Name:
Result:

**1.** *(8 points)*

Jean-Pierre jumps out of an airplane that is flying at constant altitude. Before opening his parachute, he goes through a period of freefall. Jean-Pierre's vertical speed during the time of freefall, $S$, in $\frac{m}{s}$, is modelled by the following function.

$$S(t) = K - 60(1.2)^{-t}, \qquad t \geqslant 0$$

where $t$, is the number of seconds after he jumps out of the airplane, and $K$ is a constant.

Jean-Pierre's initial vertical speed is 0 $\frac{m}{s}$.

(a) Find the value of $K$.

(b) State the equation of the asymptote of the graph of $S(t)$ and state what this asymptote represents in the context of the model.

(c) Find Jean-Pierre's vertical speed after 10 seconds.

(d) Calculate how long will it take for Jean-Pierre to reach vertical speed of 30 $\frac{m}{s}$.

**2.** *(7 points)*

The temperature of a cup of tea, $t$ minutes after it is poured, can be modelled by:

$$T(t) = 21 + 75e^{-0.08t}, \qquad t \geqslant 0$$

The temperature is measured in degrees Celsius.

(a) Find the initial temperature of the tea.

(b) Find the temperature of the tea 3 minutes after it is poured.

(c) After $k$ minutes, the tea will be below $67°C$ and cool enough to drink. Find the least possible value of $k$, where $k \in \mathbb{Z}$.

(d) As the tea cools, $T$ approaches the temperature of the room, which is constant. Find the temperature of the room.

**3.** *(5 points)*

The current population of a town is approximately 15000.

(a) Create a model for the population ($P$) of this town after $t$ years, if it is assumed that the population will increase by 9% each year. Use this model to estimate the population of the town in 2030.

(b) Create an alternative model for the population ($P$) of this town after $t$ years, if it is assumed that the population will increase **continuously** at a rate of 9% per year. Use this model to estimate the population of the town in 2030.