

THE HARDEST MATH PROBLEM

GRADE 7

The leaders of the EARTH Club learned a lot from the research they collected about bees. Now they are making plans to turn the facts into action.


"I bet a lot of students don't know that honeybees pollinate about one-third of the nation's crops, but are disappearing at an alarming rate," says Maria.

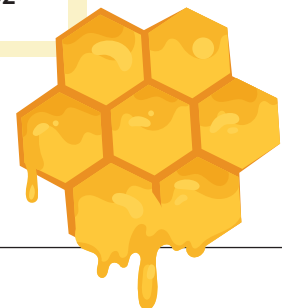
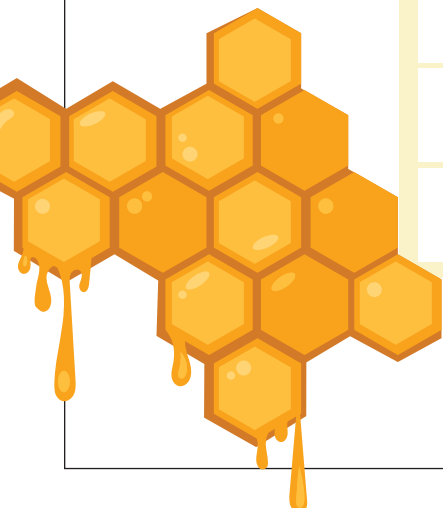
"Yeah, and pesticides are a big part of the problem," adds Vishal. "The bees need our help!"

The EARTH Club decides to launch a few exciting projects at their school to create buzz about saving the bees. It's a lot of work for the EARTH Club, and they're counting on math help from their newest member—you!

Solve the Problem

The 7th graders are planting a school garden and have decided to use only organic pesticides. They considered six products with similar ingredients that are safe for bees. Jade just finished placing their orders when—yikes!—her laptop died! And she can't remember the total amount she spent on the three different bottles she ordered. Of two combinations that had the same median for increase in honey production, she ordered the one with the lower average cost per ounce and was able to stay within the club budget of \$120. **How much money did they spend?**

Organic Pesticides 			
Product	% increase in honey production (per year)	Bulk cost (shipped in 64 oz bottles)	Shipping cost
MintMix	62%	\$34.29/ qt	\$1.15/ half-gallon
ZenEarthinol	58%	\$88.50/ gal	\$2.50/ bottle
Mito-Down	71%	\$130.60/ 2.5 gal	\$3.50/ gallon
VarroAway	99%	\$124.80/ 1.5 gal	5% of subtotal
Garden+	95%	\$75.16/ gal	Free
NoPest	80%	\$223/ 2 gal	\$.05/oz



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CHALLENGE 2 ANSWER KEY — GRADE 7

Although the problem has one correct numeric solution, there are multiple pathways students can take to arrive at the answer.

Step 1: I begin by calculating the cost of 1 bottle of each product.

Each bottle contains 64 oz. I will convert gallons (the bulk cost given) to ounces to find the per-bottle cost.

$$1 \text{ gal} * \frac{4 \text{ qt}}{1 \text{ gal}} * \frac{2 \text{ pints}}{1 \text{ qt}} * \frac{2 \text{ cups}}{1 \text{ pint}} * \frac{8 \text{ oz}}{1 \text{ cup}} = 128 \text{ oz.} \quad 1 \text{ gallon} = 128 \text{ oz.} \quad \text{Each bottle is } \frac{1}{2} \text{ gallon}$$

Product	Shipping Cost	Cost of 1 bottle
MintMix: $\frac{\$34.29}{1 \text{ qt}} * \frac{4 \text{ qt}}{1 \text{ gal}} * \frac{1 \text{ gal}}{128 \text{ oz}} * \frac{64 \text{ oz}}{1 \text{ bottle}} = \frac{\$68.58}{1 \text{ bottle}}$	\$1.15	$\$68.58 + \$1.15 = \$69.73$
ZenEarthinol: $\frac{\$88.50}{1 \text{ gal}} * \frac{1 \text{ gal}}{128 \text{ oz}} * \frac{64 \text{ oz}}{1 \text{ bottle}} = \frac{\$44.25}{1 \text{ bottle}}$	\$2.50	$\$44.25 + \$2.50 = \$46.75$
Mito-Down: $\frac{\$130.60}{2.5 \text{ gal}} * \frac{1 \text{ gal}}{128 \text{ oz}} * \frac{64 \text{ oz}}{1 \text{ bottle}} = \frac{\$26.12}{1 \text{ bottle}}$	\$1.75	$\$26.12 + \$1.75 = \$27.87$
VarroAway: $\frac{\$124.80}{1.5 \text{ gal}} * \frac{1 \text{ gal}}{128 \text{ oz}} * \frac{64 \text{ oz}}{1 \text{ bottle}} = \frac{\$41.60}{1 \text{ bottle}}$	$(0.05)(\$41.60) = \2.08	$\$41.60 + \$2.08 = \$43.68$
Garden+: $\frac{\$75.16}{1 \text{ gal}} * \frac{1 \text{ gal}}{128 \text{ oz}} * \frac{64 \text{ oz}}{1 \text{ bottle}} = \frac{\$37.58}{1 \text{ bottle}}$	Free	\$37.58
NoPest: $\frac{\$223}{2 \text{ gal}} * \frac{1 \text{ gal}}{128 \text{ oz}} * \frac{64 \text{ oz}}{1 \text{ bottle}} = \frac{\$55.75}{1 \text{ bottle}}$	$(\$0.05)(64) = \3.20	$\$55.75 + \$3.20 = \$58.95$

Step 2: Next, I find the combinations of 3 different bottles that have a total cost less than or equal to the budget amount of \$120.

I consider the most expensive bottle, MintMix, at a price of \$69.73. I subtract it from the club's budget:

$$\$120.00 - \$69.73 = \$50.27$$

The sum of the two remaining bottles within this set must be less than or equal to \$50.27 to stay within budget. If I subtract the lowest priced bottle ($\$50.27 - \$27.87 = \$22.40$), I find there is not enough money left for any of the others to be the third bottle.

So, I eliminate this bottle, MintMix, as being a possibility in the final set of 3.

I use the same set of steps and reasoning to consider the next most expensive bottle, NoPest, which costs \$58.95.

$$\$120.00 - \$58.95 = \$61.05$$

$$\$61.05 - \$27.87 = \$33.18$$

I cannot get a third bottle for less than or equal to \$33.18, so I eliminate NoPest as a possibility, too.

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CHALLENGE 2 ANSWER KEY — GRADE 7

Although each problem does have a correct numeric solution, there are multiple pathways students can take to arrive at the answer.

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There are only 3 possibilities that will give a total less than or equal to the club budget of \$120.

$$\$46.75 + \$27.87 + \$43.68 = \$118.30 \quad (\text{Zen / Mito / VarroA})$$

$$\$46.75 + \$27.87 + \$37.58 = \$112.20 \quad (\text{Zen / Mito / Garden+})$$

$$\$27.87 + \$43.68 + \$37.58 = \$109.13 \quad (\text{Mito / VarroA / Garden+})$$

Step 3: Now, regarding the two combinations with the same median increase in honey production, I must find the one with the lower cost per ounce.

The median of a data set is the middle value when the data is arranged in ascending order (from low to high).

I organize the percent increases in honey production:

$$\text{Zen/Mito/VarroA} \quad 58\%, 71\%, 99\% \quad \text{median} = 71\%$$

$$\text{Zen/Mito/Garden+} \quad 58\%, 71\%, 95\% \quad \text{median} = 71\%$$

$$\text{Mito/VarroA/Garden+} \quad 71\%, 95\%, 99\% \quad \text{median} = 95\%$$

Since the first two have the same median, I have to find the one that has "the lowest average cost per ounce."

To find the average cost per ounce, I will find each product's cost per ounce, then average those 3 unit rates.

$$\text{Zen/Mito/VarroA} \quad \frac{\left(\frac{\$46.75}{64}\right) + \left(\frac{\$27.87}{64}\right) + \left(\frac{\$43.68}{64}\right)}{3} = \frac{\$1.8484375}{3} = \$0.6161458... \approx \$0.62$$

$$\text{Zen/Mito/Garden+} \quad \frac{\left(\frac{\$46.75}{64}\right) + \left(\frac{\$27.87}{64}\right) + \left(\frac{\$37.58}{64}\right)}{3} = \frac{\$1.753125}{3} = \$0.584375 \approx \$0.58$$

I find that the combination of Zen/Mito/Garden+ has the lower unit cost per ounce.

I could also have skipped calculating cost per ounce since there is only 1 bottle that is different in the combinations. One has VarroA and the other Garden+. Since both bottles contain 64 oz and the Garden+ bottle costs less than the VarroA, I know the average cost per ounce will be less in the combination with Garden+.

Step 4: Looking back at my previous calculations in step 2, I see that the total cost of 1 bottle each of ZenEarthinol, Mito-Down, and Garden+ is \$112.20.

Answer: The 7th graders spent a total of **\$112.20** on bee-friendly pesticides.