

Student Exploration: Fan Cart Physics

Gizmo Warm-up

The *Fan Cart Physics* Gizmo™ shows a common teaching tool called a fan cart. Place fan **A** on the cart and turn it on by clicking the **ON/OFF** button below.



- Look at the blue lines coming from the fan. In which direction is the air pushed? _____
- Press **Play** (▶) and observe the cart. In which direction does the cart move? _____

By blowing to the left, the fans exert a **force** on the cart that pushes it to the right. This illustrates **Newton's third law**: A force in one direction results in an equal force in the opposite direction.

- The **velocity** (v) of the cart is its speed and direction. Click **Reset** (↺). Select the **Graph** tab, and click **Play**. Does the velocity change or is it constant? _____

A change in velocity is called **acceleration** (a).

Activity B:

Newton's second law

Get the Gizmo ready:

- Click **Reset**.
- Set the **Initial velocity of cart** to 0.0 m/s.
- Place all three fans on the cart and turn them on.



Question: How do mass and force affect acceleration?

4. Form hypothesis:

- How do you think changing the **mass** of the cart will affect its acceleration? _____
- How do you think the number of fans will affect the cart's acceleration? _____

5. Experiment: Select the **BAR CHART** tab and turn on **Show numerical values**. For each of the situations below, record the acceleration of the cart. After recording acceleration **CLICK THE GRAPH** Tab and compare the shape of the graph for each trial. Then Select the **BAR CHART** tab and continue.

Load	Number of fans turned on	Acceleration
3 fans, 0 mass units	1	
3 fans, 0 mass units	2	
3 fans, 0 mass units	3	
3 fans, 2 mass units	1	
3 fans, 2 mass units	2	
3 fans, 2 mass units	3	

6. Analyze:

Look at the acceleration values.

- How did doubling the force affect the acceleration of the cart? _____
- Compare the first and third lines of data. How did tripling the force affect the acceleration of the cart? _____
- A cart with two mass units and three fans has twice the mass as a cart with just three fans. How did doubling the mass affect the acceleration of the cart? _____

Fan Cart Physics Answer Key

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Fan Cart Physics Answer Key :

Deep Learning in Introductory Physics Mark J. Lattery, 2016-10-01 Deep Learning in Introductory Physics Exploratory Studies of Model Based Reasoning is concerned with the broad question of how students learn physics in a model centered classroom The diverse creative and sometimes unexpected ways students construct models and deal with intellectual conflict provide valuable insights into student learning and cast a new vision for physics teaching This book is the first publication in several years to thoroughly address the coherence versus fragmentation debate in science education and the first to advance and explore the hypothesis that deep science learning is regressive and revolutionary Deep Learning in Introductory Physics also contributes to a growing literature on the use of history and philosophy of science to confront difficult theoretical and practical issues in science teaching and addresses current international concern over the state of science education and appropriate standards for science teaching and learning The book is divided into three parts Part I introduces the framework agenda and educational context of the book An initial study of student modeling raises a number of questions about the nature and goals of physics education Part II presents the results of four exploratory case studies These studies reproduce the results of Part I with a more diverse sample of students under new conditions a public debate peer discussions and group interviews and with new research prompts model building software bridging tasks and elicitation strategies Part III significantly advances the emergent themes of Parts I and II through historical analysis and a review of physics education research

ENDORSEMENTS In Deep Learning in Introductory Physics Lattery describes his extremely innovative course in which students ideas about motion are elicited evaluated with peers and revised through experiment and discussion The reader can see the students deep engagement in constructive scientific modeling while students deal with counter intuitive ideas about motion that challenged Galileo in many of the same ways Lattery captures students engaging in scientific thinking skills and building difficult conceptual understandings at the same time This is the double outcome that many science educators have been searching for The case studies provide inspiring examples of innovative course design student sensemaking and reasoning and deep conceptual change John Clement University of Massachusetts Amherst Scientific Reasoning Research Institute Deep Learning in Introductory Physics is an extraordinary book and an important intellectual achievement in many senses It offers new perspectives on science education that will be of interest to practitioners to education researchers as well as to philosophers and historians of science Lattery combines insights into model based thinking with instructive examples from the history of science such as Galileo s struggles with understanding accelerated motion to introduce new ways of teaching science The book is based on first hand experiences with innovative teaching methods reporting student s ideas and discussions about motion as an illustration of how modeling and model building can help understanding science Its lively descriptions of these experiences and its concise presentations of insights backed by a rich literature on education cognitive science and the history and philosophy of science make it a great read for everybody

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