NAME James Ding
AP Calculus AB

DATE
FRQ #14

Rates

Water is pumped into an underground tank at a constant rate of 8 gallons/minute. Water leaks out of the tank at the rate of $\sqrt{t+1}$ gallons per minute, for $0 \le t \le 120$ minutes. At time t = 0, the tank contains 30 gallon of water.

(a) How many gallons of water leak out of the tank from time t = 0 to t = 3 minutes?

$\int_0^8 (8 - \sqrt{t+1})\,dt$ ~~me~~ :

$f(t) = 8t - \frac{2(t+1)^{3/2}}{3} + c$

$c = \frac{92}{3}$

$t=0$
$f(t) = 30$

$\cancel{\frac{58}{3}}$

$\boxed{\int_0^3 \sqrt{t+1} = \frac{14}{3}}$

(b) How many gallons of water are in the tank at time t = 3 minutes.

$8(3) - \frac{2(3+1)^{3/2}}{3} + \frac{92}{3} = \frac{148}{3}$

(c) Write an expression for A(t), the total number of gallons of water in the tank at time *t*.

$A(t) = 8t - \frac{2(t+1)^{3/2}}{3} + \frac{92}{3}$

(d) At what time *t*, for $0 \le t \le 120$, is the amount of water in the tank a maximum? Justify.

$x = 63$

$8 - \sqrt{t+1}$
goes from positive to negative, which indicates a max.

t	A'(t)
62.99	+
63	0
63.01	-

negative (a.k.a max)

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FRQ #15

Rates

The number of gallons, $P(t)$, of a pollutant in a lake changes at the rate $P'(t) = 1 - 3e^{-0.2\sqrt{t}}$ gallons per day, where t is measured in days. There are 50 gallons of the pollutant in the lake at time $t = 0$. The lake is considered to be safe when it contains 40 gallons or less of pollutant.

(a) Is the amount of pollutant increasing at time $t = 9$? Why or why not?

No, it's decreasing. This is because the given function $p'(t) = 1 - 3e^{-0.2\sqrt{t}}$ at $t=9$ results to -0.64, which indicates a negative rate of change, or a decrease in pollutant.

(b) For what value of t will the number of gallons of pollutant be at its minimum? Justify.

$p'(t) = 0$ $\boxed{t = 30.17.}$

t	$p'(t)$
30.15	$-$
30.17	$=0$
30.19	$+$

Positive (aka minimum)

(c) Is the lake safe when the number of gallons of pollutant is at is minimum? Justify.

$$50 + \int_0^{30.17} \left(1 - 3e^{-0.2\sqrt{t}}\right) dt = 35.104$$

Yes. The lake would be safe.

(d) An investigator uses the tangent line approximation to $P(t)$ at t = 0 as a model for the amount of pollutant in the lake. At what time t does this model predict that the lake becomes safe?

$p'(0) = 1 - 3e^0 = -2$

$(50-2x) = \cancel{P(0)} + \cancel{p'(0)}$

$40 = 50 - 2x$

$x = 5$

$\boxed{t = 5}$