Principles
Power and Energy

Ethan D. Bolker
Maura B. Mast

October 2, 2007

Plan

Lecture notes

Principles

Thinking about how to summarize what we've done so far, in order to discuss how to prepare for the exam, we have identified some principles that underly our work on numbers in context:

- Carefully read the words as well as the numbers (both in the world and in the problems on homework and exams).

- Pay attention to the words you use when writing about numbers.

  In particular, pay attention to how the units for the numbers involved interact. Writing them down explicitly even before you do the arithmetic will often help you get the right answers.

- Relative ccomparisons are usually more informative than absolute comparisons. That means you should often think in terms of multiplication and division rather than addition and subtraction.

  One consequence of this principle is that it pays to learn to use the "multiply by 1+change" idea when working with percentage increase or decrease.

- Often the most important fact about a number is its order of magnitude – essentially, the number of zeroes, or where the decimal point goes – rather than its exact value.

  Therefore an estimate is often better than an answer with lots of meaningless digits.

Power and energy

This is material we didn't cover in class, but hope to some day soon.

Power and energy come up often in everyday discourse, primarily in discussions of economics (for example, the cost of gasoline) and ecology (for example, global warming). So it's important to understand how to reason quantitatively about them.

Unfortunately, that's sometimes confusing. In order to do it well you need to master a new vocabulary.

Bear with us while we go over some (possibly) familiar ground.

Everyone knows that speed and distance are not the same thing. In fact, most people know how they are related:

$$\text{speed} \times \text{time} = \text{distance}$$

where, of course, speed, time and distance are expressed in appropriate units.

Here are some well known units for measuring speed:

- miles per hour, miles/hour, $\frac{\text{miles}}{\text{hour}}$
- kilometers per second, km/sec, $\frac{\text{km}}{\text{sec}}$

We've written each in words, as a fraction in the text, and as a displayed fraction. You can tell they are speeds because they are fractions. The word "per" gives away the story.

But sometimes the fraction isn't visible. The speed of a boat is measured in *knots*. A *knot* is $\frac{\text{1 nautical mile}}{\text{hour}}$. A nautical mile is a little longer than a mile, so when you ask the Google calculator to search for "1 knot in miles per hour" it tells you

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1 knot = 1.15077945 miles per hour
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A knot is a unit for speed, even though it doesn't look like one. If someone tells you his boat travels at 15 knots per hour you can guess that he doesn't have a boat, because he doesn't know what a knot is. The "per hour" displays his ignorance.

There's another unit for speed where the "per" is invisible: the unit *mach*. Google tells us

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mach 1 = 761.207051 miles per hour
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Use this unit to describe how fast fast airplanes go: mach 1 is the speed of sound. So any airplane flying faster than mach 1 is supersonic.[1]

So speeds aren't always what they seem. Neither are distances. The unit *light year* seems to be a unit for time, since it has that "year" in it. But in fact it's a unit for distance.

Discussion of light years here ...

Speed doesn't get you anywhere until you exercise it for some length of time. You can think of speed is *potential* distance.

Now we're ready for power and energy...

[1] We write "mach 1" rather than "1 mach" just as we write $1 rather than 1$.