# 3 Measurement

## 3.1 History of Measurement

"The Greeks, emerging from a Dark Age into literacy again about 800—700 B.C., renewed the contact with Egypt and Mesopotamia that they had conducted, perhaps indirectly, in the Mycenaean period of the Bronze Age. Again, this contact was in large part indirect at first; A sian G reek c ities, f or e xample, m ay h ave entered into a close relationship with the Lydian court at Sardes, which in turn had direct ties to Mesopotamian courts. Under such influences, t he e merging l ife-form of the Greeks began to take upon itself the questions under the weight of which the older civilizations had first thrived, then wearied.

In the late seventh or early sixth century, astronomical ideas derived from Mesopotamian records and handbooks somehow began to enter Greece. This transmission may have occurred in Ionian cities like Miletus, in Sardes, or in Near Eastern centers. However Mesopotamian astronomy entered the Greek world, it took it by storm. In the sixth century the Greek Cleostratus of Tenedos wrote a book called *Astrology*; the Hesiodic school produced a work called *Astronomy*; to Thales himself was attributed a *Nautical Star Guide*.

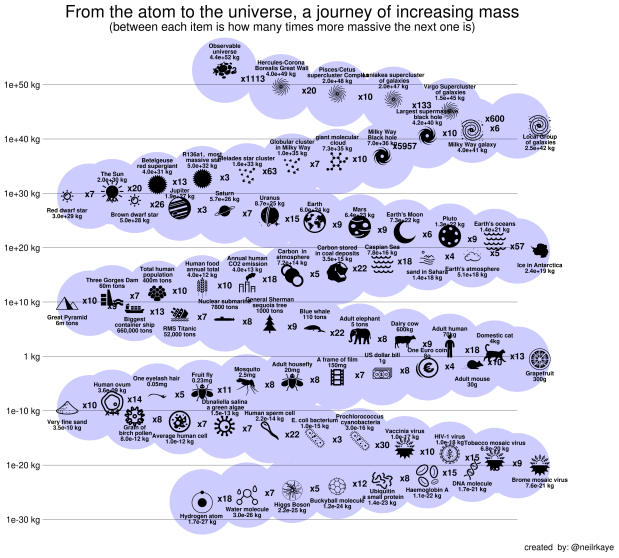



Figure 1: Log scale of objects in known universe

From Egypt other formative influences came. The Greco-Egyptian settlement at Naukratis was a colony of Miletus, a city which was steeped inthe thought and culture of both Egypt, by way of Naukratis itself, and Mesopotamia, by way of its ties with Sardes. Egyptian methods of measurement, which are said to have influenced Thales, lie behind the Greek obsession with geometry... along with the Mesopotamian-derived obsession with astronomy..." —*The Shape of Ancient Thought* by Thomas McEvilley

**Exercise 30.** *What was the first unit of measurement?*

**Exercise 31.** *Why are there 360 degrees in a circle?*

**Exercise 32.** *What is the mean, variance and standard deviation in the height of your classmates measured in cubits?*

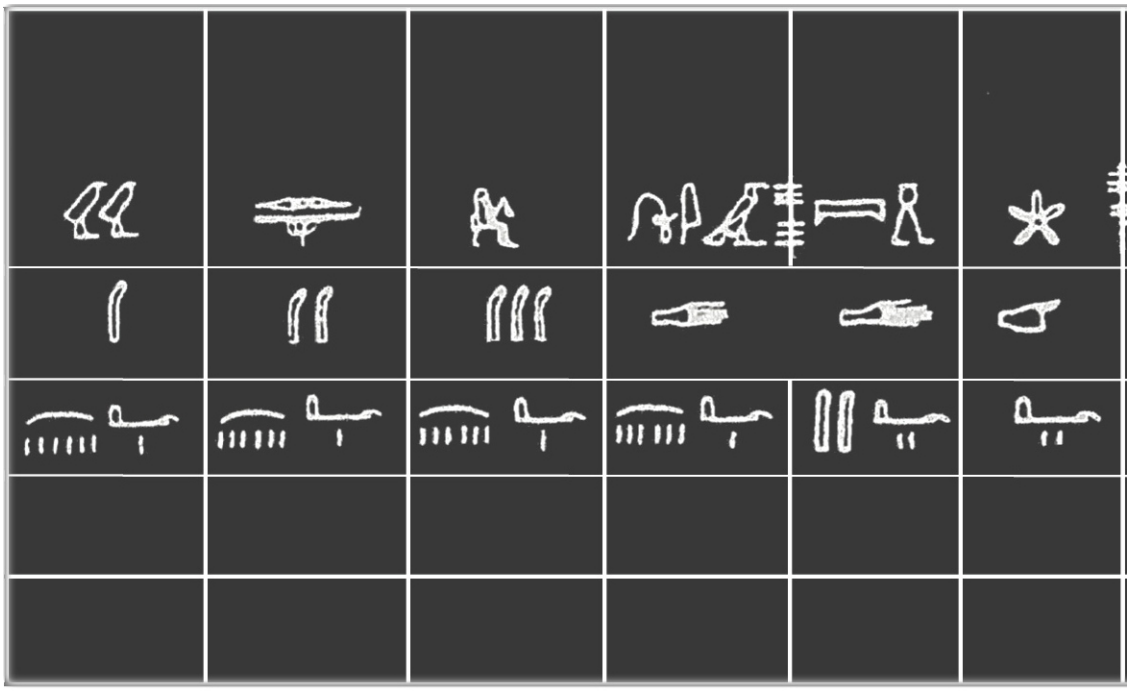
## 3.2 Modern Measurement

"Let nature speak for itself." —1878 French psychologist E.J. Marey

Mechanized science seems at firstglance incompatible with moralized science, but in fact the two were closely related.While much is and has been made of those distinctive traits-emotional, intellectual, and moral-that distinguish humansfrom machines, it was a nineteenth-century commonplace that machines were paragons of certain human virtues. Chief among these virtues were those associated with work: patient, indefatigable, ever-alert machines would relieve human workers whose attention wandered, whose pace slackened, whose hand trembled. Scientists praised automatic recording devices and instruments in much the same terms. As the photograph promised to replace the meddling, weary artist, so the self-recording instrument promised to replace the meddling, weary observer. It was not simply that these devices saved the labor of human observers; they surpassed human observers in the laboring virtues: they produced not just more observations, but better observations. Of course, strictly speaking, no merit attached to these mechanical virtues, for their exercise involved neither free will nor self-command. But the fact that the machines had no choice but to be virtuous struck scientists distrustful of their own powers of self-discipline as a distinct advantage. Instead of freedom of will, machines offered freedom from will-from the willful interventions that had come to beseen as the most dangerous aspects of subjectivity. — *Objectivity* by Lorraine Daston and Peter Galison

**Exercise 33.** *Is there such a thing as an objective measurement?*

**Exercise 34.** *How do we keep time today? How did they keep time 1,000 years ago? 2,000 years ago?*



## 3.3 Using Measurements

**Exercise 35.** *What are the units of position, velocity, acceleration?*

**Exercise 36.** *What is the density of a human?*

**Exercise 37.** *If you traveled at* $10\frac{kilometers}{hour}$ *for a day, how many miles did you travel?*

**Exercise 38.** *How many joules of energy are in an ounce of average size pitted medjool dates?*

**Exercise 39.** *Find a unit of measurement you've never heard of before! What is it typically used to measure?*