

Feb 10th, 2008

P340: Homework Assignment No. 2

DUE DATE: Friday, Feb. 29th. 2008

Please note that late assignments will not be marked

(1) The "Experimental Philosophy": Both Galileo and F Bacon pioneered what was called at that time the "experimental philosophy". Galileo did many measurements of the dynamics of bodies on earth, and of course like astronomers before him, he also measured the motions of heavenly bodies.

(a) Galileo did repeated measurements of the rolling of balls down inclined planes. His aim, amongst other things, was to establish the relationship between the time elapsed after release of a ball and the distance rolled in that time. He was able to show that the distance was proportional to the square of the time elapsed (in a formula, he showed that the distance $x \propto t^2$ where t was the elapsed time). We can call this an 'experimentally established truth' (what Bacon would have called an 'experimental axiom').

Describe how he would have done this experiment (or alternatively, how you would do it). You need to explain carefully how the distance and time were measured.

(b) In what form would the data have been accumulated. And at the end of this experiment, what sort of evidence did Galileo have for the truth of his experimental 'axiom'? How sure could he be of it?

(c) In this experiment Galileo was assuming that somehow his way of measuring time was really a measure of time. But what was he really measuring? Define what you think is meant by time in these measurements. And when Galileo argued that the motion of a pendulum was periodic in time, what was really meant here?

(d) Now suppose that we move on to a century after Galileo did his measurements (say, to 1730 or thereabouts). By this time Newton had set up a system of laws from which Galileo's results for rolling balls and swinging pendulums could be *derived*, as consequences of the laws.

Does the existence of Newton's derivation of Galileo's results from his laws make his results more believable or not? Can we be more sure of their truth? Explain your answer.

(2) Newtonian Mechanics: Now let us move on to Newton's laws, which gave people for the first time a clear idea of what a set of Laws of Nature could really look like.

(i) Give a concise explanation of what each of Newton's 3 laws of dynamics say. You should pay careful attention to explaining how distance, time, acceleration, mass, and force are to be defined, in the real world. If it helps to give examples then by all means do so. Then explain what is Newton's law of Gravitation between masses. In order to give a proper definition of all the quantities involved in his 3 laws you may also have to refer to the law of gravitation.

(ii) Now explain how you would *test* Newton's 3 laws (ie., how you would provide experimental evidence to show that they are true). Note that one way of doing this is to imagine how you might show they are *false*, ie., devise a method of falsifying one or more of them. You will probably find it helpful to imagine some specific simple experiment (or experiments) which would somehow test one or more of the laws. You do not need to know anything sophisticated about physics at all to answer this question - it is enough to understand what the laws themselves mean, and to use common sense and very simple tests (this is the sort of thing that one could ask Sherlock Holmes to do).

(3) Refraction, Reflection, and Waves: Now we consider the problem that was left behind after both Newton and Huyghens had provided alternative theories of light. In the following you will find it very useful to use diagrams in your explanations.

(i) Explain what happens when a light beam meets a planar interface between 2 media of different density.

(ii) Now explain how the corpuscular theory of Newton was supposed to explain the behaviour you have just described, and how the wave theory of Huyghens was supposed to explain it. You will have to explain in some detail here how the wave theory of Huyghens is supposed to work.

What is your opinion of the merits (or otherwise) of these two theories?