The Role of the Lab Practicum in Modeling

The lab practicum, as advocated by Jon Barber and Henry Ryan, serves as an excellent deployment activity for the application and reinforcement of the models and conceptual tools developed during the modeling cycle. The lab practicum involves giving students a laboratory-based problem. This lab problem should yield such clean results that students can be evaluated based upon their use of basic models to arrive at correct solutions. This can be done with individual students, small groups, and (as in the Barber/Ryan approach) with whole classes. The latter approach has the added benefit of helping to build strong teamwork skills among classmates. The lab practicum is an effective method of model deployment and represents "authentic assessment" at its best.

Henry Ryan and Jon Barber are two high school physics teachers from Mounds View High School in New Brighton, Minnesota. They have produced a guide for the use of lab practica in the high school physics classroom called **Practicums for Physics Teachers**. This manual includes practica from the topics of Light & Optics (5), Circular Motion (2), Projectiles (2), Static Equilibrium (1), Momentum and Energy (6), and Electricity (2). This guide is excellent in that it not only explains the rationale for using practica in high school physics, but also gives fairly detailed descriptions of the equipment and set up required for the practica that they have developed. It also includes sample data and suggested solutions for the practica included in the book. After having used the practica from the Barber/Ryan manual, it is not hard to think of problems which can serve as the basis for other practica.

The lab practicum begins with the teacher posing a problem to the whole class as a group, and providing the laboratory equipment associated with the problem. The class is then required to work on the problem and to reach consensus as to the solution of the problem within a specified amount of time. They must then present and defend their solution in front of the teacher. As students defend their solution, the teacher may question any member of the class. The whole class either passes or fails the practicum based on whether or not their solution gives results that are within a reasonable range of the "correct" answer as predetermined by the teacher. Mother Nature should be the ultimate judge of the "correctness" of the solution. The teacher should be careful to choose lab problems which yield consistent results and error ranges which are reasonable for the given experiments. Barber and Ryan use the practicum at the end of a unit in lieu of the unit reviews that they had given in the past.

The whole class practicum model of Barber and Ryan is a little uncomfortable for many teachers at first because we are usually not used to grading the group as a whole. The benefits of such an approach, however, make trying this approach worthwhile. Students learn to work cooperatively as a team and are very supportive of each other as they begin to realize the value of the contributions of <u>each</u> member of the group to the final solution of the problem. Since any member of the group can be called upon to defend any part of the solution, weaker students are motivated to really understand the solution of the problem. Stronger students are equally motivated to help those students understand. When problems are near the limit of difficulty solvable by your most capable students, this model is particularly effective.

For easier problems, the practicum could be designed such that students work alone, in pairs, or in small groups. The practica listed on the subsequent pages include some that are appropriate for individuals (pendulum period, force table), some that are probably better for pairs or small groups (over the edge), and several that are probably best done with the whole class (exploding carts). Some of these practica could be used any of the three ways, depending on the level of the class or teacher preference.

The suggested practica which appear on the following pages have been developed by many different folks, and similar practica have probably been independently developed by teachers not credited.

- * Developed by Robert Mullgardt and Rex Rice, Clayton High School, Clayton, MO
- ** Developed by Rex Rice, Clayton High School, Clayton, MO
- *** Developed by Keith Canham and Rex Rice, Mtn. View High School, Mesa AZ
- † Appears in Lab Practicum Handbook, Jon Barber and Henry Ryan, Mounds View High School, Mounds View, MN.

A detailed description of the helicopter practicum is included at the end of the document. It parallels the style of the Barber/Ryan guide, which you should seriously consider acquiring if such detail is helpful to you.

They can be reached at: Mounds View High School
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New Brighton, MN 55112
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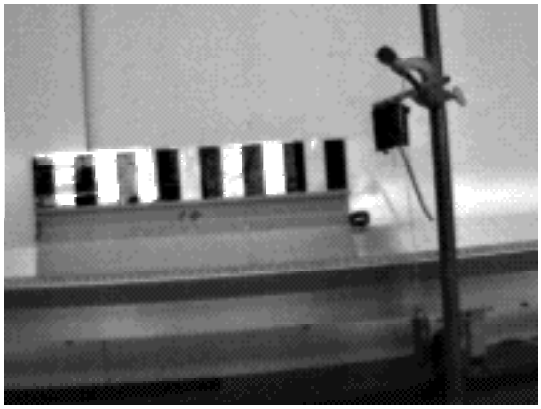
TITLE: Motion on an Inclined Air track*



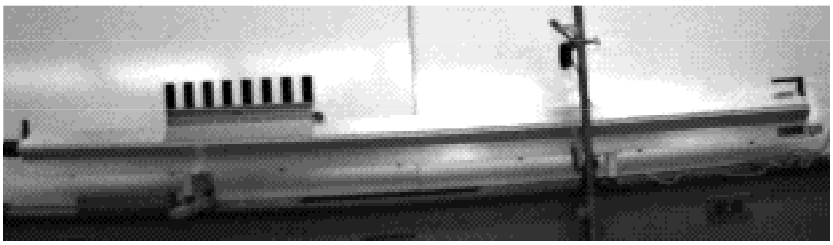
MODEL DEPLOYED:

Particle Undergoing Uniformly Accelerated Motion (Unit III)

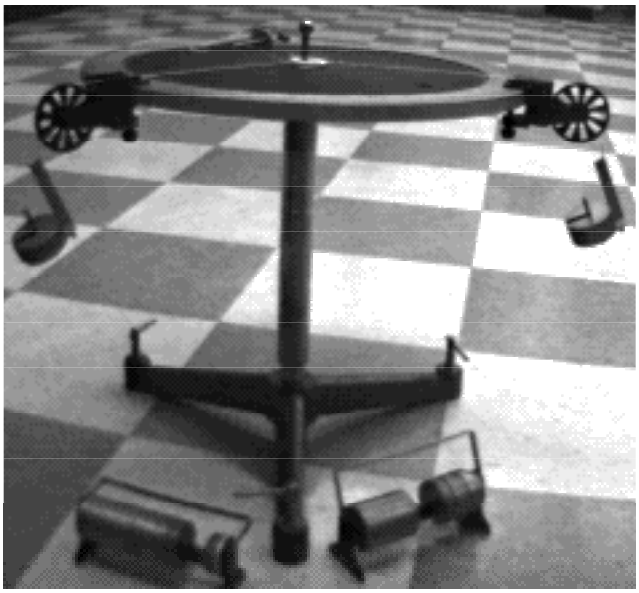
PROBLEM: Predict the time for a 2.5 cm wide picket "flag" to pass through the photogate along an inclined air track after traveling 1.00 m from rest. Glider with picket fence attached will have first traveled along the same track through a photogate, producing a velocity vs. time graph.

EQUIPMENT:

Cork Board
semicircular refraction dish
semicircular glass prism
laser
sighting pins
cardboard mask
2° wide target cardboard strip
polar graph paper



TITLE: Force Table



MODEL DEPLOYED:

Free Particle Model (Unit IV)

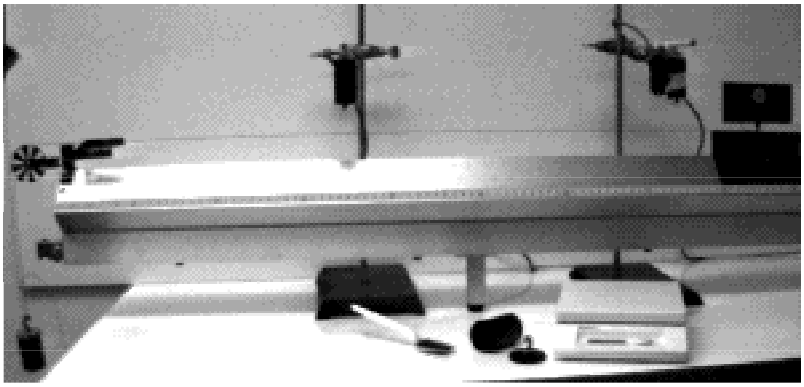
PROBLEM:

Determine the third force required to balance two known forces.

EQUIPMENT:

Force table with low friction pulleys
Mass hangers
Mass set

TITLE: Over the Edge**



MODEL DEPLOYED:

Constant Force Particle Model (Unit V)

PROBLEM:

Determine the mass of a falling weight required to cause an air track glider to accelerate at a predetermined value on a level air track.

EQUIPMENT:

Air track with air source
Glider
Low friction Pulley
2 photogates or "Smart Pulley"
Balance
Hooked film canister
Lead shot

TITLE:

Horizontally Launched Projectiles***

MODEL DEPLOYED:

Particle Models in Two Dimensions (Unit VI)

PROBLEM:

Determine the landing position of a ball released horizontally from a launching device.

EQUIPMENT:

Launching apparatus
Steel ball
2 photogates
Meter stick
Plumb bob
Carbon Paper

TITLE: Elastic Potential Energy†

MODELS DEPLOYED:

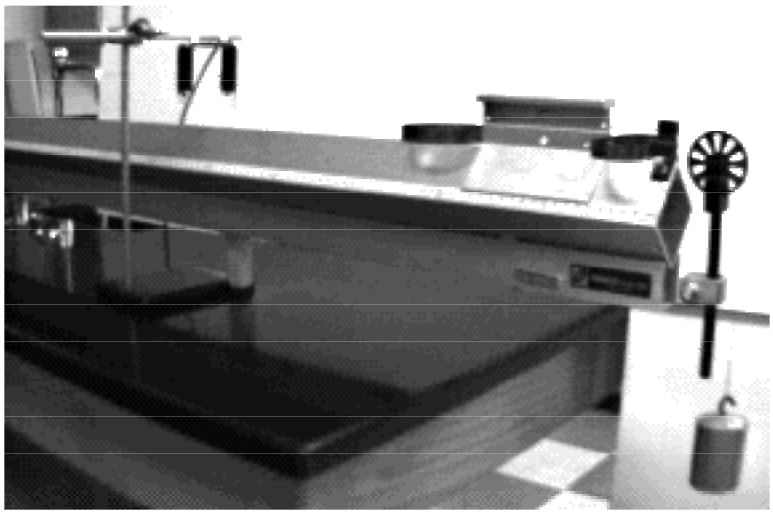
Work by a Nonconstant Force
Conservation of Energy (Unit VII)
Constant Velocity Particle Model (Unit II)

PROBLEM:

Determine the time for a glider to pass through a photogate after being launched by a Hookean Spring.

EQUIPMENT:

Air track with air source
Glider with circular spring bumper
Photogate
500 g hanging mass
String
Matches



TITLE: Flying Pucks†

MODELS DEPLOYED:

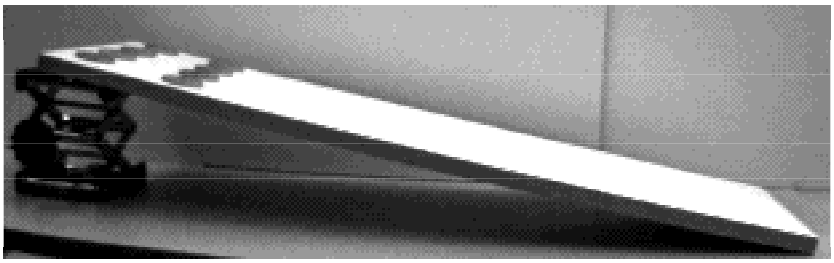
Central Force Particle Model (Unit VIII)
Free Particle Model (Unit IV)

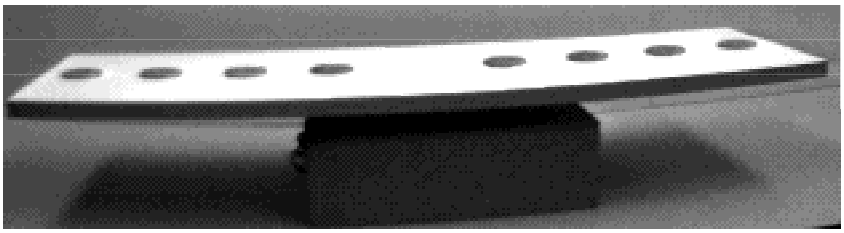
PROBLEM:

Determine which pucks sitting on a platform on a rotating turntable will slide off of the platform as the turntable approaches full speed.

EQUIPMENT:

Turntable
Plastic laminated shelf board
8 pucks
Stopwatch
Lab jack





TITLE: Helicopter Practicum**

MODELS DEPLOYED:

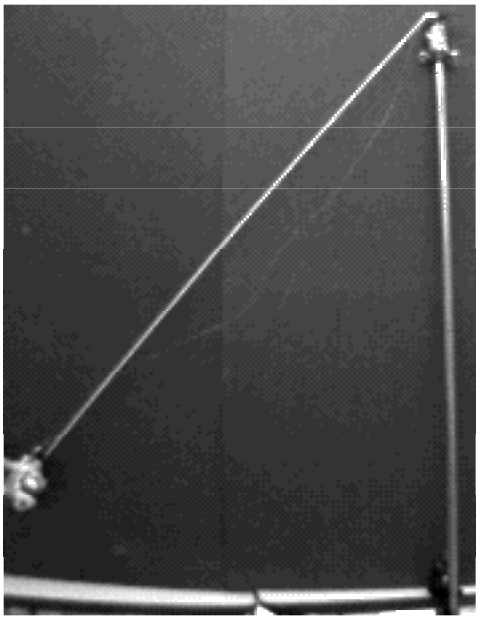
Central Force Particle Model (Unit VIII)
Constant Force Particle Model (Unit IV)

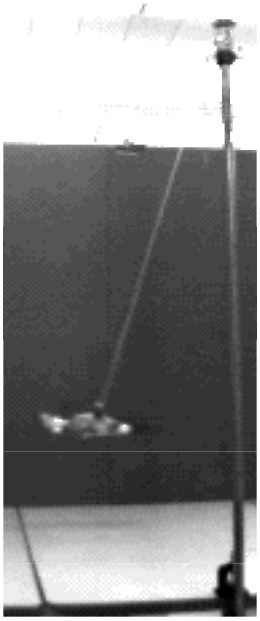
PROBLEM:

Given the ability to measure variables associated with the angle of a string causing a toy helicopter (or airplane) to undergo uniform circular motion, determine the time required to complete 30 revolutions.

EQUIPMENT:

Toy helicopter
Stopwatch
Table clamp and rod
Meter stick





TITLE: Two Dimensional Collision†

MODELS DEPLOYED:

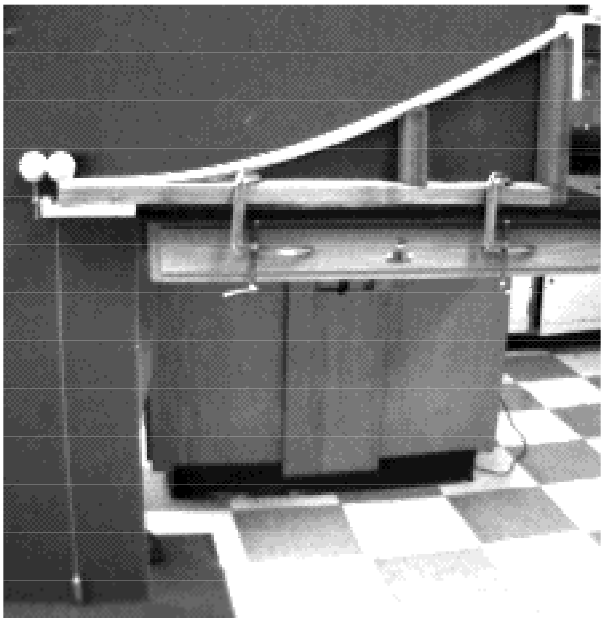
Impulsive Force Particle Model (Unit IX)
Particle Models in Two Dimensions (Unit VI)

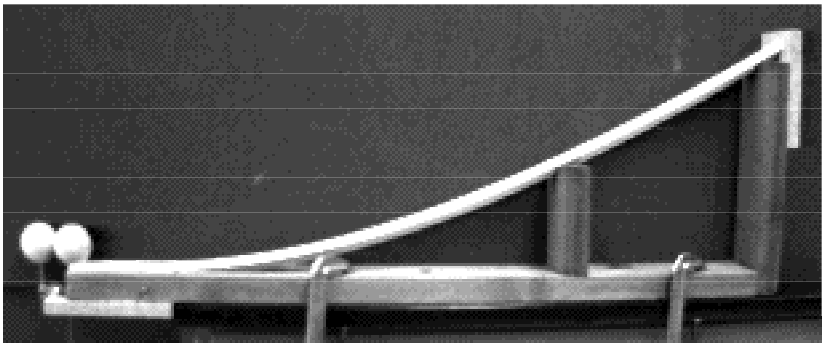
PROBLEM:

Determine the landing position of a single ball released from a ramp given the landing position of two balls after a collision.

EQUIPMENT:

Large scale two-dimensional collision apparatus
2 billiard balls (or other large hard balls)
Meter sticks
Plumb bob
Carbon paper



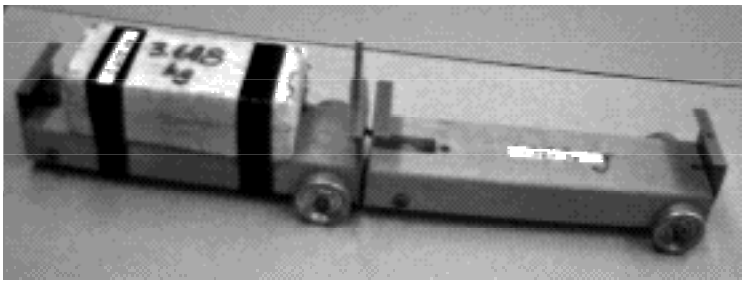


TITLE: Exploding Carts†

MODELS DEPLOYED:

Impulsive Force Particle Model (Unit IX)

Constant Velocity Particle Model (Unit II)

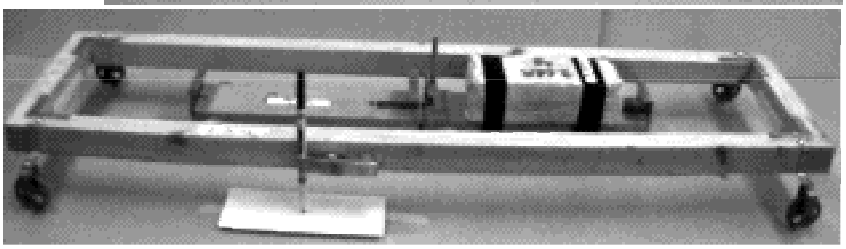


PROBLEM:

Determine the length of the line drawn by a pen attached to a frame after an explosion of two dynamics carts which stick to the frame.

EQUIPMENT:

2 dynamics carts with velcro, one spring loaded
Freely gliding frame with velcro
meter stick
felt tip pen



TITLE: Period of a Simple Pendulum

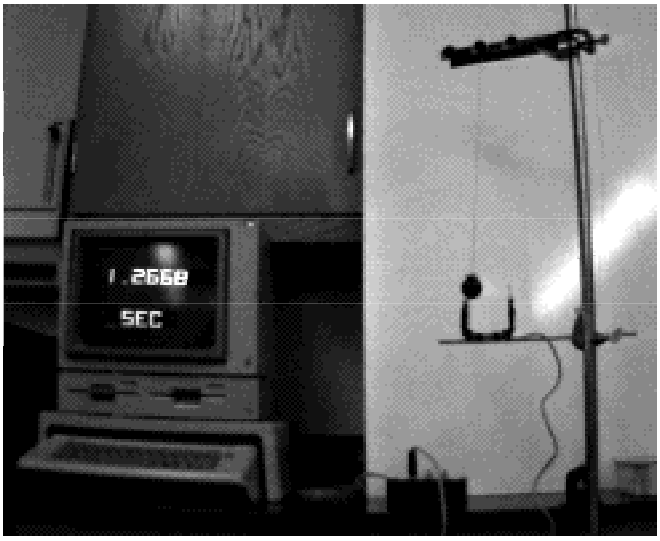
TOPIC: Pendulum Motion

PROBLEM:

Design and build a pendulum which will have a predetermined period.

EQUIPMENT:

Drilled ball
String
Pendulum clamp
Ringstand
Meter stick
Stopwatch or photogate with pendulum timer



TITLE: Period of a Hookean Spring/Mass System

TOPIC: Periodic Motion, Simple Harmonic Motion

PROBLEM:

Design and build a spring based system which will have a predetermined period.

EQUIPMENT:

Hookean spring
Mass hanger
Mass set
Ringstand
Stopwatch