
Sensor Cart Physics - Preface

The lab investigations in this manual are exclusively designed to study introductory physics topics for students in grades nine through AP physics using the Vernier Go Direct® Sensor Cart and the Sensor Cart Accessories Kit. The Sensor Cart is equipped with three sensors: a motion encoder, a force sensor and a 3-axis accelerometer. The data from the Sensor Cart is transmitted via Bluetooth technologies to devices running Vernier Graphical Analysis™. The original free Graphical Analysis app can open the investigation student and teacher data files. However, the new subscription-based Graphical Analysis™ Pro app is required to view the synced video and data feature included with the data files.

Each of the investigations in this lab guide provides the students with a Title, Introduction, Research Question, plus an embedded event video to offer guidance for the experimental design. Computers with Adobe Acrobat Pro DC or MacBooks with Adobe Acrobat Reader DC installed are required to view the 3D media. Links to Internet background information are included in the Introduction which tie the topics to real-world phenomena. The links can serve as pre-lab assignments to introduce each investigation. The Research Question and Predicted Outcome are incorporated to engage student interest and provide a purpose for the investigation. Finally, the student pages use a template format to provide students a structure for reporting findings and writing conclusions.

The Teacher Notes section provides procedural suggestions, a graph displaying sample data, and calculations for each investigation. Teachers are encouraged to guide lab groups as they formulate their own design plans to provide a data-based response to the research question. Sample spreadsheets are included where appropriate for organizing data and performing calculations. Internet links to supplemental, often advanced, background information is included and intended to be shared with students at the teacher's discretion. The NGSS Science and Engineering Practice 3 encourages science educators to guide students as they "plan and carry out investigations." Thus, procedures listing step-by-step instructions have intentionally been excluded from the student lab notes.

The Vernier Go Direct® Sensor Cart is an innovative product enabling hands-on opportunities to explore basic physics principles. Investigations involving measures of position, velocity, acceleration and force are greatly facilitated with the low friction Sensor Cart. In addition, Graphical Analysis™ provides an intuitive tool to display and analyze the collected data. *Sensor Cart Physics* is designed to give high school physics students and teachers a stimulating structure to explore kinematics, dynamics and the conservation of energy and momentum concepts.

Sensor Cart Physics is dedicated to Dave and Christine Vernier. No two other individuals have had a greater influence over the past 40 years developing probeware technologies for science education. Certainly, without their innovative leadership the Vernier Go Direct® Sensor Cart and hence this book would not exist.

Respectfully,

Roger F. Larson