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Super Free-Response Practice AB Question 2

A graphing calculator is allowed for this problem.

It is recommended that you take no more than 45 minutes for this problem.

2. The velocity of a freight elevator at a high-rise building construction site is given by the differentiable function v_F where v_F is measured in feet per second and t is measured in seconds. Selected values of v_F are shown in the table below. There are 10 feet to a floor with the ground floor being floor zero. The freight elevator is on the 30th floor at time $t = 0$.

t (sec)	0	10	20	25	30	45	60
$v_F(t)$ (ft per second)	3	20	14	5	-6	-33	-33

- (a) Determine the minimum number of times that the elevator must be stopped within the 60 seconds. Explain your answer.

Your Score _____

- (b) Justify why there must be at least one time t , for $45 \leq t \leq 60$ at which the elevator has no acceleration.

Your Score _____

- (c) What is an approximation to the instantaneous rate of change of velocity at $t = 20$? Indicate units.

Your Score _____

(d) What is the average acceleration of the elevator over 60 seconds? Indicate units.

Your Score _____

(e) Use a midpoint sum with three rectangles to approximate the value of $\frac{1}{10} \int_0^{60} v_F(t) dt$ and interpret why this approximation is inaccurate in the context of the problem.

Your Score _____

(f) Use a trapezoid sum with the four subintervals $[0, 10]$, $[10, 20]$, $[20, 30]$ and $[30, 60]$ to approximate what floor the elevator will be on after 60 seconds.

Your Score _____

(g) Use the trapezoid sum using all the data to approximate the average speed of the elevator in floors per second.

Your Score _____

- (h) A second elevator that is meant to take only workers (not equipment) to different floors has velocity for $0 \leq t \leq 60$ as $v_w = \frac{101\sin(t/4.8)}{0.05t+2}$ feet per second. Determine what percentage of the time that the speed of the elevator is greater than 28 ft/sec.

Your Score _____

- (i) How far does the worker elevator travel when its speed is greater than 28 ft/sec? Show how you got your answer.

Your Score _____

- (j) In the 60 seconds, determine how many times the worker elevator is speeding up. Explain.

Your Score _____

- (k) If the worker elevator started on the 5th floor, what floor is it closest to after 60 seconds? **(3)**

Your Score _____

(l) What is the average speed of the worker elevator in floors per second?

Your Score _____

(m) Approximate the highest floor that the worker elevator reached. Justify your answer.

Your Score _____

(n) The height h_F of the freight elevator is modeled by $h_F = \frac{t^4}{2000} - \frac{19}{300}t^3 + \frac{37}{20}t^2 + 300$, $0 \leq t \leq 45$, with t measured in seconds. On what floor does it first stop once it starts to move?

Your Score _____

(o) What is the lowest floor that the freight elevator reached for $0 \leq t \leq 45$? Explain.

Your Score _____

(p) Once both elevators started to move, at how many times did they have the same velocity?

Your Score _____

(q) Once both elevators started to move, at how many times did they have the same speed?

Your Score _____

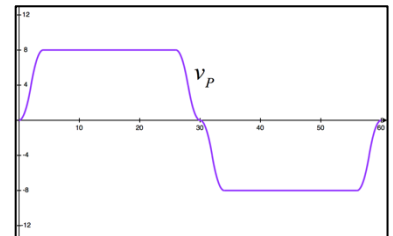
(r) Determine whether the two elevators are within 1 floor of each other at $t = 43$. Show how you arrive at your conclusion.

Your Score _____

(s) Referring to (r), are the two elevators getting closer together at $t = 43$? Explain.

Your Score _____

(t) When the building is completed, the construction elevators are removed, and passenger elevators are installed. To the right is a 60-second graph of the velocity v_p of the elevator. Briefly explain the difference in the type of ride experienced in the freight elevator and the type of ride experienced in the passenger elevator. **(1)**



Your Score _____

Grading:

Grade yourself according to the rubric that either your teacher gave you or you can find in the MasterMathMentor.com website. Be strict with yourself. Additional grading tips are given in the accompanying YouTube video for this problem.

Section	Pts available	Your score
a	3	
b	2	
c	2	
d	2	
e	3	
f	2	
g	3	
h	3	
i	3	
j	2	

Section	Pts available	Your score
k	3	
l	3	
m	4	
n	3	
o	2	
p	1	
q	1	
r	3	
s	2	
t	3	
Total	50	

There are 50 points available for this question. There is no exact formula for what number of points constitutes a 5, 4, 3, 2, or 1 on the A.P. Exam. However, these percentages are what have been used in the past based on exams released by the College Board. While you can extrapolate for just this question, realize that it tests only a limited number of AP topics. It is recommended that you do a number of questions in this series, combine your results, total your points, and then use these percentages to get a feel for how you will do in the AP exam, and more importantly, what concepts you need to strengthen to improve your score.

Grade	Percentage	This Question
5	70%	35 – 60
4	52.5%	26 – 35
3	40%	20 – 25
2	27.5%	14 – 19
1	0%	0 – 13