This print-out should have 3 questions, check that it is complete. Multiple-choice questions may continue on the next column or page: find all choices before making your selection. The due time is Central time.

This is a quick problem set to get you started using this homework server.

001 (part 1 of 1) 10 points
Needing help, the secretary of the United States Department of Agriculture asked your teacher, “If a chicken-and-a-half can lay an egg-and-a-half in a day-and-a-half, how many days will it take two chickens to lay thirty-two eggs?”

Please help your teacher select the correct answer the secretary’s question.

1. Two chickens will lay thirty-two eggs in twelve days.
2. Two chickens will lay thirty-two eggs in twenty-two days.
3. Two chickens will lay thirty-two eggs in six days.
4. Two chickens will lay thirty-two eggs in twenty-one days.
5. Two chickens will lay thirty-two eggs in eighteen days.
6. Two chickens will lay thirty-two eggs in fifteen days.
7. Two chickens will lay thirty-two eggs in twenty-four days. correct
8. Two chickens will lay thirty-two eggs in ten days.
9. Two chickens will lay thirty-two eggs in sixteen days.
10. Two chickens will lay thirty-two eggs in nine days.

Explanation:
Basic Concept: The information given in the question is the rate of egg production in one instance and you must make this rate compatible with another instance. The rate of egg production is constant. The number of eggs per chicken per day is a constant.

Solution: Since it takes a chicken-and-a-half a day-and-a-half to lay an egg-and-a-half, it will take one chicken one-and-a-half days to lay one egg. Therefore, to lay thirty-two eggs it will take two chickens twenty-four days.

Alternative Method: Unit analysis is basic to every physics problem and is central to this problem. The rate of egg production is the number of eggs produced per chicken per day. In the given instance the rate is

\[ \text{rate} = \frac{3/2 \text{ eggs}}{3/2 \text{ chickens} \cdot 3/2 \text{ days}} = \frac{2 \text{ eggs}}{3 \text{ chickens} \cdot \text{days}}. \] (1)

In the requested instance, the number of chickens is (2 chickens) and the number of eggs is (32 eggs). The number of days \( N \) is to be determined. Therefore in the requested instance, the rate is

\[ \text{rate} = \frac{32 \text{ eggs}}{2 \text{ chickens} \cdot \{N\}}. \] (2)

The rate is constant, so equating the rates Eqs. (1) and (2), we have

\[ \frac{2 \text{ eggs}}{3 \text{ chicken} \cdot \text{days}} = \frac{32 \text{ eggs}}{2 \text{ chickens} \cdot \{N\}} \]

Solving for the number of days \( N \), we have

\[ N = \frac{32 \text{ eggs}}{2 \text{ chickens}} \cdot \frac{3 \text{ chickens} \cdot \text{days}}{2 \text{ eggs}} = 24 \text{ days}. \]

The correct answer: “Two chickens will lay thirty-two eggs in twenty-four days.”

Note: The early chicken catches the worm.
Assume: The population of a large city like New York City is about $4 \times 10^6$ people. There are about 1.54 people per household. Approximately 1 household in 19.5 has a piano. The piano keyboard has about 64 notes (8 octaves) with about 2 strings per note. A piano should be tuned once per year (365.25 days). A piano tuner can tune about 4 pianos per day. And, finally, piano tuners work 252 days per year.

How many piano tuners are there in New York City?

Note: This was one of Prof. Fermi’s famous party questions. The question has been used by others, namely Prof. Feynman

Hint: The original intent of Fermi’s party question was to do an order of magnitude estimate which would give at most the accuracy of one significant figure. Approach the present problem in the following way.

1.) First do an order of magnitude estimate.

2.) Then do a more quantitative calculation using a calculator and pretend that the assumed input numbers are precise.

This calculation is significant since error analysis rounds off only after a quantitative calculation is completed.

3.) After both (1) and (2) have been done, proceed to check whether the estimated answer is in the right ball-park; i.e., in the right “order of magnitude” as compared to your second answer; i.e., the artificial quantitative answer.

4.) Enter your quantitative answer from step 2.

5.) Make the assumption that the capitalistic system does not have idle piano tuners or physics students.

Correct answer: 132.

Explanation:

Basic Concept: Order of Magnitude Calculations

Solution: To find the approximate number of piano tuners in NYC, assume that the economic laws of supply and demand are in force; that is, if we can find how many piano tuners are actually needed in NYC, we should have a good approximation of how many piano tuners there are in NYC.

How many piano tuners are needed? We first approximate how many pianos there are to tune. The population of NYC is about $4 \times 10^6$ people. There are 1.54 people per household, and about 1 piano per 19.5 households. Thus the total number of pianos should be about:

$$N_{\text{piano}} = \frac{4 \times 10^6 \text{ people}}{(1.54 \frac{\text{people}}{\text{household}}) (19.5 \frac{\text{households}}{\text{pianos}})}$$

$$\approx 133200 \text{ pianos}$$

Since a piano should be tuned once per year, and a piano tuner can tune 4 pianos per day, NYC needs about

$$\frac{133200 \text{ pianos}}{(252 \text{ days}) (4 \text{ pianos/day/piano tuner})} \approx 132 \text{ piano tuners.}$$

Note: The number of keys on a piano keyboard and the number of strings in a piano were extraneous information.

A 19th century British naturalist with a penchant for archaic units of measurement described a species of snail crawling at average speed of one furlong per fortnight. (A furlong is one eighth of 1 mile or 220 yards; a yard is 3 feet or 0.9144 meter; a fortnight is a time interval of 14 days or $14 \times 24$ hours.) Recently, a biology student re-measured the snail’s average speed and reported it as one centimeter per minute.

Which of the following is the most likely explanation of the difference between the two measurements? Hint: Use common sense.

1. The student got a much slower species of snail than the one described by the naturalist.

2. Pollution in action: the snails became somewhat slower than they used to be because of some environmental toxins.
3. The student’s snails are crawling at exactly the same snail’s pace they ever did, but he reported a slightly different value for their speed because he rounded it up in different units. correct

4. Evolution in action: even the snails got somewhat faster than they used to be.

5. The student has smoked too much weed and lost all sense of time; his measurements are garbage.

6. The student got a much faster species of snail than the one described by the naturalist.

Explanation:
Let us convert the archaic units of the 19th century naturalist’s into cm/minutes and then compare the two measurements:

\[
v = \frac{1 \text{ furlong/fortnight}}{14 \text{ days}} = \frac{(220)(0.9144) \text{ m}}{(14)(24) \text{ hours}} = \frac{(220)(0.9144)(100) \text{ cm}}{(14)(24)(60) \text{ minutes}} = 0.9979 \text{ cm/min}.
\]

Since both the naturalist and the student rounded off their results (albeit in different units), it is clear that the two measurements agree with each other and the snail’s pace has not changed at all.