PROPOSED SOLUTIONS TO EXERCISES ON UNITS AND PHYSICAL QUANTITIES

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CONTENTS

Exercises from *Sears and Zemansky's University Physics (with Modern Physics) 12th Edition*, 2008

EXERCISE 1.1

1.1 Starting with the definition 1 in. = 2.54 cm, find the number of kilometres in 1 mile.

1.1

$$1\text{ in} = 2.54\text{ cm} = \frac{1.00\text{ mi}}{63{,}360\text{ in}}$$

$$= 2.54\text{cm} \times \frac{1.00\text{ km}}{100{,}000\text{ cm}}$$

$$= 2.54 \times 10^{-5}\text{ km} = \frac{1.00\text{ mi}}{63{,}360\text{ in}}$$

$$63{,}360 \times 1.00\text{ in} = 2.54 \times 10^{-5} \times 63{,}360\text{ km} = 1.00\text{ mi}$$

$$1.61\text{ km} = 1.00\text{ mi}$$

EXERCISE 1.3

1.3 How many nanoseconds does it take light to travel 1.00 ft in a vacuum?

1.3

$$c \approx 3.00 \times 10^8 \frac{m}{s}$$

$$3.00 \times 10^8 \frac{m}{s} \times \frac{1\,ft}{0.3048\,m} = \frac{3.00}{0.3048} \times 10^8 \frac{ft}{s}$$

$$\frac{3.00}{0.3048} \times 10^8 \frac{ft}{s} \times \frac{1}{\frac{1 \times 10^9\,ns}{s}} = \frac{3.00}{0.3048} \times 10^8 \frac{ft}{10^9\,ns}.$$

$$\frac{3.00 \times 10^8}{0.3048 \times 10^9} \frac{ft}{ns} = \frac{\left(\frac{3.00 \times 10^8}{3.00 \times 10^8}\right)}{\left(\frac{0.3048 \times 10^9}{3.00 \times 10^8}\right)} \frac{ft}{ns}$$

$$c \approx 1.00\,ft \Big/ \left(\frac{0.3048 \times 10^9}{3.00 \times 10^8}\right) ns$$

$$\approx 1.00\,ft / 1.02\,ns$$

* The speed of light is ~ 1 foot per nanosecond!

EXERCISE 1.11

1.11 Neptunium. In the fall of 2002, a group of scientises at Los Alamos National Laboratory determined that the critical mass of neptunium-237 is about 60kg. The critical mass of a fissionable material is the minimum amount that must be brought together to start a chain reaction. This element has a density of 19.5 g/cm³. What would be the radius of a sphere of this material that has a critical mass?

1.11

$m_{Np} = 60\,kg$

$\rho_{Np} = 19.5\ \frac{g}{cm^3} = 19.5\ \frac{g}{cm^3} \times \frac{1.00\,kg}{1000\,g} = \frac{19.5}{1000}\ kg/cm^3$

$= 0.0195\ kg/cm^3$

$V_{critical} = \frac{m}{\rho}$ $\frac{60\,kg}{0.0195\,kg/cm^3} = \frac{60 \times cm^3}{0.0195/cm^3 \times cm^3} = \frac{60}{0.0195}\ cm^3$

$V_{sphere} = \frac{4}{3}\pi r^3$

$\frac{3V}{4\pi} = r^3$

$r = \left(\frac{3V}{4\pi}\right)^{\frac{1}{3}}$

$r_{critical\ cm} = \left(\frac{3\left(\frac{60}{0.0195}\right)}{4\pi}\right)^{\frac{1}{3}} cm \approx 9.02\,cm\ (3.s.f)$