LAB 6
Force and Acceleration & FBDs

OBJECTIVES

(1) Predict and measure the acceleration of a cart on a tilted air track.
(2) Practice drawing force diagrams and solving force problems using Newton's 2nd Law.
(3) Practice drawing free-body diagrams (FBDs).

EQUIPMENT

Pasco air tracks, carts, meter sticks, stop watch, lab jack, and various FBD stations.

THEORY

Read the abstract of the paper "Acceleration on an Inclined Plane" by DB Floogle and JW DePew for background theory. You will be testing Floogle and DePew's result

PROCEDURE

Part 1: Measuring the Acceleration

(a) Level an air track on your lab bench and measure the distance L between the feet of the track. Then put the single-foot end of the track onto a lab jack and raise the jack to a height h so the track angle is 3.5°. To find the required height h, sketch the triangle under the track and use trigonometry to solve for the height h, given $\theta = 3.5^\circ$ and L.

(b) Predict the acceleration a_{FD} of the cart for the 3.5° angle using Floogle and DePew's theory.

(c) Release the cart from rest and measure the time Δt it takes to travel the distance Δx to the end of the track. Repeat at least 25 times and list your values in a table in your lab notes. Be sure that each partner makes some of the time measurements.

(d) For each of your 25 times, use an appropriate kinematics equation to calculate the experimental acceleration a_{exp} from your values for Δx, v_i and Δt.

(e) From your 25 values of a_{exp}, calculate and average acceleration and a standard deviation. Express your results as $a_{exp} = a_{ave} \pm \sigma_a$.

(f) Setup the confidence interval $a_{ave} \pm \sigma_a$. *Is a_{FD} consistent within one standard deviation of your group's experimental measurements?*

Part 2: Force Diagrams

(a) Draw a sketch of the cart on the track and identify the forces acting on it. Choose a coordinate system oriented with the x-axis parallel to the track and the y-axis perpendicular to the track. Draw the force diagram for the cart.

(b) Use Newton's 2nd law to solve algebraically for the theoretical acceleration a_{thy} of the cart.

(c) Do you obtain the same formula as Floogle and DePew for the acceleration a_{FD}? If not, use your equation to predict an alternate theoretical acceleration.

(d) Compare your new theoretical acceleration with your group's results. That is, repeat part (1f) with your new theoretical acceleration.

Part 3: Drawing Free-body Diagrams

Follow the tactics below for drawing a Free-body Diagrams (FDB) for each of the setups in the lab:

- Identify all forces acting on the object.
- Draw a coordinate system. If those axes are tilted, for motion along an inline, then the axes of the FBD should be similarly tilted.
- Represent the object as a dot at the origin of the coordinate axes.
- Draw vector representing each of the identified forces. Be sure to label each force vector.

1. Air track cart moving on level track
2. Ladder leaning against wall
3. Tether tennis ball leaning against counter
4. Nail attached perpendicular to a magnet
5. Floating magnet
6. Cork in a bottle
7. Washer suspended with two strings
8. Tossed ball
9. Pasco cart on incline with two opposing springs