The 5th International Young Naturalists' Tournament

Municipal Autonomous Institution of General Education of the city of Novosibirsk «Gymnasium №12»

Problem №17
«Tornado machine»

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The task's condition

Build a device that can create an air tornado in the room. Learn the properties and stability of a tornado. Is the portable device sufficient to be presented in the Science Fight Room on the fifth IYNT?

Hypothesis

If a differential pressure is created in a homogeneous gaseous (liquid) medium, convection currents forming a vortex will arise.

The aim of the study

Design a device capable of creating a tornado in a science fighter on the fifth IYNT.

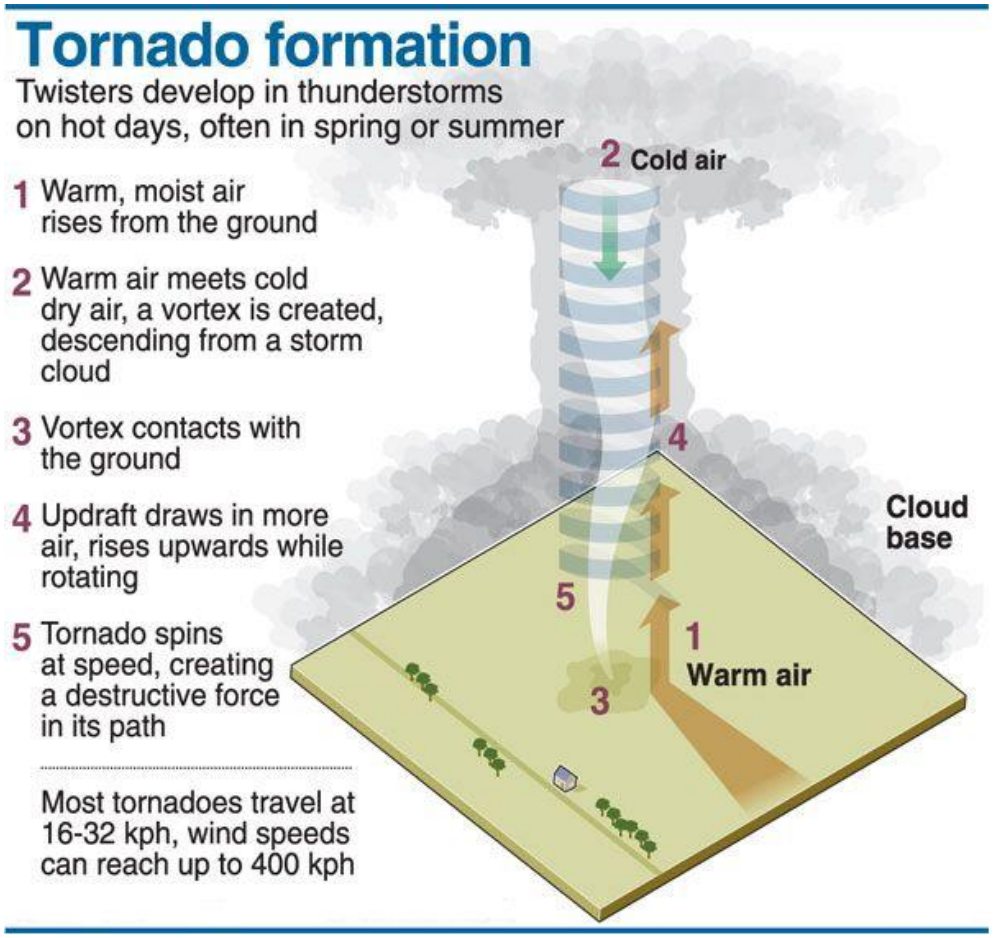
Objectives of the study

- Study the theoretical material about the conditions of tornado formation in nature.
- Identify the parameters that affect the formation of a vortex and its stable progress.
- Design a portable device that can create a tornado in the conditions of Science Fight on the fifth IYNT.
- Study the properties of the obtained vortex, the field of its application.

The theoretical part of the study

A tornado is a rapidly rotating column of air that is in contact with both the surface of the Earth and a cumulonimbus cloud or, in rare cases, the base of a cumulus cloud.

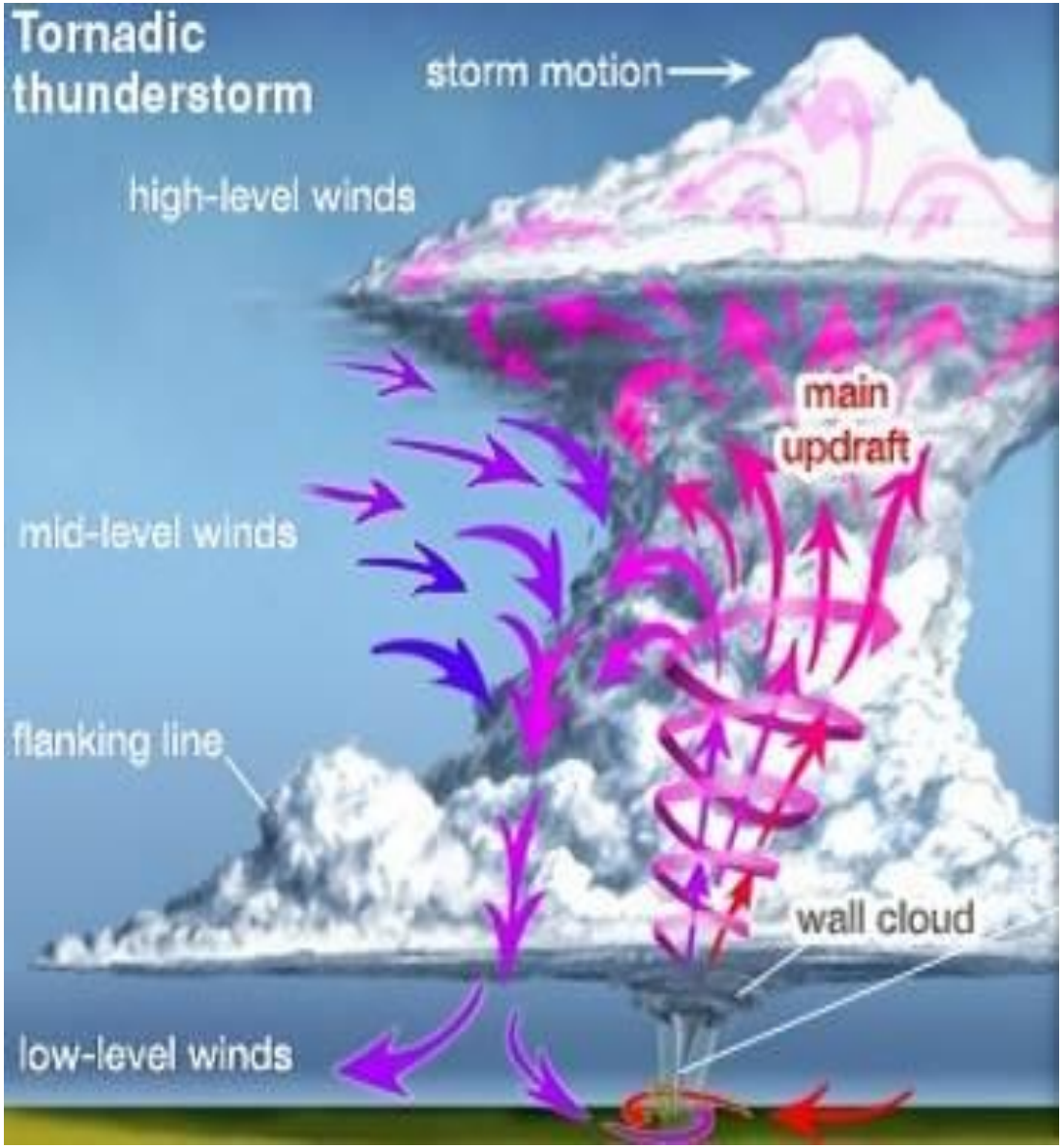
Features of formation



In a vortex system called a cyclone, atmospheric pressure decreases from the periphery to the center. Therefore, near the surface of the Earth, air currents are directed toward the center of the cyclone.

All cyclones have a rotational component of wind speed. In the Northern Hemisphere, it is directed counterclockwise, in the Southern Hemisphere it is clockwise.

Features of formation



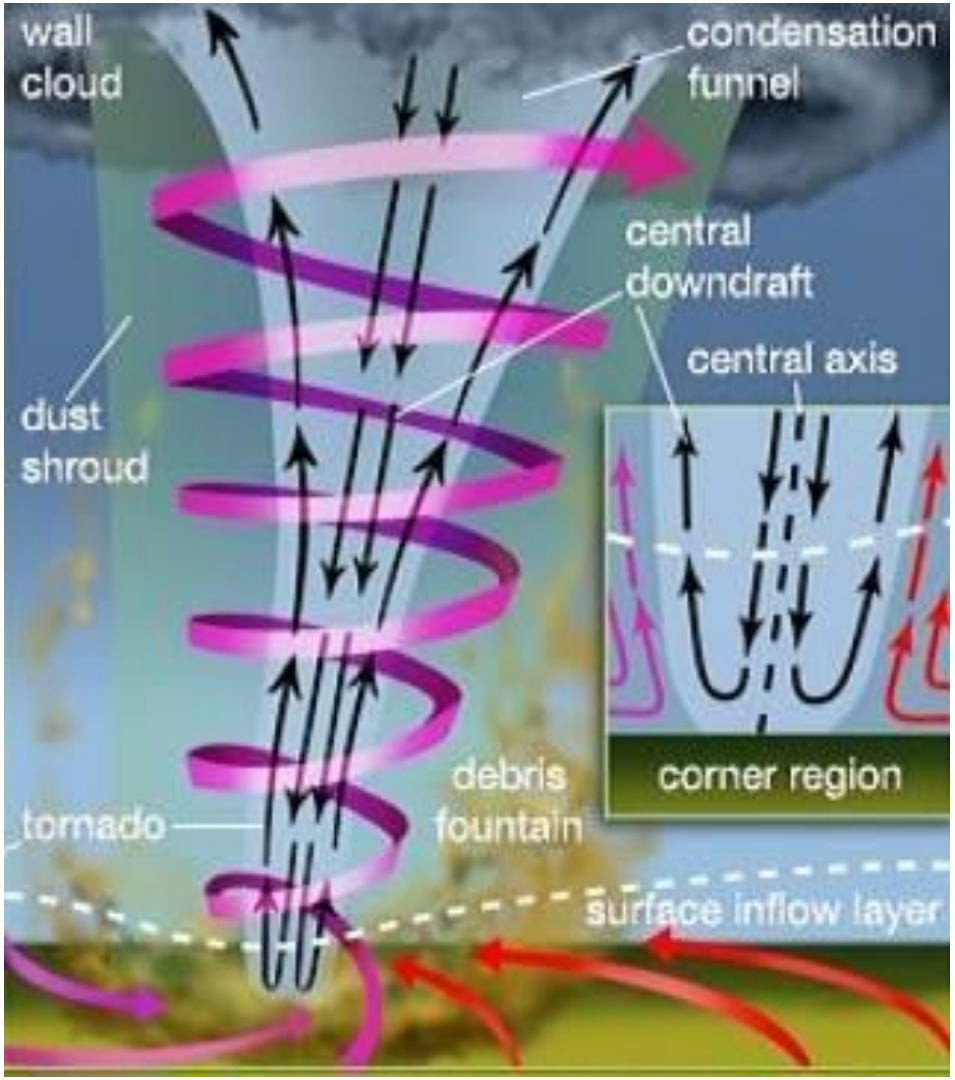
The spilled stream is the most important basis of its stability.

The maximum pressure drop and a swirling accelerating flow are always in the center of the tornado, and it is directed from the top down!

In the center of the developed tornado there is always a powerful swirling flow of cold rarefied air down.

Inside the tornado is empty.

Features of formation



As for a result, in all types of tornadoes, the main stream in the tornado goes up, with an additional motion directed along the central vertical "vacuum axis".

This stream is twisted from top to bottom.

These movements contribute to the appearance of areas of increased and reduced pressure.

The Experimental part of the study

The purpose is to reproduce a tornado in a small volume of water.

Equipment: a container with water, an electric motor, a nozzle with a motion activator, poppy seeds, sunflower oil.

The Experimental part of the study

The purpose is to define the dependence of the emergence's speed of a vortex in a liquid on the difference in pressure.

Series of experiments	Depth of immersion of the activator, cm	The average time of the emergence of a stable "trunk" of a tornado, s
1	5	6,4
2	10	9,1
3	15	13,4
4	25	20,3

Conclusion: the greater the immersion depth of the motion activator, the shorter the time required for the appearance of a stable vortex.

The Experimental part of the study

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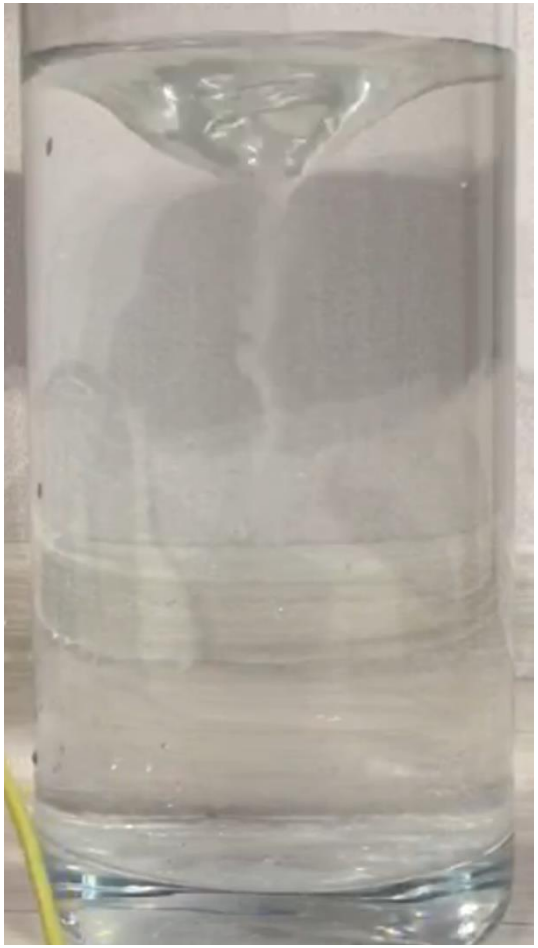

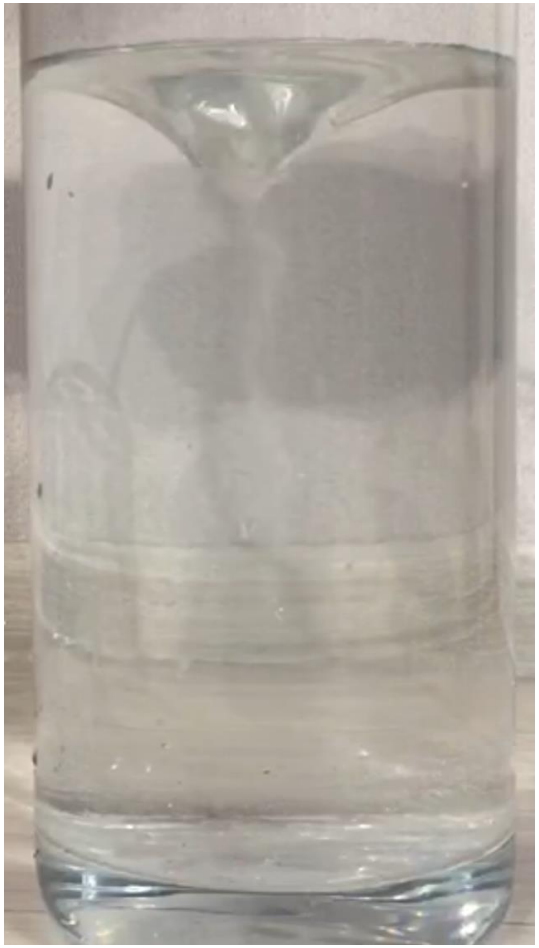

The Experimental part of the study

The purpose is to make sure in the emergence of forces that "draw" solid bodies into the cavity inside the vortex.




Thus, we made the conclusion that, the reason for the tornado formation is the formation of a vortex in a liquid or gas, which draws into a cavity with less body pressure.

The Experimental part of the study

The purpose is to design a device that allows observing an air tornado in a classroom.

The Experimental part of the study

We came to the conclusion that it’s possible to observe a gas vortex by providing a pressure difference and reporting the forced rotational moment to the gas flow.

The Experimental part of the study

Equipment: a box for observing a tornado; Peltier element (12V), cooler from computer for element cooling; thermometer; a cup of water, carbon dioxide (dry ice); stopwatch.

Экспериментальная часть исследования

The purpose is to define the dependence between the speed of air vortex's occurrence from the temperature difference in the air column.

Temperature at the top of the box, ^{0}C	Temperature in the bottom of the box, ^{0}C	Temperature difference, ^{0}C	The time of the appearance of the vortex, s
27	27	0	3,04
17	27	10	2,44
7	27	20	1,78

Conclusions

We designed device observing the phenomenon of tornado in liquid and gaseous enviroment.

It was experimentally proved that the formed funnel and the vortex trunk in the liquid behave in the same way as a natural tornado in the atmosphere.

The deeper the vortex activator is immersed, the more time it takes to create a tornado due to the pressure difference.

References

- L.Alekseeva, Vortexes that make the weather, Kvant, magazine
- Http://www.physbook.ru/index.php/Kvant._%D0%9F%D1%80%D0%BE%D1%89%D0%B0%D0%B9_%D1%82%D0%BE% D1% 80% D0% BD% D0% B0% D0% B4% D0% BE Quantum, log
- Http://files.school-collection.edu.ru/dlrstore/3f52f876-2530-8990-2aa4-3329d2619b0a/16-19_12_2005.pdf Chemistry and Life
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