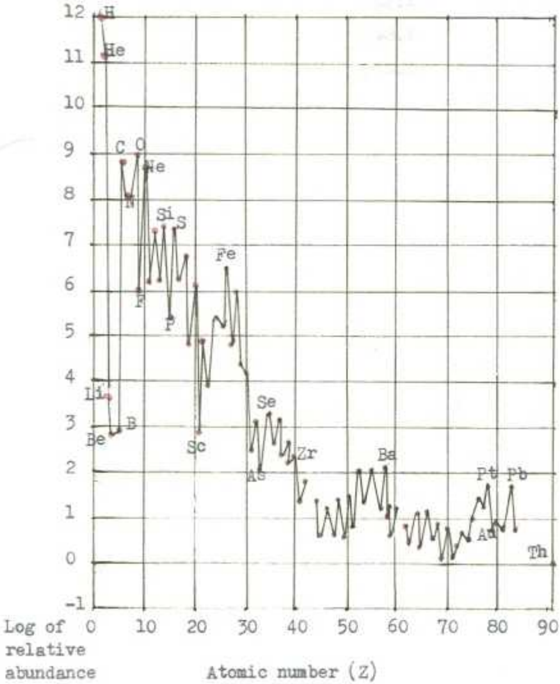
CONCISE DIRECTORY OF PHYSICS

- Stephen Wolfram -

1972

ABUNDANCE OF ELEMENTS

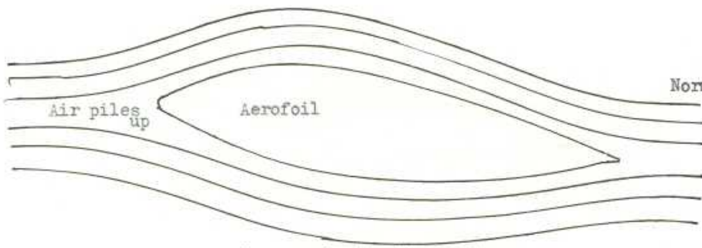


Graph of relative abundances of elements in the solar system, and probably in the universe. These were discovered, in the case of the lighter elements, using the Sun's spectra, and with the heavier ones, meteorites.

The 8 most common elements in the Earth's oceans, atmosphere, and uppermost 10 miles of curst.:

Oxygen	62.6 %
Silicon	21.2 %
Aluminium	6.5 %
Sodium	2.64 %

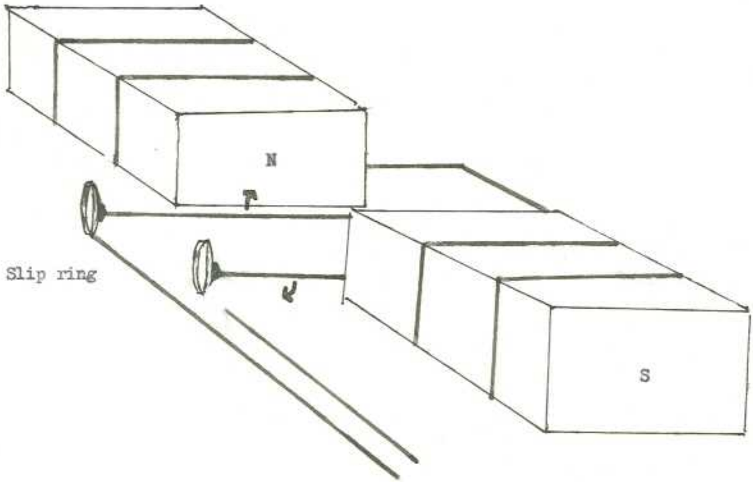
AEROFOIL



According to hydrodynamics, the sum of energies of velocity and pressure, and the potential energy of elevation remain constant. As the energy of an air mass is the sum of its velocity and pressure, it follows that if there is an increase in velocity, the pressure falls and vice-versa. As the distance over the top of an aerofoil is greater than that under the bottom, and the two airflow reach the end of the aerofoil at the same time, it follows that the upper one has more velocity and less pressure, and the lower one less velocity and more pressure. The differential has a lifting effect on the body and is called 'lift'.
Where the air meets behind the aerofoil, there is a higher pressure, due to the two streams hitting each other. This tends to push the aerofoil forward. At the front, however, as air hits the aerofoil, the aerofoil is retarded slightly. The high velocity of airflow under the wing helps to keep the wing or aerofoil up as well.

ALTERNATING CURRENT

Generation:



Alternating current changes its direction of flow at a fixed rate. The most common type used is that from the mains, which is reversed 120 times a second, thus it has a freqyency of 60 c.p.s.. The cheif advantage which alternating current has over direct current is that its voltage can be changed much more easily. A.C. is generated by an alternator, which, in its simplest form is a wire or coil rotating in an electric field between two opposing poles of a magnet. The current is drawn by means of two slip rings which are brushed by copper brushes from the coil.

ASTEROIDS.

List of important asteroids:

First twenty discovered:

Number	Name	Distance from Sun (mean A.U)
1	Ceres	2.8
2	Pallas	2.8
3	Juno	2.7
4	Vesta	2.4
5	Astraea	2.6
6	Hebe	2.4
7	Iris	2.4
8	Flora	2.2
9	Metis	2.4
10	Hygiea	3.1
11	Parthenope	2.4
12	Victoria	2.3
13	Egeria	2.6
14	Irene	2.6
15	Eunomia	2.6
16	Psyche	2.9
17	Thetis	2.5
18	Melpomene	2.3
19	Fortuna	2.4
20	Massilia	2.4

Close asteroids:

433	Eros	1.5
1566	Icarus	1.1
1620	Geographos	1.2
	Apollo	1.5
	Hermes	1.3

ASTRONOMICAL SIGNS AND SYMBOLS

SPHERICAL ASTRONOMY

a, R.A.	Right Ascension
δ, Deg.	Declination
a, A	Azimuth
h	Altitude
z	Zenith distance
λ	Celestial longitude
β	Celestial latitude
G	Galactic longitude
g	Galactic latitude
ϕ	Polar distance
θ	Sidereal time
h	Hour
m	Minute
s	Second
P	Position angle
d	Distance in seconds of arc
μ	Proper motion
π	Parrallax in seconds of arc
ϵ	Obliquity of the ecliptic
t	Hour angle

ORBIT DETERMINATION

k	Constant of gravitation
m	Planet's mass to Sun's mass
T	Time of perihelion passage
E	Epoch
ω	Angular distance from ascending node to perihelion
Ω	Longditude of ascending node
π	Longitude of perihelion point
i	Inclination of the ecliptic
e	Eccentricity of the orbit

☌	Conjuction
□	Quadrature
☍	Opposition
☊	Ascending node
☋	Descending node

CONSTELLATIONS OF THE ZODIAC

♈	Aries
♉	Taurus
♊	Gemini
♋	Cancer
♌	Leo
♍	Virgo
♎	Libra
♏	Scorpius
♐	Sagitarius
♑	Capricornus
♒	Aquarius
♓	Pisces

ATMOSPHERE.

Composition: (average at sea-level)

Nitrogen	78.08%
Oxygen	20.95%
Argon	0.93%
Carbon Dioxide	0.03%
Neon	0.0018%
Helium	0.0005%
Krypton	0.0001%
Xenon	0.00001%

Plus small very variable amounts of:

Water vapour

Hydrogen peroxide

Hydrocarbons

Sulphur compounds

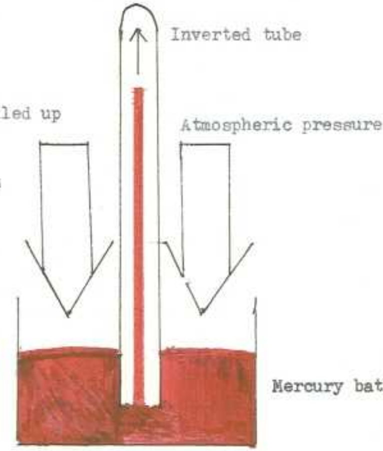
Dust particles

(The second number is the power of ten to be multiplied by)

Height: KM	Teperature: K	Pressure: mB	
0.000	288.15	10.1325	2
11.019	216.65	2.2632	2
20.063	216.65	5.4774	1
32.162	228.65	8.6798	0
47.350	270.65	1.1090	0
52.429	270.65	5.8997	-1
61.591	252.65	1.8209	-1
79.994	180.65	1.0376	-2
90	180.65	1.6437	-3
100	210.02	3.0070	-4
110	257.00	7.3527	-5
120	349.49	2.5209	-6

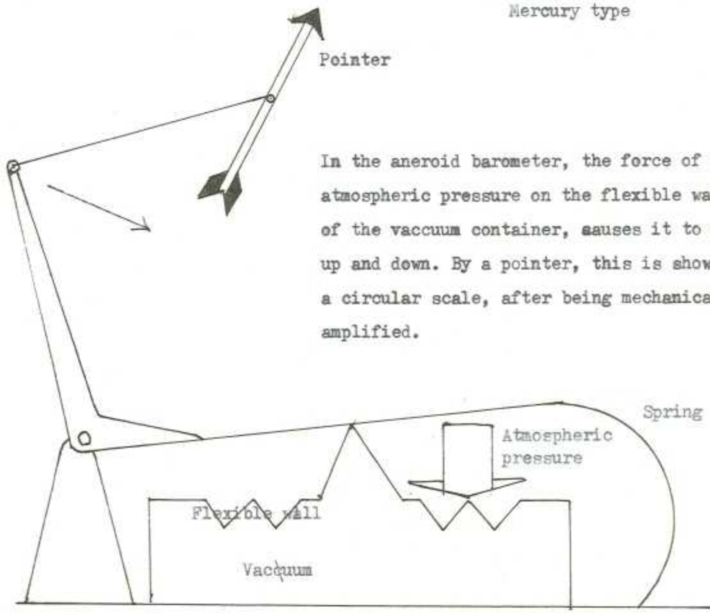
BAROMETERS

In the mercury barometer, a tube isv filled up with mercury, and then inverted into a bath of mercury. This causes a vaccuum at the top of the tube, so the mercury rises according to how much atmospheric pressure there is on the bath.



Mercury type

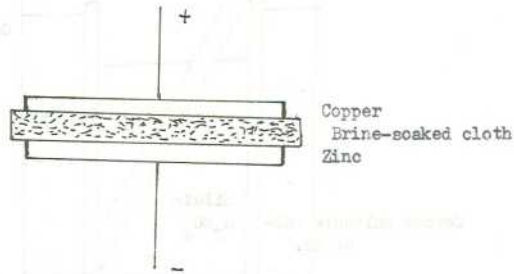
In the aneroid barometer, the force of the atmospheric pressure on the flexible wall of the vaccuum container, aauses it to move up and down. By a pointer, this is shown a a circular scale, after being mechanically amplified.



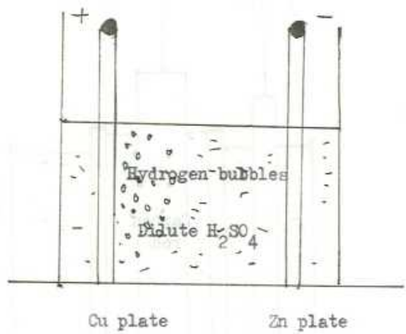
Aneroid type

BATTERIES

VOLTAIC

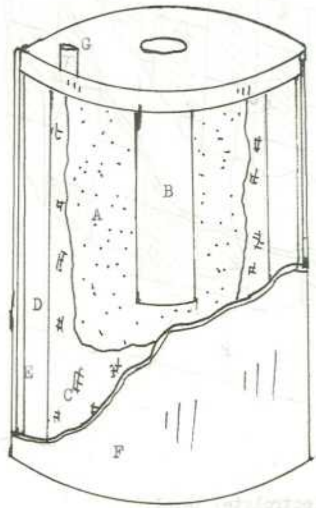


SIMPLE CELL



The disadvantage of this type of cell is that the Hydrogen gas does not conduct and thus, when there is a lot of electrolysis, the cell fails to work so efficiemtly. This is called polarization.

LECLANCHE CELL (DRY)



KEY:

A Manganese dioxide and powdered carbon

B Carbon rod (positive)

C Muslim bag

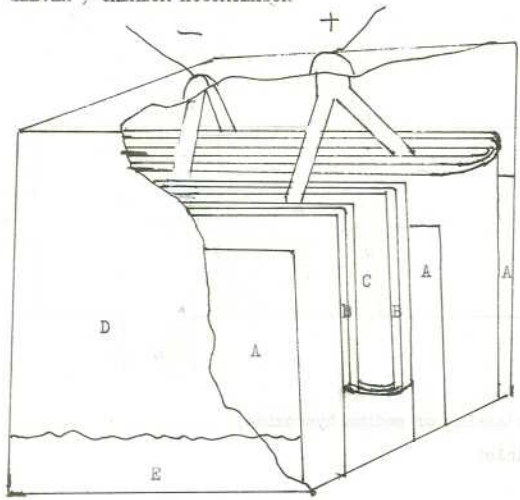
D Paste of Ammonium chloride

E Zinc (negative)

F Case

G Vent

SILVER - CADMIUM ACCUMULATOR



KEY:

A NEgative electrodes (Cadmium)

B Separators

C Positive electrodes (silver)

D Plastic casing

E Electrolyte

Other kinds of accumulator include:

Nickel - Iron (NiFe) Electrolyte - 20 % Potassium hydroxide

Zinc - air Electrolyte - 20 % Potassium hydroxide

Sodium - Sulphur @

Lithium - Chlorine @

@ these accumulators need an operating temperature of 300 - 600 °C

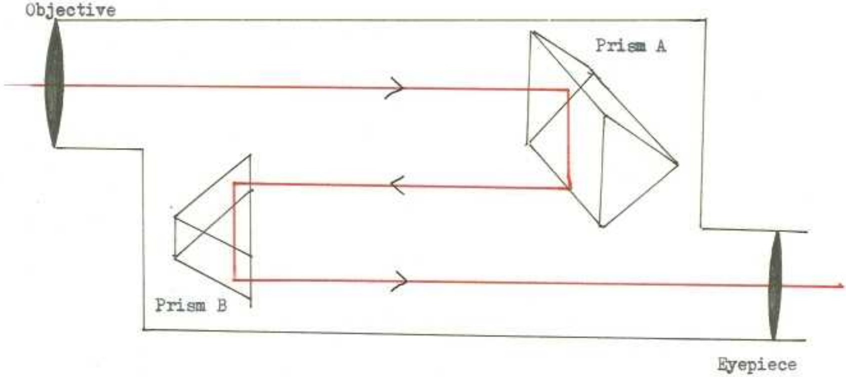
BEL.

(See article on Sound)

Increase in decibels	Increase facter
1	1.26
2	1.58
3	2.0
4	2.51
5	3.16
6	3.98
7	5.2
8	6.3
9	7.95
IO	IO

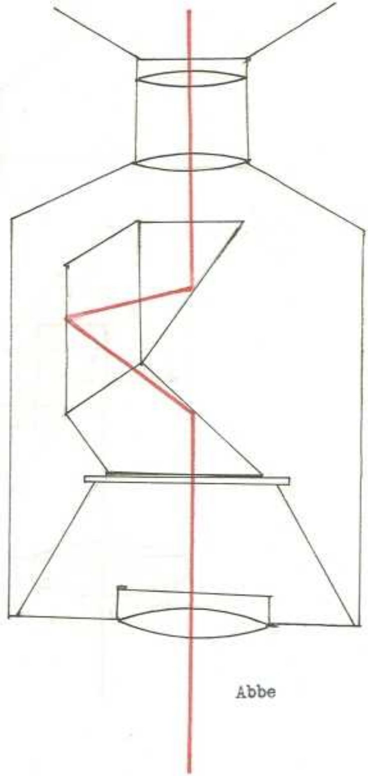
DECIBELS	
165	Saturn V launching pad at lift-off
160	Jet engines wide open
150	50 - hp siren at IOO ft.
140	Air raid siren at 20 ft.
130	Pneumatic chipper at 5 ft.
120	Shotgun blast
110	Annealing furnace at 4 ft.
100	Passing train at 500 ft.
90	Conversational speech at 3 ft.
80	Office with typewriters.
70	Light city traffic at IOO ft.
40	Average living room
30	Broadcasting studio
20	Very quiet room.

BINOCULARS, PRISM

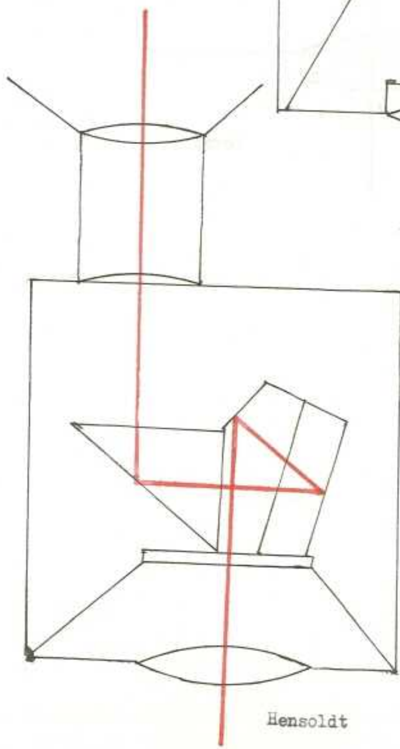


Prism binoculars are ingenious because they allow the objective to have a long focal length without the binoculars having to be very long in tube length. They also produce an erect and laterally correct image. Prism A corrects the Vertical inversion from the objective, and prism B corrects the Lateral inversion.

BINOCULARS, TYPES OF PRISM

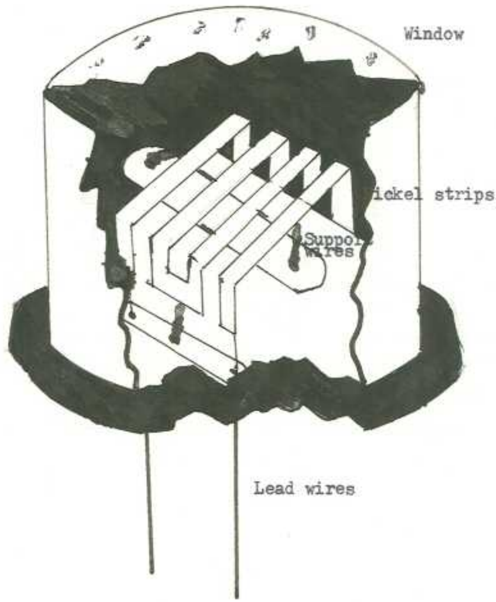


Abbe



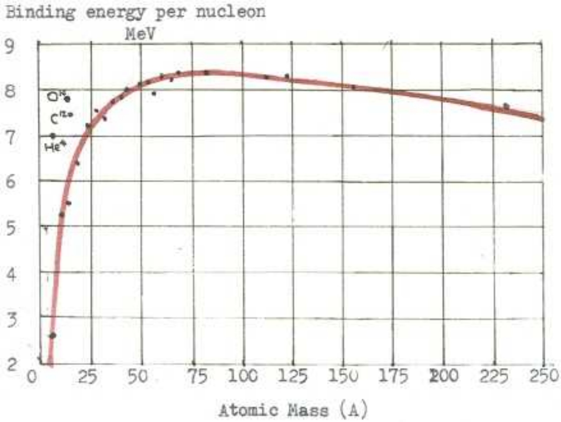
Hensoldt

BOLOMETER



The nickel strips resistance varies with temperature, and so do the phosphor bronze support wires. Thus, the amount of heat falling on the bolometer can be deduced.

BONDING ENERGY



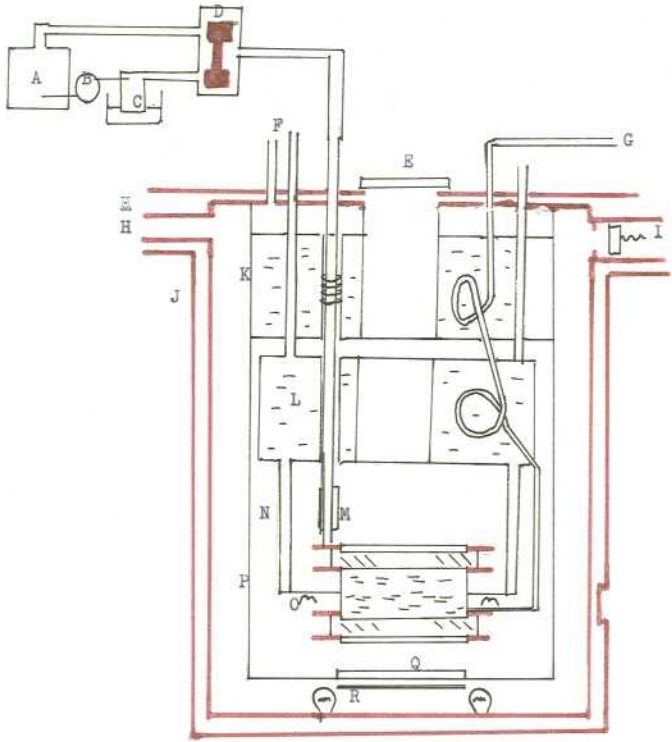
Graph of $\Delta(A,Z)c^2 / A$

It is reasonable to say that the binding energy between the parts of a nucleus is about 8 MeV.

DIATOMIC MOLECULES,.

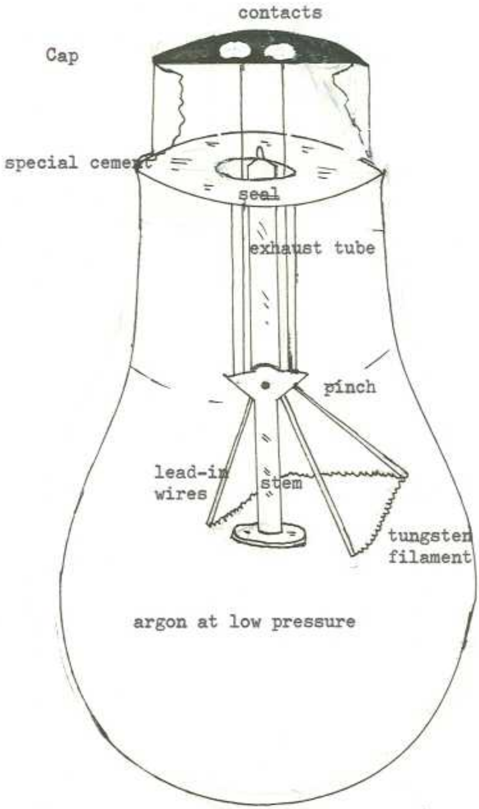
Molecule	Distance between nuclei (Å)	Energy needed to separate atoms (dissociation energy) (eV)
AgH	1.62	2.5
BaO	1.94	4.7
Br_2	2.28	1.97
CaO	1.82	5.9
H_2	0.75	4.5
Hcl	1.27	4.4
HF	0.92	6.4
HgH	1.74	0.38
KCl	2.79	4.42
N_2	1.09	9.76
O_2	1.20	5.08

BUBBLE CHAMBER , HYDROGEN



A	Expansion tank	K	Liquid N_2 jacket
B	Compressor	L	Liquid H_2 flask
C	Recompression tank (LN_2)	M	Expansion line
D	Expansion valve	N	Heat leak
E	Camera	O	Heater
F	Vents	P	Radiation shield at liquid N_2 temperature.
G	Chamber H_2 supply	Q	Shutter
H	Vaccuum pump	R	Light
I	Vent		
J	Vaccuum tank		

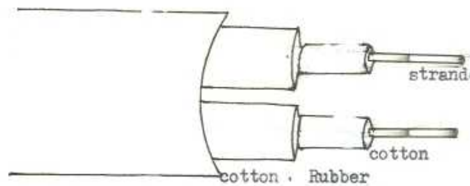
BULB, ELECTRICAL



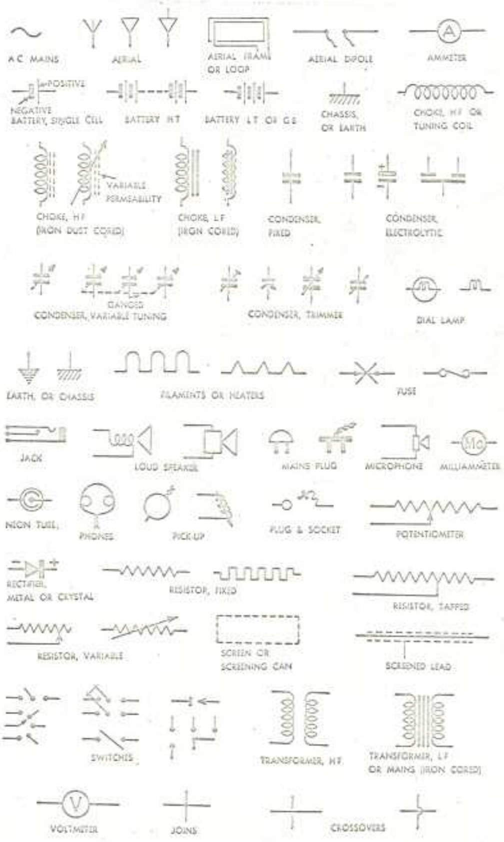
CABLES

SINGLE CONDUCTOR

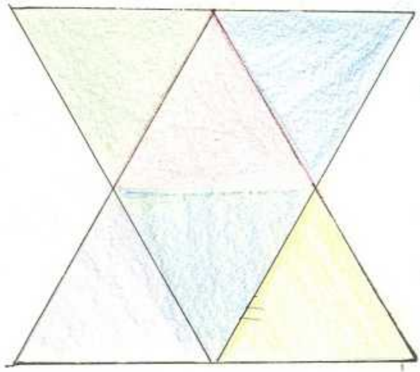
TWIN CONDUCTORS



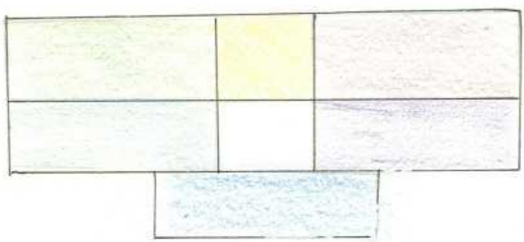
CIRCUIT DIAGRAM SYMBOLS



COLOUR



The light primaries work by addition, e.g. the three primaries make white, whereas the pigment primaries work by subtraction. If you have a red piece of paper, then it absorbs all light except red. Thus, it is obvious why the pigment primaries are complementaries to the light primaries.



Light mixing.

COLOUR CODES, ELECTRICAL COMPONENTS

RESISTORS.

0.........................Black
1.........................Brown
2.........................Red
3.........................Orange
4.........................Yellow
5.........................Green
6.........................Blue
7.........................Violet
8.........................Grey
9.........................White

(a) The colour on the body of the resistor stands for the first figure of the ohms, the tip stands for the second digit, and a band or dot stands for the number of 0's tb follow.

(b) The furthest left band represents the first digit, the next band the second digit, the third the number of 0's and the forth the tolerance. For this two colours are used: gold .... 5% tolerance
silver.............. 20% tolerance
nothing............. 10% tolerance

CONDENSERS.

Tolerance	Voltage rating	
1 %	100	Brown
2 %	200	Red
3 %	300	Orange
4 %	400	Yellow
5 %	500	Green

WANDER PLUGS.

Red..................Highest positive HT
Yellow...............2nd highest positive HT
Green................3rd highest positive HT
Blue.................4 th highest positive HT
Pink.................LT positive
Black................Common negative
Brown................Maximum negative, GB
Grey.................2nd negative GB
White................3rd negative GB

PLUGS.

Brown....................Live
Yellow/Green.............Earth
Blue.....................Negative

E

N L

Prong configuration.

CONCEPTS , PHYSICAL

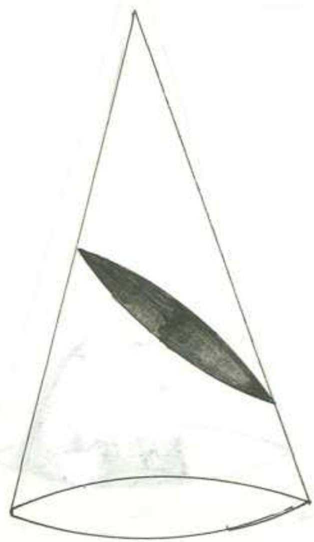
Concept	Symbol	Name	Abbr.	Definition
Length	l	metre	m	1650763.73 of wavelength of $(2p_{10} - 5d_5)$ of Kr 86
Mass	m	kilogramme	kg	International protptype Kg.
Time	t	second	s	9192631770 periods of the radiation corresponding to the transition between the ground states of Cs 133
Electric current	I	ampere	a	The current along two infinitely long, negligable thickness conductors 1m apart needed to produce 2×10^{-7} N / m force between the two.
Thermodynamic temperature	T	kelvin	K	1/273.15 of the temperature of the triple point of water.
Luminous intensity	I	candela	cd	Luminous intensity of a black-body radiator at the freezing point of platinum viewed normal to the surface is 6×10^5 cd/m^2
Amount of substance		mole	mol	Number of elementary units in 0.012 kg of ^{12}C.
Plane angle	α, β, θ etc.	radian	rad	Angle subtended at the center of a circle by an arc the same length as the radius.
Solid angle	Ω, ω	steradian		3 - Dimensional version of rad.
Area	a, A	Square metre	m^2	$a = l^2$
Volume	V	Cubic metre	m^3	$V = l^3$
Velocity	V, u		$m\ s^{-1}$	$V = dl/dt$
Acceleration	a		$m\ s^{-2}$	$a = d^2l/dt^2$
Density	ρ		$kg\ m^{-3}$	$\rho = m/V$
Mass rate of flow	$\dot{m}$, $\dot{M}$		$kg\ s^{-1}$	dm/dt
Volume rate of flow	$\dot{V}$		$m^3\ s^{-1}$	dV/dt
Moment of inertia	I		$kg\ m^2$	
Angular momentum	L_ω		$kg\ m^2\ s^{-1}$	I_ω
Momentum	$\bar{p}$		$kg\ m\ s^{-1}$	
Force	F	Newton	N	$F = ma$
Torque	T (M)	Newton metre	Nm	$T = Fl$

Susceptance	B	Siemens	S	$B = 1/X$ (one)
Admittance	Y	Siemens	S	$Y = 1/Z$ (one)
Total voltamperes	S	Voltamp	VA	$S^2 = P^2 \quad Q^2$
Reactive voltamperes	Q		VA r	
Luminous flux	ϕ	Lumen	lm	lm = cd sr
Illumination	E	Lux	lx	$lx = lm\ m^2$

CONIC SECTIONS

Circle

Ellipse



CONSTANTS

Electronic charge	1.60210×10^{-19} couloumb	e
Electronic rest mass	9.1091×10^{-31} kilogram	m_e
Electronic radius	2.81777×10^{-15} metre	r_e
Proton rest mass	1.67252×10^{-27} kilogram	m_p
Neutron rest mass	1.67482×10^{-27} kilogram	m_n
Planck's constant	6.62559×10^{-34} joule second	h
Velocity of light	2.997925×10^{8} metres per second	c
Avogadro's constant	6.02252×10^{23} per mole	L
Loschmidt's constant	$2.68719 \times 10^{25}\ m^{-3}$	N_L
Gas constant	$8.3143\ J\ K^{-1} mol^{-1}$	R
Boltzmann's constant	$1.30854 \times 10^{-23}\ J\ K^{-1}$	k
Faraday's constant	$9.64870 \times 10^{4}\ C\ mol^{-1}$	F
Stefan - Boltzmann constant	$5.6697 \times 10^{-8}\ W\ M^{-2}\ K^{4}$	σ
Gravitational constant	$6.670 \times 10^{-11}\ N\ m^{2}\ Kg^{-2}$	G
Accelearation due to gravity	$9.80665 \times 10^{0}\ m\ s^{-2}$	g
Permeability of a vacuum	$4\pi \times 10^{-7}\ H\ m^{-1}$	μ_o
Permittivity of a vacuum	$8.85418 \times 10^{-12}\ F\ m^{-1}$	ϵ_o

CONSTELLATIONS

	Abbreviation	Right Ascension	Declination
Andromeda	And	1	40 N
Antlia	Ant	10	35 S
Apus	Aps	16	75 S
Aquarius	Aqr	23	15 S
Aquila	Aql	20	5 N
Ara	Ara	17	55 S
Aries	Ari	3	20 N
Auriga	Aur	6	40 N
Bootes	Boo	15	30 N
Caelum	Cae	5	40 S
Camelopardus	Cam	6	70 S
Cancer	Cnc	9	20 N
Canes Venatici	CVn	13	40 N
Canis Major	CMa	7	20 S
Canis Minor	CMi	8	5 N
Capricornus	Cap	21	20 S
Carina	Car	9	60 S
Cassiopeia	Cas	1	60 N
Centaurus	Cen	13	50 S
Cepheus	Cep	22	70 N
Cetus	Cet	2	10 S
Chamaeleon	Cha	11	80 S
Circinus	Cir	15	60 S
Columba	Col	6	35 S
Coma Berenices	Com	13	20 N
Corona Austrina	CrA	19	40 S
Corona Borealis	CrB	16	30 N
Corvus	Crv	12	20 S
Crater	Crt	11	15 S
Crux	Cru	12	60 S
Cygnus	Cyg	21	40 N
Delphinus	Del	21	10 N
Dorado	Dor	5	65 S
Draco	Dra	17	65 N
Equuleus	Equ	21	10 N
Eridanus	Eri	3	20 S
Fornax	For	3	30 S
Gemini	Gem	7	20 N
Grus	Gru	22	45 S
Hercules	Her	17	30 N
Horologium	Hor	3	60 S
Hydra	Hya	10	20 S
Hydrus	Hyi	2	75 S
Indus	Ind	21	55 S
Lacerta	Lac	22	45 N
Leo	Leo	11	15 N

CONVERSIONS, 6-FIGURE

LENGTH:

	m	cm	in	ft
1 metre	1	100	39.3701	3.28084
1 centimetre	0.01	1	0.393701	0.0328084
1 inch	0.0254	2.54	1	0.0833333
1 foot	0.3048	30.48	12	1

	km	mi	n.mi
1 kilometre	1	0.621371	0.539957
1 mile	1.60934	1	0.868976
1 nautical mi.	1.8520	1.15078	1

1 light year = 9.46070×10^{15} metres = 5.87848×10^{12} miles

1 astronomical unit = 1.495×10^{11} metres

1 parsec = 3.0857×10^{16} metres = 3.2616 light years

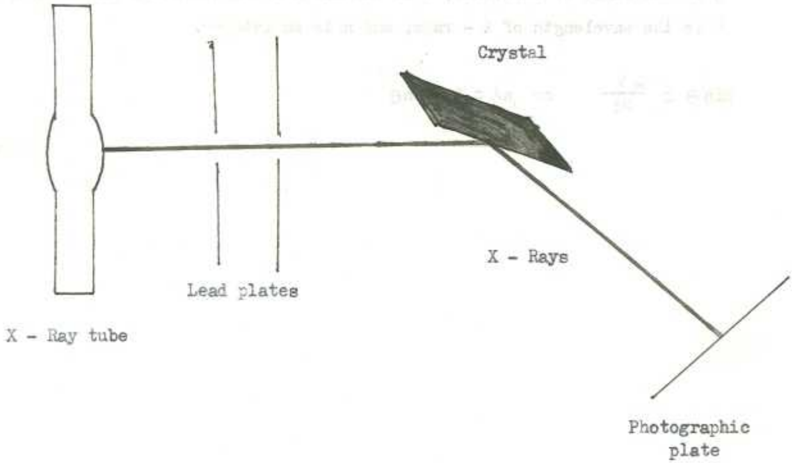
VELOCITY:

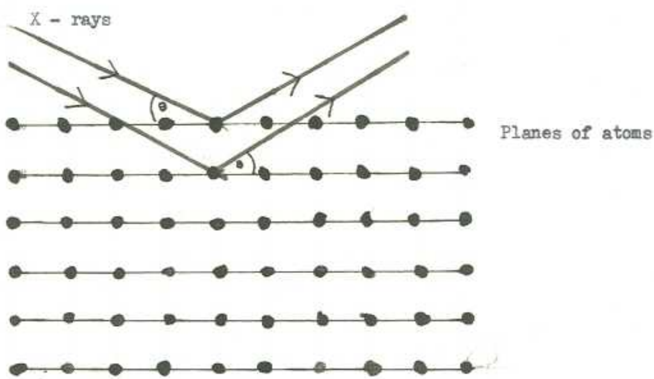
	m/sec	km/hr	mi/hr	ft/sec
1 metre/second	1	3.6	2.23694	3.28084
1 kilometre/hr.	0.27778	1	0.621371	0.911346
1 m.p.h.	0.44704	1.609344	1	1.46667
1 ft/sec.	0.30480	1.09728	0.681817	1

MASS:

	kg	g	lb.	lomg ton
1 kilogram	1	1000	2.20462	984207×10^{-9}
1 gram	0.001	1	220462×10^{-8}	984207×10^{-12}
1 pound	0.453592	453.592	1	4.46429
1 long ton	1016.047	1016047	2240	1

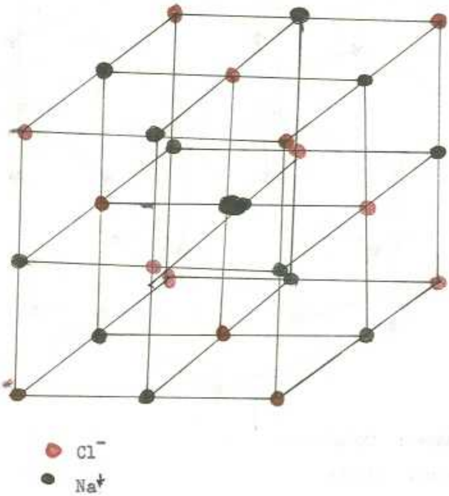
CRYSTALLOGRAPHY, X - RAY





CRYSTAL STRUCTURE

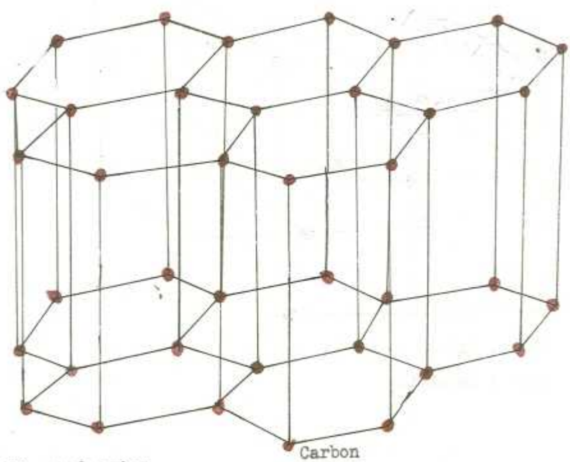
SODIUM CHLORIDE



Shape : Cubic (Face - centered)

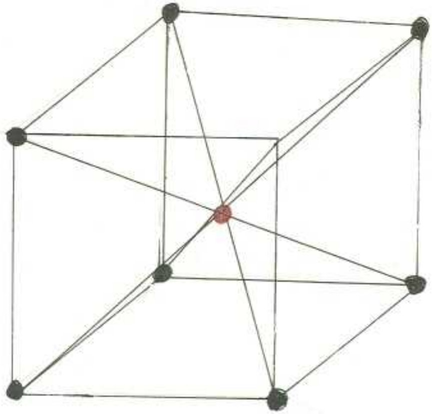
Type : Covalent (Molecular)

GRAPHITE



Shape : Hexagonal prism

Type : Atomic

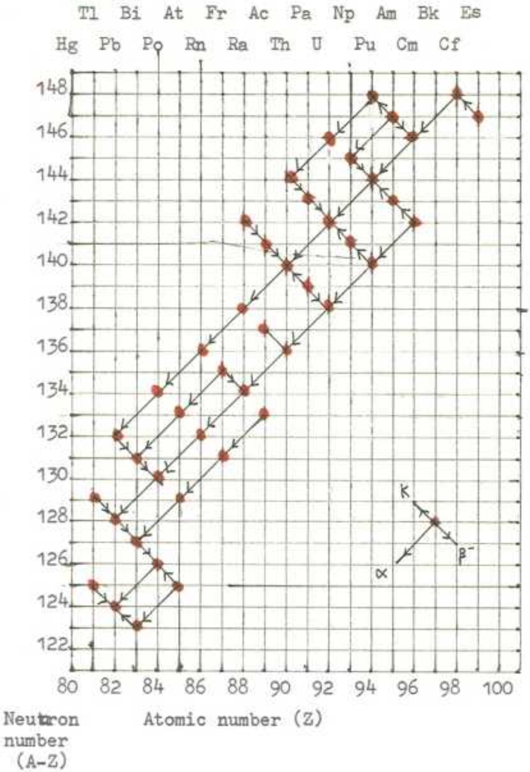


Cesium Chloride (Body centered)

Shape : Cubic

Type : Covalent

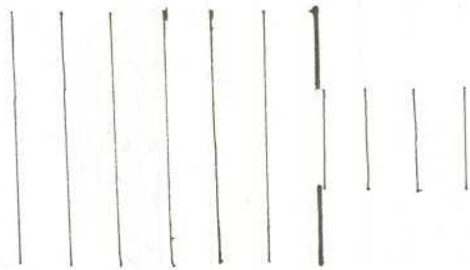
DECAYS, RADIOACTIVE



DENSITY.

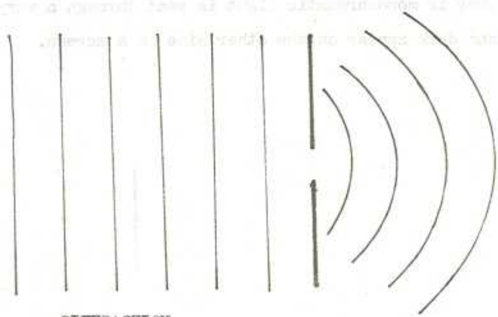
	gm/cc
Atomic nuclei	10^{14}
Center of densest stars	10^{5}
24 - carat gold	19.3
Mercury	13.6
Earth's Nickel-Iron core	@ 12
Lead	11.3
Steel	7.6 - 7.8
Titanium	4.5
Diamond	3.53
Aluminium	2.70
Quartz	2.65
Lucite	1.16 - 1.20
Human body (average)	1.07
Water	1
Ice	0.917
Buttter	0.87
Cork	0.24
Liquid hydrogen	0.071
Room air	1.2×10^{-3}
Air at 20 kms	9×10^{-5}
Interstellar space	10^{-21}
Intergalactic space	10^{-24}

DIFFRACTION.



Wave crests continued linear crests

RECTILINEAR PROPAGATION.

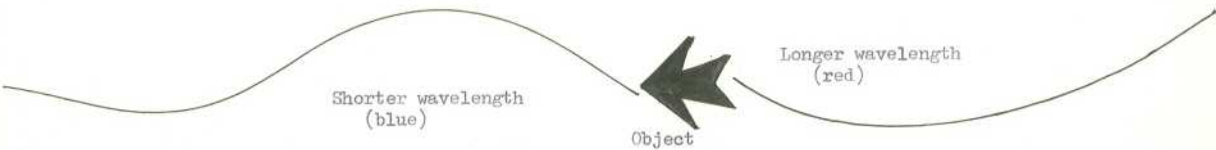


DIRFRACTION.

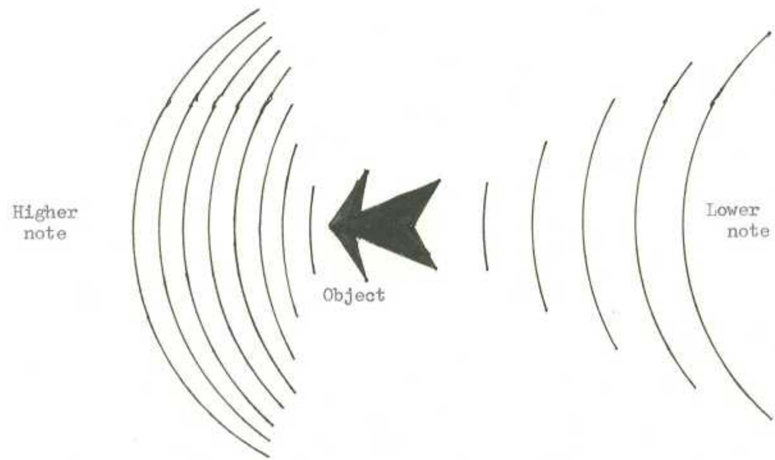
This occurs when the slit is in the region of the wavelength of the the waves. As the wave tries to push through the hole it is 'bent'. This accounts for sound being heard 'round a corner'.

D O P P L E R   E F F E C T .

ELECTROMAGNETIC WAVES



SOUND

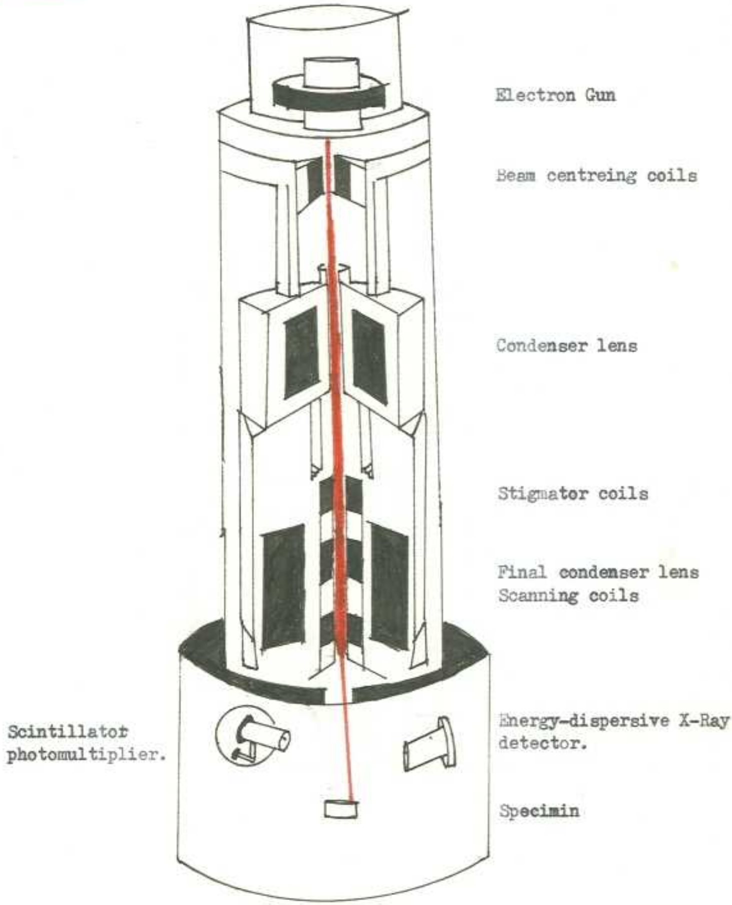


ELECTRON CONFIGURATIONS AND IONIZATION POTENTIALS OF THE COMMONER ELEMENTS

Element	At. No	K	L	M	N	O	P	Ionization potentials (Electron Volts) I	II	III	IV	V
H	1	1						13.59				
He	2	2						24.48				
C	6	2	4					11.26	24.38	47.87	64.48	392.0
N	7	2	5					14.53	29.59	47.43	77.45	97.86
O	8	2	6					13.61	32.11	54.89	77.39	113.9
F	9	2	7					7.87	16,18	30.64	56.80	114.2
Ne	10	2	8					21.56	41.07	63.50	97.02	126.3
Na	11	2	8	1				5.14	47.29	71.71	98.88	138.4
Mg	12	2	8	2				7.64	15.03	80.14	109.29	141.2
Al	13	2	8	3				5.98	18.82	28.44	119.96	153.8
Si	14	2	8	4				8.15	16.34	33.49	45.13	166.7
P	15	2	8	5				10.48	19.72	30.16	51.35	65.0
S	16	2	8	6				10.36	23.40	35.0	47.29	72.5
Cl	17	2	8	7				13.01	23.80	39.9	53.50	67.8
Ar	18	2	8	8				15.75	27.62	40.9	59.8	75,0
K	19	2	8	8	1			4.34	31.81	46.0	60.9	82.6
Ca	20	2	8	8	2			6.11	11.87	51.2	67.0	84.4
Fe	26	2	8	14	2			7.87	16.8	30.6	56.8	-
Cu	29	2	8	18	1			7.72	20.30	36.8	-	-
Zn	30	2	8	18	2			9.39	17.96	39.7	-	-
Br	35	2	8	18	7			11.84	21.60	35.9	47.3	59.7
Kr	36	2	8	18	8			13.99	24.90	36.9	43.5	63.0
Ag	47	2	8	18	18	1		7.57	21.5	34.8	-	-
Sn	50	2	8	18	18	4		7.34	14.63	30.5	40.7	72.3
I	53	2	8	18	18	7		10.45	19.13	-	-	-
Xe	54	2	8	18	18	8		12.13	21.2	31.3	42.0	53.0
Cs	55	2	8	18	18	8	1	3.89	25.1	35.0	-	-
Ba	56	2	8	18	18	8	2	5.21	10.0	35.5	-	-
Hg	80	2	8	18	32	18	2	10.43	18.75	34.2	49.5	-

N.B. The nearest sheal to the nucleus is K and then L, and so on.

ELECTRON MICROSCOPE

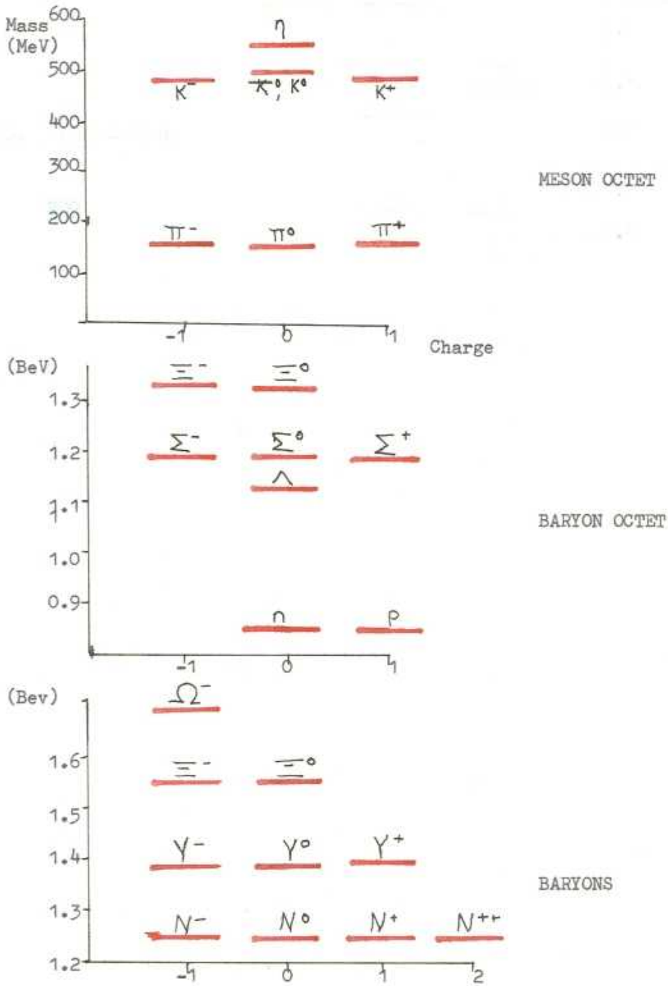


The reflected beam of electrons is then put through a series of magnetic lenses which serve to spread it out up to a magnification of 100,000 X, and the stream of electrons fall on a fluorescent screen which produces a image. The reflected X-Rays can be used spectroscopically to determine the constituents of the specimin. One of the advantages of an electron microscope is that it has a field of view and depth of view 300 times better than a light microscope.

ELEMENTRY PARTICLES

Particle	Symbol	Mass	Spin	Lifetime	Charge	Strangeness
FERMIONS		(MeV)		(secs)		
BARYON						
NUCLEONS						
Proton	p	938.26	$\frac{1}{2}$	Stable	1	0
Neutron	n	939.55	$\frac{1}{2}$	IOIO	0	0
HYPERONS					0	
Xi-particles	Ξ^0	I3I4.9	$\frac{1}{2}$	$2.9 X IO^{-IO}$	0	-2
	Ξ^-	I32I.3	$\frac{1}{2}$	$I.7 X IO^{-IO}$	-I	-2
Sigma particles	Σ^+	II89.5	$\frac{1}{2}$	$8.I X IO^{-II}$	I	-I
	Σ^0	II92.5	$\frac{1}{2}$	IO^{-14}	0	-I
	Σ^-	II97.4	$\frac{1}{2}$	$1.66 X IO^{-IO}$	-I	-I
Lambda-particle	Λ	III5.5	$\frac{1}{2}$	$2.5 X IO^{-IO}$	0	-I
Omega-particle	Ω^-	I672	$1\frac{1}{2}$	$I.I X IO^{-IO}$	-I	-I
LEPTONS						
-						
Electron	e^-	0.5II	$\frac{1}{2}$	Stable	-I	0
Neutrino	ν	0	$\frac{1}{2}$	Stable	0	0
Muon	μ^-	I05.66	$\frac{1}{2}$	$2.2 X IO^{-6}$	-I	0
BOSONS						
MESONS						
-						
Eta-particle	η^0	548.8	0	?	0	0
Kaons	K^0	497.8	0	IO^{-IO}	0	-I
	K^-	493.8	0	$I.2 X IO^{-8}$	-I	-I
	K^+	493.8	0	$I.2 X IO^{-8}$	I	I
Pions	π^+	139.6	0	$2.6 X IO^{-8}$	I	0
	π^0	I35	0	IO^{-I6}	0	0
	π^-	I39.6	0	$2.6 X IO^{-8}$	-I	0
Photon	γ	0	I	Stable	0	-

ELEMENTARY PARTICLES



ELEMENTS.

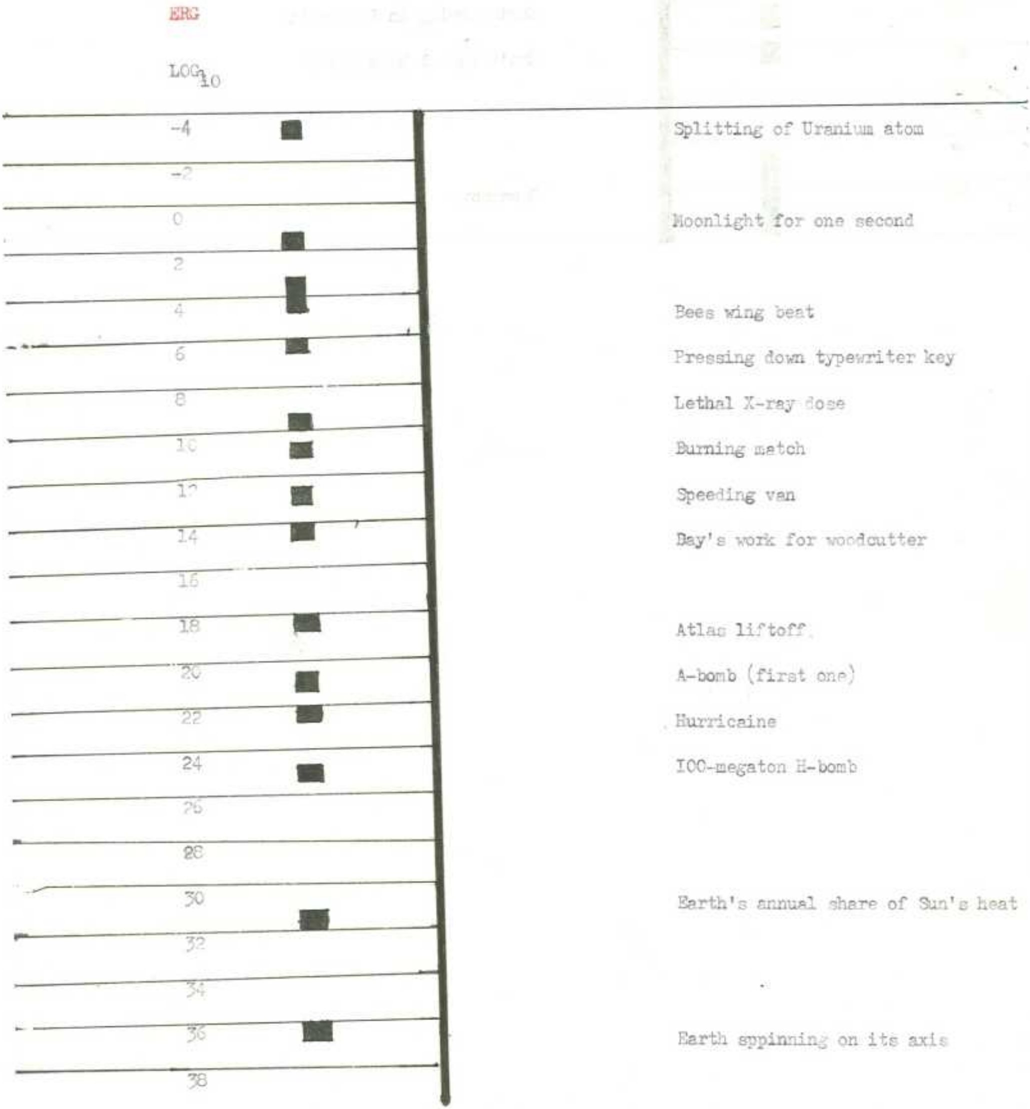
Name:	Symbol:	At. No.:	A.W.:
Actinium	Ac	89	(227)
Aluminium	Al	13	26.9815
Americiam	Am	95	(243)
Antimony	Sb	51	121.75
Argon	Ar	18	39.948
Arsenic	As	33	74.9216
Astatine	At	85	(210)
Barium	Ba	56	137.34
Berkelium	Bk	97	(247)
Beryllium	Be	4	9.0122
Bismuth	Bi	83	208.98
Boron	B	5	10.81
Bromine	Br	35	79.904
Cadmium	Cd	48	112.40
Caesium	Cs	55	132.905
Calcium	Ca	20	40.08
Californium	Cf	98	(251)
Carbon	C	6	12.011
Cerium	Ce	58	140.12
Chlorine	Cl	17	35.453
Chromium	Cr	24	51.996
Cobalt	Co	27	58.9332
Copper	Cu	29	63.546
Curium	Cm	96	(247)
Dysprosium	Dy	66	162.50
Einsteinium	Es	99	(254)
Erbium	Er	68	167.26
Europium	Eu	63	151.96
Fermium	Fm	100	(257)
Fluorine	F	9	18.9984
Francium	Fr	87	(223)
Gadolium	Gd	64	157.25
Gallium	Ga	31	69.72
Germanium	Ge	32	72.59
Gold	Au	79	196.967
Hafnium	Hf	72	178.49
Helium	He	2	4.0026
Holmium	Ho	67	164.930
Hydrogen	H	1	1.00797
Indium	In	49	114.82
Iodine	I	53	126.9044
Iridium	Ir	77	192.2
Iron	Fe	26	55.847
Krypton	Kr	36	83.80

Titanium	Ti	22	47.90
Tungsten (Wolfram)	W	74	183.85
Uranium	U	92	238.03
Vanadium	V	23	50.942
Xenon	Xe	54	131.30
Ytterbium	Yb	70	173.04
Yttrium	Y	39	88.905
Zinc	Zn	30	65.37
Zirconium	Zr	40	91.22

In the Atomic Weights, 1 equals 1/12 of the weight of Carbon isotope I2.

ENERGY.

There are seven forms of energy: Kinetic, Potential, Heat, Electrical, Chemical, Radiant, and Atomic. Out of these, only one can exist on its own in space: Radiant energy. All the others need some sort of medium, or come from matter itself, like Atomic energy. Energy is described as the ability to do work. In the natural world, except for a few cases where matter is turned into energy and vice-versa, no energy can be destroyed or created in the universe. Thus we arrive at the law of the conservation of energy . This law states that whatever energy transfers take place , no energy can ever be lost. We will now take an example of an energy chain. We will start at the sun which is 'Driven ' by atomic energy . The exact method will be discussed later , this produces radiant energy in the form of light and heat . This light then falls onto a photoelectric cell which converts it into electrical energy . This electrical energy is then used to electrolise a chemical solution turning its chemical energy into heat . Thus we have used up all the types of energy known . Nearly all the energy on this earth originates from the sun e.g. fossilised fuels etc. , but a very small amount e.g. volcanoes originate from the earth itself. It is possible to convert any given type of energy to any other except for a very few combinations . These include radiant to kinetic and atomic to kinetic and electrical . There is another type of energy inherent in the very structure of the universe as we know it at present. This is a store of energy which has not yet been tapped by man. It exists as the combination between matter and anti-matter . When an atom and an anti-atom meet a considerable amount of energy is produced , a radiation called annihilation radiation and total annihilation of both particles takes place. This is the only time when $e = mc^2$ is truly valid. Before going into the different types of energy it is worth saying that, as we go on, all the energy in this universe is gradually being turned into heat which then diffuses into the cosmos. This entropy is called the heat death of the universe, and is discussed from another angle in another article. We will start with heat energy . This energy comes in the form of the kinetic energy of molecules in a substance . The more they move around , the more heat energy the substance is said to have . There are three methods by which heat can be transferred between two things , n.b. it is impossible in nature for heat to be transferred between a cold body which already has the heat and a hot body .

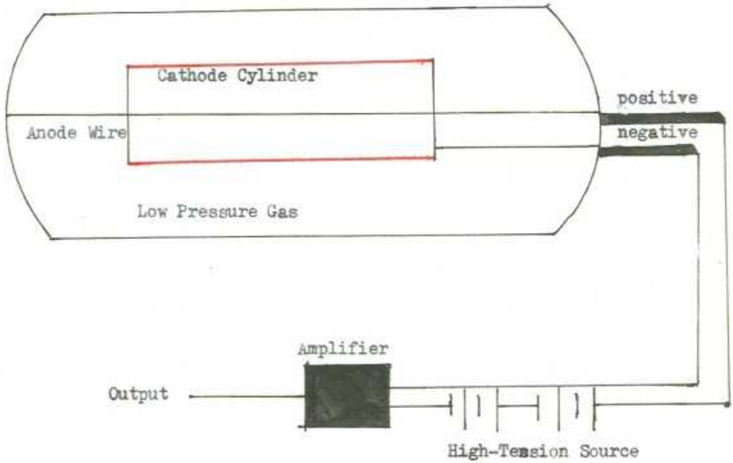

ERG
LOG10
-4
-2
0
2
4
6
8
10
14
16
18
20
22
24
28
30
34
38
Splitting of Uranium atom
Moonlight for one second
Bees wing beat
Pressing down typewriter key
Lethal X-ray dose
Burning match
Speeding van
Day's work for woodcutter
Atlas liftoff
A-bomb (first one)
Hurricaine
100-megaton H-bomb
Earth's annual share of Sun's heat
Earth sppinning on its axis

FOOD , CALORIFIC VALUES OF

	Kilojoules / 100 g
PROTEINS	
Cheese	1680
Lean meat	1200
Eggs	700
Liver	600
White fish	300
CARBOHYDRATES	
Chocolate	2300
Sugar	1600
Wholemeal bread	1000
FATS	
Butter	2900
Margarine	2900
Olive oil	2900
Fat meat	2900
OTHERS	
Peas	420
Boiled potatoes	340
Milk	300
Fresh fruit	200
Green vedgetables	150

GEIGER COUNTER.

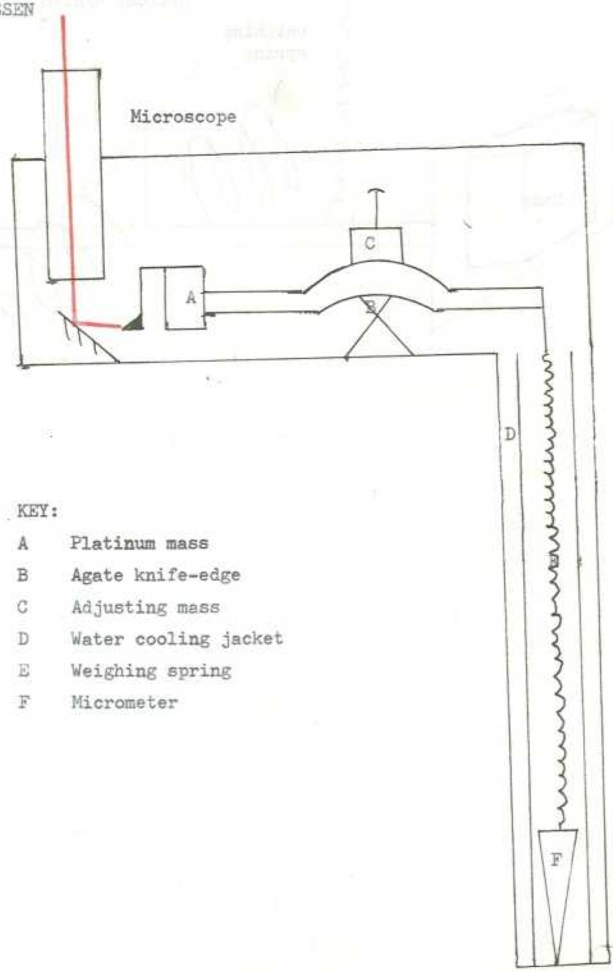
(Geiger-Mueller Tube)



The low pressure gas is usually Argon, with a touch of Alcohol vapour in. The pressurw is maintained at about 5 mm. Hg.. When an alpha, beta, or gamma particle passes between the anode and the cathode, positive ions and electrons are produced in equal numbers. The potential differance between the anode and the cathode beigg very high (I000 volts), the electrons quickly collect on the anode wire, causing an electrical pulse which is amplified and then displayed visually or aurally. The positive ions slowly diffuse onto the cathode.

GRAVITY METERS

THYSSEN



KEY:

A Platinum mass

B Agate knife-edge

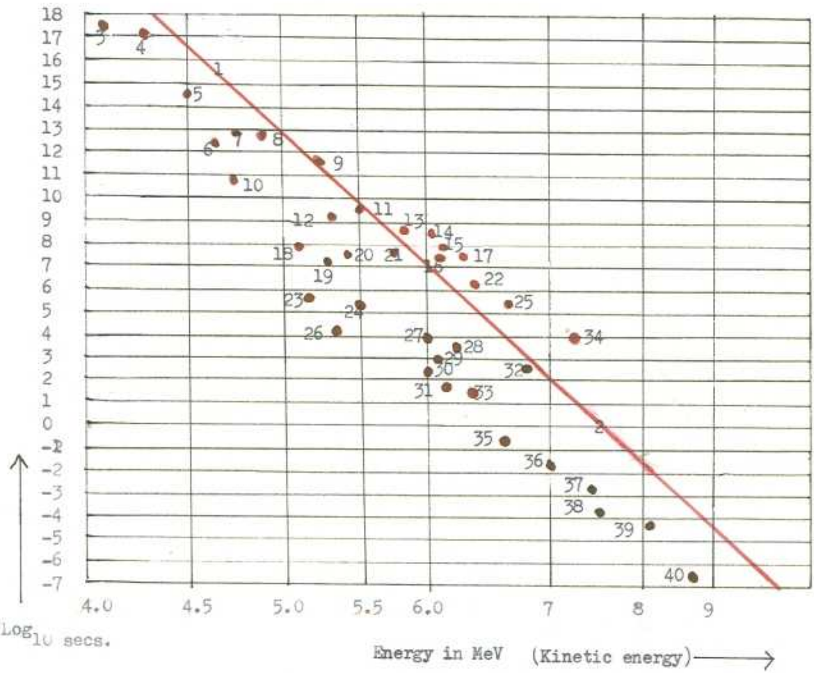
C Adjusting mass

D Water cooling jacket

E Weighing spring

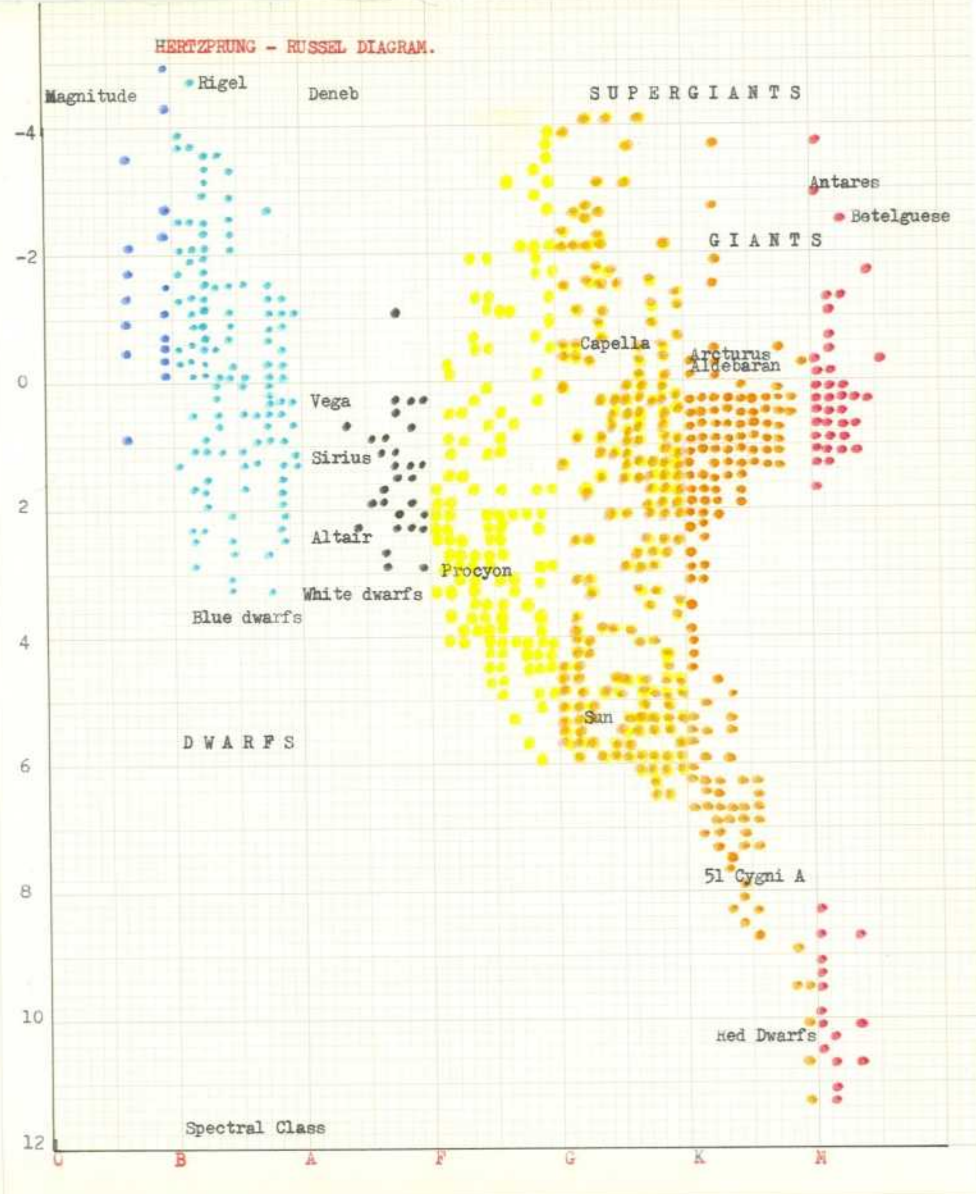
F Micrometer

HALF - LIFE OF ALPHA - EMITTERS AGAINST ENERGY OF ALPHA PARTICLES.

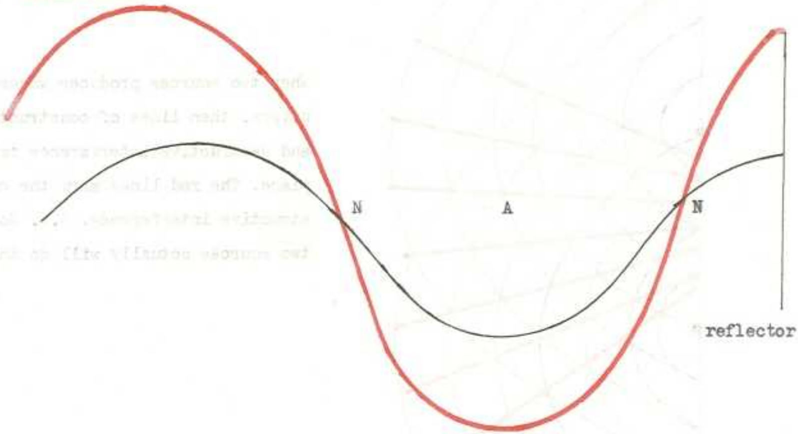


Key:

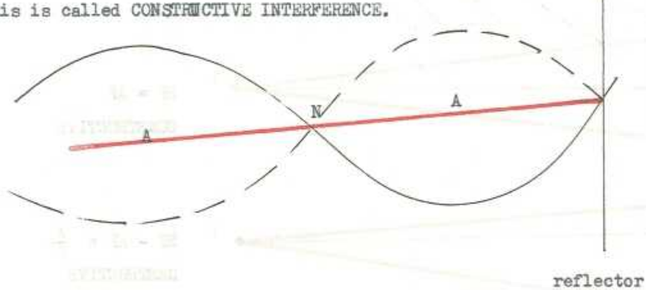
1	Theoretical curve	16	Cm^{242}	32	U^{228}
2	Theoretical curve	17	Cf^{248}	33	Ra^{222}
3	Th^{232}	18	Po^{208}	34	Fm^{254}
4	U^{238}	19	Po^{210}	35	Po^{216}
5	U^{236}	20	Th^{228}	36	Rn^{218}
6	Th^{230}	21	Pu^{236}	37	Po^{215}
7	U^{234}	22	Cm^{240}	38	Po^{214}
8	Pu^{242}	23	Po^{206}	39	At^{215}
9	Pu^{240}	24	Rn^{222}	40	Po^{212}
10	Ra^{226}	25	Cf^{246}		
11	Pu^{238}	26	Po^{204}		
12	U^{232}	27	Rn^{210}		
13	Cm^{244}	28	Bi^{212}		
14	Cf^{250}	29	Rn^{208}		
15	Cf^{252}	30	Po^{218}		
		31	Rn^{220}		


HERTZPRUNG - RUSSEL DIAGRAM.
Magnitude
Rigel
Deneb
S U P E R G I A N T S
Antares
Betelguese
G I A N T S
Capella
Arcturus
Aldebaran
Vega
Sirius
Altair
Procyon
White dwarfs
Blue dwarfs
D W A R F S
Sun
51 Cygni A
Red Dwarfs
Spectral Class
-4
-2
0
2
4
6
8
10
12
O
B
A
F
G
K
M

INTERFERENCE

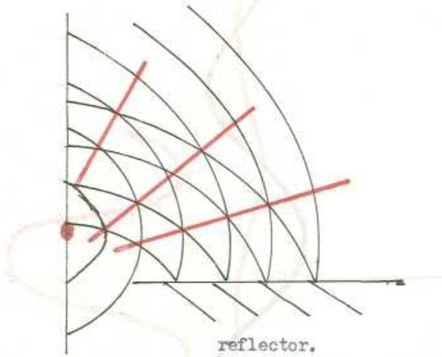


When the reflector is placed at the crest or through of the wave, the resultant reflected wave is coincident with the original, thus doubling the amplitude. this is called CONSTRUCTIVE INTERFERENCE.

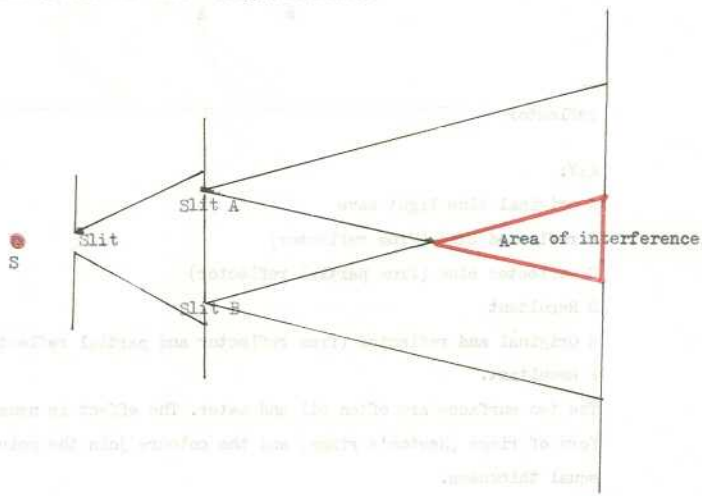


If the reflector is half-way between the crest and trough of the wave, then the crest of the reflected wave is co-incident with the trough of the original and vice-versa, thus meaning that the two waves cancell each other out, leaving nothing. This is called DESTRUCTIVE INTERFERENCE.

The A on each digram represents the anti-node, and the N the node. The node is the point at which the three waves meet, and the antinode is the point where they are farthest apart.

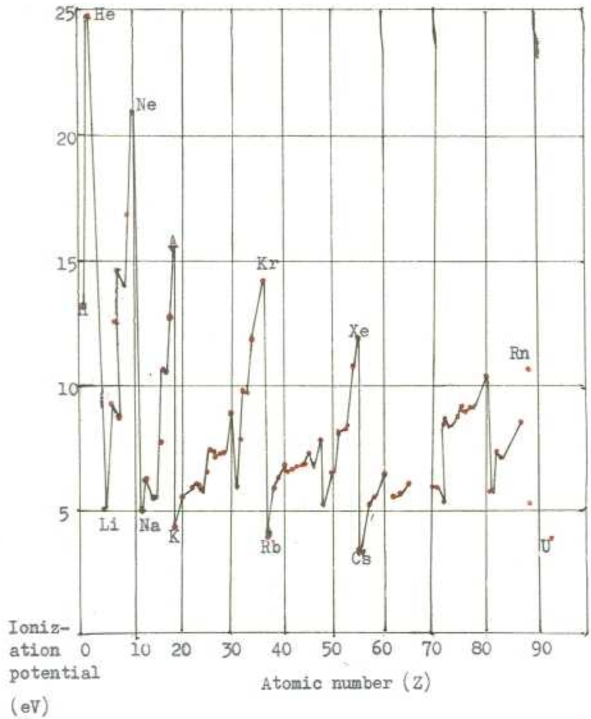


Lloyd's mirror. Interference usińg a reflector.



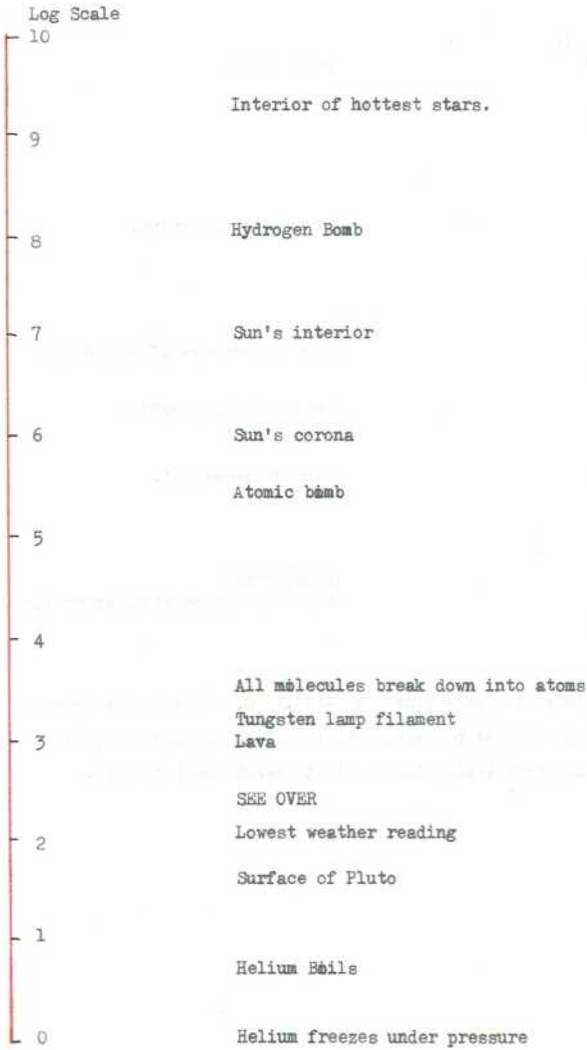
This is a practical method **of demonstrating the two source interference pattern.**

IONIZATION POTENTIAL

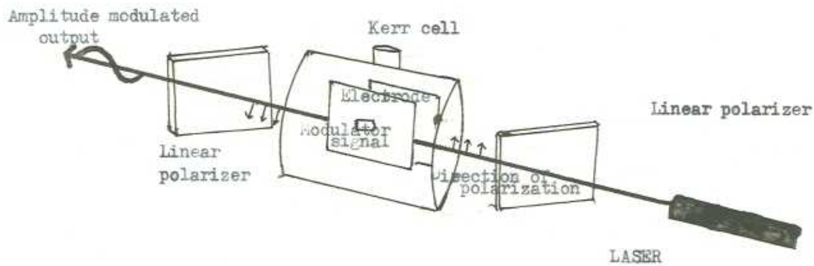


Ionization potential means the energy needed to free one electron from the nucleus.

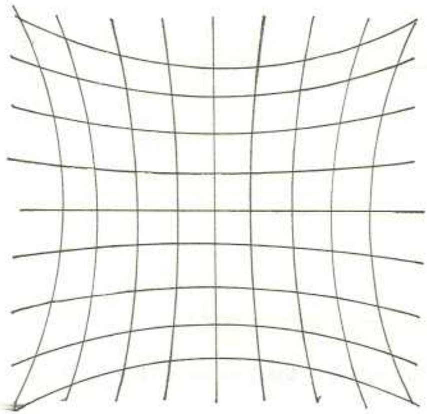
KELVIN.


Log Scale
10
Interior of hottest stars.
9
Hydrogen Bomb
8
Sun's interior
7
Sun's corona
6
Atomic bomb
5
4
All molecules break down into atoms
Tungsten lamp filament
Lava
3
SEE OVER
Lowest weather reading
2
Surface of Pluto
1
Helium Boils
0
Helium freezes under pressure

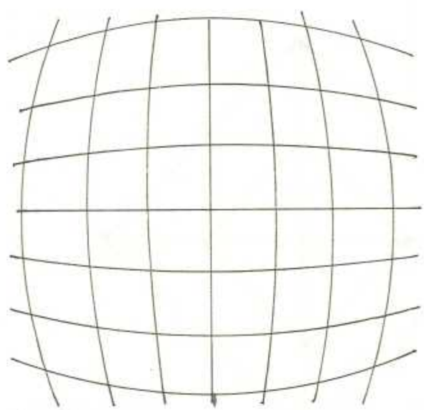
KERR CELL



The Kerr effect is that, when polarized light passes through a medium like nitrobenzene to which a high potential differance is applied, the direction of polarization is changed. Thus if there is a large potential differance in the liquid, the direction of polarization is rotated so that it is impossible for it to get through a second polarizer. This effect occurs in times of down to 10^{-8} seconds. Thus it is used for high speed shutters and as a means of modulating a LASER beam.

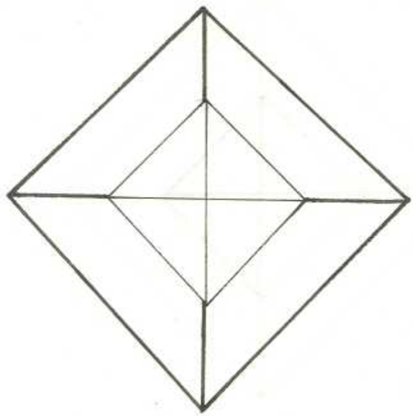


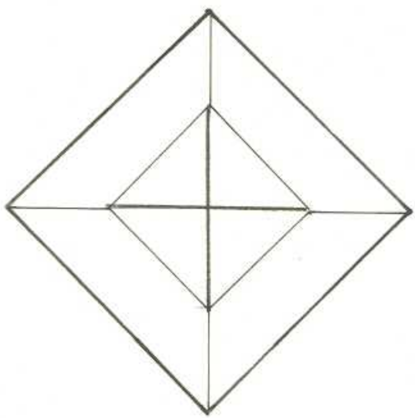
Pincushion-shaped distortion.



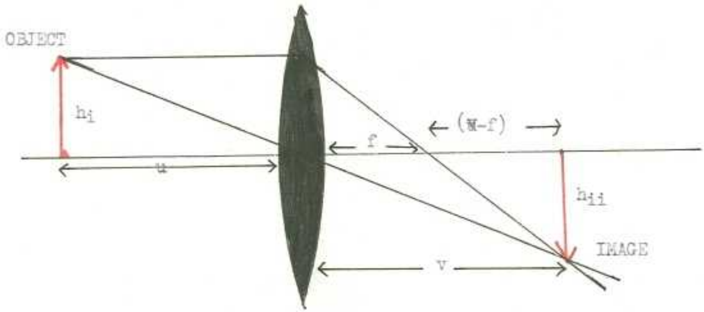
Barell-shaped distortion.

LENS ASTIGMATISM.





LENS FORMULA

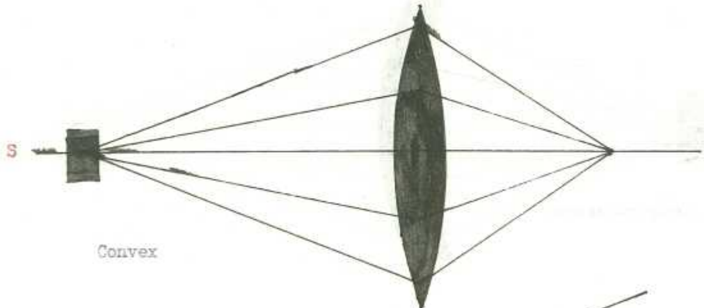


$\frac{h_i}{h_{ii}}$ equals $\frac{f}{(v-f)}$

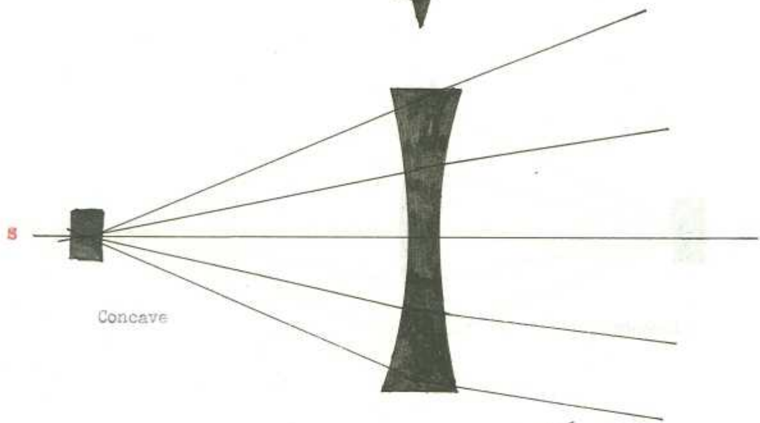
$\frac{h_i}{h_{ii}}$ equals $\frac{u}{v}$

$\frac{1}{u}$ plus $\frac{1}{v}$ equals $\frac{1}{f}$

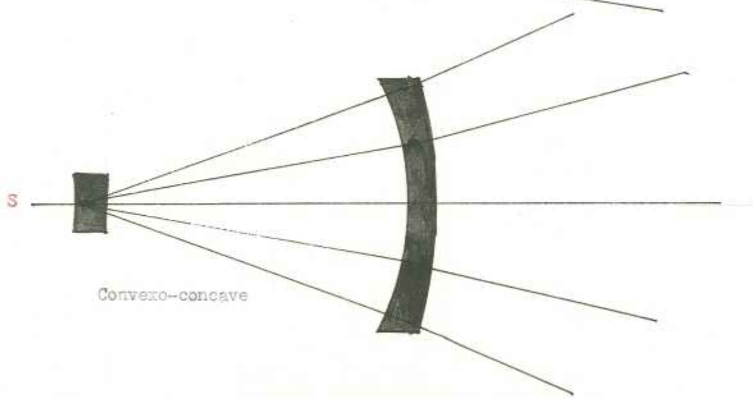
LENSES, TYPES OF



Convex



Concave



Convexo-concave

LIGHT, INTENSITY OF

The solid angle of space surrounding a given is 4π units, thus one unit is about 8 % (exactly 7.963 %). The luminous intensity of a light source is described as the luminous flux (flow) emitted per unit solid angle, or the luminous energy emitted per unit solid angle per second. However, experiment shows that the amount of energy produced by a filament is not equal all over a sphere, but depends on the direction of the filament. The unit of light intensity is the Candela (cd). This is described as the luminous intensity of liquid platinum under certain conditions. A 60 - watt bulb has a mean luminous intensity of about 50 cd.
The luminous effeciency of a light source is described as lumens per watt. A lumen is the luminous flux emitted by a source of 1 cd in 1 unit solid angle.
An 100 W tungsten (Wolfram) filament lamp has a luminous effeciency of 15 lumens per watt. The intensity of illumination of a surface is described as the luminous flux per unit area incident on it. Luminous intensity refers to a source, illumination to a receiving body. The lux is the illumination around a point P on a surface when a light of 1 cd is 1 metre from the point P in a perpendicular direction. A minimum illumination of 150 lux for libriares, 300 for offices, and 3000 for industry using micro-components, is recomended.
Illumination E equals Luminous intensity I over distance d squared.

$$E = \frac{I}{d^2}$$

LIGHT, VELOCITY OF

Measurements of:

Date	Author	Method	Result (km/s)	Error (plus or minus)
I676	Roemer	Jupiter's satellites	2I4000	
I726	Bradley	Aberration of stars	30I000	
I849	Fizeau	Toothed wheel	315000	
I862	Foucault	Rotating mirror	298000	500
1872	Cornu	Toothed wheel	298500	900
I874	Cornu	Deflection of light	300400	800
I878	Michaelson	Deflection of light	300I40	700
I879	Michaelson	Deflection of light	2999I0	50
I882	Newcomb	Deflection of light	2998I0	30
I882	Michaelson	Deflection of Light	299853	60
I908	Perrotin	Toothed wheel	29990I	84
1908	Rosa	Ratio of units	299788	30
I923	Merciar	Lecher wires	299795	30
I924	Michaelson	Rotating mirror	299802	30
I926	Michaelson	Rotating mirror	299796	4
I928	Karolus	Kerr cell	299778	20
I935	Michaelson	Rotating mirror	299774	11
I937	Anderson	Kerr cell	29977I	12
I940	Huttel	Kerr cell	299768	10
I94I	Anderson	Kerr cell	299776	14

From an average of relaible results, the velocity of light (c) is now held to be: 29979250000 cms/sec.

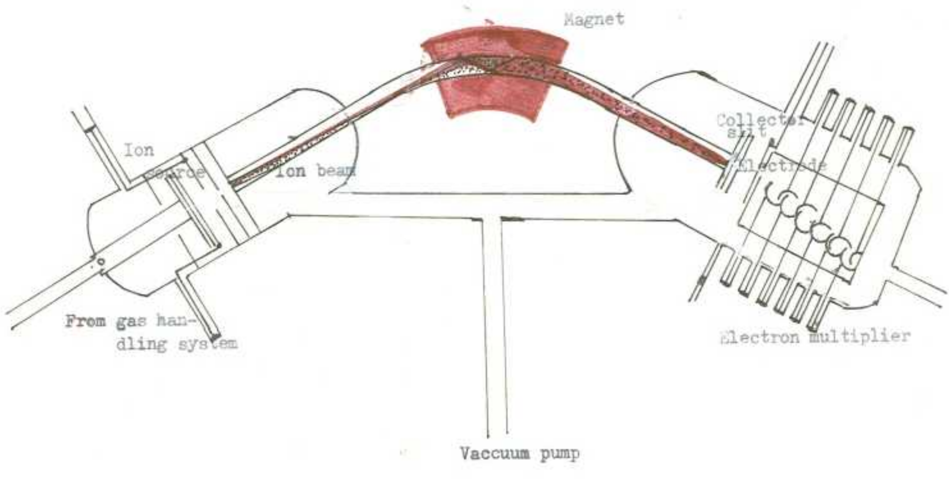
Thus, in one year light travels: 945425628000000000 cms

Light travels 887544.052654 times as fast as sound.

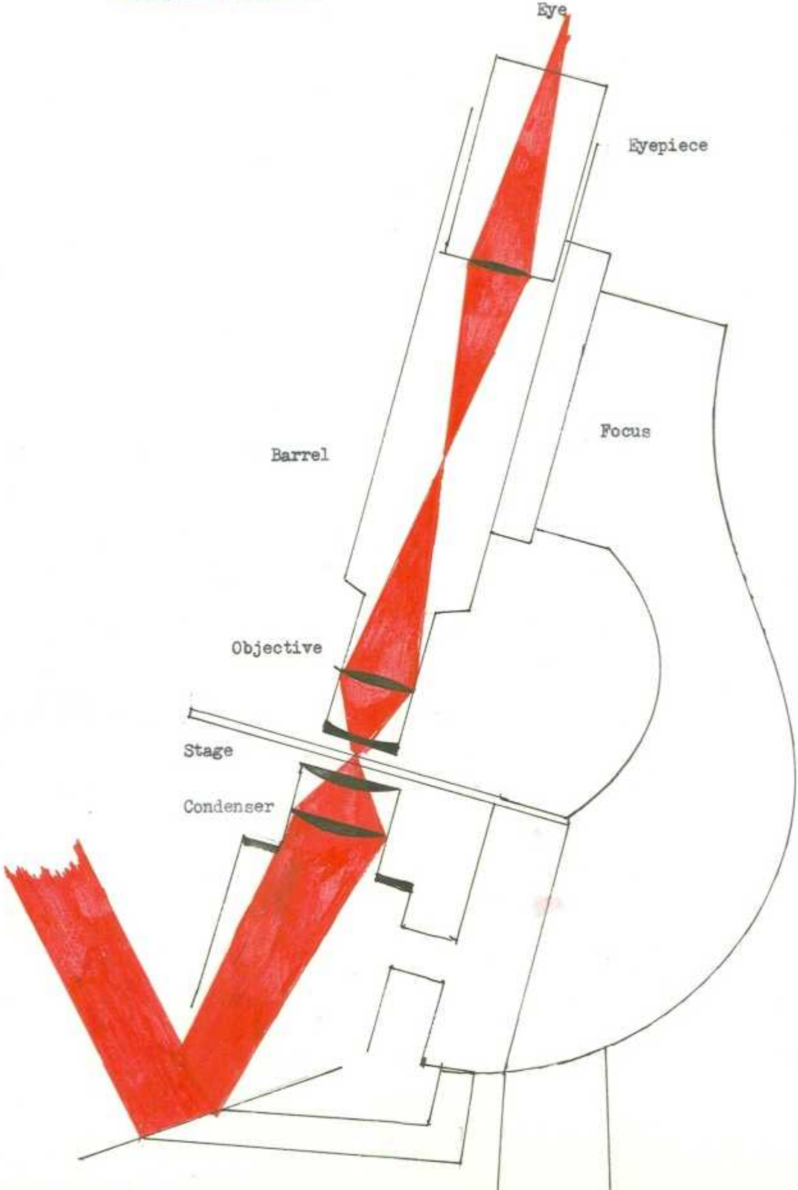
Light from the Sun takes 496.333304 secs or 8,272388 mins to reach Earth.

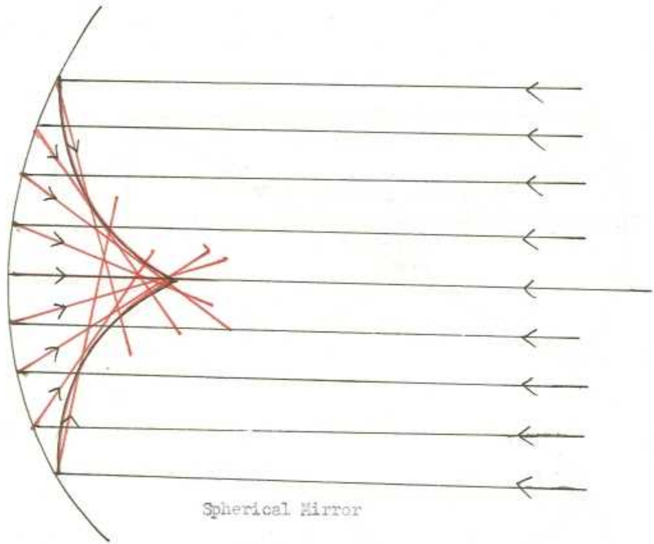
Light from the moon takes 0.948656 secs to reach Earth.

MASS SPECTROMETER

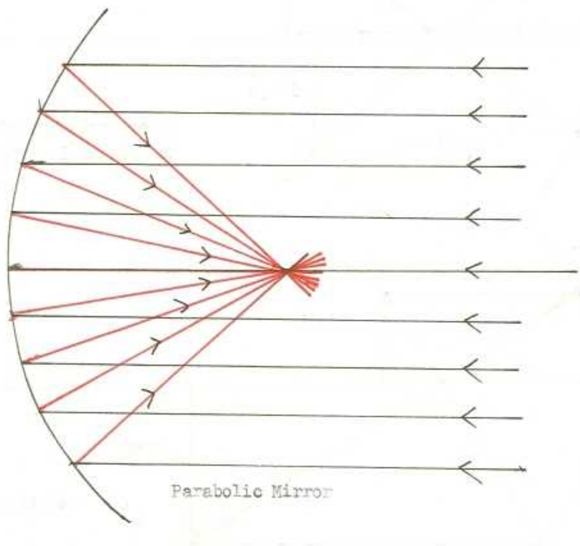


MICROSCOPE, COMPOUND





Spherical Mirror



Parabolic Mirror

MOON

Advance line of apsides, (mean) period = 8.8503 years ; annual change = $40^\circ .677$

Albedo, average = 0.07

Average length of months :	Synodic	29.530588 days
	Sidereal	27.321661 days
	Anomalistic	27.554550 days
	Tropical	27.321582 days
	Nodical	27.212220 days

Circumference = 10930 kms = 6790 miles; one degree = 30.38 kms = 18.86 miles

Diameter (mean) = 3476 kms = 2160 miles; angular diameter (mean) = 31' 07"

Distance :	Mean	384000 kms = 239000 miles = 60.3 earth radii
	Min	357000 kms= 222000 miles
	Max	407000 kms =253000 miles

Fraction of surface always visible = 41 % ; sometimes visible 18 %

Inclination of moon's equator to ecliptic = $1^\circ 35'$

Inclination of orbit plane to earth's equator : max = $28^\circ 35'$, min = $18^\circ 19'$

Librations : maximum in latitude, each direction = $6^\circ 50'$

maximum in longditude, each direction = $7^\circ 54'$

Magnitude of full moon = -12.5

Mass = 7.32×10^{25} grams = 8.0×10^{19} tons = 0.01226 of Earth's mass

Maximum orientation of lunar axis to rotation = 24.4° in each direction

Mean eccentricity of orbit = 0.0549

Mean parallax = 57' 02".54

Mean velocity in orbit = 3680 km/hour = 2287 m.p.h. = 33 miniutes of arc/hour

Regression of nodes, period = 18.5995 years, annual change = 19.358°

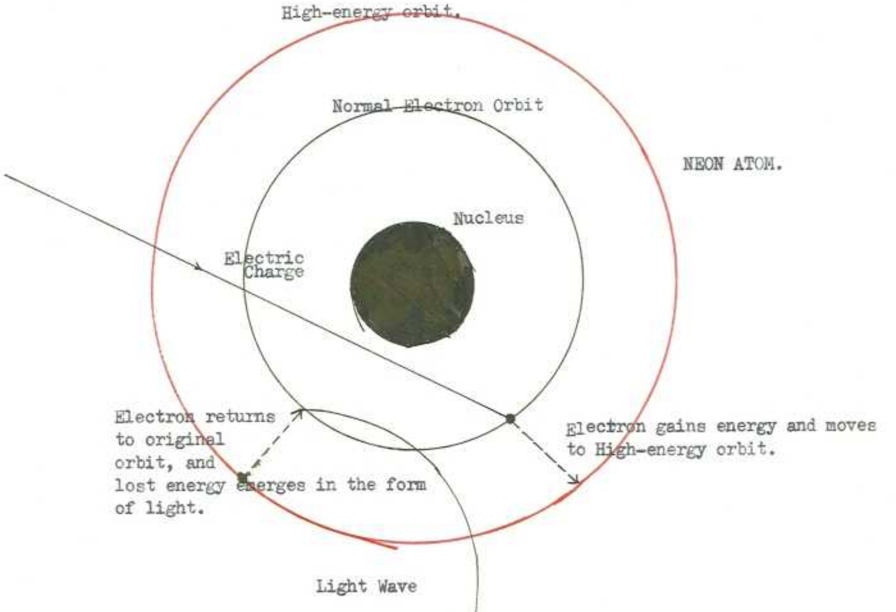
Specific gravity (mean) = 3.34 : ratio to Earth's mean = 0.6043

Surface gravity = 162 cms/sec^2 = 5.31 ft/sec^2 = 0.165 of Earth's

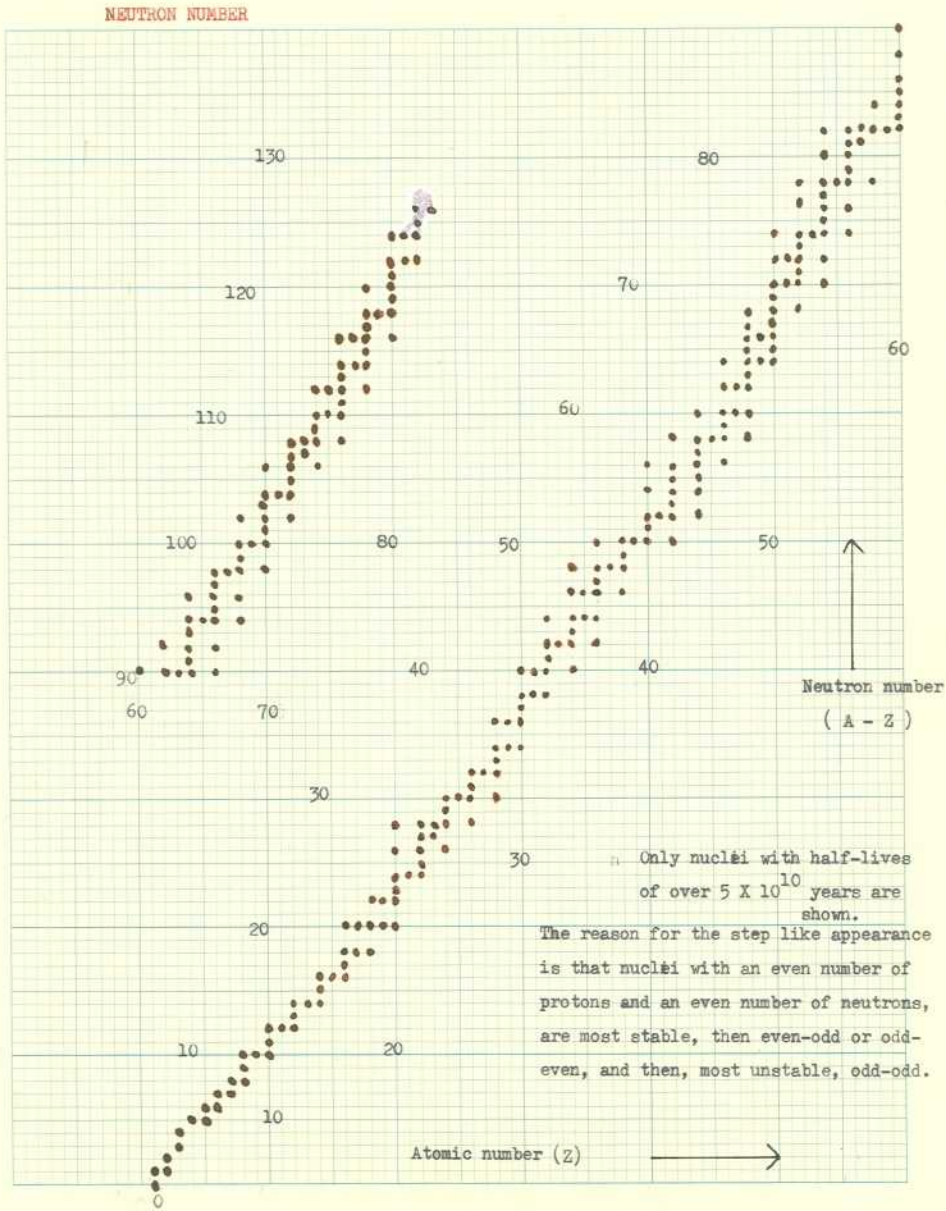
Temperature of surface, sun at zenith = 101 C : night = -157 C (approximately)

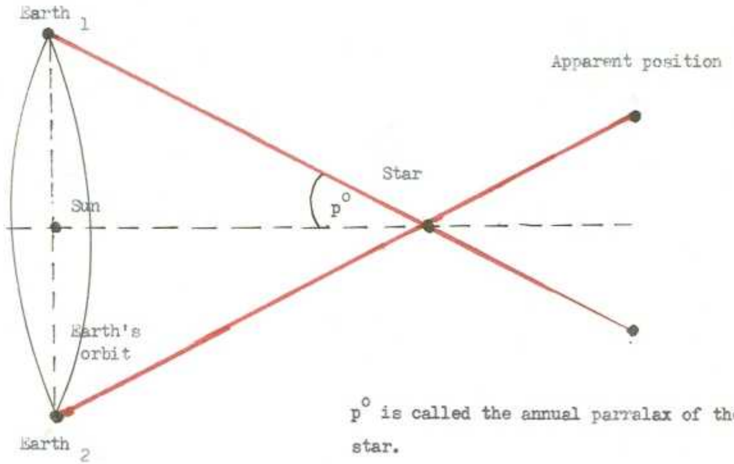
Velocity of escape at surface = 2.38 km/sec = 1.48 miles/sec = 0.213 Earth's

NEON LIGHTING.



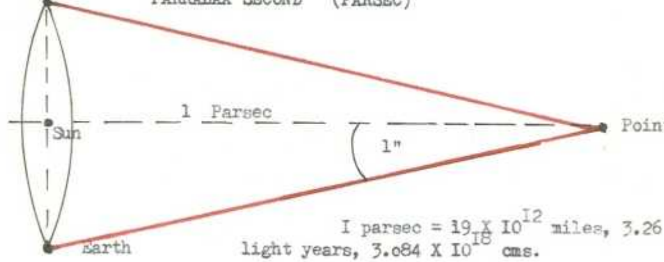
If the electron moves back to its original orbit in steps, then the steps further away from the nucleus will give off less energy, than the ones near it, due to the fact that the electron is further from the attraction of the nucleus. The wavelength of the light emited, as $E = \frac{hc}{l}$ the wavelength of the light is greater on the steps further away from the nucleus.


NEUTRON NUMBER
Neutron number
(A - Z)
Atomic number (Z)
Only nuclei with half-lives of over 5 X 10^10 years are shown.
The reason for the step like appearance is that nuclei with an even number of protons and an even number of neutrons, are most stable, then even-odd or odd-even, and then, most unstable, odd-odd.



p^{o} is called the annual parralax of the star.

PARRALAX SECOND (PARSEC)



I parsec = 19 X IO^{I2} miles, 3.26 light years, 3.o84 X IO^{I8} cms.

PERIODIC TABLE

1A	2A	3B	4B	5B	6B	7B		8		1B	2B	3A	4A	5A	6A	7A	0
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg			TRANSITION ELEMENTS								13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57* La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Rt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89* Ac															
Lanthanides			*57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Actinides*			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Am	95 Cm	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

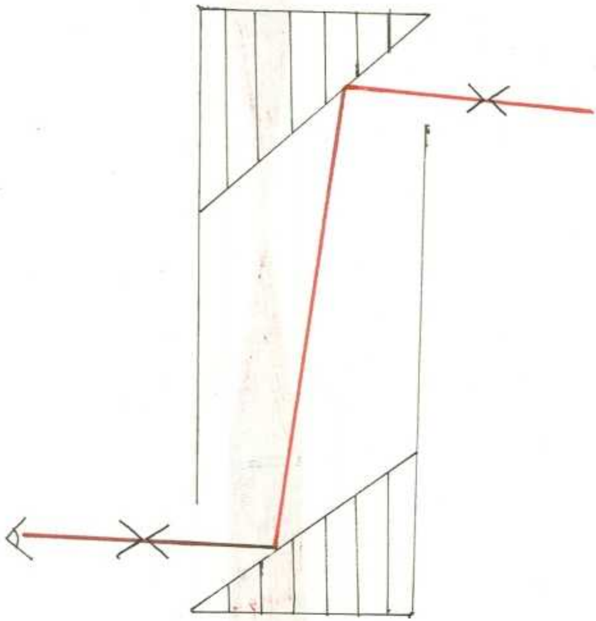


Diagram of a mirror periscope.

The second reflection cuts out the inversion produced by the first one.

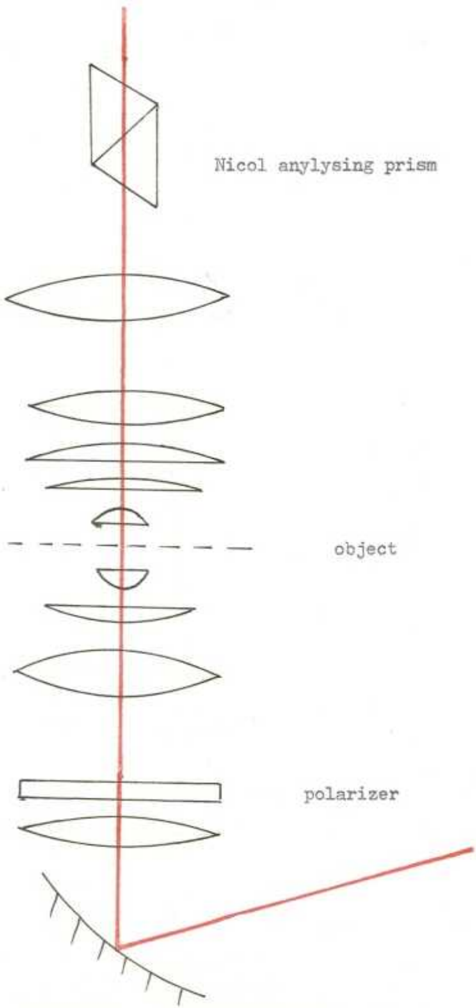
PLANETS.

	Distance from Sun A.U.	10^6 kms	Sidereal period (yrs)	Orbit velocity (km/s)
Mercury	0.387099	57.9	0.24085	47.8
Venus	0.723332	108.1	0.61521	35.0
Earth	1.0	149.5	1.0	29.8
Mars	1.523691	227.8	1.88089	24.2
Jupiter	5.202803	778	11.86223	13.1
Saturn	9.538843	1426	29.45772	9.7
Uranus	19.181951	2868	84.01331	6.8
Neptune	30.057779	4494	164.79445	5.4
Pluto	39.43871 (av.)	5896 (av.)	247.686	4.7

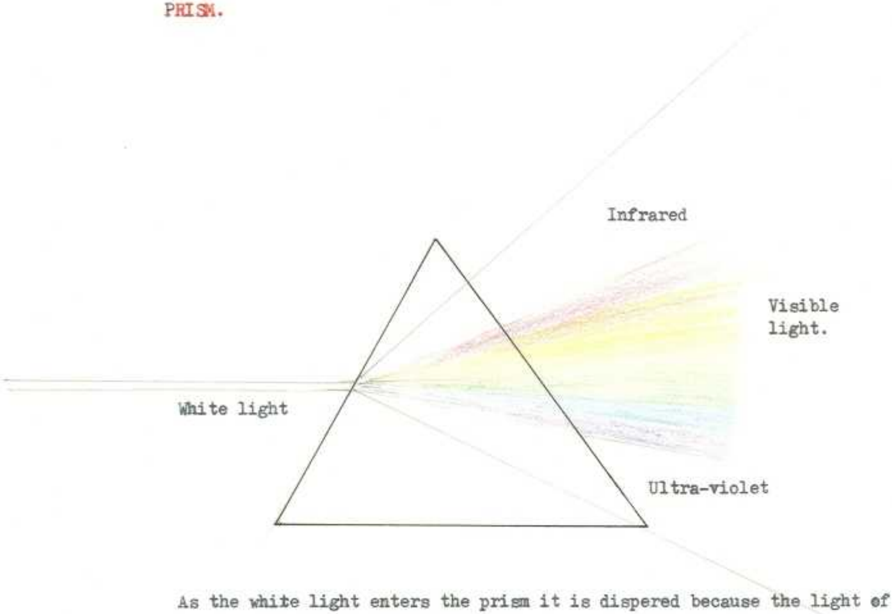
	Mass	Density (g/cc)	Surface Gravity	Diameter (km)
Mercury	0.056	5.13	0.36	4840
Venus	0.817	4.97	0.87	12300
Earth	1.00	5.52	1.00	12756
Mars	0.108	3.94	0.38	6700
Jupiter	318.0	1.33	2.64	142800
Saturn	95.2	0.69	1.13	119300
Uranus	14.6	1.56	1.07	47100
Neptune	17.3	2.27	1.41	44800
Pluto	0.9 ?	4 ?	?	5900

	Rotational period	No. of satellites
Mercury	?	0
Venus	?	0
Earth	23 56 04	1
Mars	24 27 23	2
Jupiter	9 50 30	12
Saturn	10 14	9
Uranus	10 49	5
Neptune	14 ?	2
Pluto	6 39 ?	0

POLARISCOPE, NORRENBURG



PRISM.



As the white light enters the prism it is dispered because the light of longer wavelength bends more than that of shorter.

Waves of red and blue light co-existing as they would in a light beam.

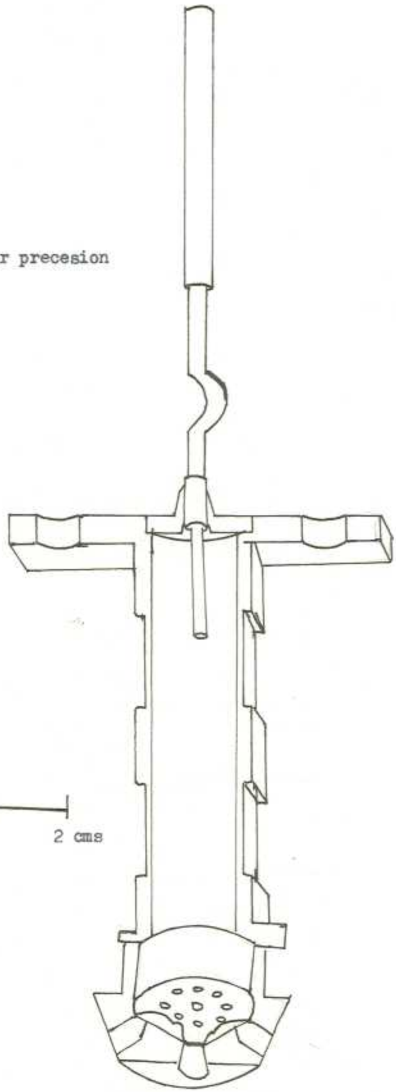
PROPELLANTS, SPECIFIC IMPULSE OF ROCKET

Propellant combinations:	Specific impulses (sec):
Liquid Monopropellants:	
Low energy monopropellants	160 - 190
Hydrazine	
Ethylene oxide	
Hydrogen peroxide	
High energy monopropellants	190 - 230
Nitromethane	
Bipropellants (liquid):	
Low energy bipropellants	200 - 230
Perchloryl-fluoride-Available fuel	
Analine Acid	
J P 4-Acid	
Hydrogen Peroxide-J P 4	
Medium energy bipropellants	230 - 260
Hydrazine-acid	
Ammonia-Nitrogen Tetraxide	
High energy biproppellants	250 - 270
Liquid Oxygen - J P 4	
Liquid Oxygen - Alcohol	
Hydrazine - Chlorine trifluoride	
Very high energy bipropellants	270 - 330
Liquid Oxygen - Fluorine-J P 4	
Liquid Oxygen - Ozone-J P 4	
Liquid Oxygen - Hydrazine	
Super high energy biproppelants	300 - 385
Fluorine - Hydrogen	
Fluorine - Ammonia	
Ozone - Hydrogen	
Fluorinen - Diborane	

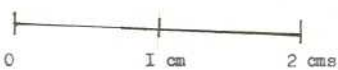
PROPULSION, ROCKET

CHEMICAL:

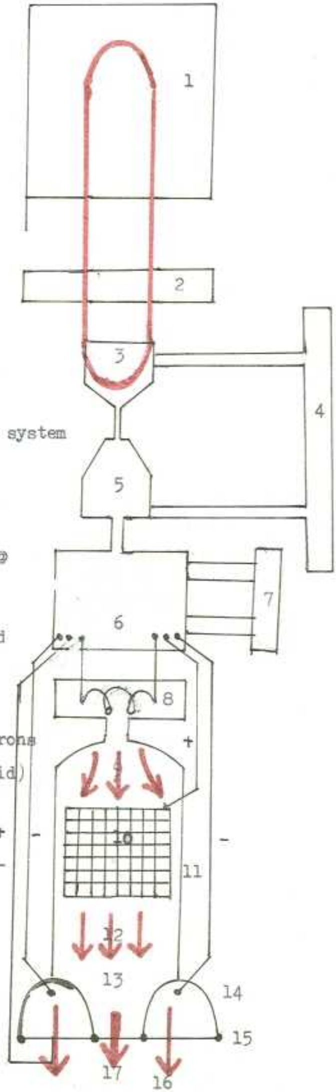
Hydrazine thruster for precesion attitude còntrol.



SCALE:



ION



KEY

1 Nuclear reactor

2 Shield

3 Heat exchanger

4 Radiant cooler

5 Turbune

6 AC & DC Generating system

7 Radiant cooler

8 Caesium vapourizer

9 Caesium vapour

10 Hot platinum grid @

11 Thrust chamber

12 Electrostatic field

13 Ions

14 Electron emmitter

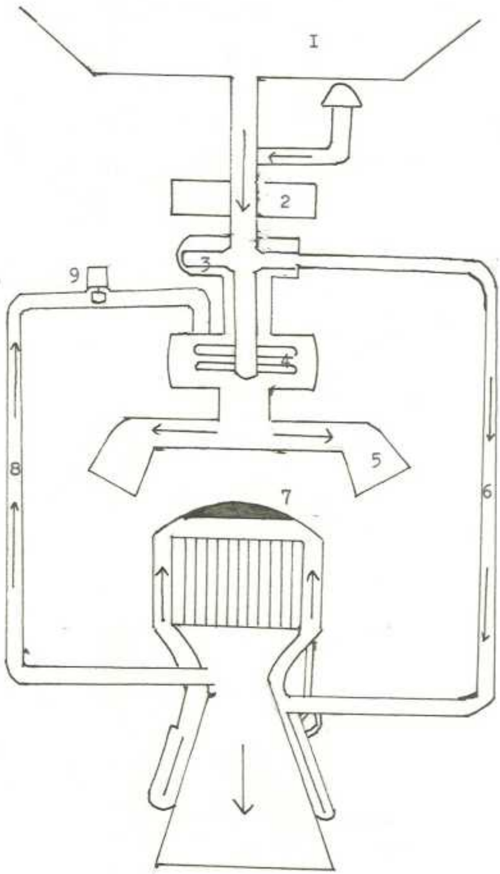
15 Accelerating electrons

16 Electrons (from grid)

17 Neutralized flow

@ This absorbs the caesium atoms, and emits ions.

NUCLEAR

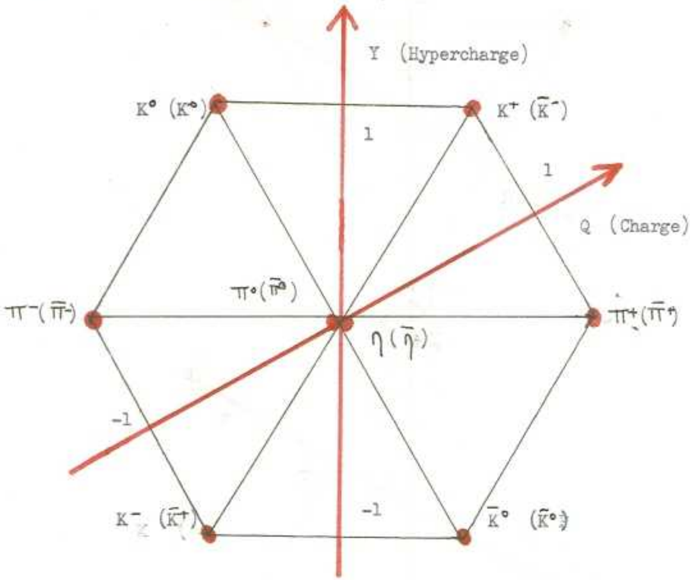


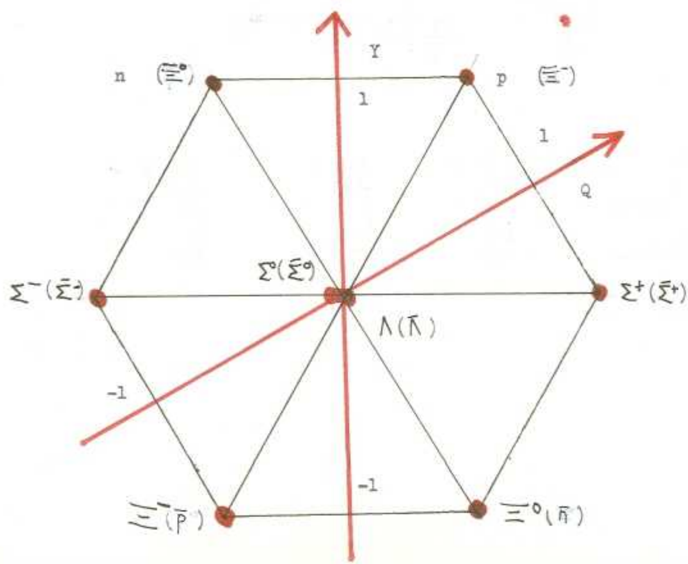
NERVA nuclear rocket engine diagram.

KEY:

I	Liquid Hydrogen Tank	6	Nozzle coolant pipe (carries full H flow)
2	Gimbal	7	Shield
3	Pump	8	Bleed to turbine (3% of reactor efflux)
4	Turbine	9	Turbine power control valve
5	Turbopump exhaust		

QUARKS





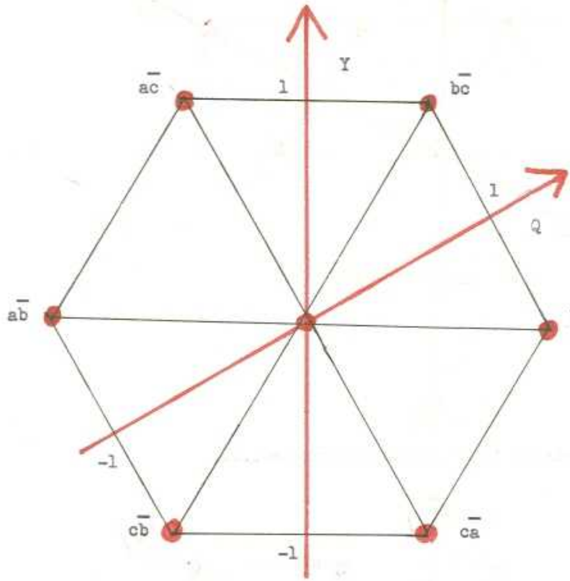


Diagram showing the combinations of Quarks needed to form the previous picturesof Baryons and Mesons.

RADIO, FREQUENCY BANDS OF

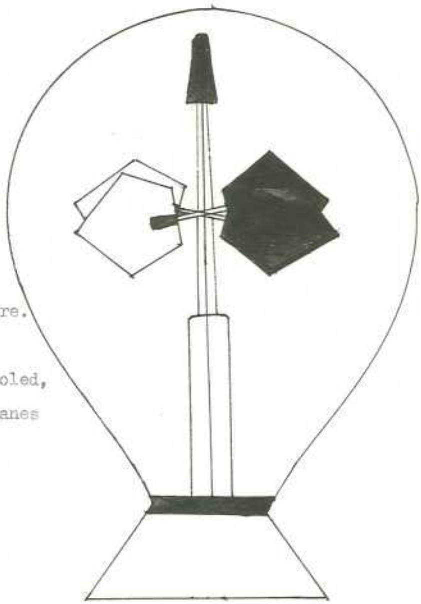
Waveband no.:	Wavelength in cms:	Metric subdivisions:	Name:	
4	$IO^{6} - IO^{7}$	Myriametric	VLF	Very low
5	$IO^{5} - IO^{6}$	Kilometric	LF	Low
6	$IO^{4} - IO^{5}$	Hectametric	MF	Medium
7	$IO^{3} - IO^{4}$	Decametric	HF	High
8	$IO^{2} - IO^{3}$	Metric	VHF	Very high
9	$IO^{1} - IO^{2}$	Decimertic	UHF	Ultra high
10	$IO^{0} - IO^{1}$	Centimetric	SHF	Super high
11	$IO^{-1} - IO^{0}$	Millimetric	EHF	Extra high
12	$IO^{-2} - IO^{-1}$	Decimillimetric	-	

Frequency band:	Frequency range: (Gigacycles)	Wavelength (cms):
P-Band	0.225-0.39	1.40-76.9
L-Band	0.39-1.55	76.9-19.3
S-Band	1.55-5.20	19.3-5.77
X-Band	5.20-IO.90	5.77-2.75
K-Band	10.90-36.0	2.75-0.834
Q-Band	36.0-46.0	0.834-0.652
V-Band	46.0-56.0	0.652-0.536
C-Band	3.9-6.2	

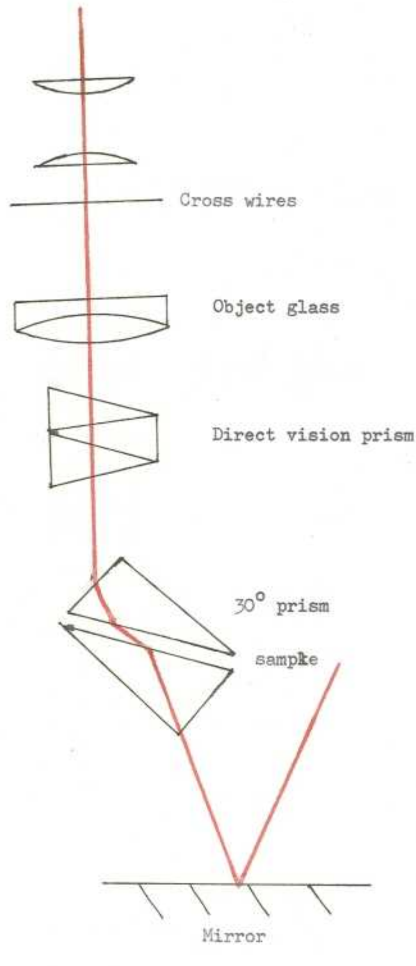
A new waveband has been proposed: ELF, to extend from $IO^{7}-IO^{8}$ cms.

RADIOMETER

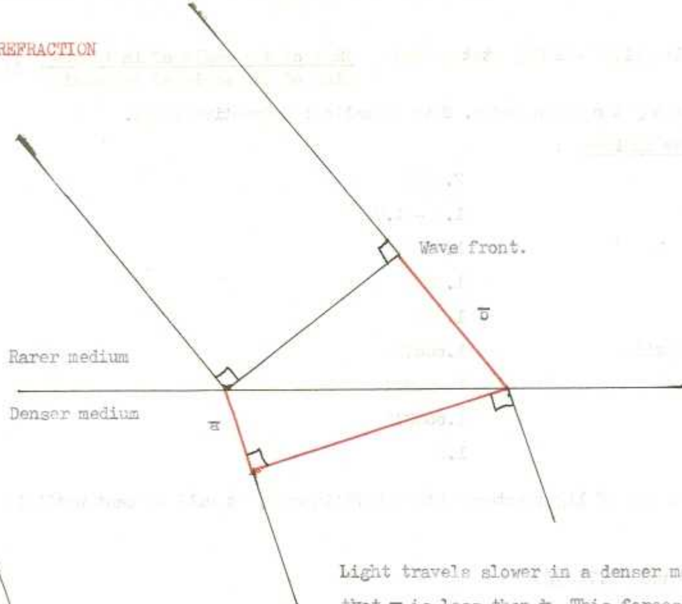
Basically, this instrument works because the black side of the vane absorbs the heat, and the light silvered reflects it, so that it stays cool. Due to a process called 'Thermal Transpiration' more gas molecules collect on the black sides, when the bulb is heated, so that there is preesure. This forces the vanes to turn clockwise, but when the bulb is cooled, the process is reversed, and the vanes retate counter-clockwise.



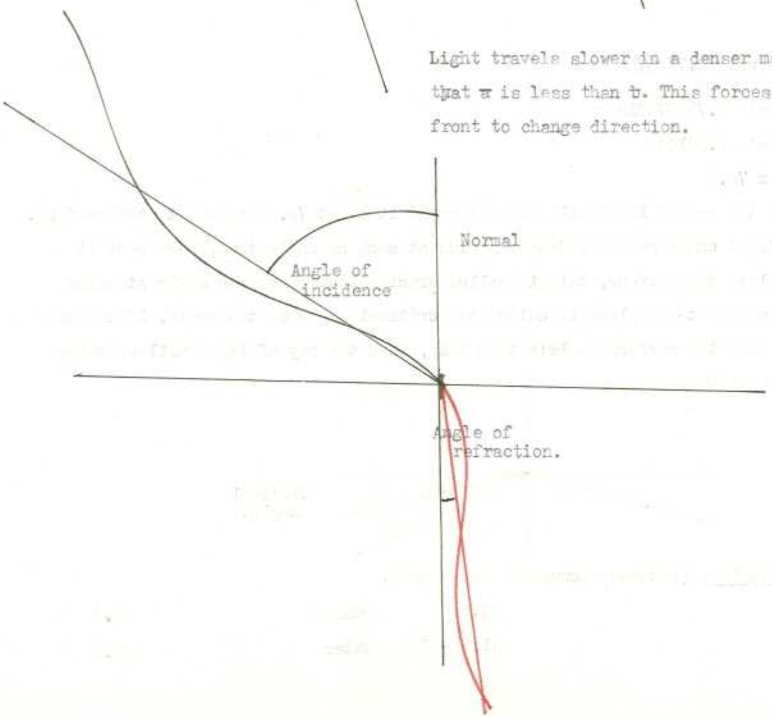
REFRACTOMETER, ABBE



REFRACTION

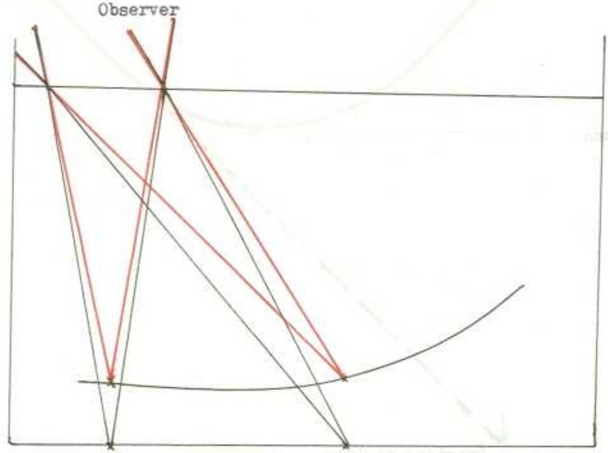


Light travels slower in a denser medium, so that $\bar{a}$ is less than $\bar{b}$. This forces the wave front to change direction.



REFRACTION, PHENOMENA DUE TO

FALSE DEPTH:

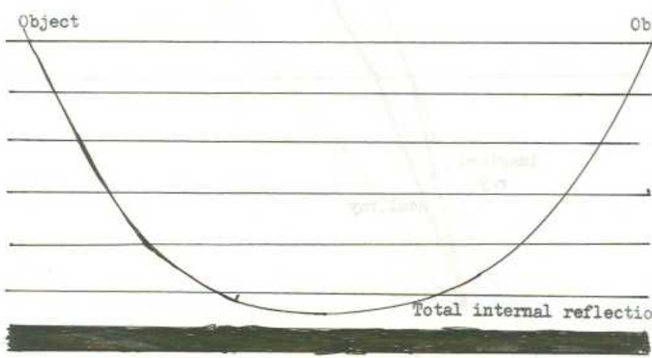


Imagined ray

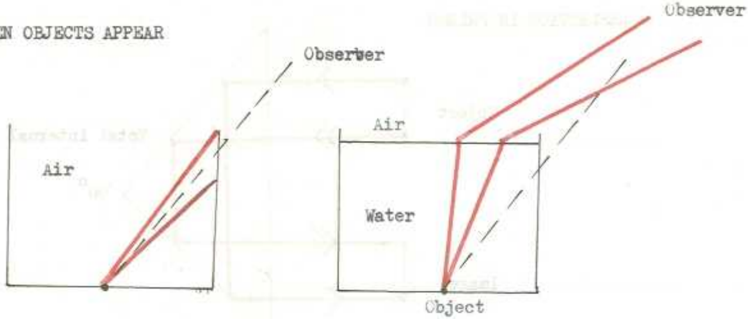
Real ray

Real ray refracted, coincident with imagined ray.

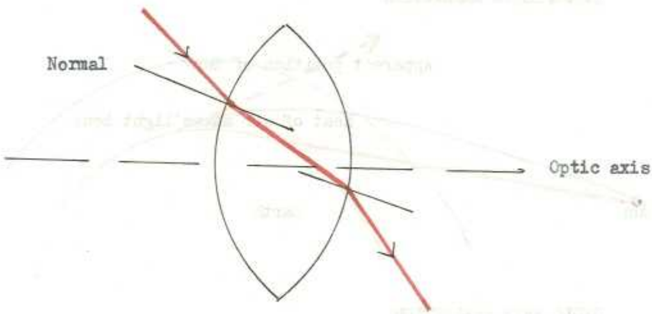
MIRAGE



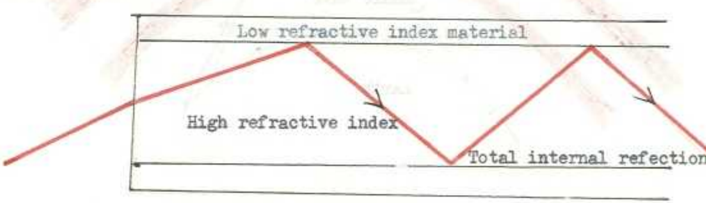
HIDDEN OBJECTS APPEAR



LENSES

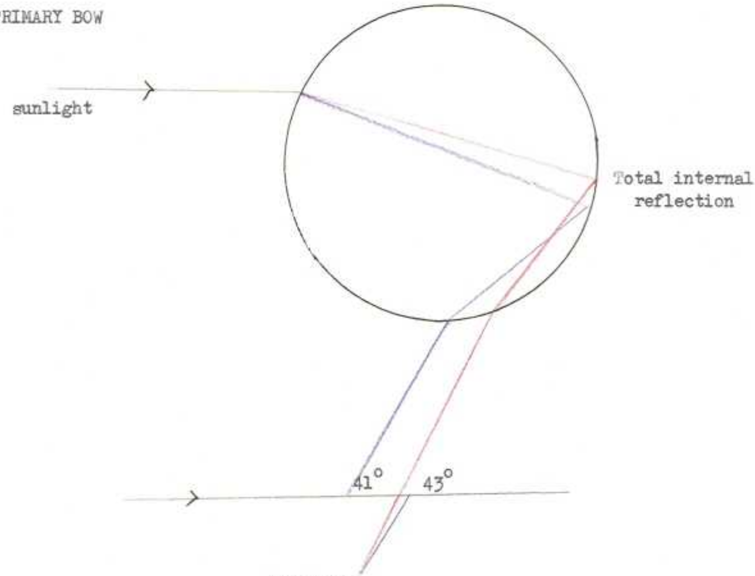


OPTIC FIBRES

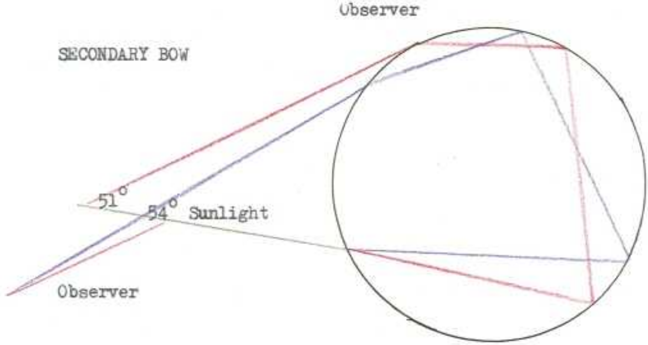


RAINBOW

PRIMARY BOW



SECONDARY BOW

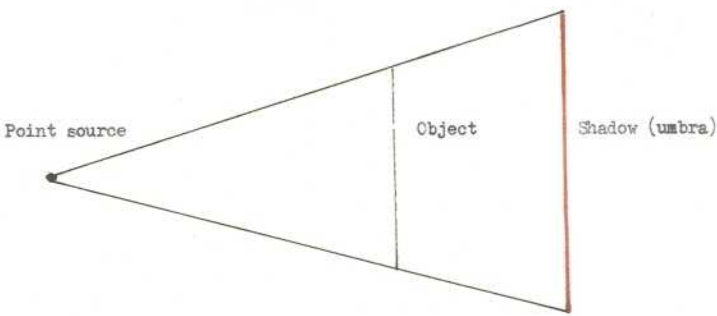


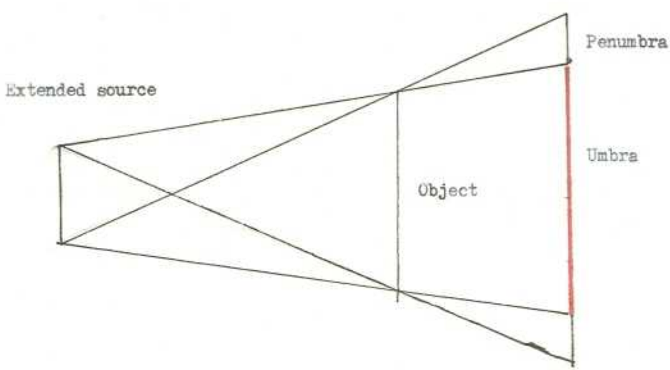
A rainbow is only visible directly away from the Sun because the rainbow is too faint compared with the sun. 10 % of the rain droplets have double internal reflection, so that a secondaty bow is very faint.

SATELLITES

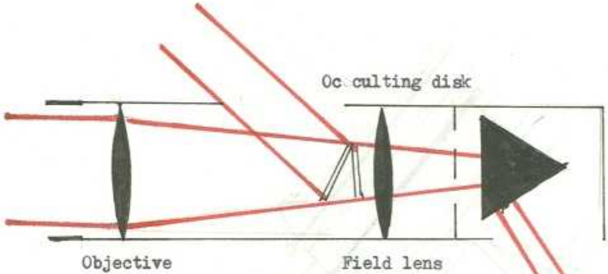
	Distance (I000 kms)	Sidereal period (days)	Magnitude
EARTH			
Moon	384.4	27.32I66	-I2.5
MARS			
Phobos	9.4	0.3189I	II
Diemos	23.5	I.265	I2
JUPITER			
V	I8I	0.49818	13
Io	422	I.76914	5.5
Europa	67I	3.55II8	6.I
Ganymede	I07I	7.I5455	5.I
Callisto	I884	I6.68902	6.2
VI	II480	250.57	I4.7
VII	II740	259.67	I8
X	II860	263.55	I9
XII	2I200	63I.I	I8
XI	22600	692.5	I9
VIII	23500	738.9	I7
IX	23700	758	I8.6
SATURN			
Mimas	I86	0.94242	I2.I
Enceladus	238	I.337022	II.7
Tethys	295	I.88780	I0.6
Dione	378	2.73692	I0.7
Rhea	587	4.5I750	I0
Titan	I222	I5.94945	8.3
Hyperion	I48I	2I.27666	I5
Japetus	3562	79.33082	I0.8
Phoebe	I2960	550.45	I4

SHADOWS

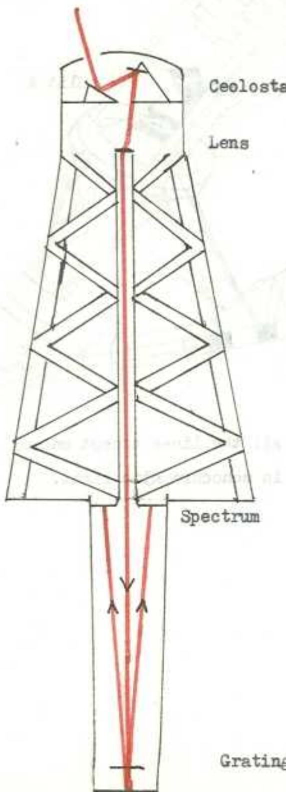

Point source
Object
Shadow (umbra)


Penumbra
Extended source
Umbra
Object

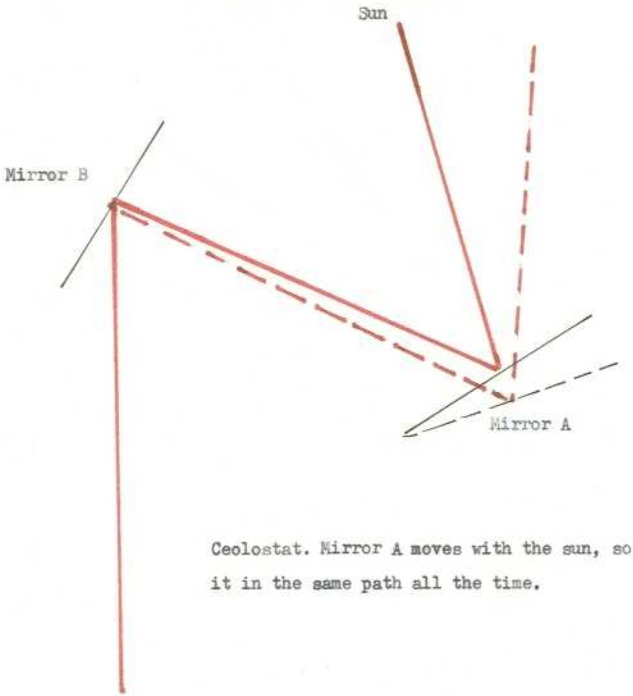
SOLAR INSTRUMENTS.



A Coronagraph. This produces an artificial eclipse allowing the solar corona to be observed.

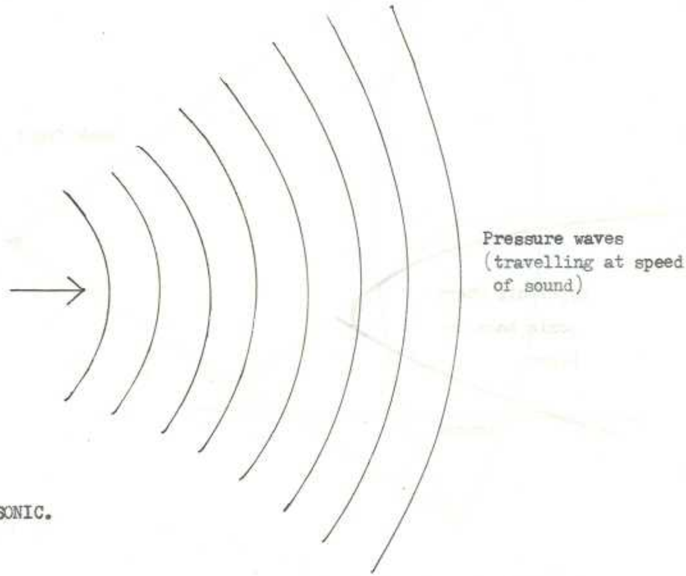


Solar spectrograph. The long tube length means that the lines on the spectrum can spread out more.

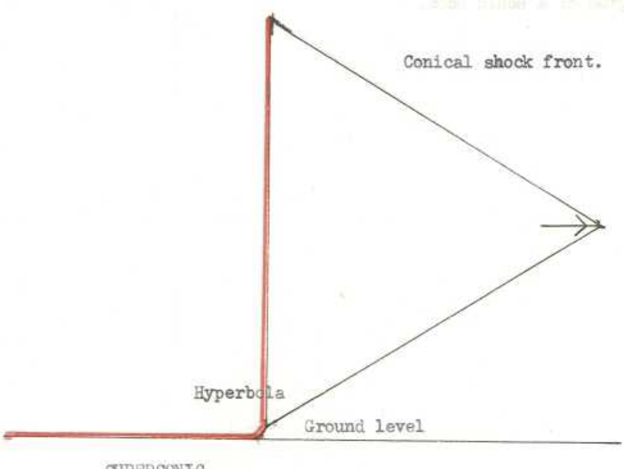


Ceolostat. Mirror A moves with the sun, so that Mirror B reflects it in the same path all the time.

SONIC BOOM.

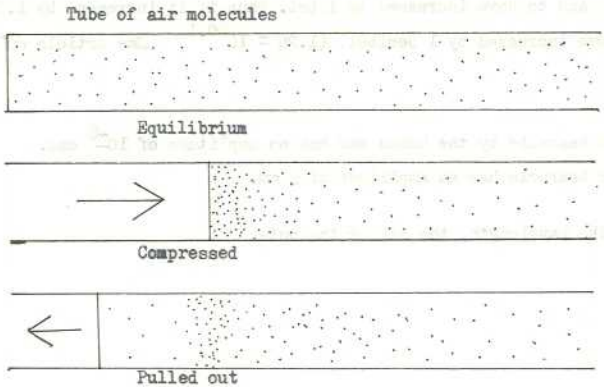


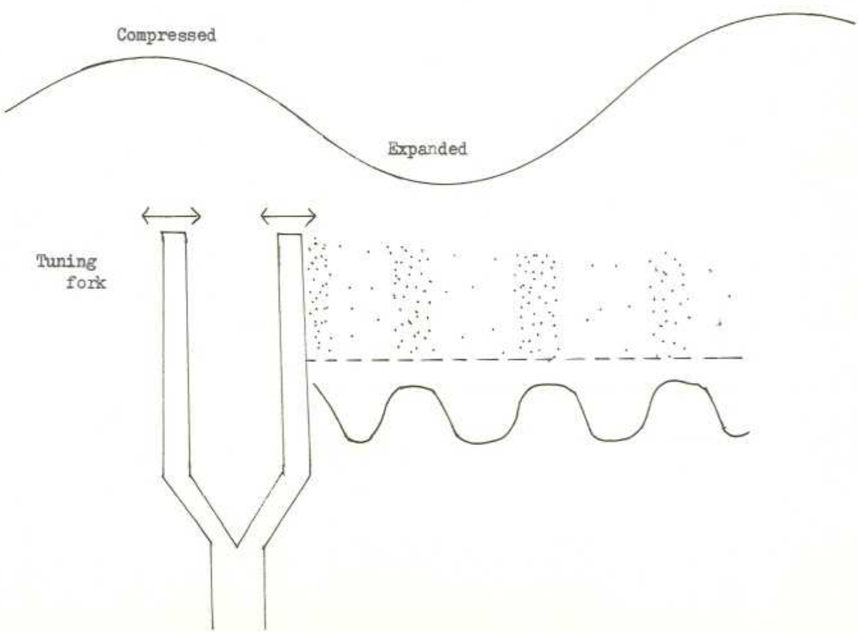
SUBSONIC.



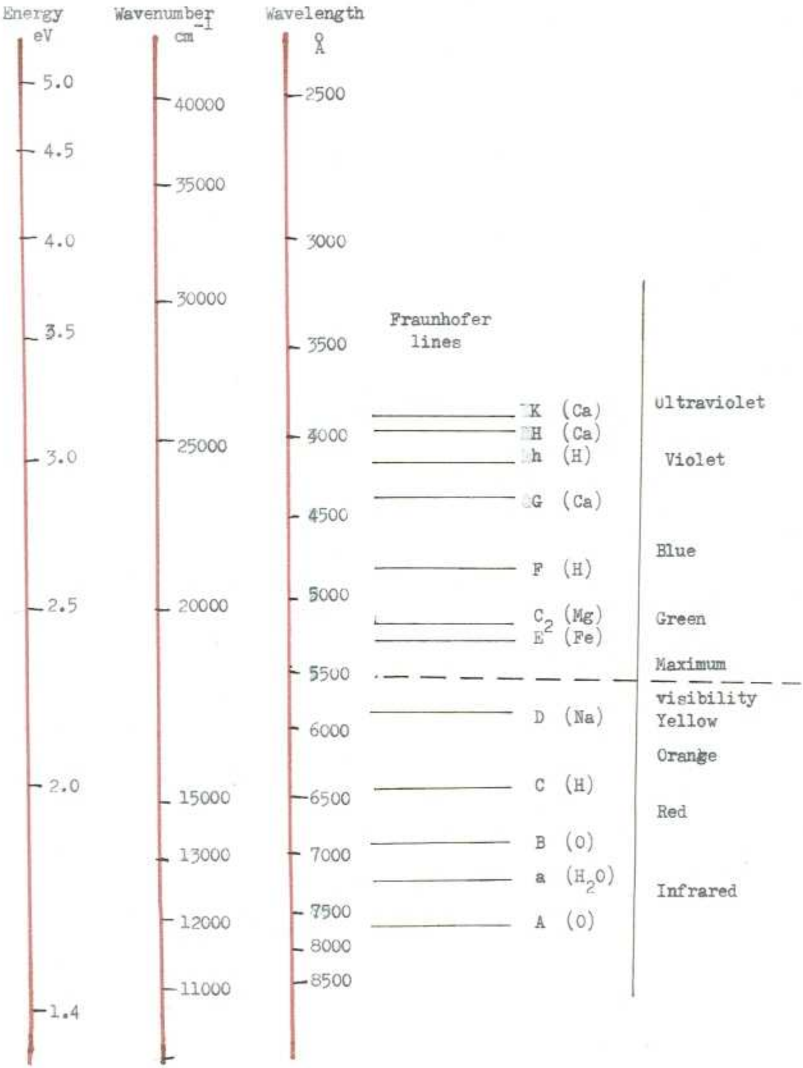
SUPERSONIC

SOUND

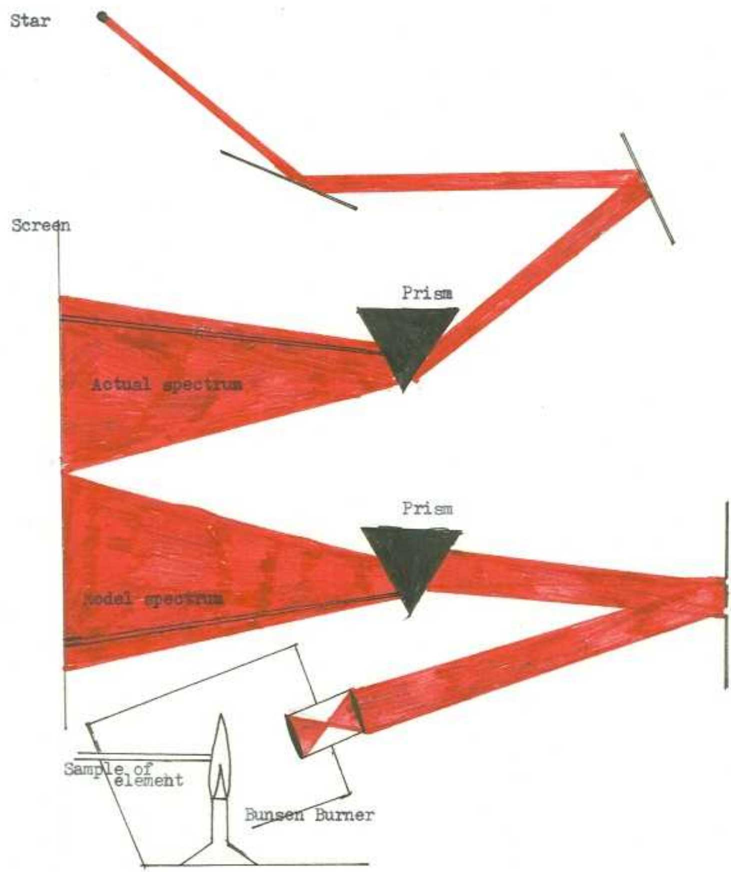

Tube of air molecules
Equilibrium
Compressed
Pulled out


Compressed
Expanded
Tuning
fork

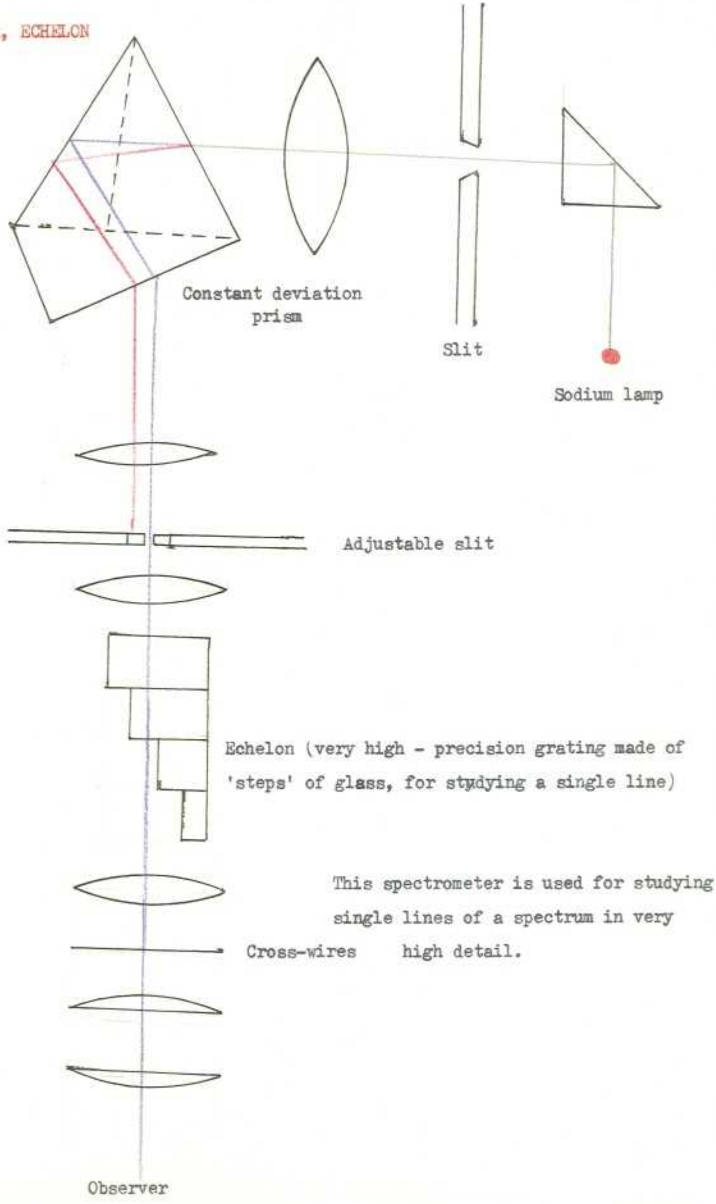
SPECTRAL NEIGHBORHOOD OF LIGHT



SPECTROSCOPE



SPECTROMETER, ECHELON



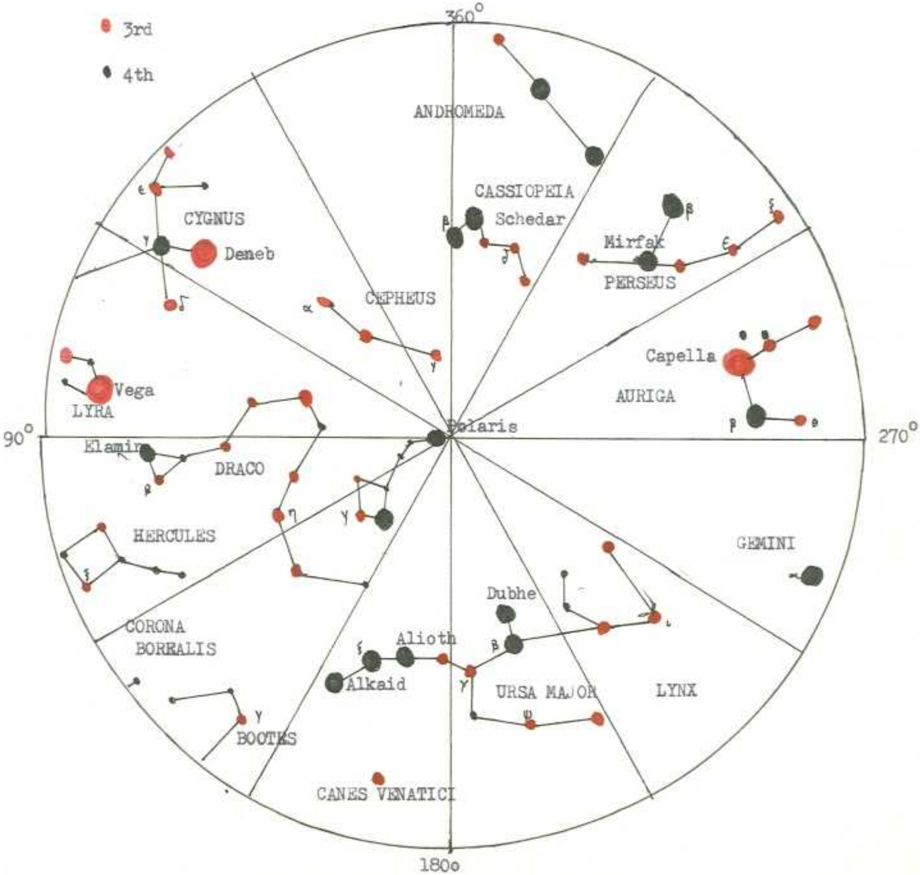
This spectrometer is used for studying single lines of a spectrum in very high detail.

STAR MAPS

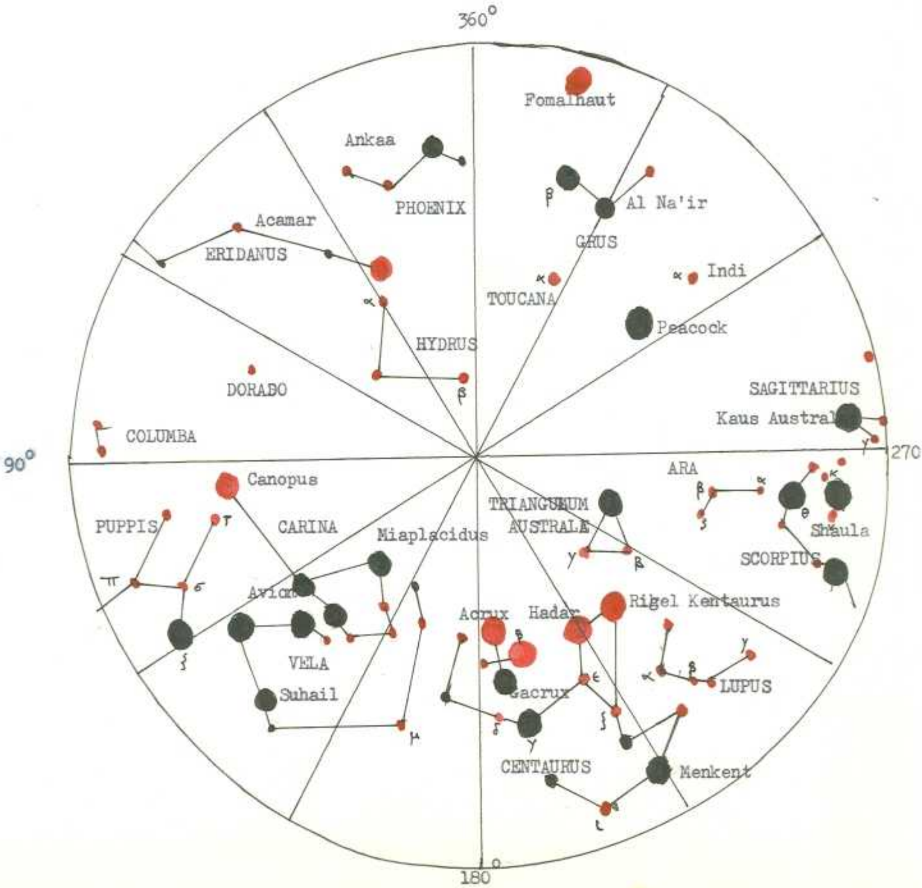
Northern sky

Magnitude:

- 1st
- 2nd
- 3rd
- 4th



Southern Sky



STARS, DOUBLE

	Magnitudes	Separation "	Position angle, deg
Gamma Andromedae	3.0,5.0		060
Zeta Aquarii	4.4,4.6	2.6	291
Gamma Arietis	4.2,4.4	8 n	000
Theta Aurigae	2.7,7.2	3	330
Delta Bootis	3.2 ,7.4	105	079
Epsilon Bootis	3.0 ,6.3	2.8	340
Kappa Bootis	5.1 ,7.2	13	237
Zeta Cancri	5.6 ,6.1	5.6	082
Iota Cancri	4.4 ,6.5	31	307
Alpha Canum Venat.	3.2 ,5.7	20	228
Alpha Capricorni	3.2 ,4.2	376	291
Eta Cassopeiae	3.7 ,7.4	11	298
Beta Cephei	3.3 ,8.0	14	250
Delta Cephei	Var ,7.5	41	192
Xi Cephei	4.7 ,6.5	6	270
Gamma Ceti	3.7 ,6.2	3	300
Zeta Coronae Borealis	4.0 ,4.9	6.3	304
Delta Corvi	3.0 ,8.5	24	212
Beta Cygni	3.0 ,5.3	35	055
61 Cygni	4.7 ,5.9	25	150
Gamma Delphini	4.0 ,5.0	10	265
Nu Draconis	4.6 ,4.6	62	312
Alpha Geminorum	2.0 ,2.8	2	151
Delta Geminorum	3.2 ,8.2	6.5	120
Alpha Herculis	Var ,6.1	4.5	110
Delta Herculis	3.0 ,7.5	11	208
Zeta Herculis	2.0 ,6.5	1.4	300
Gamma Leonis	2.6 ,3.8	4.3	121
Alpha Lyrae	0.0 ,10.5	60	180
Epsilon Lyrae	4.6 ,6.3	3	005
Zeta Lyrae	4.2 ,5.5	44	150
Beta Orionis	0.1 ,6.7	9.5	205
Iota Orionis	3.2 ,7.3	11	140
Theta Orionis	6.0 ,7.0		
Sigma Orionis	4.0,8.0	11.1	236
Zeta Orionis	4.9,10.0	3	160
Eta Persei	4.0,5.0	8.5	300
Alpha Piscium	4.3,8.5	1.9	291
Alpha Scorpii	0.9,5.3	3	275
Nu Scorpii	4.2,6.8	42	336
Theta Serpentis	4.1,6.5	23	103
Alpha Tauri	0.8,4.1	130	032
Zeta Ursae Majoris	2.3,11.2	14.5	150
Alpha Ursae Minoris	2.0,4.2	18.3	217
Gamma Virginis	3.6,9.0	4.8	305
Theta Virginis	4.0,3.7	7	340

STARS, NAVIGATIONAL

Name	Origin@	Bayer Name
Acamar	A	θ Eridani
Achernar	A	α Eridani
Acrux	M	α Crucis
Adhara	A.A	ε Canis Majoris
Aldebaran	A	α Tauri
Alloth	A	ε Ursa Majoris
Alkaid	A	η Ursa Majoris
Al Na'ir	A	α Gruis
Alnilam	A	ε Orionis
Alphard	A	α Hydrae
Alphecca	A	α Corona Borealis
Alpheratatz	A	α Andromeda
Altair	A	α Aquilae
Ankaa	A	α Phoenicis
Antares	G	α Scorpii
Arcturus	G	α Bootis
Atria	M	α Triangula Australis
Avior	M	ε Carinae
Bellatrix	L	γ Orionis
Betelgeuse	A	α Orionis
Canopus	G	α Carinae
Capella	L	α Aurigae
Deneb	A	α Cygni
Denebola	A	β Leonis
Diphda	A	β Ceti
Dubhe	A	α Ursa Majoris
Elnath	A	β Tauri
Eltanin	A	γ Draconis
Enif	A	ε Pegasi
Fomalhaut	A	α Piscis Austrini
Gacrux	M	γ Crucis
Glenah	A	γ Corvi
Hadar	M	β Centauri
Hamal	A	α Arietis
Kaus Australis	A	ε Sagitarii
Kochab	A	β Ursa Minoris
Markab	A	α Pegasi
Menkar	A	α Ceti
Menkent	M	θ Centauri
Miaplacidus	A	β Carinae
Mirfak	A	α Persei
Nunki	B	σ Sagitarrii
Peacock	M	α Pavonis
Polaris	L	α Ursa Minoris
Pollux	L	β Geminorum
Procyon	G	α Canis Minoris
Rasalhague	A	α Ophiuchi

STARS, THE TWENTY BRIGHTEST

Star	Constellation	Apparent magnitude	Colour
Sirius	Canis Major	- 1.43	White
Canopus	Carina	- 0.73	Yellowish
a Centauri	Centaurus	- 0.27	Yellowish
Arcuturus	Bootes	- 0.06	Orange
Vega	Lyra	0.04	Bluish-White
Capella	Auriga	0.09	Yellowish
Rigel	Orion	0.15	Bluish-White
Procyon	Canis Minor	0.37	Reddish
Achernar	Eridanus	0.53	Bluish-White
Betelgeuse	Orion	Variable	Reddish
β Centauri	Centaurus	0.66	Bluish-White
Altair	Aquila	0.80	White
Aldebaran	Taurus	0.85	Orange
Acrux	Crux	0.87	Bluish-White
Antares	Scorpio	0.98	Reddish
Spica	Virgo	1.00	Bluish-White
Fomalhaut	Piscis Australis	1.16	White
Pollux	Gemini	1.16	Orange
Deneb	Cygnus	1.26	White
β Crucis	Crux	1.31	Bluish-White

STARS, THE TWENTY NEAREST

	Distance (L.Y.)	Brightness@	Colour
1. Sun	0	1.0	Yellow
2. a Centauri A	4,3	1.0	Yellow
3. a Centauri B	4.3	0.28	Orange
4. a Centauri C (Proxima)	4.3	0.00005	Red
5. Barnard's star	6.0	0.0004	Red
6. Wolf 359	7.7	0.000017	Red
7. Luyten 726 - 8 A	7.9	0.00004	Red
8. Luyten 726 - 8 B	7.9	0.00003	Red
9. Lalande 21185	8.2	0.0048	Red
10. Sirius A	8.7	23.0	White
11. Sirius B	8.7	0.0008	White
12. Ross 154	9.3	0.00036	Red
13. Ross 248	10.3	0.0001	Red
14. ϵ Eridani	10.8	0.25	Orange
15. Ross 128	10.9	0.0003	Red
16. 61 Cygni A	11.1	0.052	Orange
17. 61 Cygni B	11.1	0.028	Orange
18. Luyten 789 - 6	11.2	0.00012	Red
19. Procyon A	11.3	5.8	White
20. Procyon B	11.3	0.00044	Red

@ Sun = 1

STARS, VARIABLE

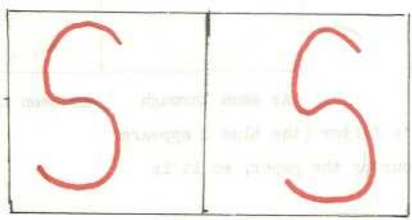
R Andromedae	0	22	38	18	6.1 - 14.9	409
W Andromedae	2	14	44	4	6.7 - 14.5	397
R Aquilae	19	4	8	9	5.7 - 12.0	300
R Arietis	2	13	24	50	7.5 - 13.7	189
R Aurigae	5	13	53	32	6.7 - 13.7	459
R Bootis	14	35	26	57	6.7 - 12.8	223
R Cassopeiae	23	56	51	6	5.5 - 13.0	431
T Cassopeiae	0	20	55	31	7.3 - 12.4	445
T Cephei	21	9	68	17	5.4 - 11.0	390
Omicron (Mira) Ceti	2	17	-3	12	2.0 - 10.1	331
R Coronae Borealis	15	46	28	18	5.8 - 14.8	Irregular
W Coronae Borealis	16	36	37	55	7.8 - 14.3	238
R Cygni	19	35	50	5	6.5 - 14.2	426
U Cygni	20	18	47	44	6.7 - 11.4	465
W Cygni	21	34	45	9	5.0 - 7.6	131
SS Cygni	21	41	43	21	8.2 - 12.1	Irregular
Chi Cygni	19	49	32	47	3.3 - 14.2	407
R Draconis	16	32	66	52	6.9 - 13.0	246
R Geminorum	7	4	22	47	6.0 - 14.0	370
U Geminorum	7	52	22	8	8.8 - 14.4	Irregular
S Herculis	16	50	15	2	7.0 - 13.8	307
U Herculis	16	23	19	0	7.0 - 13.4	406
R Hydrae	13	27	-23	1	4.0 - 10.0	386
R Leonis	9	45	11	40	5.4 - 10.5	313
X Leonis	9	48	12	7	12.0 - 15.1	Irregular
R Leporis	4	57	-14	53	5.9 - 10.5	432
R Lyncis	6	57	55	24	7.2 - 14.0	379
W Lyrae	18	13	36	39	7.9 - 13.0	196
HR Delphini	20	40	18	58	3.6 - ?	Nova, 1967
Nova Vulpeculae	19	45	27	2	4.8 - ?	Nova, 1968
U Orionis	5	53	20	10	5.3 - 12.6	372
R Pegasi	23	4	10	16	7.1 - 13.8	378
S Persei	2	19	58	22	7.9 - 11.1	810
R Scuti	18	45	-5	46	5.0 - 8.4	144
R Serpentis	15	48	15	17	5.7 - 14.4	357
SU Tauri	5	46	19	3	9.2 - 16.0	Irregular
R Ursae Majoris	10	41	69	2	6.7 - 13.4	302
S Ursae Majoris	12	42	61	22	7.4 - 12.3	226
T Ursae Majoris	12	34	59	46	6.6 - 13.4	257
S Virginis	13	30	-6	56	6.3 - 13.2	380
R Vulpeculae	21	2	23	38	8.1 - 12.6	137

STEREOSCOPIC VISION

TWO PICTURES A

Picture A Picture B

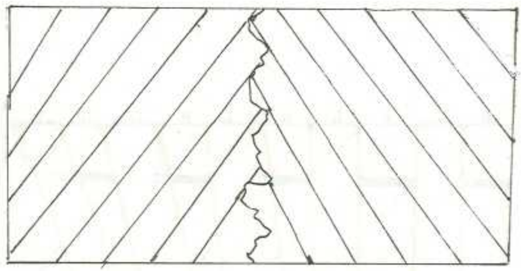
Left eye Right Eye



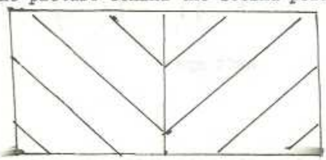
Picture A Picture B

The two pictures apperar superimposed and thus 3 - dimensional.

VECTOGRAPH

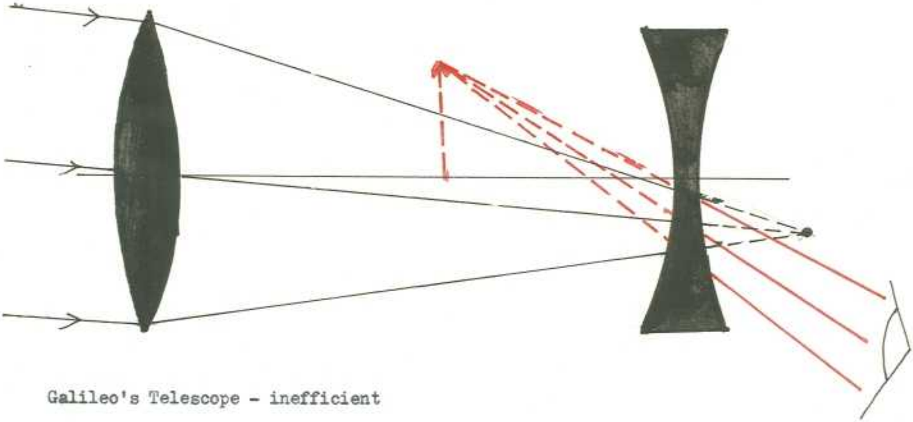


Two sheets of polaroid with their easy-axes marked on top of each other. Behind each sheet there is a picture on transparent film. Both pictures are of the same thing, but from differant angles. The easy-axes of the polaroids are not at 90° otherwise the picture behind the second polaroid would never be visible.

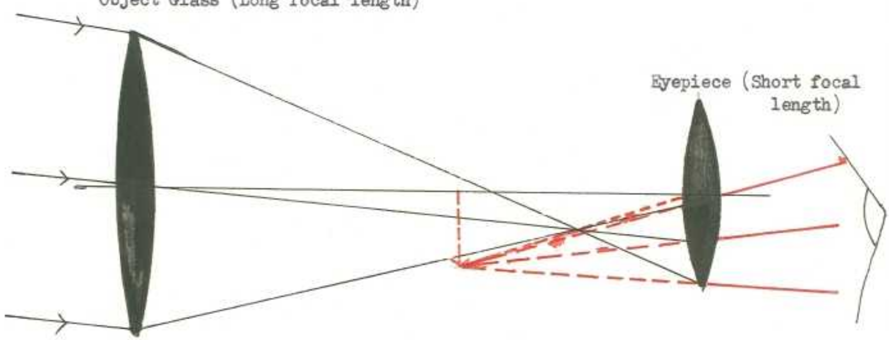


Left eye	Right eye
At 90° to the behind polaroid, so that the picture the back one is not visible to this eye. However, the picture behind the front one is visible.	At 90° to the front polaroid, so that only the picture behind the back one is visible.

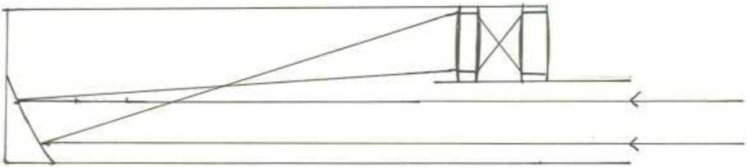
TELESCOPE, REFRACTING



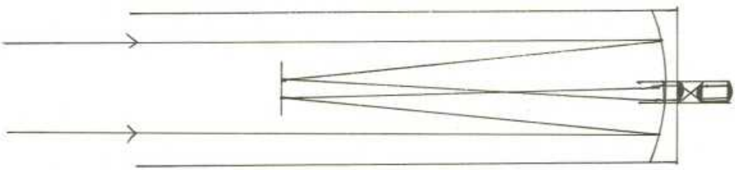
Galileo's Telescope - inefficient



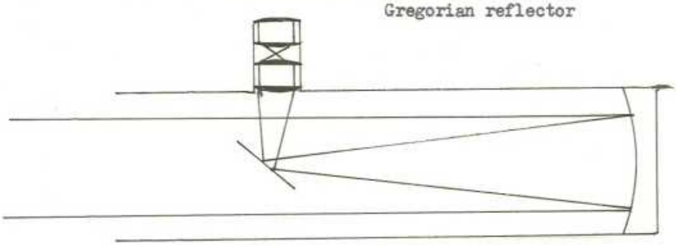
Modern refractor - quite efficient, but it is impossible for practical reasons to make for telescope, very large lenses. To re-invert the image in the astronomical refractor for terrestrial work, an auxiliary lens can be inserted at 2f from the image formed by the objective.



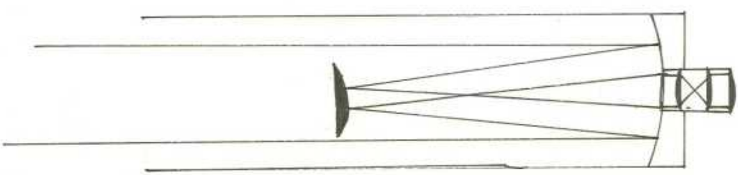
Herschelian reflector



Gregorian reflector



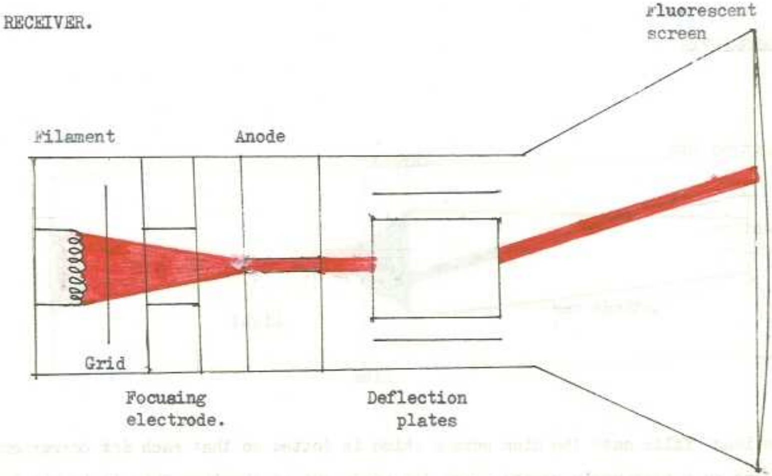
Newtonian reflector



Cassegrainian reflector.

TELEVISION.

RECEIVER.

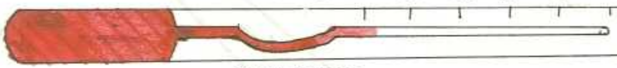


The filament produces a stream of electrons (called a cathode ray) which are attracted to the anode, and then race on through the deflection plates which, being of negative charge, deflect the now positive electrons. These plates deflect the rays so that it traverses the screen, which is made of a fluorescent material which gives off light when an electrical charge hits it, 405 or 625 times a second, thus leaving a bright trail. During each line, the intensity of the beam is varied to give light and dark, thus producing a picture.

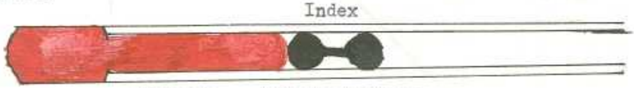
Graph of the speed of the dot while traversing a line and returning to its starting point.

THERMOMETERS

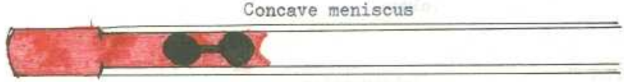
CLINICAL



Maximum

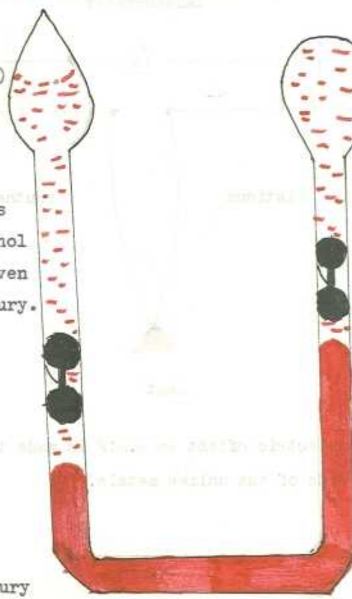


Minimum



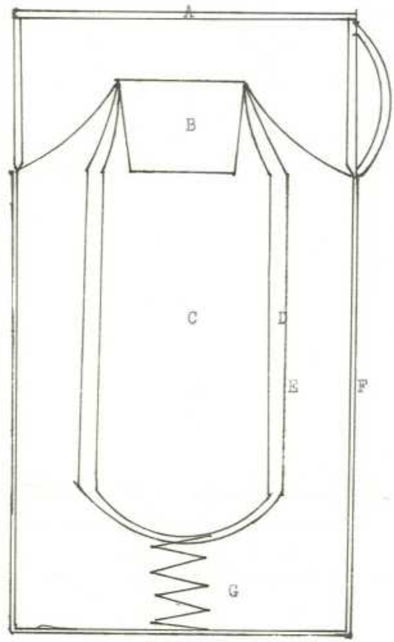
Six's thermometer

(combined min. and max.)



This thermomater works on the fact that alcohol expands more for a given temperature than mercury.

THERMOS



A Cover

B Cork

C Double-walled glass bottle

Dv High vaccuum

E Silvered surfaces

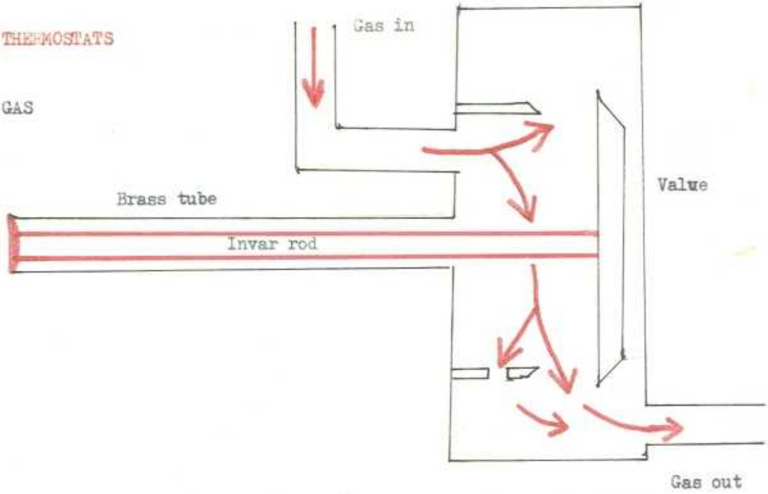
F Metal casing

G Spring

The vaccum prevents heat coming to the contents of the bottle by convection or conduction, and the silvered surfaces by radiation.

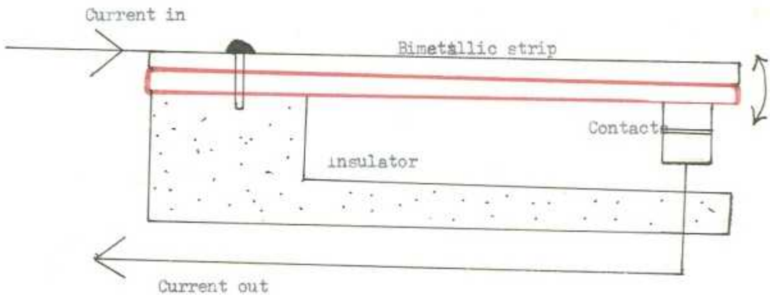
THERMOSTATS

GAS



Invar is an alloy of steel which contains 36 % of Nickel. It expands on 1/1000 000 of its length per degree Centigrade. When the brass tube expands it pushes its joiner to the invar bar to the left, and thus the invar bar pulls the valve closer so that the gas flow is reduced. The opposite happens when the temperature falls.

ELECTRICITY



At a certain temperature the bimetal bends so that the contacts break away from each other, and close when under that temperature.

According to Euclidean geometry, the angles of a triangle add up to I80°, and the proof of this is perfectly valid. But, take a triangle drawn on the surface of a sphere, the shortest distance between two points on the surface of the sphere is curved. Thus we find that the angles of a triangle here add up to slightly more than I80°. This was proved in I823 by a man called Gauss who used surveying equipment to measure the triangle made by Brocken, Hohehagen, and Inselberg in Germany. The longest side in the triangle is about I60 kms.. He measured the interior angles as:

86°I3'58.366"
53°64'5.642"
40°39'30.I65"
I80°00'14.I73"

He realized that if space was curved, then the three angles of a triangle taken on a much larger scale, would total much more than I80°. The question is: How do you measure distances in space when we are stuck within our solar system? When Pluto's orbit was predicted, using its effect gravitation-wise on othet planets, the error was found to be small. If the radius of curvature of the universe was small, then a significant error would have been discovered. As there was almost no error, it is certain that the radius of curvature of the universe is not less than $5 \times I0^{17}$ cms.. Another method of proving t e curvature of space was suggested by Schwarzschild. This was called the trigonometrical parallax. In this method, observations of a star were taken 6 months apart. The angle made between the line joining Earth to the Sun and Earth to the distant star were measured at each time. We will call these two angles a and b. On a flat sur ace, or, in this case, in flat space, a plus b is less than I80. So far as we know, this is true out until the limits of our present observations, at $3 \times I0^{20}$ cms.. Therefore, we might conclude that the radius of curvature of the universe was bigger than this, which is not neccessarily true, because some of our measures of distance, assume that space is flat. But, by triangulation, we know that the radius of the universe must be greater than $I0^{28}$ cms.. With this distance is accosiated the charecteristic LENGTH of the universe, but is this the radius or the radius of curvature of the universe ? This is one of the major problems confronare many theories of the universe, but all have one thing in common, they all accept the fact that the universe is expanding at a considerable rate. The proof of this comes in the doppler effect, which is discussed in another chapter. However, there is one possible paradox. That is that the galaxies all seem to be moving away from our galaxy, which is obviously untrue. What is obviously happening is that the distances between the galaxies are being increased, making it look as if all the galaxies are going away from us. The nearer galaxies are receding slowly, but the most distant ones which we have seen are receding at speeds of up to ½ the velocity of light. There are two main theories of the universe which are worth discussing: The Big Bang, or Superdense theory, and the Solid State theory. The Superdense or Big Bang theory postulates that there was an original single Superdense mass of energy and matter, which exploded. Thus the galaxies are fragment of this original 'bomb' and are flying outwards at a high speed. The fact that the universe is expanding means that its radius is also doing so. The other theory is the Solid State theory. This postulates that the universe started to expand with very little matter in it except hydrogen, but that as gaps are left by receding galaxies, these are filled in and the hydrogen fusions to produce all the other elements we know of. This would explain the fact that hydrogen is by far the most abundant element in the universe. Now I must explain the death of the universe. The expansion which we detect must come to an end when the first galaxies recedes at the velocity of light, because this speed is unachievable. We have good reason to believe that the speed of recession is increasing as time goes on, so this point must finally come. The other 'dying' factor in the universe is that all energy finally unwinds itself down to heat, so it is thought that eventually, this may be the only form of energy in the universe.