

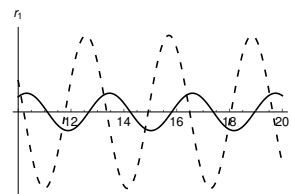
3. [15 points] A chemical reaction with two reagents (chemicals) in amounts r_1 and r_2 that may be converted from one to the other may be modeled the system of first-order differential equations

$$\begin{aligned} r_1' &= -3r_1 + 9r_2 \\ r_2' &= k r_1 - r_2 + f(t), \end{aligned}$$

where $f(t)$ is the rate at which the second reagent is being added to the reaction and k is a constant.

- a. [5 points] Write down the second-order linear equation which has r_1 as its solution.

- b. [5 points] If $f(t) = \cos(\omega t)$ is the dashed curve in the figure below, for what values of k , if any, could the long-term behavior of r_1 be that shown by the solid curve? Explain your answer.



- c. [5 points] If $f(t) = A_0$, a constant, for what values of k , if any, could the phase portrait for this system be similar to that shown in the figure below? Explain your answer.

