AP Calculus Name: _____
Hogwarts Project Date: _____ Per: ____

1) The table below gives values of the velocity, $v(t)$, of a Dementor who moves smoothly (i.e. v(t) is differentiable) at selected times.

t (sec)	0	1	3	6	10	15
$v(t)$ (m/sec)	5	1	-1	5	10	13

a) Is there a time during $0 < t < 15$ that the velocity is equal to 9 m/sec? Justify your answer completely.

b) Find an approximation for the acceleration at time $t = 2$ and indicate units. Show all your work.

c) Show that there must be a time interval such that the acceleration, $a(t)$, is equal to zero.

d) If $s(1) = 10$, then write the equation of the tangent line to the graph of $s(t)$ at $t = 1$. Then use the tangent line to approximate the value of $s(1.1)$.

e) Use a left Riemann Sum determined by the intervals given by the data to find an approximation for $\int_0^{15} v(t)dt$. Indicate units and show all work.

f) *Find the value of $\frac{1}{15}\int_0^{15} v(t)dt$ and interpret it's meaning in the context of this problem.

2) Two house elves move along a straight path. For $0 \leq t \leq 6$, the velocity of Dobby is given by the function $d'(t) = -\frac{\pi}{2}\sin\left(\frac{\pi}{4}t\right)$, while he postion of Kreacher is given by $k(t) = t^3 - 6t^2 + 9t + 3$.

a) For $0 \leq t \leq 6$, find all the times during which Kreacher is moving to the right.

b) Find Dobby's acceleration at $t = 3$. Is Dobby's speed increasing, decreasing or neither at this time?

c) Find the position function of Dobby given his initial position is 2.

3) Professor Umbridge has asked Argus Filch to once again hang a new decree from the Ministry of Magic. The ladder is 13 meters long and is leaning against the wall. Those silly Weasley twins are hiding around a corner and using magic to slowly move the bottom of the ladder away from the wall at a rate of 1 meter per second.
   a) At what rate is the top of the latter moving down the wall then the top of the ladder is 12 meters above the ground?

   b) At what rate is the top of the latter moving down the wall then the top of the ladder is 5 meters above the ground?

4) Don't be like Harry Potter who never seemed to master occlumency.
   a) Find the first and second derivative of $h(x) = g\big(f(2x)\big)$

   b) Find $\frac{dy}{dx}$ for $x = \sin(xy)$

5) *When Harry Potter was young, he got upset and "accidentally" turned his Aunt Marge into a balloon. The function $h(t) = t^3 - 4t^2 + t + 6$ gives the rate of change, in km/hr of the altitude of Aunt Marge for time $0 \leq t \leq 4$, where t is measured in hours.
   a) At what time(s) is Aunt Marge neither ascending nor descending?

   b) Assuming Aunt Marge was standing on the ground; write the function that represents her altitude.

   c) At what time during the interval $0 \leq t \leq 4$ does Aunt Marge reach her maximum height?

   d) How far is Aunt Marge from the ground after 4 hours of flight?

   e) What is the total distance traveled by Aunt Marge during the 4 hour flight?

f) Aunt Marge's shape approximates a spherical balloon. She is being inflated at a rate of 500 cm^3/sec. How fast is her radius increasing when her radius is 100 cm?

6) *It is well known that girls go to the restroom in groups, this is because of all the ladies at Hogwarts who are attacked in bathrooms. The equation $r'(t) = -3t^2 + 6t + 72$ models the number of girls being attacked in the bathroom per day. And the table below gives selected values of girls who were attacked each day.

t days	0	1	2	3	4	5	6
$r'(t)$ girls/day	72	75	72	63	48	27	0

a) Use a midpoint Riemann Sum with 3 subintervals to approximate the value of $\frac{1}{6}\int_0^6 r'(t)dt$ using correct units and explain its meaning in the context of this problem.

b) Find the number of girls who were attacked in the bathroom over the 6 day period using the model.

c) Write an equation for $r(t)$ if 10 girls were attacked when $t = 0$.


{occlumency}


WHAT IF GIRLS GO TO THE BATHROOM TOGETHOR
BECAUSE HERMOINE FROM HARRY POTTER WENT TO THE BATHROOM ALONE AND GOT ATTACKED BY A TROLL