30.1: Introduction

We'll now consider an interesting dynamics problem not covered in most introductory texts, a rolling ball on a rotating, possibly tilted, surface. As we'll see, this tough sounding problem is not that difficult to solve using Newtonian methods, and leads to some surprising results. For example, a ball rolling on a steadily rotating horizontal plane moves in a circle, and not a circle centered at the axis of rotation. We'll prove this—and demonstrate it in class. Even more remarkably, if the rotating plane is tilted, the ball follows a *cycloidal* path, keeping at the same average height—not rolling downhill. This is exactly analogous to an electron in crossed electric and magnetic fields. One reason the rolling ball problems are generally avoided is that they do not readily lend themselves to Lagrangian analysis, but can in fact be solved quite quickly with a vectorized application of Newton's laws. The appropriate techniques are described in Milne's book *Vectorial Mechanics*, which we follow.