CO_2 Cars For Principles of Technology

Purpose
The purpose of the unit is for students to learn basic science skills, problem solving skills, and how to work together on a project, as we cover linear speed, average speed, and linear acceleration, and the formulas used to find them.

Timeline
Day 1 – Introduce speed, acceleration, and work on the Carl Lewis Activity
Day 2 – Go over the packet, surf the internet for design ideas, draw 3 sketches of possible cars. Choose a design, start preliminary drawing.
Day 3 – Finish preliminary drawing, begin shaping wooden blank.
Day 4 – Finish making the car, paint, add wheels etc.
Day 5 – Race, worksheet, and final drawing

Pages in this packet

Assignments
#1: Pursue several CO_2 car internet sites to familiarize yourself with CO_2 car design. Review the specifications sheet (Pages 2-3) and then draw three sketches of possible CO_2 car designs that you might use **(10 points)**.
#2: Choose a design and make a preliminary drawing of the car you want to make on graph paper. The preliminary drawing should be dimensioned and should have a top view and a side view. Make a copy of this drawing (you will turn one drawing in and use the other when cutting out your car) **(10 points).**
#3: Follow the steps on page 4 to make your CO_2 car. Detailed instructions can be found in the teacher's binder or on internet sites. The car will be graded using the rubric on page 5 **(70 points).**
#4: Racetime **(20 points)**
#5: Final Drawing: Dimensioned, Top and side view **(10 points)**.
#6: POT Calculations worksheet **(15 points).**

Total: 135 points

CO2 Car Specifications

REGULATIONS

A. Each entry must be submitted with a full-size metric drawing of the completed vehicle. A two-view (top and side) drawing with metric dimensions is made on paper no larger than B-size drawing paper. Drawings are developed using standard engineering practices and procedures. The drawing may be produced using traditional drafting methods or CAD. The title block includes only the participant's "entry number" that is assigned at registration time and is placed on the entry and drawing during check in.
B. The official distance between the start line and the finish line on the race track is twenty (20) meters.
C. Dragsters that do not meet the following specifications/tolerances are disqualified from the race.

Dragster Body

DB1. One piece, all-wood construction. Any type of lamination will result in disqualification. No add-ons such as body strengtheners, fenders, plastic canopy, exhausts, or air foils may be attached to or enclosed within the vehicle. Fiberglass or shrink wrap are considered body strengtheners and cannot be used on car body or wheels for any reason. Two (2) or more like or unlike pieces of wood glued together are not considered one-piece, all-wood construction.

	MINIMUM	MAXIMUM
DB2. Body length	200mm	305mm
DB3. Body height with wheels		75mm
DB4. Body mass (completed car without CO_2)	55g	
DB5. Body width at axles, front and back	35mm	42mm
DB6. Vehicle total width (including wheels)		90mm

Axles/axle holes/wheelbase

A1. Dragsters must have two (2) axles per car, no more.

A2. Bottom of axle hole above bottom of car	5mm	10mm
A3. Rear axle hole from rear of car	9mm	100mm
A4. Wheelbase (axle distance apart at farthest points)	105mm	270mm

A5. Bearings, bushings, and lubricants may be used.

Spacer washer/clips

S1. Spacer washers……..8
S2. Axle clips……..8
S3. Silicone or any other type of glue/adhesive may not be used in place of wheel clips to hold wheels or axles in place.

Power Plant (CO_2 cartridge hole)

P1. The power plant hole must be at the farthest point at the rear of the car and must be drilled parallel to the racing surface to assure proper puncture of the CO_2 cartridge. A minimum of 3mm thickness around the entire power plant hole must be maintained on the dragster for safety.

P2. Hole depth…….50mm…….52mm
P3. Safety zone thickness…….3mm
P4. Chamber diameter…….19mm……20mm
P5. Lowest point of chamber diameter to race surface (with wheels)……26mm..……40mm

Eye screws

ES1. Dragsters must have two screw eyes per car that meet tolerances, no more. Screw eyes must not make contact with the racing surface. The track string must pass through both screw eyelets, which are located on the centerline of the bottom of the car. Glue may be used to reinforce the screw eyes. It is the responsibility of the car designer/engineer to see that the eye screw holes are tightly closed to prevent the track string from slipping out. As with all adjustments, this must be done prior to event check in.

ES2. Inside diameter…….3mm…….5mm
ES3. Distance apart (at the farthest points)……150mm……270mm

Wheels

W1. A dragster must have four (4) wheels, no more. Two (2) wheels must meet rules W2 and W3. The other two must meet rules W4 and W5. All four wheels must touch the racing surface at the same time. All wheels must roll. Wheels must be made entirely from plastic. Dimensions must be consistent for the full circumference of the wheel.

W2. Front diameter……..32mm……37mm
W3. Front width (at surface contact point)……2mm…….5mm
W4. Rear diameter……30mm……40mm
W5. Rear width (at surface contact point)……15mm……18mm

D. No repair or maintenance is allowed after the entries have been registered. Any entry damaged during the race is evaluated by the event coordinator to determine whether or not the vehicle is allowed to race again. In the event that the vehicle is damaged by the conference personnel, the event coordinator rules as to whether the vehicle may be repaired by the student entering the vehicle. This is the only reason a student is allowed to touch his/her vehicle after registration. Undamaged wheels that come off during the event may be replaced as determined by the event coordinator. Damaged wheels may not be replaced.
E. National TSA provides all CO2 cartridges for the race.

Steps for designing a CO2 Car

The following is a suggested sequence of steps for designing and building your CO2 car. See the web site http://www.cooz.com/co2/welcome.htm for detailed instructions on designing your CO2 car. Note: the instructor also has a binder available that has this information.

Step #1	Rough Sketch on graph paper
Step #2	Final Drawing (top & side views) / photocopy for template
Step #3	Drill axle holes (attach template/drill holes carefully)
Step #4	Use bandsaw to cut out car (cut side (save pieces), reassemble, cut top)
Step #5	Shaping (use a rasp, file, and sandpaper to finish shaping the car)
Step #6	Painting (prime, dry, sand, paint)
Step #7	Axles (½ " wider than the car, sand-polish)
Step #8	Axle bearings (cut straw to exact width of car, glue in place)
Step #9	Eye hooks (centerline of car, glue, adjust eye)
Step #10	Assembly (brass washer?)
Step #11	Details
Step #12	Testing (test the wheels for straightness and for friction)
Step #13	Race time

Rubric For Grading CO_2 Cars (70 points)

	Can't see over the dashboard **(6 points)**	Got your learners permit **(8 points)**	Drag Racing Champion **(10 Points)**
Body is within specifications	More than two mistakes	1-2 mistakes	No mistakes
Sanding	Lightly sanded, rough surface with many imperfections	Sanded but with some imperfections	No sanding marks or imperfections easily seen.
Paint Job/ Finish	Not painted or finished	Sloppy painting, no finish coat	Nice paint job with a finish coat.
Design principle of mass taken into consideration	Large, bulky and heavy, over 200 grams (W/O cartridge)	Much of the mass has been removed but still somewhat heavy, 100 – 200 grams (W/O cartridge).	Most of the mass has been removed yet car is still strong enough not to break during racing, 55-100 grams (W/O cartridge)
Design principle of aerodynamics taken into consideration	Block shaped, difficult for air to flow over the car, results in much turbulence.	Slightly curved shape, air can flow over the car but still some evidence of turbulence.	Gradual curves, air can easily flow over the car, very little turbulence.
Completion of project	Project was not completed on time	Project was completed on time but was hastily put together, lack of quality work.	Project was completed on time. Evidence of craftsmanship and quality work.
Movement of car	When rolled on a surface the wheels bind and the car veers off to one side.	When rolled on a surface little binding of the wheels, the car slightly veers off to one side.	When rolled on a surface the wheels do not bind, car rolls straight ahead.
Rubric For Grading Sketches / Drawings (20 points)			
Sketches /Thumbnails	1 sketch that is hastily done, hard to determine design of car.	2 or more sketches of possible car design, hastily done, hard to determine design of the car.	3 or more sketches of possible car design, nicely drawn, easy to determine design of the car.
Preliminary and Final Drawing	Drawing completed (hand or CAD) but not with multiple views, few or no dimensions given.	Drawing completed (hand or CAD). Has multiple views, few dimensions given.	Drawing completed (hand or CAD). Has multiple views, many dimensions given.

CO2 Car - Principles of Technology Calculations Worksheet

Three Major Assumptions
1) Minimal Friction
2) Minimal Drag
3) The CO2 cartridge runs out at the finish line

In order to determine the force of a CO2 cartridge, there are several things you will need to determine.
- Mass of the car (with the CO2 Cartridge) = _____gm_____
- Distance that the car had to travel = _____m_____
- Time that it took the car to travel the distance = _____seconds___

Note: At the end of this activity turn in this sheet as well as your sketches, preliminary drawing, final drawing and your CO2 car to be graded

Calculations (3 pts each)

1) Calculate the average acceleration of the car. a = _____m/s^2_____

2) Calculate the final speed of the car in meters/sec V_f = _____m/s_____

3) Determine the final speed of the car in mph. V_f = _____mph_____

4) Determine the force (in Newtons) exerted by the CO2 cartridge on the car.

F = _____ N

Note: If the force was 2 newtons then this means that enough force was exerted on the car to accelerate a 2 kg object 1 meter/sec in 1 second

5) Determine the average speed of the car in mph. V_{av} = _____mph_____

Race Time (2 possible grading schemes)

<1.1	20 pts	1st Place	20 pts
1.1 - 1.15	18 pts	2nd Place	18 pts
1.16 - 1.2	17 pts	3rd Place	17 pts
1.21 - 1.3	16 pts	4th & 5th Place	16 pts
1.31 - 1.4	15 pts	6th thru 8th Place	15 pts
1.41 - 1.50	14 pts	9th and greater Place	13 pts
1.51+	13 pts		

Time 1 = _____ seconds Time 2 = _____ seconds

Point Total	**Points Received**
☒ Sketches (10 points)	_____
☒ Preliminary Drawing (10 points)	_____
☒ Car Design (See Rubric) (70 points)	_____
☒ Racetime (20 points)	_____
☒ Final Drawing (10 points)	_____
☒ POT Calculations Worksheet (15 points)	_____
Total: 135 points	_____