Chapter 1 Even Problem Solutions

#20. We can look up in Appendix C that 1 barrel of oil corresponds to 42 (U.S.) gallons, and that 1 (U.S.) gallon corresponds to $3.785 * 10^{-3} m^3$. Further, we note that 1 Liter is $10^{-3} m^3$. Therefore, one gallon is 3.785 liters. Therefore:

a. $550 * 10^9 \frac{\cancel{barrel}}{\cancel{year}} * \frac{42 gal}{1 \cancel{barrel}} * \frac{1 \cancel{year}}{365 \cancel{days}} * \frac{1 \cancel{day}}{86400 s} = 730,000 \frac{gal}{s}$

b. $730,000 \frac{\cancel{gal}}{s} * \frac{3.785 L}{\cancel{gal}} = 2,800,000 \frac{L}{s}$

#50. Because the sun radiates energy isotropically (the same in every direction), we note that the Sun's total power output is spread out evenly on the sphere that has as its radius the Earth-Sun distance, which we call r, which the book gives us as 150 million km. Therefore, if the flux of sunlight we receive here on Earth is ten 100 watt light bulbs per square meter, the total power radiated by the Sun must be:

$$L = 4\pi r^2 * 10 \frac{lightbulb}{m^2 s}$$

$$L = 4\pi (150000000 \cancel{km} * \frac{1000 \cancel{m}}{\cancel{km}})^2 * 10 \frac{lightbulb}{\cancel{m^2} s} = 2.8 * 10^{24} \frac{lightbulb}{s}$$

The reason we use the symbol "L" here instead of the more intuitive symbol "P" for the power that the Sun radiates is that astronomers prefer to call this quantity the "luminosity".

#58. We estimate that our nails grow at a rate of about 3cm/year, and that the Atlantic Ocean is about 6000km wide. Therefore, the age of the Atlantic Ocean is about:

$$t_{age} = \frac{6000 \cancel{km}}{3 \frac{\cancel{cm}}{yr}} * \frac{100000 \cancel{cm}}{1 \cancel{km}} = 200,000,000 years$$