Physics 1A Discussion Worksheet (Week 3)

1 Problem 0: Dimensional Analysis (not from textbook)

Consider the three following fundamental constants of nature:

$$\text{Planck's constant } h = 6.63 \times 10^{-34}\,\frac{\text{kg}\,\text{m}^2}{\text{s}}\text{, governing quantum mechanics}$$

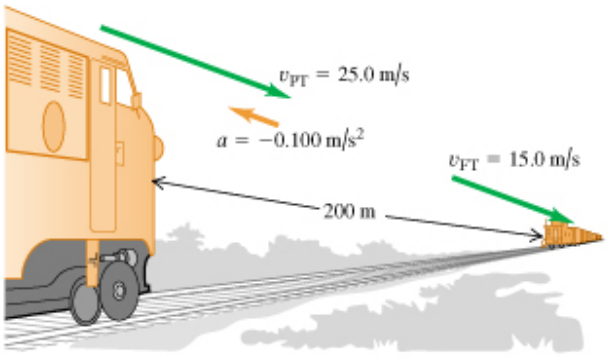
$$\text{The gravitational constant } G = 6.67 \times 10^{-11}\,\frac{\text{m}^3}{\text{kg}\,\text{s}^2}\text{, governing gravitational attraction}$$

$$\text{The speed of light } c = 3.0 \times 10^{8}\,\text{m/s, governing electricity and magnetism.}$$

Use dimensional analysis with these three constants to estimate the *Planck length* ℓ_P, which is the physical length scale at which all three of the above types of physics plays a role. (Hint: Can you use these constants to produce a quantity with the correct dimensions?)

2 Problem 1 (problem 2.62 on page 63 of the textbook)

The engineer of a passenger train traveling at 25.0 m/s sights a freight train whose caboose is 200 m ahead on the same track. The freight train is traveling at 15.0 m/s in the same direction as the passenger train. The engineer of the passenger train immediately applies the brakes, causing a constant acceleration of -0.100 m/s^2, while the freight train continues with constant speed. Take $x = 0$ at the location of the front of the passenger train when the engineer applies the brakes. Will the cows nearby witness a collision? If so, where will it take place?



3 Problem 2 (problem 2.68 on page 63 of the textbook)

An object's velocity is measured to be $v_x = \alpha - \beta t^2$, where $\alpha = 4.00$ m/s and $\beta = 2.00$ m/s^3. At $t = 0$ the object's position is $x = 0$.

a) Calculate the object's position as a function of time.

b) Calculate the object's acceleration as a function of time.

c) What is the object's maximum *positive* displacement from the origin while $t > 0$?

4 Problem 3 (problem 2.76 on page 63 of the textbook)

A Multistage Rocket. In the first stage of a two-stage rocket, the rocket is fired from the launch pad starting from rest but with a constant acceleration of 3.50 m/s^2 upward. At 25.0 s after launch, the second stage fires for 10.0 s, which boosts the rocket's velocity to 132.5 m/s upward at 35.0 s after launch. This firing uses up all of the fuel, however, so after the second stage has finished firing, the only force acting on the rocket is gravity. Ignore air resistance.

a) Find the maximum height that the stage-two rocket reaches above the launch pad.

b) How much time after the end of the stage-two firing will it take for the rocket to fall back to the launch pad?

c) How fast will the stage-two rocket be moving just as it reaches the launch pad?