery of the Earliest iron object	Ahar in Rajasthan
4.	1200-1100 B.C.	Copper rich areas with Copper smelting Traditions	Ahar, Nho in Rajasthan, also in U.P. and Bihar
5.	4th Century B.C.	King Purushottam presents Indian made steel of Alexander	Taxila
6.	4th Century B.C.	Making of pure Zinc by Distillation process	Rajasthan
7.	370-375 A.D.	(Delhi) Iron pillar fabricated. Shifted to Delhi in 1050 A.D.	Mathura (U.P.)
8.	5th Century A.D.	Huge Copper statue of Buddha 7 ft. 6 inch High & Weighing 1 ton, Fabricated in two layers	Sultanganj, Bhagalpur (Bihar)
9.	8th Century A.D. Onwards	Wootz steel of making high quality swords	Export to Damascus, Syria
10.	13th - 18th Century A.D.	Large scale production of Zinc Transfer of technology to England	Zawar - Rajasthan

ykg LrEHk & fnYyh



Detail of the Pillar's surface showing the excellent state of preservation of the inscription


मुण्डं तीक्ष्णं च कान्तं च त्रिप्रकारमयः स्मृतम्।
मृदु कुण्डं कडारञ्च त्रिविधं मुण्डमुच्यते।।
खरं सारञ्च हुन्नालं तारावट्टञ्चवाजिरम्।
काललोहाभिधानञ्च षड्विधं तीक्ष्णमुच्यते।।
भ्रामकं चुम्बकञ्चैव कर्षकं द्रावकं तथा।
एवञ्चतुर्विधं कान्तं रोमकान्तञ्च पञ्चमम्।।

लौह का वर्गीकरण

&jljRulePp;] 5@67]74]83
(12oh 'rkCnh AD)

e.M ykg (Cast Iron)	rh{.k ykg (Wrought Iron)	dkUr ykg (Carbon Steal)
1- en 2- d.M 3- dMkj	1- [kj 2- lkj 3- âUuky 4- rkjkoV 5- okftj 6- dkyykg	1- Hkked 2- pEcd 3- d"kd 4- nkod 5- jkedkUr

'k)ykg dudjtr Hkkuykgk'elkje
irhykg f}r;efnr ukxoxkfHk/kkueA
feJykg f=r;efnr fiÙky dkL;ortke]
/kkrqykg yg bfr er% lk·l;udkFkokphAA

धातुओं का वर्गीकरण

&jljRulePp;] 5/1
(12oh 'rkCnh AD)

'k) ykg (Noble Metals)	irh ykg ¼v'k) ykgk½	feJ ykg (Alloys)
1- lo.kZ 2- jtr 3- ykgk	1- ukx ¼lhlk½ 2- ox ¼fVu½	1- ihry (Brass) 2- dkalk (Bronze) 3- ortykg (Bell Metal)

v"VHkkxu rkez.k f}Hkkxdfyu pA
fonzru Hkor dkL;a rr lkjk"VHko 'kHkeAA

&jlljRulePp;] 5-204
(12oh 'rkCnh AD)

Bronze is obtained by melting 8 parts of copper and 2 parts of tin together. This was practised more in Sourashtra.

vkB Hkkx rkez (Cu) rFkk nks Hkkx fVu (Sn) dks lkFk&lkFk xykus ls dkL; izkIr gksrk gSA

dkL;

बेल मेटल

स्वल्पतालयुतं कांस्यं
वङ्कनालेन ताडितम्।
मुक्तरङ्गं हि तत् ताम्रं
घोषाकृष्टमुदाहृतम्।।

&jl jRu lePp; 8-37 (12oh 'rkCnh AD)

dkl e FkkMh ek=k e rky ¼vkl fud lYQkbM½ feykdj oduky e j[kdj xe dju l ?kk"kkd"V ¼cy eVy½ cu tkrk gA

If bronze and a little Arsenic sulphide are mixed and heated in Vankanala (an apparatus), a part of Arsenic sulphide is lost and it forms a metal called Ghoshakrishta (bell metal).

धातुओं की क्षरण–रोधता

lo.k jtr rke rh{.k o³x Hkt³xeeA
ykgUr "kfMo/k rPp ;Fkkiwo rn{k;eAA

&jlk.koe 7@96
¼12oh 'krkCnh½

N% ie[k /kkrvk dh {kj.kjk/krk dk Øe fuEuor g&
lo.k > jtr > rke > ykg > lhl > ftdA
Au > Ag > Cu > Fe > Pb > Zn

¼vk/kfud jlk;u foKku dh *Electrochemical Series* blh Øe d vu:i gA½

पारद का निष्कर्षण
(Extraction of Mercury)

&jljRulePp; 7@67 (12oh 'rkCnh AD)


उत्कौषधैर्मर्दितस्य यन्त्रस्थितस्योर्ध्वमधश्च तिर्यक्।
निर्यातनं पातनसंज्ञमुक्तं वङ्गाहिसम्पर्कजकञ्चुकघ्नम्।।

v'k) ikjn dk v/k%ikru] Å/oikru rFkk fr;dikru fof/k }kjk 'k) fd;k tkrk gA bl idkj ukx ¼yM½ rFkk ox ¼fVu½ nk"k nj gk tkr gA

चाँदी शुद्ध करना

ukxu {kkjjk tu /ekfir'kf)e PNfrA
rkj f=okjfuf{kIr fi'kkph&r y&e/;eeAA

&jljRukdj 1@13
¼8oh 'krkCnh½

v'k) pkanh lhlk d lkFk xyku vkj HkLek d lkFk xyku ij 'k) gkrh gA
¼vk/kfud Metallurgy e ;g fof/k Cupellation dgykrh g½

धातुओं को मारना
(Killing of Metals)

ukfLr rYykgekrxk ;é x/kdd'kjhA
fugU;kn x/kek=.k ;}k ekf{kdd'kjhAA

&jlk.ko 7@138]139
¼12oh 'krkCnh½

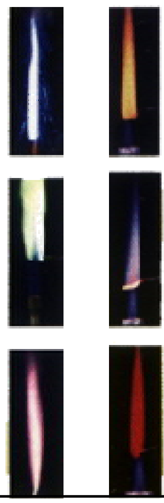
,lh dkbl /kkr ugh g tk x/kd :ih flg l u ekjh tk ld ;k tk ekf{kd :ih flg d x/kek= l u ekjk tk ldA

फ्लेम–टेस्ट

आवर्तमाने कनके पीता तारे सिता प्रमा ।
शुल्बे नीलनिभा तीक्ष्णे कृष्णवर्णा सुरेश्वरी ।।
वङ्गे ज्वाला कपोताभा नागे मलिनधूमका ।
शैले तु धूसरा देवि आयसे कपिलप्रभा ।।
अयस्कान्ते धूम्रवर्णा सस्यके लोहिता भवेत् ।
वज्रे नानाविधा ज्वाला खसत्वे पाण्डुरप्रभा ।।

The colour of the flame for metals are--
- Gold- yellow
- Silver - white
- Copper - blue
- Wrought iron - black
- Tin - ash colour
- Lead - dirty fire colour
- Pure iron - ash
- Mica - brown
- Diamond - many colours
- Khasattva - pale white.

&jlk.koe 4@49&51
¼12oh 'krkCnh½



CLASSIFICATION OF CHEMICAL SUBSTANCES

1-	egkjl	Main chemicals
2-	mijl	Subsidiary chemicals
3-	lkekU; jl	Common chemicals
4-	jRu	Gems
5-	/kkrq	Metals
6-	fo"k	Poisons
7-	{kkj	Alkalis
8-	vEy	Acids
9-	yo.k	Salts
10-	ykg HkLe	Metallic powders (compounds)

egkjl
(Main Chemicals)

ekf{kd foey 'ky piy jldLrFkkA
lL;dk njn'po lkrk·×tueFkkLVdeAA

1-	ekf{kd	Iron pyrites, FeS_2 iron sulphide
2-	foey	Cubic Sulphide of Iron, Fe_2S_8
3-	f'kyktq	Asphalt, bitumen
4-	lL;d	Copper Sulphate, blue vitriol
5-	piy	Some low-melting sulphide
6-	jld	Calamine, a zinc mineral
7-	njn	Cinnabar
8-	lkrk·×tu	Collyrium

mijl (Subsidiary Chemicals)

1-	xa/kd	Sulphur Allotropes
2-	xSfjd	Hematite (Fe_2O_3)+Laterite+Clay
3-	dkf'kl	Iron Sulphate $FeSO_4$
4-	rqofj	Alum K_2SO_4, Al_2 $(SO_4)_3$, $24H_2O$
5-	rkyd	Orpiment As_2S_3
6-	eu%f'kyk	Realgar As_2S_3
7-	vatu	Collyrium
8-	dqdqVB	Excreta of baby elephant

lkekU; jl (Common Chemicals)

1-	dkfiYyk	Mallotus philipensis
2-	xkjh ik"kk.k	Arsenic oxide
3-	uksykj	Ammonium Chloride NH_4Cl
4-	ojkVd	Marine Shell, Cowri
5-	vfXu tkj	Ambergris from fish
6-	tkyor	Lapis Lazuli, Aquamarine blue
7-	fxfj fl anj	Vermilion, (HgS) from rocks
8-	fgxqy	Cinnabar HgS, Mercuric sulphide
9-	enkM 'kxde	Litharge PbO, lead monoxide

vEy (Acids)

- ikphu Hkkjr e dkcfud vEyk dk fuek.k vuid Qyk] i"ik] ifÙk;k rFkk vU; inkFkk l fd;k tkrk FkkA mnkgj.k d fy,& uhc itkfr d Qyk l lkbfV'd vEy] VkjVfjd vEy] vkDlfyd vEy rFkk Vfud vEy] LVkbjDl cUtkbu ¼mnL; i"i½ l cUtkbd vEy] LVkjDl ¼f'kykjl½ l flufed vEy] fdf.or vé l ,flfVd vEy] ngh l yfDVd vEy rFkk xke= l fglifjd vEyA
- [kfut vEyk dk Kku Øe'k% ckn e gvkA lLdr rFkk rfey xUFkk e lY¶;fjd vEy ¼nkgty½] gkbMªkDykfjd vEy rFkk ukbfV'd vEy dk o.ku gA
- :nk;ekyk e & ^^rke nkgty;kx tk;r rRFkde 'kHkeA**

$$Cu + 2H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$$

vEyjkt (Aqua Regia)

dkfhl lU/ko ek{kh lkohj 0;k"kxU/kde] lkop;y 0;k"kdk p ekyrh & jll Hko%A f'kxeyjl% flä foMk·;s lo tkj.k%A

&jlk.ko 9@2]3 ¼12oh 'krkCnh½

dlhl] lU/ko] ekf{kd] lkohj] 0;k"k ¼rhu elky& lkB] dyh fep vkj fejpk½] xU/kd] lkop;y ¼'kkjk½] ekyrh jl& bu lcdk f'kx jl l flä djd tk ^foM* curk g] og /kkr;vk dk tyk ldrk gA

bl ;kx e dlhl dk xe djd lY¶;fjd ,flM curk gkxk] tk 'kkjk ij ifrfØ;k djd ukfV'd ,flM vkj lU/ko ij ifrfØ;k djd gkbMªkDykfjd ,flM nrk gkxkA bu nkuk dk feJ.k vEyjkt dgykrk g] ftle Lo.k vkj lyfVue vkfn /kkr;s Hkh ?ky tkrh gA

{kkj (Alkalis)

- egf"k lJr 'kY; fØ;k e vud idkj d {kkjk dk mi;ksx djr FkA
- bu inkFkk l Årdk dk {kj.k gk tkrk g] blfy, bUg {kkj uke fn;k& ^^r= {kj.kkr {k.kuk}k {kkj%**
- jlk.ko e rhu idkj d {kkjk dk o.ku g&

  ^^f=kkjk% Vd.k{kkjk ;o{kkj'plftdk**

  &jlk.ko 5@35 ¼12oh 'krkCnh½

  1- Vd.k {kkj ¼lgkxk] Borax½
  2- ;o{kkj (Potassium Carbonate)
  3- lftdk {kkj
- fry] vkikekx] dnyh] iyk'k] f'kx] ekpd] eyknd] fpUpk ¼beyh½] v'oRFk ¼ihiy½] bu o{kk dh ydMh dh jk[k e o{k {kkj gkrr gA

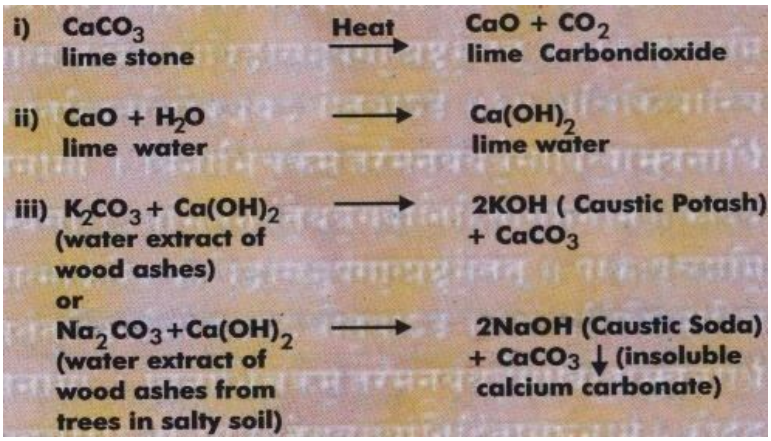
तं चिकीर्षुः शरदि गिरिसानुजं शुचिरुपोष्य प्रशास्तेऽह्नि प्रशस्तदेशजातम् अनुपहतं मध्यमवयसं महान्तम् असितमुष्तकमधिवास्य अपरेद्युः पाटयित्वा खण्डशः प्रकल्प्य अवपाट्य निर्वाते देशे निचितिं कृत्वा सुधाशकराश्च प्रक्षिप्य तिलनालैः आदीपयेत्। अथ उपशान्ते अग्नौ तद्भस्म पृथग्गृह्णीयात् भस्मशर्कराश्च। ततः क्षारद्रोणम् उदकद्रोणैः परिस्राव्य, महति कटाहे शनैः दर्व्या अवगहयन् विपचेत्। तमादाय महति वस्त्रे परिस्राव्य इतरं विभज्य पुनः अग्नौ अदिश्रयेत्। स यथा नातिसान्द्रो नातिद्रवश्च भवति मध्यमः, एष एव अप्रतीवापः पक्वः मृदुः, स एव सुप्रतीवापः पक्वः पाक्यः तीक्ष्णः।।

SUSRUTASAMHITA SUTRASTANAM 11-12

dkfLVd {kkj fuekZ.k dh fof/k ¼lJr lfgrk] l=LFkkue 11]12½

Some well grown trees in the forest are cut into logs and piled in a place free from strong wind. Lime stone/scashell should be placed on the piles and then set on fire by stalks of dry plants. When all the wood is burnt out, the fire extinguished, the ashes of the logs and the burnt lime are collected and kept separate and dissolved in water. The extract of the ashes is then mixed with lime water to get the lye which is seperated from the precipitate by filtration. The solution is concentrated to different extent by boiling and it is possible to get dilute, mild and caustic alkali.

- bl fof/k e fuEu jklk;fud vfHkfØ;k;sa gksrh g&



- lJr u {kkjk dk Hk.Mkj.k ykg ik= e dju dk fy[kk g&
  rr% dV'kdjkHk"e'kdjk{kjikd'k[kukHkjfXuo.kk% dRok··v;l ik= rfLeéo {kkjknd fuf"kP; fi"Vok ruo f}nk.k·"Viylfeere 'k[kukH;knhuke iek.ke ifrokl; lrreieÙk'pueo?kÍ;u foiprA &lJr lfgrk ½200 A.D.½

yo.k (Salts)

yo.kkfu "kMP;Ur lkeu lU/ko fcMeA
lkopy jked p pfYydkyo.k rFkkAA

&jljRulePp; (12oh 'rkCnh AD)

jljRulePp; e N% idkj d yo.kk dk o.ku g&

1- lkeu (Sea salt, NaCl+MgCl)
2- lU/ko (Rock salt, NaCl+Na_2S traces)
3- chM (yo.kk dk feJ.k ftudk xe dju l vEyjkt curk g)
4- lkopy (KNO_3)
5- jked yo.k (lkHkj] NaCl 75%+Na_2SO_4 18% + Na_2CO_3 5%)
6- pfYydk yo.k (pYg e ydMh d tyu l ikIr] NH_4Cl)

ikphu Hkkjrh; xzUFkksa esa fuEu rhu yo.kksa ds vk|ksfxd ek=k esa mRiknu ,oa foi.ku dk mYys[k gS&

1- edj/ot (Cinnabar, HgS)

2- lkSjk"Vªtk Alum, $K_2SO_4.Al_2(SO_4)_3.24H_2O$

3- lkSopZy (Salt peter, KNO_3)

- ts- czsDl uke ds vaxzst vf/kdkjh us jkW;y lkslk;Vh ¼yUnu½ ds v/;{k dks 1790 esa Hkkjr esa edj/ot (Cinnabar, HgS) ds fuekZ.k dh iz'kalk djrs gq, fy[kk fd bXySa.M esa bl yo.k ds mRiknu ds iz;kl esa os lQy ugha jgsA
- czsDl us ;g Hkh fy[kk fd Hkkjr ds yksx vPNs $HgCl_2$ rFkk Hg_2Cl_2 dk mRiknu Hkh djrs gSaA

jlUnexy ;U= fof/k;ka ¼ukxktqZu fojfpr jljRukdj ls½

- f'kyk ;U=
- ik"kk.k ;U=
- Hkw/kj ;U=
- oa'k ;U=
- ufydk ;U=
- xtnUr ;U=
- nksy ;U=
- v/k%ikru ;U=
- Hkwo%ikru ;U=
- ikru ;U=
- fu;ked ;U=
- xeu ;U=
- rqyk ;U=
- dPNi ;U=
- pkdh ;U=
- ckyqdk ;U=
- vfXu lkse ;U=
- xU/kd=kfgd ;U=
- ewl"kk ;U=
- gf.Mdk ;U=
- deHkkt u ;U=
- ?kks.kk ;U=
- xq.kkHkkd ;U=
- ukjk;.k ;U=
- tkfydk ;U=
- pkj.k ;U=

क्षिपेद्रसं घटे दीर्घे नताधोनालसंयुते।
तन्नालं निक्षिपेदन्यघटकुक्ष्यन्तरे खलु।।
तत्र रुद्ध्वा मृदा सम्यग्वदने घटयेरधः।
अधस्ताद्रसकुम्बस्य ज्वालयेत्तीव्रपावकम्।।
इतरस्मिन्घटे तोयं प्रक्षिपेत्स्वादु शीतलम्।
तिर्यक्पातनमेतद्धि वार्तिकैरभिधीयते।।

रसरत्नसमुच्चयम् अध्यायः 9

RASARATNASAMUCHAYA 9.47-49

Place the chemical in a vessel provided with a long tube immersed in an inclined position which enters into another vessel arranged as a reciever.
The mouth of the vessel and the joints should be sealed with clay and cloth.Now put a strong fire at the bottom of the vessel containing the chemicals, while,the other vessel is in cold water. This apparatus (used for distillation) is called Tiryakpatanam.


Koshti-yantra
dk"Vh ;U=


<dh ;U=

Crucible

मुष्णाति दोषान् मूषा या सा
मूषेति निगद्यते।

(Rasaratna-samucchaya 10.2)
(12th century AD)

Musha (crucible) is an instrument used for purifying metals.

उपादानं भवेत्तस्याः मृत्तिका
लोहमेव च।।

(Rasaratna-samucchaya 10.3)

The materials used to make the crucible are clay and iron.

jl'kkyk idohr lock/kkfooftreA
lok"kf/ke;n'k jE; dilefUorAA

¼jl k;u foKku i;ksx'kkyk dk fuek.k ,l jE; LFkku ij dj tgk vk"k/kh; ik/kk dk ckgY; gk rFkk lehi e tyk'k; gkA½

&jl jRu lePp;-

;{k&=;{k&lglk{k&fnfXoHkkx l'kkHkuA

ukukidj.kkirk ikdkj.k l'kkfHkrkeAA

½jlk;u foKku dh i;kx'kkyk e pgvkj dkjhMkj gk] ftue Hkkfr&Hkkfr d midj.k mÙkj] mÙkj&io vFkok io fn'kk e j[k gkA½

'kkyk;k% iofnXHkkx LFkki;nlHkjoeA

ofÐdekf.k pkXu; ;kE; ik"kk.kde pAA

u_R; 'kL=dekf.k ok#.k {kkyukfndeA

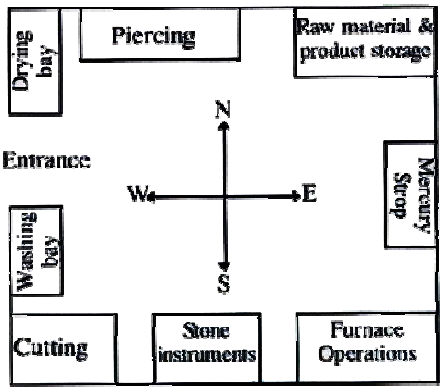
'kk"k.k ok;dk.k p o/kdekÙkj rFkkAA

¼i;kx'kkyk e io Hkkx e ikjn j[k] nf{k.k&io e ofÐde] nf{k.k e ik"kk.kde] nf{k.k&if'pe e 'kL=de] if'pe e iPNkyu] mÙkj&if'pe e l[kku gr rFkk mÙkj e o/kde midj.k j[kA½

LFkkiu fl)oLruk id;knh'kdk.kdA

inkFklxg% dk;k jllk/kugrd%AA

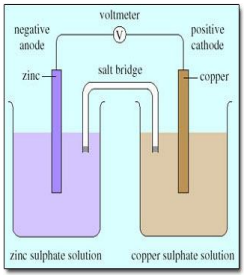
½/kkr mRiknu gr lkexh bdVBk djd mÙkj&io fn'kk e j[kuk pkfg,A½ &jljRulePp;·

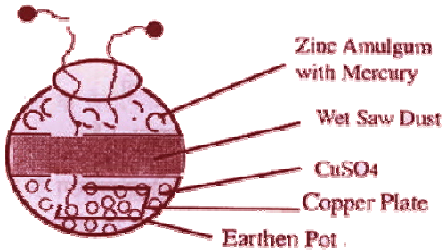


ELECTRO-CHEMICAL CELL

lLFkkl; e.e; ik= rkei= llLdre A
Nkn;fPNf[kxhou pknkfHk% dk"Bikl fHk% AA
nLrkyk"Vk fu/kkr0;% ikjnkPNkfnrLrr% A
l;kxkTtk;r rtk fe=ko#.k lfKre AA
¼vxLR; lfgrk] 14oh 'krkCnh ½

Modern Electrochemical Cell
(The Daniell Cell)
Luigy Galvani 1780
Alessandro Volta 1800





Open circuit voltage = 1.38 v
Short circuit current = 23mA

vuu tyHkxkfLr ik.kknu"k ok;"k A
,o 'krkuk dHkkuk l;kxdk;dRLer% AA

ok;c/kdoL=.k fuc)k ;kueLrd A
mnku% Loy?kRo foHkR;kdk'k;kude AA
¼vxLR; lfgrk] 14oh 'krkCnh½

Electrolysis of water was described by Cavendish in 1781.

df=eLo.kZ jtryi% lRdfr#P;rs A
;o{kkje;k/kkuk l'kä tylfé/kkS AA
vkPNkn;fr rÙkke Lo.kZu jtru ok A
lqo.kfylr rÙkke 'kkrdqHkfefr Lere AA

¼vxLR; lafgrk] 14oha 'krkCnh½

df=e Lo.kZ vFkok jtr dks yi dk lRdfr dgk tkrk gSA ykgs dks ik= es l'kä ty dk lkfé/; ikrs gh ;o{kkj ¼lkus ;k pkanh dk ukbVªsV½ rkes dks Lo.kZ ;k jtr ls <d yrk gSA Lo.kZ ls fylr mls rkes dks 'kkrdqEHk vFkok df=e Lo.kZ dgk tkrk gS ¼fo|qYysiu] Electroplating½-
&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
&

Boris Jacobi, Peter Bagration, Heinrich Lenz, Vladimir Odoyevshy (1839)

AERONAUTICS
&
SPACE SCIENCE

fueF; rnonkEcf/k Hkj}kt egkefu%A
uouhr len/kR; ;U=loLo:ideAA
ik;PNr loykdkukehfllrkFkQyineA
rfLeu pRokfj'kfrdkf/kdkj
lEinf'kreAA
ukukfoekuofp=;jpukØeck/kdeA
v"Vk/;k;foHkftr 'krkf/kdj.k;reAA
l=% ip'kr;Dr 0;ke;kui/kkudeA
oekfudkf/kdj.keDr Hkxork Lo;eAA

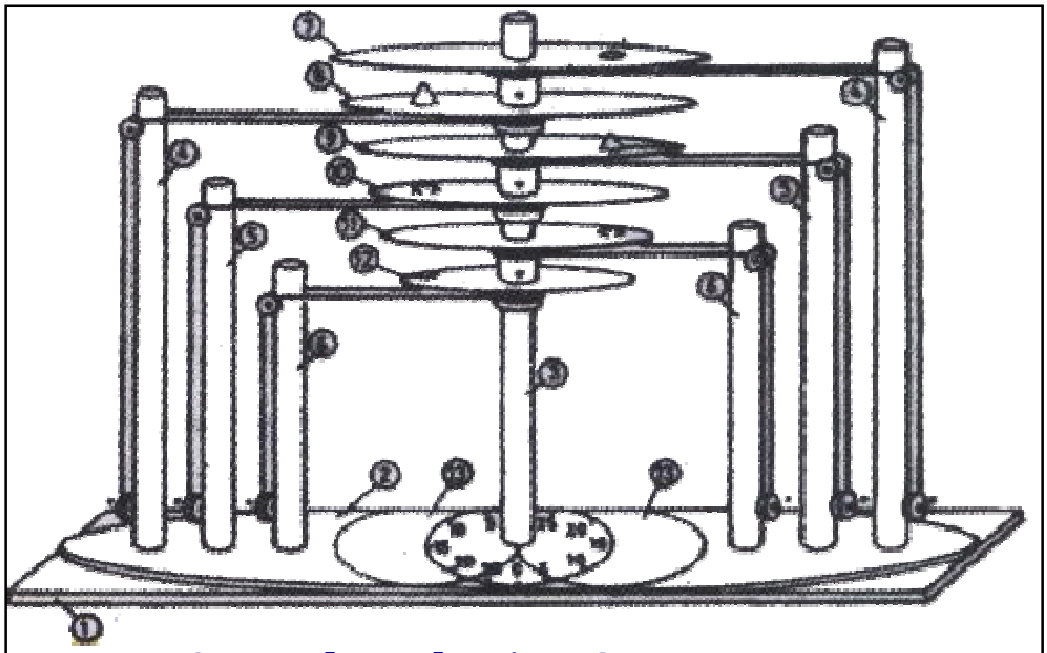
_f"k Hkj}kt
=rk;x

vFkkr Hkj}kt egkefu u on:ih len dk eFku djd ;U=loLo uke dk ,slk eD[ku fudkyk g] tk eu";ek= d fy, bfPNr Qy nu okyk gA mld 40o vf/kdj.k e oekfud idj.k g] ftle foeku fo"k;d jpuk d Øe dg x; gA ble 8 v/;k;]100 vf/kdj.k] 500 l= gA

&ck/kkuUn

Wright Brothers
17 Dec 1903 ??

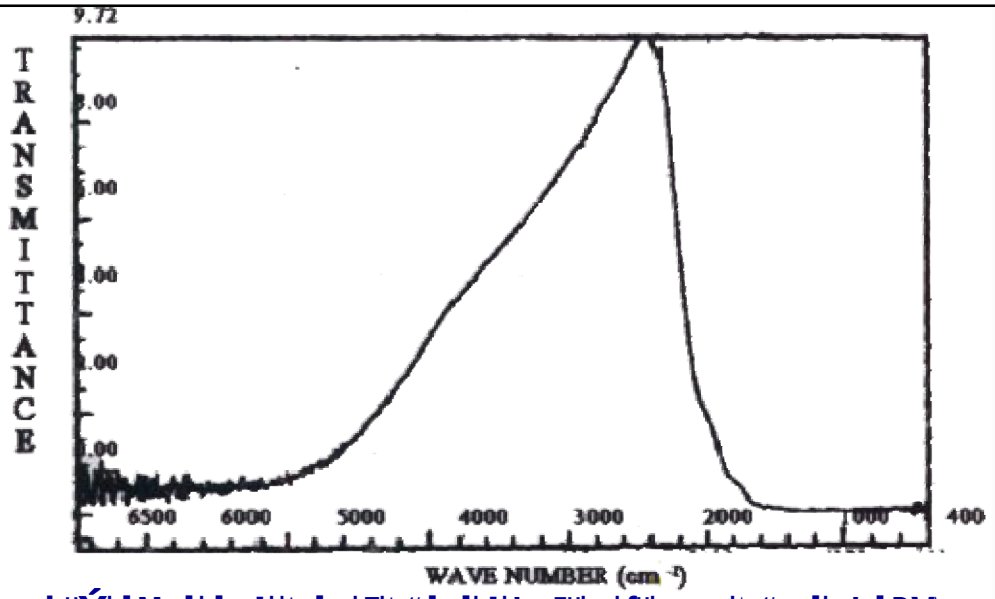
vkpk;	xUFk
ukjk;.k	foekupfUndk
'kkud	0;ke;kurU=
xx	;U=dYi
okpfLifr	;kufcUn
pkØk;.kh	[kV;ku inhfidk
/k.MhukFk	0;ke;kukFk idk'k
vxLR;	'kfDrl=
b'oj	lknkfeuh dyk
Hkj}kt	v'kckf/kuh] ;=loLo]vkdk'k 'kkL=
'kdVk;u	ok;rÙo idj.k
ukjn	o'okujr=]/ke idj.k



Sage Bharadwaja's Spectrometer

bUÝkjhM ikjn'kh inkFk

- egf"k Hkj}kt dh jpuk ^vU'kckf/kuh*
- ^idk'kLrEHkukfHkn ykg* inkFk dh fuek.k dh fof/k
- ;g inkFk idk'k dh bUÝkjhM {k= esa ikjn'kh g] fdUrq foftfcy {k= esa vikjn'kh gA
- bl inkFk dk l= g& $5(CaOSiO_2)\ (Fe_3O_4)\ (Ca_3P_2O_4)$
- bl inkFk dh fuek.k esa fuEufyf[kr ;kfxdk dk iz;ksx&
  1- [kpj (SiO_2) 2- HkkpØ ljfe=kfn{kkj (CaO)
  3- v;LdkUr (Fe_3O_4) 4- : : d $(Ca_3P_2O_4)$
- ;kfxd 1] 2] 3 rFkk 4 dk Øe'kk 8] 5] 4 rFkk 6 Hkkx feykdj Hkyh&Hkkafr ?kkVdj 940 fMxh lsaVhxzsM rd Hkkef.kd e"k (Rotating Crucible) esa xje fd;k tkrk gA rri'pkr 'kh?kzrk ls ,d Mkbl esa mMsy fn;k tkrk gA



bUÝkjM ikjn'kh inkFk ¼idk'kLrEHkukfHkn yk½ dk LiDVe

N.G. Dongre, S.K. Malinya and P. Ramchandra Rao,
Indian Journal of History of Science, **33** (4),1998,p.273.

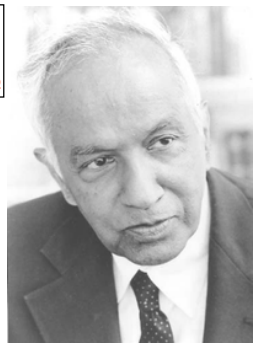
pUn'k[kj odV jkeu ¼1888&1970½

Physics
1930
jkeu iHkko

gjxkfoUn [kjkuk ¼1922&2011½

Medicine
1968
RNA

lcãU;u pUn'k[kj ¼1910&1995½



Physics
1983
pUn'k[kj fyfeV

odVjkeu jkekd".ku ¼1952½

Chemistry
2009
Ribosome

u Rog dke;s jkT;] u Lox ukiqujHkoeA
dke;s n%[krIrkuk ikf.kukekrquk'kueAA

¼g ijekRenu!½ e>s jkT; dh dkeuk ugh g]
Lox dh dkeuk ugh g vkj efDr dh dkeuk
Hkh ugh g] dkeuk g rk ;g fd n%[kksa ls
rIr ikf.k;ksa d n%[k dk nj dj lds

We are links of a great past
to a grand future.

- APJ Abdul Kalam
Ignited Minds (p. 20)


/kU ; okn