Dynamics Review Problems

Problem 1

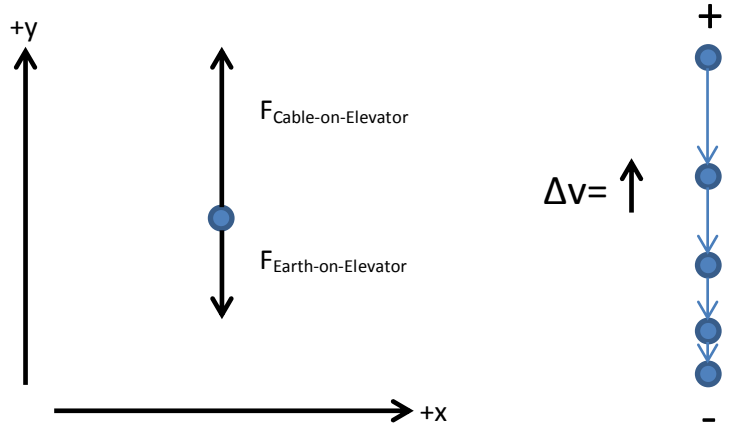
In the incredibly breathtaking and exciting Olympic sport of curling, the goal of a player is to get a large granite stone as close to a target as possible by sliding it across ice (think Bocce balls or horse shoe throwing except with sliding). The curler pushes horizontally on a stone making it speed up from rest along the ice in a straight line, during this time you cannot ignore friction. Then two sweepers (literally with brooms) sweep the ice in front of the stone making it very smooth so the stone travels at a constant velocity after it leaves the curler's hand. Finally, the two sweepers stop sweeping and the stone hits a rough patch of ice and comes to a stop.

a) Draw a motion diagram and a fore diagram for each part of the stone's motion: as the curler is pushing it, traveling across the smooth swept ice, and then finally after it hits the rough patch.
b) Are the above diagrams consistent? What makes them consistent?
c) The coefficient of friction between the 28 kg stone and the ice when it hit the rough patch was 0.11. If the stone stopped in 4 seconds, what was the initial speed of the stone? (Difficult)

Problem 2

The problem: A 1000-kg elevator is moving down at 6.0 m/s. It slows to a stop in 1.5 seconds as it approaches the ground floor. Determine the force that the cable supporting the elevator exerts on the elevator as the elevator stops. Assume that g = -9.8 N/kg (m/s^2)

Proposed Solution: The elevator at the right is the object of interest, the objects interacting with the elevator are the cable and Earth. Is there anything wrong with this solution? If so, what? Provide a correction.

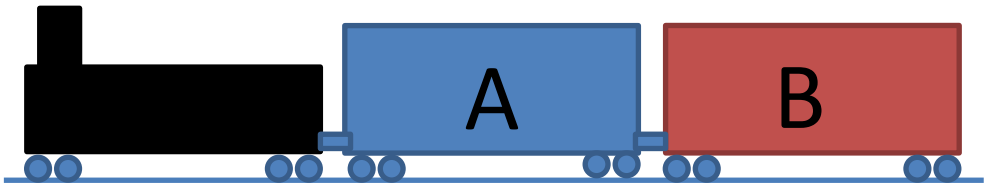


$$a_y = \frac{F_y}{m_{elevator}} \qquad \frac{\Delta v}{\Delta t} = \frac{F_{\text{Cable-on-Elevator}} + F_{\text{Earth-on-Elevator}}}{m_{elevator}}$$

$$\frac{6.0\ \frac{\text{m}}{\text{s}}}{1.5\ \text{s}} = \frac{F_{\text{Cable-on-Elevator}} + 1000\ \text{N}}{1000\ \text{kg}} \qquad F_{\text{Cable-on-Elevator}} = 3000\ \text{N}$$

Problem 3

A train engine is pulling on two railcars (see diagram below). Railcar A has a mass of 10000 kg, railcar B has a mass of 15000 kg.



a) Draw a force diagram for railcar A.
b) Draw a force diagram for railcar B.
c) Calculate the force that the engine needs to exert on railcar A to get both railcars to accelerate at -0.50 m/s^2
d) Your friend sitting in railcar A has his coffee spill on him as it was sitting on the table, but from his view nothing pushed the coffee cup over. What's going on? Help your friend explain what happened.