Challenge 1, Mechanics

Submission date: 1. November

Along the rails *(16 points)*

The train G511 travels between Beijing and Wuhan. It takes a time T of 5 hours and 15 minutes to travel the distance D 1233 km of the journey at a cruise speed v_c of 300 $\mathrm{km h^{-1}}$. There are 6 stops which respective time are 4, 5, 5, 6, 4 and 3 minutes (name them t_{si} with $i \in 1, 2, 3, 4, 5, 6$). Our goal is to estimate the acceleration a_T of the train with these data.

Please answer algebraically to all questions unless staten otherwise.

Part A. Before departure *(2 points)*

To start on a good basis let's clarify a few things.

i. (1 pt.) What is the average speed at which the train moves during the travel?

ii. (1 pt.) Explain why the latter is different from the cruise speed.

Part B. Travelling plan *(6 points)*

Assume that the train can reach its cruise speed for a finite time between each stations. *Use algebraic values to illustrate your graphs. For example you can use t_i as departure time from each stations (with $t_0 = 0$ et $t_8 = T$).*

i. (3 pt.) Sketch a graph of the speed of the train as a function of time for the first 3 stations after the departure station.

ii. (3 pt.) Sketch a graph of the acceleration a_T of the train as a function of the distance for the 3 first stations.

Part C. On the way *(8 points)*

Assume the acceleration is equal to the deceleration in this part. The hypothesis of part B. still holds.

i. (3 pt.) Express the distance between two adjacent stations $x_{i+1} - x_i$ as a function of acceleration, cruise speed and of the distance over which the train travel at its cruise speed. *(Find an appropriate name for this variable).*

ii. (3 pt.) Express the the time elapsed between the departure from two adjacent stations $t_{i+1} - t_i$ as a function of acceleration, cruise speed and of the distance over which the train travels at its cruise speed.

iii. (2 pt.) Find the acceleration a_T of the train. *Write algebraic answer before the numerical application.*