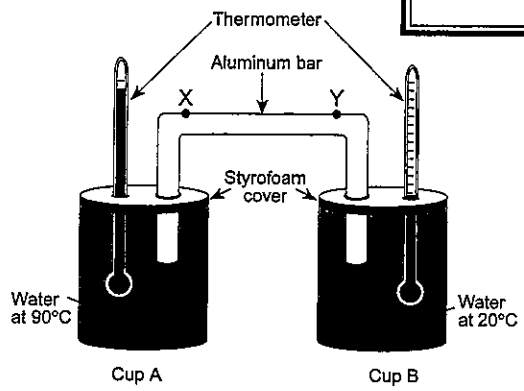
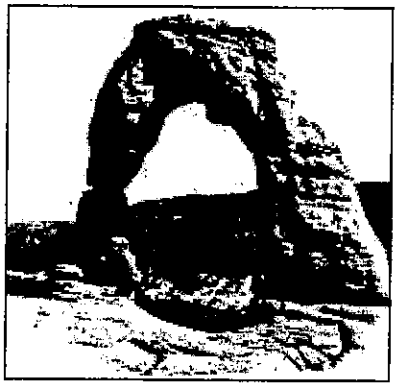
Rate of Change

$$\text{Rate of change} = \frac{\text{change in value}}{\text{time}}$$





Overview:

Certain earth science events occur quickly, like an earthquake or a landslide. Other events may take thousands or even millions of years, like mountain building or the erosion of a landscape region. In most cases, earth scientists will calculate the rate of change for an event. From these rates of changes, comparisons and conclusions can be made about the event.

The Equation:

All events take time, and the event may have caused a change to the original values (measurements) within a field. When this situation occurs, a rate of change can be obtained by using the above equation. For example, if a pile of sand 10.0 feet high is eroded over 60 days to a height of 7.0 feet, what is the rate of change for this pile of sand? The change in value involves subtracting the two variables, in this case 10.0 ft – 7.0 ft, giving a change in value of 3.0 ft. Next, as the equation shows, divide by the time.

$$\textit{Solution: } \text{Rc (rate of change)} = \frac{10.0 \text{ ft} - 7.0 \text{ ft}}{60 \text{ d}} \qquad \text{Rc} = \frac{3.0 \text{ ft}}{60 \text{ d}} = 0.05 \text{ ft/d}$$

Additional Information:

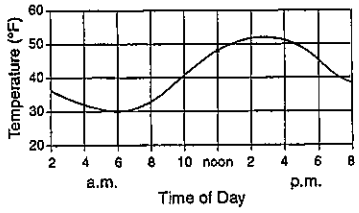
- To solve a rate of change problem from a graph, choose 2 different positions along the Time axis (usually the x-axis) and from these positions move directly up until the intersection with the graph line. At these intersection points, read over to the y-axis to obtain their values. Subtracting these two values, will give the "change in value." Use the time difference you selected, substitute into the equation and solve for the rate of change.

Set 1 — Rate of Change

1. The temperature of water in a container was 60°C. Ten minutes later, the water temperature was 35°C. What was the rate of cooling of the water?

   (1) 25°C/min
   (2) 2.5°C/min
   (3) 35°C/min
   (4) 3.5°C/min 1_____

2. The graph below shows temperature readings for a day in April. The average rate of temperature change, in Fahrenheit degrees per hour, between 6 a.m. and noon was



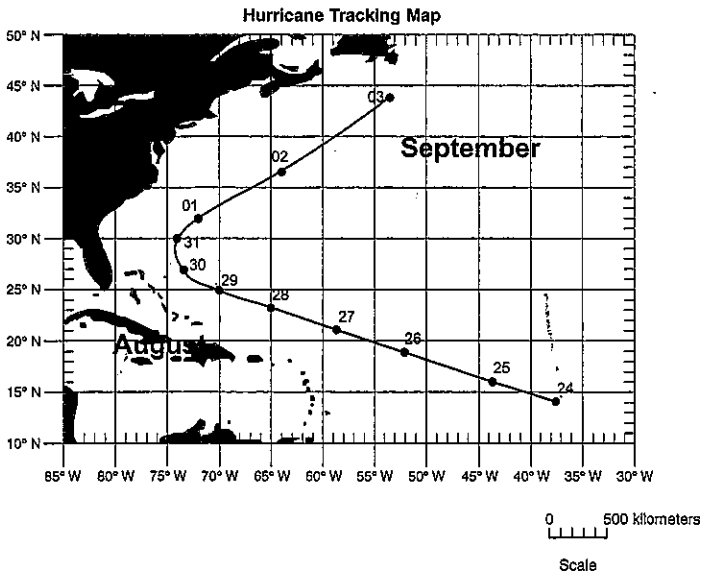
   (1) 6°F/hr (3) 3°F/hr
   (2) 8°F/hr (4) 18°F/hr 2_____

3. The rate of temperature change for the water in cup *A* for the first 10 minutes was approximately

	Temperature of Water (°C)	
Minute	Cup *A*	Cup *B*
0	90	20
1	88	20
2	86	20
3	85	21
4	83	21
5	82	22
6	81	22
7	80	22
8	79	22
9	78	23
10	77	23

   (1) 0.77°C/min
   (2) 1.3°C/min
   (3) 7.7°C/min
   (4) 13.0°C/min 3_____

4. Calculate the average daily rate of movement of the hurricane from August 24 to August 28. Follow the directions given below.



   a) Write the equation used to determine the rate of change.

   b) Substitute data into the equation.

   c) Calculate the average daily rate of movement of the hurricane and label it with the proper units.

Set 2 — Rate of Change

5. The highest elevation of Mt. Zembat in Alaska 40 years ago was measured at 7600 feet. Today the highest elevation is 7598 feet. What is the rate of change in elevation for this mountain.

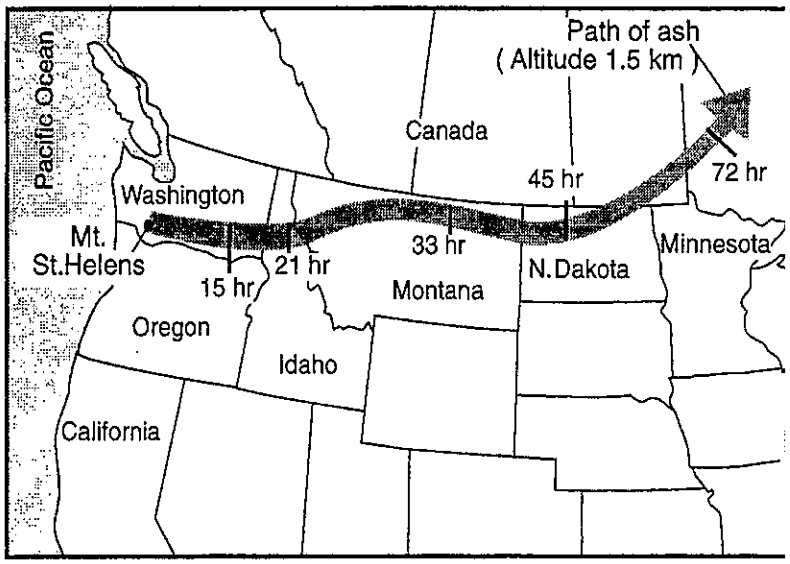
(1) 0.05 ft/yr
(2) 0.6 ft/yr
(3) 0.45 ft/yr
(4) 20 ft/yr 5_____

6. A 25-gram sample of halite was placed in a jar with five other mineral samples and water. The jar was shaken vigorously for 5 minutes. The halite sample was then found to have a mass of 15 grams. What was the rate of weathering of the halite sample?

(1) 0.50 g/min
(2) 2.0 g/min
(3) 3.0 g/min
(4) 10.0 g/min 6_____

Base your answers to question 7 on the information and the accompanying map.

The eruption of Mt. St. Helens in 1980 resulted in the movement of volcanic ash across the northwestern United States. The movement of the ash at 1.5 km above sea level is shown as a shaded path on the map. The times marked on the path indicate the length of time the leading edge of the ash cloud took to travel from Mt. St. Helens to each location.



7. Calculate the average rate of movement of the volcanic ash for the first 15 hours, following the directions below.

a) Write the equation used to determine the average rate of the volcanic ash movement.

b) Substitute values into the equation.

c) Solve the equation and label the answer with the correct units.