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Date	7/13/2023
Instructor	Samuel Chukwuemeka
Project	Water Bill Residential Rates
Company	Blue Ridge Rural Water Company https://brrwc.org/
Objectives	• Determine the costs for the water usage, in gallons, for people using the services of Blue Ridge Water Company given certain ranges of rates and using the Arithmetic method. • Write a piecewise function using the same ranges of rates for water usage. • Use that piecewise function to once again find the costs for those given ranges of rates for water usage.
Information	Residential Rates – Blue Ridge: • Systems Improvement Fee: $3.00/month • Debt Repayment Fee: $1.75/month • First 2000 gallons: $15.51 minimum/month • 2000 to 12,000 gallons: $5.13/1,000 gallons

	• Over 12,000 gallons: $8.13/1,000 gallons • Ignore Debt Repayment Fee • Minimum charge per month: $3.00 + $15.51 = $18.51 • Change charge rate to gallons from 1,000s of gallons. • From 2,000 gallons to 12,000 gallons: • $5.13 which we divide by 1,000 to get the rate per gallon rather than the rate per 1,000 gallons. The rate per gallon between 2,000 and 12,000 gallons is $0.00513. • Beyond 12,000 gallons: • $8.13 which we divide by 1,000 to get the rate per gallon rather than the rate per 1,000 gallons. The rate per gallon beyond 12,000 gallons is $0.00813.
Test Cases	We will be testing for residents that use: • 0 gallons • 10,500 gallons • 15,000 gallons

Arithmetic Method	• 0 gallons: Flat Fees: $\$15.51 + \$3.00 = \$18.51$ Variable Costs: The gallon usage doesn't go over 2,000, so there isn't a variable fee (you can think of this as the rate equals zero). $0 * 0 = 0$ Total Costs: $\$0 + \$18.85 = \$18.51$ • 10,500 gallons: Flat Fees: $\$15.51 + \$3.00 = \$18.51$ Variable Costs: The gallon usage goes over 2,000, so there is a variable fee, shown by: $0.00513(10{,}500 - 2{,}000) = 53.865$ $0.00513(8{,}500) = 43.605$ We must simplify this term, as the unit is dollars, so it will become: $\$43.61$ Total Costs: $\$43.61 + \$18.51 = \$62.12$

	• 15,000 gallons: Flat Fees: $\$15.51 + \$3.00 = \$18.51$ $0.00513(10{,}000) = \$51.30$ Variable Costs: The first 12,000 gallons are covered by the flat fees, however since we have exceeded that amount in this case, we use the difference of 15,000 and 12,000 to determine the variable costs. $0.00813(3{,}000) = \$24.39$ Total Costs: $\$24.39 + \$51.30 + \$18.51 = \$94.20$
Piecewise Function	Let C equal total costs. Let w equal water usage in of gallons. • Piece 1: When w is less than or equal to 2,000, we have no variable costs, and therefore our cost is determined to be our fixed cost alone, which is \$18.51. $C(w) = 18.51$

- Piece 2:

When w is between $2{,}000$ and $12{,}000$ inclusive, the rate per gallon is $\$0.00513$. To account for the first $2{,}000$ gallons covered by the fixed costs, we will multiply the rate by the difference of w and $2{,}000$. By adding the fixed cost of $\$18.51$ to the variable cost, you get the first piece shown as:

$C(w) = 0.00513(w - 2{,}000) + 18.51$

$C(w) = 0.00513w - 10.26 + 18.51$

$C(w) = 0.00513w + 8.25$

- Piece 3:

When w is beyond $12{,}000$, the rate per gallon is $\$0.00813$. However, to account for the first $12{,}000$ gallons as well as the first $2{,}000$ of those $12{,}000$, we find the product of the rate for piece 2 ($\$0.00513$) and $10{,}000$. The rate for any gallons consumed over $12{,}000$ is $\$0.00813$ and this only applies to the difference of w and $12{,}000$. These two products must be added to the fixed costs to get the total cost. This is shown by:

$C(w) = 0.00813(w - 12{,}000) + 0.00513(10{,}000) + 18.51$

$C(w) = 0.00813(w - 12{,}000) + 51.30 + 18.51$

$C(w) = 0.00813(w - 12{,}000) + 69.81$

$C(w) = 0.00813w - 97.56 + 69.81$

$C(w) = 0.00813w - 27.75$

	$C(w) = \begin{cases} 18.51, \ if \ w < 2{,}000 \\ 0.00513w + 8.25, \ if \ 2{,}000 < w \leq 12{,}000 \\ 0.00813w - 27.75, \quad if \ 12{,}000 < w \end{cases}$
Piecewise Function Method	1. <u>0 gallons:</u> Because $0 < 2{,}000$ we use piece 1. $C(0) = \$18.51$ 2. <u>10,500 gallons:</u> Because $10{,}500 < 2{,}000$ we use piece 2. $C(10{,}500) = 0.00513(10{,}500) + 8.25$ $C(10{,}500) = 53.865 + 8.25$ $C(10{,}500) = 62.115$ We will simplify this by rounding as the unit is money. This will give us: $C(10{,}500) = \$62.12$ 3. <u>15,000 gallons:</u> Because $12{,}000 < 15{,}000$ we will use piece 3. $C(15{,}000) = 0.00813(15{,}000) - 27.75$ $C(15{,}000) = 121.95 - 27.75$ $C(15{,}000) = \$94.20$

MLA Citations:

"Blue Ridge Rates." *Blue Ridge Rural Water Company Inc.*, brrwc.org/blue-ridge-rates. Accessed 21 July 2023.

Chukwuemeka, Samuel D. "Piecewise Functions - Water Bill." *Piecewise Functions*, piecewise-functions.appspot.com/#studentProjectWaterBill. Accessed 21 July 2023.