

Questions Answered by Huygens: 1652-1673

1. What is the distance of vertical fall in the first second in the absence of a resisting medium -- i.e. the proportionality constant in Galileo's "law" of free-fall?
2. What rules of impact for perfectly "hard" spheres in head-on collision, in contrast to those proposed by Descartes, agree with experience?
3. Is Descartes' quantity of motion conserved in head-on impact of perfectly "hard" spheres, and, if not, what quantity is (or quantities are) conserved?
4. What is the strength of the tendency (*conatus*) to recede from the center in uniform circular motion?
5. What is the tension in the string retaining a body moving in uniform circular motion?
6. What is the "law" fully characterizing the relationship between the dimensions of conical pendulums and their periods?
7. Where must a 90-degree circular-arc pendulum be intercepted for its bob to reach the vertical with its string remaining taut in ascent?
8. From what principles can Galileo's claim of pathwise-independence of speed acquired in the absence of a resisting medium be derived, and does it hold regardless of the trajectory of descent?
9. Given that the circular arc is not the answer, what is the isochronous path in descent, assuming uniform gravity acting along parallel lines?
10. How can an isochronous pendulum be constructed -- i.e., one that maintains the same time to complete a full arc regardless of the arc-length of descent?
11. With gravity as in (9), what is the "law" fully characterizing the relationship between the dimensions of simple isochronous pendulums and their periods?
12. Where is the "center of oscillation" of a circular-arc pendulum with multiple small bobs or a physically large bob, and how can the solution for this center be used to tune pendulum clocks?

Beyond Galileo

- **The range of topics covered by Huygens under largely the same basic hypotheses as Galileo (+ Torricelli and Cartesian inertia) reaches far beyond the theory in *Two New Sciences*: the *Galilean-Huygensian theory* of motion under uniform (parallel) acceleration.**
- **Huygens introduced multiple theory-mediated means for measuring the fundamental quantities – i.e. the constants of proportionality – of that theory, opening the way to a new form of evidence for it from agreeing measurements that presuppose different hypotheses.**
- **In extending the theory beyond its initial idealizations Huygens opened the way to another new form of evidence by showing that the initial theory is a first approximation that can be extended to cover deviations from it without requiring new basic hypotheses.**

***Theoretical physics*: theoretical solutions to new problems, proceeding as much as possible from principles – or at least direct generalizations of them – that yielded empirically supported solutions to previous problems**

The Development of "Newtonian" Mechanics

