London 12 Sept. 1810

Mon Even: Mr Singer began his lectures for the season

— Plan 3 courses of 14 lectures each.

— First course courses of Statics, Hydrostatics, Hydraulics, Pneumatics, Optics, Natural Chemistry, and Meteorology.

— Second course Electricity

— Third course Electro Chemistry

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Lectures on Tuesdays & Fridays

Scientific Inst.ⁿ 12 Jan.ʸ 1811
Introductory Lecture Importance of the subject and best mode to be followed both by the lecturer and the student — This occupied three fourths of the Lecture — The subject and manner tiresome uninteresting —
He then considered the prop.ˢ of matter — Extension Divisibility — Infinite Divisibility Mathematical Demonstration Solidity — inertia. Drops of water drawn on a brass carriage with three wheels to shew the tendency of a body to continue in its present state — better shewn by the motion of a basin of water by the hand on the table

— The double fifty used in the R.ᵉ of the air pump, was set going on the table to shew the effect of resistance to motion — Another Experiment to the same purpose different weights made to descend by turning a wheel and axle having weights inversely proportional to the diam.ᵗ all these were intended to shew that friction and the resistance of the air bring the motions of all bodies to an end. Hence it is deduced that a body in motion would move for ever if every obstacle was removed. —

Mr. Bingen 13th Lecture ~~1810~~
Friday 23 Feb. — 1810

— Chemical properties of air
Difference between Mechanical
and Chemical properties —
— That an animal without a
supply of fresh air will die in
an obstruction — Light ex-
tinguished —
— History of the Chemical discove-
ries relating atmospheric air
Boyle, Mayo, Hales, Priestley, Caven-
dish Lavoisier &c. ———
— Atmospheric air composed of
two different Gases, Oxygen and
Azote — Former supports life and
flame the latter extinguishes both
Experiments with a taper — In Az:
Gas extinguished, in Oxygen Gas lighted
in a mixture of 80: and 20: in the
proportion of about four Az: to one Ox:
Same as in Atmospheric air ———

Eudiometry – Tube with part divided into cubic inches – Experiments with Nitrous gas – A retort with a long neck divided into cubic inches – held perpendicular in the water, the surface of which was at a certain division on the neck. A small bit of Phosphorus put into the body or other part of the retort, and set on fire by a candle held below – The diminution of the air in the retort was shown by the divisions on the neck This M.S thinks the best mode of ascertaining the purity of atmospheric air. Davy's Eudiometer Atmospheric air is found to contain at all times and in all situations nearly the same quantity of oxygen Gas – Instability of atmospheric air in some places owing, M.S supposes, to a quantity of Carbonic acid Gas, which has been found sometimes to the amount of 5 p Cent – He thinks this cause has not been noticed before by Philosophers. – Oxigen Gas from a Gas holder sent up the inner tube of a Argand's lamp, did not produce any remarkable effect, nor when blown on the flame of a candle. —

– for this Custom M.S– explained the action of the Lungs – Lungs Glass. – Effect of breathing – Heat – red colour of the blood.

+ Dr Priestley, and M.S, invented many useful experiments, but he adapted them experiments to a preconceived theory instead of deducing his theory from the experiments. — M. Lavoisier broke a large air pump receiver by burning Phosphorus in Oxygen Gas. The same took place.

Tuesday 27th Feb.y 1810

Mr Singer's 14th Last Lecture of this 1st Course.

— Short recapitulation of the former Lectures — Respiration — Animal heat in proportion to the size of the Lungs — Table of animals — hot and cold blooded — Quadrupeds, Birds down to frogs, worms

— Lungs — Cells — small holes in different parts of the Body for breathing:

— Calorie — expands bodies not by its repulsive, but by its attractive power

— Conductors of heat very different Cast a brass wire and glass rod of the same thickness with each a piece of sealing

on one end of both was hot
over the sand bank at about
an inch from the bar. That on the
iron melted much sooner than the
other — Different colored clothes
— Principle of cold country wool
fine &c. —
— Mr. C condemns the com-
mon mode of heating rooms
by grate — says that means
we sit to the fire the colder we
are
— Different mode of heating room
Steam does not answer — best
flues with hot air below the floor
— Hydrogen and Oxygen form water
Decomposition shown afterwards
Composition — Inflation air blow
from a bladder through a
small pipe set on fire and
burned under a receiver placed
in water vessel — Explosion of
a mixture of Oxige and Hydrogen

water decomposed by vegetable
respiration to the rays of the sun
The Hydrogen enters the plant
and the oxygen is set free.
— A quart of oxygen of the atmosphere
by the breathing of one man, and
the burning of one candle —
Atmosphere renewed principally
by the vegetable Kingdom —
Decomposition by the
Oxygen not destroyed, but only
changed its state — No body an-
hilated. When deprived of its ca-
loric, oxygen is reduced to its solid
state.
— Springs caused not by capillary
attraction of water from the sea,
this would not take place to such
a distance as the source of the
Nile and other great rivers
— Springs owing to the great quan-
tity of rain that falls on mountains
— Intermitting springs have been

explained by Ferguson and others by supposing a syphon like passage to the water from the cavity or reservoir—
Dr Dalton's account is that when the cavity has a wholly bottom it fills and runs over—When a sandy or gritty bottom the water will ooze through it and the stream be constant.
—They have more rain in a mountainous than in a plane country.
—Hygrometry—various degrees of rain—Journey, Cats walking behind his ears &c—
Marble floors in the lower parts of houses moist.
Tried Hygrometer a London one a present by Mr Boyle—found a height of Inches
—Pound of the best oat, sweet other vegetable substances
—Whale bone, Human hair—Sponge or many Inches of paper on a balance—
—Glass of cold water from a well when brought into a warm room condenses the water on out side of the glass
Mr Dalton recommends this as the best Hygrometer for indicating rain. If the difference between the temperature of the cold water and the air be only a degree or two then rain may be soon expected; but if ten degrees, then it cannot rain that day. In winter the water must be cold artificially to occasion moisture on the outside of the glass.
This Hygrometer exhibits the real fact—real rain is occasioned in the same manner by condensation, as the outside of the glass

— mineral water —
— Exp. com. Salt in water
by Nitrate of Silver —
— Iron by prussiate of Alkali
— Copper by ammonia —

At the conclusion of the
lecture M. S— read from
the Rambler the advantages of living
in a Garret — high situations
& this was, I think, ill timed

Tuesday 6 March 1830 —
1 Lecture of M. Singer's 2
course — Electricity —
M. S. has printed outlines
to every Lecture —

Introductory — Nature of Electrical Science — Its utility and importance — pleasures derived from its cultivation — Plan of the present lectures — Sketch of the early stages of Electrical discovery with experimental illustrations — Invention and subsequent improvement of Electrical machines —

— History — Amber by Thales — Lincurium by Theophrastus —
Gilbert in 160 his treatise on the Magnet — Discovered a number of Electrics — Tried their effects with a small brass needle balanced on a point, like a mag-

petite needle, having two small
circular pieces of paper at the
extremities — This attracted by excited
Tourmaline, sealing wax, Glass tube
resin &c. — Other discoveries
have mentioned see D. Priestley
History
— Boyle — Dry objects more attracted
moister a conductor &c —
— Otto Guericke attempts with
W. Boyle — Sent Electrical
machine, Globe of sulphur.
— Hawksbee's Exper. and book
— Grays diff discovery of the Elect.
division of bodies into conductors
non conductors &c &c —
— Newton Experiment with the
Glass plate —
— Du Fay's discoveries — Resin-
ous and positive Elect. &c — New
Exper. — Papers given in to the
Roy. Academy of Sciences —
— Improvement of Elect machine
— Glass Globe with an axle plate
horizontally — when filled with
Atmospheric air the Elect. Light
is on the out side, when exhausted
on the inside. —
— Cylinder Machine — Nairne's
Improvement —
— Plate Machine by Ingenhousz
not approved at first — Improved
by Cuthbertson —
— Messrs. Cuthbertson and Singer are
now engaged in a series of Experi-
ments to ascertain the comparitive
power of the Cylinder and plate
machines. Nothing conclusive has
as yet taken place — The two seem
to be nearly the same power
when first in action in the
Lecture room. Plate is mounted
so as not to produce negative El.
This a great disadvantage.

Experiments

1 Amber rubbed on the arm attracts small slips of paper

2. Stick of sealing wax Ditto

3. Glass tube - Ditto

4 Ditto and feather - same due to the tube —

5. Newtons Exp! Glass suspended at the two ends on two books about an inch from the table small bits of paper below. -

6. A quarter of a sheet of writing paper, first warmed and then rubbed strongly with a bit of Indian gum, attracts the table on which it was rubbed strongly adheres to the wall of the room - laid on the upper metal plate of the Electrophorus, a spark may be taken from the other or under side of the metal - insulated -

7. A piece of Brown paper well dried and folded to about 2 or 3 inches in breadth, if this be rubbed hard between the arm and side it gives sparks of electricity. (then only insulated). —

8. When the small globe machine was rubbed by a piece of silk with amalgam on it, held in the hand below the Globe, circles of Elect. light appeared on the outside — when the Globe was exhausted of air, then were no circles on the outside, but the light appeared in the inside. —

9. The Glass tube first attracts a feather, then repells it.

W. L. does not admit of Electrical repulsion. He thinks that in this experiment, the feather is attracted by the air —

10. When a Glass tube with a cork in its [illegible] is rubbed, the cork attracts light bodies as well as the tube — The same thing takes place at the end of a long wire stuck into the cork

N.B. These were the first of a long series of Experiments by Mr Gray which ended in the discovery of conductors and non conductors of Electricity.

11. Brass hoop with threads tied to it, placed with the Globe machine within it. On working the machine the threads attracted towards the centre of the Globe. —

Friday 9th Month 1810

Lecture 2 Subject: Electricity

~~Continuation of part of~~

Excitation of Electricity considered — Circumstances of — incident to this phenomenon — appearances by which it is attended — Best means of producing them — Management of the Apparatus — Causes of Electric appearances, and Nature of Electric action, illustrated by numerous experiments

Recapitulation of part of last Lecture — Dr Franklin's discoveries and various Electrical Experiments on Conductors and Nonconductors —

+ Dr Franklin's Hypothesis —

— Capacities of bodies —
Sugar in hot, and cold water
Sulphuric acid and water &c.

— Electrical capacities — when
one body contains more and
another less, & the two are brought
into contact a quantity of Elec.
is given out when separated —
Positive and negative Electricity
always produced at the same
time — Expt. a bit of fur or
cat skin fold.d round a rod of
glass and rubbed with a stick
of sealing wax, the wax is found
to be negative and the skin posi-
tive — this Expt. made with the
glass tube, the tube is not
positive and the skin negative
— This was shown by two feathers
suspended by silk threads from
the extremities of a glass rod sup-
ported horizontally on an upright
stick of glass.

— It was long the opinion that
the Electricity was produced from
the Cylinder, that ~~no~~ conductors
have no electricity — It appears
however, says M. S. that conductors
have all the Electricity, and non
conductors possess no Electricity —
— Excitation on the Electrical
machine — The simple con-
tact of the amalgamated
rubber with the cylinder produ[ces]
Electricity along the line of
contact, when by the turning
of the cylinder this line is
removed the Electn becomes in-
sulated, this is followed by another
&c till the accumulation be-
comes great. —
— Tin amalgam. Mr S. thinks Kien-
mayer's the best — How laid on
— after applied, a little tallow or
lard on the hand applied to the [illegible]
cylinder, will generally render the M. power[ful]

– A new theory of Electricity has been published, which asserts that there are two electricities, one composed of Caloric and Oxygen Gas, the other of Caloric and Nitrogen the former produces positive the latter negative Electricity This Hypothesis is overturned by Mr Davy's Experiments – In oxygen Gas the Electrical Machine acted scarcely better than in Atmospheric air in Carbonic acid Gas, the machine acted much more powerfully than in Oxygen Gas or Atmospheric Air – Carb: acid Gas contains no azote. –

– attractions alone will account for Electric phenomena –
– Wilkinson's figures for Demonstr –
His own — Negative, not satisfactory
– Davie's, his ~~[illegible]~~ Explanation not satisfactory –
– Comparative advantage of a wheel

Tuesday 13th March 1810

3 Lect. Electricity

— General consideration of Electric phenomena — Incontestable proofs of the corporeal nature of Electricity — Luminosity of Electric light and its divisibility in appearance — Electric illuminations, comprising a very brilliant series of illustrations.

Negative and positive Electricity — Effects of heating iron and small steel & glass — Small brass conductor with two pith balls hanging from one end — being brought near one end the balls diverge as the other

The former end is positive, the ball negative. While the wire remains in position over the [illegible], touch the conductor with the finger and the balls will collapse, when the finger is withdrawn at the same instant the balls will again diverge. — with positive Elect.

— two, and those small conductors were made use of in these Experiments, the wire of brass about 14 or 15 Inches long and an inch in diameter, with balls on the ends. —

— Inverted Electricity! —

Mr. S. — Heard, at the commencement of the Lecture, the figures on the board for his demonstrations that attraction will account for the divergency of balls negatively Electrified

Mr. Singer says that there is no use for repetition in any part of Nature —

Experiments

1. Read - pocket memorandum.
2. An three downy feathers — in the darkroom
3. Points possitive, and negative - star - pencil -
4. From the positive ball to the negative - to ascertain the direction of the electric fluid
5. Short spun glass tube, thin glass
6. Ditto longer white glass.
7. Ditto, wheat and grain sugar Diamond and Emerald
8. Ditto - Diamond and ruby
9. Spangles 3 feet long, over the whole length.
10. Gale way
11. Ornament for the corner of a room
12. Light, acted well.
13. Singer - thin acted badly
14. Spirit round a large cylindrical jar - was beating the whole did not act.
15. - Pasteboard - Glass plate 15 Inches diameter - on this a brass hoop was supported by three glass feet, at about 2½ Inches above the plate - on this plate a ball of glass 2 to 3 feet Diameter rolled round on this the brass hoop which hoop was connected with the conductor of the machine

— In the course of the Lecture Mr. S— mentioned an opinion of a Mr. that some bodies might conduct the positive

Electricity and intercept the negative, and Vice Versa. ~~If that~~ the one Electricity might pass through the other! —

+ To prove that Electricity is material

16. A little sealing wax was stuck on a wire inserted in the conducter. Some wax was blown in very fine threads, on a paper held at more than a foot distance from the wax.

17. Bucket and capillary tube in the bottom. Shewn by drops in the inside

N.B. The Experiments noted above are not always in the order in which they were performed

Friday 16th March 1810.

Lect: 4— Electricity Mr Singer

Consideration of the Electric Spark and its Divergation; sound, motion, form and light — Influence of different surfaces and Masses, on the Spark — action of Balls and points — Theory of Electric light — Effects of the Spark on various substances

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Exp.s

1 Deflection from a small fountain Electrified

2. Experiment Flame between two balls the one on the negative, the other on the positive conductor. The flame seemed to incline most to the negative conductor. The

ball connected with the nega-
tive conductor grew hot the
other remained cold – this shewn
by a piece of wax put on ~~ball~~
each. – In this Experiment the
latter was always placed near
the negative ball – it ought to
have been in the middle. —

– Effect of different sized balls in
taking sparks —

– Zig Zag form. Length regulated
by the size of the ball – the
largest ball about 5 inches &
other down to a point

– A large brass, and a still larger
Tinfoil conductor. The former on
a glass support, the latter sus-
pended from the ceiling by silk
cords — a great variety sparks
taken from these in different
ways

– Points throw off by draw off
the electric matter at a greater
distance than round or flat
surfaces.

– Exp ball receiving sparks from
the conductor, a point at a greater
distance prevents the sparks

– Points act in proportion
to their length – Richard's Exp –
the points carried off much
less Elect.^y than one projecting
much farther from the body on
which they were placed.

– Nicholson's 5 Inch ball and point
were passing through it – sparks
taken with the point projecting
to different distances from the
surface of the surface of the ball

+ Sparks taken with a point
within a glass tube, strong
and the sound loud as on a ball.
also zig zag form

+ Point in a sponge take the same

+ Fergusons five prisms models all acted very well. —

— W. S. says that it is commonly said that the air in contact with the conductor is in a contrary state to that of the conductor, but he maintains that they are in the same state

— His theory of points is this. The conductor is surrounded by atmospheric air electrified in the same state as the conductor. The air being a bad conductor of elect[ricit]y prevents the electricity of the conductor from escaping. When a pointed wire is attached to the conductor it projects beyond that part of the electrified atmosphere next the conductor into a more distant part less electrified. The air in this part attracts the electricity from the point, and consequently from the conductor in a constant stream.

— W. S. likes the comparisons that has been made between points and tubes. It is true the action is similar, but very differently modified — In tubes the larger the diameter, more water is discharged; the reverse is the case with electrified points. Also the longer the tube, less water is discharged which is not the case in electricity

+ Hence I think the comparison improper, as it does not hold in the principal result the quantity of matter discharged

Tuesday 20th March 1810

Electricity Lect. 3 — Oersted

— History of the discovery of the Leyden Jar — Experiments to demonstration of its effects — Theory of its action — Cause of the vast accumulation of power in the Leyden Jar. Accordance of its phenomena with other electric appearances. —

— Von Kleist was the inventor of the Electric Charge — He used a glass phial with a cork in it — Afterwards used the arrangement with water in the phial and termed a shock. great surprise &c &c

— Improvements of D. Watson and Dr. Bevis. The former used an outside coating of shot but the latter used foil for the inside. The latter

coated both inside and outside with gold, silver, lead or tin foil

— Charging — Elect. attracted by conductors — Glass has no more Electricity when charged than when in its natural state.

+ The act of charging may be explained thus. The glass attracts the Elect from the conductor on one side and part of its natural share of Electricity is attracted from the the other side by conducting bodies

— Two plates of wood covered with Tinfoil, both insulated, if the under one be electrified by a spark from a charged jar the pith balls connected with it will diverge. If now the other plate held by its insulating handle be brought near, but not in contact with the under plate the pith balls converge, even

the plate and they diverge. This was explained by saying that two metallic plates when brought near each other have a greater capacity for Electricity than when separate —

— All the Electric jars were Cylinders, equally wide throughout.

jar charged, spontaneous discharge by two turns of the wheel.

+ Discharge by the discharging rod

— One jar charged at the out side of another — Different discharges.

— Some affirm that in charging the Electric matter penetrates the glass — This not so, says it abounds.

— His explanation of the great accumulation of the Electricity in the Leyden jar, I think not satisfactory.

— Passage of the Electric light shown by a charged jar — by the aurora borealis flash, and the luminous conductor, presented back to the positive and negative conductor of the machine. —

— Electrometers — quadrant Elect.r for all and every sort jar charge to 45° — The discharges very different. ——

Friday 23 March 1810

— Elect.y Lect. 6th M. Cuyp

— Further consideration of the Leyden Jar — Charge of a plate of air — Effect of Jars of different thickness — Comparison of the effects with the theory — Application of the process of the jar to experiment — Mode of forming a circuit — Nature of Electrometers and discharges — Influence of the charge on fluid and brittle bodies. ——

— Recapitulation of the mode of charging Jars and plates — Theory —

— A Pile of air charged — Two circular plates of wood about three feet in diameter covered

with Emeril. In the centre of the lower plate is fixed a pillar of Solid Glass. In the centre of the upper plate there is a wooden socket through which the Glass pillar passes and to which it may be made fast by a wooden ~~socket~~ screw in the upper part of the socket above the upper plate. By this simple contrivance, the plates can be readily fixed at any distance, and parallel to each other. This is a great improvement on Mr Nairne's construction of the ~~upon~~ instrument.

Expt. on this, first charging the plate of air between, when the Lower plate is connected with the ground a shock, when the whole is insulated, no shock but large sparks

Expt. with Charged Jars

+2 Small jars charged, discharged different ways

Discharging rod - with the arms - Electric shock -

+3 Methods of preserving Electric Jars - of fixing the wires in them - three modes, covered. Jars mounted, the best -

Mr Cuthbertson's mode. Two pieces of wood one at bottom the other near the top of the coating a tin tube between them. -

3. Electrometer - Quadrant by Mr Henley - Method by Mr Lane.

Proofs - Cuthbertson's the best - Jars discharged by it (see C° Elec)

4. Experiments with jars of different thicknesses. Greatest highest charge -

— Experiments —

5. To determine the direction of the Electric matter in the discharge of a jar — N.B. a very large jar was made use of in this and the following experiments —
— A card was placed between the balls of the universal discharger, on the discharge, the flame was thrown towards the negative side. —

6. A cork ball supported on two sticks of sealing wax on the U: discharger, was blown towards the negative ball. —

7. The rarefaction of the air in a small wooden gun threw a cork or wooden ball to some distance.

8. — Ditto — ~~with~~ when a few drops of water were put into the gun + Brunner too be have a solid ball of Glass an inch in diameter, by exploding

a small quantity of water in its centre. —

9. Ditto with a little oil in the gun or mortar. —

10. Slip of paper in the U: discharger torn to pieces and the fragments thrown into a considerable height above the table

11. Wafer — Ditto

12. Piece of wood splitted —

13. Straw round the same

14. — Spirits fired at the opposite end from the jar —

Spirits fired in the same manner by sending the shock through the water of the Thames by Mr Canton — then Expt of his —

Thursday 27th March 1810

Elect.y Lect: 7th – Mr Singer

– Effects of the charge continued
+ Destruction of cohesion, aggregation and combustion – Inflammation of Hydrogen Gas resin, Phosphorus, Gunpowder, Metals &c.
Explanation of these effects, a
<u>wire melted without burning a
thread in contact with it</u>

Exp.

1. Cotton with resin fired
2. Ditto on a strip of paper
3. Candle with resin lighted
4. Resin ⅔ the surface of water fired
5. Hydrogen gas in a bladder with a stop cock fired by a spark from the conductor – By Lenses – In a strong glass vessel – By the Ball of the

removes at discharger, the tube of the bladder six or eight inches below the bladder. This tube has a good effect

6. A mixture of Oxygen and Hydrogen gas fired different ways

7. Two inches of wire burned in Oxygen by a middle sized jar, in

8 heat expansion not when breathed into, burnt four inches of the same wire. In these experiments Cuthbertson Electrometer was used.

9. Great jar displayed eight inches of wire, without applying a thread in contact with it.

10. Different metals struck onto glass. Only one sheet of glass used, on which the foil was laid.

11. Spirits fired at both ends of the room at once.

Electricity according to Singer has neither light nor heat — It only emits light and heat from the bodies through which it passes, and from which it meets with resistance — The more resistance the more heat and light. All bodies contain both light and heat, says W. S — and Electricity contains

+ a bit of phosphorus was fired by a spark —

Friday 30th March 1810 —

Electricity Lect: 8th — W. Longe

Effects of accumulated Electricity.

Power of a large Electric battery —

Eight feet of steel wire melted at one Explosion. Gold, Platina, Silver, Copper, Iron, tin and lead melted and beautiful figures produced on paper by their Oxides. —

— Two batteries of 15 Jars each were employed in burning eight feet of Steel wire — The batteries were the same as Cuthbertsons each contained about 17 square feet of coated surface — The Leyden and plate machine very little used in this experiment. One of the batteries would have produced the same effect, but it is best to have a large

coated surface and not a high
charge, by this a spontaneous
discharge and breathing jar are
avoided —

— The different ~~wires~~ metals mention
above were in wires of different
thicknesses some 1/50 part of an
inch some more others less. —
In lengths from 4 to 5 inches,
stretched on two pins about
a quarter of an inch distant
from a piece of paper on which
the oxide appeared, beautifully
variegated — some were stuck
on a single slip of glass.
When there are two pins they
are generally broken by the
discharge. Cuthbertson's dis-
charging Electrometer was
used in all these Experiments.
— W.S. said he could burn a

wire in water, and this was a
proof that Electricity had no
heat, but that the heat was
elicited from the wire. — This I think
doubtful. —"

+ see Cuthbertson's Exp^t
in his late work on Elect^y —

— The increase of the charge by
breathing into the jar was
shewn — Charge about double.

+ When the two batteries were
discharged through a wire eight
foot in length there was very
little sound on the discharge.
But in the short wires the
Explosion was very loud, tho'
less so than when the discharge
is spontaneous — W.S. — did not
assign any cause — said that it
could not be owing to the resista

so commonly supposed. He thinks the more western the clouds would be the report. —

Sunday 3 April 1810

Electricity Lect 9th M. Singer

— Electricity applied to explain the cause of Thunder — Franklins Experiments — Lightning drawn from the clouds — mode of defending buildings from Thunder exemplified by models, an obelisk, a house on fire, explosion of a powder mill, ships mast &c. &c. —

M. S. began with a harangue on the utility of Science in general and of Electricity in particular — The importance of the subject of this evening's Lecture, the phenomena of Thunder —

— M. Singer first compared the Electric spark to Lightning, the his spark was very small when compared to what we can now produce. —

Dr Franklin — History of his discovery of the identity of Elect.ty and lightning —

Experiments —

1 Effect of points first discovered in America — Balls and points presented to the conductor. —

2. Great Jar discharged thro' M.r D— by a point —

3. Thunder house —

4. Obelisk —

5. Powder house —

6. Fan house — —

7. Ships in a vessel of water

Songs concluded with a grand Eloge on Franklin — as this was given after 2 o'clock, the rest of the toasts went away in the middle of it. —

Friday 6th April. 1810. —

Electricity Lect. 10th — Mr Singer —

— Origin of Atmospheric Elect.

Explanation of the nature and effects of thunder storms. direction for security from danger &c. &c. —

Half an hour employed in recapitulating the former lecture.

— Romas ~~in~~ Dangerous experiment with the kite — Richmond of Petersburgh, killed see Priestly's Hist.

— Expt. —

1 Zig Zag sparks

2. wire made red hot } $\frac{1}{150}$ inch

3. Ditto melted — }

4. Three bells with a pointed wire connected with them ring at a great distance from the Machine

5. Evaporation of water produces Electricity — The earthen ware crucible filled on the Gold leaf Electr— a little coal put in it and water thrown on it, the vapour highly electrified —

6. The same Experiment diversified — A metallic funnel of tin foil and Gold leaf within the tin, was placed over the crucible to receive the vapour as in the last experiment. The Electrometer touched the out skirts of this artificial cloud. It was strongly affected as in the last experiment. Electricity of the vapour both positive. The Electrometer and Crucible negative —

7. The two large plates formerly used for charging a plate of air — Copper one connected with the conductor — Sparks between them like some kinds of lightning. The sparks generally passed along the stick of glass that joined the plates —

8. A jar coated on the inside as usual, but on the outside to only about an inch from the bottom, resembles ramified lightnings. —

9. Sparks sent through a lump of Chalk, shattered it.

— W. L. thinks the atmosphere is furnished each Elect. by the evaporation of water by the heat of the Sun —

— His account of this, and of the figure of the flash, and noise of thunder is taken from Morgan — Vallons opinion —

— The formation of clouds he did not pretend to account for. — This is a very dispute subject

Tuesday 10th April. 1810

Elect. 7 Lect 11. W. Sawyer

— Luminous appearance of the atmosphere — Nature of Northern lights, falling Stars, Meteors &c. illustrated by a variety of beautiful Experiments. —

— Experiments to determine the best metals for conductors — Lead and Zinc bound with a quantity charge — Copper the best for the part in the earth and Zinc for the upper part. The former kept cooled by water, and the latter by Lightning than any other metal.

— Short lightning — no thunder —

— Meteors — Aurora borealis, in the upper regions of the Atmosphere.

— Electric light more vivid in proportion to the resistance it meets with —

— Near the Extrem. of the plank, luminous conductor, and a large cave exhausted by a good air pump — This elegant experiment exhibited the Electric light in various forms and colours in proportion to the degree of exhaustion and ~~distance~~ length of the electric spark. —

— The air pump is on Smeaton's plan, with some alterations —

— Mr. S. does not admit of Davy's explanation of the Aurora Bor:s the Elect.y prevented from Entering the earth in the northern regions by the ice which Mr D— says is a perfect non conductor, and supposing the north part of the earth to be in a different state from the southern — this, Mr S. denies. He says the earth must be *all* electrified in the *same way*.

— Falling Stars — He has not yet been able to exhibit this phenomenon by Electricity — tried some experiments on this subject — exhausted tube small bore —

— Has discharged along the surface of glass — water on the glass, and on ditto through a length of 12 or 14 inches, the whole line luminous, but no resemblance to a falling star —

— Ignis fatuus — Mr S. thinks is owing to *luminous insects*. — Dr Darwin denied the existence of such a phenomenon

Friday 13th April 1810

Electr: Lecture 12th W. Singer

Short summary appearances of phenomena Relating to Electricity to the phenomena of Phosphorescence - Brilliant luminous appearances produced by Electricity. Elegant Experiments on this subject.

W. S. began this lecture with repeating the experiment of the Aurora Bor: in the Exhausted rec. - after this a spitting star shewn by sending the charge of a middle sized jar through the same receiver partially exhausted - the charge descended in a dense, bright Luminous ball - if there was, but a little air more or less in the receiver, the experiment did not succeed. From this it was inferred that

the Aurora can formed in the upper regions of the atmosphere and the falling Star in a lower Stratum. —

History of the Phosphori — from Du Fay, Beccaria, Wilson, Canton. — Experiments

1. Thumb rubbed transparent.
2. Paper — shook out over it.
3. Lumps of chalk shaken into luminous powder — like Canton.
4. Ditto — & Sugar — more luminous.
5. Carbonate, and sulphat of Barytes — The latter a beautiful green.
6. Three solid ends, Bologna, Bononia and Canton — The latter the most beautiful.
7. Compound salts — Carbonat of Pot ash — of Ammonia — Soda — muriat of Pot ash &c — The last the most beautiful of all these last.
8. Canton Phosphorus — a compound of sulphur and lime — This longer visible than any of the former — Sulphur alone — lime — neither sulphur nor lime visible Phosphoric light separately, or at best but in a small degree. — This fact is worth attending to. —
9. Phosphorus always luminous — dark in the dark, light and smoke from it, particularly if moved —
10. Letters written with it on black or blue paper — When blown on, a dense smoke and the light diminished — Flame or is consumed in the formation of Phosphoric light —

11th Phosphorus dissolved in Oil
a little in the bottom of a glass
when the cork is taken out it
enters through the mouth of the
phial, and descends slowly to the
bottom. Stop the phial and the
light soon disappears —

12 Three large jars filled with
distilled water, placed on
three intervals of a step of tin foil
on a board. On the discharge
of the large Electric jar through
the tin foil they were all
illuminated. —

13 Four eggs between three rods of
glass - large jar sent thro' them
with very little noise - illumi-
nated them. —

14 Oranges - did not succeed - Dis-
charge went over the surface.

Tuesday 17th April 1810

Lect. 13 – N. Series

– The Electrophorus and its effects – Importance of this instrument with regard to Theory. – Universal existence and action of Elec.; proved by the Condenser, Doubler, Multiplier and Spinning Instrument – Natural Electrical Energies illustrated by some curious experiments –

Electrophorus about 12 Inches in Diam.r – Exp.s on it the same as usual – as Bergen, Cuthbertson and Volta, the inventors, original experiments – The electrophorus when insulated, had two Leith balls suspended from each plate

— of the other instruments exhibited in the Lecture, the small common Electrometer, is the best. It discovers very minute quantities of Electricity. —

— Experiments with powder, figures traced with the salt of a weekly charged jar on a resinous plate — on a glass plate — with negative and positive Electricity, separately — both both on the same plate. The powder used was a mixture of red lead and sulphur.

Sunday 22 — April — 1810

Elect. Lect. 14th Mr. Singer

— Electric energies of metals, outline of discoveries in Galvanism. — Strong muscular action excited on the limbs of dead animals — Chewing, sucking and other functions of life excited in the head of an animal recently killed — general consideration of these phenomena — Conclusion of the course

— Early observations of the connection between Electricity and animal life — Baydonis observations —

— Galvani's Discoveries on the Torpedo and Gymnotus Electricus — History of this discovery — Mr Hunter's dispute — Galvani — Nature of his discoveries

— frog, with zinc and silver — Exp.
did not succeed well — with
two batteries of 30 series each
frog laid on one pole was throw
— Galvani's theory — Animal Elec.
Valli — Fowler — Fabroni &c.
— Volta — theory — the metallic plates
produce the Electricity — Experi-
ment with two plates of Copper
and Zinc, glass handles, condens-
ing Electrometer — In this Exp-
eriment the Electricity was barely
perceptible.
— Wilson's Experiment of sifting
Copper filings through a Zinc
sieve, on a plate of metal placed
on the gold leaf Electrometer, the
leaves opened readily with nega-
tive Electricity, and this without

the assistance of the condenser. Had
the sieve been of Copper and the
filings of Zinc, the Electricity would
have been positive — This by far
the most delicate test of Electricity,
all condensers, doublers and mul-
tipliers, are wholly unnecessary —
— Proofs of the identity of Galvanic
and Common Electricity — Shock —
Light — burning of metals —
Exp.ts &c with a battery of 30
plates of inches square, gave
little light would not fire Gun-
powder — it burned gold and silver
leaf, partially —
— Concluded the course with a
Dissertat.n on the great utility of
these Sciences —
— Hall began his 2d course on Chem.
the 10 May — Mondays and Thursdays

Thursday 10th May 1810

Elec: Chem: Science Lect 1st

- Introduction to the subject
Objects of Chemical inquiry.
Extent and utility of ~~inquiry~~,
its application. First principles of the Science. Nature of
Chemical attraction illustrated
by experiments.

- Three kinds of attraction
Gravitation - Aggregation and
affinity or chemical attⁿ
- This last principally considered
in and illustrated by the usual
experiments, of solutions, precipitations, Colours &c
- Opinions respecting the cause

of Solution – needles and tubes or sheaths – Newton considers it as a species of the same power which returns the planets in their orbits –

– In chemical action one of the bodies at least must be fluid, or a fluid must be added E. G. Nothale of copper rotted in tin foil when dry does not act on the tin foil, but when moistened a little with water produces smoke and flame. A mixture of sugar and oxy-muriate of potash exhibits no action, but if sulphuric acid be poured on the mixture, it burst into flame

– Ice and salt act on each other which seems an exception to the general rule – This is only an appearance

– Tables of affinity –

– Bryonian and Kirwans figures for simple and compound affinity –

Monday 14 May 1810

Mr Davy's 2 Lectures on E. C. Sci.

Of the different States assumed by various bodies under different circumstances. Nature of Gases; their general properties shewn by experiments.

Heat — Latent — reason for this term. —

— Whether heat be imponderable, or the effect of motion or vibration. —

— Mr D adopts the former opinion. Mr Davy is the principal supporter of the old opinion. —

— Heat always tends to an Equilibrium — illustrated in the usual manner

— Expands all bodies, whether solid fluid or aeriform, the three states in which bodies are can

Ex. Sound — Expt. on the Expansion of solids, thus only denoted — Fluids — Thermr., common, Leslie's differential thermometer — Description of the common sort of Fahrenheit — Expt. of air and gases — Mercurial Thermometer — small bubble of Ether on a colored fluid in a glass flask converted into gas by pouring hot water on it, the colored fluid expelled from the mouth of the flask pressure into the water of the cistern. — Ether made to boil in the exhausted receiver. When the receiver was removed from the pump, and a match applied to its mouth, it exploded with a deep blue colored flame.

+ Gases — Oxygen and Hydrogen gas prepared — Gun barrel with

pigeons in the Gasometer. Hydrogen Gas in the common proof bottle Expt. Hydrogen Gas in an open air-pump receiver open at top burnt downwards — Hydr. gas and atmospheric air exploded — Expt. made with Oxygen Gas. — Iron burnt in Oxygen Gas, red globule sometimes turned round its axis!! as Mr. S. said Taper in a small jar of Oxygen Gas. —

— Carbonic acid gas made in a balance — D. Black's Expt.

Thursday 17th May 1810

Dist. Ch. S. Lect 3. Mr Sayre

- Combination of Gases with other bodies, results of these combinations. Formations of Acids, Acids &c. Recent discoveries relative to this class of Substances

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- Gases exist in bodies in a condensed or Solid State. This condensable substance dissolved in Caloric forms a Gas. A gas therefor consists of two substances at least. In converting a Solid or liquid into Gas a great quantity of heat is combined or becomes latent in the vapours or Gases. Exp. Evaporation of Ether from the large bulb of a thermometer in the tube of which was a small quantity of coloured water - On the contrary steam returned to water gives out a great quantity of heat sufficient to make a large quantity of cold water boil at a considerable distance. It is applied economically in heating water in some manufactories -
- Muriatic acid gas was attempted to be made in a retort and thrown into cold water in an air jar to heat it. The Experiment did not succeed with much time lost. -
- Nitrous Gas made with copper filings - Eudiometry small extent, divided into cubic inches held perpendicularly in the water eudiometer, water raised to a particular division. A bit of Phosphorus in the belly of the

retort set on fire, the water rise in the neck of the retort and the divisions point out the dimi-nution. This Mr. S. thinks the best Eudiometer — Eudiometry of little use in ascertaining the salubrity of the atmosphere —

— Phosphorus burned in oxygen Gass produces Phosphoric acid —

— Vitriolic acid — Sulphur burned in ox: Gass, produces Sulphuric acid. Water in the plate tasted acid. — Charcoal burnt in oxygen Gass — carbonic acid. Extinguished a taper, it should also have shewn to be heavier than Atmospheric air —

— Carbonic acid made in a common phial thro' the cork of which a glass tube passed, the outer end bent down wards into an air jar, all on the table without a water bason or any other apparatus. This is a convenient mode of making Carb. acid Gass. —

— Various metals burnt with oxygen Gass. The metals were in comp fily dust, they were laid on a lump of charcoal acted on by a stream of Oxygen Gass from a Gasometer —

— New nomenclature — oxide in-stead of calx a term highly im-proper when applied to metals.

— A combination of oxygen with different bases form the acids, some of which however have not yet been decomposed. —

Monday 21st May 1810

El. Ch. Decom. Lect 4th

— Nature of simple bodies.
Characters by which they are distinguished. Probable limit of their number. Recent investigation of their properties. Powerfull influence of chemical attn. General results of combination &c

— did not attend —

Thursday 24th May 1810

El. Ch. Decom. Lect 5th Mr. Davy

Of chemical analysis. Nature of the processes usually employed to ascertain the constituent ingredients of bodies. Decomposition by heat. By affinity. Theory of these processes. Their advantages and disadvantages. General consideration of the nature of chemical union. Both composition and decomposition shown to depend on the agency of attraction. &c

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In the first three two lectures Mr. D. described the bodies supposed to be simple — He exhibited the decomposition of water, according to Lavoisier's method. Exp. succeeded very well. —

In the last or 5th Lecture — Analyses of wood by distillation Products — Steps of potash-salt water &c these only described — Reduction of Lead — red lead and charcoal. Exp. — Wax burned by the flame of a candle

– Nitrous acid distilled with Woulf's apparatus, two intermediate bottles. Experiment on Colours – Acids and Alkalies – Vegetable infusions – litmus – violet – red cabbage. Solution of + iron with infusion of Galls, with Oxymuriate of Alkali, this last makes a good sympathetic ink, shewn in several experiments. Mr. S. prefers this to the sulphurets which are seldom completely invisible – – Solution of Gold in Nr. mur. acid precipitated by Ether, by sat. acid. – Silver from Nitric acid by Muriatic acid – separation in refining the metals for the coinage –

Monday 28th May 1810

E. R. C. S. Lecture 6th W. Suy.

General con_sideration of the nature of attraction. Evidence of the existence of this property as arising from different operations. Electrical attraction. Circumstances under which this power is developed. Usual consequences of its action. Illustrations by experiment. Extent and singularity of the Phenomena arising from Electricity. Deductions naturally drawn from the preceding facts.

– Attraction of cohesion – brass plates leaden balls strongly cohere. Cork balls floating on water rush together, this experiment accounted for by the French philosophers, from the

corks falling into the hollow be-
tween them - down an inclined
plane. —
– Electric attractions - Feather attracted
by the conductor, then moves from
it not because it is repelled but
because it is attracted by the mo
moisture in the air Says W. S.
The phenomena of confined Elect.ʸ
by the three small conductors ex-
plained in the same manner
by an attractive power, without
the aid of repulsion. I think the
old theory is most satisfactory
– Charging explained on the same
principles - see Morgan and
Wilkinson -

Thursday 31st May 1810
El. Cov.ᵗ Science Lect. 7. Mr Singer
– Elect.ʸ employed as a Ch. Agent
Researches of the earlier Electricians
History of the applications of
Electricity to the purposes of Chem:
inquiry, made prior to the year
1800. Nature of the apparatus em-
ployed. Its imperfections. Circum
stances necessary to be attended
to in similar experiments.
Exhibition of some contrivances
for this purpose &c. ——
– Recapitulation of part of last
lecture - one principle, attraction,
accounts for all the electrical Phe-
nomena. No necessity for repulsion
Says W. S. —
– Abbe Nollet - D. Priestley &c -
Their experiments to shew the

chemical effects of the Electric fluid —

— iron wire fused — D. Franklin battery of 80 square feet charged — discharged only 2 feet of wire 1/16 of an inch — W. S — a battery of 15 jars = 20 square feet burnt 4 feet of the same wire. Machine now much more powerfull —

— Decomposition of water by Elect^y — W. Carlisle just repeated them by Elect — His apparatus for burning a mixture of Hydrogen and Oxygen Gases, consisted of a strong glass tube of an oval shape fixed on an air cushion with a stop cock between. A wire hermetically sealed passed thro the top of the tube to near the bottom where it approached near another wire. The mixture of Hy: and Oxygen gases was contained in the large cavity. By opening the stop cock, the tube became filled. The stop cock was then shut and the charge of a jar sent down the wire, a flash took place, but no explosion, this often being repeated a number of times produced water in the upper part of the tube —

— Alcohol in a small glass tube bent at an obtuse angle with a wire through each end approaching near to each other in the bend of the tube. A large brass ball was placed at about two inches from the ball connected with the Conductor. The bent glass tube with

the alcohol is brought in contact with the former when sparks of light are seen between the wires and bubbles of air rising through the Alcohol - Hydrogen Gas. -

- In the same manner Ether oils and other fluids may be decomposed - When Gases are to be acted on by Electricity a glass tube of 1½ or 2 Inches in diameter having one end shut and at the other a stop cock to screw it to the air pump, and at the other shut end, two wires pass thro' the sides of the tube and approach within a quarter of an inch of each other. This tube is first exhausted of air thro' the stop cock with the proper Gas and an Electric shock or spark sent through the wires. When this experiment is performed with ammoniacal Gas the Gas swells into from a five times its bulk and is converted into Hydrogen and Nitrogen Gas, in the proportion of 20 of the former to 80 of the latter - This fact was discovered by Dr Priestley -

Monday 4th June 1810

If. Ch: Tenns Lect. 8th W. Sorge
– Discovery of the Voltaic battery.
Varieties of its construction. Theory
of its action. Exhibition of the early
experiments on its chemical
agency. Discoveries of the British
Philosophers. Chemical facts derived
from their labours. ——

– Oxidation and reduction of
metals by Electricity – Chain on
paper – wires stretched at a small
distance from paper, by the explo-
sion of a battery beautiful figures
produced – Acids better conductor
than water. Expt. sulphuric
acid on a long slip of Glass
and water on another, the bat-
tery was discharged at double
the distance thro' the acid that it

was thro' the water. —
– oxides of tin and lead reduced
by sending a charge of a large
jar or small battery thro' them
in a glass tube. – Metallic
particles were evident after the
discharge.

— Two plates, copper and zinc
produce Elect. – Neg: and positive.
The condensing Electrometer a very
little effect – Copper sieve and zinc
filings – W. strongly affected (this
is in my opinion the best test
for discovering small quantities of
Electricity).

+ Volta's couronne des tasses
– Pile described ——
– Cruickshank's trough –
– Wilkinson's improvement
– Dr. Babington – Wedgewoods ware
troughs –

Galvanic Experiments —

— Water decomposed different ways.
— two small glass tubes in a wine glass — air in one found to be oxygen gas by lighting a taper which blown out, and the other hydrogen by burning it —
— Sol.n of Acetate of Lead and Nitrate of Silver reduced by putting them in the Voltaic circuit — reducing by the negative wire — Lead and Silver true. —
— W. S. finds that the Voltaic machine will act with pure water and for small works this not so powerfully as when used —

Thursday 7th June 1810 —

Elect.y Ch.l Decomp.n by W.m Singer

Comparative action of [redacted] different voltaic Batteries. Explanation of the action of large and small plates. Best disposition of an Apparatus for general experiments. Energy of a large Voltaic apparatus. Its action on combustible bodies, and on metals. Decomposition of Nitre by deflagration. Sulphuric acid from charcoal — Experiments on this subject. —

W. Singer finds that a part of muriatic acid added to Nitrous acid produces a greater effect than when either of the acids are used singly. —

— Wire was bound by a small trough of Shrink, 32 Series. — The whole battery consisted of 300 Series —
— This burned the Metals in Wire as well as in foil, the latter is best burned by applying it to a flat Plate of Metal. A large Cell Charcoal burned with great brilliancy. Silver leaf gives a greenish yellow colour, but if a piece of Charcoal is put on the end of the conducting wire the colour is white like that of the charcoal itself
— Green powder fired —

11th Lecture 1840

Lecture 10th Electricity Secon

Account of the experiments which led to the suspicion that and Affinities were formed during Electrical decompositions Mr Davys Experiments on this subject and the conclusion drawn from them. Electricity the cause of Chemical attraction. Experiments in proof. Importance of this discovery —

*13. The above should have been the subject of the Lecture this week: but Mr Singer employed the time in following out the subjects of the last lecture. —
— Comparison of two batteries of 60 series each, the plates of one 2 Inches square, those of the other 6 Inches — Both charged with the same fluid —

— The small plates were fired in the trough in the old plan the other in the new.
— The shock was the same in both. If any difference the small battery felt somewhat stronger than the large one
— Cause of the difference between the effects of large and small plates — Great plates produce more electricity, but smaller plates have more intensity. Bad conductors such as water, animal bodies &c do not carry off the whole electricity from great plates, metals carry off the whole, hence the reason why they are so easily burned by great plates and charcoal so easily fired
— This illustrated by experiments in common Elect.y — Omit speak

through a bad conductor — Elect.y from one turn of the wheel thrown into a small phial gives a shock but into a large jar gives a big shock and into a battery a still big shock —
— Cause of the electric light — it is from the body, not from the electric matter —
— Large jar and Battery charged with the Voltaic battery. A single contact however rapid charges to the utmost height which is that of the Voltaic battery and says M. Singer would one of the intent of Galvanic aliens in the same time. This I think very unlikely. —
— Davy's theory of Galvanic action by Induction from pan to pan, M.S — objected to — Gave one of his own — frequent renewal of the contact

between the metal and the acid
by the falling off of the oxide —
— But why is not the balance
restored between the positive and
negative plate — Because says Mr D.
there is a constant production of
both Electricities — This is sufficient to
account for the fact.

Thursday 15 June 11 Lectures
This lecture tho' the 11th in
number was really the 10th
in subject — see the heads of
last lecture

— Acids produced at the Pos.
and alkalies at the ne-
gative pole — History of all
the Experiments on this sub-
ject — Mr Davy's discoveries
He proved that the Acid and Alkali
proceeded from the Materials made
use of in the experiments, or
that from water is decomposed
only into oxygen and hydrogen.
— Mr Davy proved that Acids
and Alkalies were formed at the positive
Alkalies and inflam. round the negative end
of the battery — Hence the oxygen
gas at the Zinc end and the hydrogen
gas at the copper end of the battery
in the decomposition of water
— Colours. — Inversion of red cab-
bage in two glass tubes suspended
from an insulated brass wire, and
connected with moist cotton, the
Zinc wire turned the one red, and the
copper wire turned the other green.
— Same experiment with two watch
glasses — Also with litmus paper —

Monday 18th June 1810 —

Mr. Sergiis 12th Lect. by No. but 11th by heads as follow —

— Influence of the power in discovery on chemical science. Improvement in the art of Analysis. Natural Chemistry of bodies. Instances of decomposition by electric powers. Decomposition of Salins and earthy compounds, and of Natural Neutral combinations. Geological Phenomena explained by these experiments

Heads of Lecture 12th

— General application of the methods of Electro-chemical ~~science~~ Analysis Decomposition of acids by electricity. Nature of this class of bodies. Experiments on acids, and on acid and metalic combinations. Inferences drawn from these investigations.

Mr. S— does not follow exactly the order of the printed prospectus —

Experiments

— Transfer of acids and alkalies through bodies ~~[illegible]~~ which have a powerful attraction for them — watch glasses and glass tubes as in last lecture —

— Acids and alkalies produced on moist lit paper laid on a tinct of Sulphat ~~of sulphat~~ of Barytes. ~~This~~ by 50 three inch plates. —

— A piece of flat silver in sol. of sulphat of copper is not affected, but connect the silver with the negative end it & is acted on in the same manner as iron by the sulphat of copper. —

— A copper wire in ~~a~~ diluted nitric acid is acted on by the acid and bubbles of air escape — Touch it with the positive wire of the battery, and the action ceases.

— Sulphur and phosphorus burn in Oxygen Gas. — Sulphuric and Phosphoric acid produced. As sulphur is positive why should the acid be negative? Owing to the oxygen. Hence also Phosphoric acid is more powerfully negative than Sulphuric acid, because it contains much more Oxygen

— Test paper acted on by Electy. from the conductors of a small Electrical machine — Acid from the positive but no alkali from the negative conductor. — Platina wire ~~from~~ ~~through a~~ finely pointed sealed in the ends of glass tubes. —

— Insulated copper plate laid on powdered lime and applied to the condensing electrometer, repeated several times, gold leaves diverged with positive but with benzoic acid, with negative El

+ In the transfer of acids and alkali they produce no effect on test paper in their passage, — points of the wire only.