Modern physics began with the stars. Some people were very good at observing and recording the movements of the stars, and this data enabled other people who were good at theorizing to develop mechanics, the study of the motion of matter. This history is an instructive example of the interplay of reasoning and measuring. It is also evidence that studying anything you find interesting, even “irrelevant” things (what could be less applicable to everyday life than the stars?), has a way of producing the most relevant work of all. The work of astronomical dreamers, Brahe and Kepler and Newton, made the Industrial Revolution possible.

Many fields are waiting for you to describe them better. Physics far exceeds psychology as a predictive science, but this may not always be the case. Consider mathematical description not as the “cold, impersonal” treatment of a subject, but rather as especially clear description. When our equations describe a system well, we have understood that system well.

In this light, immerse yourself for a while in the exemplary equations of aeronautics and astronomy.

One)

Two) The potential energy of a mass above the ground is given by mgh, while kinetic energy is given by (1/2)mv^2 . While the object is in free fall (until it hits the ground and loses energy through collision) its total energy is conserved. Neglect drag.

1. Find the speed of an object fallen from 100m just before it hits the ground.
2. An object is thrown upward from 0m at 30m/s. What is its maximum height?
3. An object is dropped with starting velocity 0m/s and reaches 200m/s. How far has it fallen?
4. You jump off a 15m cliff into the water with starting upward velocity 1m/s. How long until you hit the water?

Three) Let’s now *not* neglect drag. How does this change the governing equation of motion?

Fdown = g

Changes to

Fdown = g – yv

That is, the air is going to slow down a falling object, and the upward force it exerts is a linear function of the object’s velocity.

Here is the general solution of this differential equation:

….

1. Prove the existence of a terminal velocity – ie, the object reaches a maximum speed and stays at it until it hits the ground – using a limit.

“… the empirical background of economic science is definitely inadequate. Our knowledge of the relevant facts of economics is incomparably smaller than that commanded in physics at the time when the mathematization of that subject was achieved. Indeed, the decisive break which came in physics in the seventeenth century, specifically in the field of mechanics, was possible only because of previous developments in astronomy. It was backed by several millennia of systematic, scientific, astronomical observation, culminating in an observer of unparalleled caliber, Tycho de Brache. Nothing of this sort has occurred in economic science. It would have been absurd in physics to expect Kepler and Newton without Tycho…” – Theory of Games and Economic Behavior, von Neumann