HOW MUCH WILL YOU PAY?

Overview

In this activity students read water meters in gallons and cubic feet, and calculate residential GPCD (gallons per capita per day). They then determine water costs based on different rate structures, constructing tables and graphing the results on histograms and line graphs. The study of rate structures shows their influence on water use. Some rates promote conservation. Some do nothing to discourage heavy use, some offer incentives as discounts on heavy use.

Subjects: Math, Social Studies, Science

Group Size: teams of four students

Estimated Teaching Time: three hours

Curriculum Framework: IIIB1, IIIB2, IIIB3, VA, VB, VC, VIA, VIB, VIC

Environmental Education Framework: Goals IIIA, IVA, IVB, VA

Vocabulary: conservation, flat rates, GPCD, histograms, inclining and declining block rates, line graphs, per capita, uniform block or constant rates, water management

Objectives

Students will:

- read two types of water meters.
- convert cubic feet measurements to gallon measurements.
- calculate GPCD based on meter readings.
- calculate water rates and water costs per 1000 gallons based on different rate structures.
- display the calculated rates on tables, histograms, and line graphs.
- analyze the rate structures that are most likely to encourage conservative water use.

Background

METER READING. Water meters measure the volume of water entering a plumbing system. They can be found on the property of individual homes, apartment buildings, schools, and industrial complexes. Most meters are read monthly by a water company official. There are a great variety of water meters used throughout the U.S., but most record either the number of gallons or the number of cubic feet the user consumed. One hundred cubic feet (ccf) of water contain 748 gallons of water; one cubic foot of water contains 7.48 gallons of water. During this activity, students will convert between these two units of measure.

Two types of meters will be introduced in this activity: a **straight-reading meter** (with a single dial, measuring gallons and cubic feet) and a **circular-reading meter** (with multiple dials and measuring

cubic feet). Call your city's utility billing or conservation office to learn the type of meter most commonly used in your area.

Residential water meters record the amount of water used in multiples of ten. In the **straight-reading or single dial meter**, much like the odometer on your car, a sweep hand measures each unit of water used and records that volume - first in the ones place, then the tens, hundreds, thousands, ten thousands, hundred thousands, and even millions place on the gallon-reading meters. Water meters measure with different accuracy. Plus or minus 3% is considered acceptable.

Look at the handout, METERS IN CUBIC FEET AND GALLONS. In the first example, the sweep hand measures each gallon of water used to 10 gallons. The first number on the right is a stationary zero; it does not move because the sweep hand does the work. The main reason for the sweep hand is to test for leaks. Except the stationary zero in the ones place, the rest of the number is read like your car's odometer. To determine how much water has been used during a month, the reading at the beginning of the month must be subtracted from the reading at the end of the month.

The second example shows how a straight-reading meter would look if volume was measured in cubic feet. With each sweep of the second hand the ones place registers each cubic foot of water that moves through the pipes to the customer. The cubic foot examples shown here represent the same volume of water use as illustrated by the gallon single-reading meter, recorded with a different unit of measure.

Circular-reading or multi-dial meters are slowly being phased out because they take more time for meter readers to read, and because users cannot detect leaks. Each dial shows the volume of water **up to that amount** that has gone through the meter on its way to the user. The **one-foot dial** records tenths of volume up to one cubic foot of water; the **10-foot dial** records the number of one foot units used up to ten cubic feet of water; . . . the **100,000-foot dial** records the number of 10,000 cubic feet of water that have gone through the meter. To read the circular-reading meter, start with the 100,000 circle and move clockwise. When the hand is between two numbers, always read the lower number.

To decide the gallons of water used per day per person, measurements must be converted from cubic feet to gallons. If 25,080 gallons of water were used by a four-person family during the 31-day month of May, the amount of water used by each person per day can be calculated by dividing the total gallons by the number of days in the month and the number of people in the household (yielding residential GPCD or gallons per capita per day). In this example:

25,080 gallons/31 days = 809 gallons per day used in household
809 gallons/4 people = 202.26 gallons per person per day

This large number of gallons per person per day reflects all use in and around the home, including outdoor watering and perhaps filling

a swimming pool. This volume is similar to the 1992 average residential GPCD for Scottsdale, which was 206. See related activity, **The Water You Use,** for more GPCD information.

RATE STRUCTURES. Although we live in the Sonoran Desert where water is scarce, the water prices paid by customers in the Valley of the Sun are low when compared with the rest of the country and even with other parts of Arizona. During 1992-93, the average single-family residential customer in Phoenix paid only $11.89 per month for water; the Phoenix residential GPCD was 151. (All Phoenix water users also pay an environmental water charge of $.04 per cubic foot (ccf) of water used to pay for modifications to keep treatment plants in compliance with the federal Clean Water Act. Most cities include these compliance costs as part of one rate.) The average residential customer in Tucson paid $23.68 per month and in Flagstaff $21.20 per month. Average bills for other communities follow.

SINGLE-FAMILY (5/8" METER) RESIDENTIAL AVERAGE WATER BILL - 1993

Boston	$26.91	San Francisco	$16.57
Houston	$25.41	Tempe	$16.18
Scottsdale	$22.87	New York	$13.64
Los Angeles	$21.33	Washington, D.C.	$13.55
San Diego	$20.98	Milwaukee	$12.41
Glendale	$19.93	Jacksonville	$11.98
Chandler	$18.81	Phoenix	$11.89
Philadelphia	$18.08	Memphis	$10.57
Mesa-West Zone	$17.64	Chicago	$ 9.95
Mesa "Typical"	$16.76	Detroit	$ 9.66

Water rates may vary by:

- season (which each city can define differently),
- user classification (residential: single-family and multi-family, commercial, industrial and public/other),
- meter size (with base charge based on meter size), and
- amount of water consumed (block rate structures).

Some wonder why we should have to pay for water, a natural resource that falls from the sky. What they are forgetting is the few inches of rain that fall in the Phoenix area are insufficient to sustain our 20th century urban populations and lifestyles. Our water must be delivered and stored through a system of pipes, pumps, dams, and canals. Without sufficient water, communities cannot thrive. Historically, as populations and income levels have increased, per capita water consumption has increased. Controlling water use patterns becomes critically important to the survival of communities. How should the costs be divided among users? Should those who use the most water pay the least or the most per gallon used? Should customers be rewarded for conserving or should they pay less for using more?

Throughout North America, summer is usually the season when the greatest volume of water is used and when water shortages can occur. During the afternoons of 110° days, Valley residents may be washing

cars, watering yards, filling pools, and running evaporative coolers that use water. During these peak use periods, water supplies may not satisfy the demand for a short time. Many cities in the Southwest have added summer surcharges to their water rates in an attempt to control the volume of water used.

Communities often establish two or more water rate classifications. Commercial and industrial customers who bring jobs to communities or who do not contribute to peak use periods may pay less per gallon than residential users. Setting a rate structure judged fair by all customers while still allowing the water utility to recover its costs is a challenging problem for water managers.

Part II of this activity presents a greatly simplified introduction to water rates. Students will study four rate structures (inclining and declining block rates, flat rates, and constant rates), calculating rates based on one meter size (5/8") for residential use. They will also calculate what three families paid per 1,000 gallon units (KGAL). After graphing these rates, students will interpret their data, examining the implications of different rate settings on water use. Students will discover that although the greatest water users may pay the largest bills, they do not always pay the greatest amount per unit used.

Rate structures are one water management tool employed by utilities to influence the volume of water customers use. The American Water Works Association, however, found only 16% of utilities surveyed nationwide use conservation pricing schemes.

Block rates break water use into units, or blocks. Sometimes, customers pay a small basic rate for say, 10,000 gallons of water per month, but once that amount is exceeded, rates change. In other cases especially in the Southwest, the base rate is assessed whether you use any water or not, and all water use is paid by volume used. This activity follows the latter pattern.

Inclining block rates. Efforts to promote conservation and control demand have yielded water rates that penalize people for using more water. The more water used, the greater the consumer must pay per gallon. Many cities in the Southwest use an **inclining block rate**, where rates in excess of the base rate increase when enough water is used to move into the next higher block. Note that the higher rate is only charged to the portion of water that "spills" into the next block. The more water customers use, the more paid per unit. Users could save money by using less water or using more water efficient devices, thus, this structure provides an incentive for conservation. Mesa, Scottsdale, and Glendale have a two-block structure; Chandler has a four-block structure; and Tempe has a six-block structure. All increase rates in some way during the summer.

Declining block rates. Assuming apparently that an adequate supply of water is guaranteed, other utilities calculate water rates such that customers using large volumes pay less per unit consumed than small volume users. With **declining block rates**, the first block is more expensive than the last, and users have little motivation to

conserve - the more they use the less their per gallon cost will be. The American Water Works Association reported 40% of utilities surveyed nationwide use uniform rate structures. Baltimore, Indianapolis, Detroit and Columbus (OH) are just a few of the cities still using declining block rates. In this activity, Family 2 is the beneficiary of this type of rate.

Flat rates are used whenever water use is unmetered. All residential customers pay one rate, despite the volume of water used. New York City continues to use flat rates, although meters will likely be added to all residences by 1995. In 1992, New York City charged approximately $15 per month to flat rate users.

With **constant or uniform block rates**, customers pay the same amount per block whatever the volume of water used. Constant rates may not promote conservation. Neither, however, do constant rates reward greater consumption. The American Water Works Association estimates 44% of utilities use uniform rate structures. The City of Phoenix uses uniform block rates that vary by season (winter, spring/fall, and summer) for their residential customers.

This activity involves students in a variety of ways with numbers that may mean something to them: money and units of measurement. The confidence and skills gained in calculating and displaying data in tables, histograms, and line graphs are important.

Materials

OPTIONAL: GALLONS IN A CUBIC FOOT

- 1 cubic foot box
- 8 gallon containers: 7 1/2 gallons of water
- plastic box

WATER METER READING

- calculators
- METERS IN CUBIC FEET AND GALLONS, make one overhead or provide one per team
- LET'S READ METERS, one handout per team

WATER RATES

- calculators
- WATER RATE STRUCTURES, one per team
- COMPARISONS OF WATER RATES: HISTOGRAMS, one per team
- COMPARISONS OF WATER RATES: LINE GRAPHS, one per team
- colored pencils or crayons

Procedure

1. Let students know they will learn about units of measurement and how to read water meters, and figure out how much water costs in cities using different rates. Tell students most houses and apartment buildings have meters that measure all water before it reaches their faucets. As water flows through the meters, dials record the amount in one of two units of measurement - either in gallons or in cubic feet.

OPTIONAL: GALLONS IN A CUBIC FOOT. If necessary, help students unfamiliar with volume measurements see the relationship between cubic feet and gallons by filling a box one foot per side (and lined with a plastic bag) with about 7 1/2 gallons of water.

WATER METER READING

2. Display or distribute METERS IN CUBIC FEET AND GALLONS to illustrate how water meters are read. Shown here are straight-reading meters calibrated in gallons and cubic feet, and circular-reading meters calibrated in cubic feet. Work through reading each meter and how to learn monthly water use, and the formulas for converting cubic feet to gallons and calculating the amount of water families use in their homes each day (or GPCD - gallons per capita per day). Remind students that per capita means per person. Encourage students to find what kind of water meter they have at home.

3. Give each team a copy of LET'S READ METERS. Students are to read the meters for three families, determine their monthly water use, convert cubic feet measurements to gallon units, and calculate how much water each family member used in a day. Check calculations as you circulate the room. After pointing out that the average Phoenix residential water user consumes about 150 gallons each day, you might encourage students to examine their GPCD data and name each of the three families.

WATER RATES

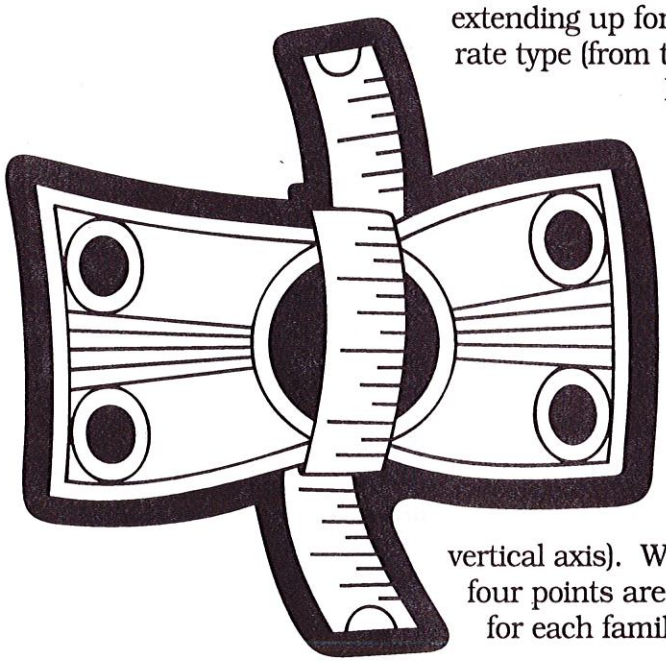
4. Using WATER RATE STRUCTURES, point out the four types of rates: flat, constant, increasing block, and decreasing. Follow the Scott Family example provided for each water rate. Then let teams use the monthly water use data for the three families (recorded on LET'S READ METERS) to learn what each family would pay per month based on different water rate structures. In addition, students calculate the cost each family paid per gallon of water used for each rate.

5. Have students display the water rate data (from WATER RATE STRUCTURES) on the graphs provided on COMPARISONS OF WATER RATES. Two types of graphs will be constructed: histograms or bar graphs, and line graphs. The histogram displays the actual amount of money the families would have paid under each rate

structure. The line graphs compare the actual cost paid per gallon used by water rate structure.

Histograms. You may need to remind students that in histograms the length of the bar illustrates the amount of money paid. Each family will have four bar graphs. Use of different colors makes constructing and reading more fun. Let students choose their own colors for each rate, or try:
green - flat rates
blue - constant rates
yellow - increasing block rates
red - declining block rates

Line Graphs. All the data for the three families will be plotted on the line graph, which provides a visual comparison of what each family paid per gallon of water used by rate. Remind students of line graph construction: they will make a dot or point at the intersection of the line extending up for each rate type (from the horizontal axis) and the line extending to the right for the money paid per gallon (from the vertical axis). When all four points are plotted for each family, a solid line can be drawn connecting the points. Also remind students to label the line representing each family. Again, encourage students to be creative or suggest these colors for each family:
Family 1 - pink
Family 2 - orange
Family 3 - purple



6. Conclude by asking students to examine, analyze, and discuss their interpretations of their work. *For what reasons did the teams select the names they did for each family?* See QUESTIONS TO CONSIDER, from COMPARISONS OF WATER RATES: HISTOGRAMS and COMPARISONS OF WATER RATES: LINE GRAPHS.

Additional questions
a. What kind of rate should commercial or industrial users be charged? What if a company that will employ 1000 people is trying to decide between your city with inclining block rates and another city with constant rates? What will your city offer these users? What would you do if you owned the company?
b. If water rates tripled in your community during the next year, what could you, your family, and the students at your school do to use less water?

c. Which data display (tables, histograms, line graphs) did the students prefer reading? ... constructing? Challenge students to construct histograms from the line graph data, and vice versa.

Extensions

1. Learn about the rate structure and average residential monthly water costs in your community. Calculate bills for families using 100, 150, 200 and 500 gallons of water per person per day.

2. Compare the cost of bottled water versus tap water. If you had to wash and cook with bottled water, how much would you spend each year? How much more would water cost than it currently does?

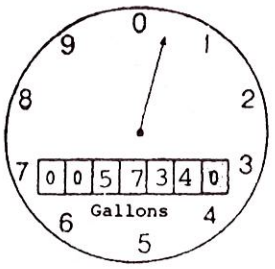
3. Calculate how much it costs to shower for a year or fill a swimming pool, by using the per gallon rates calculated in this activity and data available in the WATER IN OUR DESERT COMMUNITY activity **The Water You Use**.

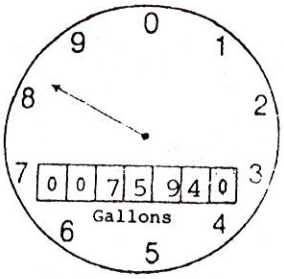
4. Investigate low-flow devices and figure out how much money and water could be saved by using them at home or at school.

Evaluation

1. Read the water meters and record the readings on the line. Be sure to give the unit of measurement

METER 1: _____ METER 2: _____





2. Given that 1 cubic foot equals 7.48 gallons, convert the gallon reading above to cubic feet. Be sure to show your work.

   ANSWER: _____ cubic feet

3. What do gallons per capita per day mean to a family?

4. Which of the four rate structures (constant or uniform block rates, declining block rates, flat rates, or inclining block rates) are more likely to encourage people to conserve water? Use examples to justify your answer.

Resources

American Water Works Association. **Opflow**, Vol. 20, No. 4, April 1994.

Caskey, P., City of Flagstaff Water, Sewer and Refuse. 1993. Personal conversation 12-30-93.

City of Scottsdale, Water Conservation Office. **Water Audit Guide.**

Henfling, G., Water Resource Specialist for the City of Phoenix. Personal conversations, 1-3-94 FAX, 2/7/94 correspondence.

Mee, W.R., Water Conservation Director for the City of Phoenix, Water & Wastewater Department, Water Conservation and Resources Division. 1993. Personal conversations and 6-7-93 correspondence.

Massachusetts Water Resource Authority. **Water Wisdom.**

Molino, F., Tucson Water, Water Conservation Office. 1993. Personal conversation 12-30-93.

Tucson Water. **SAVE: The Homeowner's Guide to Using Water Wisely.**

ANSWERS

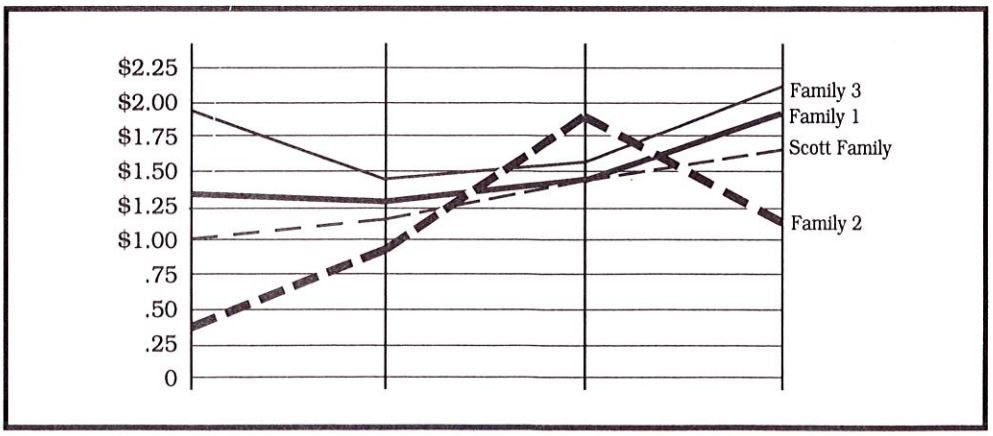
[Note: The selected volumes reflect the 1992 residential GPCDs of Phoenix (154), Gilbert (150), Glendale (147), Peoria (140), Mesa (138), and Chandler (136); Paradise Valley (533); and Tempe (114).]

Family 1 used 18,600 gallons of water during April. Each of the four family members used 150 gallons of water per day (GPCD). Depending on which town they lived in, monthly bills could be $25 (flat rate), $23.88 (constant/uniform block), $27.32 (increasing block rate: $9 + $8 + [$1.20 x 8.6 remaining gallons] = $27.32), or $34.75 (decreasing block rate: $9 + $15 + [$1.25 x 8.6] = $34.75). Their cost per 1000 gallons used were: $1.34 (flat rate), $1.28 (constant/uniform block), $1.47 (increasing block rate), or $1.87 (decreasing block rate).

Family 2 used 9,118 cubic feet and 68,202 gallons of water in April. Each of the four family members used 550 gallons of water per day (GPCD). Depending on which town they lived in, monthly bills could be $25 (flat rate), $63.56 (constant/uniform block), $121.40 (increasing block rate: $9 + $8 + $12 + $16 + [$2 x 38.2] = $121.40), or $75.15 (decreasing block rate: $9 + $15 + $12.50 + $10 + [$.75 x 38.2] = $75.15). Their cost per 1000 gallons used were: $.37 (flat rate), $.93 (constant/uniform block), $1.78 (increasing block rate), or $1.10 (decreasing block rate). Note: 550 GPCD is very high. This example shows one extreme in water use. The cost per thousand gallons in the increasing block rate (as opposed to the decreasing block rate cost per thousand gallons) clearly demonstrates the disincentive of using large amounts of water.

Family 3's water meters read 357,140 cubic feet in March and 358,964 cubic feet in April. Family 3 used 1,824 cubic feet and 13,644 gallons of water during April. Each of the four family members used 110 gallons of water per day (GPCD). Depending on which town they lived in, monthly bills could be $25 (flat rate), $19.88 (constant/uniform block), $21.32 (increasing block rate: $9 + $8 + [$1.20 x 3.6] = $21.32), or $28.50 (decreasing block rate: $9 + $15 + [$1.25 x 3.6] = $28.50). Their cost per 1000 gallons used were: $1.84 (flat rate), $1.46 (constant/uniform block), $1.57 (increasing block rate), or $2.09 (decreasing block rate). Note: This family clearly benefits from lower water use, when comparing the increasing block to the decreasing block cost per thousand gallons. Note that the decreasing block cost per thousand gallons is so high because the benefits of low-price higher-use blocks do not really kick-in until high amounts of water are used (such as Family 2's usage).

The line graphs will look like this:



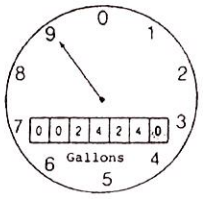
HOW MUCH WILL YOU PAY? - STUDENT PAGE

METERS IN CUBIC FEET AND GALLONS

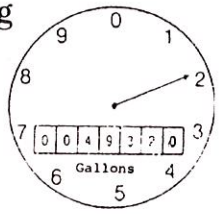
STRAIGHT-READING METERS

Example 1

May Reading
24,240



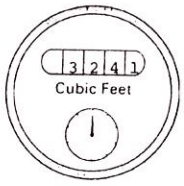
June Reading
49,320

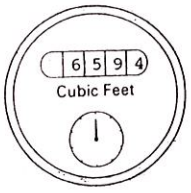


49,320 June Reading
-24,240 May Reading
25,080 Gallons of Water in May

Example 2

May Reading
3241 cubic feet

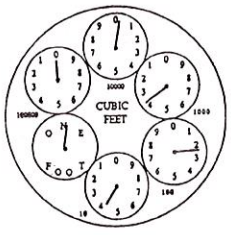




June Reading
6594 cubic feet

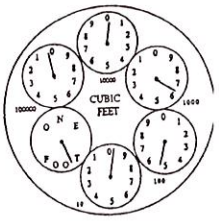
6594 cubic feet June Reading
3241 cubic feet May Reading
3353 cubic feet used in May

CIRCULAR-READING METERS. To read the circular-reading meter, start with the 100,000 circle and move clockwise. When the hand is between two numbers, always read the lower number.



May Reading
3241 cubic feet

Numbers Read		
May		June
0	100000	0
0	10000	0
3	1000	6
2	100	5
4	10	9
1	1	4



June Reading
6594 cubic feet

TO CONVERT CUBIC FEET TO GALLONS, USE THIS FORMULA:

_____ CUBIC FEET x 7.48 GALLONS/1 CUBIC FOOT = _____ GALLONS

3353 cubic feet x 7.48 gallons/1 cubic foot = 25080 gallons

TO DETERMINE THE GALLONS OF WATER USED BY EACH PERSON IN A FAMILY EACH DAY (GPCD - gallons per capita per day), you must know 3 things:

How much water, measured in gallons, was used?
How many days were in the month?
How many people live in the home?

The formula: ____ GALLONS USED DURING MONTH ÷ ___ DAYS IN MONTH ÷ ___ PEOPLE IN HOME

In our example for a family of 4 people:

25080 gallons ÷ 31 days ÷ 4 people = 202.26 gallons per capita per day

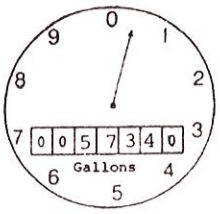
HOW MUCH WILL YOU PAY? - STUDENT PAGE

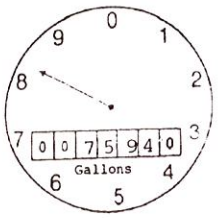
LET'S READ METERS

Directions

1. Read the water meters and record the readings for each family.
2. Calculate the volume of water used during March (Reading for April - Reading for March Water used) NOTE: MARCH HAS 31 DAYS.
3. Convert cubic feet readings to gallons, if necessary (____ cubic feet x 7.48 = ____ gallons)
4. Find GPCD (gallons per capita per day) = ___ GALLONS USED IN MONTH ÷ ___ DAYS IN MONTH ÷ ___ PEOPLE IN HOME

FAMILY 1: 4 family members

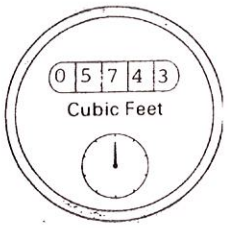


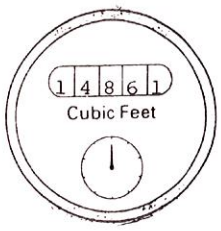


March reading: _____ gallons April reading: _____ gallons

March water use: _____ gallons
GPCD (gallons per capita per day): _____ gallons

FAMILY 2: 4 family members

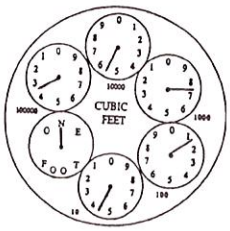


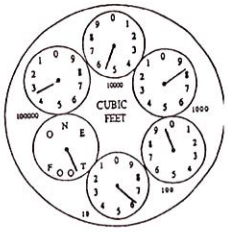


March reading: _____ cubic feet April reading: _____ cubic feet

March water use: _____ gallons
GPCD (gallons per capita per day): _____ gallons

FAMILY 3: 4 family members





March reading: _____ cubic feet April reading: _____ cubic feet

March water use: _____ gallons
GPCD (gallons per capita per day): _____ gallons

HOW MUCH WILL YOU PAY? - STUDENT PAGE

WATER RATE STRUCTURES-1

Directions

1. Transfer the volume of water each family used during March to Table 1. Because some water rates in this activity are based on water used in 1,000 gallon units, determine per-thousand-gallon use of each family. The Scott Family is added as an example.
2. Imagine the families could live in four different towns (A, B, C, D) each with a different way of deciding residential water bills. Calculate the monthly water bill for each family under each rate structure. Record those amounts on the tables.
3. Calculate the cost each family pays for every 1000 gallons of water used under each rate structure. Cost per 1000 gallons can be found by dividing the monthly water bill by the number of 1000 gallon units of water used in a month. Record on tables.

TABLE 1: MONTHLY WATER USE, TOTAL AND PER THOUSAND GALLONS

Family	Gallons used in a month	# of 1000 Gallons
Scott Family	25,080	25.1
Family 1		
Family 2		
Family 3		

FLAT RATES. In city A, no one has a water meter. Every homeowner pays $25, no matter how much water is used.

Scott Family Example: If they lived in City A, the Scott Family (which used 25,080 gallons of water or 25.1 blocks of 1000-gallons) would pay $25 for water. They would pay $1 for every 1000 gallons of water used.

Cost for 1000 gallons = water cost ÷ # of 1000 gallons used

Scott Family cost for 1000 gallons = $25 ÷ 25.1 blocks of 1000 gallons = $1

TABLE 2: MONTHLY WATER BILLS IN CITY A - FLAT RATES

FAMILY	# OF 1000 GALLONS	WATER BILL	EVERY 1000 GALLONS COST:
Scott Family	25.1	$25	$1.00
Family 1		$25	
Family 2		$25	
Family 3		$25	

CONSTANT OR UNIFORM BLOCK RATES. In city B, water users pay a base rate of $9 for water service. For every thousand gallons of water they use, customers pay $.80. The rate is constant or uniform. If 1000 gallons were used in one month, the bill would be $9 + $.80, or $9.80.

Monthly bill = Base Rate: $9.00 + Constant or Uniform Block: 80¢ x Number of 1000 Gallons

WATER RATE STRUCTURES-2

Scott Family Example: Monthly bill = $9 + ($.80 x 25.1) = $29.

If they lived in City B, the Scott Family (which used 25,080 gallons of water or 25.1 blocks of 1000 gallons of water) would pay $29 for water. They would pay $1.16 for every 1000 gallons of water used. Cost for 1000 gallons = $29 ÷ 25.1 = $1.16

TABLE 3: MONTHLY WATER BILLS IN CITY B - CONSTANT OR UNIFORM BLOCK RATES

FAMILY	# OF 1000 GALLONS	WATER BILL	EVERY 1000 GALLONS COST:
Scott Family	25.1	$29	$1.16
Family 1			
Family 2			
Family 3			

INCLINING BLOCK RATES. In city C, water users pay a base rate of $9 for water service. For each of the first 10 blocks of 1000 gallons of water used, customers pay $.80. For each of the second 10 blocks of 1000 gallons used, customers pay $1.20. For each of the third 10 blocks of 1000 gallons used, customers pay $1.60. And for all remaining blocks of 1000 gallons, customers pay $2.00. The cost of water inclines or increases as more water is used.

Monthly bill = Base Rate: $9.00

+ ($.80 each for the first ten blocks) ❑❑❑❑❑❑❑❑❑❑

+ ($1.20 each for the second ten blocks) ❑❑❑❑❑❑❑❑❑❑

+ ($1.60 each for the third ten blocks) ❑❑❑❑❑❑❑❑❑❑

+ Inclining Rate 4
$2.00 x All Remaining # of 1,000 Gallons

Scott Family Example: Monthly bill = $9 + ($.80 x 10) + ($1.20 x 10) + ($1.60 x 5.1) = $37.16. If they lived in City C, the Scott Family would pay $37.16 for water. They would pay $1.48 for every 1000 gallons of water used. Cost for 1000 gallons = $37.16 ÷ 25.1 = $1.48.

TABLE 4: MONTHLY WATER BILLS IN CITY C - INCREASING BLOCK RATES

FAMILY	# OF 1000 GALLONS	WATER BILL	EVERY 1000 GALLONS COST:
Scott Family	25.1	$37.16	$1.48
Family 1			
Family 2			
Family 3			

HOW MUCH WILL YOU PAY? - STUDENT PAGE

WATER RATE STRUCTURES-3

DECLINING BLOCK RATES. In city D, water users pay a base rate of $9 for water service. For each of the first 10 blocks of 1000 gallons of water used, customers pay $1.50. For each of the second 10 blocks of 1000 gallons used, customers pay $1.25. For each of the third 10 blocks of 1000 gallons used, customers pay $1.00. And for all remaining blocks of 1000 gallons, customers pay $.75. The cost of water declines or decreases as more water is used.

Monthly bill = Base Rate: $9.00

+ ($1.50 each for the first ten blocks) ❑❑❑❑❑❑❑❑❑❑

+ ($1.25 each for the second ten blocks) ❑❑❑❑❑❑❑❑❑❑

+ ($1.00 each for the third ten blocks) ❑❑❑❑❑❑❑❑❑❑

+ Declining Rate 4
75¢ x All Remaining # of 1,000 Gallons

Scott Family Example: Monthly bill = $9 + ($1.50 x 10) + ($1.25 x 10) + (1.00 x 5.1) = $41.60. If they lived in City D, the Scott Family would pay $41.60 for water. They would pay $1.68 for every 1000 gallons of water they used. Cost for 1000 gallons = $37.16 ÷ 25.1 = $1.68.

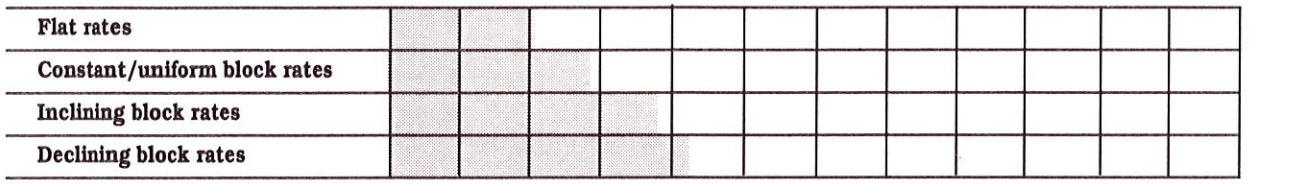
TABLE 5: MONTHLY WATER BILLS IN CITY D - DECLINING BLOCK RATES

FAMILY	# OF 1000 GALLONS	WATER BILL	EVERY 1000 GALLONS COST:
Scott Family	25.1	$41.60	$1.68
Family 1			
Family 2			
Family 3			

COMPARISONS OF WATER RATES: HISTOGRAMS-1

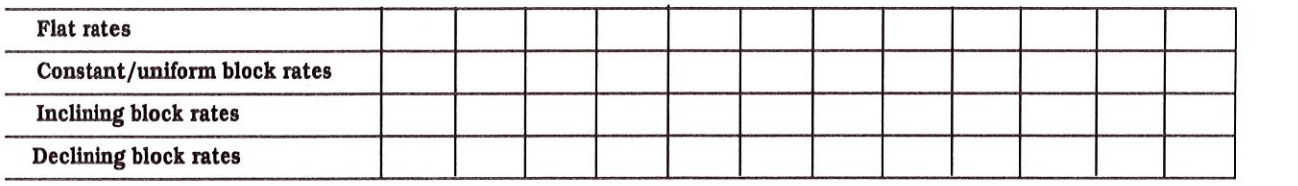
Directions: At the top of each histogram or bar graph, record the number of gallons of water each family used in March. Then, use the data you calculated on WATER RATE STRUCTURES to construct histograms that show what each family would have paid for their monthly water use under each of the rate structures. The Scott Family provides an example again.

The Scott Family's Monthly Water Bills by Rate Structure. The Scotts used 25,080 gallons of water this month.



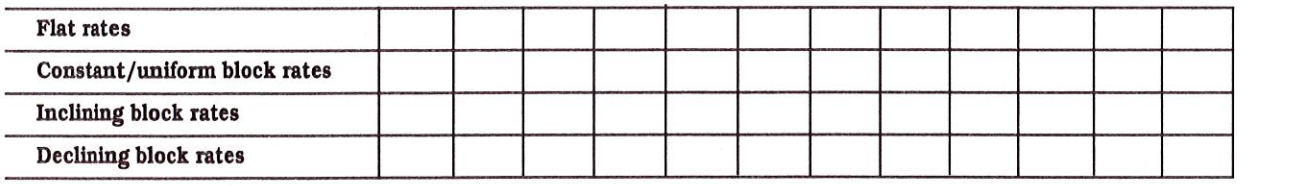
$0 10 20 30 40 50 60 70 80 90 100 120 130

Family 1, which used _____ gallons of water: Monthly Water Bills by Rate Structure



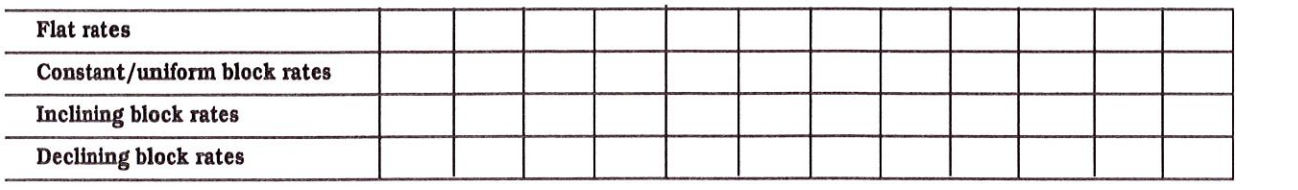
$0 10 20 30 40 50 60 70 80 90 100 120 130

Family 2, which used _____ gallons of water: Monthly Water Bills by Rate Structure



$0 10 20 30 40 50 60 70 80 90 100 120 130

Family 3, which used _____ gallons of water: Monthly Water Bills by Rate Structure



$0 10 20 30 40 50 60 70 80 90 100 120 130

COMPARISONS OF WATER RATES: HISTOGRAMS-2

QUESTIONS TO CONSIDER

1. Which family used the greatest amount of water? ... the smallest?

2. Which family had the highest monthly water bill and under what rate structure was that bill paid?

3. Which family had the lowest monthly water bill and under what rate structure was that bill paid?

4. Under which rate structure would the Scott Family pay their highest bill?

   Under which rate structure would Family 1 pay their highest bill?

   Under which rate structure would Family 2 pay their highest bill?

   Under which rate structure would Family 3 pay their highest bill?

   WOULD ALL FAMILIES PAY THEIR HIGHEST BILLS UNDER THE SAME RATE STRUCTURE? IF NOT, WHAT FACTOR(S) ACCOUNT FOR THE DIFFERENCES?

5. Under which rate structure would the Scott Family pay their lowest bill?

   Under which rate structure would Family 1 pay their lowest bill?

   Under which rate structure would Family 2 pay their lowest bill?

   Under which rate structure would Family 3 pay their lowest bill?

   WOULD ALL FAMILIES PAY THEIR LOWEST BILLS UNDER THE SAME RATE STRUCTURE? IF NOT, WHAT FACTOR(S) ACCOUNT FOR THE DIFFERENCES?

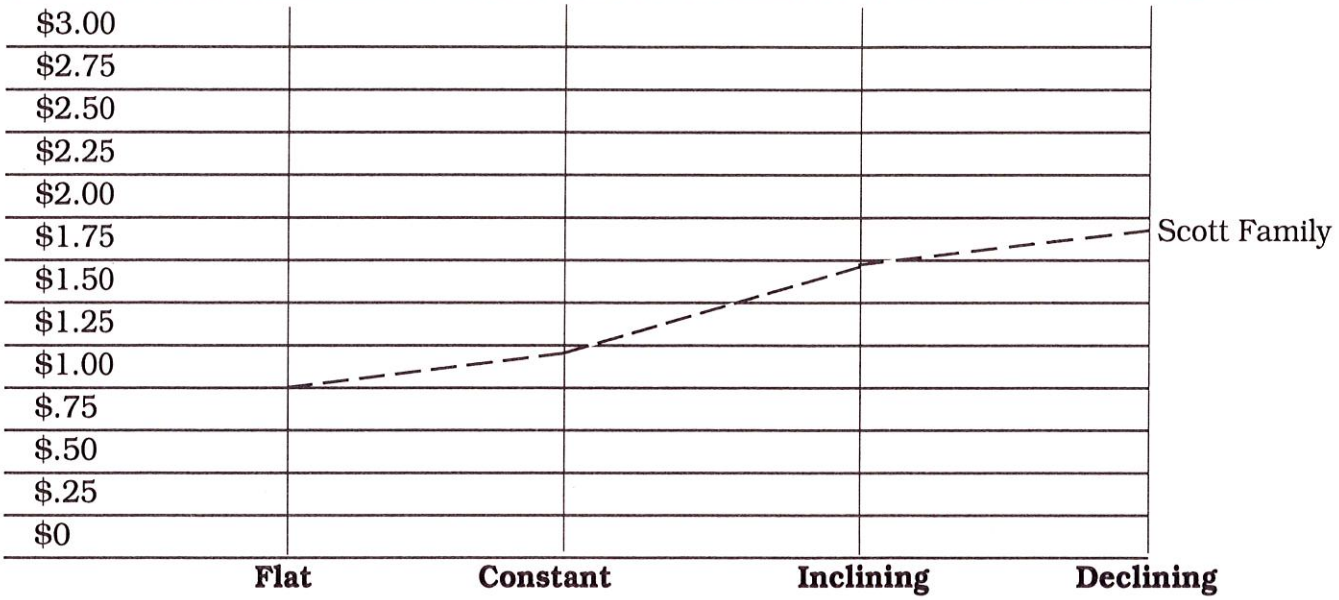
6. At this point in your data analysis, which type of water rate seems like the best deal for the consumers? ... for the water company? ... for our water supply? ... for other organisms with whom we share the planet?

HOW MUCH WILL YOU PAY? - STUDENT PAGE

LINE GRAPHS

Directions: Use the data you calculated on WATER RATE STRUCTURES to construct line graphs that show what each family would have paid for every 1000 gallons of water used under the different rate structures. Be sure to label each line with the family's name or number. The Scott Family provides an example again.

LINE GRAPH: A COMPARISON OF WATER RATE STRUCTURES BY COST PAID PER 1000 GALLONS



WATER RATE STRUCTURES

QUESTIONS TO CONSIDER

1. Which family used the greatest amount of water during the month? ...the smallest?
2. Which family would pay the smallest per 1000 gallon rate for water and under what rate structure?
3. Which family would pay the highest per 1000 gallon rate for water and under what rate structure?
4. Under the flat rate, which family would pay the greatest amount per 1000 gallons? ...the smallest amount?
   Under the constant or uniform block rate, which family would pay the greatest amount per 1000 gallons? ...the smallest amount?
   Under the inclining block rate, which family would pay the greatest amount per 1000 gallons? ...the smallest amount?
   Under the declining block rate, which family would pay the greatest amount per 1000 gallons? ...the smallest amount?
5. Would all families pay their GREATEST amount per 1000 gallons used under the same rate structure? If not, what factor(s) accounts for the differences?
6. Would all families pay their LOWEST amount per 1000 gallons used under the same rate structure? If not, what factor(s) accounts for the differences?
7. Family 2 used five times as much water per person per day as did Family 3. Did they pay five times as much for their water under any rate structure? Should they have paid more or less?
8. Which type of rate is most likely to encourage people to conserve water?
9. Under which type of rate(s) would people be more likely to waste Water?
10. At this point in your data analysis, which type of water rate seems like the best deal for the consumers? ... for the water company? ... for our water supply? ... for other organisms with whom we share the planet?
11. In which city or under which water rate structure would you like to live?
12. What could each of these families do to be more conservative with their water use?