2. (I) How many significant figures do each of the following numbers have: (*a*) 214, (*b*) 81.60, (*c*) 7.03, (*d*) 0.03, (*e*) 0.0086, (*f*) 3236, and (*g*) 8700?

2. (*a*) 214 — 3 significant figures

(*b*) 81.60 — 4 significant figures

(*c*) 7.03 — 3 significant figures

(*d*) 0.03 — 1 significant figure

(*e*) 0.0086 — 2 significant figures

(*f*) 3236 — 4 significant figures

(*g*) 8700 — 2 significant figures

3. (I) Write the following numbers in powers of ten notation: (*a*) 1.156, (*b*) 21.8, (*c*) 0.0068, (*d*) 328.65, (*e*) 0.219, and (*f*) 444.

3. (*a*) $1.156 = \boxed{1.156\times10^{0}}$

(*b*) $21.8 = \boxed{2.18\times10^{1}}$

(*c*) $0.0068 = \boxed{6.8\times10^{-3}}$

(*d*) $328.65 = \boxed{3.2865\times10^{2}}$

(*e*) $0.219 = \boxed{2.19\times10^{-1}}$

(*f*) $444 = \boxed{4.44\times10^{2}}$

4. (I) Write out the following numbers in full with the correct number of zeros: (*a*) 8.69×10^4, (*b*) 9.1×10^3, (*c*) 8.8×10^{-1}, (*d*) 4.76×10^2, and (*e*) 3.62×10^{-5}.

4. (*a*) $8.69\times10^{4} = \boxed{86,900}$

(*b*) $9.1\times10^{3} = \boxed{9,100}$

(*c*) $8.8\times10^{-1} = \boxed{0.88}$

(*d*) $4.76\times10^{2} = \boxed{476}$

(*e*) $3.62\times10^{-5} = \boxed{0.0000362}$

5. (II) What is the percent uncertainty in the measurement 5.48 ± 0.25 m?

5. $$\%\text{ uncertainty} = \frac{0.25\text{ m}}{5.48\text{ m}}\times100\% = \boxed{4.6\%}$$

7. (II) Add $(9.2 \times 10^3\ \mathrm{s}) + (8.3 \times 10^4\ \mathrm{s}) + (0.008 \times 10^6\ \mathrm{s})$.

7. To add values with significant figures, adjust all values to be added so that their exponents are all the same.

$$(9.2\times10^3\,\mathrm{s})+(8.3\times10^4\,\mathrm{s})+(0.008\times10^6\,\mathrm{s})=(9.2\times10^3\,\mathrm{s})+(83\times10^3\,\mathrm{s})+(8\times10^3\,\mathrm{s})$$

$$=(9.2+83+8)\times10^3\,\mathrm{s}=100.2\times10^3\,\mathrm{s}=\boxed{1.00\times10^5\,\mathrm{s}}$$

When adding, keep the least accurate value, and so keep to the "ones" place in the last set of parentheses.

8. (II) Multiply $2.079 \times 10^2\ \mathrm{m}$ by 0.082×10^{-1}, taking into account significant figures.

8. $(2.079\times10^2\,\mathrm{m})(0.082\times10^{-1})=\boxed{1.7\,\mathrm{m}}$. When multiplying, the result should have as many digits as the number with the least number of significant digits used in the calculation.

11. (I) Write the following as full (decimal) numbers with standard units: (*a*) 286.6 mm, (*b*) 85 μV, (*c*) 760 mg, (*d*) 60.0 ps, (*e*) 22.5 fm, (*f*) 2.50 gigavolts.

11. (*a*)	286.6 mm	$286.6\times10^{-3}\,\mathrm{m}$	$\boxed{0.2866\ \mathrm{m}}$	
(*b*)	85 μV	$85\times10^{-6}\,\mathrm{V}$	$\boxed{0.000085\ \mathrm{V}}$	
(*c*)	760 mg	$760\times10^{-6}\,\mathrm{kg}$	$\boxed{0.00076\ \mathrm{kg}}$	(if last zero is not significant)
(*d*)	60.0 ps	$60.0\times10^{-12}\,\mathrm{s}$	$\boxed{0.0000000000600\ \mathrm{s}}$	
(*e*)	22.5 fm	$22.5\times10^{-15}\,\mathrm{m}$	$\boxed{0.0000000000000225\ \mathrm{m}}$	
(*f*)	2.50 gigavolts	2.5×10^{9} volts	$\boxed{2,500,000,000\ \text{volts}}$	

19. (II) Determine the conversion factor between (*a*) km/h and mi/h, (*b*) m/s and ft/s, and (*c*) km/h and m/s.

19. (*a*) $(1\,\text{km/h})\left(\dfrac{0.621\text{ mi}}{1\text{ km}}\right) = 0.621\,\text{mi/h}$, and so the conversion factor is $\boxed{\dfrac{0.621\,\text{mi/h}}{1\,\text{km/h}}}$.

(*b*) $(1\,\text{m/s})\left(\dfrac{3.28\text{ ft}}{1\text{ m}}\right) = 3.28\,\text{ft/s}$, and so the conversion factor is $\boxed{\dfrac{3.28\,\text{ft/s}}{1\,\text{m/s}}}$.

(*c*) $(1\,\text{km/h})\left(\dfrac{1000\text{ m}}{1\text{ km}}\right)\left(\dfrac{1\text{ h}}{3600\text{ s}}\right) = 0.278\,\text{m/s}$, and so the conversion factor is $\boxed{\dfrac{0.278\,\text{m/s}}{1\,\text{km/h}}}$.

21. (II) A *light-year* is the distance light travels in one year (at speed $= 2.998 \times 10^8$ m/s). (*a*) How many meters are there in 1.00 light-year? (*b*) An astronomical unit (AU) is the average distance from the Sun to Earth, 1.50×10^8 km. How many AU are there in 1.00 light-year? (*c*) What is the speed of light in AU/h?

21. (*a*) Find the distance by multiplying the speed times the time.

$$1.00\text{ ly} = \left(2.998\times10^{8}\text{ m/s}\right)\left(3.156\times10^{7}\text{ s}\right) = 9.462\times10^{15}\text{ m} \approx \boxed{9.46\times10^{15}\text{ m}}$$

(*b*) Do a unit conversion from ly to AU.

$$(1.00\text{ ly})\left(\frac{9.462\times10^{15}\text{ m}}{1.00\text{ ly}}\right)\left(\frac{1\text{ AU}}{1.50\times10^{11}\text{ m}}\right) = \boxed{6.31\times10^{4}\text{ AU}}$$

(*c*) $$\left(2.998\times10^{8}\text{ m/s}\right)\left(\frac{1\text{ AU}}{1.50\times10^{11}\text{ m}}\right)\left(\frac{3600\text{ s}}{1\text{ hr}}\right) = \boxed{7.20\text{ AU/h}}$$

24. (I) Estimate the order of magnitude (power of ten) of: (*a*) 2800, (*b*) 86.30×10^2, (*c*) 0.0076, and (*d*) 15.0×10^8.

24. (*a*) $2800 = 2.8\times10^3 \approx 1\times10^3 = \boxed{10^3}$

(*b*) $86.30\times10^2 = 8.630\times10^3 \approx 10\times10^3 = \boxed{10^4}$

(*c*) $0.0076 = 7.6\times10^{-3} \approx 10\times10^{-3} = \boxed{10^{-2}}$

(*d*) $15.0\times10^8 = 1.5\times10^9 \approx 1\times10^9 = \boxed{10^9}$

27. (II) Estimate the number of liters of water a human drinks in a lifetime.

27.

2 liters of water per day. Approximate the lifetime as 70 years.

$$(70\ \text{y})(365\ \text{d}/1\ \text{y})(2\ \text{L}/1\ \text{d}) \approx \boxed{5\times10^4\ \text{L}}$$

***36.** (II) The speed v of an object is given by the equation $v = At^3 - Bt$, where t refers to time. (*a*) What are the dimensions of A and B? (*b*) What are the SI units for the constants A and B?

36. (*a*) For the equation $v = At^3 - Bt$, the units of At^3 must be the same as the units of v. So the units of A must be the same as the units of v/t^3, which would be $\boxed{L/T^4}$. Also, the units of Bt must be the same as the units of v. So the units of B must be the same as the units of v/t, which would be $\boxed{L/T^2}$.

(*b*) For A, the SI units would be $\boxed{\text{m/s}^4}$, and for B, the SI units would be $\boxed{\text{m/s}^2}$.

56. One liter (1000 cm^3) of oil is spilled onto a smooth lake. If the oil spreads out uniformly until it makes an oil slick just one molecule thick, with adjacent molecules just touching, estimate the diameter of the oil slick. Assume the oil molecules have a diameter of 2×10^{-10} m.

56. The volume of the oil will be the area times the thickness. The area is $\pi r^2 = \pi (d/2)^2$, and so

$$V = \pi (d/2)^2 t \rightarrow d = 2\sqrt{\frac{V}{\pi t}} = 2\sqrt{\frac{1000\,\text{cm}^3 \left(\frac{1\text{ m}}{100\text{ cm}}\right)^3}{\pi \left(2\times 10^{-10}\,\text{m}\right)}} = \boxed{3\times 10^3\,\text{m}}.$$

59. An angstrom (symbol Å) is a unit of length, defined as 10^{-10} m, which is on the order of the diameter of an atom. (*a*) How many nanometers are in 1.0 angstrom? (*b*) How many femtometers or fermis (the common unit of length in nuclear physics) are in 1.0 angstrom? (*c*) How many angstroms are in 1.0 m? (*d*) How many angstroms are in 1.0 light-year (see Problem 21)?

59. (*a*) $$1.0\,\text{Å} = \left(1.0\,\text{Å}\right)\left(\frac{10^{-10}\,\text{m}}{1\,\text{Å}}\right)\left(\frac{1\text{ nm}}{10^{-9}\,\text{m}}\right) = \boxed{0.10\text{ nm}}$$

(*b*) $$1.0\,\text{Å} = \left(1.0\,\text{Å}\right)\left(\frac{10^{-10}\,\text{m}}{1\,\text{Å}}\right)\left(\frac{1\text{ fm}}{10^{-15}\,\text{m}}\right) = \boxed{1.0\times 10^5\,\text{fm}}$$

(*c*) $$1.0\text{ m} = (1.0\text{ m})\left(\frac{1\,\text{Å}}{10^{-10}\,\text{m}}\right) = \boxed{1.0\times 10^{10}\,\text{Å}}$$

(*d*) $$1.0\text{ ly} = (1.0\text{ ly})\left(\frac{9.46\times 10^{15}\,\text{m}}{1\text{ ly}}\right)\left(\frac{1\,\text{Å}}{10^{-10}\,\text{m}}\right) = \boxed{9.5\times 10^{25}\,\text{Å}}$$

63. Make a rough estimate of the volume of your body (in m^3).

63. Consider the body to be a cylinder, about 170 cm tall $(\approx 5'7'')$, and about 12 cm in cross-sectional radius (which corresponds to a 30-inch waist). The volume of a cylinder is given by the area of the cross section times the height.

$$V = \pi r^2 h = \pi (0.12 \text{ m})^2 (1.7 \text{ m}) = 7.69\times10^{-2}\,\text{m}^3 \approx \boxed{8\times10^{-2}\,\text{m}^3}$$

66. The density of an object is defined as its mass divided by its volume. Suppose the mass and volume of a rock are measured to be 8 g and 2.8325 cm^3. To the correct number of significant figures, determine the rock's density.

66. $$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{8\,\text{g}}{2.8325\,\text{cm}^3} = 2.82\,\text{g/cm}^3 \approx \boxed{3\,\text{g/cm}^3}$$