a.

$$\frac{d[A]}{dt} = -k_1 - k_2[A]^2$$

b.

$$\int \frac{d[A]}{\frac{k_1}{k_2} + [A]^2} = \int -k_2 dt$$

$$\sqrt{\frac{k_2}{k_1}} \tan^{-1}\left(\sqrt{\frac{k_2}{k_1}}[A]\right) = -k_2 t + C$$

$$[A] = \sqrt{\frac{k_1}{k_2}} \tan\left(-\sqrt{k_1 k_2} t + C\right)$$

Since $[A]$ at $t = 0$ is equal to 1 molar, $C = \tan^{-1}\left(\sqrt{\frac{k_2}{k_1}}\right)$

c. This is when $[A] = 0$ which happens when $-\sqrt{k_1 k_2} t + C = 0$ or when

$$t_f = \frac{\tan^{-1}\left(\sqrt{\frac{k_2}{k_1}}\right)}{\sqrt{k_1 k_2}}$$

d. The concentration of $[B]$ after a certain time is $k_1 t$. The total amount of $[A]$ decomposed after a time is $1 - \sqrt{\frac{k_1}{k_2}} \tan\left(-\sqrt{k_1 k_2} t + C\right)$, so the concentration of $[C]$ after a certain time is

$$1 - \sqrt{\frac{k_1}{k_2}} \tan\left(-\sqrt{k_1 k_2} t + C\right) - k_1 t.$$

After the time found in part c elapses, the ratio of B to C is $\frac{k_1 t_f}{1 - k_1 t_f}$.