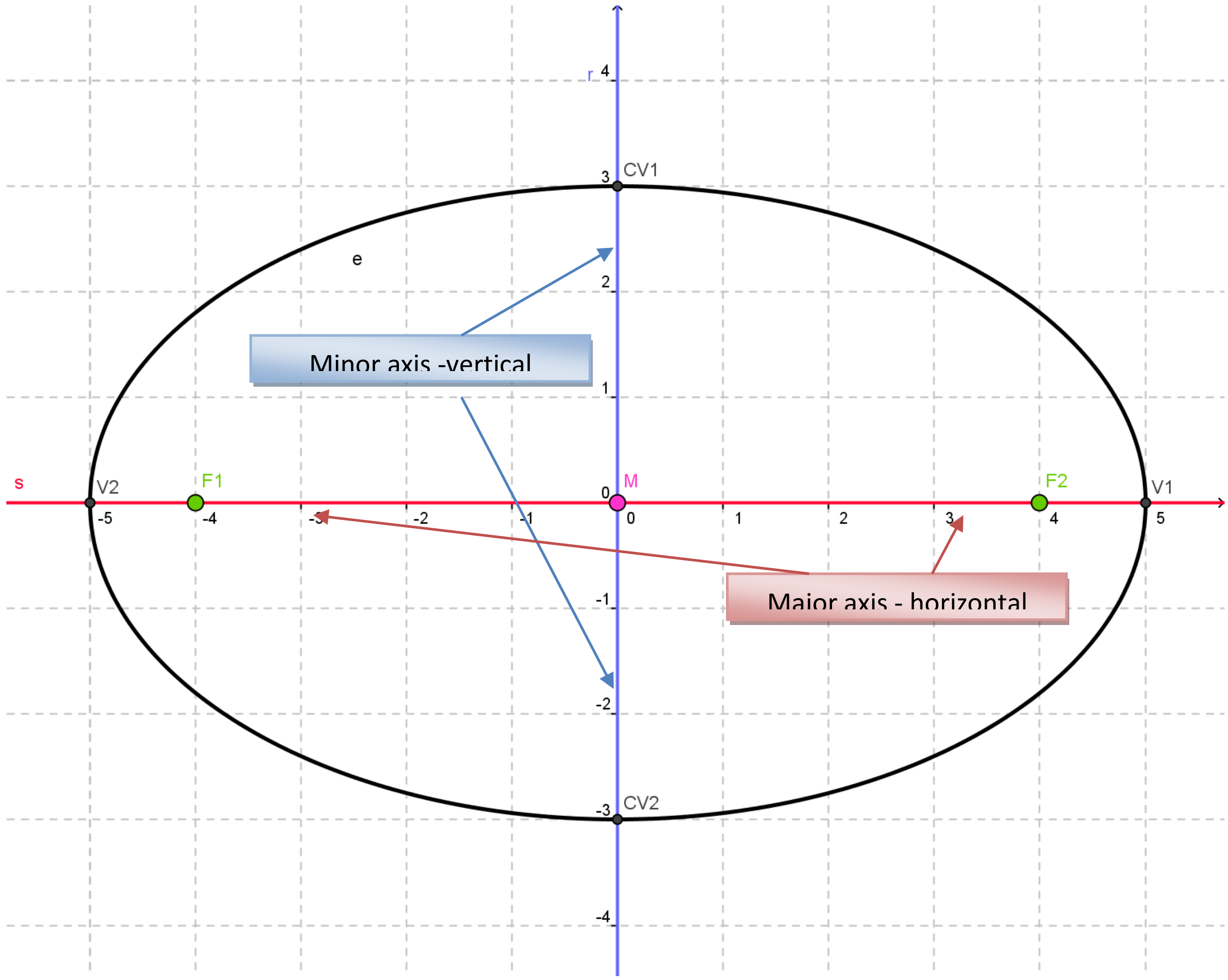
1. Each student (may need groups of 2) needs paper, string, ruler, 2 thumbtacks, and 2 corkboards (each student needs a piece of paper)
2. Draw a line on paper (if not already there)
3. Put paper on top of 2 corkboards. Place 2 thumbtacks on the line- not too close to the edge of the paper. The string needs to be held down by the thumbtacks, but it shouldn't be tight- it should be a little loose.
4. Put pencil against string (on inside) and draw on the top from left to right (probably start on top and go to right, go back to top and go to left). Now draw the same thing on the bottom. The result should be an ellipse (often called an oval).
5. Take the paper off the corkboard.
6. The two holes (from the thumbtacks) are **foci** (plural for focus- a parabola has one focus; an ellipse has two foci). Label them both with ***F***s.
7. Find the midpoint of the segment between the foci. This point is the **center**. Label it with ***M***.
8. Draw a new line perpendicular to your original line – make it go through the center (***M***).
9. You now have two axes (plural for axis- a parabola has one axis; an ellipse has two axes- one is horizontal, one is vertical). One axis is longer than the other axis (this has to happen- if the axes had equal lengths, the shape would be a circle, not an ellipse).
10. The longer axis is the **major axis**. The shorter axis is the **minor axis**.
11. The major axis intersects the ellipse in two points. Label these points with ***V***s for **verticies** (plural for vertex- a parabola has one vertex; an ellipse has two verticies). This segment is the longest possible segment in the ellipse.
12. What points are always on the major axis?

13. The minor axis also intersects the ellipse in two points. Label these points with ***CV***s for **co-verticies**). This segment is the shortest possible segment to pass through the center in the ellipse.
14. What points are always on the minor axis?

15. Do you understand the following drawing? Is it similar to yours?



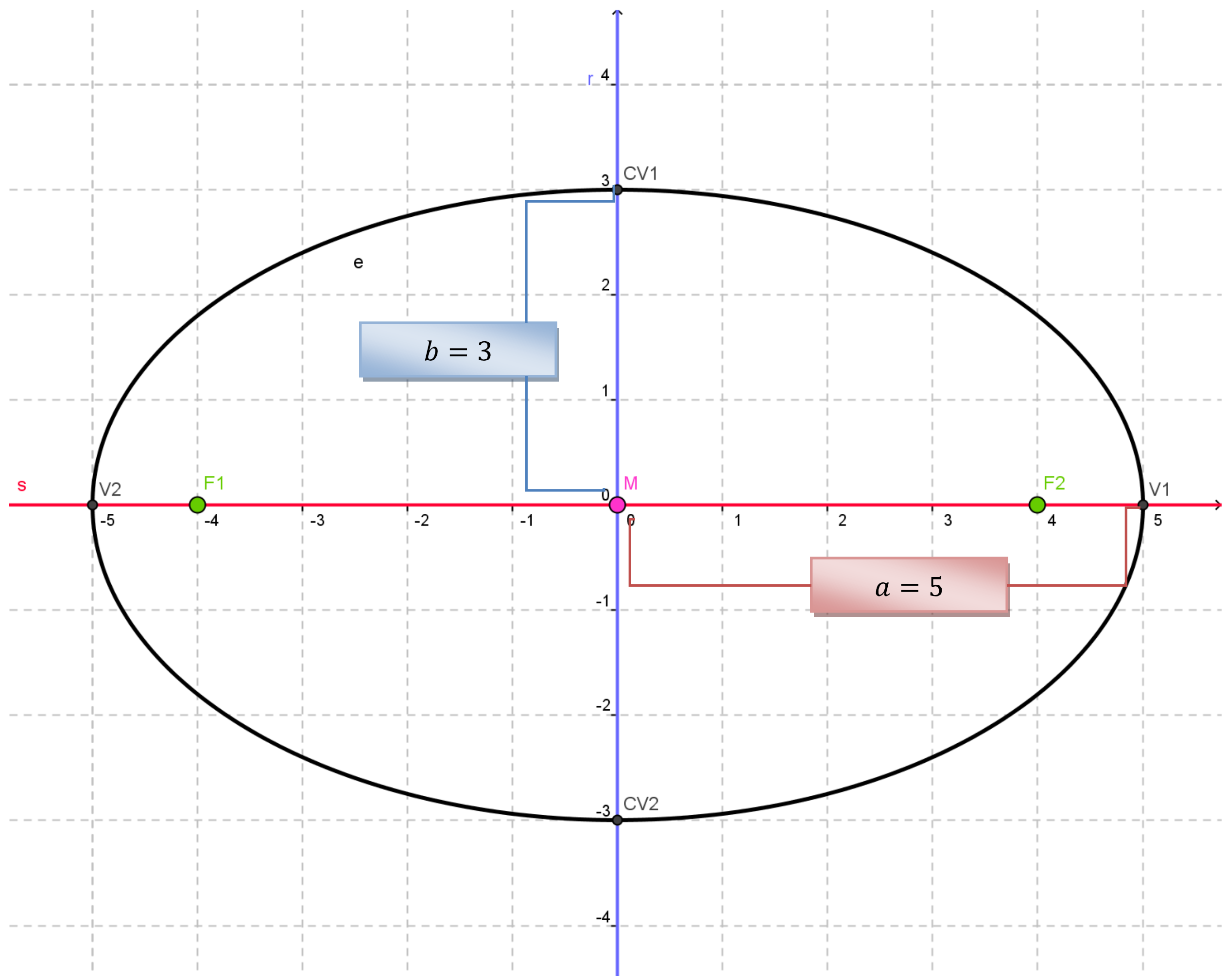

In a circle, the distance from the center to any point on the circle is called a radius.

We will focus on two radii (plural for radius) in an ellipse.

The longest possible radius must be on the major axis and must go through a focus on its way from the center to a vertex on the ellipse. We will call this focal radius ***a***.

The shortest possible radius must be on the minor axis. It goes between the center and a co-vertex. We will call this shorter radius ***b***.

You will see this on the next drawing.




The equation for an ellipse with center (0, 0) and a HORIZONTAL major axis is

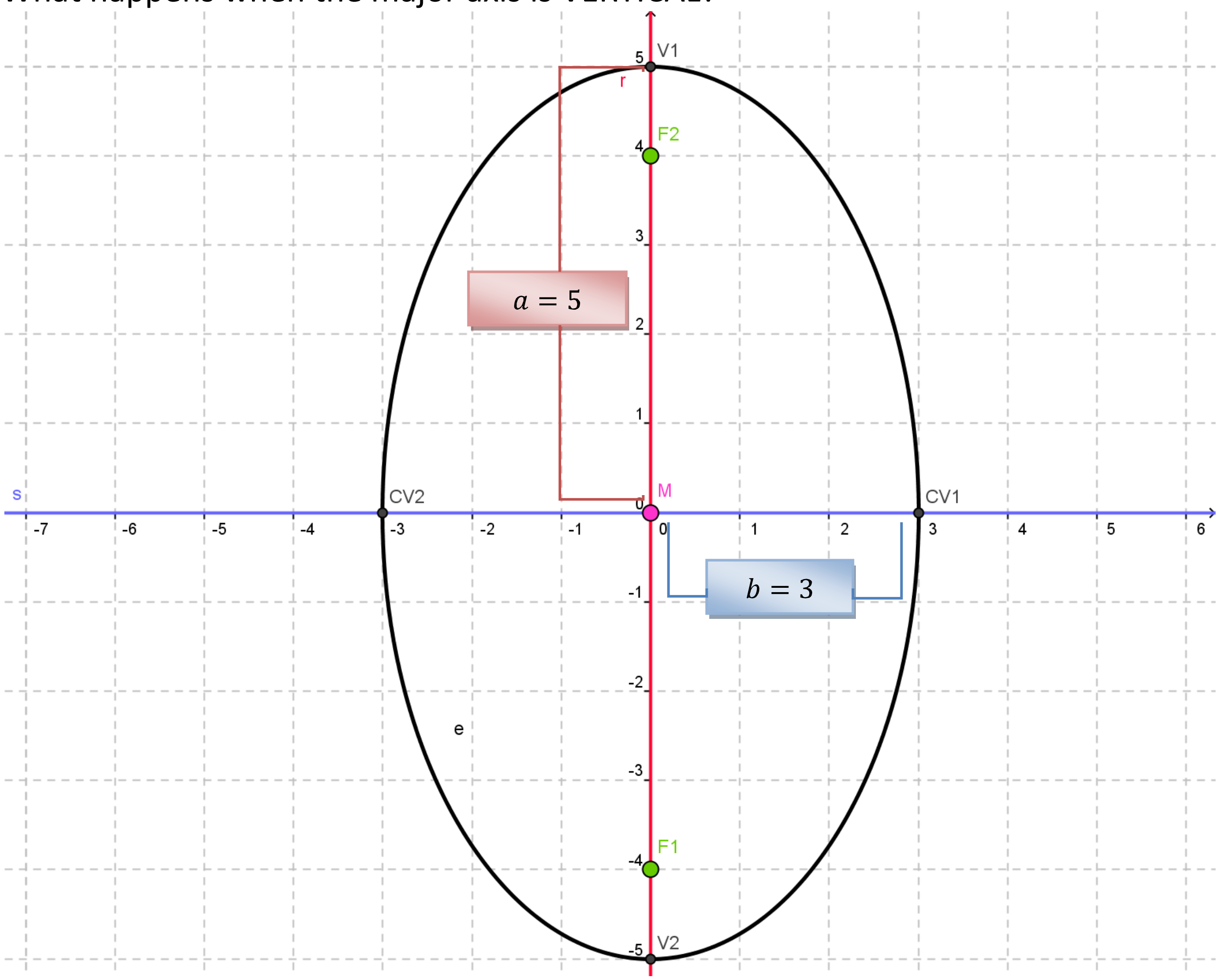
$$\boxed{\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1}$$

Notice that the major axis (***a***) is horizontal and so is the $x$-axis, and they end up in the same fraction.
Notice that the minor axis (***b***) is vertical and so is the $y$-axis, and they end up in the same fraction.

The equation that fits our ellipse is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \longrightarrow \frac{x^2}{(5)^2} + \frac{y^2}{(3)^2} = 1 \longrightarrow \boxed{\frac{x^2}{25} + \frac{y^2}{9} = 1}$$

What happens when the major axis is VERTICAL?




The equation for an ellipse with center (0, 0) and a VERTICAL major axis is

$$\boxed{\frac{\boldsymbol{x}^2}{\boldsymbol{b}^2} + \frac{\boldsymbol{y}^2}{\boldsymbol{a}^2} = \mathbf{1}}$$

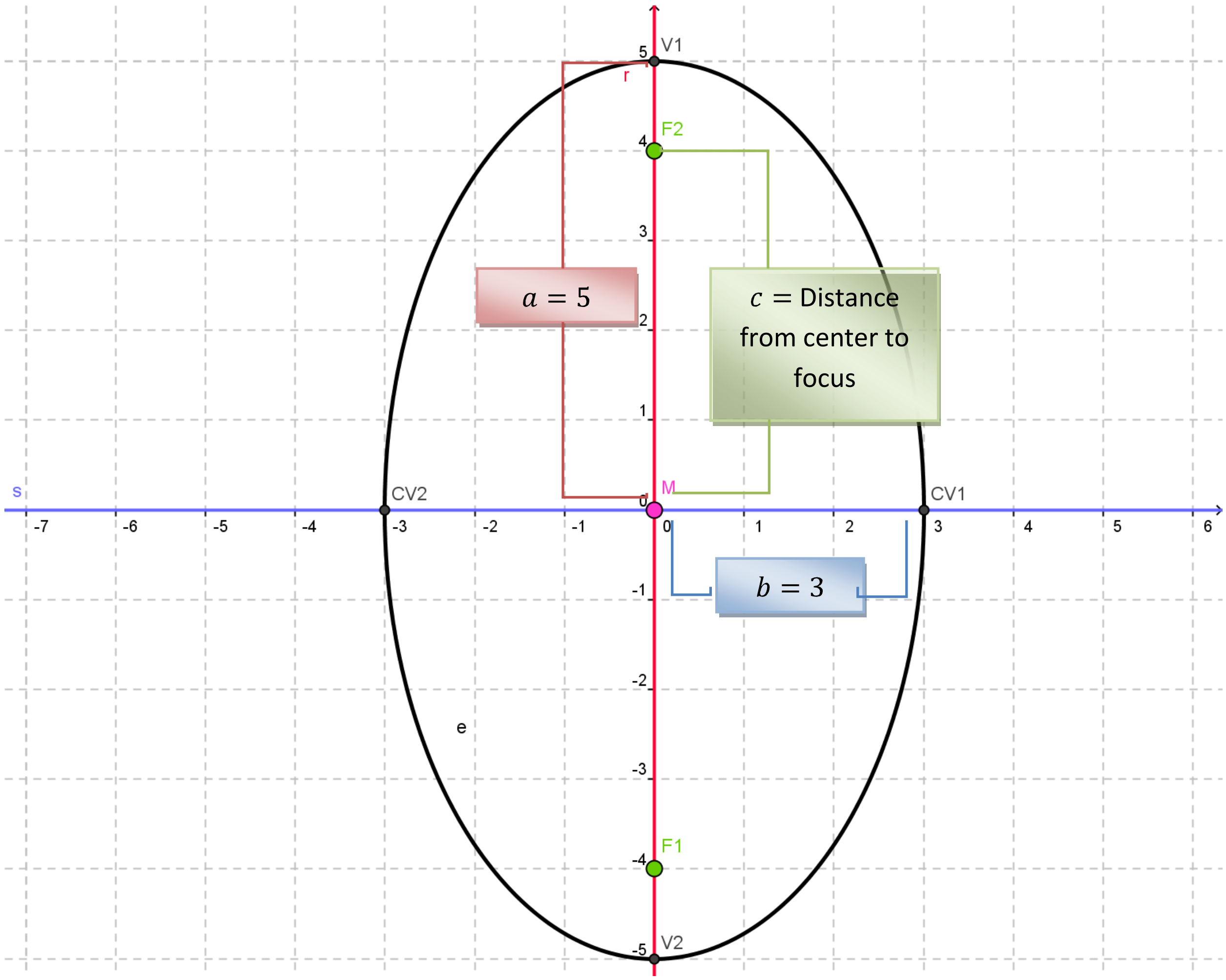
Notice that the major axis (***a***) is vertical and so is the $y$-axis, and they end up in the same fraction.
Notice that the minor axis (***b***) is horizontal and so is the $x$-axis, and they end up in the same fraction.

The equation that fits our ellipse is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \longrightarrow \frac{x^2}{(3)^2} + \frac{y^2}{(5)^2} = 1 \longrightarrow \boxed{\frac{\boldsymbol{x}^2}{\mathbf{9}} + \frac{\boldsymbol{y}^2}{\mathbf{25}} = \mathbf{1}}$$

How can you find the foci if you know verticies & co-verticies?

The distance between the center (***M***) and a focus (***F***) will be called *c* (in a parabola, the distance between the vertex and the focus was also called *c*).




In an ellipse

$$\boxed{c^2 = a^2 - b^2}$$

In our ellipse,

$$c^2 = (5)^2 - (3)^2$$
$$c^2 = 25 - 9$$
$$c^2 = 16$$
$$c = 4$$

(Since $c = 4$ you can find the foci by starting at the center and moving a distance of **4** in both directions on the major axis)