CO2 Car Lab

Text:
Volume: 1 Chapter: 1
Unit number: _____ Title of unit: ____________
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Attach the Following Documents:

1. **Lab Instructions**
2. **Student Handout(s)**
3. **Rubric and/or Assessment Tool**

Short Description (Be sure to include where in your unit this lab takes place):

Students will use supplied CO2 car kits to build a CO2 powered race car. Students will race cars on a track against each other to determine an overall winner for design, speed and most accurate calculations of car velocity and scaled speeds. Students design and construct a CO_2 dragster and measure the mass of the vehicle, recording the mass in a data table. Using a launch and timing system, the dragster is tested using CO_2 cartridges and is timed over a given distance. The average velocity is calculated using the formula: v = d/t [velocity (meters/sec) = distance (meters) divided by time (sec)].

From the recorded mass and time and the calculated velocity data, determine what relationship dragster mass has with average velocity.

CO2 Car

LAB PLAN

TEACHER: *(Teacher Prep/Lab Plan)*

- **Lab Objective**
  Determine the relationship between CO2 car's mass and its velocity.
- **Statement of prerequisite skills needed** *(Vocabulary, Measurement Techniques, Formulas, etc.)*
  Scaled Drawings, Metric Measurements, Time Measurements,
- **Vocabulary**
  Acceleration: is the rate at which velocity changes with time
  $$\bar{\mathbf{a}} = \frac{\Delta \mathbf{v}}{\Delta t}.$$
  Speed: is the magnitude of its velocity (the rate of change of its position);
  $$v = \frac{d}{t}$$
  Velocity: the speed of an object and a specification of its direction of motion

$$\bar{\mathbf{v}} = \frac{\Delta \mathbf{d}}{\Delta t}.$$

Mass: can be defined as a quantitative measure of an object's resistance to acceleration

$$\boldsymbol{F} = M\boldsymbol{\alpha}$$

Kinematics: is the branch of classical mechanics that describes the motion of points, bodies (objects) and systems of bodies (groups of objects) without consideration of the causes of motion

Inertia: is the resistance of any physical object to a change in its state of motion or rest, or the tendency of an object to resist any change in its motion

Thrust: is a reaction force described quantitatively by Newton's second and third laws. When a system expels or accelerates mass in one direction, the accelerated mass will cause a force of equal magnitude but opposite direction on that system.

Friction: is the force resisting the relative motion of solid surfaces, fluid layers, and material elements sliding against each other

Drag: the force which resists motion of an object through a fluid or air

- **State Standards addressed:** *(Highlight "Green" Standards, you may use your District's Power Standards if applicable)*
  - **Math:**

  A1.1.A: Select and justify functions and equations to model and solve problems

  A1.1.B: Solve problems that can be represented by linear functions, equations, and inequalities

  A1.2.B: Recognize the multiple uses of variables, determine all possible values of variables that satisfy prescribed conditions, and evaluate algebraic expressions that involve variables

  A1.8.A: Analyze a problem situation and represent it mathematically

  A1.8.B: Select and apply strategies to solve it mathematically

  - **Reading:**
  - **Writing:**
  - **Leadership:**
  - **SCAN Skills/Workplace Skills:**

- **Teacher Preparation:** *(What materials and set-up are required for this lesson?)*
  - Materials:

  CO2 car kits, 1 per student

  Stop watches, 1 per 2 students

  CO2 car track w/start line and finish line

  Graph paper for scaled designs

  Student handout and rubric

  - Set-Up Required:

  Students will have time to design their cars and to cut out and shape their wood blocks into car shapes. This will be over the course of a week or more. When cars are finished students will take turns racing their cars and calculating speed, velocity and relative data to complete handout.

- **Lab Organizational Strategies:**
  - Grouping/Leadership/Presentation Opportunities:

  Students who are familiar with wood working tools, or who are more comfortable with the tools will assist other students who aren't as confident with machinery.

  - Cooperative Learning:

  Students will help time each-other's cars and assist one another with calculations.

  - Expectations:

Every student will design, build and race a CO_2 car. They will collect and record data to be used to fill in a handout and calculate answers to questions that pertain to their car's performance.

- Time-line:

3 weeks

- **Post Lab Follow-Up/Conclusions** *(to be covered after student completes lab)*
  - Discuss real world application of learning from lab:
    How would the information and calculations we used in this lab be useful to us in our daily lives?
  - Career Applications:
    What careers could use the information we learned from this lab?
    How can what we learned in this lab be applied to other classes?
  - Optional or Extension Activities:

Car Design and Build Rubric

Activity	Doesn't Meet Standard (1)	Approaching Standard (2)	Meeting Standard (3)	Exceeding Standard (4)
Initial Car Designs	Less than 5 cars designed. No thought was applied to final project.	Less than 10 but more than 5 car designs were presented. Little thought to final design was applied.	15 or less, but more than 10 car designs were presented. Thought of final car design was evident.	More than 15 original designs were presented. Extra thought was used to ensure final project meets all requirements.
Final Car Design	Car doesn't match design	Car is similar to design but is not a match.	Car matches design.	Great care was taken to match car to design.
Shaping/Sanding	Many saw marks left. Corners not rounded.	A few saw marks left. Some corners not rounded.	Most saw marks were removed. Some corners not rounded.	All saw marks were removed. All corners were rounded.
Painting	No finish was applied.	Finish was applied poorly. Signs of dripping, bare spots, dull look or incomplete	Some signs of dripping, blank spots or dull paint.	Shiny paint, no drips or blank spots.
Detailing	No detailing applied to car at all.	Some detailing in the form of hand painting	Hand painted details, added some extra materials, objects or pictures	Very nicely detailed by hand. Lots of added materials, objects or pictures

Car Speed and Performance Rubric

Activity	Doesn't Meet Standard (1)	Approaching Standard (2)	Meeting Standard (3)	Exceeding Standard (4)
Race	Car was not raced successfully. (Did not finish race, if not attempt was made to race student will receive a 0.)	Car raced successfully. Won at least 1 race.	Car raced successfully. Won at least 2 races.	Car raced successfully. Won the tournament bracket.
Racing Longevity	Car Raced 1 successful race.	Car Raced 2 successful races.	Car Raced 3 successful races.	Car Raced 4+ successful races.
Calculations of Car Speed	Student did not complete speed calculations.	Student did not accurately determine speed of car mathematically.	Student accurately determined speed of car mathematically.	Student was highly accurate in determining speed of car mathematically.
Car Speed	Marks from saw and file were not removed. Step 1 sanding is poor.	Some saw/ file marks were evident. Step 2 sanding is poor.	Most saw/ file marks were removed. Step 3 sanding is unfinished.	All saw/ file marks were removed. Step 3 sanding is complete.
Pre-Race Design Check off	Pre-Race Design Check Off was not completed. (If no work was done to the Pre-Race Design Check Off the student will receive a 0.)	Pre-Race Design Check Off was not complete or accurate.	Pre-Race Design Check Off was completed and accurately represents car design.	Pre-Race Design Check Off was completed with high amount of accuracy with thought of how each step effected final project.

CO2 Dragster Unit

Determining Kilometers per Hour (KPH)

When given the race time of a car in seconds and the distance traveled, follow the steps below to figure out a dragster's KPH.

1. Write down your Elapsed Time (ET) in seconds

   Time in Seconds__________

2. Write down your reaction time in seconds

   Time in Seconds_________

3. Subtract Reaction time from ET.

   Time in Seconds__________

4. Divide the length of the track (_____ meters) By your race time (this is how many meters per second your car traveled.)

   Meters per Second_________

5. Multiply that number (Meters per second) times 60 to get the Meters per minute.

   Meters per minute_________

6. Multiply that number (Meters per minute) times 60 to get Meters per hour.

   Meters per hour___________

7. Divide that number (Meters per hour) by 1000 (the number of Meters in a Kilometer to get Kilometers per Hour (KPH)

   Kilometers per Hour_______