Physics 1401
Homework Solutions - Walker, Chapter 1

Conceptual Questions

CQ3. (a.) No. If two quantities have the same units then they necessarily have the same *dimensions*. For example 3 m and 5 m both have the dimensions *length*. (b.) Yes. For example, we could have two quantities with *dimensions* of *length* but different *units*, such as 3 m and 52 cm.

Problems

4. 136.8 teracalculations per second = 136.8×10^{12} calculations/s. So the number of calculations it can do in a microsecond is:

$$\left(136.8\times10^{12}\ \text{calculations/s}\right)\left(1\times10^{-6}\,\text{s}\right)=136.8\times10^{6}\ \text{calculations}\ .$$

5. v is a velocity, a is an acceleration, and x is a length. So in order for the equation to be dimensionally consistent, we must have:

$$\left(\frac{[L]}{[T]}\right)^2=\frac{[L]}{[T]^2}[L]^p$$
$$\frac{[L]^2}{[T]^2}=\frac{[L]^{1+p}}{[T]^2}$$

So we must have 2 = 1 + $p \Rightarrow p$ = 1.

7. v and v_0 are velocities, a is an acceleration $\Rightarrow$ $v=\frac{[L]}{[T]}$, $v_0=\frac{[L]}{[T]}$, and $a=\frac{[L]}{[T]^2}$. (Also note that t represents time, so $t=[T]$. So for $v=v_0+at$ to be dimensionally consistent, we must have:

$$\frac{[L]}{[T]}=\frac{[L]}{[T]}+\frac{[L]}{[T]^2}[T]$$
$$\frac{[L]}{[T]}=\frac{[L]}{[T]}+\frac{[L]}{[T]}$$
$$\frac{[L]}{[T]}=\frac{[L]}{[T]}\ .$$

Since we get the same dimensions on the left-hand side and the right-hand side, the original equation $v=v_0+at$ is dimensionally consistent.

9. Must have:

$$[T]=\sqrt{\frac{[M]}{k}}$$

(Note that the factor of 2π doesn't show up here because it is *dimensionless* and therefore has no bearing on the *dimensions* of the right-hand side.) Solving for k above gives:

$$k = \frac{[M]}{[T]^2}$$

13. Total weight = 2.45 lb + 10.1 lb + 16.13 lb = 28.7 lb (keeping one decimal place).

14. (a.) 0.000054 has 2 significant figures... the 5 and the 4. (Leading zeroes are never significant.)
(b.) 4 sig figs... the 3, 0, 0, and 1.

15. Area of a circle = πr^2.
(a.) Area = $\pi(14.37 \text{ m})^2 = 648.7 \text{ m}^2$. (Keep 4 sig figs since 14.37 m has 4 and π has infinitely many sig figs.)
(b.) Area = $\pi(3.8 \text{ m})^2 = 45 \text{ m}^2$ (keeping two sig figs).

20. $(3212 \text{ ft})\left(\frac{12 \text{ in}}{1 \text{ ft}}\right)\left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right)\left(\frac{1 \text{ m}}{100 \text{ cm}}\right)\left(\frac{1 \text{ km}}{1000 \text{ m}}\right) = 0.9790 \text{ km}$. Note that I've kept 4 sig figs in the answer because 3212 ft has 4 sig figs and each of the conversion factors is known *exactly*. To make it more clear that there are 4 sig figs in the answer, it would be better to express it in scientific notation as 9.790×10^{-1} km.

24. $\left(\frac{55 \text{ mi}}{\text{hr}}\right)\left(\frac{5280 \text{ ft}}{1 \text{ mi}}\right)\left(\frac{12 \text{ in}}{1 \text{ ft}}\right)\left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right)\left(\frac{1 \text{ m}}{100 \text{ cm}}\right)\left(\frac{1 \text{ km}}{1000 \text{ m}}\right) = 89 \text{ km/h}$.

32. $\left(\frac{9.81 \text{ m}}{\text{s}^2}\right)\left(\frac{100 \text{ cm}}{1 \text{ m}}\right)\left(\frac{1 \text{ in}}{2.54 \text{ cm}}\right)\left(\frac{1 \text{ ft}}{12 \text{ in}}\right) = 32.2 \text{ ft/s}^2$.