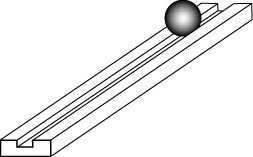
**Engineering for Efficiency – Minimizing Friction Activity**

**Objectives:**

* Understand the role of forces in determining the motion of an object
* Understand friction and air resistance as forces that oppose motion
* Apply knowledge of what causes friction between two surfaces
* Apply knowledge of law of conservation of energy.

The inventions always start off as a prototype that demonstrates the key concepts but lacks style, comfort, reliability, or efficiency. After proof that the concept works, engineers work to improve upon the design, for example: compare the first Model T Ford to a current automobile, or the first cell phone to new smart phones, etc. These things function just like the original concept but have had great improvements made to them over the years.

Your job is to take a design for a notecard “car” and improve upon its design to minimize frictional and air resistance forces acting on it as it moves. You will be judged based off of how far your “car” goes down the hallway when provided with a fixed amount of energy, as this will indicate how efficient the design is.

**For Submission:**

1. Brainstorming Sketches, **Individual**
2. Final Design Sketch, **Group**
3. Complete and tested “Car”, **Group**
4. Design Feature Sheet, **Group**

**Materials and Constraints:**

Your design must be able to “catch” a marble that has been released down a ruler ramp that is supported on top of 3 textbooks. Your “car” must be placed within a few inches of the end of the ramp. It must be carried by the marble until it comes to a complete stop. Your design can be of any size or configuration, but must be cut out from a 3x5 notecard. After brainstorming, your group will come together to settle on one final design of which you will create an annotated final sketch and fill out your design feature sheet. This must be completed before testing.

For testing, we will go out into the hallway to have a long stretch of uninterrupted hallway. You can run as many practice runs as time permits, but will only get 3 official trials. The longest of your trial runs will be taken as your grade. Alterations can be made to your design, or you can start from scratch as long as a final design is ready by testing time.

**Pre-design Questions**

1. What factors can affect how much friction exists between 2 surfaces in contact? (List at least 3)
2. What factors affect how much air resistance a surface has when moving through still air? (list at least 2)
3. Which of the factors from #2 and 3 can you change in your design? Provide ideas for how you could change each in order to improve efficiency.
4. Identify several surfaces that will come into contact to create friction. How could you minimize friction at these points?

**Design Feature Sheet**

Fill in the design feature and what variable it affects (air resistance, friction between marble and card, friction between card and floor) and your justification in the table. Must have at least 3.

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| --- | --- | --- |
| **Design Feature** | **Variable affected** | **Justification (how your feature changes variable)** |
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**Notecard Car Rubric**

Designer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Section** | **Comments** | **Score (X/Possible)** |
| **Individual Brainstorming Sketches:** Must include several design ideas with annotations. |  | **/10** |
| **Final Design Sketch:** Must include multiview sketch of final design with annotations. |  | **/10** |
| **Car Performance: TBD**. |  | **/10** |
| **Design Feature Sheet:** Detailed entries that demonstrate your understanding of friction and air resistance and their role in efficiency. Must have at least 3. |  | **/10** |

**Total:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/40**