Solved problems in classical mechanics

Book Title:
Solved problems in classical mechanics – Analytical and numerical solutions with comments

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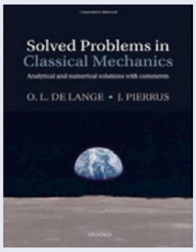

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Review Title:
Solved problems in classical mechanics

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Newtonian physics has been tried and tested for more than three centuries, and classical mechanics is deeply entrenched in standard introductory courses of physics. High school physics the world over begins with a discussion of Newton's three laws of motion, often followed by Newton's law of gravitation. Introductory university physics continues to build on Newton's laws by considering more complexity – usually involving dynamics, for example, the motion of rigid bodies and studies of rotational motion. Classical mechanics is often, but not always in South Africa, taught at more senior levels at universities, and here the focus tends to be on Hamilton's principle and on Lagrange's formulation of classical mechanics. The applications at this level are invariably more complex – applications to coupled systems, chaotic systems, and so on. It is no exaggeration to say that there are several hundred excellent textbooks on classical mechanics available that have been published over the past century or so. The question is whether there is room for yet another textbook on classical mechanics in the world.

What I find remarkable about the book of de Lange and Pierrus, is that the authors, who are academics at the University of KwaZulu-Natal, even dared to embark on this hefty project (about 600 pages), in a field that is clearly mature and very well established. Did they have the foresight to carve out a niche that makes their contribution unique and useful in a very crowded subject area?

The answer is yes and emphatically so. The authors make significant contributions to classical mechanics by considering more complex – and hence more realistic – problems, many of which are only tractable on the computer. They use Mathematica, which is a useful symbolic manipulation package, to solve their problems. They give excerpts of their computer code, which is very readable. By presenting their computational methodology in such detail, the authors are helping the reader to understand the algorithmic structures of their solutions which are readily transferable to other programming languages. This approach enables any competent computational physics student to use their favourite computing language (such as fortran, C, C++ and java) to develop their own coded solutions to the same problems. In these respects, the book is enormously pedagogical and useful. It is a very good resource for teaching standard theoretical and computational classical mechanics. Considering that classical mechanics is basic to both physics and practically all the engineering disciplines, there is potentially a very wide readership.

The range of topics within the book is very impressive. The authors cover problems in one, two and three dimensions, as well as problems involving linear oscillations, energy and potentials, momentum and angular momentum, multiparticle systems, rigid bodies, non-linear oscillations, reference frames and the relativity principle. The book is written in the form of problems with solutions and with comments. The solutions are often accompanied by graphical representations. Students would do well to turn some of these solutions to graphical animations using visualisation tools. The authors could perhaps continue to be involved in this project by making their visualisation resources available on the web. Their comments are very insightful and often point to something new that can and should be explored further by the reader. This exploration in turn encourages the reader to build on the programming solutions provided by the authors.

I found the final chapter, 'The relativity principle and some of its consequences', to be especially elucidating, and the problems very instructive and even suggestive. If one asserts that the laws of physics are equally valid in all inertial frames, then the notion of a universal speed emerges very naturally, and the mystery that is often accompanied by Einstein's theory of special relativity dissipates quite quickly. With physics, however, it is very often easier to argue the case retrospectively in elegant ways as is done here. But the genius of Einstein will always remain a mystery.