Quizbit Week 3 Solutions

Thursday, October 13, 2022 3:18 PM

Individual Quizbit 2

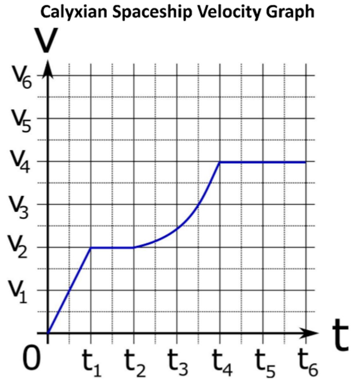
PH211, Fall 2022

You are encouraged to discuss these questions with others, but those conversations need to be only in words. Please do not write down steps for others, draw pictures, show math steps, or consult online resources. Any work shown here should be your own thoughts and not copied from any source. You will be graded on the clarity of how well you communicate your steps and reasoning, not on absolute correctness. Hand write your solutions (paper or tablet) and turn your work into Gradescope.

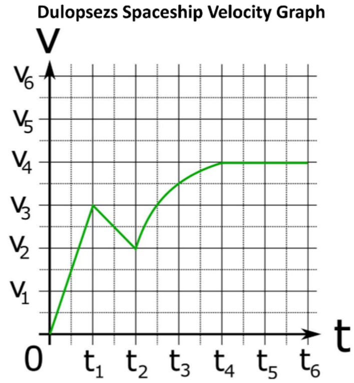
Problem Statement | The αCεE race happens once every Galactic year. The goal is simple: starting from rest at Alpha Centauri, the first spaceship to reach Epsilon Eridani wins. There is a catch, the only propulsion systems allowed are matter-antimatter annihilators that provide thrust. So no wormhole generators, cytonic hyperdrives, time machines, or any device that doesn't use thrust produced directly from the matter-antimatter interactions. Each contestant must submit their engineering designs for their matter-antimatter drive to the αCεE race governing board exactly 0.137 Galactic years before the race begins.

The velocity profile for two alien ships, Calyxian and Dulopsezs, were taken from the submitted engineering designs and shown below. The axes are identical for each design (e.g. v_2 on the Calyxian graph is the same v_2 on the Dulopsezs graph).

Calyxian Spaceship Velocity Graph



Dulopsezs Spaceship Velocity Graph



(a) Describe the motion of the Calyxian spaceship throughout its entire motion. Break this description up into intervals for easier communication (e.g. between time **0** and $\mathbf{t_1}$, between $\mathbf{t_1}$ and $\mathbf{t_2}$, etc...). Hint: The motion involves position, velocity, and acceleration information.

(b) Which spaceship would win the race? Use the provided graphs to support your answer.

Group Quizbit 2

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You will be working with your group to create a single solution for these questions. You are encouraged to think about the questions beforehand, and discussing with your classmates is encouraged, but do not bring a solution to your group's working session. You are working to develop a shared solution, with the input and problem solving skills of all your group members. You will be graded on both the clarity of how well you communicate your steps and reasoning, and on absolute correctness.

Problem Statement | Consider a hot air balloon at rest on a non windy day that is 3,000 meters directly above you while you stand on the surface of the Earth. Since it is not windy, the hot air balloon does not move relative to you. A skydiver exits the hot air balloon at an initial speed of zero and falls towards the surface of the Earth. The skydiver reaches a maximum constant speed (terminal speed) 15 seconds after they exited the balloon.. The skydiver uses a parachute 30 seconds after they exit the balloon and quickly reaches a new constant terminal speed. The skydiver reaches the ground 45 seconds after they exited the balloon.

(a) Sketch a plot of the velocity of the skydiver as a function of time. Be sure to include axis titles and estimated values.

(b) Sketch a plot of the acceleration of the skydiver as a function of time. Be sure to include axis titles and estimated values.

(c) After landing, the same skydiver goes back up to the same height in the same hot air balloon and jumps again. This time, the skydiver uses a parachute that is smaller than the first parachute. The parachute is deployed at the same 30 second mark as before. Sketch a new velocity vs time for this second jump with the smaller parachute. Make sure this graph is approximately to scale with respect to the first graph.

(c)

(a)

($t_0 \rightarrow t_1$) The velocity is lineaarly increasing while in the positive quadrant meaning that the ship is speeding up linearly in the positive direction. Since the slope of velocity vs time is a constant value, the acceleartion is zero. The postion would be increasing quadratically.

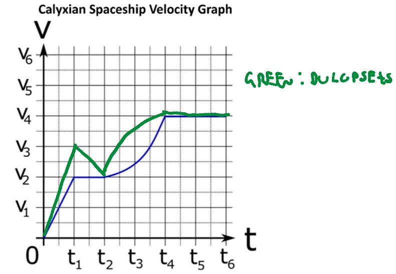
($t_1 \rightarrow t_2$) The velocity is a constant positive value which means the ship is moving at a constant speed in the positive direction. The slope of velocity vs time is zero, thus the acceleration is zero. The position would be increasing linearly.

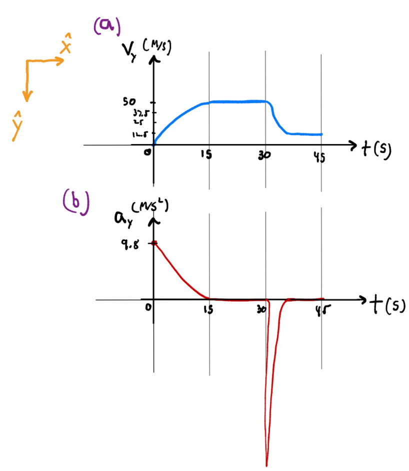
($t_2 \rightarrow t_4$) The velocity is non-linearly increasing while always remaining positive. The ship is speeding up in the positive direction. The slope of velocity vs time near $\mathbf{t_2}$ is a small positive value and the slope increases as t increases towards t4. This means that the acceleration starts as a small positive acceleartion and increases to larger positive values between $\mathbf{t_2}$ and $\mathbf{t_4}$.

($t_4 \rightarrow t_6$) The velocity is a constant positive value which means the ship is moving at a constant speed in the positive direction. The slope of velocity vs time is zero, thus the acceleration is zero. The position would be increasing linearly. The ship has also reached its maximum speed of $\mathbf{v_4}$.

(b) The Dulopsezs win the race. This can be found a few different ways. One way is to sketch both plots on the same axes as shown below. Note that both ships start from rest and begin moving at the same time after t = 0. Then at all points in time, the Dulopsezs have a larger velocity in the positive direction, so they will always be in front of the Calyxians. They both start at the same point in space too as per the rules of the race (start from Alpha Centuari...).

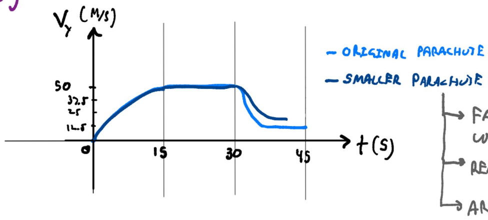
Calyxian Spaceship Velocity Graph





approximately to scale with respect to the first graph.

(c)



→ FASTER TERMINAL VELOCITY WHEN PARACHUTE IS OPEN

→ REACHES GROUND BEFORE 45 SEC

→ AREA UNDER V vs t THE SAME FOR BOTH CURVES