Physics of Music

Homework 1
Winter 2008
SOLUTIONS

1. Express the following in meters using scientific notation:
   (a) 1.2 μm \[1.2 \times 10^{-6} \text{ m}\]
   (b) 348 mm \[3.48 \times 10^{-1} \text{ m}\] although usually with a number this size, we just write 0.348 m.
   (c) 1540 km \[1.54 \times 10^6 \text{ m}\]
   (d) 34 nm \[3.4 \times 10^{-8} \text{ m}\]

2. Perform the following calculations WITHOUT using a calculator:
   (a) \[\frac{(10^7)(10^{-3})}{10^{-12}}\] \[10^{16}\]
   (b) \[\frac{(3 \times 10^4)(10^6)}{6 \times 10^8}\] \[50\]
   (c) \[\frac{(10^{-9})(10^3)}{2 \times 10^{-2}}\] \[2 \times 10^{-5}\]

3. The SI system uses meters, kilograms, and seconds as its fundamental “building blocks.” (There are also units for electrical charge and some others, but for this class we need not worry about them.) Units for other quantities are made with combinations of these. For example, the units for velocity are m/s. The units for force are kg-m/s², and this combination is given a special name, the newton.
   (a) What would be the “natural” SI units for pressure? (This is also given a special name, the pascal.)
   Pressure is force per unit area, so the unit would be \[\text{N/m}^2\]. If you substitute kg m/s² for N, the units are kg/(m-s²).
   (b) What is the SI unit for density (amount of mass per unit volume)?
   The unit of density is \[\text{kg/m}^3\].
   (c) The frequency of a violin string depends on its mass per unit length. What is the SI unit for this quantity?
   Simply \[\text{kg/m}\].
4. What is the “music of the spheres”, and where did this idea come from?

I’ll quote two different references. From Wikipedia online:

“Musica universalis or music of the spheres is a medieval philosophical concept that regards the proportions in the movements of the celestial bodies - the Sun, Moon and planets - as a form of musica (the medieval Latin name for music). This music was not thought of as an audible sound, but simply as a mathematical concept. The Greek philosopher Pythagoras was frequently credited with originating the concept, which stemmed from his semi-mystical, semi-mathematical philosophy and its associated system of numerology. (See Pythagoreanism.) Some Surat Shabda Yoga, Satgurus considered the music of the spheres to be a term synonymous with the Shabda or the Audible Life Stream in that tradition, because they considered Pythagoras to be a Satguru as well.

At the time, the Sun, Moon and planets were thought to revolve around the earth in their proper spheres - the most thorough and imaginative description of the concept can be found in Dante’s Divine Comedy. The spheres were thought to have been created by God in proportional relations that were reflected in the whole-number relations of the pure musical intervals.

According to Max Heindel’s Rosicrucian writings, the heavenly "music of the spheres" is heard in the Region of Concrete Thought (World of Thought), which is an ocean of harmony. It is also referred in Esoteric Christianity that this is the place called the "Second heaven".

The medieval concept of music comprised three different forms of musica: musica universalis, musica mundana, and musica instrumentalis. Only musica instrumentalis actually referred to sounds made by musicians (both singers and instrumentalists).”

Here is a quote from http://www.harbour.sfu.ca/ hayward/van/glossary/spheres.html:

The concept of the "Music of the Spheres" dates back at least to the 16th century, and is a central idea in the Elizabethan world picture:

”The idea that the universe is bound together by harmony or concord is fundamental in Elizabethan cosmology. The music of the spheres orders the heavens, and music alike orders and tempers human passions and social forces.” (The Norton Anthology of English Literature, vol 1., p.1049)

There is more at this site if you care to look at it.
5. Shown below is a string on which two disturbances are traveling at a speed of 2.0 cm/ms, in opposite directions. Draw the shape of the string (A) 1 ms later, and (B) 1.5 ms later. Also, (C) convert the speed of 2.0 cm/ms to units of m/s.

\[
(2.0 \text{ cm/ms}) \left( \frac{0.01 \text{ m}}{\text{cm}} \right) \left( \frac{\text{ms}}{0.001 \text{ s}} \right) = 20.0 \text{ m/s}
\]