17. Atmospheric Electricity

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Problem To Be Investigated

Original Problem:

Electric field is present in the atmosphere even in good weather. Suggest an interesting problem concerning atmospheric electricity.

Our Problem:

Electricity in the atmosphere varies depending on the humidity levels. How does humidity interfere with atmospheric electricity and how can we figure out its effects on it?

What is Atmospheric Electricity?

It is an electric field surrounds us all the time, even in fair weather.

This current is caused by the combined effect of all the thunderstorms around the world moving negative charge to the ground and positive charge to the atmosphere

Atmospheric Electricity

That atmospheric electric current is distributed across the entire surface of the planet unless there is a thunderstorm when it is electrically active and local voltage and current values go much higher and lightnings might occur.

Causes of the Electricity Level Change

Some environmental causes to change the electricity levels in the atmosphere are:

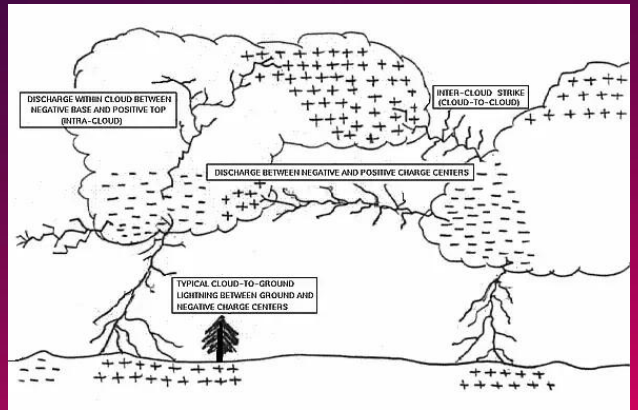
- The moisture contained in it (humidity)
- The expansion, condensation, and variation of temperature of the atmosphere
- Evaporation from the earth’s surface
- Chemical changes which take place upon the earth’s surface

Lightning

During a thunderstorm, cumulonimbus clouds, or “thunderheads” are formed in unstable atmospheric zones where there is typically a lot of heat and moisture. These types of clouds have typically strong ascending and descending air currents.

Lightning (II)

Colliding particles of rain, ice, or snow inside storm clouds increase the imbalance between storm clouds and the ground and negatively charge the lower reaches of storm clouds. Objects on the ground, and the Earth itself, become positively charged—creating an imbalance that nature seeks to correct by passing current between the two charges.

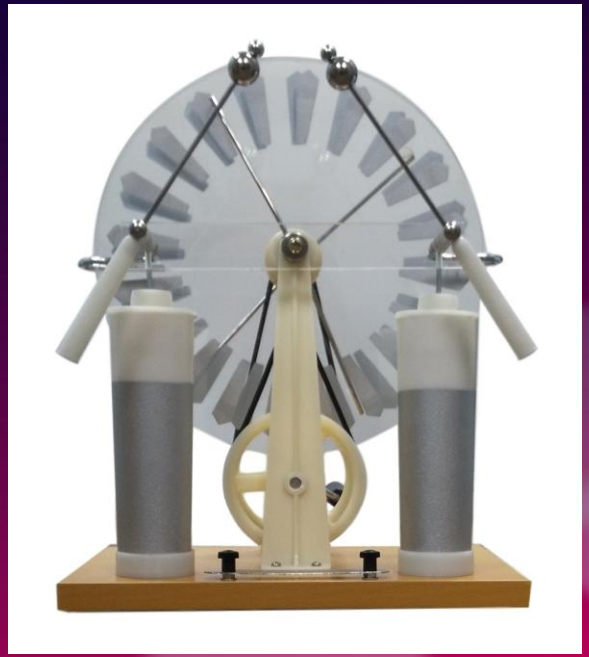


Lightning (III)

Lightning is extremely hot and as the current between the two charges passes it causes surrounding air to rapidly expand and vibrate, which creates the loud thunder we hear a short time after seeing a lightning flash.

Wimshurst Machine

The two plates spinning have metal sectors that spin in opposite directions.
The metals produce electric charge that is being stored in the two cylinders (positive in the one and negative in the other), called Leyden Jars.
When the two metal spheres come close to one another, the electrical charge tries to balance between the two, creating a lightning spark, just like the clouds in a storm do.



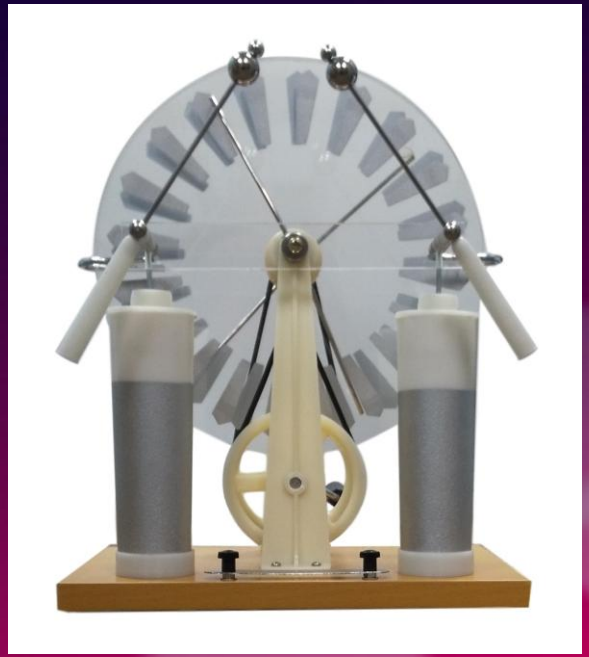
The Experiment

Lightings

In the experiment we conducted we wanted to see the differences in the brightness of the lightnings and their frequency, based on how humid the atmosphere was.

Experiment Description

With the use of a Wimshurst Machine we will create electric charge which will ignite an electric spark, when we bring the two poles up close.
We will experiment in different areas of the same acreage and different humidity levels.
The distance of the poles, the temperature, and the room size will stay the same at every experimentation.
We will count the frequency of the lightnings and we will try to see if there any differences in their brightness.



Variables

Independent Variables:

- Humidity

Dependent Variable:

- Lighting Brightness
- Lighting Frequency

Fixed Variables:

- Room size
- Temperature
- Distance between the two poles
- Pace at which the plates of the Wimshurst Machine were being rotated

Hypothesis

In more humid environments, lightnings should be more vibrant and also, should appear more frequently on the Wimshurst Machine.

Space #1: Kitchen

Humidity Level: 51.1%

Temperature: 29°C

Lighting Percentage: 122 Lightings/ minute

Space #2: Teacher’s Lounge

Humidity Level: 46.5%

Temperature: 29°C

Lighting Percentage: 103 Lightings/ minute

Space #3: Lab A

Humidity Level: 37.1%

Temperature: 29°C

Lighting Percentage: 89 Lightings/ minute

Space #4: Lab B

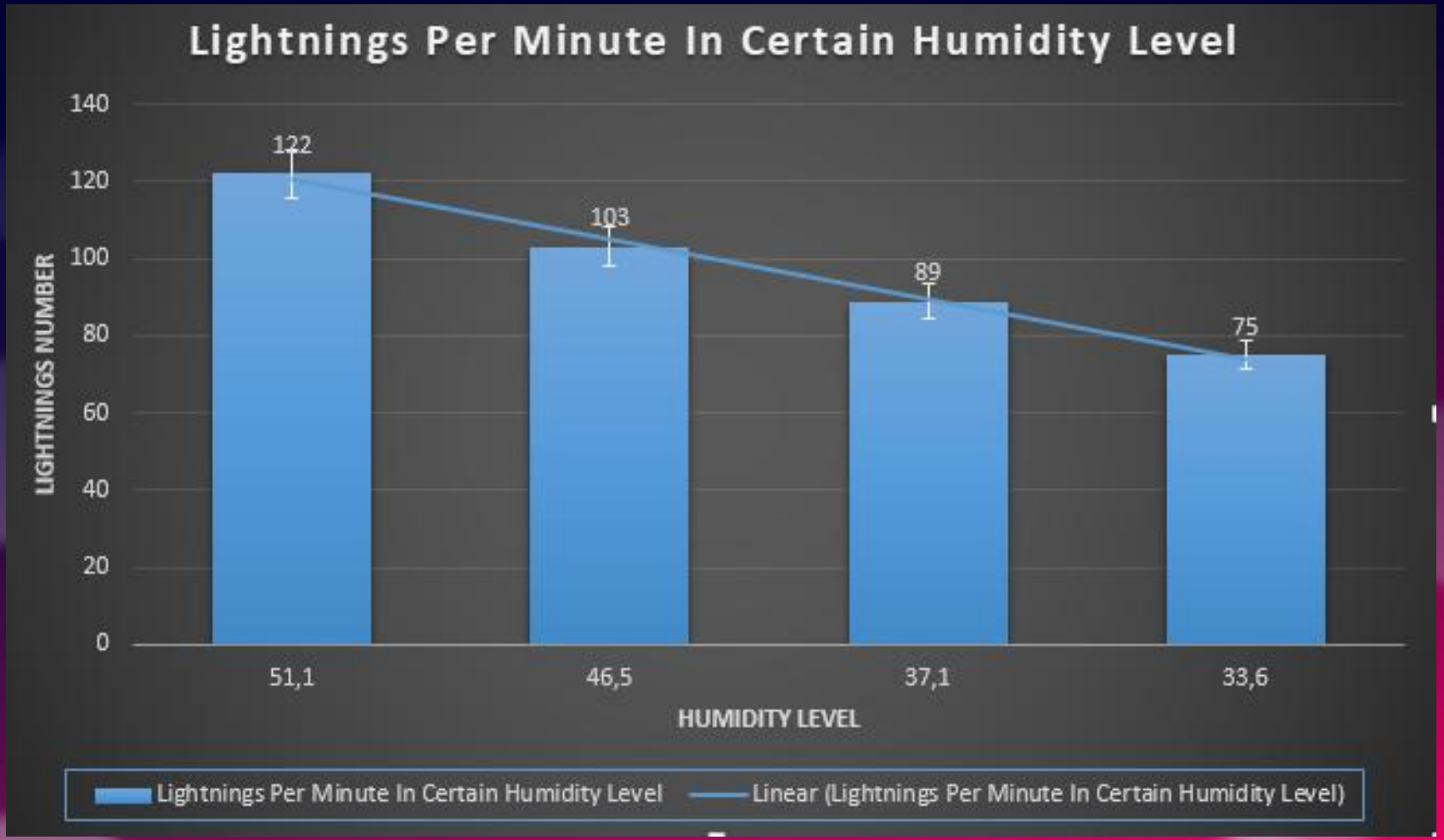
Humidity Level: 33.6%

Temperature: 29°C

Lighting Percentage: 75 Lightings/ minute

Space	Humidity Level	Lightnings per minute*
#1 Kitchen	51.1%	122
#2 Teacher’s Lounge	46.5%	103
#3 Lab A	37.1%	89
#4 Lab B	33.6%	75

*Average out of six measurements


Lightnings Per Minute In Certain Humidity Level
140
120
100
80
60
40
20
0
LIGHTNINGS NUMBER
122
103
89
75
51,1
46,5
37,1
33,6
HUMIDITY LEVEL
Lightnings Per Minute In Certain Humidity Level
Linear (Lightnings Per Minute In Certain Humidity Level)

Conclusion

We indeed noticed a difference in brightness in the electric sparks of the Wimshurst Machine, and we also saw that the frequency at which they appeared was increasing in more humid environments.

References

- https://www.electricuniverse.info/atmospheric-electricity/
- http://electricmuseum.com/?p=44
- https://www.nationalgeographic.com/environment/natural-disasters/lightning/
- https://demos.smu.ca/index.php/demos/e-n-m/43-wimshurst-machine

Thank you for your attention!