**Решение задачи №17 «Торнадо-машина»**

**Команда «12ФМ» г. Новосибирск, 8 класс**

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**Слайд 1.** Hello, my name’s Artem Redko, I’m the member of the 12FM team from the city of Novosibirsk, Russia. I want to represent the solution of the problem №17 «Tornado machine».

**Слайд 2.** The condition of the problem you can see on the screen.

**Слайд 3.** During the study of theoretical material we made a hypothesis: if create a differential pressure in a homogeneous gaseous or liquid medium, convection currents forming a vortex will arise.

The aim of the study is to design a device that can create a tornado in a Science Fight’s Room on the fifth IYNT.

**Слайд 4.** The objectives you can see on the slide.

**Слайд 5.** Tornado is one of the most dangerous and destructive phenomena of nature, which takes away hundreds of lives across the planet. 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. There’s a very huge pressure in different parts of tornado.

**Слайд 6.** The weather on the globe depends on the presence of giant atmospheric vortices-cyclones and anticyclones, which determine the vortex regime in this region of the Earth.

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.

**Слайд 7.** Tornadoes pass three main stages in their development. At the first stage the initial funnel appears from the storm cloud, hanging over the ground. Cold layers of air that are directly under the cloud, rush down to replace the warm layers, which rise up. The potential energy of this system is converted into the kinetic energy of the rotational motion of the air. The speed of this movement increases.

The value of the rotation speed increases with the passage of time, while in the center of the tornado the air begins to rise vigorously. This is the second stage of the tornado's existence - the formed vortex’ stage of maximum power.

**Слайд 8.** At the final stage, the vortex is destroyed. The power of the tornado weakens, the funnel narrows and breaks away from the surface of the earth, gradually rising back into the cloud.

**Слайд 9.** In the experimental part we decided to use water as a physical model of tornado’s reproducing. The choice of this substance is justified by the fact that it’s convenient to observe water in the laboratory.

During the first experiment we reproduced the tornado in a small volume of water. To do this, use a liter glass jar with water, an electric motor, a nozzle in the form of a long needle with an oval nozzle (motion activator).

In the course of the experiment we poured water into the jar to the level of three quarters of the volume. One quarter should be free in order to avoid splashing. For visualization, the poppy seeds were added to the water, we waited until the seeds felt to the bottom of the can and put the nozzle into the jar.

As a result, all seeds rise vertically upward, participating in a vortex motion. Under the action of the driving force, a funnel is formed.

Grains, together with water flows from the central column, are thrown to the walls of the vessel, and there they continue their descending movement to the bottom of the vessel, then return to the central part of the liquid. The cyclic process begins.

Then the funnel’s developing. The funnel becomes deeper and at some point in its development a trunk appears.

Thus, we made sure that the formed funnel develops the same way as a natural tornado in the atmosphere.

**Слайд 10.** The purpose of second experiment is to define the dependence of the emergence’s speed of a vortex in a liquid on the difference in pressure.

We pour in a liter glass jar water to the level of three quarters of the volume. At the same rotational speed of the activator, we will immerse it at different depths, thus changing the pressure difference.

**Слайд 11**. We measured the time of a vortex’s appearance by a stopwatch. The measurements are presented on the slide. Thus, the deeper the immersion depth of the motion activator is, the shorter the time required for the occurrence of a stable vortex is.

**Слайд 12**. The purpose of the next experiment is presented on the slide. To observe the retracting forces, we immerse the activator into a vessel with water to a depth of 5 cm, turning on the motor. On the surface of the water we placed several chips of different sizes.

In the course of the experiment it was noted that chips of small sizes diverged to the edges of the vessel, making a slow movement along the walls when the activator was immersed in water. Chipes of big size were falling into the depths and participated in the rapid movement inside the funnel, being at almost the same depth.

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.

**Слайд 13.** The purpose of the fourth experiment is to design a device that allows observing an air tornado in a classroom.

Equipment: a box with clear walls, with through holes at the base, a cuvette with a burning substance, matches and a fan.

We placed the cuvette with a burning substance in the box, covering the outlet from above to prevent the smoke from emerging. Then, we inserted the working fan into the outlet and observed the vortex.

A similar vortex was obtained with the evaporated solid fraction of carbon dioxide (dry ice), which under usual conditions passes into the vapor state, bypassing the liquid phase.

**Слайд 14**. 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.

**Слайд 15.** For the next experiment we used the installation shown on the slide. Equipment: a box for observing tornadoes; Peltier element (12V), cooler from computer for element cooling; thermometer; a cup of water, carbon dioxide (dry ice); stopwatch.

**Слайд 16.** Thepurpose of the last experiment is to define the dependence between the speed of air vortex’s occurrence from the temperature difference in the air column.

We regulated the air temperature at the top of the tornado using the Peltier element to cool the air in the upper part of the box. Stopwatch measured the time required for the appearance of a vortex. The measurements are shown in the table.

As a result, the greater the temperature difference is, the shorter the time required for the air flow to form a vortex is.

**Слайд 17.** You can see the conclusions on this slide.

**Слайд 18.** References are on the screen.

**Слайд 19.** Thank you very much for your attention, I’m ready to answer your questions.