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 and Conceptual Exercises
4. 136.8 teracalculations per second = $136.8 \times 10^{12}$ calculations/s. So the number of calculations it can do in a microsecond is:

$$(136.8 \times 10^{12} \text{ calculations/s})(1 \times 10^{-6} \text{ s}) = 136.8 \times 10^6 \text{ calculations}.$$ 

8. $v$ 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:

$$\left(\frac{L}{T}\right)^2 = \left(\frac{L}{T}\right)^p$$

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

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

10. $v$ and $v_0$ are velocities, $a$ is an acceleration $\implies v = \frac{L}{T}, v_0 = \frac{L}{T},$ 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:

$$\left(\frac{L}{T}\right) = \left(\frac{L}{T}\right) + \left(\frac{L}{T}\right)$$

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.

12. Must have:

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

(Note that the factor of $2\pi$ 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:

$$k = \frac{M}{[T]^2}$$
16. Total weight = 2.35 lb + 12.1 lb + 12.13 lb = 26.6 lb (keeping one decimal place).

17. (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.

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

23. \[
\left(3212 \text{ ft}\right) \left(\frac{12 \text{ in}}{1 \text{ ft}}\right) \left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right) \left(\frac{1 \text{ m}}{100 \text{ cm}}\right) \left(\frac{1 \text{ km}}{1000 \text{ m}}\right) = 0.9790 \text{ km}.\]
   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 $9.790 \times 10^{-1}$ km.

27. \[
\left(55 \text{ mi/hr}\right) \left(\frac{5280 \text{ ft}}{1 \text{ mi}}\right) \left(\frac{12 \text{ in}}{1 \text{ ft}}\right) \left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right) \left(\frac{1 \text{ m}}{100 \text{ cm}}\right) \left(\frac{1 \text{ km}}{1000 \text{ m}}\right) = 89 \text{ km/h}.\]

35. \[
\left(9.81 \text{ m/s}^2\right) \left(\frac{100 \text{ cm}}{1 \text{ m}}\right) \left(\frac{1 \text{ in}}{2.54 \text{ cm}}\right) \left(\frac{1 \text{ ft}}{12 \text{ in}}\right) = 32.2 \text{ ft/s}^2.\]