Name
Date

Spatial Thinking

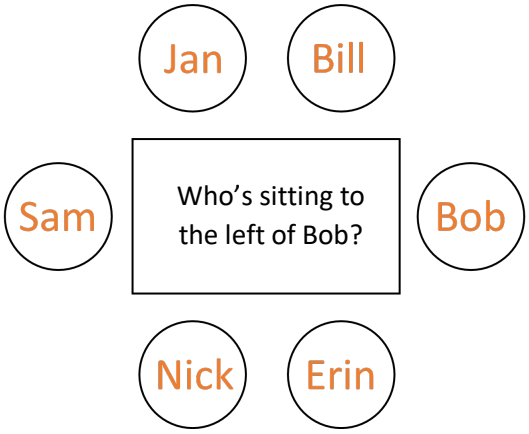
Spatial thinking, simply put, is *how we think about objects in space and all the ways we can transform and manipulate those objects mentally*. Research has shown that science, technology, engineering, and math (STEM) students are successful in those fields because, on average, they have greater spatial thinking ability than their non-STEM counterparts. Thankfully, spatial thinking can be improved!

The activity you will be doing today involves using three spatial skills to complete an introductory geology exercise: mental rotation, spatial orientation, and spatial visualization.

Mental rotation involves turning an object about an axis.

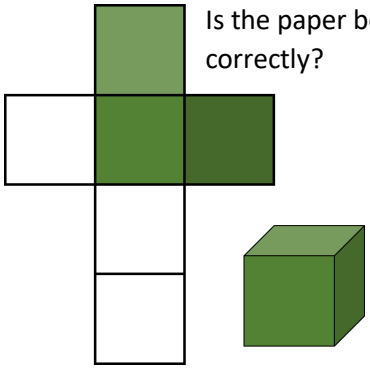
What direction was this word rotated?

Spatial orientation involves understanding perspective and how one object relates to a frame of reference.



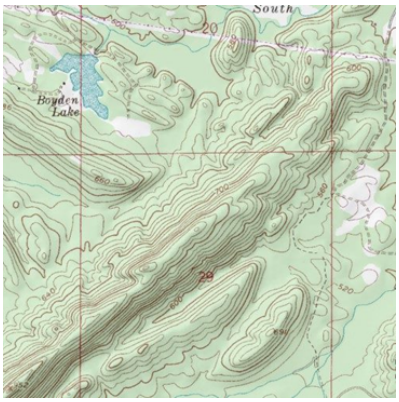
Spatial visualization involves any multi-step mental manipulation of an object to complete a task.

Is the paper box folded correctly?



Topography

Topography is the *physical shape of a landscape*. It includes how high or low, how wide, and how deep or thick landforms within the landscape are. To document the topography of landscapes, geoscientists use topographic maps that use lines to mark areas of the same elevation. With this topographic information, we can determine how water moves about the landscape or the relative height of landforms in the landscape, to name a few.



As you can see from the 2-dimensional topographic map to the left, it may be difficult to understand what these features may look like in 3-dimensions. That's where the augmented-reality (AR) sandbox is here to help! Using this technology, we can recreate this two-dimensional topographic map to explore the landscape in 3-dimensions. In this activity, you will be asked to work through this worksheet, complete written answers, and work in the AR sandbox,

When geosciences are working with maps and landscapes, they need to use spatial skills much like the ones mentioned earlier. This activity will use mental rotation, spatial orientation, and spatial visualization.

What you'll DO

1. Recreate landscapes from topographic maps in the AR sandbox.
2. Identify common landforms.
3. Orient yourself in the landscape to identify features using cardinal and relative directions.
4. Sketch the landscapes you create in the sandbox in 2-D and 3-D.

What you'll LEARN

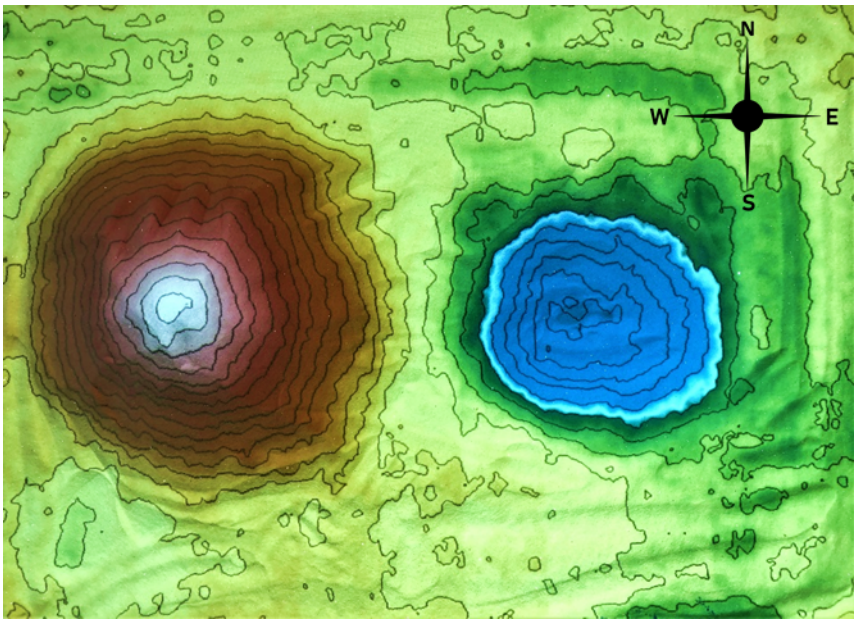
1. How to use colors and numbers to represent elevation.
2. How to identify the characteristics of watersheds.
3. How to interpret steepness of slope.
4. How to spatially represent landscapes in 2-D and 3-D.
5. How to use cardinal and relative directions to give and receive instructions.

Let's get started!

Elevation

Elevation is *the height of a landform relative to a fixed point*. The way we measure elevation is by comparing it to sea level, which is universally measured as 0 ft. On a topographic map we can depict elevation using colors and numbers.

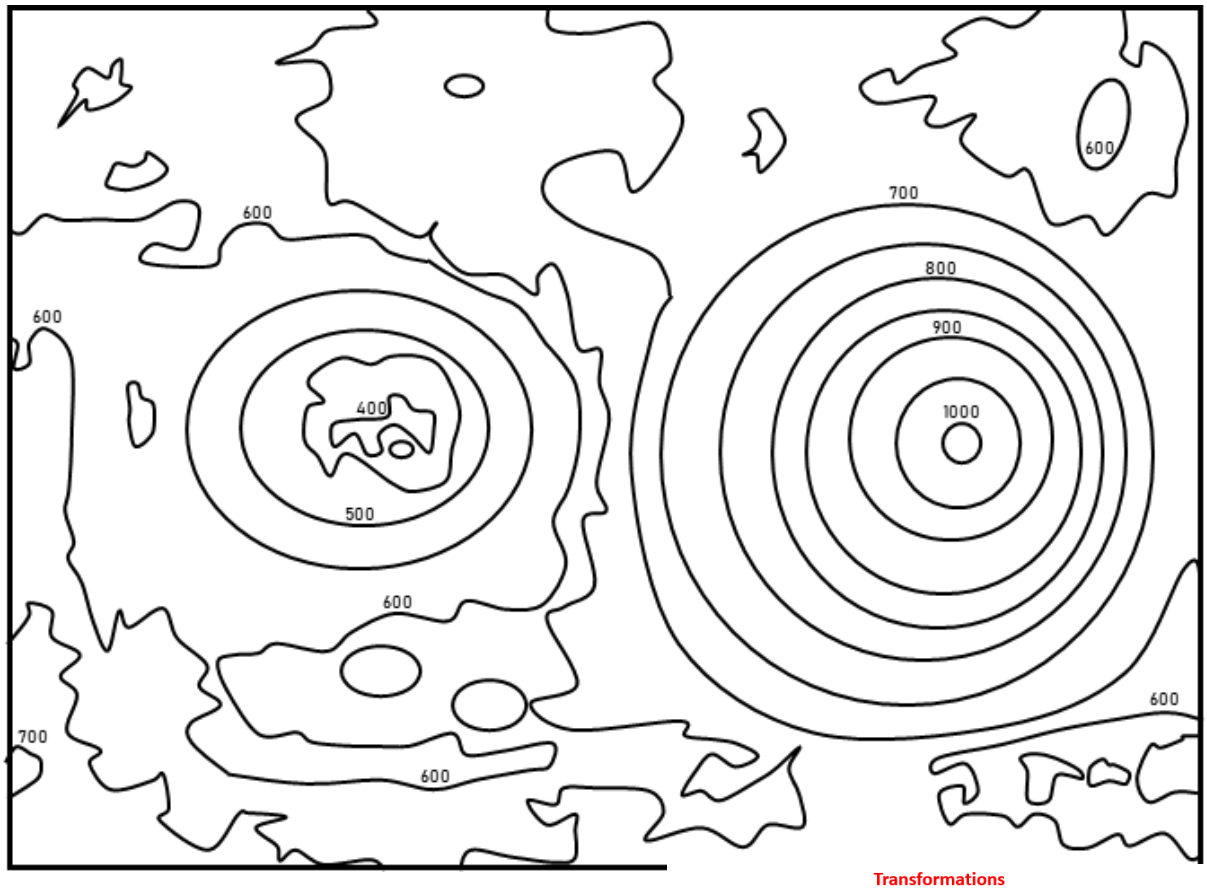
For example, the topographic map below was made in the AR sandbox. Take a second to **write** your predictions about what point on the map is the highest and what point is the lowest.



Recreate this map (above) in the sandbox, and try to match the colors in the sandbox to the ones on the map. Were your predictions correct?

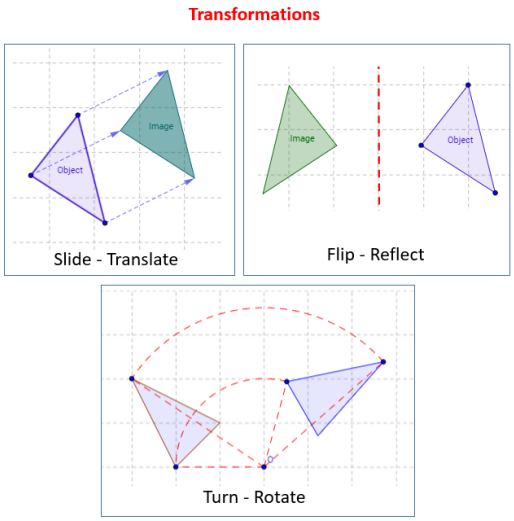
So, how do the colors represent elevation, e.g. Is green higher than red? Is yellow lower than blue? How do you know?

Examine the map below. Does it look familiar? Instead of colors, this map has numbers representing elevation. **Mark** the areas with the highest elevation and the lowest elevation.



Compare this numbered topographic map to the colorful topographic map. What happened to the map to achieve this new position?

A. Rotation
B. Flip
C. Translation



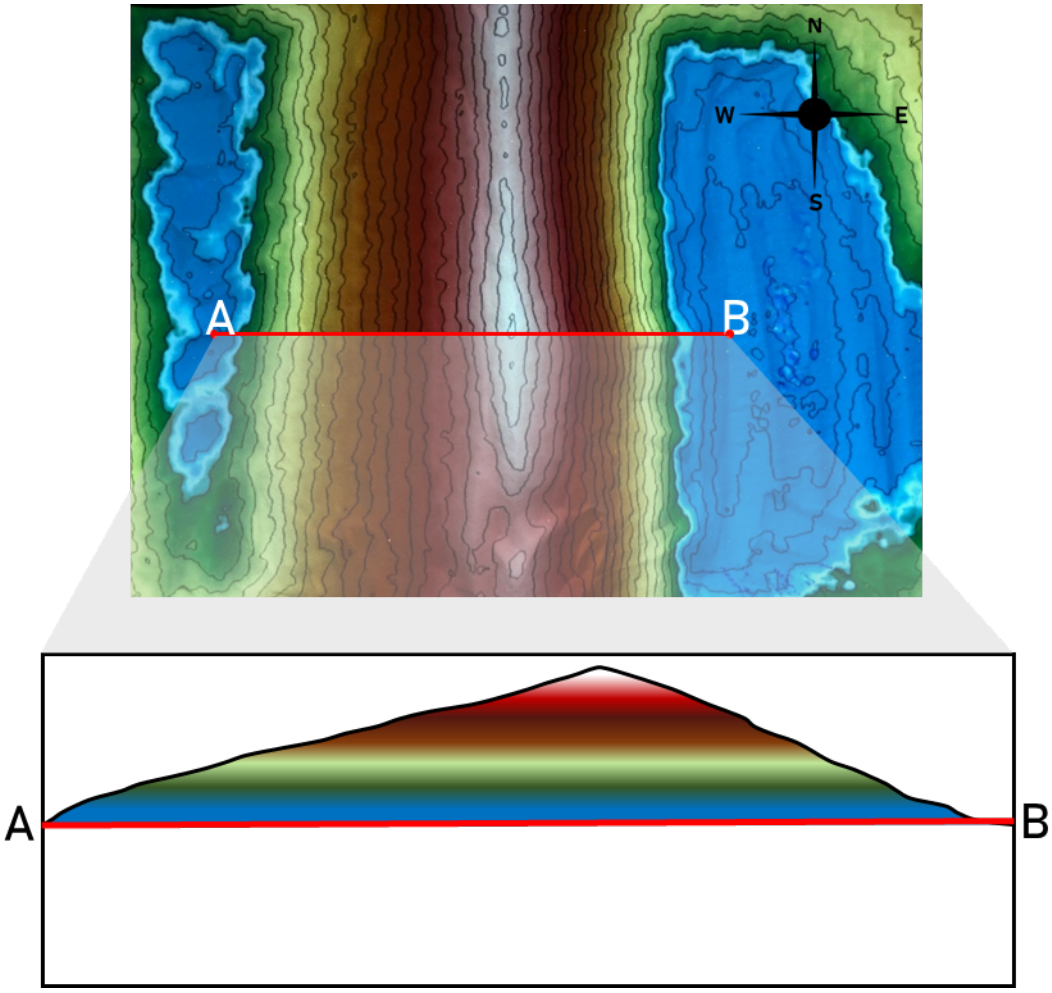
Remember: Mental rotation involves being able to turn an object, or map in this case, and reproduce maps from that rotation.

Based on the original colorful map on the previous page, d**raw** a compass on the numbered map above indicating which way is now North, South, East, and West.

Topographic Profiles

Topographic profiles are *cross-sectional views of landscapes*. Cross-sections can show us how relatively tall, wide, and steep a landform is from the side. Taking a cross-section looks like we're cutting into the landscape to see its profile.

For instance, look at the topographic profile of a ridge, an elongated, narrow hill, in the below image. The cross-section, A-B, goes from West to East.



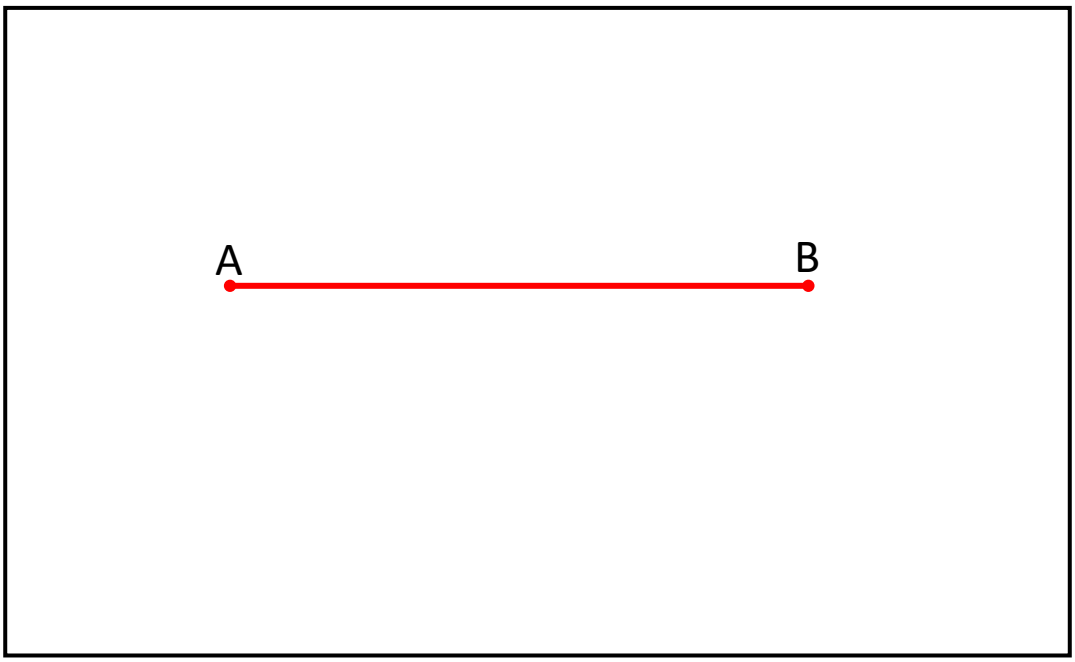
Take a note of the topographic profile above. **Mark** the steeper side of the ridge with a check. Notice the *spacing* between the lines. How is the spacing different for steeper slopes and shallower slopes?

Recreate this map in the sandbox using what you determined the line spacing to mean about steepness of slope.

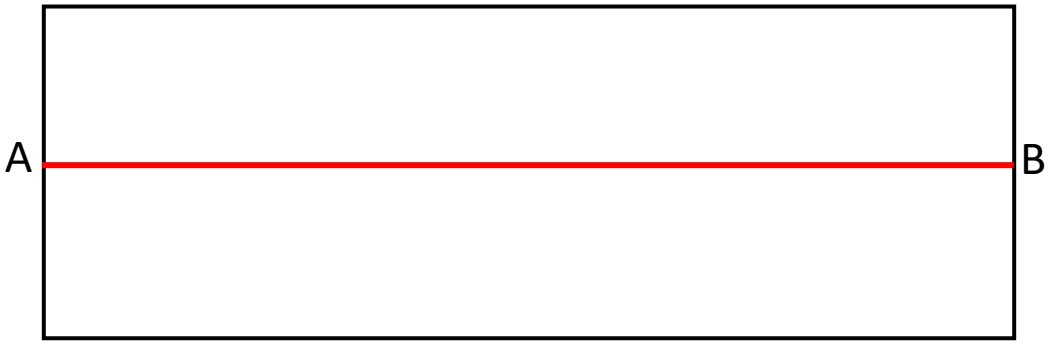
Topographic Profiles

This activity involves spatial visualization, which is using multiple mental skills to solve a spatial problem.

Create your own landscape in the sandbox by first drawing a compass to mark the cardinal directions, and then sketching your landscape in the box below. To help start you out, **make** a lake in the northeast corner of the sandbox.



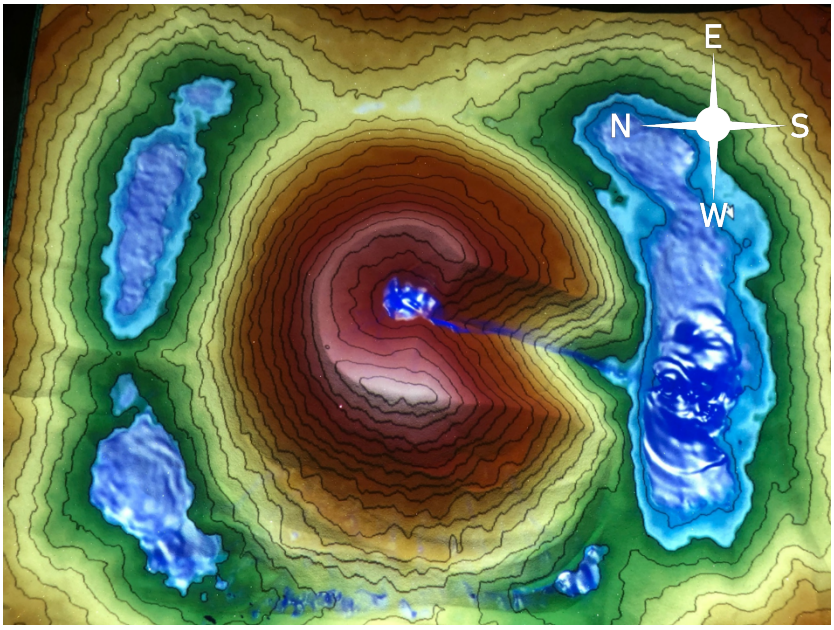
Roughly **sketch** what the topographic profile of this cross-section of your landscape from A to B would look like. Refer to the previous page for help sketching your profile. **Write** what direction your cross-section is in.



Reflect and **write** on how you were able to create your topographic profile.

Common Landforms

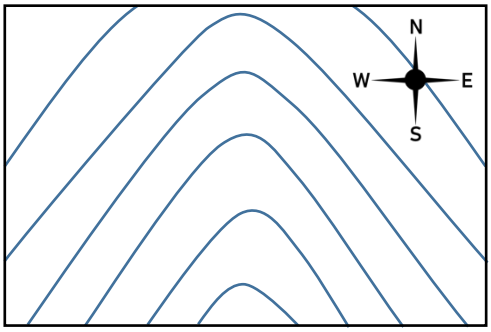
There are common landforms that are identifiable on maps, like river channels and ridges. We've already seen an example of a ridge on a landscape. Let's take a look at how to identify a river channel.

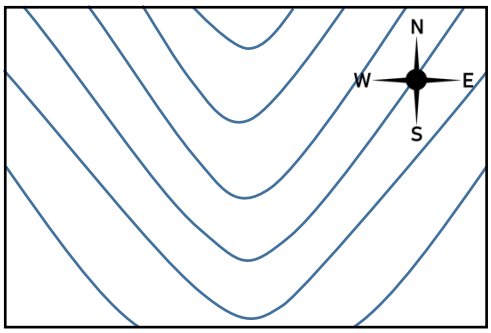


In the map above, we see a conical volcano with lakes in its central crater, to the south at the base of it, and two to the north. Let's investigate the features of the landscape by **creating** this map in the sandbox. (Tip: Build the volcano first before carving your river).

Write what the contour lines look like at the river channel, *a landform that allows for a narrow body of water to travel from high areas to low*, extending from the top of the mountain to the lake to the south? (Tip: To make it rain in the sandbox, stretch your hand out over where you want it to rain.)

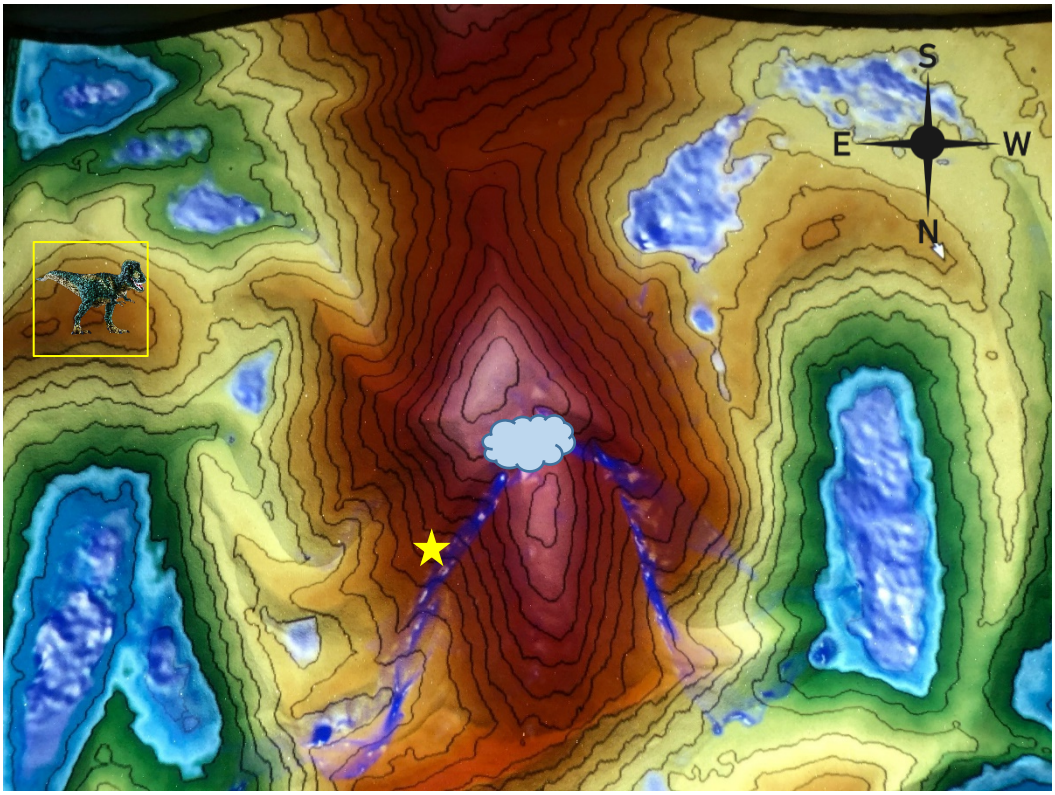
Draw an arrow on each of the diagrams below indicating which direction the water is flowing.





Positioning Yourself in the Landscape

Recreate this landscape in the sandbox with the North direction facing the wall. Grab a dinosaur from the container below, and place it on the hill on the East side of the map. That dinosaur is you! This activity involves spatial orientation where you have to make decisions about where things are related to each other in space.



If you, the dinosaur, traveled west to get to the good watering hole, what feature would impede your journey?

A. A deep lake
B. A ridge
C. A glacier

Write which direction is the river traveling where it is marked with a star? The cloud is marking where it has just rained. (Tip: To make it rain in the sandbox, stretch your hand out over the area where the cloud is.)

Thank you for completing this activity!