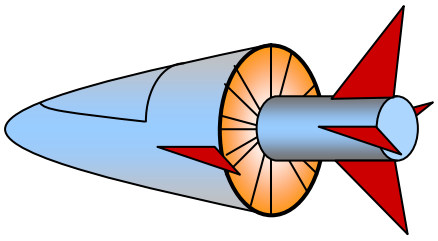
Example Problem for Model Testing

One night in Nevada, photographs are taken of a strange craft flying over the desert. From the photos, the major diameter of the craft is estimated to be 7.5 m. Using the photo, a small model having $D = 0.25$ m is built, and tested in a water tunnel.

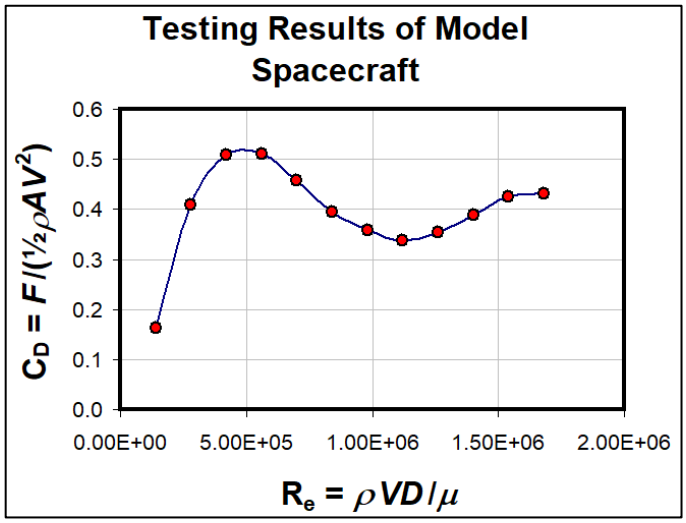
Model In Water	
μ	8.90×10^{-4} Ns/m2
ρ	997 kg/m^3
D	0.25 m
A	0.4909 m^2

Actual Aircraft (Air)	
μ	1.84×10^{-5} Ns/m2
ρ	1.19 kg/m^3
D	7.5 m
A	44.18 m^2



Model Testing Data & plot:

V (m/s)	F_D (N)	Re	C_D
0.5	1	1.40E+05	0.163
1.0	10	2.80E+05	0.409
1.5	28	4.20E+05	0.509
2.0	50	5.60E+05	0.511
2.5	70	7.00E+05	0.458
3.0	87	8.40E+05	0.395
3.5	107	9.80E+05	0.357
4.0	132	1.12E+06	0.337
4.5	175	1.26E+06	0.353
5.0	238	1.40E+06	0.389
5.5	314	1.54E+06	0.424
6.0	380	1.68E+06	0.431



I. If eyewitnesses claim that the craft was moving at U = 2.0 m/s, what is the drag force?

$$Re = \frac{(1.19\ \text{kg/m}^3)(2\ \text{m/s})(7.5\ \text{m})}{(1.84\times10^{-5}\ \text{Ns/m}^2)} = 970{,}109 \rightarrow \text{look up value on plot} \rightarrow \quad C_D = 0.356$$

$$F_D = C_D\left(\frac{1}{2}\rho A V^2\right) = (0.356)(0.5)(1.19\ \text{kg/m}^3)(44.18\ \text{m}^2)(2\ \text{m/s})^2 \qquad \boxed{F_D = 37.5\ \text{N}}$$

II. If other eyewitnesses claim that the craft was moving at U = 5.0 m/s, what is the drag force?

$$Re = \frac{(1.19\ \text{kg/m}^3)(5\ \text{m/s})(7.5\ \text{m})}{(1.84\times10^{-5}\ \text{Ns/m}^2)} = 2{,}425{,}272 \rightarrow \text{look up value on plot} \rightarrow \text{no data there!}$$

Calculation can't be done!

→ More experiments are needed to answer this question!