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Some Thoughts on Physics, Chemistry, etc.

A

Oct. 1, 1878.

I intend that the volumes included under the above title shall comprise a record of my ideas and the inventions which I have made or shall make in the course of my life. I intend them primarily for my own reference and use but they may at some time interest or be useful to others. I have labelled them with the letters of the alphabet. This volume (A) contains only those ideas which have been well pondered and which I consider of value at the time of writing. No idea is to be entered in this book until at least a fortnight has elapsed since it first occured to me. Volume B will contain those ideas of secondary value or which are unfinished at the time of writing. In volume C I shall set down the ideas as fast as they occur to me and this volume will undoubtedly contain much worthless matter.

Feb. 23. 1880. The above proposed arrangement proved impracticable. This book will contain short notes of ideas and B + C longer accounts being classified somewhat according to the nature of the ideas.

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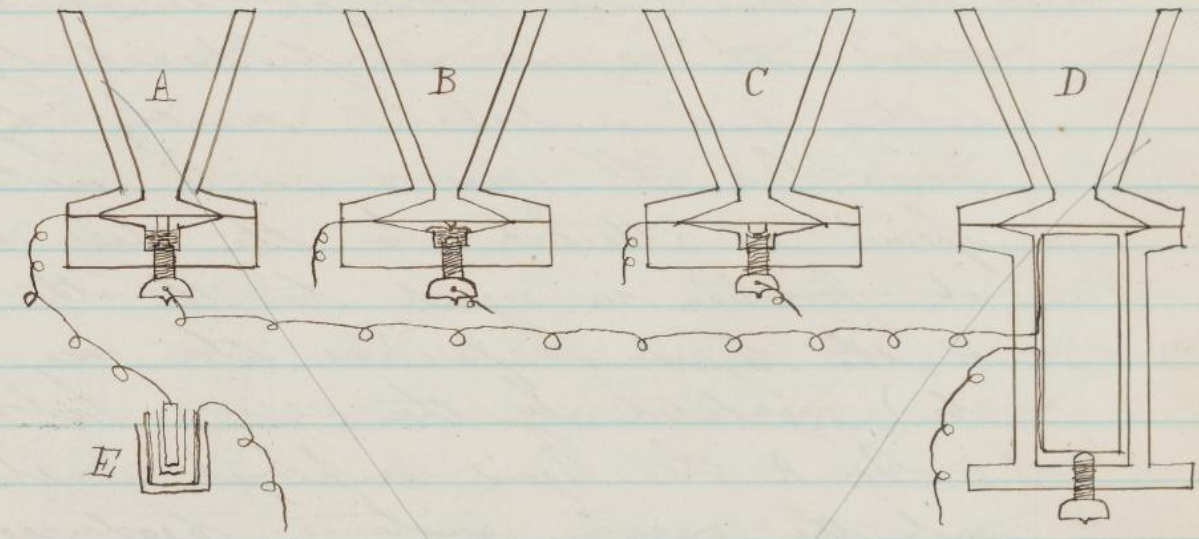
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Improved Telephone.

Sept. 21, 1878.



The fault with Bell's Telephone is the faintness of the sound produced; and from its construction it is evident that the sound produced must necessarily be fainter than the voice producing it. The only way in which the sound produced can be made louder is by increasing the current in the wire. (and this must be done by a battery.) If the sound can be so increased that it shall be louder than the original voice and so that relays can be introduced there is no reason why the Telephone should not supersede the ordinary instruments now used in the telegraph offices. An additional improvement would be to have it record the messages itself. In case the present instrument should be successful I think both these additions may be made as will be seen by consulting Vol. C. p. 1.

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Figs. A B & C are three different forms of transmitters and D is the receiver. In all these forms the principle involved is that the current is produced by the battery and modulated merely by the voice. In all cases a small metallic point is attached to the disc and its position in regard to the other point or the liquid surface (as the case may be) regulated by the screw below.

In A the liquid employed is alcohol and the varying resistance produced by varying the thickness of the layer of the liquid between the two points.

In B the liquid employed is mercury and as the disc vibrates it varies the surface of contact with the liquid and thus varies the resistance. In A the diameter of the vibrating point should be found by experiment and in B the angle of the point, which might vary from that of a camhric needle to an angle of 160°. This form was invented May 20, 1878.

In C a minute drop of glycerine is placed in a hollow cup in the top of the screw. Here the varying resistance is produced by thinning the layer of liquid and at the same time increasing the surface of contact.

The receiver D consists merely of a

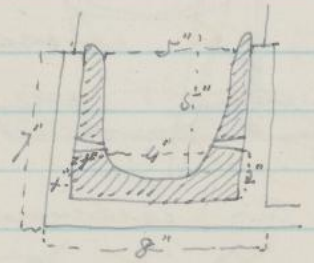
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vibrating disk underneath which is placed an electro-magnet whose distance may be regulated by a screw thus varying the loudness of the sound produced.

The above is useless, Feb. 23, 1880. See Note Book C Page 1

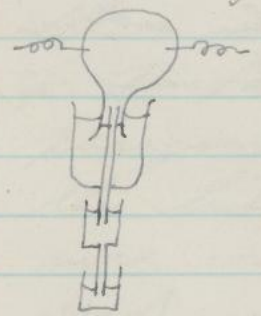
Furnace for High Temperatures by Despretz.



Feb. 23, 1880. Copied this in May 1879 from Percy's Metallurgy. Fuel. P. 75. 8 nozzles 3/16 inch diameter at small end. Charcoal size of Walnut.

Notes on Ozone. ~~Dec.~~ Nov. 23, '75.

They occurred to me while reading a book on the subject lent me by Prof. Nichols in the ~~spring~~ autumn of '75 ~~I think~~. Nov. 23. A flask



inverted over $C_{10}H_{16}$ (oil of turpentine) and filled with O + O_2. Passing into it is a small tube for letting in more O. See P 145 – 150. Dissolve O_2 in $C_{10}H_{16}$ & get saturated solution O_2 ~~dissolving~~ in Alcohol Water ? + KI. Try burning properties, weight, volume etc. Evaporate.

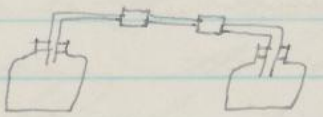
Theory. When an electrical machine works O is drawn to the conductors. Both atoms move as far apart as possible & leave conductor. Meet ordinary mol. O & draw one atom in between them. The mol. is crowded &

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eager to get rid of spare atom in other words mol. is active. Heat destroys O_2. It pushes atoms further apart till they get too far & one is crowded out.

Place two bottles against the two conductors of electrical machine. Leave months & take them off. See if there is any difference between them. Unite the O_2 & Antozone with Hg. Dissolve them in $C_{10}H_{16}$. Heat them & see if they are converted into O.



Fill the two receivers with O & pass current. Take two large conductors one + & one − & place them near receivers. The O_2 will flow into one & the Antozone into the other. Then close the cocks & proceed as above.

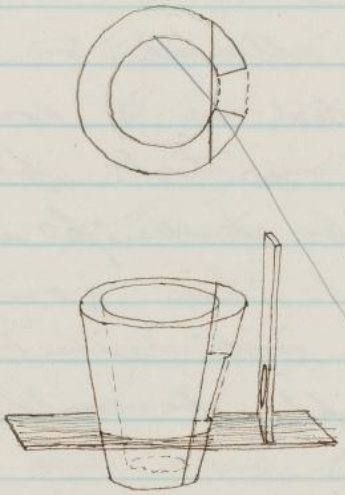
Heat O_2 to a temp. when it is converted into O. Note the temp. & also the expansion. See A. 40.

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Photometer Lamp.

Jan. 2, 1878.



One side of a cast iron crucible is sawed off & replaced by a piece of platinum foil. The side which has a large hole bored in it is then replaced and fastened on firmly. Perhaps it would be as simple to have the crucible cast in two parts in the first place. A diaphragm of any desired size is placed before the hole and the crucible filled with some salt melting at a white heat. This is melted save a slight scum left floating on top. It will then keep a constant temperature and give off a uniform light per square unit of surface as seen through the diaphragm. The light would be nearer the brilliancy of a gas jet and much more constant and reliable than the standard candle flame hence it would be particularly applicable to measuring the bright and white lights as the sun the electric magnesium & calcium light. It might also be used in photometric measurements of the stars.

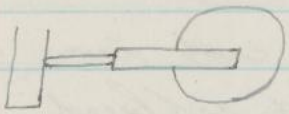
The above is useless. Feb. 23, 1880. See Thesis

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Tuning Fork Barometer.

Feb 23 1880



A tuning fork with two long flat plates attached to its prongs mounted on a sounding box. Another tuning fork without plates tuned to coincide with it at Bar. 760 mm. To determine pressure set them going & count beats. Temperature will affect them alike. By using a chronograph it could be made self-recording.

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Differences between Electric Poles.

Feb. 23, 1880.

1 Sour taste and ozone
2 Spark passing from ball to point
3 Blast of air from − to + striking paper
4 Wearing of carbons.
5 Brush in vacuum tubes & Crookes's experiments.

Mar. 20, 79.

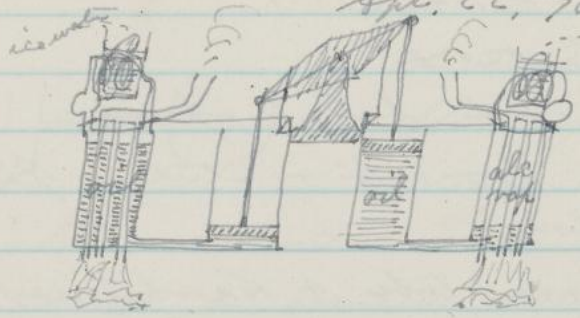
In using the Holtz Machine I noticed that if a sheet of paper be held between the poles, and near to the positive one, that sparks readily penetrate it; but if it be moved near the negative pole, the sparks almost always pass round the edges and with a somewhat louder snap; and the paper is blown vigorously away, indicating a powerful current of air from the − to the + pole. The difference is very strongly marked with seven inch sparks. ~~See Page 39~~ At ⅙ way from the positive pole the paper is easily perforated and it is not blown about.

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Alcohol Engine

Apr. 22, '78.



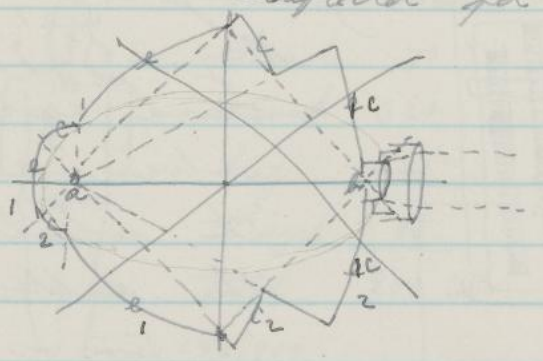
Alcohol Engine

It would work at a comparatively low temperature & would lose less by radiation on that account.

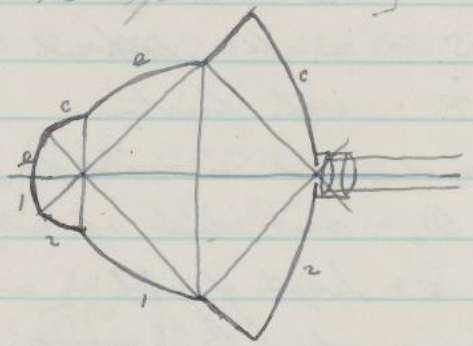
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Reflector for Lantern Nov. 5, '77.



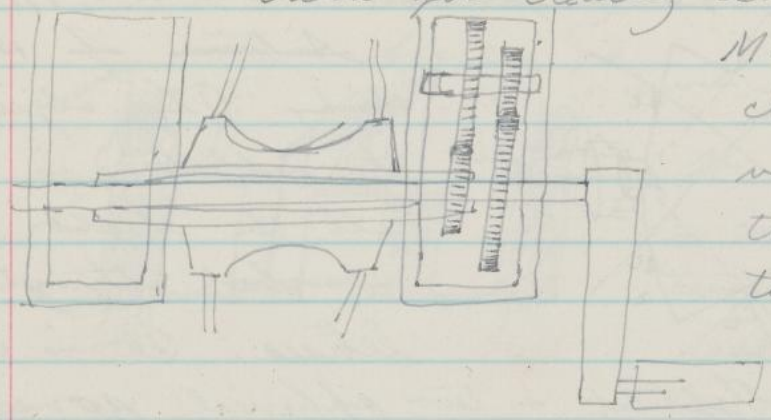
~~Antumus of 1878.~~ I ~~think~~. The objects of the reflector is to send all the light now absorbed through the lenses. It is composed of ~~three~~ two elliptical & two spherical zones. The elliptical zones marked e have their two foci at the pts a & b, the spherical ones marked c have their center at a. The lantern is particularly adapted to the electric light. The figures show the number of reflections. If a simple elliptical or parabolic mirror were used, it would approach the light too closely behind, and elsewhere would be too distant.



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Gears for Racing Bicycle.



May. 26, 79. The crank axle revolves inside the wheel axle, the latter going two or three times as fast though in the same direction.

Calculations in regard to my Bicycle

Mar. 7, 1880.

R = radius wheel in inches. W = total weight

r = " treadle " " S = surface exposed to resist: air. [in sq. ft.

P = resistance at rim. F = coef. friction.

p = " " treadle. m = speed in miles per hour.

D_h = horizontal dist: of slope D_v = vert: dist: of slope

q = resist: air in lbs. per. ft.^{2} s = length of step in walking in inches.

$$P = F'W + qS + \frac{WD_v}{D_h} \qquad p = \frac{PR}{r} \qquad \text{max. } \frac{D_v}{D_h} = \frac{pr}{RW} - F'$$

$\frac{5280 \times 12}{2\pi R}$ = rev. per. mile = no. strokes of each leg.

$\frac{5280 \times 12}{2\pi R} \times \frac{2\pi r}{12} p$ = ft. lbs. per mile.

$\frac{5280 \times 12}{2\pi R} \times \frac{m}{60}$ = rev. per. min.

$\frac{5280 \times 12}{2\pi R} \times \frac{m}{60} \times \frac{2\pi r}{12} p$ = ft. lbs. per min.

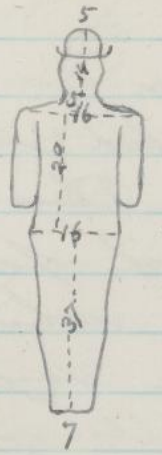
$\frac{5280 \times 12}{2s}$ = steps each leg per mile. $\frac{5280 \times 12}{2s} \times \frac{m}{60}$ = steps per min.

$5280 P_1^*$ = ft. lbs. per. mile walked. $5280 P \times \frac{m}{60}$ = ft. lbs. per. minute.

* See Page 18

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Surface	Area.	Pressure	Wind	Coef. Friction*	
Head	70	miles	lbs. per ft.²	Material	%
Trunk	320	2	.02	Loose Sand	25
Legs	425	4	.08	Fresh Earth	12.5
Biceps	85	8	.32	Common By-roads	10.
Total	900 in²	12	.72	Dry High road	2.5
144 | 900		16	1.28	Macadamized	3.3
6.25 ft²				Graveled roads	2.9

*Haswell.

Measurements

$R = 27$ For S, g, & E see Tables $\overset{mean}{map}\ p = 1.25$

$r = 5.75$ $W = 125 + 50 = 175$ lbs. map val. p in stroke = 2 mean p.

$P = .025 \times 175 + .32 \times 6.25 + 0 = 4.4 + 2.0 = 6.4$ lbs. $p = \frac{6.4 \times 27}{5.75} = 30$ lbs.

$\frac{D_r}{D_h}$ map $= \frac{125 \times 5.75}{27 \times 175} - .025 = .152 - .025 = .127 = \tan 7° 20'$ or slope of 12.7 in 100.

$\frac{5280 \times 12}{2 \times 22 \times 27} \times 7 = 373$ rev. per mile. $\frac{5280 \times 12}{2\pi R} \times \frac{2}{15} = \frac{373 \times 2}{15} = 50$ rev. per min.

$\frac{5280 \times 12}{2 \times 33} = 960$ steps per mile walking. $\frac{5280 \times 12}{2 \times 33} \times \frac{3.75}{60} = 60 =$ steps per min.

$\frac{5280 \times 12 \times 7}{2 \times 22 \times 27} \times \frac{2 \times 22 \times 5.75 \times 30}{2 \times 2} = 33700$ ft. lbs. per mile

$\frac{5280}{27} \times \frac{5.75 \times 30 \times 8}{60} = 45.00$ ft. lbs. per. min. under most fav. circumstances at a speed of 8 mile per hour.

$P_1 = .025 \times 125 + .08 \times 6 = 3.12 + .48 = 3.60 =$ resistance to walking.

$5280 \times 3.6 = 19000$ ft. lbs. per. mile walking.

$5280 \times 3.6 \times \frac{3.75}{60} = 1188$ ft. lbs per minute.

The last three equations are probably all under stated and it is impossible to det. their values. Probably the two last should be about doubled.

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Submarine Boat

Nov. 1, 1877. approx.

The boat would be shaped like a mackerel & built of iron. There should be an outer & inner shell if possible, (the latter of wood perhaps), which would partially guard against any danger from collision. An electric light would be placed just under the nose. Fresh oxygen would be constantly escaping from receivers. While CO_2 would be absorbed by $Ca H_2 O_2$. A pump would keep up a constant circulation. The motor would be an electric battery working a dynamo-electric machine. A propellor would be put in the place of the tail fin. Pectoral fins would be kept horizontal and used for rising or sinking. They would also counteract the ~~the~~ twisting action of the propellor & would be assisted by a large dorsal fin like a sharks. Two vertical side fins near the tail would serve for horizontal steering. The boat would also contain a large closed tank full of water & connected with the outside by a hole in the bottom. Above this should be placed a reservoir of compressed air. Slight variations in specific gravity would be made, by allowing a little of this to escape into the tank, & then pumping it back. In case of accident

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all the air would be permitted to escape which would instantly fill the tank & cause the boat to rapidly rise to the surface. This would be important for if the water once began to leak in the boat would grow heavier every instant and harder to raise to the surface. Besides which if she began to sink the pressure would increase & the water run in more rapidly; it being a case of unstable equilibrium so to speak. The dimensions might be 20 × 4 × 3 to accomodate two. One person in 24 hours uses up 17½ ft³ of O & would require from 3 to 6 lbs of $Ca\,H_2O_2$. 36 average Grove Cells per horse power. If the propeller were made to work by hand a good deal of trouble & expense might be saved. Hatches with quick means of exit would be desireable. If double doors were furnished explorations in diving armor could be made. Perhaps each diver could carry his own oxygen & $Ca\,H_2O_2$. The armor might be made for swimming rather than walking. He would carry for protection besides his knife a long spear furnished at the head with a dynamite cartridge which could be exploded from the hand. On meeting a shark he would thrust this under ~~this~~ belly or into ~~its~~ mouth. Mar 5. '20. A piece of clock-work like that in the sketch might even be employed as a motor.



[air. Above the piston is a vacuum, below compressed

See D. 24.

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Peculiarities of Wave Length.

May, 1879.

The wave lengths of some of the more conspicuous solar lines seem to lie in a regular arithmetical progression. Call $n = 643.5^-$ and we have the following table.

Lines	Expn.	Obs.	Theory	Diff	%	Substance
A	$a+n$	7605^-	7829			
a	a	7185^-	7185^-	0	0.00	
B	$a-\frac{n}{2}$	6867	6863	-4	.07	
C	$a-n$	6562	6542	-20	.30	H
D	$a-2n$	5892	5898	+6	.10	Na
E	$a-3n$	5269	5250^-	-14	.26	
b_1		5183				Mg
F mid	$a-4n$	4601	4611	+11	.24	H
G						
h		4101				
H_1	$a-5n$	3968	3968	0	.00	
			3646			

In the case of the two b lines F + G we cannot use either of them but must take their mean value. The lines A b_1 + h do not agree to this rule. Notice of these facts has been taken in my Graduating Thesis.

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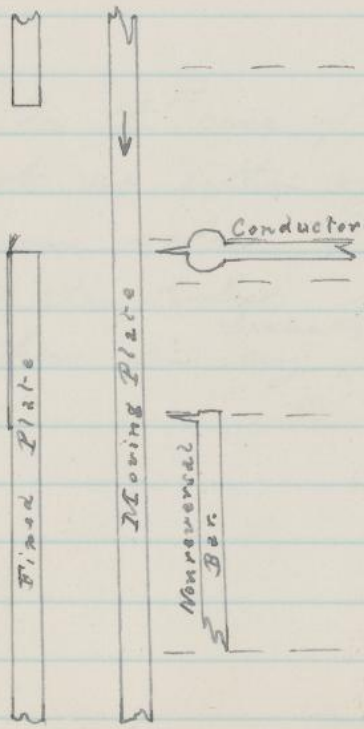
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Experiments on the Holtz Machine.

Feb. 1877. (?)

The object of these experiments was to obtain data from which a satisfactory explanation of the action of the machine might be deduced. Different portions of it were touched just before the passage of the spark with the proof plane, & tested with a gold leaf electroscope with regard to the sign & degree of the charge, the latter being estimated by the divergence of the leaves. What is now needed is a series made just after the spark. In the following table three sets of observations are shown, the first two being made at the same time at the two opposite sides of the machine. Notice that in them the combs of both armatures are +. The sketch represents a side view of the machine.

	Outside Fixed	Inside Fixed	Inside Moving	Outside Moving	Bars
— — — —	0-1-1	2-2-4	3-3-6	3-3-6	
— — —	5 4 -1		2-3-6	3-1-4	
— — —	2 0 -2	1-0-1.5	1 ±0 -1	1-1-2	4-4-8
— — — —	0-0-1	0-1-1	1-2-3	∓2-0∓2	-3±2.5
— — —	1 1 0	-2 0 2	-3 +3 +6	-2 3 5	



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Bare

-4-8

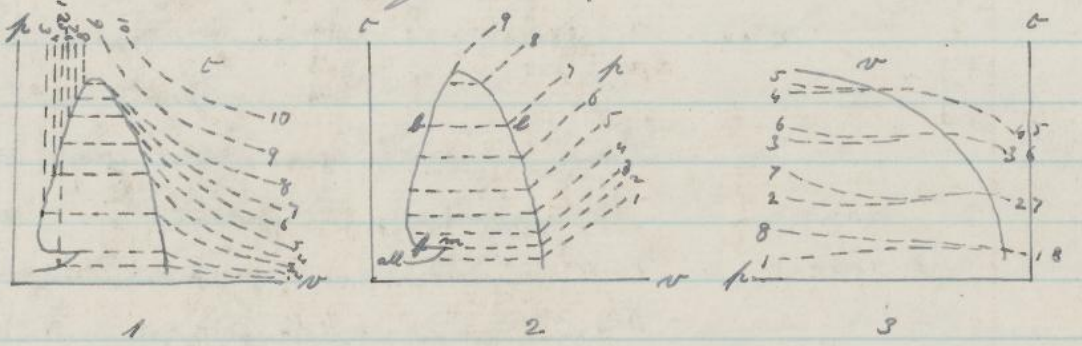
±25

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Volumes of Vapors at the Points of Liquefaction under different Pressures.

May. 23, 1878.



1 2 3

The full line represents the curve of the fluid, in this case water, viewed from each of the three ordinates in turn. It will be observed that there are four distinct points on each contour — melting, freezing, boiling, & liquefying (Fig. 2). They are generally confounded into two because for temperature & pressure they agree. It would be interesting to note the last contour passing through f & m. The portion of the curve from a little above f to b has been determined for all pressures below 760 by Exp. 125. Phys. Man. Vol. II. And the point b may be laid off on it by Exp. 133. A. which also represents two portions of the curve as seen from the prolongation of v. Fig. 3. These two portions are projected on one another & hence appear as a single line. They are included between the ordinate v & the apex but do not reach either. The last table on the next page is taken from Gardner's Natural Philosophy. Curves for CO_2 near critical points are given in Nature V 110 P. 106. Critical point 31° C 80 atmospheres

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t	p	w	t	p	w
	Water d .622			Water d .622	
100	760	1700	212	29.92	1696
50	92	12160	170.6	12.22	3891
10	9	109 000	140.	5.69	7937
0	4.6	205-600	100.4	1.87	22513
	Alcohol d 1.614		71.6	.76	52260
100	1698	295-	32	.20	182323
	Turpentine d 5.01		-4	.05-	65-05-88
100	131				
	Mercury d 6.976		I do not know where or how the above were obtained.		
100	.75-	15-3600			

Formulae.

Uncorrected for variation in vapor density.

V = vol. in litres — d = vapor density (suffixed const.)

p = press in mm. — w = wt. in grams.

t = temp. — α = coef. exp. air.

wt 1 litre of air = 1.293

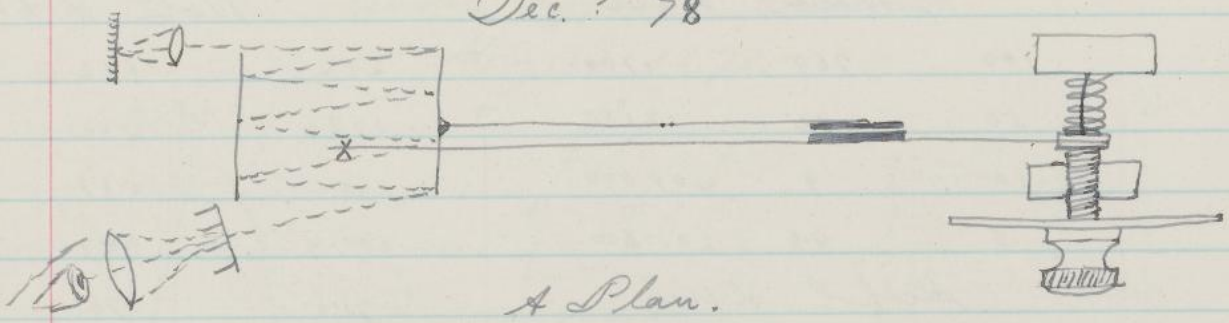
$$V \times 1.293 \times \frac{1}{1+\alpha t} \times \frac{p}{760} \times d = w \quad \therefore V = \frac{w(1+\alpha t)\,760}{1.293 \times p \times d}$$

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Apparatus for Measuring Force of Gravitation.

Dec. ? '78



A Plan.

A horizontal pendulum supports at one end a thick piece of platinum foil at the other a long strip of looking-glass. The bar is a glass fibre. Opposite the mirror is fixed another similar piece, and a compound microscope is arranged as seen in the sketch. Another glass fibre supporting a piece of platinum foil is fixed at one end and at the other is attached to a plate of glass moved by a micrometer screw. Thus the motion of one platinum is measured by the microscope, the other by the micrometer. This apparatus is peculiarly adapted to measuring repulsions and attractions of thin layers of air surrounding all objects. The glass plate rest on a fine needle. A needle might be supported vertically by the mirror & dip into mercury to prevent undue oscillation of the pendulum. Thin plates can be interposed between the plates & the effect noted, also try heating the platinum. Try blackening one of the faces.

Length silk fibre 100 mm Length glass needle 100 mm

Dist bet. " " 1 mm

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Necessary facts to the above Calculations.

Earth weighs 60×10^{20} kgms.

1000 kgm attracts 1000 kgm at dist. of 6400 km with the force of $\frac{1 \times 1000 \text{ kgm}}{60 \times 10^{20}}$

1 " " 1 " " " " 1 " " $\frac{1 \times 1000 \times 41\,000\,000}{1\,000\,000 \times 60 \times 10^{20}} = \frac{41}{6 \times 10^{18}}$ kgm

1 gm " 1 gm " " " 1 mm " $\frac{41 \times 10^{12} \times 1000}{6 \times 10^{18} \times 10^{6}} = \frac{41}{6 \times 10^{9}}$ gms

$\frac{7 \times 1000 \text{ mgms}}{10^9} = \frac{7}{1\,000\,000} = .000\,000\,7$ mgms.

Ver sin 1".

$R^2 - R^2 \sin^2 1" = R^2 \cos^2 1"$ $\quad R(1 - \cos 1") = R \text{ vers sin } 1"$

vers sin $1" = .000\,000\,000\,011\,7$ $\quad$ 10 vers sin $1" =$ vers sin $10"$

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On the Velocity of Intense Sounds, particularly Thunder.

Apr. 29, '78.



If a number of observers be scattered over a country within a few miles of one another, and a flash of lightning occur in their midst its approximate position may be determined by drawing circles on a map with the observers positions as centers and radii proportional to the intervals between the flash & the sound as heard by each. If after observing ~~many~~ several flashes it was found that their ~~areas about each~~ breadths were excessive it might reasonably be concluded that a larger linear unit was required for the radii. Those stations would be preferred which were about the same distance from the flash, and the distances might lie generally between 1 and 5 miles. If the lightning struck that would be a great assistance and even one observer could do something then. The thunder clouds always lie so near the earth that at a distance of a mile or so that factor could be neglected. A table like the following should be furnished to each observer.

No	Time Flash h	m	s	First Sound h	m	s	Direction	Remarks
1	2	30	13		30	25	N N	Vertical
2		46	9			24	N E	Heavy bursts 30 29

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Watches should afterwards be compared if possible. The following set of observations was obtained by Mr. Frank Very & myself Aug. 29, '78. The first column gives the differences between the times at which the flashes were observed by us. The second the interval between the flash & sound as observed by Very, the third as observed by me. The fourth sum of these two. The distance between our stations was 6¼ miles & allowing 5 seconds to a mile this would give a sum of 33 seconds. That is if the lightning occurred at a single point.

Flash	Very	Picking	Sum
0	6	10	16
+1	8	10	18
+1	8	6	14
-1	17	6	23
+2	23	4	27
0		8	
0	30	5	35
0	38	17	55

the minimum sum possible would be 33 seconds. But here we find out of seven observations only two exceeded this amount. The most distant flash the thunder of which I heard had an interval of 1 min 46 sec. Thunder faint & short. If this was the first sound it would allowing 5 sec. per. mile correspond to a distance of 21 miles. Out of 15 flashes observed by Mr. Very it was noticed that the first three came quite close together but afterwards there was a pretty regular interval between them only once exceeding by a minute the average value of 3 min 42 sec. Once there was a break of 6.41 but if we suppose

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an unobserved flash occurred here we shall have two intervals of 2.20 + 3.21. On May 21st '79. Mr. Holman observed 9 flashes. The first 3 came close together but afterwards the interval averaged ~~to~~ 3.17. Only one flash varied from this to the extent of a minute the interval being 2.09

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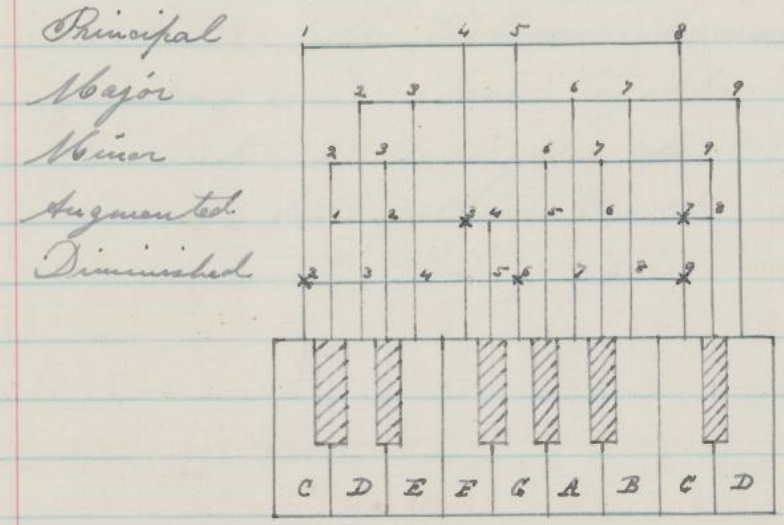
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A Representation of the Musical Scales.

Oct. 3, 1879.



P + Maj 1 $\frac{8}{7}$ $\frac{5}{4}$ $\frac{4}{3}$ $\frac{3}{2}$ $\frac{5}{3}$ $\frac{15}{8}$ 2

Minor $\frac{16}{15}$ $\frac{6}{5}$ $\frac{8}{5}$ $\frac{7}{4}$

A + D $\frac{7}{5}$

Keys	#	b
C	0	
G	1	
D	2	
A	3	
E	4	
B	5	
F#	6	6
D6		5
A6		4
E6		3
B6		2
F		1
C		0

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Exact Multiplications by Logarithms.

Jan. '17 (?)

This method is applicable only to multiplication, & is particularly suited to determining powers.

(1) $(a+b+c)\times(d+e+f) = ad + ae + af + bd + be + bf + cd + ce + cf$

(2) $(a+b+c)\times(a+b+c) = a^2 + 2ab + 2ac + b^2 + 2bc + c^2$

If place logs. are used divide the numbers into sets of three figures beginning from the right- each, calling the left-hand set a, the next b, and so on. Then apply the above formulae. Each term will consist of at most six figures of which the two right hand ones must be determined by direct- multiplication. The proper number of zeros must be added to each term and the whole added together. Where high powers are required this operation must be repeated a sufficient number of times to obtain the final factors.

~~using the following formula:—~~

~~(3) $(a+b)\times(a+b)\times(a+b) = a^3 + 3a^2b + 3ab^2 + b^3$~~

For example see next page.

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Exp. Find the value of 3^{50}.

$3^{12} = 3^6 \times 3^6$ $\quad 3^{24} = 3^{12} \times 3^{12}$ $\quad 3^{24} \times 3^{24} = 3^{48}$ $\quad 3^{50} = 3^{48} \times 3^2$

~~$(a+b)^4 = a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$~~ $\quad (a+b)^2 = a^2 + 2ab + b^2$

$\log 3 = .477121$

$\underline{6}$

$2.862726 = 729 = 3^6$

$\underline{2}$

$5.725452 = 5.31441 = 3^{12}$ (a, b)

729 / 729 / 61 / 8 / 41

$\log 5.31 = 2.725095$ $\quad \log 441 = 2.644439$

$\underline{2}$ $\quad \underline{2}$

5.450190 $\quad 5.288878$

$a^2 = 281961000000$ $\quad b^2 = 194481$

5.31 / 5.31 / 31 / 3 / 61

$\log 5.31 = 2.725095$

$\log 441 = 2.644439$

$\underline{\quad}$

5.369534

31 / 41 / 31 / 4 / 71

41 / 41 / 41 / 4 / 81

$2ab = 234171 \times 2 = 468342000$

281961000000

468342000

194481

$\underline{\quad}$

$282429.36481 = 3^{24}$ (a, b, c, d)

$\log 481 = 2.682145$

$\underline{2}$

5.364298

$d^2 = 231361$

a $\log 282 = 2.450249$ $\quad$ b $\log 429 = 2.632457$ $\quad$ c $\log 5.36 = 2.729165$

$\underline{2}$ $\quad \underline{2}$ $\quad \underline{2}$

4.900498 $\quad 5.264914$ $\quad 5.458330$

$a^2 = 795.24$ $\quad b^2 = 184041$ $\quad c^2 = 287296$

82 / 82 / 64 / 6 / 24

29 / 29 / 61 / 8 / 41

36 / 36 / 16 / 8

81 / 81 / 81 / 8

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$(a+b+c+d)^2 = a^2+2ab+2ac+2ad+b^2+2bc+2bd+c^2+2cd+d^2$

a 2.45-0249 a 2.45-0249 a 2.45-0249 b 2.632457

b 2.63 2457 c 2.72916 5- d 2.68214 5- c 2.72916 5-

5-08 2706 5.179414 5.132394 5.361622

120978 15-1152 135-642 229944

b 2.632457 c 2.72916 5- 82 82 82 29

d 2.68214 5- d 2.68214 5- 29 36 81 36

5.314602 5-.411310 38 92 82 74

4 6 6 7

206349 25-7816 29 36

a^2 = 79524 000000 000000 000000 81 81

29 36

2 8

$2ab$ = 241 956000 000000 000000 35- 39

24 40

$2ac$ = 302304 000000 000000 31 36

$2ad$ = 271 284000 000000 27 29

117 144 = sum of digits of 3^{100}

b^2 = 184041 000000 000000

$2bc$ = 459 888000 000000 These two pages give all

$2bd$ = 412698 000000 the figures required to per-

c^2 = 287296 000000 form this example.

$2cd$ = 515 632000

d^2 = 231361

3^{48} = 79766 443076 872509 863361

9

3^{50} = 717897 987691 852588 770249 Ans

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Measurement of High Temperatures.

Feb. 24, 1878.



A clay ball filled with air. Measure the volume of contained air by inverting it under a receiver in mercury. Place it in the liquid whose temperature is to be measured. When the liquid solidifies place it under a receiver & break the ball & measure the inclosed air. The expansion or contraction of the clay must be determined by some other method. See P. 49. Also C P. 45.

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Suggestions & Notes.

Dec. 12, '78. A tide mill would furnish 300 h. p. per square mile of water enclosed if the tides rose 10 feet.

Mar. 30, '78. Construct an instrument to measure the loudness of sounds, just as a photometer measures the brightness of light. Use limit of audability as the test in a muffled room.

Apr. 6, '78. See Tait's "Recent Advances in Phys. Science" on the Diffusivity or Conduction of Heat, Electricity, Matter, and Momentum.

Apr. 27, '78. A Siren with an irregular slit cut ~~in~~ in it instead of the holes. This slot is to be cut of such a shape that when blown by steam it shall repeat sentences in a loud voice.

May 27, '78. Analyze the air in a room in winter. Take specimens from different portions & determine the temperature, hygrometric state, % of O, CO_2, & impurities.

March 12, '75. When the mech. value. of electricity is determined perhaps we can express mechanical work, entropy & electric quantity in one unit say ft lbs & pressure temperature & potential in another.

Dec. 23, '75. Hydrogen Phosphide might be used to light

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a gas burner.

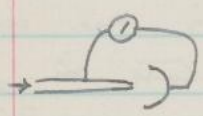
Jan. 4, '76. Connect two boilers one with the steam & the other with the exhaust part of an engine. Fill both half full of SO_2 liquefied & expose first to sun & put other down a well or into a river.

Dec. 29, '76 Get notes of various pitch be sounded rapidly repeated several times in a second & find how soon they appear as one sound. Mar. 19, '80. Learn analagous to that of heat. Apr. 9, 80 Combination of Siren & Organ Pipe or Toothed Wheel & Vibrating Rod. Apr. 1, '77. Prove whether H conducts heat by condensing it & thus making it similar to other gases. Try also compounds of it. See Saint-fr.

Apr 15th '77. Try experiments on rabbits guinea-pigs etc. as to origin of life by means of microscope.

Apr. 29, '77. A simple form of chronograph could be made by attaching the pencil to one of the weights of an Atwoods Machine & letting it move over a long slip of paper.

Apr. 29, '77. Prove contact theory of battery by



blowing air or hydrogen through zinc tube at copper disc. Current passes through connecting wire & galvanometer. Jan 30, '82. Use a zinc plate perforated with pin holes.

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March 1, '77. A hydrometer might be used as a portable form of balance.

June (?) '77 Measure the viscosity of liquids.

Aug (?) '77 Determine the mech. equiv. of electricity.

~~Febo 24~~ Aug. '77. Determine the mech. equiv of light of given intensity & wave length. See C. p. 10. Also find greatest light can be produced by least power.

Nov. 2, '77. Determine the velocity with which various odors diffuse themselves, & so find also the lower limit to the speed with which the air particles travel through space.

Nov. 21, '77. A piece of brass may be made by its own weight to slide over a piece of wood so slowly that it will take just a century to travel three miles. Glass on wood has greater friction. (See note book on Phys. Lab.)

Nov. 21, '77. Experiment on the best shapes for propellors for vessels by means of models. Apr. 1, '80. the unit of speed should be the diam. of the propellor.

Mar. 19, '79. Find that edges of heated platinum crucible are rather brighter than middle. This would have a reference to determining the density of the atmosphere of the sun which would be rather greater than the present calculated result.

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April, 22, '79. The intrinsic brilliancy gives I think the boiling point of carbon at the atmospheric pressure. Try the effect of varying the pressure.

Oct. 14, '75. An idea occurred to me for an improvement in Vanes, for which I took out a patent.

Nov 13, '79. Determine the ratio of the length to breadth of the ether waves. Determine the total magnetization possible of an electro-magnet together with the laws of strength of current etc.

May, 79 (2) Determine the total carrying power of a wire as exemplified in the magneto-electric machines.

May '79 (2) Work up the two systems of electric units.

May 80 (3) Measure accurately the wave-lengths by Newtonrings formed by surfaces 2 cms. apart.

Nov (2) 78 Work up peculiarities of spectrum. See Comet 467.9. Yeu C. 167.

May (2) 78 Experiments on electrolysis. See Comet 716.9

Mar. 1, '79. To show Na absorption with lime light, put Na in long metal tube with glass ends & produce vacuum. Heat by water bath or lamp.

Mar. 2, '79. Noticed the effect of the "black drop" in transit with a gas flame. When the light diminished the drop disappeared. By using darker shade glasses perhaps the effect can be removed.

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Mar. 20, '79. When a sheet of paper is placed between the poles of a Holtz Machine ⅛ way from the + pole, it is easily perforated & no effects on the paper are produced. If moved towards the − pole however, the paper is strongly blown away from it. See Page 9

Mar. 22, '79. During a Total Lunar Eclipse look for Auroras around the Moon. These would indicate a rare atmosphere.

Apr. 1, '79. Measure light transmitted by Gold Leaf in order to determine ratio of diameters of molecules to intermolecular spaces.

Apr. 3, '79. Non-luminous bodies are faintest when midway between us & the source of light, if not directly in line. They are equally brilliant at positions equidistant from this center, or equidistant from the source & eye. Thus the Moon would give us an equal amount of light if 240 000 miles from the sun instead of from the earth, supposing she did not then shine by her own light.

Apr. 11, '79. Try to decipher the phonautograph inscriptions by magnifying them considerably ~~more~~ i.e. use an arrangement to give greater amplitude in proportion to the thickness of the line. There must be some key. The same mark can never correspond to two separate sounds. This

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is shown by the phonograph.

Apr. 15, '79. When viewing Geisler Tube through Optical Circle noticed a rapid succession of faint sparks from the eye piece stiking me just under the eyebrow. I could also feel them with my nose, but not with tongue or fingers. The Circle was insulated on wood.

June 29, '79. It is said lightning turns milk sour. Perhaps ozone has something to do with it. Try electric sparks.

Aug. 6, '79. A magnesium wire was burned in the evening from Moat Mt. distant from Barnes's It was slightly fainter than Venus & rather bluer. Perhaps 4 times as bright as Arcturus.

Aug. 26, '79. How could a comet composed of matter separate into two parts of itself? See B 131

Look for companion to Procyon & 5th satellite of Jupiter.

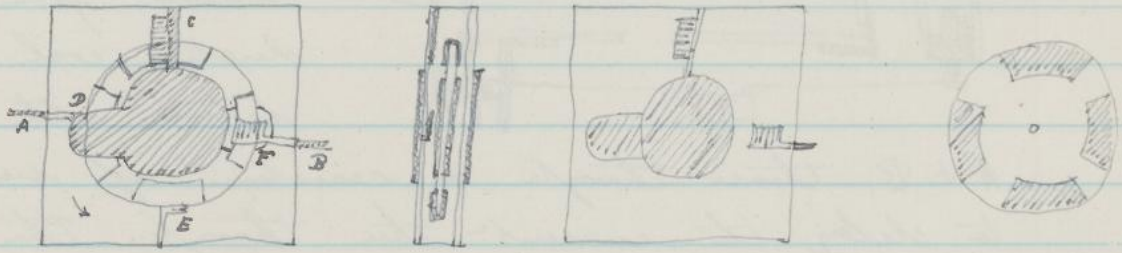
Find if increased number of stars is proportional to decreased brilliancies. If not where are the breaks? Represent them by a curve. One deep break might indicate the limits of our cluster. All 1st mag. stars visible in our lat. lie in Milky Way or near it save Regulus, Arcturus, Spica, & Fomalhaut, which lie 40° to 50° from it. Total no. 1st mag. stars 13. (Continued on Page 50.)

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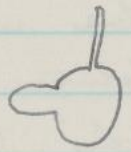
A New Form of Electrical Machine.

Oct. (?), 1872.



1 2 3 4

The working parts of the machine are represented in figures 1, 2, 3, & 4. 1 Represents the whole thing put together. 2 A side section of the same. 3 The upper fixed plate only. 4 The revolving plate. The lower fixed plate is just like the upper one but is turned round 180°. In 3 the portion shaped like ⊥ is above the plate while the two combs are below & come in contact with the revolving wheel. To start the machine one of the conductors ⊥ is charged + the wheel revolved the two wires A & B being connected with the ground. When one of the revolving pieces of tinfoil comes in contact with comb D it is charged − ~~+ carries it to comb~~ by induction from the top plate. It is then carried to E which takes most of the charge for the lower plate of tinfoil (not shown). It then goes on to comb F & loses what was left of it − charge + becomes + by induction from the lower plate (not shown). It now goes to comb C & gives up most of it + charge to upper plate + then on to D. All the 3 plates are of glass.

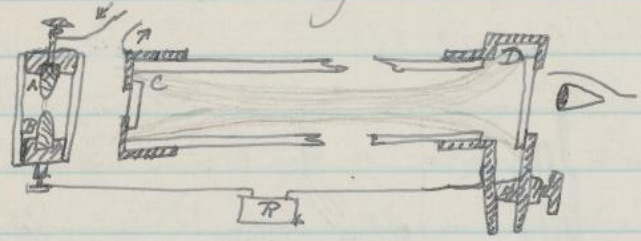


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Electricity as an Ether Current.



June 1, 1874. A current from an induction coil passed between the electrodes A + B thence through a resistance if necessary to delay the current then through the Geysler Tube back to the machine the current is reversed as rapidly as possible. If the Geysler tube is 1 meter long then for 300 000000 part of a second during the reversal of the current the sodium line (A + B are supposed made of sodium) will disappear. This supposes the current moving through vacuum at the rate of 300 000000 metres per. sec. If it does not so much the better. The spark between A + B last perhaps .00 002 sec. + in this time the current could travel 6 000 metres. Hence we must if possible shorten the duration period between A + B + lengthen the reaching period between C + D. The duration period between C + D should also be shortened probably if possible. Hence use very small tube + small quantity of electricity but high tension. By inserting resistance coils in different parts of the circuit the various portions of the current may be hurried or delayed. Perhaps a Holtz Machine would be the best thing to use. CD might be filled with H_2SO_4. Reversing current, ~~+ spark A B,~~ + H_2SO_4 occurred to me Mar. 28, '78. A grating + telescope is of course placed between D + the eye. The

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idea of the spark AB occurred to me Feb. 17, '79.

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Rotary Engine or Water Meter.

Mar 13 1875

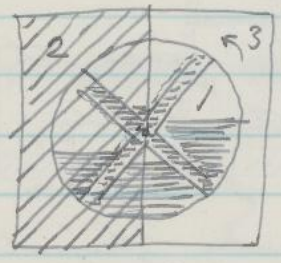


1 Cylinder 2 Piston 3 Thin plate sliding up + down.

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Sun Motor
Sept. 8, 1875.



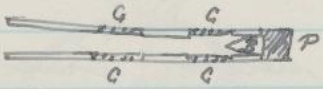
1 is a hollow brass wheel painted black & divided into four compartments connected two & two & each half full of ether. 2 is a wooden box which covers half the wheel & is painted black on the inside & covered with tin foil outside. 3 is a mirror placed so as to reflect sunlight on the other side of the wheel.

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Cannon Cartridge

Dec. 29, '75.



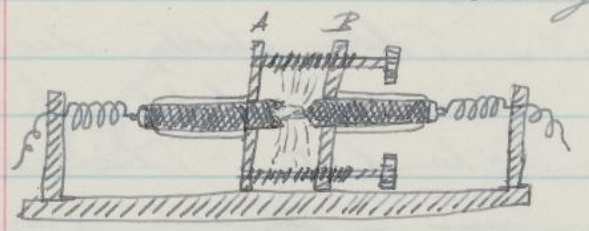
The cartridge goes the full length of the gun. P is the powder, B the ball & GGGG gun-cotton placed in rings and exploded by the passing projectile. The force is thus applied more economically.

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Regulator for Electric Light.

May 5, 1877.



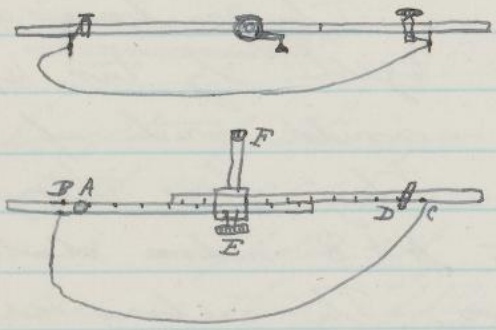
The carbons are pressed together by two springs & would touch if permitted They pass through holes in two brass plates A & B whose distance apart is regulated by screws. The carbons are coated except at the tips with wax paraffine or similar substance. If the arc is not long enough the wax ~~melts~~ does not melt & the carbons burn away if too long wax melts fast & the springs push the carbons together. The light is by this means also kept in one place. By using substances of different melting point greater or less accuracy can be obtained in the adjustment.

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Apparatus for drawing Ellipses.

Mear. 21?/80.



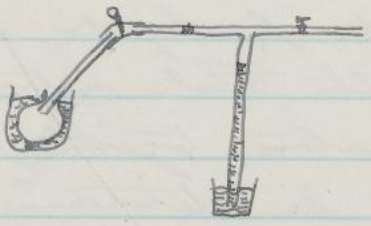
Two sliding divided bars are held by a clamp E. This clamp ~~was~~ is separate from the bars & may be attached at any part of them. To it is fastened a leg F which rest on a little flat plate. A silk cord is fastened at one end by a conical pin A. it thence passes through the eye of a very fine sewing machine needle B then through another C to the pin D which is like a violin peg and round this it is wound.

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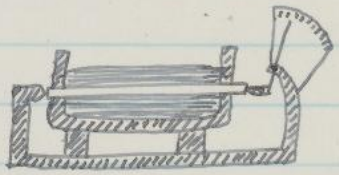
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Measurement of High Temperatures

Feb. 6, 1879



A clay bulb connected with a clay capillary tube is joined by a rubber connection to a capillary glass tube connected with the air + with a barometer. In the glass tube is a mark to which a drop of H_2SO_4 must be brought by varying the pressure of the air. The glass tube may be drawn slightly out from the rubber connection + a pinch-cock attached to prevent the drop from being sucked into the clay tube when the instrument is being cooled. At the same time the pressure on the other side should be diminished. The coefficient of expansion of the clay may be determined by placing a bar of it in a bath of some of the substances whose melting points have been determined.



Feb. 20, '79. It would improve my air thermometer to connect my glass capillary tube with the barometer by a piece of stout rubber tubing + to use a siphon barometer instead of the other form. By using a pressure of 15.0 cms at 300° abs .05 cm would correspond to 1° + at 1500° abs the pressure would be 75. cms. In order to obtain equal accuracy in reading the drop .05 cms of capillary tube must equal 1/1500 of capacity of clay bulb. The rubber connection should be done away with.

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Angular diameter of the Stars.

Febr. 16, 1879.

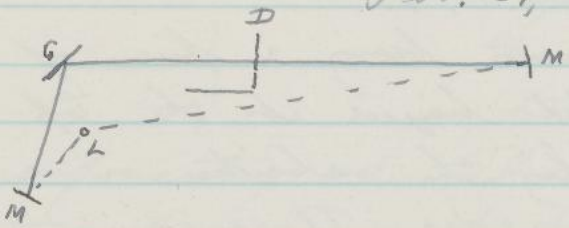
By observing the amt. of light in different parts of the spectrum, the total intrinsic brilliancy of the fixed stars, together with their temperatures may be determined. Given their total & intrinsic brilliancy we may obtain their apparent angular diameters. The total brilliancy at high temperatures may depend somewhat on the nature of the radiating surface.

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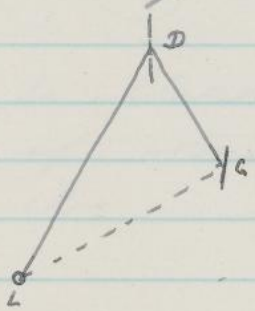
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Mirror Photometer.

Feb. 27, 1879.



An apparatus designed to determine the amount of light reflected from mirrors ~~&~~ glass or other bodies at varying angles. L is the light. M.M are two mirrors exactly alike & so placed that the angle G M L are always equal. D is a Bunsen Disc & G the glass or mirror to be tested. The angle M G M may be varied.



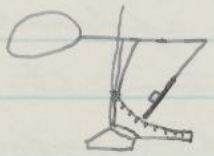
March 20, 1880. I think the apparatus in the lower figure would be quite as good & much simpler.

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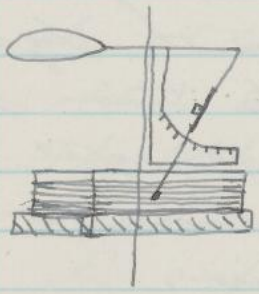
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Anemometer.

Jan. 10, '79.



A vane bearing a piece of sheet metal hinged at the top and marking the velocities on a scale. Mar. 22, '80. The scale is attached to the vane so as to turn with it. A pointer is attached to the swinging plate which dips into a circular tank of water to prevent ~~swinging~~ vibrations.



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Density of the Earth.

May 4, '79.



Use the rate of vibration of a horizontal pendulum with compensating wt. Then turn it round 180° & time it again. A boulder 21 ft. in diameter on a stone pier, is equal to a common ball 7 ft. in diam.

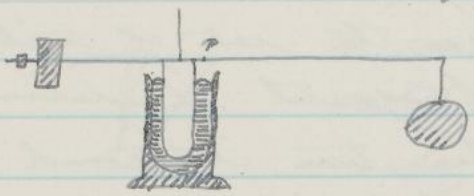
Dec (?) '79 Mr. Holman suggested using a common-ball suspended but slightly above its center of gravity. This would vibrate very slowly & could be placed very near to any large mass of stone or metal, both above & under it.

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Density of the Earth.

Feb. 21, 1880.



A ball hung from a rod floating in mercury or water. Hang another ball near it & measure the pull by a horizontal pendulum attached near the axis of the rod at P. Keep the float in place by a silk fibre ~~#~~ or else coat it with some material so that it shall be repelled from the walls by capillary action. Surround all with glass case and by exhausting & heating balls.

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Suggestions and Notes.

Sept. 4, '79. Suppose a Milky Way composed of Suns of average size, distance, and brilliancy, given their number, find their maximum distance from the earth by a photometric comparison with the Sun.

Sept. 8, '79. Another summer observe conditions of moisture (wet + dry bulb), clearness, rain (showers or storm) + if possible amt. of cloud on Washington. Find relation between moisture + clearness.

Nov. 18, '79. Have as a sun motor a thermo fish floating on a river or branch of the sea.

Dec. 31, '79. Work up the measurement of velocity of the stars by the spectroscope down to velocities of 1 mile per second. D_1 to D_2 = 200 miles per sec. Have a gigantic speculum of short focus backed with mercury. See Sci. Amer. 1874 I 159. Continued Apr. 27, '80. P. 56.
Dec ? '78 (?) A telescope might be attached to a large globe which was floated in mercury thus taking off most of the friction from the pivots.
Apr. 1, '80. See Scientific American 1874 I 159.

Apr. 1, '80. Try to polarize light totally in one plane, + then in the other at right angles, so that if one should look at the sun it would be jet black. By a very slight compensation for the atmosphere the corona would pulsate be visible and

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also any inter-mercurial planets that may exist. See Page 39.

Jan, '80 Meteorological Observations. See Plate VIII

Apr. 27, '80 Continued from Dec. 31. '79. P. 55. Apply spectroscope to Algol to test its motion as suggested in Scientific American Nov. 1, '73 by J. M. Barr.

Sept 25, '80. Determine the size of the molecules by Thompsons Methods not only of H but also of some of the more complicated organic compounds.

Dec 7, '80.  The correct form for a projectile is similar to that for a ship, & should involve as little commotion as possible at both front & rear ends. A sinusoid of rotation ~~is~~ is theoretically the best form but practically both ~~the~~ ends should be shortened. ~~An~~ An independant ring could be placed behind the projectile if found desireable.

Jan. 23, '81. Perhaps the Ether is not composed of closely lying individual particles, but is a uniform substance, infinitely divisible, & pervading all space.

Jan 23, '81. When electricity is distributed on the surface of a sphere, in the thick-

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ness of the layer such as would be caused by the repulsion varying inversely as the square of the distance?

Mar. 11, '81. The principle of the Atwood's Machine may be applied to regulating a Chronograph.

Mar. 19, '81. Compared the Laboratory Examination marks of the B.26. Students for the last four years, — 35 young ladies and 55 men. Found their averages were exactly 72% in both cases.

July 3, '81. To obtain the attraction of unit mass for unit mass, one might employ the sun or moon as an intermediate body between the unit & the earth.

July 4, '81. Compared a reflection of the Moon in a lens with the comet; Moon was perhaps 10 times as bright but not nearly as blue. Comet must certainly be as blue as Electric Light.

Oct. 31, 81. It was suggested by Prof Langley that the ~~excess~~ temperature of a blackened thermometer bulb ~~was~~ above the surrounding medium was to the temp. of a distant source as the angular area of that source was to the area of the surface of a sphere. Try various measurable sources from 0° to 300°C.

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Oct. 4, '81. Made an apparatus illustrating the Dyne by ~~fusing~~ drawing out a glass tube & fastening one end in a vertical wooden post. The fine tube was horizontal & the loose end bent in a hook moved in front of a paper scale. Pressing it from one division to another one, I exerted 1 dyne of force, = .980 mgms. A dead flies leg weighed .24 mgms & his wing .06 mgms. Could weigh to 1/60 of a mgm.

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Warning Observatory Domes.

Dec. 9, '79.



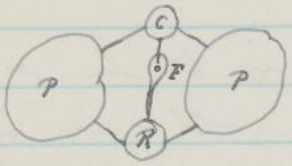
The dome is to be warmed by steam which cold air is sucked in the direction of the arrows. This might perhaps be done by carrying the pipe A down to the basement & connecting it with a chimney, but it would be better to use a steam blower. The cap surrounding the objekt glass could slide on the tube, so as to be adjusted to the varying distance between the lens & dome.

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Furnace for Producing High Temperatures.

Feb. 19, 1880.



Two pumps PP take air or CO_2 from Receiver R & force it at high pressure into Condenser C. It escapes through tube back to receiver striking the object to be heated in the furnace F on the way. 125-0 ft. sec. gives temperature of 100° C & 6-30 v^2; ∴ 12 5-00 ft. sec. gives 10 000° C suffering no radiation. Interesting theoretically even if not practically.

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Microscope for High Powers.

Mear. 13, 80.

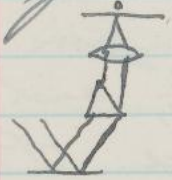
Ordinary first-class microscopes magnify 1000 times, & the best results have been attained with this power in resolving fine lines, using 1/8" objectives or similar powers. 10 000 diameters & even 15 000 have been used however. My idea would be to use large lenses which could be conveniently worked & corrected. I should use a single achromatic 1" diam & 2" or 3" focus as an objective, give it a conjugate focus of 15 to 30 ft., and view it with an ordinary eye-piece. Place a diaphragm 1/4" over the objective, which could be moved to different parts, illuminate with direct sunlight & correct each portion of the lens separately till it gave perfect definition. A compound microscope might then be used as an eye-piece & more careful corrections made. With conjugate foci of 2" & 30' we should get a magnifying power of 180 × the power of the eye-piece. Greater lengths of even 1/4 mile might be used. 35-0 H mole. placed in contact would reach between two of the lines of Nobert's 19th band. Hence if we obtain a magnifying power of 35-0 000, other things being equal we might see the molecules in solids & liquids, though they would be blurred from their rapid motions. I do not think the comparatively large size of the ether waves

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would interfere. Some of the large molecules of compound bodies might certainly be visible. A magnifying power of 25-0 000 would require conj. foci of 2" & 1000' & an eye-piece of 60 mms. But whether any thing of this sort could be done or not, I think higher powers than at present could be attained by making the instrument larger.

June 24, 81. The sunlight would be reflected through a prism & only the yellow rays used which would be concentrated on the object.



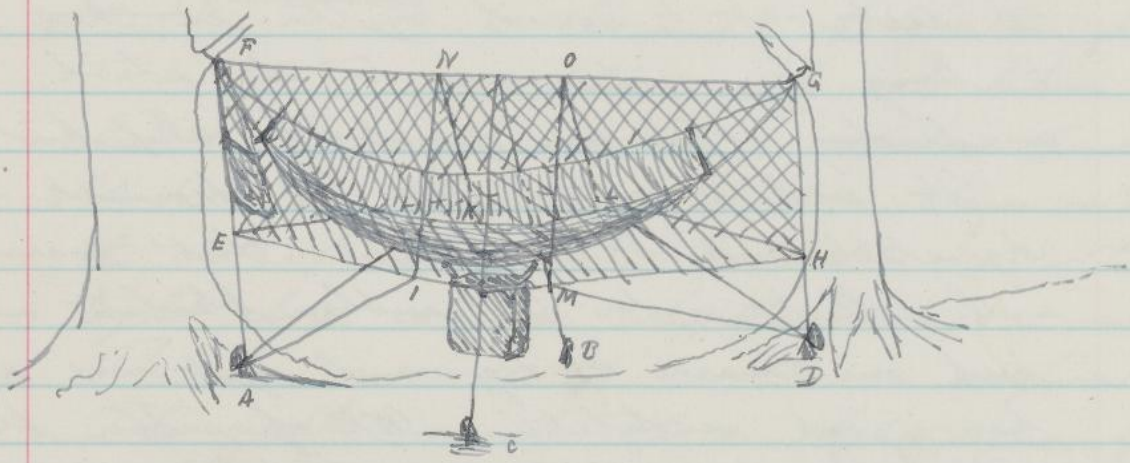
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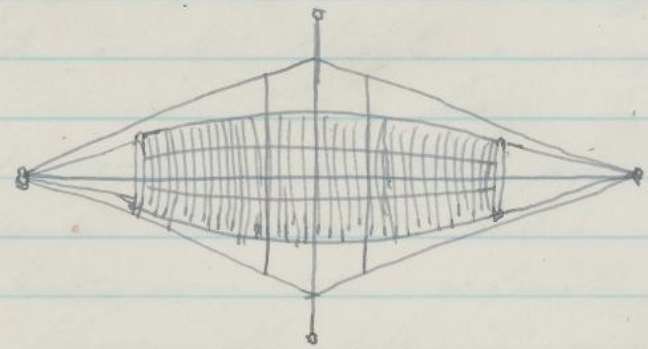
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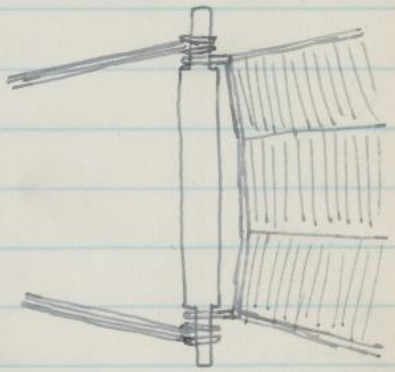
Hammock for Camping Out.

Dec. 17, '79.

The idea is to obtain something which will be warm to sleep in, protect one from rain, and be light to carry.







A light hammock is suspended between two trees. Two tent-pins A.D are driven in between their roots, & a cord slipped round one goes over the limbs & down around the other. Two more tent pins C.B are driven in on the two sides, and a rope from one of them goes over the ridge rope & down on the other side to the other to serve as stays. A rubber-blanket

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LOMEFE is thrown over the ridge rope, fastened at E and stayed at L + M to D. Another rubber blanket KNIHGH in the same way is fastened at H, I, + K. A Haversack may be hung inside + a Knapsack hung below. The lower figures show a plan + the method of making the hammock. The cloth is cut out + sewed together in three pieces + hung by rope rings to the stick. The suspending ropes are joined by slip knots.

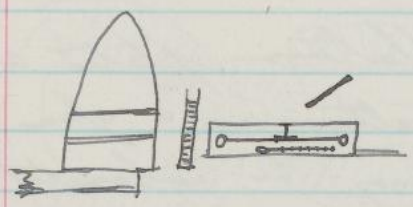
It will be noticed that the hammock is quite adjustable and it is thought that warm air will collect under the rubber blanket and keep one warm + dry and yet we shall have good ventilation. Wt of rubber blanket 6 lbs hammock (est.) 3 lbs. ~~Total 9 lbs.~~ Tent pins + stays (est.) 1 lb. Total 10 lbs.

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Apparatus for determining the Effect of Temperature on Gravitation.

Jan. 28, 1881. See B. 1. 131.



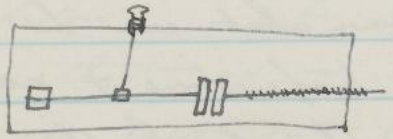
The cannon shot can be heated to various temperatures & a screen to the needle of further from it as desired. The tank between the shot & the needle contains a solution of alum. Under the needle is placed a thermometer by the aid of which the temperature of the air-tight box can be kept constant in all parts. The box is connected with an aspirator. The needle consists of a light piece of wood supporting two bullets. In the middle is a piece of soft iron by which oscillations can be imparted to it through a magnet which is then removed. It is hung by several silk fibres placed together or a stout spider's thread or a hair. The cannon shot would keep a high temperature (say red heat) some time especially if played on by gas flames all over its surface, or if covered by a glass receiver to impede convection currents.

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2d Apparatus for determining the Effect of Temperature on Gravitation.

Jan. 28, '81. See B page 131.

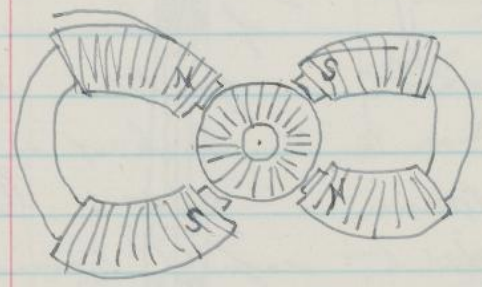


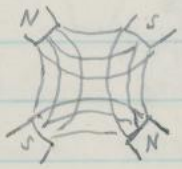
Two platinum plate are placed near together in a glass box which may be exhausted. They are suspended by platinum wires. In the middle of the needle is a bit of clay to which the fiber is attached. A piece of soft iron may be used to swing it. This could be attached by wax + melted off with a burning glass. The platinums should be black + are heated red hot by a reflector placed below which receives its light from a large mirror heliostadt. Instead of the iron the fibre (which should vibrate by torsion) could be twisted by the air-tight screw. Experiment must be made when heated as well as when cold with the other platinum near, + removed to a distance to eliminate the effect of temperature on the torsion of the thread. Also to note the law of the effect of the distance. The glass case should extend so far below the needle that the reflector will not heat it.

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Dynamo-Electric Machine.
Feb. 28, '81.





Lines of force.

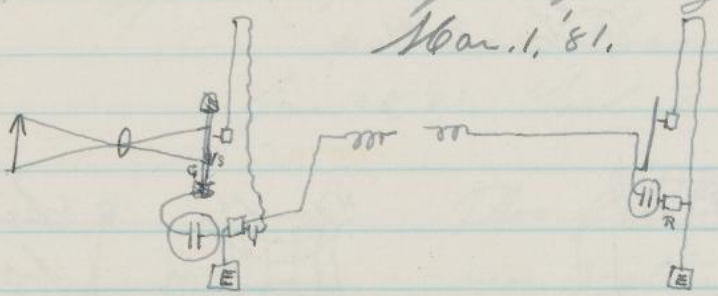
The field of force is more even there in the Brush and I think the lines are better arranged.

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Transmission of Sight by Telegraph.

Mar. 1, '81.



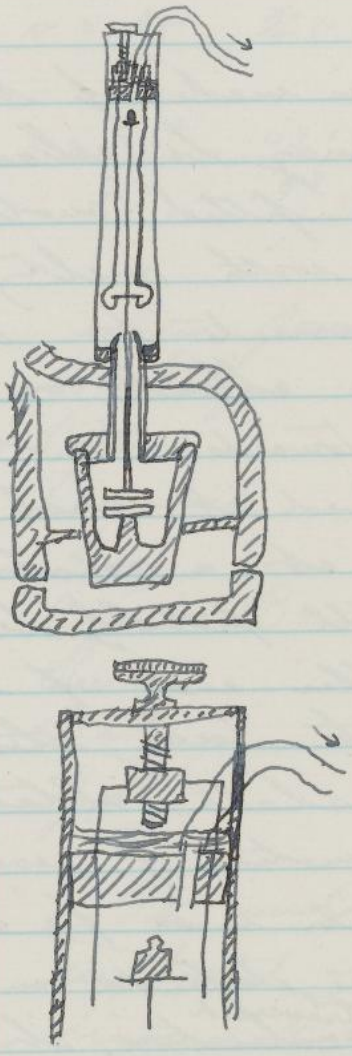
Transmitter Receiver

A thin plate of selenium S is fastened to the back of a glass plate G. On this the image is cast. A pointer rapidly traverses the selenium in close parallel lines. From the battery the current enters a copper frame, then through the selenium, pointer and induction coil to the battery. A very rapidly acting commutator is used. The secondary current passes from the earth through the line, through ferro-cyanide paper & a pointer to the earth. A small battery with a high resistance is placed at the receiving end which neutralizes the current when it passes through selenium unaffected by light. Instead of ferrocyanized paper perhaps a sensitized photographic plate might be used. In this case silver & copper must be substituted for glass.

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3d Apparatus of Gravitation at High Temperatures.
June, 13, '81.



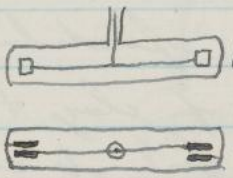
A metronome pendulum has the lower part made of clay & the lower rod of platinum foil it swings over another piece of foil both being inside a crucible in a furnace The position of the pendulum can be adjusted by a thumb-screw at the top which raises the supports which are fixed in a rubber plug covered with a layer of oil. A rubber tube permits one to exhaust the crucible. If the upper weight is of iron it can be set in motion by a magnet. The times of transit of the upper part of the pendulum may be observed and estimated to tenths sec. In 24 hrs there are 864000 tenths secs. If 2 plates each measure 2 × 2 × .2 cms one will weigh 17 gms. If dist. bet. centers is .3 cms. attraction will be $\frac{1}{80000}$ attrac. earth ∴, 864000 : p = 80000 : 1 ∴ p = 11 = no. of ~~added~~ subtracted tenths ∴ we can det. attrac within $\frac{1}{11}$ = .09% in 24 hrs. An electric apparatus might be arranged to keep it going for several days. ~~There is an~~ Jan. 30, '82. It would be better not to use a metronome pendulum, but a simple one with a clay rod. One must det. expans. of clay by timing when lower plate removed.

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4th Apparatus for Gravitation at High Temperatures.

July 4, 81.



The tube is made of hard glass & may be exhausted. outside is fitted another which may be filled with melting ice or steam. Also arrangement for heating to red heat. The discs attract one another slightly & the movable ones slowly move towards the others. The apparatus is then revolved at such a rate as to keep the discs at a constant mean distance (there will probably be some oscillations). As the upper end of the fibre revolves with the tube, there will be no torsion, & we shall obtain a uniformly accelerated motion of revolution. As the attraction of a unit mass for unit mass, at unit distance, depends on the square root of ~~this~~ the space traversed ~~acceleration~~, it seems as if this might form a most accurate method of determining this ~~constant~~.

Approximate value of this constant.

Mass Earth = 6×10^{24} gms. Radius Earth = 6.4×10^{8} cms.

$f = \alpha \frac{mn}{d^2} \therefore \alpha = \frac{fd^2}{mn} = \frac{980 \times 4.1 \times 10^{17}}{1 \times 6 \times 10^{24}} = \frac{4.0 \times 10^{20}}{6 \times 10^{24}} = 6.7 \times 10^{-5}$

Attrac. force of 1 gm for 1 gm at dist. 1 cm. = accel. produced in 1 gm by 1 gm at dist 1 cm after acting on it 1 sec. in dynes.

$F' : f = A : a = \frac{M^2}{D^2} : \frac{m^2}{d^2}$ If the 4 masses weigh 17 gms each

we have $A : 6.7 \times 10^{-5} = \frac{2 \times 17^2 \times 10^2}{3^2} : \frac{1}{1}$ $\therefore$

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$A = \frac{6.7 \times 2 \times 289 \times 10^{-3}}{9} = 13.4 \times 32 \times 10^{-3} = .43$

$v = \frac{Al}{m}$ $\quad$ If $l = 60$ sec. $\quad v = \frac{.43 \times 60}{34} = .76$ cms per sec. after 1 min.

$s = \frac{Al^2}{2m} = \frac{.43 \times 3600}{68} = 23$ cms passed over in 1 min.

Density of the Earth.

Amer. Journ. Sci. XXIII 51 Jan. '82.

Maskelyne	4.71
Carlini	4.84
Cavendish	5.48
Airy	5.418
Cornu + Baille	5.56
Reich	5.58
Baily	5.66
Jolly	5.69

It would be well to begin with lead nuts supported on a beam made of 3 glass tubes drawn out or possibly 1 full sized tube.

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Thermo-battery as Gun-motor.

Nov. 16, '81.

Thermo-battery runs by Gun & diffused & floating in lake. Alternate copper & iron bars 1" x 1/8" x 1/8" Area 1 ft² Diff. temp. 10° C Cobalt #6.

EMF 1870 volts 1.5 ohms .58 webers .05-.05 kgmms

∴ 20 ft² = 1 kgmm. or 15-00 ft² = 30 x 5-0 = 1 h.p. or 27 h.p. per acre.

W = work C = current R = resistance T = time

$W = C^2 R T$ $\therefore \frac{W}{T} = C^2 R$ 1 weber = $C^{+8} \times 10^{-1}$ abs units

1 ohm = $R \times 10^9$ abs. units 1 erg = $C^2 R T$ ∴ 1 weber through 1 ohm =

$C^2 R \times (10^{-2} \times 10^9 = 10^7) = \frac{W}{T} \times 10^7 = 10\,000\,000$ ergs = .1+ kgmm nearly.

∴ 1 weber through 760 ohms = 1 horse power.

9.8 weber ohms = 1 kgmm. per sec.

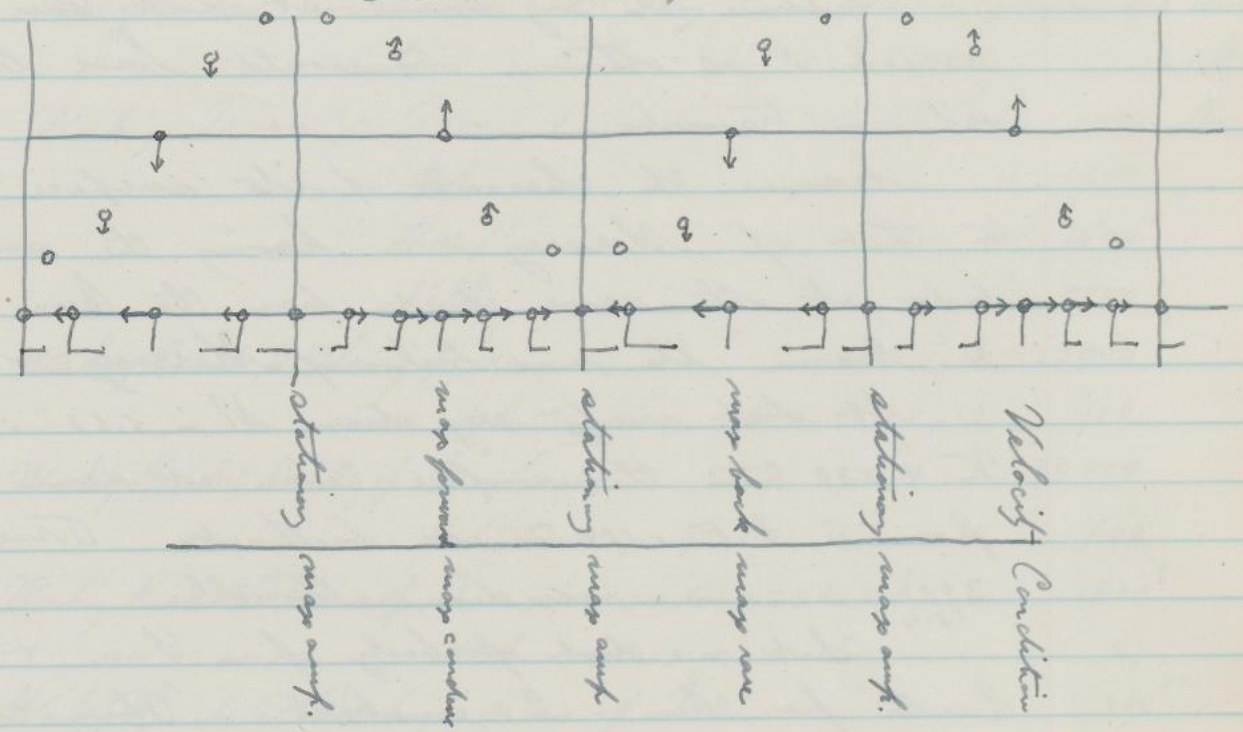
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Illustration of Wave Motion.

Dec. 12, 80.

Direction → of Waves



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Vulcan.

June 2, '81.

Assume its ang. diam. at dist. Sun does not exceed .5" as otherwise it would have been observed in transit.

Assume the character of its surface similar to that of Mercury & ∴ having the same albedo at the same dist. from the Sun

Assume the map. bril. of Mercury = −2. mags.

At dist. unity ang. diam. M is 6.68" ∴ 13.4 diam V. & 180 times the surface. Hence at same dist from S. & E. 180 times as brilliant. True diam V. $\frac{3000}{13.4}$ = 220 m = map. diam. allowable.

Let x = dist of body from Sun & a = dist. Earth from Sun. C = constant. Then the total light given out by a body $I = \frac{C}{x^2(a-x)^2}$

In present case $I = \frac{1}{180} = \frac{C}{4^2(10-4)^2} = \frac{C}{16\times 36} = \frac{C}{576}$ ∴ $C = \frac{576}{180} = 3.2$

Applying the formula we get the following results where x is expressed in even millions.

Elong.	x	I	mag. less than M	map. mag.
30°	40	$\frac{1}{180}$ = .0056	5.6	3.6
15°	20	.0125	4.8	2.8
7.5°	10	.040	3.5	1.5
3.8°	5	.142	2.1	.1
2.2°	3	.38	1.0	−1.0
1.5°	2	.82	.2	−1.8
.7°	1	3.27	−1.3	−3.3

Assuming dist. = 20 000 000 & inclin. orbit 15° area to be searched would be 30° × 7.5°. Period by Keplers Law $1^3 : \frac{1}{2}^3 = 88^2 : x^2$ x = 29 days. If dist. = 10 000 000 miles period = 10 days.

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Strength of Materials.

May 16 (?) '81.

A cyl. bar cast iron 1 ft. long & 1 in. in diam. weighs 2·6 lbs.
" " " ash " " " " " .25 lbs.

Working Tenacity - Iron 1 in. in diam. $\propto d^2$ Coef 3 17000 lbs
Ash 10 1300
Hemp 5 1600*
Silk 5-† 8000
Working Resist. to Shearing of Iron " " 3 13000
Ash 10 110
Working Resist to Crushing of Iron (cast) " " 3 29000
Ash (direction grain) 10 700
Working Resist to Torsion of Iron 1 in. in diam $\propto d^3$ 1800‡
Ash 27
Working Resist to Breaking across of Iron " 900**
Ash 14**
Iron 15·00§
Ash 5·0§

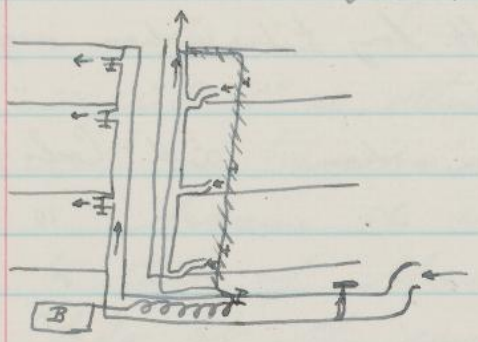
Coef. means Coef. of Safety. Where not stated in table it is (probably) given in Rankine.
* "Strength of Materials" † Taken same as hemp ‡ Rankine p. 356
** Rankine p. 355 § Rankine p. 634.

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Ventilation.

Feb. 18, 1882.



The outside air after passing the main valve is heated by steam to about 70° and is fed out at the ceilings of the rooms. A second tube carries the foul air from the floors out at the roof. Valves regulate the relative supply to the rooms. Thermometers are placed in the outflowing & inflowing pipes & an thermometer can be introduced A metallic thermometer in the exhaust main regulates electrically the main valve. A wet & dry bulb indicates the amount of steam to be let into the induction main. Other steam valves are unnecessary. The most important temperatures & wind velocities are taken in the exhaust main. By having the induction ports at the top of the room draughts are avoided. Open fires may be used to warm oneself when in from a walk, & for appearance sake.

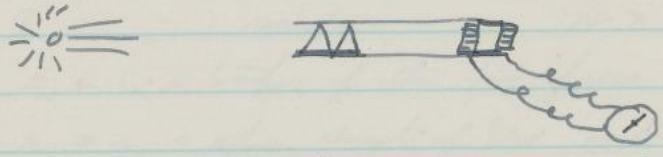
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Photometer

Nov. 1, 1883.

The object of this instrument is to do away with the Standard Light altogether, & also to be independant of the eye as an instrument.



The light shines on a thick violet prism which transmits the yellow rays to a thermo-pile. The deflection of a Thomson galvanometer then indicate the amt. of energy of that wave length received.

A sheet covered with Ag Cl might be substituted for the thermo-pile. In that case it would be surrounded by a layer of powder consisting of flour with a little lamp black mixed with it - say 1%.



Possibly external radiation could be better cut off from the thermo-pile if an ordinary prism were used.

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Scale of Temperature.

Nov. 9, '83.

Determine high temperatures by direct radiation on thermopile. Construct a scale which may or may not agree with the absolute centigrade.

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Sun Motor (see p. 5-5.)

Nov. '83.

Theoretical efficiency of a Therma-pile used as a Sun Motor.

E = total E.M.F. $\quad e$ = EMF of 1 pair

C = " current $\quad c$ = current " "

R = " resistance $\quad r$ = resistance external

t_1 & t_2 = temps. of the two faces $\quad n$ = no. of couples

r_1 & r_2 = spec. resist. of two metals. $\quad l$ = length of pair

a_1 & a_2 = area of surfaces of two metals $\quad k$ = thermal conductivity

T = time in seconds.

$$E = en(t_2 - t_1) \qquad R = \frac{2 r_1 k n}{a_1} + r \qquad r_1 a_2 = r_2 a_1$$

$$\frac{r_1}{a_1} = \frac{r_2}{a_2}$$

$$C = \frac{E}{R} = \frac{n e a_1 (t_2 - t_1)}{2 r_1 k n + a_1 r}$$

$$W = C^2 R T = \frac{E^2}{R} T = C E T \text{ in amp volts.}$$

$W = C E T \times 10^7$ cgs units $\therefore$ $W_1 = \dfrac{n^2 e^2 a_1 (t_2 - t_1)^2 T \times 10^7}{2 r_1 k n + a_1 r}$ ergs used

$$W_2 = J Q = \frac{2 n k a_1 (t_2 - t_1) T \times 4.2 \times 10^7}{l} \text{ ergs wasted.}$$

Let $n = 1 \quad e = .00\ 00\ 16 = 16 \times 10^{-6} \quad a_1 = 1 \quad (t_2 - t_1) = 1$

$T = 1 \quad r_1 = 1 \times 10^4 \times 10^{-9} = 1 \times 10^{-5} \quad l = 1 \quad r = 0 \quad k = .18$

$$W_1 = \frac{1 \times 256 \times 10^{-12} \times 1 \times 1^2 \times 1 \times 10^7}{2 \times 1 \times 10^{-5} \times 1 \times 1 + 0} = 128 \text{ ergs used}$$

$$W_2 = \frac{2 \times .18 \times 1 \times 1 \times 1 \times 4.2 \times 10^7}{1} = 15\text{-}120\,000 \text{ ergs wasted}$$

I doubt the accuracy of the calculation but the principle is correct in general.

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Density of the Stars in Space.

Nov, '83.

r = dist. l = light v = vol. of shell. $r = \frac{1}{\sqrt{l}}$

$v = \frac{4\pi}{3}(r_1^3 - r_0^3)$ $r = \frac{1}{\sqrt{10^{-.4}}} = \frac{1}{10^{-.2}} = 10^{.2}$

Dist. of 1st mag. star = 1. $v = c(10^{.6} - 10^{0}) = 4. - 1. = 3.$

Mag	light	dist		r_1^3	no.	ad.	Stars	dens $= \frac{\text{star}}{\text{vol}}$
1	10^{0}	10^{0}	= 1.0	10^{0}	1	1	10	
2	$10^{-.4}$	$10^{.2}$	= 1.6	$10^{.6}$	4	3	10	3.3
3	-.8	.4	2.5	1.2	16	12	37	3.1
4	-1.2	.6	4.0	1.8	63	48	128	2.7
5	-1.6	.8	6.3	2.4	250	186	310	1.6
6	-2.0	1.0	10.0	3.0	1000	750	1016	1.4
7	-2.4	1.2	16.0	3.6	4000	3000	4328	1.4
8	-2.8	1.4	25.0	4.2	16000	12000	13598	1.1
9	-3.2	1.6	40.0	4.8	63000	48000	57960	1.2
9.5	-3.4	1.7	50.0	5.1	125000	62000	237544	
10	-3.6	1.8	63.0	5.4	250000	186000		1.3

The "Durchmusterung" gives the faintest stars observed as 9.5 mag. They are more probably 10 mag but both values have been calculated the latter giving a straight line nearly, when plotted with the mean distances bet. the mags. for abscissae & dens. for ordinates.

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Inventive Faculty.

Apr. 14, 1880.

The following Chronological List is made out to illustrate through different years the development of my brain in the direction of original ideas. It also shows in which months it is most active. It will be noticed that hard study has little or no effect on the flow of ideas. This may be best seen by the Curve . In the winter of 74-75 I was in the Advanced Class E.H.S. and had to study comparatively little; in 76 I entered the M.I.T. & studied harder, next year harder still, then still harder so that in Mar Apr & May '78 I could think of hardly anything save my studies. Get these three months are well represented. The latter ~~early~~ part of '78 I studied hard and the early part of '79 I was very busy on my thesis. The latter part of '79 my Telephone ideas occupied all my thought. One reason of the sharp rise in Feb. & Mar. 1880 is that I was busily copying into my Note Books all the ideas of previous years, & improvements & new ideas naturally arose from it. In mid-summer there is a regular decline during the summer vacation & I think there is one also about Dec. & Jan. The maximum portion of the year seems to be in Mar. & Apr. & the continuation of the curve ~~should~~ on the left, should extend as an unbroken straight

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line for 18 inches back from Feb. 1878. In the Chronological List the following abbreviations have been used: T. No., Total Number of Ideas Physical & Metaphysical. Month, Month or probable Month in which the idea occured to me. No. P., Number of Inventions which admit of Physical Proof & are wholly or in part new to Science so far as I am aware. In., Index letter under which the idea will be found. V., Value. P., Probability. E., Expence of Time or Money. For further particulars see Explanation of Index Page 180. Several names inserted in the Index have been omitted here, namely:- all those known to have been suggested by other persons; all those marked n. w. (not worked up); and all those which although included in the Note Books, I now consider valueless, and have marked 0 under the probability column; and all these repetitions, where the work comes under two different years but no entries of original ideas are added to the first ones. In some cases for instance "Electricity & Light, Connection between" distinct ideas occurred on the respective years. The final marking as given in the Index & in the last year is 3 2 2 but in the previous years the probability of success would only have been 1 and is so marked.

Apr. 25. Taking Edwards's valuations of my best inventions, we find that if they average about the same for the different years, but the average rises a little towards the end; indicating that

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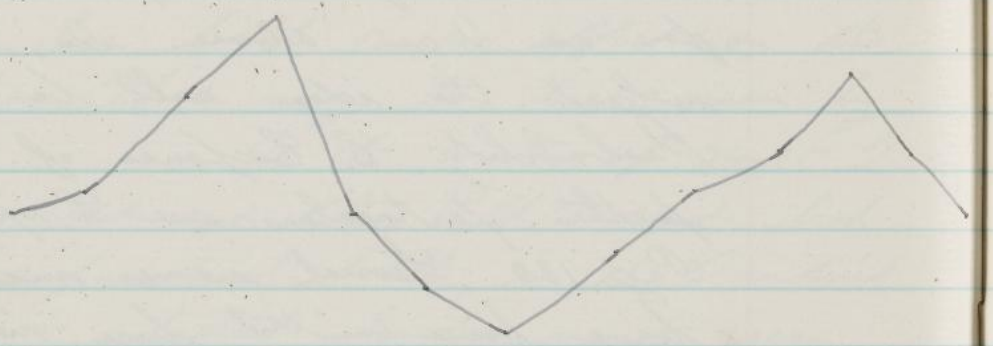
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Yrs.	Av. Vol.
74	2
75	—
76	3
77	1.8
78	1.9
79	2.1

I may have been more strict in the last years than I was at first. Taking all my inventions up to Jan 1800 and adding them together by months we get the following list:—

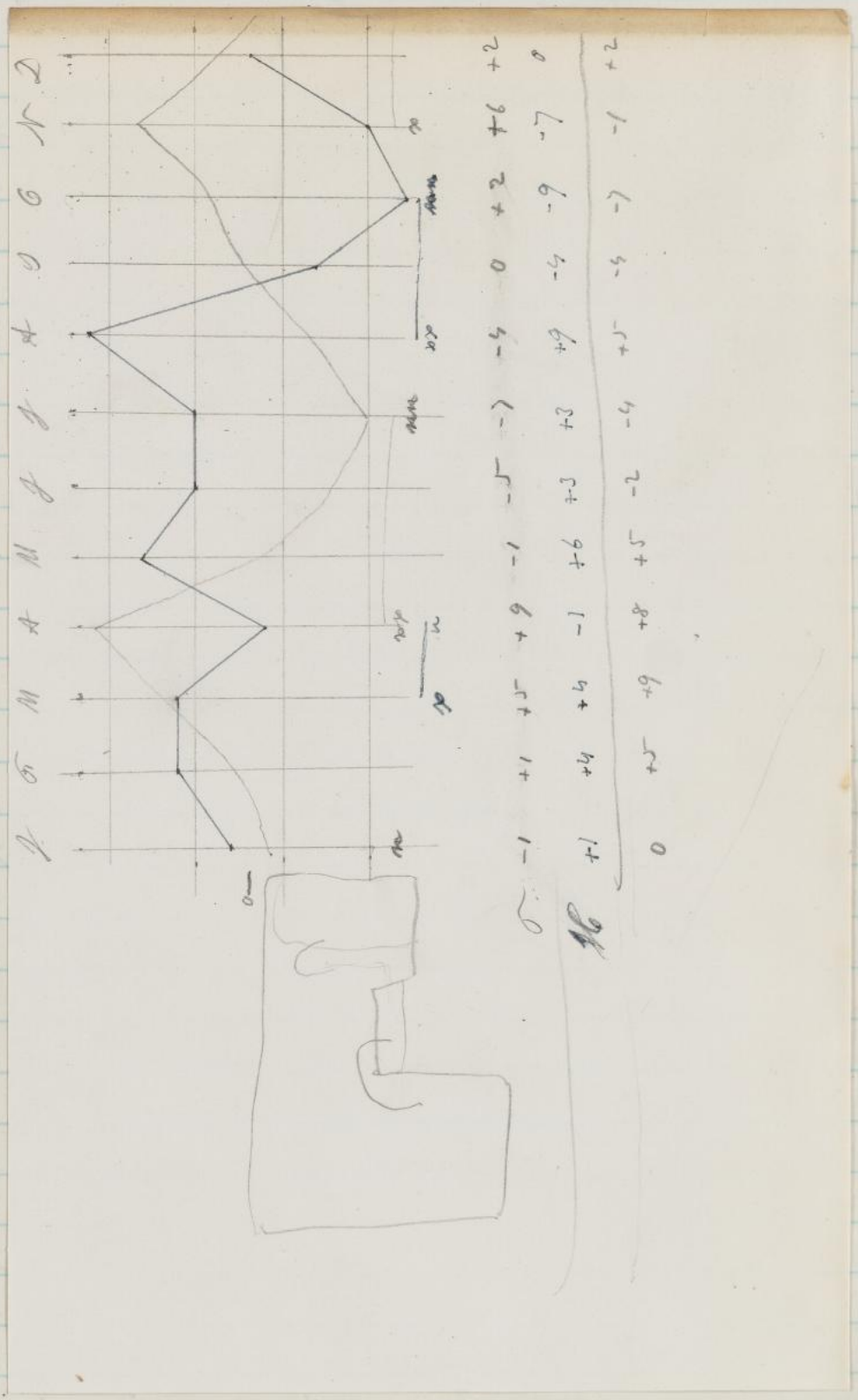
J	F	M	A	M	J	J	A	S	O	N	D
7	8	13	17	7	3	1	5	8	10	14	10

Which may be graphically represented by the enclosed curve. This shows very well the maximum and minimum points of brain activity.



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Chronological Order of Inventions. Apr, 10, 1880.

T. No.	Month	No.	In.	V.	P.	E.
		1872				
1	Oct	1	E	1	2	2
		1874				
2	Apr	2	G	1	C	3
3	June	3	E	3	1	2
4	Oct	4	F	3	2	2
		1875				
5	Mar	5	A	3	1	2
6	"	6	R	1	2	2
7	Sept	7	M	1	3	3-
8	"	8	P	1	3	3
9	Oct	9	W	1	C	2
10	Nov	10	O	1	2	2
11	Dec	11	B	3	1	1
		1876				
12	Jan	12	M	2	2	1
13	"	13	A	3	1	2
14	June	14	P	1	C	3
15-	Dec	15-	R	1+	2	2
		1877				
16	Jan		G	II	C	3
17	Feb	16	K	1	2c	3
18	Mar	17	B	1	3	3
19	Apr	18	B	1	3	3
20	"	19	E	1	3	2+
21	"	20	M	3	2sp	2
22	"	21	M	2	2c	3
23	"	22	P	1	3	2

T. No.	Month	No.	In.	V.	P.	E.
		1877 (continued).				
24	Apr	23	R	2	2-	2
25-	May	24	B	1	2	2
26	"	25-	E	2	2	2
27	Oct	26	A	3	1	2
28	"	27	A	3	1	1
29	"	28	D	3	1	1
30	"		F	II	C	3
31	"		V	I	C	3
32	Nov		F	I	C	3
33	"	29	P	2+	3	2
34	"	30	R	1	3	2
35-	"	31	G	3	3	1
36	"	32	N	1	2+	3
		1878				
37	Jan	33	P	2	C	2
38	Feb	34	O	2	2	1
39	"	35-	P	1	3	2
40	"	36	T	3	2	2
41	Mar	37	E	3	1	2
42	"	38	G	2	3	2
43	Apr	39	A	2	1	1
44	"	40	G	1	2	2
45-	"	41	V	1	1c	3
46	May	42	A	1	3	3-
47	"		V	I	C	3
48	July	43	E	2	3c	1
49	Sept	44	E	3	2sp	2

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J. No.	Month	No.	I.	m.	V.	S.	E.
	1878 (continued).						
50	Sept.	45	T	3	1+	^	2
51	Oct.		E	II	-	c	3
52	Nov		B	XX		c	3
53	"	46	D	3	1		1
54	"	47	N	3	1+		1
55	"	48	T	1	2+		2
56	Dec	49	G	3	2		2
	1879						
57	Jan	50	A	1	3		3
58	"	51	M	3	2-		2
59	"	52	P	1+	3	^	3
60	Feb	53	E	3	2		2
61	"	54	O	1	c		3-
62	"	55	Y	2+	1		2
63	"	56	T	3	2		2
64	Mar	57	B	1	c		3
65	"	58	L	1+	3	^	2
66	"	59	E	3	1		3
67	"	60	M	1	c		3
68	"		P	X	c		3
69	"	61	R	1	c		3
70	"	62	Y	1	2		2
71	"	63	Y	1	2		2
72	Apr	64	K	1	2		2
73	"	65	E	1	c		3
74	"		Y	I	c		3
75	"	66	M	2	2		2+
76	"	67	P	2	2		2

J. No.	Month	No.	I.	m.	V.	S.	E.
	1879 (continued).						
77	Apr	68	P	2	3		3
78	"	69	Y	1	3	^	3
79	May	70	B	1	2		1
80	"	71	G	3	2		2
81	"	72	W	1	c		3
82	June	73	E	1	1		3
83	Aug	74	A	3	1		2-
84	"	75	T	1	c		3
85	"	76	M	1	3		2
86	"	77	P	1	c		3
87	"	78	Y	3	2	nf	2
88	Sept	79	L	1+	2		2
89	"	80	M	1	3		2
90	"	81	O	1	2		2
91	"	82	T	3	1	^	2
92	Oct		M	I	c		3
93	Nov	83	D	1	c		2+
94	"	84	L	1+	c		3
95	"	85	M	1	3		1
96	"	86	T	2-	c		2
97	Dec	87	Y	2	3		2
98	"		T	XXX	c		2+
99	"	88	M	1	2		3
100	"		Y	XXX	c		3
101	"	89	O	2	2		1
102	"	90	Y	2	2		1
103	"	91	T	3	1+	^	2

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T. No.	Month	No.	Im.	V.	P.	E.	T. No.	Month	No.	V.	P.	E.
		1880										
104	Jan		M	II	c	3						
105	"	92	P	3	2	2						
106	Feb	93	B	1	3	3						
107	"		E	I	c	3						
108	"	94	G	3	2	2						
109	"	95	G	3	2	2						
110	"	96	M	2	c	3						
111	"	97	T	3	2	2						
112	Mar	98	B	1	2	3						
113	"	99	B	1	c	3						
114	"	100	E	1	3	3						
115	"	101	T	1	c	3						
116	"		J	~~XI~~	c	3						
117	"	102	L	2	2	3						
118	"	103	M	3	2	2						
119	"		M	~~X~~	c	3						
120	"	104	M	2	2	3						
121	"	105	M	1	3	3						
122	"	106	P	2	3	2						
123	"	107	P	1	3	3						
124	"	108	P	1	c	3						
125	"		T	II	3	3						
126	Apr	109	J	3	1	2						
127	Jan		M	I	c	3						

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Summary of Inventions

Apr. 14, '80.

The following Summary includes all the Ideas mentioned in the list, ~~or not~~ in which ~~both~~ neither V nor P ~~exceed~~ are not is less than 2.

1	1874	Flyer	3	2	2	2[x]	1
2	1876	Sun-Motor (using SO_2)	2	2	1	3	1
	—	~~(Rapid) Repetition of Notes~~	1+	2	2		
3	1877	(Theory of) Molecular Forces	3	2nd	2	1	1
4	"	Molecular Motions	2	2°	3	3	2
	—	~~Rabbit, Experiments on~~	2	2	2		
5	"	Electric Light, Regulator for	2	2	2	2	3
6	"	Propellers, Marine	2+	3	2	2	4
7	"	Submarine Boat	3	3	1	1	5
8	1878	Photometer, Spectroscope	2	c	2	3	1
9	"	Oxygen, Method of obtaining	2	2	1	2	2
10	"	Temperatures, Measurement of High	3	2	2	1	3
11	"	Sounds, To measure the loudness of	2	3	2	3	4
12	"	Eclipse, Total Solar	2	3°	1	2	5
13	"	Elements, Classification of the	3	2nd	2	1	6
	—	~~Telephone, Battery~~	3	1+c	2		
	—	~~Electrical Attributes, Definitions of~~	II	c	3		
14	"	Certainty, Scale of	XX	c	3	2	7
	—	~~Na, K, Co etc., Method of producing~~	3	1+	1		
15	"	Gravitation, (Small Apparatus)	3	2	2	1+	8
16	1879	Electricity + Light, connection bet.	3	2	2	3	
17	"	Temperatures, Measurement of High	3	2	2	2	
18	"	Molecules, Relative Dimensions of	2	2	2+	3	
19	"	Phonautograph Inscriptions	2	2	2	2	
20	"	Photometer for Comet Tails etc.	2	3	3	3	
21	"	Gravitation (Horizontal Pendulum)	3	2	2	1+	

[x] An independent set of valuations by Edward.

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Year	Name	V	S	E	Ed.
1879	Gravitation (Suggested by Holman)	3	2	2	
22 "	Stars, Theory of Variable	3	2 sp	2	2
23 "	Electrical Resistances, High	2	3	2	3
24 "	Financial Problems	~~XXX~~	c	2+	
25 "	Life, Future	~~XXX~~	c	3	
26 "	Observatory Domes, Warming	2	2	1	1
27 "	Stars, Velocity of the	2	2	1	1

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Notes on Indexs.

Apr. 15, 1880.

Abbreviations employed. Val. Value of idea supposing it perfectly successful. Prob. Probability of Success. Exp. Expense of Time or Money. B. Book P. Page. const. construction. The ideas are divided into three classes. First - those Inventions Views and Theories without the Realm of Natural Science & therefore incapable of Experimental Proof. These are marked I II & III according to their value, III indicating those ideas of the highest value. Second Collections & Simplified Representations of Known Physical & Mathematical Facts & Laws; marked I. II & III according to value. Third Discovered Facts, Laws, Observations, Calculations, & Inventions, complete & incomplete, probable & improbable. These are marked 0, 1, 2, & 3 according to value, + + - signs are also used, 3 denoting those ideas considered of most value.

Under Probability c means completed, ~~for~~ ~ partially completed, n.w. not worked up, & n.p. not proved as yet. 0 means impossible, 1 improbable, 2 possible, & 3 probable.

Under Expense 1 means that the carrying out the idea would involve considerable expense, 2 that it would require more than a week to complete the inquiry, & 3 that it could be done in less than a week. + & - signs are used 1+ or 2- indicating that both time & money would

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be needed. A certain choice is made in selecting the book into which an idea shall be entered. A contains generally short accounts of ideas which have not received any very lengthy investigation. B contains astronomical ideas, and theories incapable of experimental proof. C contains those inventions on which some time has been bestowed, or which I intend to shortly investigate and D is devoted wholly to Artificial Flight. There are necessarily many exceptions to the above rules and they are intended merely to give a general idea of the arrangement. Many of my early ideas were noted down on loose scraps of paper these have been collected and Feb. 29, 80 I began copying them of them which were of value into my Note Books. The task was completed Mar. 26. Since then I have been working on the Index & List of Inventions besides noting down those Ideas which have occurred to me in the mean time. Five years hence in 1885 I may have to write my Index over again. It would be interesting then to give a second valuation to all my ideas.

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Index. Apr. 6, '80.

Name	Date	Val.	Prob.	Exp.	B.	P
Air in Room, Analyse	May 27, '78.	1	3	3-	A	35
Alcohol Engine	Apr. 22, '78.	2	1	1	A	10
Aluminum ($Al_2(SO_4)_3 + C_6$)	Mar 22, '75	3	1	2	C	151
" " ($Al_2(SO_4)_3 + 3K_2ClO_3$)	Jan · '76	3	1	2	C	151
" " (High Temperature)	Oct. 17, '77	3	1	2	C	151
" " (Low " ")	Oct 17, '77	3	1	1	C	151

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Am

Name	Date	Vol.	Pict.	Exp.	S.	P.
Anemometer (Simple const.)	Jan 10 '79	1	3	3	A	52
Astronomical Discoveries	Aug 26 '79	3	1	2-	A	40

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Ba

Name	Date	Val.	Prob.	Exp.	B.	P
Balance, Portable	Mar. 1, '77.	1	3	3	A	37
Barometer, Air	Mar. 30, '80.	1	2	3-	C	157-8
" " , Aneroid	May 27, '77.	1	2	2	B	6
" " , Tuning-fork	Feb. 23, '80	1+	3	3	A	8
Battery, Prove Contact-theory of	Apr. 29. '77	1	3	3	A	36

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Be

Name	Date	Val.	Prob.	Cap.	B.	P
Bicycle Calculations	Mar. 7, '80	1	C	3	A	12
" Gears	May 26, '79	1	2	1	A	12
"Black Drop" in Transits	Mar. 2, '79	1	C	3	A	38

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6a

Name	Date	Val.	Pict.	Exp.	B.	P
Cannon Cartridge	Dec. 29, '75	3	1	1	A	46
Carbon, Boiling Point of	Apr. 22, '79	1	2	2	A	38
Certainty, Scale of	Nov. 3, '78	XX	C	3	C	105
Chronograph. (Simple const.)	Apr. 29, '77	1	3	2+	A	36
Clearness of Atmosphere	Sept. 8, '79	1+	2	2	A	55
Chlorine, Dissociation of	Apr. 11, 80				C	168
Chronograph regulator	Mar. 11, 81.				A	57

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Name	Date	Vol.	Pub.	Cop.	B.	P.
Comet of 1858	Mar. 28, '79	1	30	2	B	11
Conduction of Heat	Apr. 6, '78	1	n.w.	2	A	85
Current, Carrying Power of a wire for	May '79	2	n.w.	2	A	36
Comparison of spectr. of gas. nebulæ	Mar. 19, 81				A	57
Comet, Photometric of	July 4, 81				A	57

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D.

Name	Date	Val.	Prob.	Exp.	B. P.
Daylight, Artificial (simply as an imitation.)	Nov. 11, '79	1	C	2+	C 141
Diamonds, Artificial	Oct. 17, '77	3	1	1	C 103
" " " "	Nov. 10, '78	3	1	1	C 103
Dyne, Apparatus illustrating	Oct. 4, '81.				A 38

E.

Eclipse, Aurorae during Total Lunar	Mar. 22, '79	3	1	3	A 39
" Observations " " Solar	July 29, '78	2	3	1	B 143

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Electrical

Name	Date	Vol.	Pag.	Ref.	D.	P.
Electrical Attributes, Definitions of	Oct. '78	II-	c	3	C	96
" Machine	Oct (?) '72	1	2	2	A	41
" Resistances, High	Dec. 31, '79	2	3	2	C	131
Electric Light, Regulator for	May 5, '77	2	2	2	A	47
" Poles, Differences between	Feb. 23, '80	I	c	3	A	9
" Units, Two Systems of	May (?) '79	I-	nw		A	38
Electricity and Light, Connection bet.	June 1, '74	3	2	2	A	42
also Mar. 28, '78. and Feb. 17, '79.						
Electricity on Milk, Effect of	June 29, '79	1	1	3	A	40
Electrolysis, Experiment on	May (?) '78	1	nw	2	A	38
Electricity, Mech. Equiv. of	Aug. (?) '77	3	nw	2	A	37
Electric Sparks, Sensitiveness of Face to	Apr. 15, '79	1	c	3	A	40
Electricity, Distribution of	Jan 23, '81				A	5-6
Electric Machine, Dynamo-	Feb 28, '81				A	73

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Electrical (continued)

Name	Date	Vol.	Pub.	Cop.	S.	P

Elec.

Elements, Classification of the	Sept. 29, '78.	3	2 ap	2	C	23
Ellipses, Apparatus for drawing	Mar 21(?) '80.	1	3	3	A	48
Ether Waves, Properties of	May (?) '79.	3	nov	2	A	38
Ether, constitution of	Jan. 23, '82.				A	56

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Fa.

Name	Date	Vol.	Pub.	Exp.	B.	P
Financial Problems	Dec. 6, '79	XXX	C	2+	B	71

Flight

Flight, Power required for	Mar. 26, '80.	1	C	3	D	28 & 30
Flyer	Oct. (?) '74	3	2	2	D	2 & 24
Flyer, Wedgelike action of	Aug. '79	1	C	3	D	3
Flying Machine	1868	3	0	2	D	1

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Flight (continued).

Name	Date	Vol.	Prob.	Exp.	B.	P.

Fo.

Force, On the use of the term	Oct. 24, '77	I	C	3	B	1
Friction of Brass and Wood	Nov. 21, '77	I	C	3	A	37

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G.

Name	Date	Vol.	Pag.	Cap.	B.	P.
Gas Burner, Hydrogen Phosphide	Dec. 23, '75	1	new	2	A	35
Gravitation, A Thing of	Feb. 23, '80	3	2	2	B	131
" " (Small Apparatus)	Dec. (?) '78	3	2	2	A	24
" " (Suggested by Holman)	Dec (?) '79	3	2	2	A	J-3
" " (Horizontal Pendulum)	May 4, '79	3	2	2	A	J-3
" " (Floating Sewer)	Feb. 21, '80	3	2	2	A	J-4
" " (At high Temperature)	Jan. 28, '81				A	71
" " " " "	" " "				A	72
" " " " "	June 13, '81				A	75
" " " " "	July 4, '81				A	76
" " (employing arm or moon)	July 3, '81				A	J-7

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H.

Name	Date	Vol.	Prob.	Exp.	B.	S
Hammock Tent for Camping Out	Dec. 17, '79	1	2	3	A	69
Holtz Machine, Current of Air from	Mar. 20, '79	1	c	3	A	9
" " " , Expts on	Feb. '77(?)	1	2 c	3	A	20
Hydrogen, Coef. Conduction of Heat for	Apr. 1, '77	1+	nw	2	A	36
Happiness, Theory of	Jan. 29, '82				B	159
" , Secret conduct of	~~Jan. 29, 82~~					

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1.

Name	Date	Vol.	Pt.	Exp.	S.	P
Intermercurial Bodies, To render visable	Apr. 1, '80	3	1	2	A	55
Inventive Faculty	Mar. 25(?), '80	XX	C	3	A	160

J. K.

Jupiter, Temperature of Apr. 15, '80 B 15-2

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L

Name	Date	Vol.	Pd.	Exp.	B.	P
Lamp Shade	Mar. 19, '80	2	2	3-	C	144
Life, Future	Dec. 25, '79	~~XXX~~	C	3	B	101
" , Statistics of Human	Nov. 1, '79	1+	C	3	B	80
Light from Non-Luminous Bodies	Apr. 3, '79	I	C	3	A	39
" , New Undulatory Theory of	Oct 26, '77	3	0	2	B	3
Logarithms, Exact multiplication by	Jan '77	II	C	3	A	31
Light, Mech. Equiv. of	Aug (?) '77	3	nw	2	A	37
Life, Theory of	May 25, '80				B	15-3

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No.

Name	Date	Vol.	Pub.	Exp.	B.	P
Magnetization of Bars	May (?) '79	2-	nw	2	A	38
Magnitudes of Various Quantities	Jan. 25, '80	II	c	3	B	136
Medium, Visit to a	Feb. 10, '80	2	c	3	B	120
Metric System, Objections to the	Mar. 14, '80	X	c	3	B	141
Meteorological Observations	Jan. 80	I	c	3	A	5-6

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Mi

Name	Date	Vol.	Pub.	Cap.	B.	S
Microscope for High Powers	Mar. 13, '80	3	2	2	A	67
Milky Way, True position of	Aug. 26, '79	1	3	2	A	40
" " " " " "	Sept. 4, '79	1	3	2	A	55

Mol

Molecular Forces, Theory of	Apr. 12, '77	3	2 m.p.	2	C	3
Molecular Motions	Apr. 15, (13) '77	2	2	3	B	145
also Mar. 16, '80						
Molecules, Relative Dimensions of	Jan. 19, '79	3	2-	2	C	166
" " " " " " "	Apr. 1, '79	2	2	2+	A	39
" " Absolute " " "	Sept. 25, '80				A	56
Morality	Jan 29, '82				B	165

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Mol. (continued).

Name . Date . Val. Prob. Exp. S. S

Mot-

Motors, Aerial		. Mar. 24, '80	1	3	3	D	23
Motor, Gun	(Using Sulph. Ether)	Sept. 8, '75	1	3	3-	A	45
" "	(Using SO_2 condensed)	Jan. 4, '76	2	2	1	A	36
" "	(Tide Mill)	Mar. 12, '78	I	new 2	3	A	35
" "	(Thermo Pile)	Nov. 18, '79	1	3	1	A	55-
" "	"	Nov. 16, '81				A	78
" "	" calculation	Nov. '88				A	85-

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Mob. (continued).

Name . Date . Val. Prob. Exp. B. S

Mea.

Musical Scales, A representation of Oct. 3, '79 I c 3 A 30
1

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N.

Name	Date	Vol.	Pag.	Exp.	B. S
Na, K, Ca, etc., Method of obtaining	Nov. 9, '78	8	1+	1	C 102

O.

Observatory Domes, Warming	Dec. 9, '79.	2	2	1	A	65
Oxygen, Method of obtaining	Feb. 11, '78	2	2	1	C	150
Ozone, Notes on	Nov. 23, '75	1	2	2	A	5

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P.

Name	Date	Vol.	Pag.	Exp.	B.	P
Parallax of the Sun + Stars	Jan 26, '80	3	2	2-	B	151
Phonautograph Inscriptions	Apr. 11, '79	2	2	2	A	39
Phonetic Spelling	Mar. 12, '79	X	C	3	B	66
Periodicity, To determine	Feb. 22, '84				B	91

Phot

Photometer, Color	Mar. 2, 80	2	3	2	C	15-6
" " for Comet Tails, etc.	Apr. 3, 79	2	3	3	B	148
" " Lamp	Sept 8, '75	1	3	3	C	15-2
" " , Mirror	Feb. 27, '79	1	C	3-	A	5-1
" " , " "	Mar. 20, '80	1	3-	3	A	5-1
" " with Revolving Disc	Apr. 29, '79	1	3	2	C	15-3
" " , Spectroscope	Jan. 18, '78	2	C	2	C	15-7
Photometric Comparison of Mg. + Stars	Aug. 6, '79	1	C	3	A	40
" " Observations of Vision	Jan 20, '79	1+	3C	3	C	110
Posterity-	Jan 29, '82				B	166
Photometer, (see Standard Light)	Nov 1, '83				A	83

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Phot. (continued)

Name . Date . Vol. Pub. Exp. B. S

Prob.

Profiles of Birds, etc.	June 26, '76.	1	C	3	D	7, 10+20
~~also July 10, '77~~ & Mar 23, '80	~~July 10, '77~~	+	C	8	D	H+20
" " " Bulbs for Drawing	~~Mar. 23, '80~~	+	C	8	~~D~~	~~20~~
Projectiles	Dec. 7, '80				A	5·6

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Prob. (continued)

Name	Date	Vol.	Prob.	Exp.	B.	S

Prof.

Propellors, Marine	Nov. 21, '77.	2+	3	2	A	37
" " , Testing Aerial	Feb. 10, '78	1	3	2	D	26
" " " " "	Sept. 30, '79	1	2	2	D	26

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Prof. (continued)

Name . Date . Vol. Prob. Conf. B. S

2.

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B.

Name	Date	Vol.	Prob.	Case	B.	P.
Rabbits, Experiments on	Apr. 15, '77	2	2	2	A	96
Radiation from inclined Surfaces	Mar. 19, '79	1	C	3	A	87
Reflector for Electric Light	Nov. 5, '77	1	3	2	A	11
Repetition of Notes, Rapid	Dec. 29, '76	1+	2	2	A	36
Rotary Engine or Water Meter	Mar. 13, '75	1	2	2	A	44

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S.

Name	Date	Vol.	Pt.	Exp.	B.	S
Siren for Sound Speaking	Apr. 27, 78	1	2	2	A	35
Soarer, Experiments with	Apr. 15, 74	1	C	3	D	144
Sodium absorption with Siren Light	Mar. 1, 79	1	2	2	A	38
Sounds, To measure the loudness of	Mar. 30, 78	2	3	2	A	35

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Name	Date	Vol.	Pag.	Ref.	B.	P.
Spectrum, Light of diff. parts of	Apr. 26, '79	1	3	3	C	153-4
" " , Photographic properties of	Mar. 9, '79	1	2	2	C	167
Stars, Angular diameter of	Feb. 16, '79	2+	1	2	A	50
" , Theory of Variable	Aug. 24, '79	3	2	2	B	149
" , Velocity of the	Dec 31, '79	2	2	1	A	55
Submarine Boat	Nov. (?) '77	3	3	1	A	14
Stars, Density of the — in clusters	Nov. '83				A	87
Spectra, Scale of lines in Stellar	Dec. 13, '85				B	171

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T.

Name	Date	Val.	Prob.	Exp.	B.	P
Telephone, Battery	Sept 21, '78	3	4-	2	C	1, 5-04+15
also Dec. 2, '79.						
Telephone Wood	Nov 30, '79	2-	C	2	C	122
" " , Magneto	Sept. 22, '79	3	1-	2	C	64+120
Telescopes, Magnefying Power of	Mar. 5, '80	II	3-	3	C	118
" " , Mounting for Astronomical [Suggested by Sci. Amer.]	Dec '78 (?)	1	3	1	A	5-5-
Temperatures, Method of producing High	Feb. 19, '80	3	2	2-	A	66
" " , Measurement of High	Feb. 24, '78	3	2	2	A	34
" " " " " "	Feb. 6, '79	3	2	2	A	49
Thermometer, Air	Nov. 1, '78	1	2+	2	C	100
Temperatures, Measurement of High	Oct. 31, '81.				A	57
Thermo-battery as Sun-motor	Nov. 16, '81.				A	78
Temperatures, High, Scale of	Nov. 9, '83.				A	84

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T. (continued)

Name	Dat.	Vol.	Pag.	Col.	B.	S

96.

Undulatory Theory, Arguments against	Oct. 26, '77.	I	c	3	B	3
Unit for expressing different quantities	Mar. 12, '75	I	new	3	A	95

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V.

Name	Date	Vol.	Pub.	Lab.	B.	S
Velocity of Intense Sounds	Apr. 29, '78	1	1n	3	A	26
" " " Transmission of Sounds	Nov. 6, '77	1	2+	3	A	37
Viscosity of Liquids	June 9, '77	1	3 new	2	A	37
Volumes of Vapors	May 23, '78	I	c	3	A	22
Vulcan	June 3, '81				A	80

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W.

Name	Date	Vol.	Pub.	Exp.	B.	P.
Wave Length, Determination of (suggested by Edlund.)	Mar. '80	2	2	2	A	98
Wave Length, Peculiarities of	May '79	1	C	3	A	18
Weather Vanes, Improvement in	Oct. 14, '75	1	C	2	A	98
Wave Motion, Illustration of	Dec 12, '80				A	79

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K, D, and E.

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Appendix

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