5. These two standards have contrasting implications for how one ought to go about doing physical astronomy and other sciences: piecemeal versus global approaches
    a. Descartes challenges the feasibility of doing piecemeal science on the grounds that not enough proper evidence is going to be available to prevent being led down garden paths
    b. Piecemeal science promising only when one can proceed strictly and rigorously from basic laws, thereby safeguarding against being misled
    c. Otherwise, the only adequate constraints against being misled must come from pursuing a global account
6. This tension between two approaches to marshaling evidence for scientific theories continues to the present day

IV. Cartesian Conceptions of Empirical Science

A. Descartes' Conception of the Problem

1. Reason alone can yield certainty in geometry and other matters, but it can take us only so far toward knowledge of the material world
    a. Geometry provides certainty within the realm of possibility, and it offers a standard of rigor in reasoning
    b. But the actual world -- the one God chose -- cannot be singled out from geometrical and mathematical considerations alone

    > "For, seeing that these parts could have been regulated by God in an infinity of diverse ways; experience alone should teach us which of these ways He chose." [46]

    c. The problem is how to bring empirical considerations to bear in a decisive way
2. The problem Descartes saw in turning to the empirical world is reflected in his criticisms of Galileo's *Two New Sciences*

    > "He seems to me very faulty in ... never stopping to explain [*explicandae*] completely any matter, which shows that he has not examined things in order, and that without having considered the first causes of nature he has only sought the reasons of some particular effects, and thus he has built without foundation [*fundamento*]. (p. 387f of Drake)

    a. Also, the account of fall is "built without foundation, for first he should have determined what weight is" (p. 390), and the theory is incomplete since it fails to treat pendular motion (p. 391)
    b. One can easily imagine similar criticisms of Kepler's orbital theory, with complaints about the *ad hoc* physics, but even more so questions about the true regularity of the trajectories, versus their being epochal parochialisms, in the absence of proper mechanical foundations
3. The standard reading of these critical remarks (*vide* Drake) is that Descartes was unwilling to pursue a strict program of empirical science; but there is another reading: he was afraid of garden paths in empirical science
    a. He could not help but see Ptolemy as a paradigm of brilliant, yet unsuccessful empirical

reasoning, and he could legitimately ask how Galileo and Kepler had insured against making similar mistakes

b. He drew the same basic conclusion that Kepler had: the only way to safeguard against such errors is to make sure that the conclusions being drawn were consistent with true physical causes

4. A strong case can be made that, not just for Descartes, but for others in the first half of the 17th century as well, a key issue was how to avoid another garden-path
5. The suggestion, then, is that Descartes' pursuit of a comprehensive causal picture may have been not so much a commitment to a program different from empirical science, as it was a view about how to do successful empirical science
   a. No empirical conclusion is secure unless it is based on a secure causal account of the relevant phenomena
   b. The problem is how to obtain a secure causal account; clearly we cannot just put forward hypotheses based on characterizations of the phenomena, for the insecurity of these characterizations is the source of the problem in the first place
6. One obvious step toward securing foundations for such a causal account is to try to establish universal principles governing all causation in the material world -- i.e. laws of nature
   a. This amounts to identifying which questions truly call for causal answers and what sort of answers to these questions are appropriate
   b. Given his views about the role of reason in "first philosophy," it was natural for him to think that these conceptual foundations could be established *a priori*, via a clear and distinct grasp of the relevant ideas
   c. Grounding empirical science on metaphysics, including metaphysics of God, seemed necessary to him, for metaphysics on the firmer footing
7. Notice, however, that some might have viewed the foundation not as lying in metaphysics and God, but instead in fundamental principles governing motion
   a. E.g., *All departures of any body from rest or from uniform motion in a straight line require an external action or force arising from some other body (in contact with it) that effects a change in motion by transferring some of its motion to the other one, with the aggregate of their total motion remaining the same before and after*
   b. Starting from a principle of this sort, viewed as an empirical claim to be supported by empirical evidence, instead of being derived from metaphysics, is the stance Regius, and various later Cartesians, adopted

B. How To Do Science: the Cartesian Solution

1. The first goal of empirical science ought to be at least a broad outline of the causal mechanisms and processes that govern phenomena, for only then will we be in a position to judge the likelihood that empirical factors are not misleading us