Christmas Cartesian Diver

Our Cartesian diver is designed with an eyedropper for the diver, which floats at the top of a sealed plastic bottle filled with water. In a nutshell, when you squeeze the sides of the bottle, the diver sinks to the bottom. When you stop squeezing the bottle, the diver rises back to the top.

Step 1: Supplies

Image 1.1

1.1 Your kids can build their Cartesian diver with just a 1-liter soda bottle, an eyedropper, and some mounting putty. If you're helping them build our Christmas Cartesian diver, the rest of the supplies listed in our **Tools/Supplies Tab** will upgrade their Cartesian diver with a festive holiday twist **(see Image 1.1)**.

Step 2: Preparation

Image 2.1

2.1 If they haven't already done so, have your kids empty and rinse out the contents of their 1-liter soda bottle.

2.2 Help them remove any labels, price tags, or other materials that could interfere with the view inside the bottle.

2.3 Finally, have your kids fill a glass with water. The glass of water will be used to test their eyedroppers throughout the project **(see Image 2.1)**.

Step 3: Testing

Image 3.1

Image 3.2

3.1 Make sure your kids verify that their eyedropper will fit through the neck of their bottle **(see Image 3.1)**.

3.2 Next, your kids need to test their eyedropper for any leaks. Have them partially fill their eyedropper with water using the glass they filled earlier. The eyedropper should be able to hold the water without it draining out of the bottom **(see Image 3.2)**.

Note: If the water leaks out, there's a problem with the bulb on top. First, check to see that the bulb is attached properly, then have your kids test the dropper again. If the water continues to drain out the bottom, they will need a new eyedropper.

Step 4: Build Steps

You've gathered the needed tools and supplies, and you've walked your kids through the necessary prep work. Now it's time for them to follow the steps below to build their own Christmas Cartesian diver.

Image 4.1

4.1 Fill your 1-liter bottle with water **(see Image 4.1)**.

Note: We prefer to stop filling our bottles about an inch from the top. This will prevent any displaced water from spilling as you add your eyedropper.

Image 4.2

4.2 Fill your eyedropper with water using the glass you filled earlier. Set your dropper halfway in the water, squeeze the bulb to remove any air in it, then release the bulb. You should see some water get sucked up into the dropper. **(see Image 4.2)**.

Image 4.3

4.3 Now test the buoyancy of your eyedropper using the glass of water. If your eyedropper floats on its side as seen in **Image 4.3**, continue to **Step 4.4** to add weight to the bottom of your dropper. If your eyedropper is already hovering vertically near the top of the water in the glass **(see Image 4.5 below)**, you can skip to **Step 4.5**.

Image 4.4

4.4 If your eyedropper floated on its side in the previous step, you need to add some weight to the end of your dropper. As discussed in our **Investigations Tab**, we prefer to use mounting putty. Attach a small amount of putty (or other weight) to the end of your dropper leaving one side visible. This will allow you to see what's happening inside the dropper when you use your Cartesian diver **(see Image 4.4)**.

Note: The more putty you can add to the dropper now the easier it will be to make it sink when you squeeze the sides of the bottle in **Step 4.7**.

Image 4.5

4.5 If your eyedropper continues to float on its side, add a little more putty until it hovers vertically near the top of the water **(see Image 4.5)**.

Note: If your eyedropper sinks to the bottom of your glass, too much weight was added. Remove a small amount of putty, and continue to run tests, until your diver hovers at the top of the water **(see Image 4.5)**.

Image 4.6

4.6 You can now place the eyedropper into your bottle of water. Add any additional water needed to fill the water to the very top of the bottle, then securely place the cap back on **(see Image 4.6)**.

Image 4.7

4.7 It's time to see your Cartesian diver in action. Squeeze the sides of your bottle firmly until the eyedropper sinks. Release the sides of your bottle to watch the eyedropper rise back to the top **(see Image 4.7)**.

Note: Don't panic if you're unable to make the eyedropper sink no matter how hard you squeeze the sides of the bottle. We built and rebuilt quite a few Cartesian divers to test for any issues and discovered two common problems.

Issue 1: Not enough water in the bottle.

Solution: Check to make sure you remembered to top off the water in the bottle after adding your eyedropper.

Issue 2: The eyedropper isn't heavy enough.

Solution: Go back to **Step 4.4** to see if you can add more putty to the bottom of the dropper without it automatically sinking in the glass of water.

Note: Remember, the eyedropper sinks as soon as it's denser than the water that surrounds it, so the heavier you can make your diver, the less pressure needed to sink it.

It's now time to add our Holiday Twist to this classic experiment!

Image 4.8

4.8 Our first Holiday Twist, **Diver Hovering**, is a game of precision using your hovering skills. Our North Pole thermometer has been divided into four sections, with each section worth more points than the previous one.

Practice hovering your diver between the marked areas. Challenge your family and friends to see who can earn the most points after a pre-determined number of rounds **(see Image 4.8)**.

Feel free to use any point system or design you want. If you'd like to use our thermometer design and point system, the values are:

1. 5 points for hovering your diver between 50 degrees down to 30 degrees.
2. 10 points for hovering your diver between 30 degrees and 0 degrees.
3. 20 points for hovering your diver between 0 degrees and - 10 degrees.
4. 25 points for hovering your diver anywhere in the red section at the bottom of the thermometer.

To make this game more challenging, add a minimum hover time the diver must stay within the marked areas. Even more challenging, try to hover the diver in a sequence of pre-determined sections.

Image 4.9

4.9 Our second Holiday Twist, Bell Ringing, is a game of chance. Add Christmas bells in a variety of colors and sizes to the bottom of your bottle. Assign point values based on how many bells you have of each color and size.

Practice sinking your diver until it touches a bell every time. Challenge your family and friends to see who can earn the most points after a pre-determined number of rounds **(see Image 4.9)**.

The point system for our bells was:

1. 5 points for touching one of the two large gold bells.
2. 10 points for touching one of the two medium red bells.
3. 25 points for touching the single small green bell.

To make this game more challenging, limit the number of tries allowed each turn. You can also shake the bottle between rounds to change the position of the bells.

We Hope You Enjoy Your Christmas Cartesian Diver!