

• LAB REPORT •

Introduction:

First of all, we are going to tell what corpuscular-kinetic model theory is. Corpuscular-kinetic model says that all matter has particles which have constant motion.

The experiment we are going to do consist in taking 3 glasses of different surface but with the same amount of water. Then we will apply the 3 glasses in the same casserole but with very hot water, with a temperature of 60°C. All the glasses will be in the same time in casserole (3 minutes). And we will see the reaction.

We will put name to the glasses: **glass 1** (20 cm of diameter), **glass 2** (22,4 cm of diameter), **glass 3** (24,8 cm of diameter)

Investigation Question:

→What is the relation between heat transfer and surface area?

Hypothesis:

If we apply the three glasses of different surface, then we are going to see that the temperature of the largest glass, once the 3 minutes have passed, will be lower because having more surface will cost more time for the thermal energy transmission of the glass water to arrive.

Variables:

The **independent variable** is the surface because we can control the size of the three glasses. We are going to calculate the surface of each glass.

The **dependent variable** is the temperature of the water inside the glasses after 3 minutes. We are going to measure it by a thermometer (°C)

The **control variable** of this experiment will be the temperature of the water in the casserole. We will measure it with a thermometer (°C).

Another control variable will be the quantity of water that will be inside the glasses because we will decide a fix number of the quantity we will put and this way the only thing that can vary in these experiment is the dependent variable. We are going to measure the quantity of water with a glass mixer (ml).

And finally, another control variable will be the time that the 3 glasses will be in the casserole. We will know the time by a mobile stopwatch (min).

Materials:

→3 glasses but each one with different surface. They will be the main objects to complete our experiment.

→Water. We will put natural water in the three glasses and also water on the casserole (doesn't matter the initial temperature of that water because what we need is the water heated up).

→Kitchen thermometer. This will be useful to measure the temperature of the three glasses at the end of the experiment and also the water of the casserole (60°C).

→Casserole, the casserole is the recipient in which we are going to put the water that we will boil and will be what it will heat the water inside the glasses.

→Mobile Stopwatch, this will be useful to know how many time the water of the two glasses will spend heating up.

→Glass Mixer. The glass mixer will be helpful to know the quantity of water that we put in each glass.

→ Jar. We are going to need the jar to put the water in the glass mixer.



Method:

First of all, we are going to take three crystal glasses that are going to be of a different surface. Then we have to take a jar of water and put it on the table of the kitchen or anywhere else for the water to be at a room temperature. Now we are going to take a casserole and we are going to put inside a little quantity of water (we don't need the water to be at a specific temperature because that water will heat up anyways). We are going to put the **glass 1** over the water in the casserole and let it heat (the vitro fire is at the level 5) until the water reaches 60°C. In the main time we are going to measure the quantity of water that we are going to put in the glasses (75 ml) with a glass mixer. When the water in the casserole is nearly 60°C (approximately 47 °C), we are going to take the water from the table and we are going to look at what temperature the water inside the jar is at, with a thermometer. Then, we are going to put the water of the jar in a glass mixer (75 ml) and make sure that the temperature of the water in the casserole is 60°C (using a kitchen thermometer) before adding the water from the glass mixer to **glass 1**. We will use the stopwatch of the mobile phone and note what temperature the water in the glass is every 30 seconds for 3 minutes. When the 3 minutes have arrived we are going to remove **glass 1** from the casserole. When this moment arrives, we will repeat the entire process that we have previously done with **glass 2** and **glass 3**.

Analysis:

→Table:

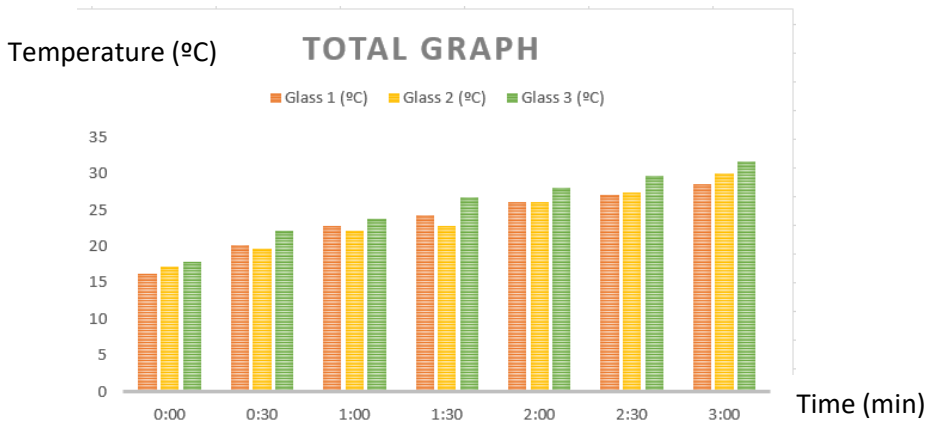
Here there is a table of how has developed this experiment. We can see that the **Glass 3**, which has the biggest surface is the one which has lasted with the highest temperature.

Time (min)	Glass 1 (°C)	Glass 2 (°C)	Glass 3 (°C)
0:00	16,3	17,2	17,8
0:30	20,2	19,6	22,2
1:00	22,8	22,2	23,8
1:30	24,2	22,8	26,8
2:00	26	26,1	28,1
2:30	27,1	27,3	29,7
3:00	28,5	30	31,6

This has happened because the heat depends on the transmission surface. The larger the surface is, the more thermal energy is transmitted, so the **glass 3** with the same time as the others and with the same amount of water, has a higher final temperature. This means that the transmitted thermal energy is much higher and depends on the surface.

→Graphs:

We can see the total graph.



In these total graph we can see how the temperature of **glass 1** is lower than the **glass 2** and **glass 3**. This happens because the surface of glass 1 is smaller in such a way that it takes longer for the water to heat up than in the other glasses. We can see that **glass 2** (the intermediate one, that is, the one that does not have much or very little surface) is the second to have the highest temperature, in such a way that we can conclude that the larger the surface, more thermal temperature. This happens because the heat depends on the transmission of the surface.

Explanation:

In this experiment the thermal energy is transmitted from the water in the casserole to the water in the glasses by conduction. But also is convection, because as bigger is the surface more particles can occupy the space, so it will be harder to heat up. This happens because the particles that are on the bottom of the glass are closer to the metal and they heat up earlier than the others, when this happens that particles as they are hot they move much more than the others and they go up forming a rotation, that means that the particles that they were on the top they heat up, so finally all particles are hot. For that reason, when we have a bigger surface, when there are more particles it will take longer to heat up. As we already know, conduction happens when two objects are in contact (through collisions between particles), convection happens when liquids and gases interpose (from the movement of the particles) and, finally, radiation happens when there are waves electromagnetic (no material is needed as magnetic waves can propagate in the void). So we have come to the conclusion that this experiment is conduction since two objects come into contact.

To find out how are the surface influences of the transmission of thermal energy, we have calculated the contact surface that each glass has with the water in the casserole (both the base and the side of the glass). These are the contact surfaces:

→ Glass 1:



$$\begin{aligned} S &= \pi \cdot R^2 \\ S &= 3,14 \cdot 10^2 \\ S &= 314 \text{ cm}^2 \\ S &= 2\pi \cdot R \cdot h \\ S &= 2 \cdot 3,14 \cdot 10 \cdot 8 \\ S &= 502,65 \text{ cm}^2 \\ S_{\text{total}} &= 502,65 + 314 = 816,65 \text{ cm}^2 \end{aligned}$$

Total Surface: 816,65 cm²

→ Glass 2:



$$\begin{aligned} S &= \pi \cdot R^2 \\ S &= 3,14 \cdot 11,2^2 \\ S &= 393,9 \text{ cm}^2 \\ S &= 2\pi \cdot R \cdot h \\ S &= 2 \cdot 3,14 \cdot 11,2 \cdot 11 \\ S &= 774,1 \text{ cm}^2 \\ S_{\text{total}} &= 393,9 + 774,1 = 1.168 \text{ cm}^2 \end{aligned}$$

Total Surface: 1.168 cm²

→Glass 3:



$$\begin{aligned} S &= \pi \cdot R^2 \\ S &= \pi \cdot 12,4^2 \\ S &= 483,05 \text{ cm}^2 \\ S &= 2\pi \cdot R \cdot h \\ S &= 2\pi \cdot 12,4 \cdot 9 \\ S &= 701,20 \text{ cm}^2 \\ S_{\text{total}} &= 483,05 + 701,20 = 1.184,25 \text{ cm}^2 \end{aligned}$$

Base = 24,8 cm
Altura = 9 cm

Total Surface: 1.184,25 cm²

As we can see the **glass 3** has the largest surface and if we check the final temperature in the obtained in the data we can see that this glass has a higher temperature than the other glasses. Instead, **glass 1** gets the lowest temperature. This confirms that the transmission of energy depends on the contact surface. The larger the surface, the greater the thermal transmission is.

We can also see that, in order to obtain the same temperature in the three glasses, we need to spend less energy with a glass with a larger surface area, and this is achieved with less time.

Conclusion:

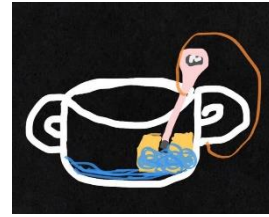
We have been able to see that the hypothesis is wrong since we thought that the smaller the surface of the glass is, the highest temperature has, but it is not correct. What happened after doing the experiment is that the bigger the glass is, the more temperature has. So the hypothesis would be:

→If we apply the three glasses of different surface, then we are going to see that the temperature of the smallest glass, once the 3 minutes have passed, will be lower because the thermal energy transmission depend on the surface it has. The bigger the surface, the more heat transmission there will be.

We think that the way we did the experiment was fine, but we had some problems. What we founded difficult was to look at the mobile stopwatch and write down the temperature every 30 seconds because we had to be aware that the recording time did not pass ... this was a bit confusing. Another thing that we didn't do quite good was that the initial temperature of each glass was different. We should have looked better and noticed more that they were all at the same temperature because if the initial temperature is different, the other temperatures could also be wrong and could be the reason why one has a higher temperature and the others less. The room temperature was different because when we did the experiment with **glass 2** and **glass 3** the temperature of the kitchen was different than the room temperature when we did the

glass 1, because a cake was on the oven when we did the experiment with **glass 2** and **glass 3**. This could be one of the reasons that glasses were on different temperature.

Some things that we could improve of the experiment is holding the thermometer with a chicken gum. This will be useful because we will not need someone holding the thermometer, that way that person could be helping taking notes/photos or looking at the mobile stopwatch each 30 seconds.



Evaluation:

Because of the Covid-19 we could not do the experiment together, so only one of us did it, which was a small problem since we need someone to take the photos for us or to put the stopwatch since those two things had to be done by one person and as a result some of the photos taken were moved. Using the idea that we have proposed at the end of the conclusion, it could have helped us because, as we have previously said, it could have prevented the photos from being moved.

Another thing that we could have improved is that all the glasses were the same thickness size since not all of them were the same. They looked similar but they are a little bit different.

Some photos while we have taken measurements, the temperature ...

