

Math on a Sphere

Topic 2: Forward and Right commands

In the first exploration of the sphere, we saw how to move the turtle about (and to draw lines) by using the `forward` command. Here, we'll gain a little more facility with moving the turtle. Let's begin once more with our starting screen, as shown below.

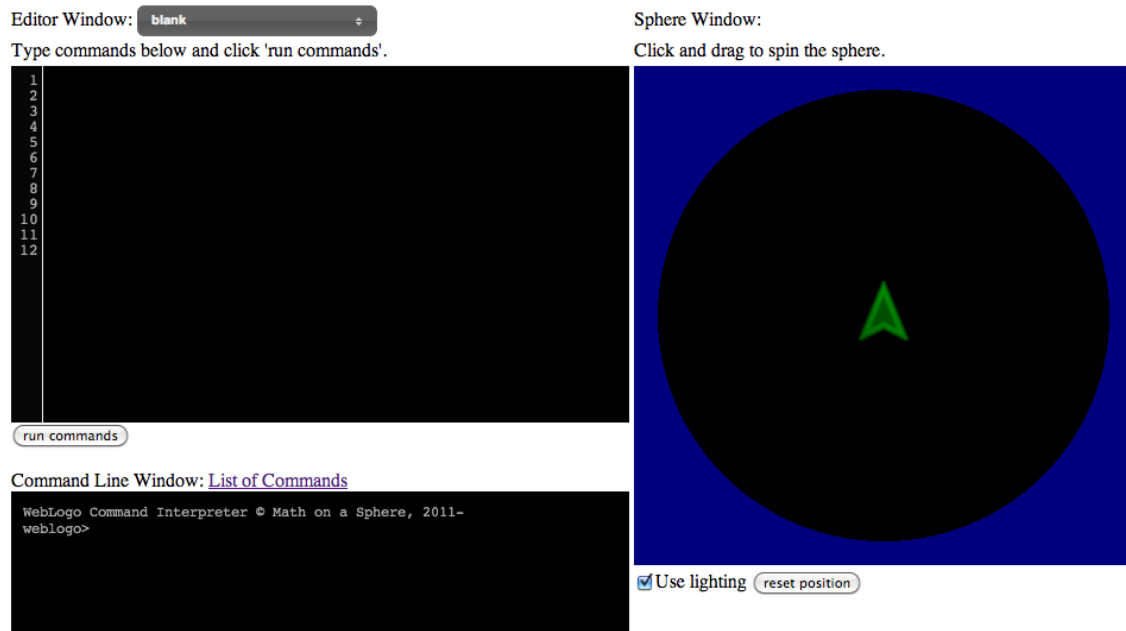


Figure 1. The starting screen.

Once again, let's move the turtle forward toward the North Pole. As an experiment, let's try a different number for our `forward` command; let's try moving the turtle forward 30 steps:

```
forward 30
```

Now the sphere should look as in the figure below:



Figure 2. The turtle has moved forward 30 steps.

The number that we use with the `forward` command is sometimes called the *argument* for the command: that is, we could say that we just now tried our `forward` command with an argument of 30. In our sphere language, we have chosen to make 90 "steps" the amount that the turtle needs to take to go from the equator to the North Pole. To move the turtle from its current position to the North Pole, we have to take 60 more steps. Let's move the turtle forward, then, to the North Pole by typing this command:

```
forward 60
```

Now, the turtle will be up at the North Pole, having taken a total of 90 steps from its original position. The sphere should look as in the figure below:



Figure 3. The turtle has moved forward a total of 90 steps to arrive at the North Pole.

In the previous exploration, once the turtle was at the North Pole, we turned it in an "about face", by 180 degrees. This time, let's try a different argument for the `right` command; instead of turning the turtle 180 degrees, we can have it make a "right-face" turn of 90 degrees:

```
right 90
```

Once we've turned the turtle, we can use the mouse to turn the sphere interactively and get a better view of where the turtle is, as in the figure below:



Figure 4. The turtle is at the North Pole, and has turned 90 degrees, making a "right face".

Now that we've turned the turtle, if we tell it to move forward, it will move in the (new) direction that it is pointing. Let's try moving the turtle forward 90 steps:

```
forward 90
```

Once the turtle has moved forward, we can use the mouse to turn the sphere and get a view of the turtle's new position. The overall pattern drawn by the turtle should now look as it does in the figure below:



Figure 5. The turtle has now drawn two lines, with a 90-degree turn in between.

In Figure 5, the turtle is now back at the "equator" of the sphere, since it moved 90 steps from the North Pole. (Of course, it's not at the very same *position* on the equator that we started with.) The turtle is now pointed toward the South Pole of the sphere; we can turn it another 90 degrees to the right so that it is facing along the equator. In fact, let's type in *two* commands, one after the other: we'll turn the turtle 90 degrees to the right, and then move it 90 steps forward. By doing these two steps, we end up with a set of three lines making a closed shape, as in the figure below:



Figure 6. The turtle has now drawn three lines, ending up in the same spot that it began (but with a different heading).

The turtle is now back at its original (starting) position, but with a different heading than it began with.

We have now seen how to move the turtle about the sphere using `forward` and `right` commands, and we've gotten a very first sense of how to use different arguments to those commands to create patterns. Before we go any further with drawing on the sphere, in the next exploration, we'll pause just a bit to reflect on what we've done so far, and what it all means.