Solutions for Homework14

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Abstract

In this document we will show the solutions for problems represented in the given homework for this week.

Contents

1 Task 1

1.1 Problem

In the given graph which represents the movement of a car, answer the following:

- Between which point and point the car accelerate, and between which points it decelerate?
- What is the distance traveled at point C? and what is it at point F?
- Indicate line segments with 0 acceleration, does that mean the car is not moving? Explain.
- What are the values of acceleration and deceleration of the car at each segment?

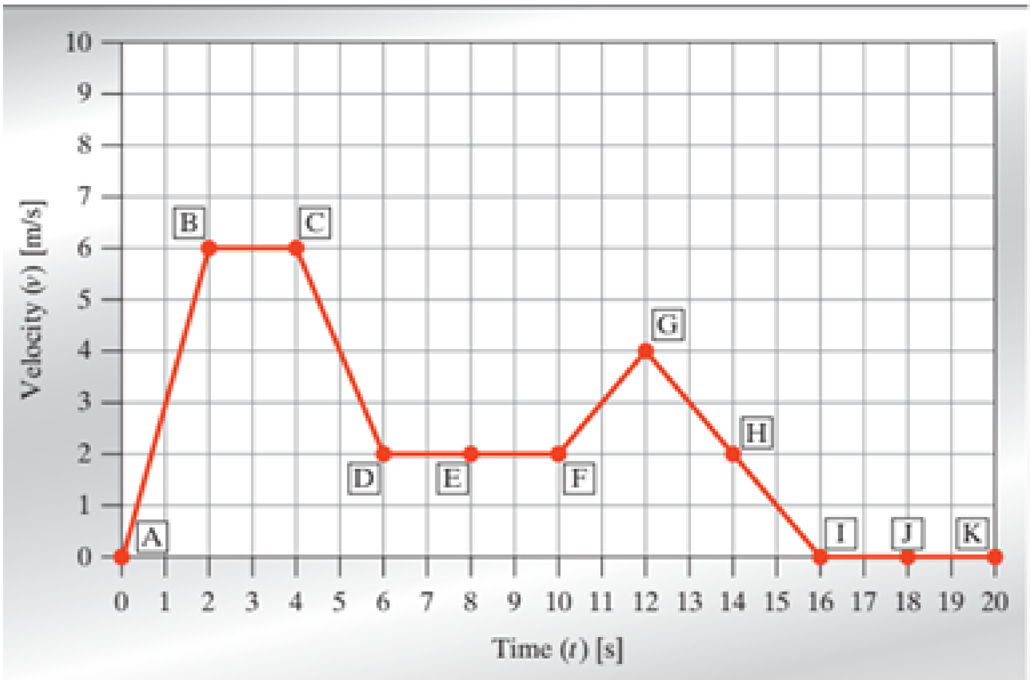

Figure 1: Velocity-Time of the car

1.2 Solution

1. The car accelerates at points:
   - $A \to B$
   - $F \to G$

   And it decelerates at points:
   - $C \to D$
   - $G \to I$ ($G \to H$ & $H \to I$)

2. To get the distance we can just find the integral from point A (0) to whatever points we want. So to see what the distance traveled at point C is we just have to evaluate

$$\int_A^C v * dt = \int_A^B v * dt + \int_B^C v * dt$$

which is just the area under the graph so from $A \to B$ we have a right triangle with sides 1×6 which means that the area from that triangle is $\frac{6}{2} = 3$, and from $B \to C$ we have a rectangle with sides

2×6 so in total the area of the rectangle is 12 meaning that the distanced traveled from $A \to C$ is $3 + 12 = 15m$. To find out the distance traveled from $A \to F$ we have to solve the following integral:

$$\int_A^F v * dt = \int_A^C v * dt + \int_C^B v * dt + \int_D^F v * dt$$

Since we already know that $\int_A^C v * dt = 15m$ we just have to find the other two integrals, which at the end end up being $15 + \frac{2*4}{2} + 2 * 2 + 2 * 4 = 15 + 4 + 4 + 8 = 31m$

3. The line segments with 0 acceleration are
   - $B \to C$
   - $I \to K$ $(I \to J$ & $J \to K)$

   This does NOT mean that the car isn't moving, this just means that the velocity of the car isn't changing or in other words

$$\frac{dv}{dt} = 0$$

4.

Line Segment	Acceleration value $\left[\frac{m}{s^2}\right]$
$A \to B$	3
$B \to C$	0
$C \to D$	-2
$D \to E$	0
$E \to F$	0
$F \to G$	1
$G \to H$	-1
$H \to I$	-1
$I \to J$	0
$J \to K$	0

2 Task 2

2.1 Problem

An environmental engineer has obtained a bacteria culture from a municipal water sample and allowed the bacteria to grow. The initial count of Bacteria is A, and their growth formula with time being in hours is given by:

$$B = B_0 e^{Ct}$$

A: is the summation of your birthday digits divided by 0.5
C: is the summation of your IUS ID number divided by 50.

- What is B_0? And what is its value?
- After how many hours, the amount of Bacteria would be 100000?
- Pick up 4 to 5 points in time and draw the graph of Bacteria growth. (This is done by pen and pencil)
- Use Octave to plot the graph of bacteria growth

2.2 Solution

$$A = \frac{1+4+1+2+2+0+0+2}{0.5} = \frac{12}{0.5} = 24$$
$$C = \frac{2+2+0+3+0+2+2+8+9}{50} = \frac{28}{50} = 0.56$$

1. B_0 is the initial amount of bacteria in our system and since our variable A represents the initial count of bacteria we can conclude that $A = B_0$.

2. To figure this out we simply have to figure out the following equation:

$$24 * e^{0.56*t} = 100000$$

$$0.56 * t * \ln 24 * e = \ln 100000$$
$$0.56 * t = \frac{\ln 100000}{\ln 24 * e}$$
$$t = \log_{24*e} 100000 * \frac{1}{0.56}$$
$$t \approx 4.9207[h]$$

3. Using the following code:

```
% Clear previous junk
clear all;
clc;

% Set up needed variables
A = 24;
C = 0.56;
t = linspace(0,20,10000);

% Calculate bacterial growth
B = A.*exp(C.*t);

% Plot the graph
plot(t,B, 'r*');
grid on;legend("Number of ...
    bacteria");xlabel("Time");ylabel("Bacteria");title("Bacterial growth");
```

We get the following graph

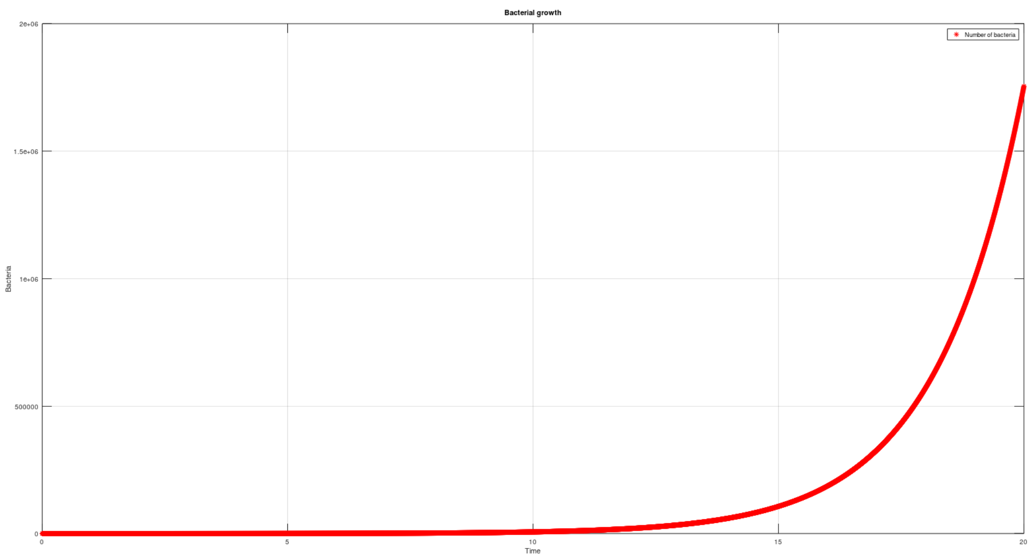

Figure 2: Bacterial growth plot

3 Task 3

3.1 Problem

3.2 Solution

4 Task 4

4.1 Problem

4.2 Solution

5 Task 5

5.1 Problem

5.2 Solution

6 Task 6

6.1 Problem

6.2 Solution

7 Task 7

7.1 Problem

7.2 Solution

8 Task 8

8.1 Problem

8.2 Solution

9 Task 9

9.1 Problem

9.2 Solution

10 Task 10

10.1 Problem

10.2 Solution