Physics 173, Physics of Sustanable Energy
Extra problems

Scientific notation for numbers

1. Express the following numbers in scientific notation. You may have to look up some of the numbers.

   (a) 250 *Ans:* 2.5×10^{2}

   (b) half a million

   (c) 1/8 (one eighth)

   (d) your age

   (e) 5%

   (f) The human population of the world

   (g) The distance in miles from Los Angeles to Saint Louis

2. The number 59 can be written in scientifc notation in different ways, e.g. 59×10^{0} or 5.9×10^{1} or 0.59×10^{2}. Write the number 0.25 in three different ways using scientific notation.

3. Which of the following equalities are valid?

   (a) $0.9 \stackrel{?}{=} 9.0\times10^{-1}$ *Ans:* true

   (b) $0.05 \stackrel{?}{=} 5.0\times10^{-3}$ *Ans:* false

   (c) $7.5\times10^{2} \stackrel{?}{=} 0.75\times10^{4}$

   (d) $250 \stackrel{?}{=} 0.25\times10^{3}$

   (e) $0.003 \stackrel{?}{=} 3\times10^{-2}$

   (f) $0.03 \stackrel{?}{=} 3\times10^{-2}$

4. Calculate the following without using a calculator. In each case, do the calculation in scientific notation, and also convert the numbers to ordinary numbers and do it in that notation as well.

   (a) $3.0\times10^{1} + 5.0\times10^{1}$ *Ans:* 8.0×10^{1}; $30 + 50 = 80$

   (b) $8.0\times10^{0} + 2.0\times10^{0}$

   (c) $2\times10^{0} \times 2.5\times10^{2}$

   (d) $5\times10^{-2} \times 4\times10^{1}$

   (e) $6\times10^{5} / 3\times10^{2}$

Units and unit conversions

1. (a) Describe in everyday terms how big a cubic centimeter is.
   Ans: It is roughly the volume of a finger tip

(b) Describe in everyday terms how big a gallon is.

(c) Describe in everyday terms how big a liter is.

(d) Describe in everyday terms how heavy a kilogram is.

(e) Roughly what volume of water weighs a ton?

2. Perform the following conversions:

   (a) Sound travels at 760 miles per hour. What is that in meters per second?
   Ans: $(760\,\text{mi/hr}) \times \dfrac{1600\,\text{m}}{1\,\text{mi}} \times \dfrac{1\,\text{hr}}{3600\,\text{s}} = 340\text{m/s}$

   (b) How many square centimeters are there in a square meter?

   (c) How many cubic centimeters are there in a cubic meter?

   (d) Water flows through a shower head at 3 gallons per minute. What is that in milliliters per second? Does your answer make sense, given your experience of showers?

   (e) The density of granite is 1.5 ounces per cubic inch. What is that in grams per ml? Does your answer make sense, given what you know about how much heavier than water granite feels?

   (f) The heat emitted by a human at rest is about 100 W. What is that in Calories per hour? Does your answer make sense, given what you know about human food intake and power output?

3. Look up the mass of the earth and the mass of the sun, in kilograms. How many times heavier is the sun than the earth? Round the result to one significant figure of accuracy (e.g. 587 rounds to 600), and express the answer in three ways:
   (a) in scientific notation; (b) as ordinary numerals; (c) in words.
   Is the sun more or less than a million times heavier than the earth?

4. The soft drink "Sprite" is basically just water, with tiny amounts of flavoring in it. What is the weight, in kilograms and pounds, of a two-liter bottle of Sprite?

5. A typical T-shirt is made of material that has a "fabric weight" (mass per unit area) of about 150 g/m^2. Suppose your shirt weighs 4 ounces. What area of fabric (in square meters) does the shirt contain? Does your answer seem about right?

6. A regular car traveling at 40 mi/hr travels about 20 miles per gallon of fuel consumed.

   (a) How many kWh of energy does the car consume per mile traveled?

   (b) What is the power consumption, in kW, of the car?

   (c) How much of that energy is wasted by the inefficiency of internal combustion engines?

   (d) If there were a car with an engine that was 100% efficient, how many kWh would it consume per mile traveled?

   (e) What is that energy being used for? Where does it end up?

   (f) What would be the gasoline mileage (miles per gallon) of such a car?

Answers:

Scientific notation for numbers

1. (a) 2.5×10^{2}
   (b) 5×10^{5}
   (c) 1.25×10^{-1}
   (d) e.g. 1.9×10^{1}
   (e) 5×10^{-2}
   (f) 8×10^{9}
   (g) 1.8×10^{3} miles

2. e.g. 2.5×10^{-1}, 25×10^{-2}, 0.25×10^{0}

3. Which of the following equalities are valid?

   (a) true
   (b) false
   (c) false
   (d) true
   (e) false
   (f) true

4. (a) 8.0×10^{1}; $30+50=80$
   (b) $8+2=10=10.0\times10^{0}=1.0\times10^{1}$
   (c) 5.0×10^{2}; $2250=500$
   (d) $5\times10^{-2}\ \times\ 4\times10^{1}$
   (e) $6\times10^{5}\ /\ 3\times10^{2}$

Units and unit conversions

1. (a) A cubic centimeter is roughly the volume of a finger tip, or a typical 6-sided die.
   (b) A gallon is two big soda bottles; a gallon is the biggest milk container in the supermarket.
   (c) A liter is about the volume of two fists. A liter is a cube that's 4 inches along each side.
   (d) A kilogram is the mass of a pineapple, or a cabbage, or a quart of milk.
   (e) About a cubic meter.

2. (a) 340 m/s
   (b) $100^{2}=10^{4}$

(c) $100^3 = 10^6$

(d) 190 ml/s. Imagine holding a cup upto the shower head. It would fill up in about a second.

(e) 2.7 g/ml. It's significantly denser than water.

(f) 86 Cal/hr. So in a day that would be 2000 Cal, which is about how much food energy we eat in a day, so that makes sense.

3. Earth: (a) 6×10^{24} kg; Sun: 2×10^{30} kg; ratio = 3×10^5 = 300,000 = "three hundred thousand". So the sun is less than a million times heavier than the earth.

4. 2 kg, 4.4 lb.

5. 0.75 m^2; The area should be about (waist circumference) $\times$ (torso height), which is about (36 inches)$\times$(20 inches) or 1 m $\times$ 0.7 m.

6. (a) 1.7 kWh/mi

   (b) 70 kW

   (c) 80% is wasted; 20% = 14 kW gets to the wheels

   (d) 0.3 kWh/mi

   (e) The energy is being used to overcome air resistance and friction with the road. It ends up heating the air and road and tires.

   (f) 100 mi/gal