The Lift Equation

Worksheet

The Lift Equation

$$L = Cl \times r \times \frac{V^2}{2} \times A$$

Lift = coefficient x density x $\frac{\text{velocity squared}}{\text{two}}$ x wing area

Coefficient **Cl** contains all the complex dependencies and is usually determined experimentally.

Student Names:

_____

What do we need to know in order to find the value of L in the equation above?	
What would we have to do to the equation if we wanted to find the value of Cl instead?	

Complete the following table and use the results to solve the problems below.

Variable to solve for:	*Original equation & work:*	*Final Equation:*
L	$L = Cl \times r \times \frac{V^2}{2} \times A$ already in final form.	$L = Cl \times r \times \frac{V^2}{2} \times A$
Cl	$L = Cl \times r \times \frac{V^2}{2} \times A$	
r	$L = Cl \times r \times \frac{V^2}{2} \times A$	
V	$L = Cl \times r \times \frac{V^2}{2} \times A$	
A	$L = Cl \times r \times \frac{V^2}{2} \times A$	

Using the lift formula solved for the variable in question, answer each of the following:

Suppose you are flying a 17,100 pound aircraft at 48,000 ft where the air density is 0.0004 slugs/cu ft. Your current cruising speed is 180 mph and the wing area of the aircraft is 2000 sq ft. You need to make some altitude changes and will need to know the "Lift Coefficient" of the aircraft in order to do so. What is the Cl for your aircraft?	Cl =
Due to heavy air traffic in the area at 48,000 ft, you are instructed to descend to 30,000 ft where the air density is 0.00089 slugs/cu ft. The weight and dimensions of the aircraft haven't changed, so you'll need to adjust your speed for the new cruising altitude. What should the new V be when you level off at 30,000 ft?	V =
After some time, 500 pounds of fuel have been used and the aircraft now weighs less. Assuming you haven't adjusted your speed since you began to cruise at 30,000 ft, what is the current air density, r, for your current altitude?	r =
After landing and unloading your cargo, your aircraft is re-fueled and you take off again for the return trip. The tower directs you to ascend to 25,000 ft where the air density is 0.00107 slugs/cu ft. You do so and level off. You are now flying at 80 mph and have the aircraft on autopilot. Out of curiosity, you decide to calculate how much your cargo weighed. Naturally, you'll need to know how much your aircraft weighs now so that it can be compared to the weight with all the cargo. So, how much does the aircraft weigh (L) now? How much did the cargo weigh?	L =

Use FoilSim to test each of your four answers. Make sure to follow the directions on the directions page.

Now that you have tested the calculations you did above by entering the appropriate variable values for each problem, does FoilSim agree with your calculations? If not, where do they differ? What sources of error can you find?	