

Physics Comics and Stories: **Creating comics for high school and university students**

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Abstract

We are creating a series of comic book stories in English, Spanish, and French intended to help high school and introductory college students with solving specific types of physics problems. In this paper we review the motivation behind this project and the structure of these stories. We also describe the responses from students, and how the cast of comic characters used in our stories are being used in the new edition of a leading physics textbook.

Introduction

Comic books have been used to inform the general public about physics for eight decades (Highsmith 1943; Greene 1946; Palais 1946; Cole 1960; Thompson 2013; Burniat 2016; Johnson 2017). A few attempts have been made to create entire textbooks for introductory physics in a graphic novel format (Gonick 1990; Calvin 2022), but these have not been widely adopted by faculty.

We are developing a more narrowly targeted comic-book project, *Physics Comics and Stories*, intended to supplement rather than replace a conventional textbook for introductory high school or university physics. Our goal with these stories is twofold: to assist students with the process of solving physics problems (for most students, the most challenging aspect of a physics course) and to improve the conceptual understanding needed to set up a problem and interpret the answers. To this end we use a Socratic-like dialogue between the lead characters, assisted by comic relief.

Why is physics difficult?

Physics has a well-deserved reputation as a difficult subject for high school and university students who encounter it for the first time. One important reason is that students arrive in their first physics course not completely innocent of physics, but rather with an initial knowledge state about the physical world that is based on their experiences as a child. Unfortunately this initial knowledge state includes many misconceptions that conflict with modern concepts of physics (Neidorf 2019). The range of student misconceptions about physics extends across the full gamut of the subject, including Newtonian physics (Halloun 1985), electricity and magnetism (Maloney 2001), and optics (Goldberg 1985).

A second important reason why physics is difficult is that developing expertise means becoming an expert problem-solver in physics. This is a multi-faceted skill that requires knowing how to interpret a problem in words, convert it to a mathematical representation, solve the mathematical problem, and interpret the results (Hsu 2004).

Physics Comics and Stories: Confronting misconceptions and modeling problem-solving

In *Physics Comics and Stories* we confront common selected misconceptions in physics and model the steps used by expert problem-solvers. This is done in the form of a dialogue between a beginning student named Alonzo and a more advanced student named Elena, with assistance from Elena's cat Kepler and an anonymous squirrel. To avoid giving students the sensation of merely being presented with a lecture in comic book form, there are no "professor" characters in our stories.

Each story in *Physics Comics and Stories* concerns a particular type of physics problem that experience shows to be particularly challenging to students. At the beginning of each story, Alonzo verbalizes the difficulties that students commonly face with problems of this type (Figure 1a). The story then reviews the physics concepts that underlie the physics problems under study. These are concepts that the student will have encountered in their conventional textbook, but the comic medium makes it possible to present the information in a conversational manner and with a three-dimensionality that is difficult to reproduce in standard textbook illustrations (Figure 1b).

After the concept review, Kepler the cat presents the reader with formative questions to test their conceptual understanding (Figure 2). These questions are designed to evoke common misconceptions about physics and to help students overcome them.

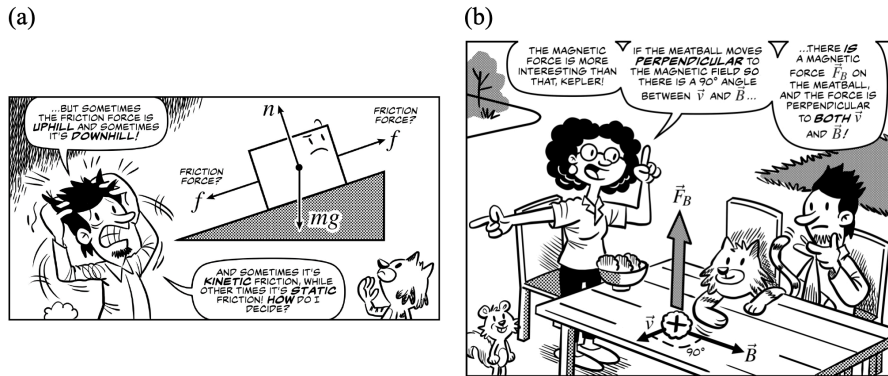


Figure 1 : (a) Alonzo, like most students, finds problems with friction to be challenging. (b) Elena explains the magnetic force on a moving charged particle.

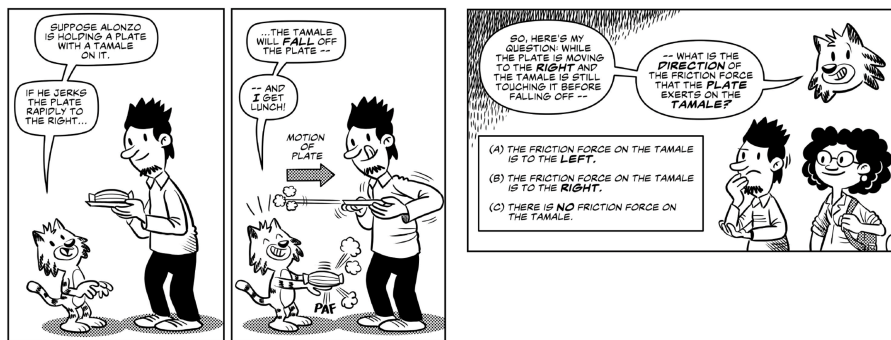


Figure 2 : Kepler poses a question about the force of friction.

Elena then poses a physics problem based on the concepts that have just been reviewed. The entire cast assists in showing how to solve the problem, including pointing out key features of the process that are often overlooked or underemphasized in conventional textbooks or in-class instruction (Figure 3). All of the mathematical steps in the solution are included, and the results are interpreted and explored.

The story ends with a review (by Kepler and the squirrel) of the physics concepts used in the story and the problem-solving techniques learned (Figure 4).

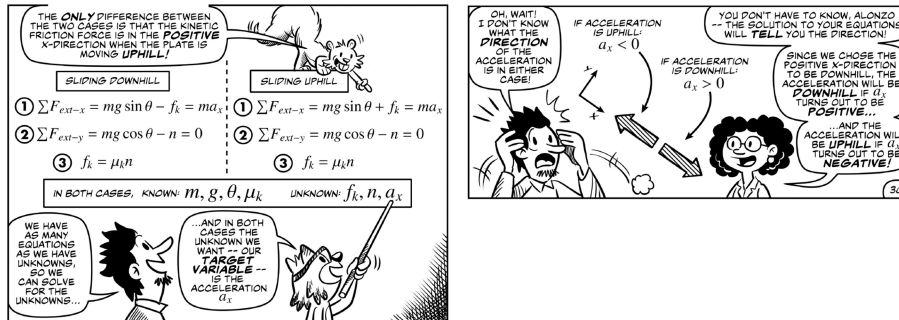


Figure 3 : The entire cast works together to solve a problem involving friction and other forces.

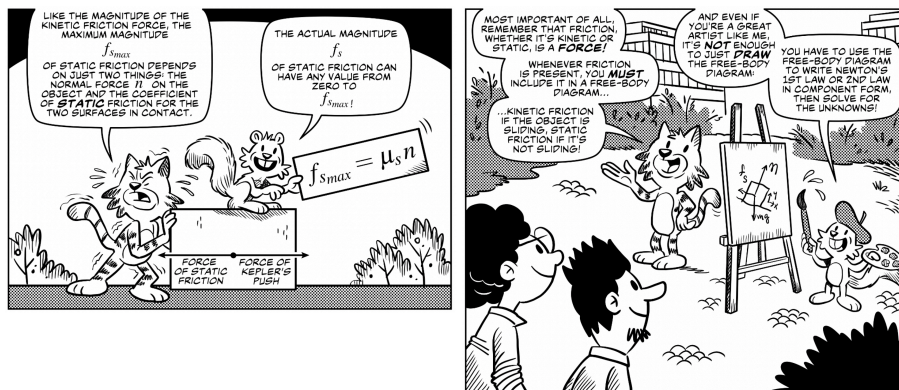


Figure 4 : Kepler the cat and the squirrel summarize key ideas about solving problems involving friction.

Student feedback and further work

We have informally surveyed 45 introductory physics students at high schools and universities in the United States to get their responses to *Physics Comics and Stories*. Their responses have been very positive, including the statements “The material is easier to grasp as it is like watching a conversation,” “I found the equations easy to follow because everything was big and labeled,” and “The diagrams presented through the art were extremely clear, and great physics models to learn from.” We plan to conduct more in-depth student surveys during 2025 in both the United States and Mexico, using both the English and Spanish versions of *Physics Comics and Stories*. (A French version is currently in preparation.)

At present there are three stories available or in preparation: a 36-page story on static and kinetic friction, a 14-page purely qualitative story that concentrates on misconceptions about how airplane wings produce lift, and a story on magnetic forces (in preparation). The first two of these stories are available in print format in both English and Spanish (Ramírez de Arellano 2024) and in electronic form on request. A fourth story on image formation by lenses is under development.

In addition, the characters from *Physics Comics and Stories* will appear in spot illustrations in the new edition of the introductory textbook *University Physics* (Young 2025, in press), where they will help students overcome common misconceptions and points of confusion (Figure 5).



Figure 5 : The squirrel and Kepler address why electric current in a wire is not a vector.

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