Write legibly, clearly indicate the question you are answering, and put a box or circle around your final answer. If you do not clearly indicate the question numbers, I will take off points. Write as much work as you need to demonstrate to me that you understand the concepts involved. If you have any questions, raise your hand and I will come over to you.

It is estimated that t hours after $8{:}00$ am, the population of a certain bacterial sample, denoted $N(t)$, will be changing at a rate of

$$N'(t) = \frac{9t}{\sqrt{t+5}} \text{ hundred bacteria/hour.}$$

1. [2 pts] Set up the integral that describes the **average** change in the bacteria population from $9{:}00$ am to $3{:}00$ pm.

9:00am is 1 hour past 8:00 am

3:00pm is 7 hours past 8:00 am

$$\text{Average} = \boxed{\frac{1}{7-1} \int_1^7 \frac{9t}{\sqrt{t+5}} \, dt}$$

2. [8 pts] Compute the value of the integral from # 1.

$$\frac{1}{6} \int_1^7 \frac{9t}{\sqrt{t+5}} \, dt = \frac{9}{6} \int_1^7 t(t+5)^{-\frac{1}{2}} \, dt$$

$$\boxed{\begin{array}{l} u = t+5 \Rightarrow t = u-5 \\ \frac{du}{dt} = 1 \Rightarrow du = dt \\ u(7) = 7+5 = 12 \\ u(1) = 1+5 = 6 \end{array}}$$

$$= \frac{3}{2} \int_{u(1)}^{u(7)} (u-5) u^{-\frac{1}{2}} \, du$$

$$= \frac{3}{2} \int_6^{12} \left(u^{1-\frac{1}{2}} - 5u^{-\frac{1}{2}}\right) du$$

$$= \frac{3}{2} \int_6^{12} \left(u^{\frac{1}{2}} - 5u^{-\frac{1}{2}}\right) du$$

$$= \frac{3}{2} \left[\frac{1}{\frac{1}{2}+1} u^{\frac{1}{2}+1} - \frac{5}{-\frac{1}{2}+1} u^{-\frac{1}{2}+1}\right]_6^{12}$$

$$= \frac{3}{2} \left[\frac{1}{\frac{3}{2}} u^{\frac{3}{2}} - \frac{5}{\frac{1}{2}} u^{\frac{1}{2}}\right]_6^{12}$$

$$= u^{\frac{3}{2}} - 15u^{\frac{1}{2}} \Big|_6^{12}$$

$$= \boxed{12^{\frac{3}{2}} - 15\sqrt{12} - \left[6^{\frac{3}{2}} - 15\sqrt{6}\right]}$$