Math 105—Calculus I   Project 1
not really a drag...

by Gavin LaRose (glarose@NebrWesleyan.edu), Nebraska Wesleyan University, January 1997

Independent Mathematical Contractors, Inc., moving into its fourth phase of business success, has established itself as one of the top mathematical consulting companies in Lonlinc, Skanebra. In this capacity, it has recently hired you into its burgeoning ranks of competant mathematicians. Your first contract comes from the Rocket Tech division of Utoff AF Base, which has apparently been charged by the National Space Agency (NSA) to work on aspects of the vaunted national space program.

Rocket Tech Division

Utoff A.F. Base
1 Piecemeal Dr.
Haoma, SK
13681-0050

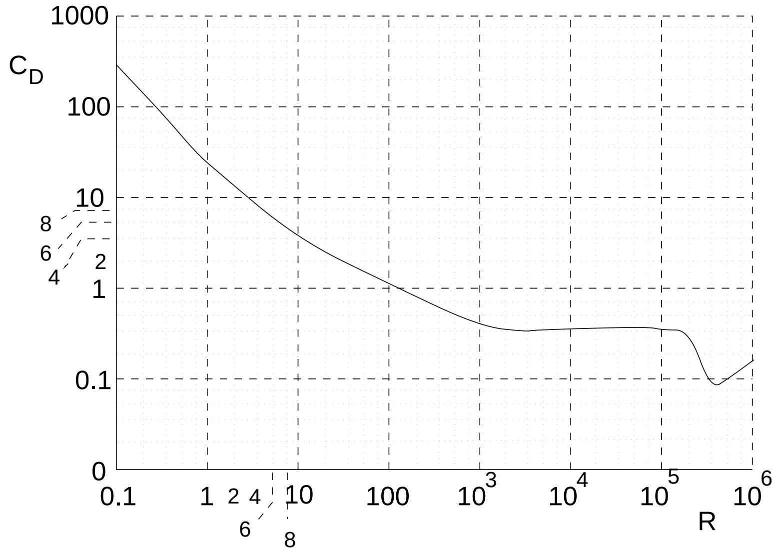
24 January, 1997

Independent Mathematical Contractors, Inc.
Suite 2, Strawmarket Business Plaza
Lonlinc, SK 04685

Dear IMC:

As part of the Rocket Tech Division's growing rôle in the progress of the space program, including the development of the space station Omfreed, we are currently investigating different methods of returning objects to Earth from orbit. One such method is, of course, simply to install a heat shield on the object and allow it to fall from orbit to an essentially soft landing on Earth. It is with aspects of this that we are now concerned, and have—after a number of previous, successful contracts—therefore commissioned your aid in its analysis.

Data culled from earlier work by the NSA has shown that the *Drag coefficient*, C_D, on an object such as we might be returning to Earth varies with a quantity known as the *Reynolds number*, R, as shown in the figure to the right. The Reynolds number is defined to be $R = \rho v d/\mu$, where ρ is the density of air, v the velocity of the object, d a measure of its size, and μ the viscosity of air. We assume that ρ, d, and μ are constants. It has been experimentally determined that C_D is given by $C_D = \frac{2F_D}{\rho v^2 A}$, where F_D is the drag force on the object and A is a measure of the cross-sectional area of the object.



We have contracted with you first to determine from the experimental data functions to model C_D and thus the drag force as functions of R. Then, based on these functions, we need an expression to give the drag force as a function of the velocity of the object. It is often reported that the drag force, depending on the velocity of the object, is either proportional to v or to v^2—so we would like an estimate based on your results as to the validity of these approximations and whether they are likely to be applicable to our case.

To assist you in this project, we have arranged for you to be able to contact a local expert in many fields, Dr. Gavin LaRose, with any technical questions you might have. You must in any event contact him with a report of at least preliminary work by the 31st of January and again by or on the 6th of February. Your final 3–5 page typewritten report† is due on the 10th of February.

Sincerely,

Lieutenant General Rick N. Backer
Commander, Rocket Tech Division

† *Any equations in your solution may be hand-written in blank lines between your typewritten explanation if you wish. Sample reports are available for examination from Dr. LaRose.*