The Mathcad Challenge

Overview
At the conclusion of each of the three conference sessions, the presenter will provide a clue to the audience. Collect all three clues, answer the problem statement below using Mathcad Prime 1.0, and email your worksheet to mathcadchallenge@ptc.com.

Prize: 5 people will each win a $100 AMEX gift card!

Solution
The winners will be chosen based on the accuracy of solution; Mathcad Prime 1.0 must be used to calculate the solution. Out of all correct answers, 5 winners will be selected at random. The **deadline for submission is Monday, April 18 at 11:59PM EDT**.

The Challenge Problem Statement

A train leaves New York at 9:45am EDT, heading for San Francisco...

The train system consists of a straight-line tunnel connecting the two cities. The train uses a MAGLEV (magnetic levitation) system consisting of permanent magnets in the tracks and superconductive electromagnets in the train. To accelerate it uses a combination of electromagnetic force and gravitational pull of the Earth. The deceleration comes also from the gravitational pull of the Earth, as well as aerodynamic drag of the train.

Problem: Compute the arrival time in San Francisco assuming constant propulsion force.

Simplifying assumptions:

- We are ignoring the cost, or the feasibility, of building such a system
- We are assuming that the gravitational pull of the Earth is constant throughout the tunnel
- We are assuming the air in the tunnel is at standard atmospheric conditions (see simplified formula on next page)
- We assume that the resistance of the tracks is zero, so that all of the energy loss comes from the aerodynamic drag
- Use the constants provided on the next page to solve the problem

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Constants:

$$\rho_0 := 1.225\ \frac{kg}{m^3}$$ Density of air under standard conditions (1)

$$R_{earth} := 6371.0\ km$$ Mean radius of the Earth (1)

$$Lat_{N.Y.} := 40.75339°$$ Latitude and longitude of the N.Y. train station (2)

$$Lon_{N.Y.} := -73.97715°$$

$$Lat_{S.F.} := 37.77643°$$ Latitude and longitude of the S.F. train station (2)

$$Lon_{S.F.} := -122.39433°$$

$$g = 9.807\ \frac{m}{s^2}$$ Gravitational constant (as defined in Mathcad)

Formulas:

$$F_d(v) := \frac{1}{2} \cdot A_{train} \cdot \rho_0 \cdot v^2 \cdot C_d$$ Force required to overcome air resistance

References: (1) Wikipedia (2) Google Maps

Three Clues (Input Parameters)

The 3 Input parameters will be revealed as "clues." One clue will be revealed after each conference session at PlanetPTC Virtual - Mathcad. 1:00 pm – 5:00 pm EDT on April 14th.

1. Mass of the train (m_{train}) =165 metric tons
2. Effective drag coefficient of the train (C_d) = 0.09
3. Effective frontal area of the train (A_{train}) is = $10m^2$

Submission

Email your worksheet to mathcadchallenge@ptc.com

Official Sweepstakes Rules