Name _____ Period _____ Date_____

Glacier Simulation Activity

Objectives:

- Determine the factors that affect the motion of glaciers, and calculate the speed of glacier movement.
- Discover what a glacier budget means for the growth and destruction of a glacier, and describe the features it leaves behind.

Google "Phet" and click on the first link, then "Play with Sims", then "Glaciers"

Background:

1. Describe the following terms to someone who did not study Earth Science.
    a. Glacier –

    b. Iceberg –

2. Understanding glacier formation, what is the relationship between the following:
    a. Temperature and glacier size

    b. Snowfall amount and glacier size.

    Explain what causes a glacier to grow or recede?

3. Describe the features that are associated with a glacier that moves through a mountain, explain how they are formed.

Hanging Valley / U-shaped Valley –

Arêtes –

Horns –

Cirques –

4. Glaciers are described as the "Most Erosive Force in Nature", what does this statement mean? Explain the difference between weathering and erosion.

5. What is the material that is transported with glaciers called? _____
    Describe the following deposition features of a glacier:

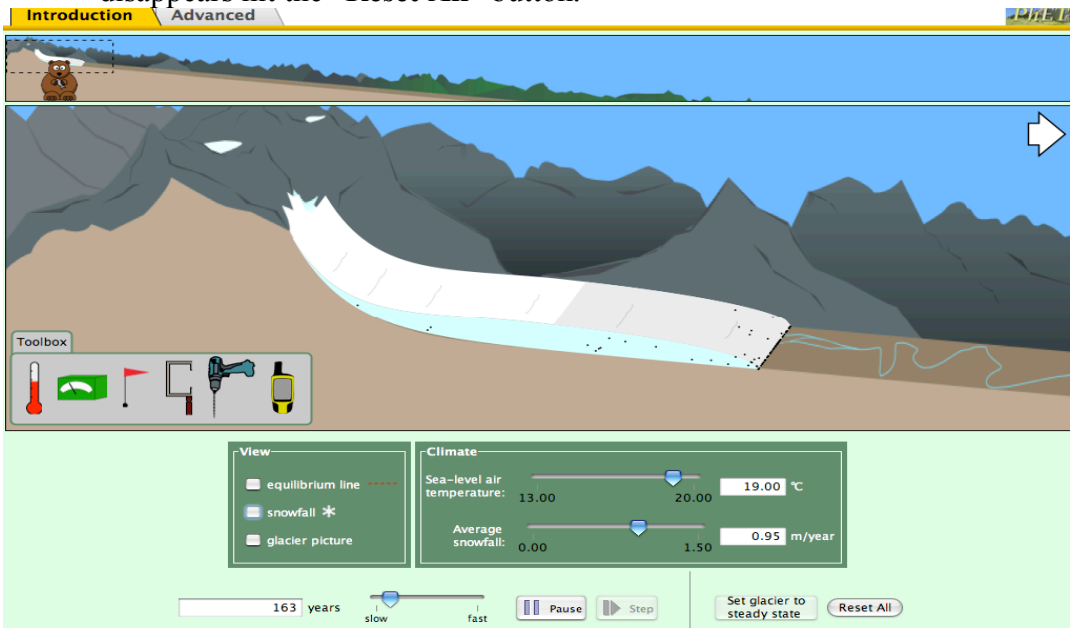
Moraines –

Outwash Plains–

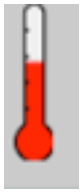
Drumlins/Eskers –

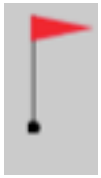
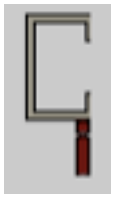
Procedure:

1. Open http://phet.colorado.edu/new/simulations/ and click on "Glacier", or go to Google and type "phet" and click on the first link.
2. * Turn off the snowfall effect. Play with simulation for 5 minutes. Grab the bear and change viewpoints, try to make the glacier grow/shrink. If the glacier disappears hit the "**Reset All**" button.



3. Looking at the toolbox, identify each tool and describe what it can be used for to measure.



4. Equilibrium line: This line indicates the boundary where the freezing meets the melting of the glacier. Change some factors and describe what happens to the equilibrium line and what happens to the glacier.

   - When you set the temperature and snowfall; and hit the STEADY STATE button, what happens to the glacier?

Predictions

1. If the average annual snowfall increases (m/yr), what will happen to the glacier?

2. If the temperature changed, describe the two things that could change in the glacier.

3. If the temperature is decreased and the snowfall is increased,
   a. Will the equilibrium line move up the mountain or down the mountain? Explain.
   b. What will this do to the glacier? (advance or retreat) Explain.
   c. What will happen to the glaciers thickness and length if the climate change as #3 describes?

I. Glacier Speed

Using the toolbox you will determine the speed of a glacier, and what parts of a glacier move faster than others.

Drilling: Set to the temperature and snowfall to an amount that creates a decent sized glacier. Press the "STEADY STATE" button and Pause the motion of the glacier. Drill several vertical holes through the glacier.

a. Draw a sketch of what the glacier looks like with the drill holes, before the glacier moves again.

Before movement:

b. Press play and allow the glacier to move, draw a sketch of the drill holes, as the glacier is moving.

After movement:

c. Explain why you drawing appear this way. What is the cause of this phenomenon?

d. Click on the "Ice Flow Vectors" in the Advanced section. A flow vector is nothing more than an arrow representing the speed and direction of the glacier. Explain why the Ice Flow Vectors are larger on the top of the glacier compared to the bottom.

e. To determine the speed of the glacier, two quantities are needed: distance and time. Pause the glacier to allow accurate measurements.

Measurement: Place a flag on the glacier at a known distance (Use of the GPS or coordinate system can assist in this measurement). Record the initial horizontal position of the flag and initial time in the table below.

	Position (meters)		Time (years)
Initial Position		Initial Time	
Final Position		Final Time	
Final – Initial			

Show calculations below:
Speed = (Change in position) / (Change in time)

II. Glacier Observations
Many features are present when a glacier advances or retreats on a mountain slope. Answer the following questions about the features of the glacier valley.

1. What are the tiny black dots that move through the glacier? Where did this material originate? Where are the black dots deposited?

2. Make the glacier retreat up the mountain. What happens to all the material that is moved with the glacier? Why is the stream curvy?

3. In the background, why are the mountains spiked?

4. Create the largest glacier possible and turn the time up to FAST.
    a. What is created at the end of the glacier time goes on? Is this an end or terminal moraine, explain how you know.

    b. Create a pattern of 4 -5 moraines as you make the glacier recede. Draw a sketch of the moraines created by your glacier as it retreats up the mountain. (hint: you need to allow the glacier to stop moving every once in a while to create a moraine.)

5. Press RESET ALL, and set the glacier back to its starting location. Make the glacier completely melt away. Once this is done, increase the snowfall to maximum and decrease the temperature to its lowest point.
    a. How many years will it take the glacier to return to its original position?
    b. Could this occur in real life?

6. Look at the picture below and identify at least 5 erosion or depositional features on the glacier in Alaska.

III. Glacier Budget
In this section you will observe how a glacier budget is determined and its meaning for the state of the glacier. Define the following terms:

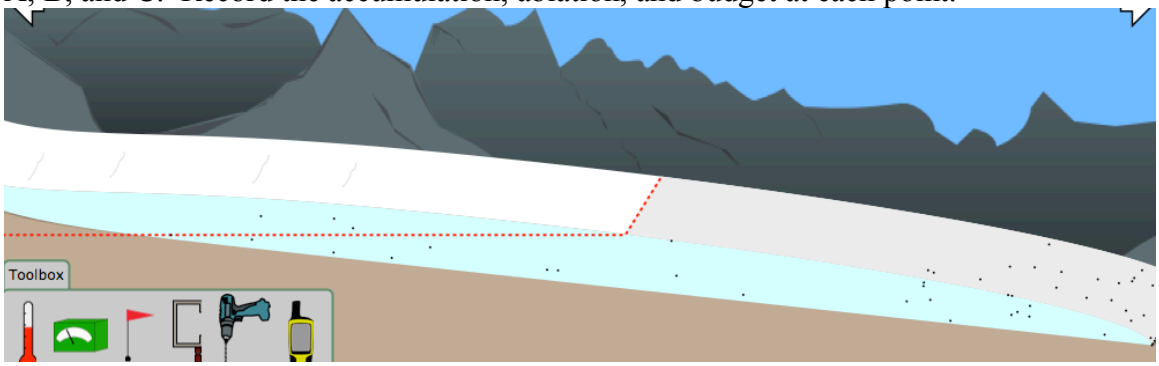
Accumulation –

Ablation –

Glacier Budget – a measurement of the rate by how much glacier will grow or retreat each year.

Glacier Budget = Accumulation – Ablation

Create a glacier your own unique glacier.
1. Using the green box (budget-meter), place the meter on the glacier in 3 locations; A, B, and C. Record the accumulation, ablation, and budget at each point.



A:

B:

C:

What is the glacial budget equal to at point B? What does this have to do with the equilibrium line?

2. Using the depth meter, determine the thickest/deepest section of your glacier. Why do you think this section of the glacier is the thickest/deepest?