Physics 200 Name: _____
Rotational Motion
Spring Car Project Outline (may be subject to change)

Group Size: 2 students. A few students may work alone, but there are not enough supplies for everyone to work alone.

Project Goals:

- Design, build, and refine a spring-powered car using CAD skills, laser cutting, and/or 3-D printing.
- Create a car that attains the fastest possible top speed and/or flies as far as possible after launching itself from the classroom ramp.
- Analyze/measure the car's characteristics from a physics standpoint (e.g. Mass, Force, PE, KE, Power, Efficiency, Friction, Torque, Moments of Inertia…)

Restrictions:

- The *car* must have at least three wheels that actually roll along the ground.
- The car may be powered only by spring PE.
- The car's sole source of accelerating force must be at least one wheel rotating and pushing against the ground via friction. This wheel must roll along the ground for at least one full rotation.
- Materials are limited to those described below. **Exceptions/additions may be granted upon consideration by Mr. Stapleton.
- Mr. Stapleton reserves the right to introduce additional restrictions as necessary to avoid egregious departure from the spirit of fair competition.

Provided Materials/Tools/Processes:

- One 11.5" x 23.5" sheet of plywood. The thickness of the plywood is approximately 0.19", but a closer measurement will be given later.
- One 11.5" x 23.5" x 0.13" sheet of cardboard.
- Up to 4 Skateboard bearings (OD 0.865", ID 5/16", Thickness 0.27")
- 5/16" wooden dowels (compatible with bearings; may be used as axles)
- Rubber bands. (You may use some other spring if you provide that spring.)
- Cotton Twine and Nylon Cord.
- Nails (trimmed for release pins)
- Hot glue

Provided Tools/Processes:

- Laser Cutting. Mr. Stapleton will laser cut your plywood and cardboard with one file each. Do not *count* on him making multiple trips to the Fab lab to laser cut using multiple files.
- 3-D Printing. All students may use the Maker Space 3-D printers. If you are printing for personal reasons, your first print is free and there is a small fee thereafter. Prints for this project will be free unless they are large. I'm not sure what will be considered too large. We can discuss it when the time comes. Reserve 3-D printing for small parts or parts that cannot be made any other way.
- Hot glue guns
- Saws
- Drill
- Sandpaper
- Dremel (maybe)

Tentative Process:

1. Brainstorm ideas. Consider the following questions.
    a. How will you maximize traction (good friction)?
    b. How will you minimize sources of friction that will slow your car?
    c. How will you maximize Kinetic Energy, and therefore velocity?
    d. What role will moment of inertia play, and how will you deal with it?
    e. How will you make sure that your car travels in a straight line?
    f. If you want to launch your car off of the ramp, will it have proper clearance for the radius of the ramp's curve?
    g. A rubber band's force decreases as it unstretches. How might you even out the force exerted by your car? Is it worth trying?
    h. What radius is best for wheels? A smaller radius or a larger radius?
    i. Will your car be rear wheel drive, front wheel drive, or all wheel drive?
2. Create sketches of your car.
3. Design a prototype: Create a virtual cardboard version (0.13" thickness) of your car using Rhino or some other CAD software.
4. Laser cut parts.
5. Create and assemble your car.
6. Test and troubleshoot your car. Refine your design.
7. Version 2.0: Create a final CAD model incorporating plywood (0.19" or 5 mm thick).
8. Laser cutting.Car
9. Assembly, testing, tuning.
10. Perform an analysis of your car's properties, characteristics, and capabilities.