AP Calculus AB
Skill Builder: 8.3 – Using Accumulation Functions and Integrals in Applied Contexts - AP Exam FRQ Practice

1. A parking garage has 230 cars in it when it opens at 8 AM (t = 0). On the interval $0 \le t \le 10$, cars enter the parking garage at a rate modeled by the function $E(t) = 58\cos(0.163t - 0.642)$ and leave the parking garage at a rate modeled by the function $L(t) = 65\cos(0.281t) + 7.1$ beginning at 9 AM and continuing until 6 PM (t = 10). Both $E(t)$ and $L(t)$ are measured in cars per hour while t is measured in hours.

a.) How many cars enter the parking garage over the interval t = 0 to t = 10 hours?

$$\int_0^{10} E(t)\,dt \approx 510.159 \text{ cars}$$

$e(t) := 58 \cdot \cos(0.163 \cdot t - 0.642)$ Done

$l(t) := 65 \cdot \cos(0.281 \cdot t) + 7.1$ Done

$\int_0^{10} e(t)\,dt$ 510.16

510.15994582031

b.) Find $E'(5)$. Using correct untis, explain the meaning of this value in the context of the problem.

$E'(5) \approx -1.627 \text{ cars/hour}^2$

$\frac{d}{dt}(e(t))|_{t=5}$ -1.6274

The rate at which the cars are entering the parking garage is decreasing by approximately 1.627 cars per hour per hour.

c.) Find the number of cars in the parking garage at time t = 10. Show the work that leads to your answer.

$$C(10) = 230 + \int_0^{10} E(t)\,dt - \int_1^{10} L(t)\,dt \approx 665.103 \text{ cars}$$

$230 + \int_0^{10} e(t)\,dt - \int_1^{10} l(t)\,dt$ 665.103

d.) Find the time t on $0 \le t \le 10$ when the number of cars in the parking garage is a maxumum. To the nearest whole number, what is the maximum number of cars in the parking garage? Justify your answer.

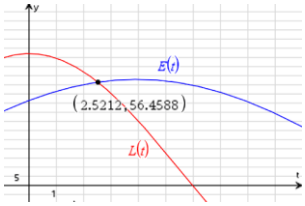
Let the number of the cars in the garage at time t be modeled by

$$C(t) = 230 + \int_0^t E(x)\,dx - \int_1^t L(x)\,dx$$

$C'(t) = E(t) - L(t)$

$C'(t) = 0$ when $E(t) - L(t) = 0$ or $E(t) = L(t)$ which occurs when $t \approx 2.521$ hours.

t	$C(t)$
0	$230 + \int_0^0 E(t)\,dt = 230$
2.521	$230 + \int_0^{2.521} E(t)\,dt - \int_1^{2.521} L(t)\,dt \approx 264.425$
10	$230 + \int_0^{10} E(t)\,dt - \int_1^{10} L(t)\,dt \approx 665.103$



$230 + \int_0^{2.521} e(t)\,dt - \int_1^{2.521} l(t)\,dt$ 264.425

The maximum number of cars in the garage is approximately 665 cars at time t = 10 or 6 PM.