**12.** (14 pts.) Sunny and Tyrrell have been dating since New Year's Eve. Sunny has noted that the amount of affection she has for Tyrrell, measured in bushels, is growing at a linear rate. However, since she is a math major, she tells her friend that her affection is growing as the slope of the line tangent to the curve $f(t) = \sqrt{t}$ at the point $(4,2)$, where $t$ is in weeks since the first of January.

**(a)** At what rate is Sunny's affection for Tyrrell growing? Write your answer in a complete sentence.

$$f(t) = t^{1/2} \qquad f'(t) \; \frac{1}{2} t^{-1/2}$$

$$f''(4) = \left(\frac{1}{\sqrt{4}}\right) = \frac{1}{4}$$

*Sunny affection is growing at the rate of $\frac{1}{4}$ bushel per week*

**(b)** Find an equation of the line that is tangent to $f$ at the point $(4,2)$. This is the model for Sunny's affection, $S(t)$.

$$S(t) = \frac{1}{4} t + 1$$

$$a \; \frac{1}{4}(4) + b$$
$$b = 1$$

Tyrrell, being an applied mathematician, determines that he can model his affection for Sunny according to the power function $T(t) = kt^2$ (again in terms of bushels and weeks).

**(c)** If Tyrrell's model passes through the point $(8,3)$, what is $k$?

$$3 = k(8)^2 \longrightarrow k = \frac{3}{64}$$

**(d)** If Sunny and Tyrrell's affection models continue to hold, and if the person with the most affection for the other buys Valentine flowers, who will buy the flowers? Explain. (Hint: Valentine's day is two days from now.)

*Valentine's Day occurs @ t ≈ 6.*
$$S(6) = \frac{6}{4} + 1 = 2.5 \text{ bushels of affection.}$$
$$T(6) = \frac{3}{64}(36) = 1.6875 \text{ bushels of affection.}$$
*Sunny will buy the flowers.*

**(e)** Is there a time that Sunny and Tyrrell will have equal affection for one another? If so, approximately when. If not, why not?

*If so then*
$$\frac{1}{4} t + 1 = \frac{3}{64} t^2$$
$$16 t + 64 = 3 t^2$$
$$3t^2 - 16t - 64 = 0$$
$$(3t + 8)(t - 8) = 0$$
$$t = -\frac{8}{3} \quad \text{or} \quad t = 8$$
*discard*

*Yes, Sunny & Tyrrell will have equal affection for one another at t=8, or in early March. At that time each will have 3 bushels of affection for the other person.*