The geometry of rain and snow

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Many years ago people noticed, that some places get a great deal more rain than others. People find that by monitoring plants. It is possible to measure how much water the rain brings? It seems to be a difficult task, which required some special tools. Absolutely not. It’s not need to collect all rainwater, which was absorbed in the soil. All that is need was to measure the thickness of the layer of the rainwater. That is the easiest way to take that measurement.

In the rain the same quantity of rainwater evenly distributes over entire surface of the soil. We can measure a small area of the surface. For that purpose we have to use a circular or rectangular vessel to collect water. The vessel’s bottom area we must calculate. The walls of the selected vessel should be perpendicular to the base.

How to measure the height of water in a container?

We can put the ruler in the water to check the height. It is a good way if the height of the water is some centimeters. But if the rain was light and we have only a few millimeters? Here it is important to measure all parts of millimeter accurately. The tip would be to pour the water into a smaller vessel in which it would make water higher. It is very convenient to use a graduated container. Depending on the vessel, students will need to use cylinder or rectangular parallelepiped formulas of the volume without getting lost in the units of their measurement.

It can be quite difficult to use formulas of volumes working with younger pupils. Therefore, we recommend in this case to choose a large vessel (for rainwater collection) and a small one (for measuring water volume) in proportional sizes. For example, if they are round and the bottom radius of one vessel is 10 times larger than the other, the bottom areas will differ 10x10 = 100 times. That means, if the height of the water in the smaller vessel is 20 centimeters, that the height in the larger vessel would be 2milimeters (20x10=200 and 200:100= 2). Knowing this proportion a teacher can make calculations easier for students if it’s needed.

One more thing, the teachers should think in advance about the transfer of water from one vessel to another. The measurements could be distorted if a wrong movement by the students accured during the pouring of the water. In this case, a larger vessel for collecting water should be chosen, which has a liquid discharge mechanism. It can be as a simple hose at the bottom of the vessel.

How much rainwater has dripped? Let take a land area is a rectangle with width is 24 meters and length is 40 meters. It can be a school garden, green zone or flour beds or something similar. After a rain students would count how much rainwater was poured into that place. First, the aforementioned water layer thickness must be calculated. Suppose we have obtained a height of 4 mm of water with the help of our meter. Let’s count how many kilograms of water the rain cloud brought to this place. We calculate how many cubic centimeters of water per square meter of land area. 1 m^2 = 100x100 = 10000 cm^2

The amount of rain per $1m^2$ is equal to 10000x0.4 = 4000 cm^2.

You know that $1cm^2$ weighs 1gr which means that 4 kilograms of water (4 liters) is added to $1m^2$. Thus, we calculate the area of the selected area: 40x24 = 960 m^2

The water content is calculated 4x960 = 3840kg which is almost 4 tons of water!!

To illustrate to students what a ton of water looks like, let's at least roughly turn it into buckets that would have been needed to water that area of land the way rain did. 3840: 10 = 384 buckets with a capacity of 10 liters! It rained for maybe 15 minutes and touched the ground evenly.

How much did snow fall?

We will learn to count how much water is contained in fallen snow. The method of counting is the same as for rainwater. The difference is that snow must be melted beforehand. But in some cases, we can make a count of the amount of water without melting the snow. If it was snowing calmly and the ground is covered by snow evenly we can measure the thickness of the snow layer in different places and count the average. We suggest measuring from 3 to 5 samples for counting the average.

Now it is time for our test. We will count how many millimetres of water is obtained from the snow layer measured in centimetres. Having found this proportion we easily would count the amount of water that did fall on the ground. We want to pay attention to the measurement of the snow layer during a raging blizzard. If we left the container on the ground, the amount of snow probably will be wrong, because of the wind, which can inflate much more snow or blow out snow from the container. In any case, we could get much distorted data.

It’s advisable to choose a higher place than the level of the ground. Also, to make several measurements again. How to get a proportion between the thickness of snow and the amount of water. We have to fill up the container with snow and measure the height of the snow. Then we let the snow melt and measure the height of the water. For convenience, we measure the height of the snow in centimetres and the height of the water – in millimetres. The test we should repeat some times again.

After making these measurements, students can talk about the amount of water that falls down during the year in various parts of the globe. They can compare precipitation in deserts and tropics. Students can find the information they need online.

It is not so complicated to understand, that after measuring the annual rainfall on the various places of the globe we can count the total amount of the rainfall. It is clear, that the same layer of water falls on land and oceans. It is about 78 centimetres! It is easy to calculate how much water falls down on the whole surface of the Earth. For that we need to know the area of the Earth’s surface. We know, that 1metre is about 40/10.000.000 (the fraction could be simplified) of the length of the Earth’s equator . In other words the equator is equal to 40 000 000 m or 40 000 km. The diameter is equal to 40 000 : 22/7 = 12700km.

We can calculate the diameter of sphere by multiplying the diameter by itself and by 22/7. We get an area of 509,000,000 km^2 on the Earth's surface (starting with the fourth number, we write zeros, because only the first three numbers are significant). Let calculate how much water falls on to the whole surface of the Earth. First we will calculate how much water falls out on a square meter: 78 x 10 000 cm2 = 780 000 cm^3. A square kilometer contains 1000 x 1000 = 1 000 000m^2

So, 780 000 000 000 cm^3 = 780 000 m^3 of water. On the entire surface of the globe over the year 780 000 x 509 000 000 = 397 000 000 000 000 m^3 = 39 700km^3. Thus, every year about 40 000 km^3 of water fall on the Earth.

We conclude the description of the method. The teacher can further develop it at his own discretion; he can only apply part of it.