Name: _____ Date: _____ 13.2

Sample Problem 2: Travel Time for Interstellar Distances

Problem

1. At a speed of 300 000 km/s, how far will light travel in five years?
2. At 29 000 km/h, how many years would it take to travel a distance of five light years?
3. If a human generation is 50 years, how many generations will it take to go that far?

Solution

1. Given that one light year $= 9.5 \times 10^{12}$ km

   So, five years $= 5 \times (9.5 \times 10^{12}$ km), which equals _____ km

   or _____ km.

2. At 29 000 km/h (2.9×10^4 km/h), how long will it take to travel _____ km?

   To solve for the number of hours it will take,

   $$\text{time} = \frac{\text{distance}}{\text{speed}} = \frac{\text{km}}{2.9 \times 10^4 \text{ km/h}} = \text{\_\_\_\_\_ h}$$

   Convert the hours to years using 8760 h/year.

   $$\text{years} = \times \frac{1 \text{ yr}}{8760 \text{ h}}$$

   It will take _____ years to travel five light years at a speed of 29 000 km/h.

3. At a span of 50 years per generation,

   $$\text{generations} = \frac{\text{yr}}{50 \text{ generations/yr}}$$

   = _____ generations

   It will take _____ generations to travel five light years.

   This would get us to our three closest neighbouring stars, Proxima Centauri (4.2 light years) and Alpha Centauri A and B (4.4 light years), but not to our next closest star, Barnard's star (6.0 light years).

   For an extra challenge, perform the calculation using a speed of 62 000 km/h. This is the approximate speed of *Voyager 1* as it nears the boundary between our Sun and interstellar space.

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How Far Apart Are Stars?

To demonstrate just how far apart stars could be, consider that, on the average, there is one star for every 1×10^9 cubic light years of space. What distance would there be between the stars if our Sun was reduced to the size of a grain of sand of 1 mm^3?

To do the calculation, students need to know that
- the diameter of the Sun is 1.4×10^6 km, so 1 mm = 1.4×10^6 km (that will be our scale for this question)
- 1×10^9 cubic light years of space is a cube 1000 light years (l.y.) to a side.
- 1 light year = 9.5×10^{12} km
- there are 1×10^6 mm in a km

HINTS

First: Convert the side of the cube to a distance in km.

Second: At a scale of 1 mm = 1.4×10^6 km, how large is each side of the model of our cube of space?

Third: With 1×10^6 mm/km our model is

Therefore, each grain of sand (a star the size of our Sun) would be separated by a distance of _____ km.