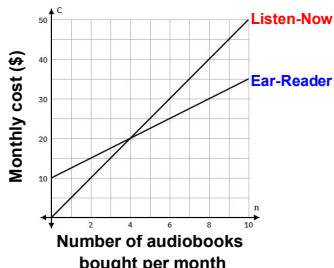# 3.10 - Solving Linear Systems Algebraically

Example 1: (taken from last lesson)

Listen-Now offers audiobooks at \$5 each with no monthly fees. Ear-Reader offers audiobooks at \$2.50 each, but charges a \$10 monthly fee. The relations are graphed below.

The solution to the system is the point of intersection.

It is not always efficient (or perfectly accurate) to solve through graphing!

Instead of solving graphically, we will solve the system using the equations. We will be using the **comparison method**.

Step 1: Write out a "let" statement.

Let C represent the cost
Let n represent the # of audiobooks

Step 2: Write out the equation of each relation.

☞ Ear-Reader: $C_E = 2.50n + 10$ Listen-Now: $C_L = 5n$

☞ We can use subscripts to tell the relations apart!

Step 3: Compare the equations! The **solution** is where the costs for both companies are equal. Mathematically...

☞ $C_E = C_L$

$$2.50n + 10 = 5n$$
$$10 = 5n - 2.50n$$
$$\frac{10}{2.50} = \frac{2.50n}{2.50}$$
$$4 = n$$

Step 4: Solve your equation for the first variable! Substitute this value back into either equation for the second variable.

Sub $n = 4$ back into either equation

$C_L = 5n$
Sub $n = 4$
$= 5(4)$
$= \$20$

Step 5: Write a therefore statement.

∴ The solution is $(4, 20)$

OR

Both cost \$20 at 4 audiobooks

Example 2: A company is looking to buy t-shirts for their employees. "Designz" offers a fixed cost of $100 where each shirt costs $5. "Shirts!" offers a lower fixed cost of $40, but a higher cost per shirt at $7 each.

Solve algebraically and explain which company you would choose based on your number of employees.

Let C represent cost
Let n   "   # of shirts

Designz

$$C_D = 5n + 100$$

Shirts!

$$C_S = 7n + 40$$

Set them equal!

$$5n + 100 = 7n + 40$$
$$100 - 40 = 7n - 5n$$
$$60 = 2n$$
$$\frac{60}{2} = \frac{2n}{2}$$
$$30 = n$$

Now solve for the cost

$$C_D = 5n + 100$$

Sub n = 30

$$= 5(30) + 100$$
$$= 150 + 100$$
$$= 250$$

∴ At 30 shirts, they both cost $250.

∴ If the company needs fewer than 30 shirts, go with Shirts! Otherwise go with Designz.

<u>**Recall:**</u> Simple interest is calculated using the formula $I = \Pr t$

Example 3: You don't have enough money to buy a new TV, but two stores are offering a buy now pay later program. GoodBuy offers the TV for $340 at 10% simple interest. LaterShop offers the same TV for $270 but at 20% simple interest.

The equations that model the total cost "C" if you take "n" years to pay the store back are:

<div align="center">

GoodBuy   **LaterShop**

$C_G = 34n + 340$ $C_L = 54n + 270$

</div>

Solve the system algebraically, and explain how you would make your decision to save the most money.

$34n + 340 = 54n + 270$

$340 - 270 = 54n - 34n$

$\dfrac{70}{20} = \dfrac{20n}{20}$

$3.5 = n$

Sub into C_L

$C_L = 54(3.5) + 270$

$= 189 + 270$

$= 459$

$\therefore$ They both cost $459 after 3.5 years.
− Choose Latershop if under 3.5
− Choose Goodbuy if over 3.5

Challenge! - Can you figure out we found the equations for total cost?