Terminal Velocity Worksheet

Use this worksheet to predict your terminal velocity in the wind tunnel. During your flight, an instructor will record your actual terminal velocity. Later, you will compare the two values and see how close your prediction was.

1. Derive the equation for your predicted terminal velocity.

Terminal velocity occurs when the iFlyer is stable, or when there is no acceleration in either direction. In this case, the force of the iFlyer's weight equals the force of air drag:

$$F_D = F_W$$

The equation for drag force is $F_D = \frac{1}{2}v^2\rho C_d A_f$, and the force of weight is $F_W = mg$, where:

v = terminal velocity
C_d = drag coefficient
ρ = air density
A_f = frontal area
m = flyer's mass
g = gravitational acceleration

Substitution yields:

$$\frac{1}{2}v^2\rho C_d A_f = mg$$

Use this space to solve the above equation in terms of terminal velocity, v:

2. Use the scale to measure your mass, m in kg:

m = _____ kg

3. Use the default value for the density of air @ 20°C and 1 atmosphere: 1.20 kg/m^3

ρ = _____ kg/m^3

4. Use the default value for gravitational acceleration: 9.81 m/s^2

g = _____ m/s^2

5. Use the following chart to choose the drag coefficient best suited for the human body:

object shape	C_d
sphere	0.5
cylinder	1.2
flat plate	2.0

C_d = _____

6. Use measuring tape and the chart below to calculate the total frontal area of your body.

Some common area formulas:

Circle: $A = \pi r^2$ Ellipse: $A = \frac{1}{4}\pi l w$ Rectangle: $A = lw$

Body element	Frontal area formula (choose from list above)	Measured Length, l (cm)	Measured Width, w (cm)	Frontal area (cm^2)	Multiplier	Total Body Element frontal area (cm^2)
Face					1	
Neck					1	
Torso					1	
Hands					2	
Arms					2	
Legs					2	
Feet					2	
				Total frontal area, A_f (cm^2)		

Divide this total frontal area by 10,000 to find A_f in units of m^2:

A_f = _____ m^2

7. Use the space below to calculate your predicted terminal velocity, v in m/s:

AFTER YOUR FLIGHT:
8. Calculate your *actual* terminal velocity (recorded by your iFLY Educator) in m/s:

Actual terminal velocity, v_{actual}: _____ mph × 0.447 = _____ m/s

9. Calculate the percent error, $\%\Delta v$, in your predicted terminal velocity:

$$\%\Delta v = \left[\frac{v_{actual} - v_{predicted}}{v_{actual}}\right] \times 100$$

$$\%\Delta v = \underline{\hspace{3cm}}$$

10. List some factors you think may have caused this difference: