Phase I – Research and Planning –

1. Identify the "Big" concept to be covered by the engineering design challenge.
Big Ideas:
Conservation of Momentum in collisions where momentum = mass * velocity
Impulse (FΔt=Δmv) where increasing time of contact will decrease the force on the object during a collision

2. Research appropriate learning standards associated with the topic.
NGSS
HS-PS2-3 Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
SEP: Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
DCI: PS2.A: Forces and Motion: If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.
CCC: Systems can be designed to do specific tasks.

3. Identify and discuss the different types of problem solving and declarative/procedure knowledge needed.
Types of Problem Solving for this Design Project with collisions and forces would of course include Design Problems because the students will be designing a device to minimize the force on an object during a collision. Students would also be working with Decision-Making Problems as they select the design strategy they wish to test. They will also be Troubleshooting as they test prototypes of their designs and use procedural knowledge for best practices for testing the objects. Students will also need to use Rule-Using Problems as they analyze the amount of force an object can tolerate before breaking using the declarative knowledge of the definition of momentum and impulse, and using the conservation of momentum.

4. Explore objectives and ancillary concepts/content covered by the project.
Definition and equation of momentum (p=m*v)
Momentum can be changed. (Impulse= Δp = FΔt = mΔv)
Constructing equations for conservation of momentum in both elastic and inelastic collisions

5. Identify possible activities.
Egg drop / water balloon drop activities
Designing a safer car for car accidents
Designing a helmet
Design a rocket-propelled egg drop
Design a bungee jump egg drop
Design water-balloon catcher for a trebuchet launch

Have students come up with a device that minimizes the force on an object during a collision of their choice

6. Select the best activity for your classroom.
With summertime coming up, I think the best activity will include water balloons. If acceptable, I would like to have students design a device to protect a water balloon in free fall.