Welcome To Math 34A! Differential Calculus

Instructor:

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South Hall 6431X (Grad Tower, 6th floor, blue side, first door on the right)

Office Hours:

MTWR after class 2:00-3:00, and by appointment. Details on Gauchospace.

Warm-up

How many times do we need to triple 1 to get the following numbers?

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- 9

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- 9 $\boxed{2}$

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- 9 $\boxed{2}$
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How many times do we need to decuple 1 (multiply 1 by 10) to get the following numbers?

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  (The founders of Google spelled it wrong intentionally.)

Linear Interpolation

1. In 2000, a population was 1000. In 2010, it was 1100. What would you guess the population was in 2005?

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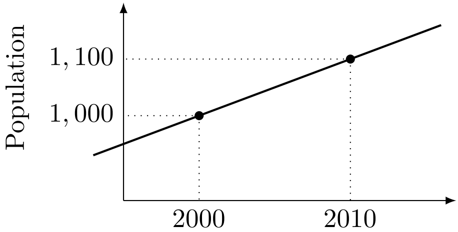

This is a guess

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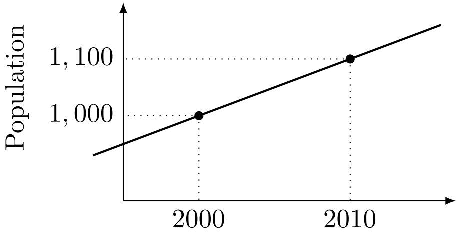

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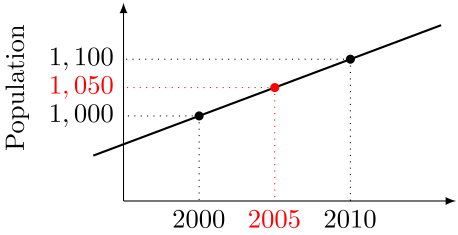

This is a guess based on the assumption that population grows at a constant rate.

"Constant rate" means that the graph of population is a straight line.

Linear Extrapolation

2. In 2000, a population was 1000. In 2010, it was 1100. What would you guess the population will be in 2020?

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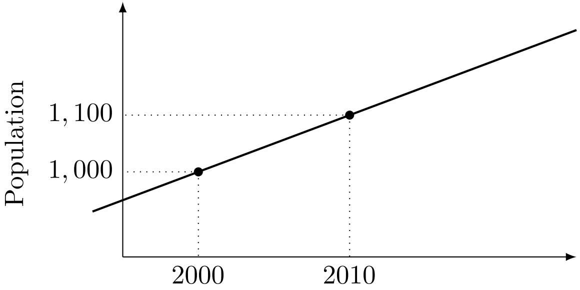

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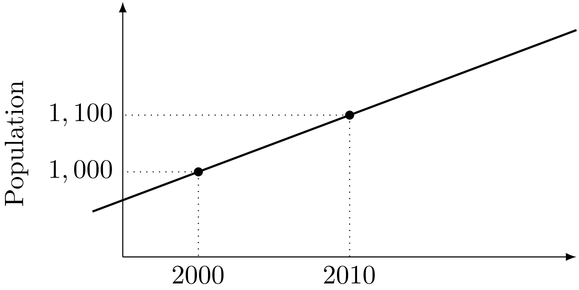

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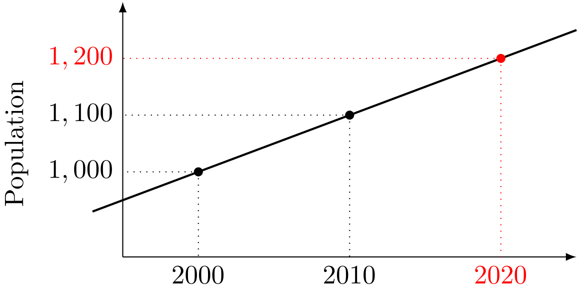

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The idea is to assume the population (or whetever) grows at a constant rate.
Then use this to predict.

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Method:
(1) Use given data to draw a straight line and find equation
$y = mx + b$
(2) Use the equation to make predictions.

3. In 2000, a population was 1000. In 2010, it was 1100. Let

x = number of years after 2000 (Ex: $x = 3$ is the year 2003)

y = population in the year x

Find the equation of a line $y = mx + b$:

A: $2000 + 1000x$ B: $1000 + 2000x$ C: $1000 + 100x$ D: $1000 + 10x$

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Answer: $\boxed{\text{D}}$

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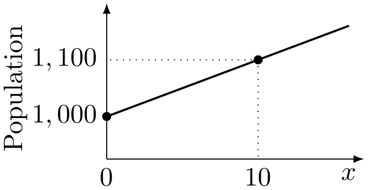

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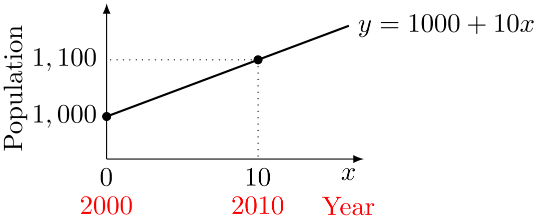

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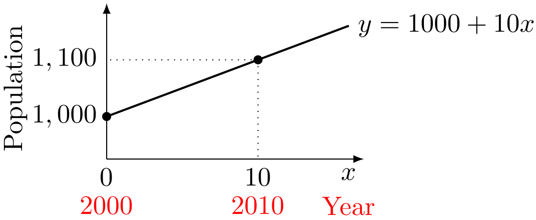

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A= 2015 B= 2025 C= 2035 D= 3350 E=Other

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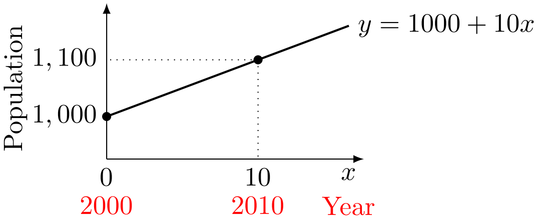

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A= 2015 B= 2025 C= 2035 D= 3350 E=Other $\boxed{\text{C}}$

Another Example

5. The number of unemployed in LA on January 1, 2015 was $50,000$. After 100 days, it was $45,000$.

- Estimate the number of unemployed 300 days after Jan. 1.

A$= 40,000$ B$= 35,000$ C$= 30,000$ D$= 25,000$ E$= 300$

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- Suppose $x =$ the number of days after January 1
  $y =$ number of unemployed people on day x.

  Then the equation of the line used for this linear extrapolation is $y =$

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- How many days until unemployed reaches $30,000$?

  A$= 40$ B$= 140$ C$= 200$ D$= 300$ E$= 400$

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Proportionality

Simple Idea: $y \propto x$ "y is proportional to x" means:

If you double x, then y doubles. Triple x then y triples. And so on.

Example: If you are paid by the hour then

$$(\text{amount you earn}) \propto (\text{number of hours you work})$$

If you work for 10 hours, then you are paid \$50. How much are you paid if you work for 20 hours?

A= \$20 B= \$50 C= \$200 D= \$100 E=Other

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If you work for t hours, how much are you paid?

A= \$50 B= \$50t C= \$10t D= \$20t E= \$5t

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If you work for t hours, how much are you paid?

A= \$50 B= \$50t C= \$10t D= \$20t E= \$5t $\boxed{\text{E}}$

Because you are paid \$5/hour (or \$50 for 10 hours). The number "5" is called the constant of proportionality.

Proportionality Example:

Suppose $y \propto x$ and $y = 15$ when $x = 4$.

(a) What is y when $x = 8$?

A$= 15$ B$= 4$ C$= 8$ D$= 30$ E$= 60$

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(a) What is y when $x = 8$?

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(b) What is y when $x = 12$?

A= 15 B= 45 C= 30 D= 36 E= 12

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(c) What is x when $y = 150$?

A$=14$ B$=1500$ C$=40$ D$=450$

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A= 15 B= 45 C= 30 D= 36 E= 12 $\boxed{\text{B}}$

(c) What is x when $y = 150$?

A= 14 B= 1500 C= 40 D= 450 $\boxed{\text{C}}$

Constant of Proportionality

"y is proportional to x" means $y = Kx$, where K is called the constant of proportionality.

Example: We are told

- Tax is proportional to income, and
- The tax on \$1,000 is \$280.

Express $y =$ amount of tax paid in terms of $x =$ the income. Then $y =$

$$\text{A} = 1000x \quad \text{B} = 280x \quad \text{C} = \frac{1,000}{280}x$$

$$\text{D} = 2.8x \quad \text{E} = 0.28x$$

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Question: What does the constant of proportionality $K = 0.28$ mean?

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$$\text{A}= 1000x \qquad \text{B}= 280x \qquad \text{C}= \frac{1,000}{280}\,x$$
$$\text{D}= 2.8x \qquad \text{E}= 0.28x \qquad \boxed{\text{E}}$$

Question: What does the constant of proportionality $K = 0.28$ mean?

Answer: It is the tax on one dollar.

Example

For this question, we assume:

- The weight of an elephant is proportional to its height cubed, and
- An elephant 1 meter high weighs 1/3 tons.

How many tons does an elephant h meters tall weigh?

A= $h/3$ B= h^3 C= $h^3/3$ D= $(h/3)^3$ E= $(3h)^3$

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Question: What does the constant of proportionality $K = 1/3$ mean?

Answer: It is the weight of 1 cubic meter of elephant.

More Complicated Examples

$$\boxed{y \text{ is inversely proportional to } x \text{ means } y \propto 1/x}$$

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Example:

- I have \$300
- N = number of apples I can buy
- p = price per apple

Then N is inversely proportional to p: $N \propto 1/p$.

What is the constant of proportionality?

More Complicated Examples

Strength of Light

- $P =$strength of light (power per unit area)

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Newton's Law of Gravity: $F \propto \frac{m_1 m_2}{r^2}$

Constant of proportionality: $G \approx 6.67 \times 10^{-11}\ \mathrm{m}^3/(\mathrm{kg}\,\mathrm{s}^2)$
(the <u>Gravitational constant</u>)

Review

1. Solve for x in the equation

$$\frac{3}{x+a} = \frac{a}{x+2}.$$

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2. Multiply out and simplify. Check your answer.

$$(a-3b)(4a+2b)+6ab$$

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$$\frac{3}{x+a} = \frac{a}{x+2}.$$

$$x = \frac{6-a^2}{a-3}$$

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$$(a-3b)(4a+2b)+6ab$$

$$= 4a^2 - 4ab - 6b^2$$

$=$

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3. Substitute $x = 3t - 4$ into

$$2x(x+1).$$

Simplify the result as much as possible.

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(you don't <u>have</u> to pull out the 6)

Review

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(a) How far apart are they at noon?

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Review

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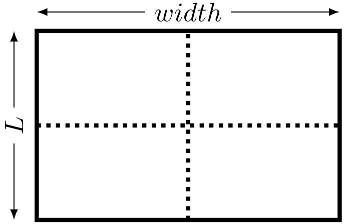

(b) The outer boundary fence (on the perimeter of the field, shown solid) costs \$4 per meter, and the inside fence (shown dotted) costs \$3 per meter. Express the total cost of the fence needed in terms of L.

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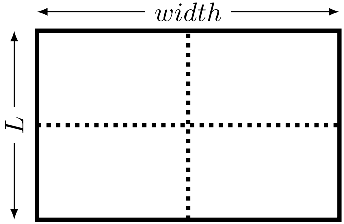

(b) The outer boundary fence (on the perimeter of the field, shown solid) costs \$4 per meter, and the inside fence (shown dotted) costs \$3 per meter. Express the total cost of the fence needed in terms of L. (Answer: $\frac{11\left(L^2+500\right)}{L}$)

That's it. Thanks for being here.