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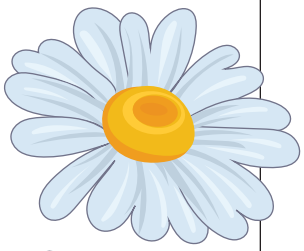
THE HARDEST MATH PROBLEM

GRADE 6

There's a new club at Monroe Middle School thanks to three persuasive students—Vishal, Maria, and Jade. When the principal read their proposal for EARTH Club, she smiled and said, "**E**nvironmentally **A**ware and **R**eady **t**o **H**elp! What a great title! Now what activities do you have planned?"

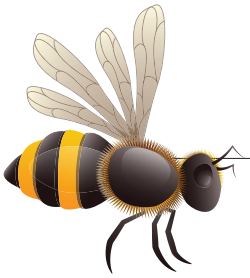
"First, we'll study the declining population of bees," said Vishal.

"Bees are vital to our ecosystem," Maria explained. "Did you know that when they transfer pollen, they start the process of reproduction in about 80 percent of plants? That includes fruits, vegetables, flowers, and seeds."

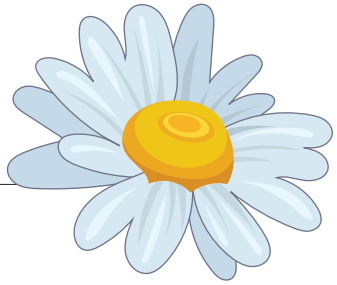


"It also includes around 90 different types of food, like apples and pumpkins," added Jade.

"Wow," said the principal. "The EARTH Club is officially approved!"



Solve the Problem



Vishal loves to eat! He wants to know *which* foods are pollinated by bees. He found out that the **honeybee**, one of 20,000 different bee species, makes honey and provides most of the pollination for blueberries, broccoli, cherries, and many other foods. (Yum!) The honeybee provides 100 percent of the pollination for almonds. But, honeybees are dying from habitat loss, the varroa mite, pesticides, and climate change. Below are approximate rates of honeybee loss in the U.S. for nine consecutive years.

Year	1	2	3	4	5	6	7	8	9
Rate of Loss	36.2%	29.0%	46.2%	37.5%	40.9%	40.0%	32.6%	40.5%	40.1%

What survival rate in the 10th year would make the average rate of loss over the 10-year period equal to 38.0%?

Definition: Survival rate is the opposite of rate of loss.

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CHALLENGE 1 ANSWER KEY — GRADE 6

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Survival Rate Calculation

Step 1 Let's start with what I do know. I know the equation for finding the average of a set of numbers.

$$\textit{Average} = \frac{\textit{sum of all the values}}{\textit{the number of values in the set}}$$

Step 2: Since I need to make the "average rate of loss equal to 38.0%," I substitute the number 38 into "average" on the left side of the equation. I also know I am calculating the average for "the 10-year period," so I substitute the number 10 into "the number of values in the set" (the denominator of the fraction).

My equation now looks like this:

$$38 = \frac{\textit{sum of all the values}}{10}$$

Step 3: What number divided by 10 gives me 38? Well, that's easy: 38 x 10, or 380. So the numerator of this fraction, in other words, the sum of all the percentages for the 10-year period, must be 380.0%.

Step 4: I don't have all 10 numbers, but I do have 9 of them. I'll find the sum of the first 9 rates.

$$36.2\% + 29.0\% + 46.2\% + 37.5\% + 40.9\% + 40.0\% + 32.6\% + 40.5\% + 40.1\% = 343.0\%$$

Step 5: Since the sum of the first 9 rates is 343% and the sum of all 10 rates needs to be 380%, I'll subtract.

$$380.0\% - 343.0\% = 37.0\%$$

This means the rate of loss for the 10th year must be 37.0%.

Step 6: But wait! I have to be careful here. The question asked for the survival rate in the 10th year, not the rate of loss. To find the survival rate in the 10th year, I'll take all of the population (100%) and subtract the loss (37%) to get the percent that survived.

$$100.0\% - 37.0\% = 63.0\%$$

Final Answer: In order for the average rate of honeybee loss to be 38.0% over the 10-year period, the honeybee survival rate in the 10th year would need to be **63.0%**.

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THE HARDEST MATH PROBLEM

GRADE 7

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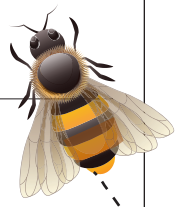
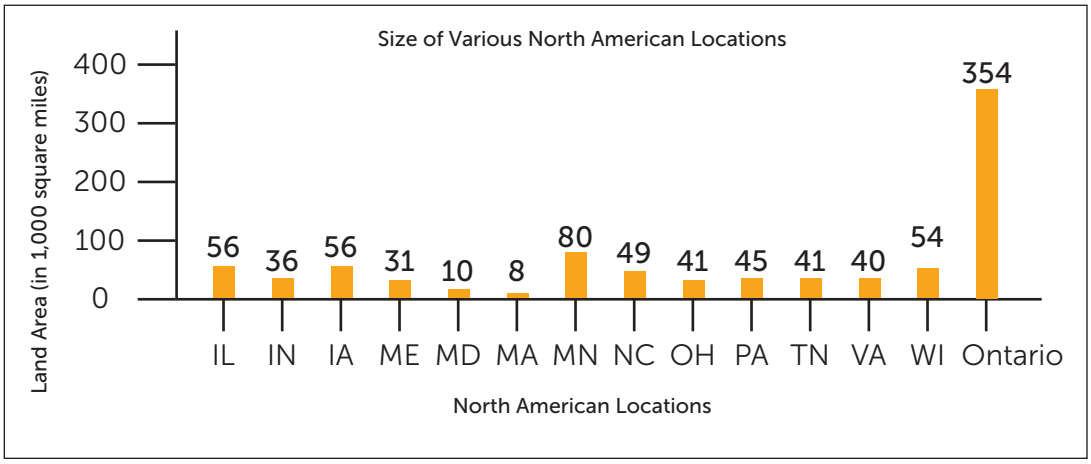


Solve the Problem

Maria found out that "bumblebee" isn't just a nickname. The **rusty patched bumble bee** (*Bombus affinis*) exists, but it's now on the endangered species list. Twenty years ago, an estimated 727,731,000 of these bees lived across America and Canada. Today, they are usually found only in the states and the province shown below.



Assume an even distribution of bees per mile across these territories. Suppose today's scientists sample an area of five square miles within each territory, and find, on average, 3 nests with 205 living rusty patched bumble bees per nest.

What is the percent decline, to the nearest whole number, of rusty patched bumble bees from 20 years ago to today?

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THE HARDEST MATH PROBLEM
CHALLENGE 1 ANSWER KEY — GRADE 7

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Population Decline Calculation

Step 1: Let's start with what I do know. The population 20 years ago was 727,731,000 bees. To find out how much it has declined, I must find the population today.

Step 2: I know that per every 5 square miles, on average, there were 3 nests and each contained 205 living bees. I multiply 3 by 205 to get the average number of living bees per every 5 square miles.

3 x 205 = 615 living bees per every 5 square miles

Step 3: I will divide 615 by 5 to get the unit rate.

615/5 = 123 living bees per 1 square mile

Step 4: Next, I need to find the total number of square miles in all the territories. And I must be careful! The title of the graph is Land Area (in 1,000 square miles). That means, for example, the land area in Illinois is not 56 square miles but 56 x 1,000, or 56,000 square miles!

Total Land Area = (56 + 36 + 56 + 31 + 10 + 8 + 80 + 49 + 41 + 45 + 41 + 40 + 54 + 354) x 1,000

= (901) x 1,000

= 901,000 square miles

Step 5: The number of bees per square mile multiplied by the total number of square miles will give me the total number of bees.

123 bees per square mile x 901,000 square miles = 110,823,000 total bees today

Step 6: To find the percent change in bees from 20 years ago to today, I use the following formula:

$$\%\ of\ change = \frac{amount\ of\ change}{original\ value}$$

$$\%\ of\ change = \frac{(727{,}731{,}000 - 110{,}823{,}000)}{727{,}731{,}000}$$

$$\%\ of\ change = \frac{616{,}908{,}000}{727{,}731{,}000} = 0.847714334...$$

Step 7: To change the decimal to a percent, I multiply by 100.

0.847714334 x 100 = 84.7714334%

But, wait! I have to round "to the nearest whole number" (84.77... rounds to 85).

Final Answer: The percent decline of rusty patched honey bees from 20 years ago to today is about **85%**. I could also report this as a change of -85%.

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THE HARDEST MATH PROBLEM

GRADE 8

There's a new club at Monroe Middle School thanks to three persuasive students—Vishal, Maria, and Jade. When the principal read their proposal for EARTH Club, she smiled and said, "**E**nvironmentally **A**ware and **R**eady **t**o **H**elp! What a great title! Now what activities do you have planned?"

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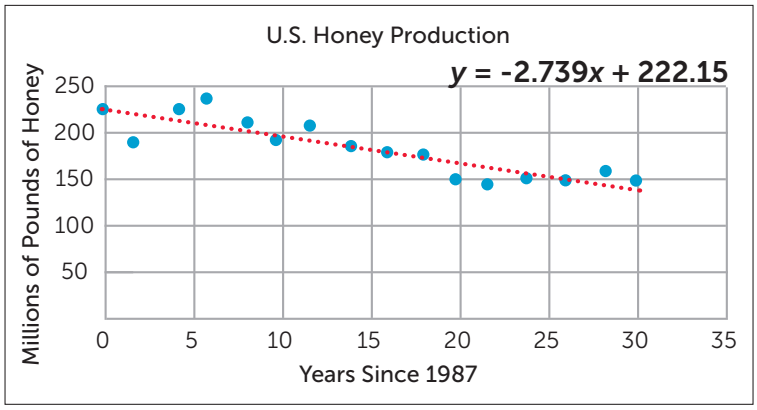
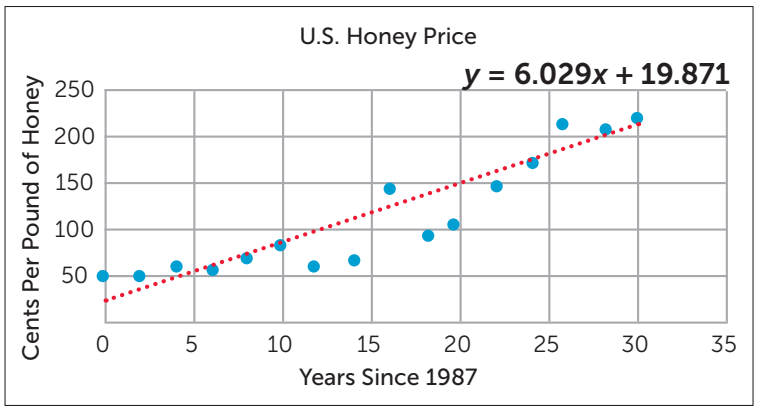
Solve the Problem

Jade read that honey is in high demand at stores right now because more and more people want natural sweeteners. She was interested in looking at the relationship between honey production and the cost of honey over the same set of years. She considered the graphs below:





For the **25-year** period from 1992 to 2017, **find the percent change in honey production and the percent change in honey price**. Include the complete decimal in the trend line equations. For example, use 6.029 and 19.871 (all digits to the thousandths place) in the production equation. Round only at the end of all your calculations, and round each of the final two answers to the nearest whole number percent.

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THE HARDEST MATH PROBLEM
CHALLENGE 1 ANSWER KEY — GRADE 8

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Calculating Changes in Production and Price

Step 1: The first thing I need to do is really look closely at the graphs. For both graphs, the x-axis is labeled "Years Since 1987." For the production graph, the y-axis is labeled "Millions of Pounds," and for the price graph, the y-axis is labeled "Cents Per Pound."

Step 2: Next, I will label my trend line equations so I remember what the variables represent.

Honey production

$y = -2.739x + 222.15$

y: Millions of pounds of honey

x: Number of years *since* 1987

Honey price

$y = 6.029x + 19.871$

y: Price of honey in cents per pound

x: Number of years *since* 1987

Step 3: I will start with honey production and use that equation to find the value y, millions of pounds of honey, for each of the two years.

1992 – 1987 = 5 years, so

$x = 5$

$y = -2.739x + 222.15$

$y = -2.739(5) + 222.15$

$y = -13.695 + 222.15$

$y = 208.455$

2017 – 1987 = 30 years, so

$x = 30$

$y = -2.739x + 222.15$

$y = -2.739(30) + 222.15$

$y = -82.17 + 222.15$

$y = 139.98$

In 1992, honey production was 208.455 million pounds (which is a shorter way of writing 208,455,000 pounds), and in 2017, it was 139.98 million pounds (139,980,000 pounds).

Step 4: To find percent change in honey production between these two years, I use the percent change formula:

$$\%\ \text{of change} = \frac{\text{amount of change}}{\text{original value}}$$

$$= \frac{(208.455\ \text{million} - 139.98\ \text{million})}{208.455\ \text{million}}$$

$$= \frac{(208.455\ \text{million} - 139.98\ \text{million})}{208.455\ \text{million}} = \frac{68.475\ \text{million}}{208.455\ \text{million}} = 0.328488163... \approx 33\%$$

Since honey production went down from 1992 to 2017, this is a 33% decrease in honey production. I could also report this as a change of -33%.

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CHALLENGE 1 ANSWER KEY — GRADE 8

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Step 5: Now I will use the equation for honey price and do similar substitutions.

In 1992	In 2017
$y = 6.029x + 19.871$	$y = 6.029x + 19.871$
$y = 6.029(5) + 19.871$	$y = 6.029(30) + 19.871$
$y = 30.145 + 19.871$	$y = 180.87 + 19.871$
$y = 50.016$	$y = 200.741$

In 1992, the price of honey was 50.016 cents per pound, and in 2017 it was 200.741 cents per pound.

Step 6: To find percent change in honey price between these 2 years, I use the percent change formula:

$$\%\ of\ change = \frac{amount\ of\ change}{original\ value}$$

$$= \frac{(200.741 - 50.016)}{50.016}$$

$$= \frac{150.725}{50.016} \approx 3.013535668... \approx 301\%$$

Since the value went up from 1992 to 2017, this is a 301% increase in honey price.

Final answers: For the 25-year period from 1992 to 2017, the percent change in honey production was a **33% decrease (or -33%)**, and the percent change in honey price was a **301% increase**.