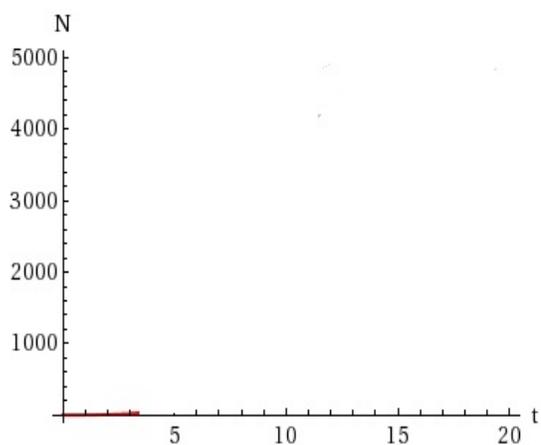


**DIRECTIONS** To receive full credit, you must provide complete legible solutions to the following problems in the space provided. Be sure to supply all the necessary steps that lead to your answers.

1. The number  $N(t)$  of supermarkets throughout the country that are using a computerized checkout system is described by the initial-value problem

$$\frac{dN}{dt} = N(1 - 0.0002N), \quad N(0) = 1.$$

- a. Use the phase portrait concept of Section 2.1 to predict how many supermarkets are expected to adopt the new procedure over a long period of time. By hand, sketch a solution curve of the given initial-value problem.
- b. Solve the initial-value problem and then use a graphing utility to verify the solution curve in part (a).



2. A tank in the form of a right-circular cylinder standing on end is leaking water through a circular hole in its bottom. As we saw in (10) of Section 1.3, when friction and contraction of water at the hole are ignored, the height  $h$  of water in the tank in centimeters after  $t$  seconds is described by

$$\frac{dh}{dt} = -\frac{A_h}{A_w} \sqrt{2gh},$$

where  $A_w = 40 \text{ cm}^2$  and  $A_h = 2 \text{ cm}^2$  are the cross-sectional areas of the water and the hole, respectively.

Solve for  $h(t)$  if the initial height of the water is  $h$ . Give its interval  $I$  of definition. Use  $g = 980 \text{ cm/s}^2$ .