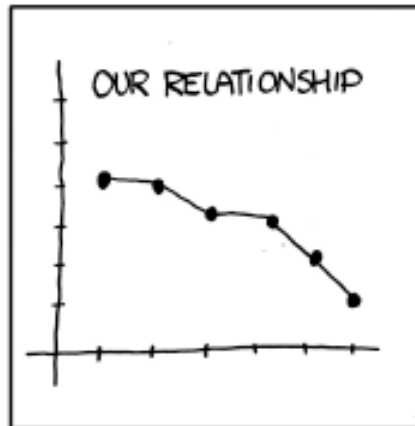


■ **Theme Music: Wynton Marsalis**  
*Where or When?*

■ **Cartoon: Randall Munroe**  
*XKCD*



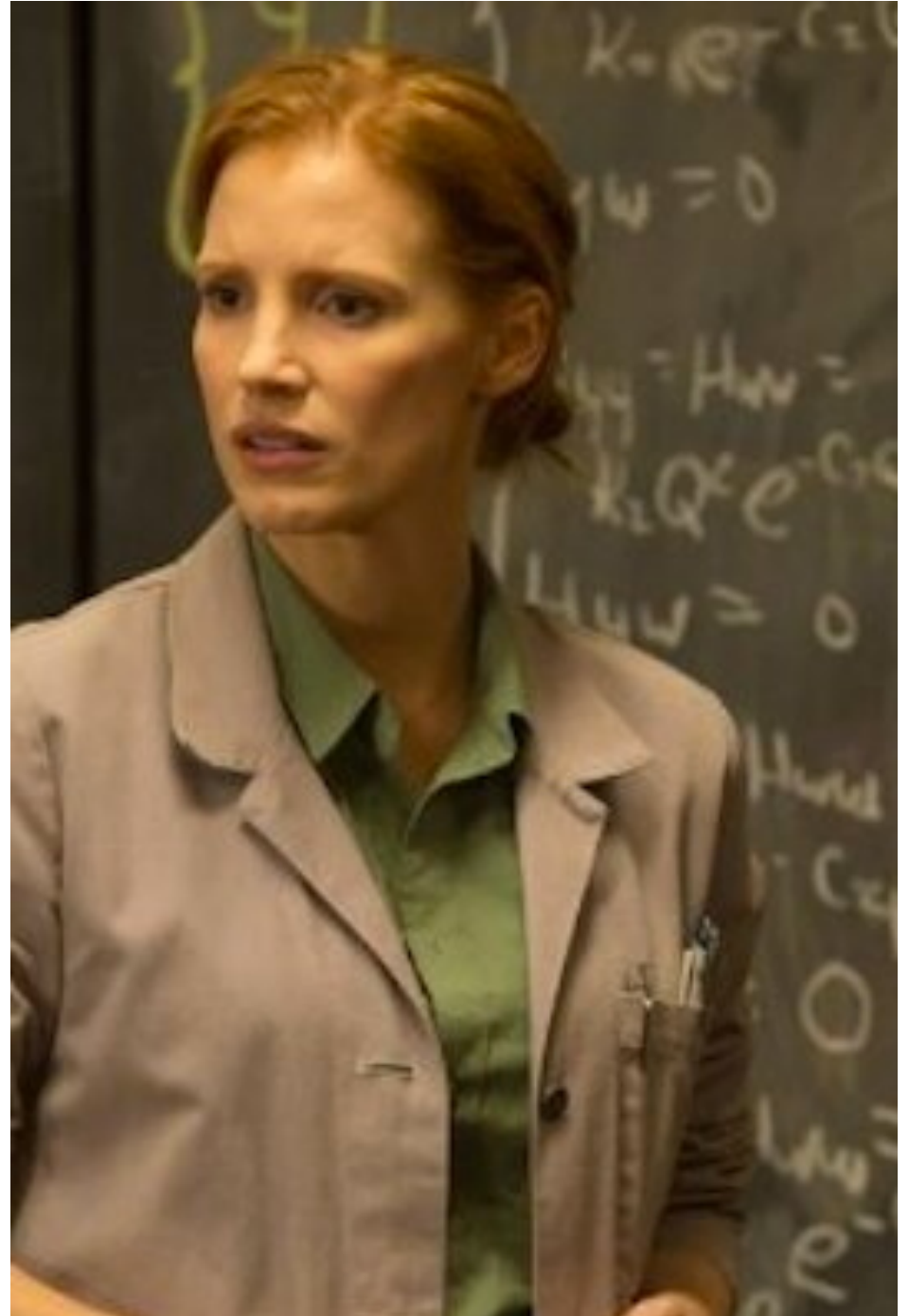
# *The Equation of the Day*

Functions

$$x(t)$$

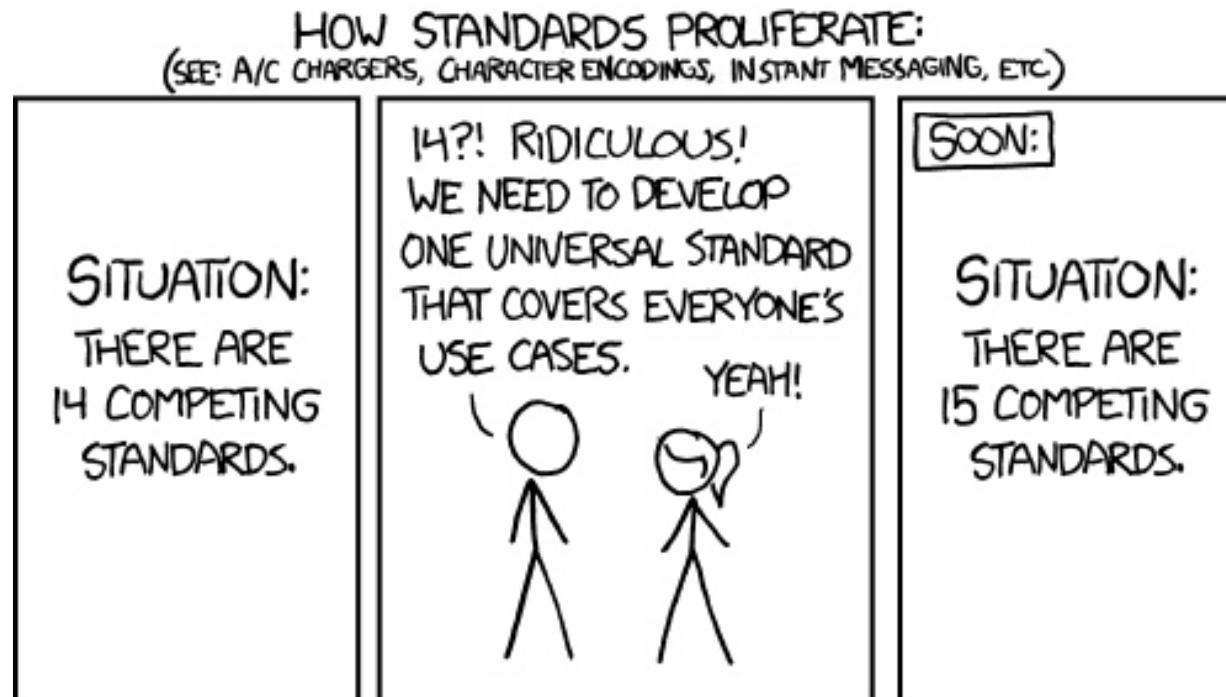
9/4/15

4



# Reading question

I was reading the page under the "change" link and I was surprised that even in NASA there was issues with engineers not using the same notations. How is it possible that such an intelligent group of people haven't standardized this yet?



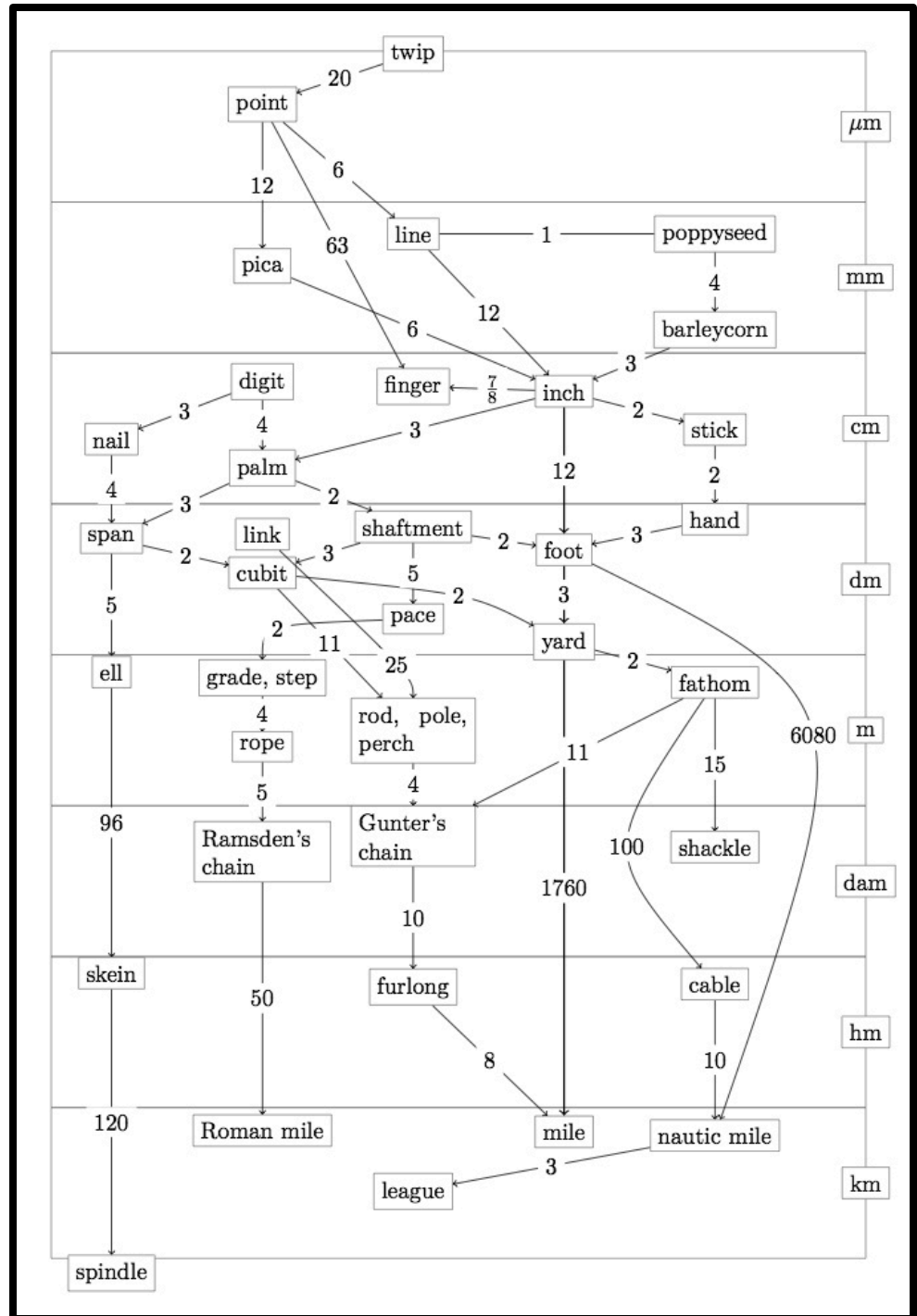
**Why do we still use inches, feet, and miles instead of meters?**

**Tablespoons, cups, pints, quarts, and gallons instead of liters and ml?**

**Why do doctors still measure blood pressure in mm of Hg?**

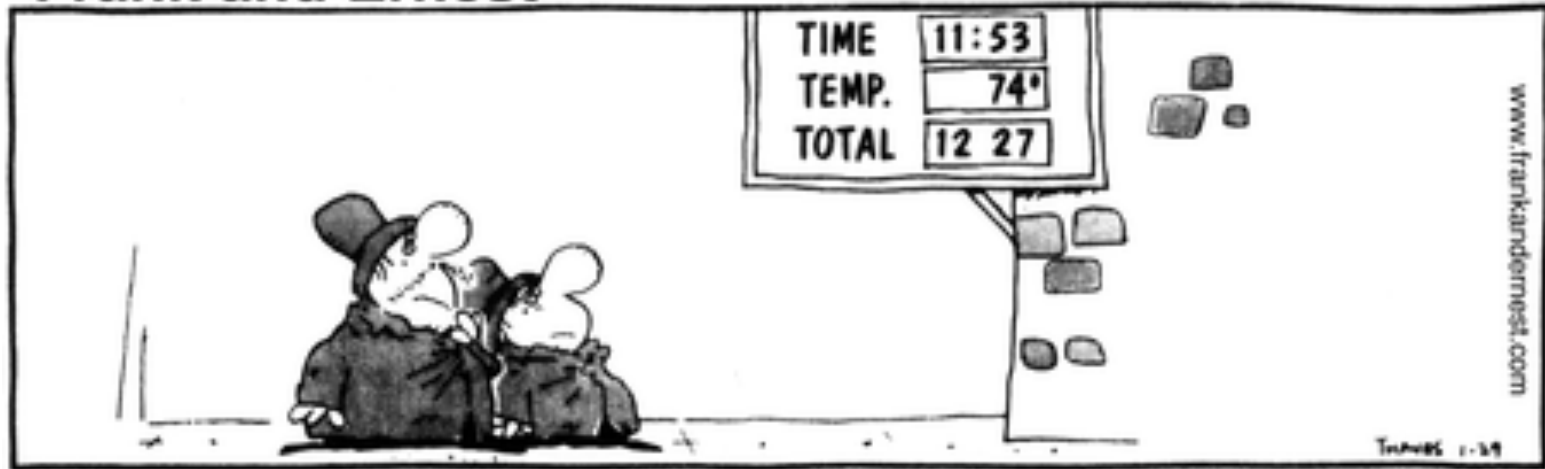
**1 atm = 14.7 psi  
1 atm = 760 mm of Hg  
1 atm = 100 kPascal**

9/4/15



# Reading questions: Technical

Frank and Ernest



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- Is it possible to add two quantities together if they have different units?

- Aren't we putting time and temperature together? Why is that even used in math and biology?

I waited to see my doctor for 1.5 hours. They told me it would be another 30 minutes. If they were correct, how long will I have waited?

# Reading questions: Deeper

- Are dimensions unitless? So if you have two dimensions of length together. However, what and one is in feet? Do dimensions not have units or do we just convert the units to match?  
*Since every chair has a color, why doesn't the category "chair" have a color?*
- Why can you multiply and divide quantities with different dimensionalities but we can't add or subtract quantities with different dimensionalities?

# Reading questions

Units are immensely important, but why are we using bracket notation to know the dimensional of a problem?

It doesn't ultimately solve the problem, it just tells me what the dimensions are, which can already be identified by looking at them, all that's left is conversions. So why is bracket notation being so highly stressed?

# Reading questions

- When would we need to use estimation techniques like this outside of physics?
- If we make an assumption, can that assumption be considered wrong on an exam? for example, if you wanted us to estimate how much one's hair grows in a year, and I assume it grows an inch/minute. This is clearly wrong, but its my assumption for the problem.
- When we guess something to start an estimation, it might vary from person to person. How can we know who is right when sometimes the value can be somehow abstract or hard to specifically calculate?



# Foothold ideas

- We may choose to use an idea for a while – as a “foothold,” to see how it works, and perhaps reject it later in favor of a replacement or refinement.
- These ideas become the basic principles we will use to reason – the “stakes in the ground” of our safety net.



# Foothold Ideas:

## Estimation – Quantifying experience

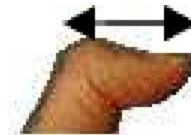


- **Don't** look up data online or get it from friends!\*
- **Don't** use your calculator! Use 1-digit arithmetic
- **Do** figure out your estimations by starting with something you can plausibly know and scale up or down
- **Do** check your answer to see if it's reasonable
- **Do** learn a small number of Useful numbers
- **Measure** your body parts

*\* Sometimes on exams or homework we will give you or tell you to look up some numbers that you might in principle be able to estimate but that would take too much time.*

# My personal scales

	inches	centimeters
First digit of thumb		
Open handspan		
Forearm (cubit)		
Full height		



# Useful numbers (people)

<i>Numbers</i>	
Number of people on the earth	~7 billion ( $7 \times 10^9$ )
Number of people in the USA	~ 300 million ( $3 \times 10^8$ )
Number of people in the state of Maryland	~ 5 million ( $5 \times 10^6$ )
Number of students in a large state university	~30-40 thousand ( $3 \times 10^4$ )

# Useful numbers (distances)

<i>Macro Distances</i>	
Circumference of the earth	~24,000 miles (1000 miles/ time zone at the equator)
Radius of the earth*	$2/\pi \times 10^7$ m
Distance across the USA	~3000 miles
Distance across DC	~10 miles

# Useful numbers (bio)

<i>Bio Scales</i>	
Size of a typical animal cell	~10-20 microns ( $10^{-5}$ m)
Size of a bacterium, chloroplast, or mitochondrion	~1 micron ( $10^{-6}$ m)
Size of a medium-sized virus	~0.1 micron ( $10^{-7}$ m)
Thickness of a cell membrane	~5-10 nm ( $10^{-8}$ m)