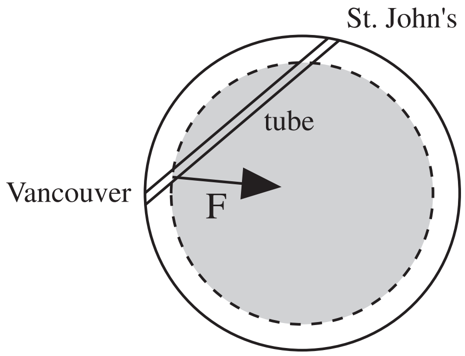

Figure 1: Sending mail, the fast way, across Canada.

PHY140Y

Spring Term – Week 2

January 8, 1999

1. I have a brilliant idea that will speed up the mail delivery in this country. It is my idea. Remember that.

   What we should do is bore a frictionless tube from Vancouver to St. John's. To send something across the country you just drop your mail in the hole, as shown in Fig. 1. How long would it take to send mail in this way? How long would it take to send mail from Alberton to Copetown? Remember, this is my idea!

2. The space shuttle is in a circular orbit 250 km above the ground. It is attempting to dock with the Hubble Space Telescope, which is in exactly the same orbit, but 10 km ahead of the shuttle. The team has a tight deadline, and must rendevous in exactly 1 hour.

   (a) Consider the options available to shuttle crew. Can they just accelerate? If not, why?

   (b) They are going to make this work by reducing altitude a certain amount, re-establishing a circular orbit at the new alititude, and catch up that way. How far must they drop?

   (c) Is this the most efficient way of rendevousing in terms of fuel?

3. (a) Write an expression for the force exerted by the moon, mass M, on a particle of water, mass m, on the earth at a point directly under the moon. The radius of the moon's orbit around the earth is r and the earth's radius is R.

   (b) Compare this force with the force on the particle of water if it was at the earth's centre.

   (c) Show that the difference in these forces is approximately proportional to $1/r^3$.

   (d) Calculate the force on the particle of water if it is on the earth's surface exactly opposite to the point above the moon. Compare this force with that exerted at the earth's centre.

   (e) Now explain why there are two tidal bulges on the earth's surface.