USGS

Rocky Mountain Mapping Center

Hydrology, Weather, and Mining Lesson

Author: Joseph Kerski, USGS Geographer

Hydrology: The Work of Rivers

Be sure to list the units (feet, meters, etc.) for all your answers!

The work of rivers includes erosion of the land surface and transportation of these eroded materials downstream. The gradient of a river refers to the amount of elevation a river drops over a given horizontal distance over the land surface. The gradient is one factor that affects the amount of work a river can perform.

1) Would you expect the gradient of a river to be greater near the source of a river or near the mouth of a river? Circle your answer (2 points):

Greater near source Greater near mouth

2) Why? (4 points)

Examine the USGS topographic map of Arvada, Colorado. Note that Clear Creek spans the east-west width of the map.

3) What direction does Clear Creek flow across this map? (2 points)

East to west West to east

4) How do you know? (4 points)

5) Estimate the elevation of the river where it enters the map (3 points).

6) Estimate the elevation of the river where it exits the map (3 points).

7) What is the approximate distance that Clear Creek flows on this map in feet (3 points)?

Gradient is usually expressed as vertical distance divided by horizontal distance. It may also be expressed as a

percentage. For example:

If a river dropped 100 feet for each 1000 horizontal feet it flowed,
the gradient as a percentage would be 100 / 1000 = .1 x 100% = 10%

8) What is the gradient of Clear Creek?

_____ vertical feet per 1000 horizontal feet (2 points)

_____ % (2 points)

Examine the USGS topographic map of New Orleans West, Louisiana.

The elevation of the river where it enters the map (on the west) is 3.8 feet above sea level.
The elevation of the river where it exits the map (on the west) is 2.8 feet above sea level.

9) What is the approximate length of the Mississippi River on this map (2 points)?

10) What is the gradient of the Mississippi River in this area (4 points)?

11) Compare your gradients of Clear Creek vs the Mississippi River. Based on the gradient information alone, which river do you would you expect to be able to do more or less work
(2 points)?

Clear Creek at Arvada Mississippi River at New Orleans

The work of rivers not only is dependent on the gradient, but on the discharge, or the amount of water flowing through the river. The discharge is found by the formula:

$Q = va$
where Q = discharge, in cubic feet per second
v = velocity, in feet per second
a = cross-sectional area
The cross-sectional area = depth (in feet) x width (in feet)

The average depth of the Mississippi River at New Orleans is 35 feet.
The velocity of the Mississippi River at New Orleans is 5 feet per second.

12) What is the average width of the river (2 points)?

13) What is the discharge of the Mississippi River at New Orleans (5 points)?

14) Which do you think is greater: The discharge of Clear Creek at Arvada or the Mississippi River at New Orleans (2 points)? Circle your answer.

Clear Creek at Arvada Mississippi River at New Orleans

15) Which river do you think can do the most work (2 points)? Circle your answer.

Clear Creek at Arvada Mississippi River at New Orleans

16) Is this the same as your answer in question 11 (1 point)? Circle your answer.

Yes No

17) Which do you think is a more important contributor in determining how much work a river can do (2 points)? Circle your answer.

Gradient Discharge

Hydrology: Effects of Pumping on Groundwater Elevation

In the map below the table, a gravel road divides a dry pasture from an irrigated pasture. Irrigation is accomplished by flooding the pasture from the pumping well, well number 1.
There are also 10 observation wells that are used to monitor groundwater levels, numbered 2-11.

18) Fill in the water level elevation field in the table below (3 points):

well number	land surface elevation	depth to water	water level elevation
1	520	20	
2	520	19	
3	520	18	
4	520	17	
5	520	16	
6			

518
14

7
519
16

8
520
18

9
519
15

10
519
16

11
520
19

19) Draw the water level contours in the map below at 1 foot intervals from 500 feet to 504 feet. (6 points)

20) Why is the water level elevation lowest at pump 1? (3 points)

This is called drawdown, which forms a cone of depression in the aquifer around pumping wells.

21) Does the cone of depression extend further away from the pumping well on the dry side or on the irrigated side of the pasture (2 points)? Circle your answer.

Dry side Irrigated side

22) Why? (4 points)

Everyday Weather: Chinook Winds

The prevailing, or most common, winds in Colorado blow from west to east. The eastern slope of Colorado is subject to chinook winds. Chinook is an American Indian term
meaning "snow eater," referring to the warm temperature of these winds.

Examine the USGS topographic map of Rocky Mountain National Park. Note the Continental Divide running the length of the park.

A wind starts at 40 degrees F at Grand Lake in the southwest section of the park.

23) What is the elevation of Grand Lake in feet (1 point)?

The wind rises to flow over the Continental Divide and blows toward the northeast. As it rises, it cools at a rate of 5 degrees per 1000 feet.

24) What is the temperature of the wind as it blows over the Continental Divide at Ptarmigan Point (4 points)?

The wind then moves downward toward the town of Estes Park. As it does, it warms at 7 degrees per 1000 feet.

25) What is the temperature of the wind as it blows over Lake Estes in the town of Estes Park (4 points)?

26) From what direction is the wind blowing as it blows over Lake Estes (2 points)?

27) If you were on a sailboat on Lake Estes, would you be moving toward or away from the powerplant (2 points)? Circle your answer.

Toward powerplant Away from powerplant

Hydrologic Processes Affecting the Earth's Surface

Continue examining the USGS Rocky Mountain National Park map.

28) What process created the wide U-shaped valley in Moraine Park at approximately 40 degrees 21' north latitude, 105 degrees 37' west longitude (3 points)?

29) Name one reason why there are no trees growing on Moraine Park (2 points)?

30) Name at least two reasons why there are no trees growing on the top of the Continental Divide (6 points).

Geo-Resources: Effects of Mining

Examine the following figure from USGS Bulletin 2220: Environmental Considerations of Active and Abandoned Mine Lands: Lessons from Summitville, Colorado.

From 1985 through 1992, the Summitville open-pit mine produced gold using a method where the ore pile is sprayed with water containing cyanide, which dissolves the minute
gold grains. This has caused environmental problems downstream from the mine.

31) Examine the map and graph below. How has the mining at Summitville affected the pH values of the Alamosa River (3 points)?

32) Are these values an indication of a base or an acid (2 points)?

Base Acid

Examine the map below.

33) List at least two of the possible affects to lands downstream from the Summitville mine (6 points).

U.S. Department of the Interior
U.S. Geological Survey
Rocky Mountain Mapping Center
Maintainer:webmaster@rockyweb.cr.usgs.gov
URL:http://rockyweb.cr.usgs.gov /public/outreach/chinook.html
Last modified: 26 August 2002