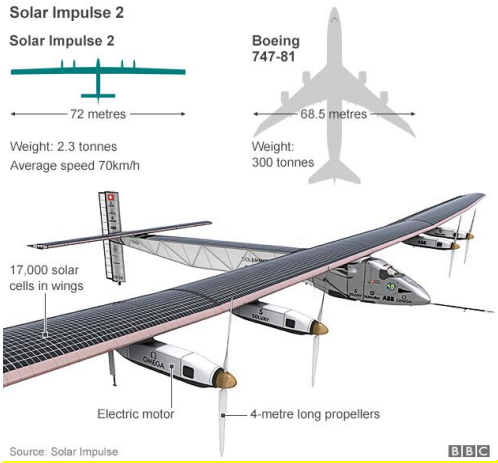
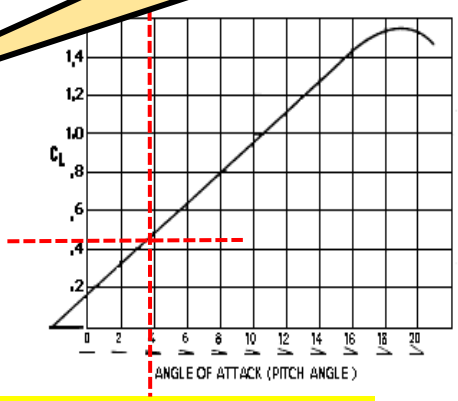
FLUIDS

Unit 18 Dr. John P. Cise, Professor of Physics, Austin Com. College, 1212 Rio Grande St., Austin Tx. 78701 jpcise@austincc.edu & New York Times by Associated Press July 26, 2016.



Air Density Change with Altitude		
Altitude (ft)	Density (lb/ft3)	Density (kg/m3)
Sea Level	0.075	1.1[illegible]
5000	0.066	1.060
10000	0.056	0.904
15000	0.048	0.771
20000	0.041	0.652
25000	0.034	0.549
30000	0.029	0.458
35000	0.024	0.379

Average flight height = 5000 ft. Thus, air density d = 0.066 lb./ft.^{3}



Historic Solar Flight Marks First Round-The-World Journey

ABU DHABI, United Arab Emirates — The world's first round-the-world flight to be powered solely by the sun's energy made history on Tuesday as it landed in Abu Dhabi, where it first took off on an **epic 25,000-mile (40,000-kilometer) journey that began more than a year ago.** Since its March 2015 take off, the Swiss-engineered Solar Impulse 2 has made **16 stops around the world without using a drop of fuel** to demonstrate that using the plane's clean technologies on the ground can halve the world's energy consumption, save natural resources and improve quality of life. After landing the plane, pilot Bertrand Piccard was greeted outside the cockpit by his Solar Impulse partner and fellow pilot Andre Borschberg. **The aircraft is uniquely powered by 17,248 solar cells that transfer energy to four electrical motors that power the plane's propellers. It runs on four lithium polymer batteries at night. (((The plane's wingspan stretches 236 feet (72 meters) to catch the sun's energy. At around 5,070 pounds)))** (2,300 kilograms), the plane weighs about as much as a minivan or mid-sized truck. An empty Boeing 747, in comparison, weighs 400,000 pounds (180,000 kilograms). To help steady it during takeoffs and landings, the plane was guided by runners and bicyclists.

Over its entire mission, Solar Impulse 2 completed more than 500 flight hours, cruising at an average speed of between 28 mph (45 kmh) and 56 mph (90 kmh). The carbon-fiber plane is a single-seater aircraft, meaning its two Swiss pilots — Piccard and Borschberg— had to take turns flying solo for long days and nights.

An aircraft's lift capabilities can be measured from

$$L = (1/2)\, d\, v^2\, s\, CL$$

- **L** = Lift, which must equal the airplane's weight in pounds
- **d** = density of the air. This will change due to altitude. **v** = velocity of an aircraft expressed in feet per second
- **s** = the wing area of an aircraft in square feet
- **CL** = Coefficient of lift , which is determined by the type of airfoil and angle of attack.

INTRODUCTION: Purpose of this application is after finding the coefficient of lift the angle of attack is verified as about 4 degrees. **Take the average height of flight to be 5,000 ft.**, thus from chart above **d = 0.066 lb./ft.^{3}** . The wings are 236 ft. long and 12.3 ft. wide = **2901 ft.^{2} = area = s. At left L = plane weight = 5070 lb.**

QUESTIONS:(a) Convert weight density of air d = 0.066 lb./ft.^{3} to slugs/ft.^{3}?(b) Speed of solar impulse 2 is said to be 28 – 56 mph. Thus, take average Speed to be 43 mph. Convert 43 mph to ft./s.? (c) Find Coefficient of lift CL for the Solar Impulse 2? Use the Lift equation at left. (d) Knowing the CL, find the angle of attack with chart in upper right?

HINTS: weight/g = mass , g = 32 ft./s.^{2} , 60 mph = 88 ft./s.

ANSWERS: (a) 0.00206 slugs/ft.^{3} = d , (b) 63 ft./s. = v , (c) CL = ~ 0.43 (d) Angle of attack = ~ 4° by calculations using the lift equation.

http://CisePhysics.homestead.com/files/SolarImpulse2.pdf