Hover Above the Earth
ACTIVITY SHEET

*Name*_____ *Date* _____ *Teacher*_____

Introduction: *In this activity, you will build a small hovercraft. You will determine the forces that are applied to the hovercraft that demonstrate how the force of friction works, and using the data collected, you will determine the coefficient of friction.*

Materials:
1. 20 cm x 20 cm cardboard square
2. self-adhesive shelf paper
3. scissors
4. 10" or 11" round balloon
5. marker, any color
6. scale (in kg increments)
7. white glue
8. ruler
9. pencil
10. pattern for a circle or a compass
11. squirt bottle cap (like from dish soap bottle)
12. timing device, i.e. stopwatch
13. tape

Discussion:
Every day people travel from the Eastern shore of Great Britain across the English Channel to France in a vehicle called a hovercraft. The hovercrafts that cross the water have MANY air jets under them. The pilot fires up an engine that sends so much air out of the jets that the hovercraft rests on a thin cushion of air. The air reduces friction and allows the hovercraft to scoot easily over the water.

Procedure:
HOVERCRAFT BUILDING:
1. Trace around the pattern or use the compass to make a circle of 16 cm diameter. Cut out the circle with the scissors. Don't leave a lot of "trash" hanging off of the circle – you want it as clean and neat as possible.

2. Place your bottle cap in the center of your circle and trace around it (very closely).

3. Corrugated cardboard has 3 layers: a top paper layer, a middle wavy, ribbed layer, and a bottom paper layer. Within the circle you just traced, you will cut through the top and middle layers of cardboard. Take your cardboard circle to the teacher who will use the razor knife to gently cut through the 2 layers and lift them out or use sharp scissors to cut through the layers. If you cut through the cardboard using scissors, take care to cut through two layers only!

4. Use the scissors to cut a small square (with 0.6 cm sides) out of the remaining layer of cardboard from within the small inner circle.

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5. Cover both sides and the edges of the cardboard with the shelf paper. Leave the small cutout circle on the top uncovered. Leave the small cutout square on the bottom uncovered.

6. Wedge the bottle cap down into the circle on the topside. It should fit VERY snugly. If it is loose, put a thin bead of glue around the edges of the small circle, then wedge the bottle cap into the circle.

7. Press down on the cap to close it. Blow up the balloon. Twist the neck of the balloon to hold the air in while you fit the balloon over the bottle top spout. Be sure that the balloon stands straight up from the cap. Pull on the neck of the balloon to adjust it. If the balloon leans over, the hovercraft won't work. Release the neck of the balloon. It will release a little air into the neck and then should stand straight.

8. Test your hovercraft to see if it works. Grasp the neck of the balloon and the valve to open it. Place the hovercraft on a smooth surface (like your desk) or a tile floor, and watch the hovercraft scoot.

Note: *The smooth surface of the contact paper is what allows the hovercraft to have very little friction when in contact with the smooth floor. The top of the hovercraft should only have the bottlecap and the balloon and the bottom should look like a smooth circle with a small .6 cm by .6 cm square in the very center. This small square should be the ONLY place that air escapes from the balloon. If air is escaping out the sides of the hovercraft, the holes need to be covered.*

DATA GATHERING:

9. Measure the surface area of the air jet nozzle on your hovercraft and record the measurement on the Data Sheet. (This is the small square on the bottom.)

10. Calculate the surface area of the hovercraft disk and record your measurement on the Data Sheet.

11. Measure the Normal Force of the hovercraft and record the measurement on your Data Sheet.

12. Measure the volume of air necessary to fill your balloon full (mark the neck of the balloon with a marker so that each time you refill the balloon with air, you reach the same volume). Record it on your Data Sheet.

13. Measure the mass of the hovercraft. Add the mass of the hovercraft with that of the filled balloon and record the measurement on your Data Sheet.

14. Starting your hovercraft at the starting line, measure how far you craft makes it with your volume of air and how long it takes to get there. (Someone has to be the driver and someone has to be the timer.) Just give it a small push or flick with your finger at the same time you release the air in the balloon.

15. Repeat step #14 twice more for a total of 3 times and take the best time and distance to mark down on the Data Sheet.

16. Using the calculations of finger flicks/newton, answer the analysis questions at the bottom of the Data Sheet.

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1. *Surface area of Air Jet Nozzle (in mm) = _____ (in cm) = _____*

2. *Surface area of the hovercraft disk (in mm) = _____ (in cm) = _____*

3. *Mass of the hovercraft (in grams) = _____ (in kg) = _____*

4. *Mass of the balloon filled with air (g)=_____(in kg)= _____*

5. *Mass of hovercraft & balloon {#3 + #4}(g) = _____ in (kg)= _____*

6. *Normal force of your hovercraft (in Newtons) = _____*
   Use this space to figure the F_N of your hovercraft:

7. *Coefficient of friction on the hovercraft = _____*
   Use this space to figure μ of your hovercraft:

8. *Total mass of hovercraft = _____*

9. *Volume of air within the balloon = _____*

10. *Velocity Measurements:*

Trial 1	***Trial 2***	***Trial 3***
Distance (cm):_____	*Distance (cm):_____*	*Distance (cm):_____*
Time(s):_____	*Time(s):_____*	*Time(s):_____*

11. *Best hovercraft distance (in m) _____ best time (in s) =_____*

Formulas:

$F = ma$ $F_N = F_w$ $F_A = F_f$ $A = \pi r^2$ (Circle) $V = 4/3\ \pi r^3$ (sphere)

$F_f = \mu F_N$ $F_W = mg$ $v = d/t$ $a = v_f\text{-}v_i/t$

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ANALYSIS SHEET

1. *If 1 finger flick equals .001 N of F_A, what would the acceleration of your hovercraft be with the force of 1 finger flick? a.* _____

   *With the force of 5 finger flicks? b.*_____

   *With the force of 100 finger flicks? c.*_____

2. *Using your coefficient of friction, how much force is necessary to get your hovercraft to accelerate just a mere 1 m/s^2? a.* _____

   If using the force of .001N, how many finger flicks is that equivalent to? b. _____

3. *What is the velocity of your hovercraft? (determined from #11 on Data Sheet)* _____

4. *The initial velocity of the hovercraft is zero (0). Using the time you recorded from your trials and the velocity from #3, what is your acceleration?* _____

5. *Did your hovercraft accelerate?* _____

   If yes, at what rate? _____

   If no, why not? _____

6. *What errors in your data recording might have occurred during this activity?*

_____
_____
_____
_____

Conclusion: *What is your conclusion regarding this activity and the reliability of your measurements and calculations? Were you able to create a hovercraft that illustrated all the aspects of the forces you have studied related to this activity?*

_____
_____
_____
_____
_____
_____