Safegg Cars
a design challenge exploring momentum, impulse, inertia and forces

Central Question: Can you build a paper car strong enough to protect a raw egg during a head-on collision?

Knowledge Probe: (15 points)

What is momentum and impulse?
How does inertia affect passengers in a car?
How can Newton's Laws of Motion be applied to a moving vehicle and its passengers?
What forces are exerted on passengers in a moving vehicle while it's moving and when it's stopped?
What engineering and design features determine a vehicle's crashworthiness?

Rules:

1. Your teacher will provide all the supplies you will need including but not limited to the wheels, axles, and axle housing.
2. You may only use two sheets of copy paper and unlimited amounts of glue to make your car.
3. Your car must include a minimum of three (3) safety design features, which you will explain upon presentation of your vehicle for its trials.
4. Maximum car width is 7 centimeters (including axle and wheels). Maximum car length is 16.5 centimeters. Minimum car mass without the egg is 40 grams. Vehicles will be disqualified if they exceed the maximum length and width dimensions, do not meet the minimum mass requirement, or contain stickers, paint, tape, cardboard or any other non-licensed materials that contribute to their structural integrity.
5. Vehicle designs must allow for easy access to and removal of the egg (occupant) for inspection after the crash.
6. Vehicle designs should be able to withstand two to three collisions without parts replacement or repairs.
7. There can be no physical contact between the vehicle and designers once the vehicle has been released onto the track.
8. All vehicles must display the following information on their frames:
   - vehicle name
   - builders' names
   - vehicle length in centimeters
   - vehicle mass in grams
9. Each team with an uninjured (uncracked) egg will earn two extra credit points. Each team with an injured but still alive (unbroken) egg will earn one extra credit point.
10. In order to win (earn five points extra credit) you must have BOTH a car with the greatest momentum AND an egg occupant that survives the crash unharmed.

Investigative Plan: (15 points)

Describe your building process. Summarize the problems you encountered during the building and how you solved them. This should be no less than two paragraphs. Include a photograph or large hand-drawn picture of your vehicle. Label key design features that make your car crashworthy and measurements (length and width).

Observations: (10 points)

Create a data table that provides the following:

- width of vehicle
- length of vehicle
- mass of vehicle with and without egg occupant
- distance traveled by vehicle
- total time of run (measured with a stopwatch)
- velocity at time of impact (from photogate; need to attach an index card to car)
- average velocity

Data Analysis: (10 points)

1. Show all equations and calculations used to obtain the quantities listed below:
   - final velocity = width of photogate flag/photogate time
   - momentum = (total mass of vehicle with egg) x (final velocity)
2. Draw a free body diagram showing your car with its egg occupant moving down the ramp.
3. Describe the performance of your vehicle and whether or not it met your expectations.

Evaluation: These questions should be answered in about four to five paragraphs, no bulleted points or incomplete sentences. (15 points)

1. Explain how your vehicle's design protected the egg. Be sure to use scientific terminology in your explanation.
2. Compare your vehicle's performance to another vehicle in the class. What were the strengths and weaknesses of each design? Be sure to cite data and calculations to support your conclusion.
3. How would you modify your car to improve its performance?

Scoring Rubric (cut and paste this rubric into your lab notebook)

Category	**Points possible**	**Points earned**	**Description**
quality	10		Construction shows evidence of time and effort made
creativity	5		Overall design or particular feature of design is unique.
performance	5		Carries egg the entire length of the track
measurements	5		Meets requirements for width, length, and mass.
lab notebook	60		Thorough completion of components outlined above
Total	85		
Extra credit	5		+1 point for simply injured egg (cracked) +2 points for alive and healthy (uncracked) +5 points for greatest momentum and uninjured egg