Physics 250 Laboratory:
Forces & Motion-Mythbusting[1] Edition
(Forces)

Score: _____ Section #:_____

Name:_____

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Name: _____

Lab-Specific Goals:

- To experimentally test some "myths" about forces & motion. You will need to design and execute experiments to test these myths and then analyze your results to determine if these myths are false ("busted"), true ("confirmed"), or maybe possible ("plausible").

Equipment List:

- Airtrack system with two gliders; gliders have hook at one end and rubber bands at other end; Airtrack system has pulley at one end.
- Photogate system (2 gates)
- String
- Mass hanger & mass set

Introduction:

In this experiment, you will test four "myths" about forces & motion. For each one, you will design an experiment and then analyze your results to determine if the "myth" is confirmed, busted, or plausible. People have puzzled over what causes motion for millennia and the understanding the correct relationship between forces and motion was the foundation for the scientific revolution of Galileo and Newton. Many different ideas about forces and motion are out there, and it's up to you to sort them out – which are true and which BUSTED!

[1] Inspired by the Discover Channel show "Mythbusters", which has no relationship to (or responsibility for) this laboratory or the Penn State physics department.

Introductory Activity: Measuring Glider Velocity

Set up the air track and level so that a glider placed at rest on the airtrack (with the air on) will stay at rest. (There is some bowing to the tracks, so it may not be possible to make it perfectly level over the entire length, but do the best you can.)

Now make sure that you know how to use the photogates in their two different modes (see the Acceleration of Gravity lab for more information about these two modes):

PULSE MODE (2 photogates): This mode measures the time between when one photogate is triggered and when the other photogate is triggered. It is good for finding the time the glider takes to get from one gate to another and thus finding the average velocity in that interval. (Have the memory switch to off.)

GATE MODE (1 or 2 photogates): This mode measures the time that one of the photogates is blocked. It is good for finding the time it takes the glider's "sail" (10 cm-long) to pass through the gate and thus in finding the velocity of the glider at the point on the track.

Collecting multiple time measurements in GATE mode:

1. Flip the memory switch to "On".
2. Release / push the glider (as appropriate for your experiment) so that it passes through the photogates.
3. The time displayed on the screen is the time that the first photogate triggered was blocked. (We'll call that Δt_1.)
4. Toggle the memory switch to "Read" and another time will be displayed. This time is the total time that the photogates were blocked, or $\Delta t_1 + \Delta t_2$, where Δt_2 is the time the second photogate triggered was blocked. (It can also be used for a single photogate that is blocked twice.)

Always press RESET between readings to zero the timer.

Before starting any of your experiments, make sure that you are able to use the photogates (one and two) and calculate the velocity of the glider from your measurements. Also make sure that the air track is level.

You have other equipment available to you for your experiments:

- You can hang a mass over the pulley at one end of the air track and connect that mass to glider with a string. (The force the hanging mass applies to the glider is not exactly the same as the weight of the hanging mass as you'll discover next week, but for our purposes today we can ignore this difference.)
- You can also apply a force on the glider with your hand.
- If you collide any gliders together, be sure that the rubber-band ends of each glider collide.

The four "myths" you will be testing about forces & motion are:

1) A constant (non-zero) net force causes constant velocity motion & constant velocity motion requires a (non-zero) net force acting on the object.
2) Velocity is always proportional to the force acting on it *at that instant*.
3) An object can move in the *opposite* direction of the net force acting on it.
4) In a collision between two objects (one moving and one at rest), only the object that is getting hit (the one at rest) has a force acting on it.

For each "myth", you need to:

(1) Develop and carefully describe a procedure you will use to test the "myth". (None of the myths should require a complex setup or procedure.) Note: one way a myth can be busted is by demonstration of a counter-example, so you may not need to collect numerical data to bust/confirm every myth.
(2) Collect data and record in a data table (if appropriate). You should only need a few runs for each myth. The data may be numerical and/or observations you have made during your experiments.
(3) Analyze your data and observations to determine whether the "myth" is "busted", "confirmed" or "plausible". Carefully explain your reasoning based on your data/observations for your statement about each myth.

For one of your myths, you must graph your data in a way that is meaningful for the experiment using the graph paper at the end of the lab report and then interpret what the graph says about the "myth". On your graph, you must draw a dotted line showing what the myth predicts the graph should look like. Then discuss whether the data matches the prediction of the myth.

When you are done with all four "myths", you will record your answers on the class answer sheet and the front of the room.

Myth #1: A constant (non-zero) net force causes constant velocity motion & constant velocity motion requires a (non-zero) net force acting on the object

This myth is: _____ (Busted, Confirmed, Plausible)

In the space below, describe the procedure you will use to test this myth. Include a sketch of your experimental apparatus (e.g., where the glider will start, where the photogate(s) will be positioned, etc.). Be sure to indicate what measurements you will make and what calculations you will do.

In this space, make a data table for your measurements and calculations (if appropriate) or record your observations in a systematic way. *Be sure to make several "runs" for each experiment!*

In the space below, describe your data analysis and what conclusion you came to based on your analysis.

Myth #2: Velocity is always proportional to the force acting on it at that instant

This myth is: _____ (Busted, Confirmed, Plausible)

In the space below, describe the procedure you will use to test this myth. Include a sketch of your experimental apparatus (e.g., where the glider will start, where the photogate(s) will be positioned, etc.). Be sure to indicate what measurements you will make and what calculations you will do.

In this space, make a data table for your measurements and calculations (if appropriate) or record your observations in a systematic way. *Be sure to make several "runs" for each experiment!*

In the space below, describe your data analysis and what conclusion you came to based on your analysis.

Myth #3: An object can move in the *opposite* direction of the net force acting on it

This myth is: _____ (Busted, Confirmed, Plausible)

In the space below, describe the procedure you will use to test this myth. Include a sketch of your experimental apparatus (e.g., where the glider will start, where the photogate(s) will be positioned, etc.). Be sure to indicate what measurements you will make and what calculations you will do.

In this space, make a data table for your measurements and calculations (if appropriate) or record your observations in a systematic way. *Be sure to make several "runs" for each experiment!*

In the space below, describe your data analysis and what conclusion you came to based on your analysis.

Myth #4: In a collision between two objects (one moving and one at rest), only the object that is getting hit (the one at rest) has a force acting on it

This myth is: _____ (Busted, Confirmed, Plausible)

In the space below, describe the procedure you will use to test this myth. Include a sketch of your experimental apparatus (e.g., where the glider will start, where the photogate(s) will be positioned, etc.). Be sure to indicate what measurements you will make and what calculations you will do.

In this space, make a data table for your measurements and calculations (if appropriate) or record your observations in a systematic way. *Be sure to make several "runs" for each experiment!*

In the space below, describe your data analysis and what conclusion you came to based on your analysis.

Discussion:

For each of the myths addressed above, give an argument from the physics we have studied already for why it is correct ("confirmed") or incorrect ("busted"):

1) A constant (non-zero) net force causes constant velocity motion & constant velocity motion requires a (non-zero) net force acting on the object.

2) Velocity is always proportional to the force acting on it *at that instant.*

3) An object can move in the *opposite* direction of the net force acting on it.

4) In a collision between two objects (one moving and one at rest), only the object that is getting hit (the one at rest) has a force acting on it.

Graph for Myth #_____

Be sure to label the graph and use the graph in your data analysis & discussion for this myth.

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