

Gregory L. Baker (2011): *Seven Tales of the Pendulum*

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This book grew out of an earlier publication, *The Pendulum: A Case Study in Physics* (2005), by Gregory Baker and James Blackburn, who have both been involved in active research into pendulum behaviour. That book was a technical treatise intended for students of physics. *Seven Tales of the Pendulum* tells the same story but with most of the technical and mathematical details removed and with the addition of information about the history and cultural setting of pendulum physics. It is intended for the “general reader with an interest in science” (ix).

The overall story told in this book has a noticeable coherence and each of the tales takes the reader one step closer to the most recent developments in our understanding of pendulum motion and its relevance to other systems.

In the Introduction the author describes the nature of the simple pendulum and three different ways of representing its motion—time series, phase plane diagram and probability diagram—all of which are referred to in later chapters. He also outlines the content of the seven tales which follow.

The historical background of pendulum methods to measure the shape, density and rotational motion of the earth along with recent developments of these methods are discussed in Tale 1. The work of many people is discussed, including that of Leon Foucault.

In Tale 2 the author deals with small angle oscillations of the pendulum and its use as a mechanical regulator in clocks from the time of Galileo onwards. Along with the contribution of others, Huygens’ development of the pendulum clock is discussed in some detail.

The use of the torsional pendulum to measure the universal gravitational constant and to find the relationship describing the force between electrostatic charges is covered in Tale 3. In addition reference is made to the equivalence of gravitational and inertial mass. The research work of Cavendish, Coulomb, Eötvös, Dicke and Gundlach is mentioned in this chapter.

In these first three tales the material dealt with is directly relevant to physics as taught in secondary school. The next four tales take the reader into realms somewhat beyond this and thus provide valuable opportunities for extension in the classroom.

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Tale 4 is a bridge between the earlier and the later tales. It commences with a description of O Botafumeiro, a huge, hanging censer in the cathedral of Santiago de Compostela in Spain. The length of the chain is about 20 m and the censer can be caused to swing through a half angle of around 80° , giving the censer a speed of almost 70 km/h at the bottom of the swing! This tale introduces the reader to the four regions of pendulum motion: (a) small angle oscillations where the period is independent of the amplitude; (b) large angle oscillations where the period depends on the amplitude; (c) hindered rotation in which the initial push takes the pendulum over the top but where the rotational speed is variable—slower at the top and faster at the bottom; and (d) non-hindered rotation in which the initial push is so great that the difference between the upper and lower speeds is negligible. Discussions of the physics of the playground swing and of the pendulum in Edgar Allen Poe's short story—"The Pit and the Pendulum"—complete this chapter.

The behaviour of the pendulum when subjected to periodic forcing is the substance of Tale 5, which introduces the notion of chaotic dynamics. Chaotic systems are unstable, deterministic systems which are so sensitive to the initial conditions in such a manner that the outcome appears to be random and probabilistic. This means that minute changes in one of the parameters—amplitude of forcing, frequency of forcing, damping—can lead to radical differences in that behaviour. As these parameters are varied, pendulum motion can move abruptly between periods of apparent chaos and periods of regularity.

Tale 6 introduces the idea of coupling between pendulums with a story from Huygens who reported to his father that, when he started, at different times, two pendulum clocks which hung near each other on the same wall, it was not long before they were beating in synchrony. This story leads to a discussion of the synchronisation between two chaotic pendulums and how this might be relevant for the secure communication of information.

In the final tale the role of the pendulum model for quantum systems is discussed.

The book concludes with a chapter entitled "Odds and Ends" in which pendulum systems which do not fit neatly into the overall structure of the book are considered. These include the double pendulum, the system known as Newton's cradle, the relativistic pendulum and the Long Now clock, a recent pendulum clock designed to be accurate for 10,000 years. Brief comments on the pendulum as a model for human society bring the story to a close.

Seven Tales of the Pendulum would be a fine addition to the bookshelf of a teacher who wished to understand more about physics than he or she was required to teach and who wished to stimulate his or her students to investigate areas beyond the syllabus. Complex ideas are explained clearly by the author and the use of diagrams and photographs provides valuable support for these explanations. The historical and cultural material will enhance the impact of the book for those for whom it is written. There is a useful Glossary of Terms and suggestions for further reading. It is a pity that the Springer publication (Matthews et al. 2005), which covers similar subject matter and is directed to a similar audience, is not listed.

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Reference

Matthews, M. R., Gauld, C. F., & Stinner, A. (2005). *The pendulum: Scientific, historical, philosophical and educational perspectives*. Dordrecht: Springer.