Question 15 (9 marks)

A chef needs to use an oven to boil 100 mL of water in five minutes for a new experimental recipe. The temperature of the water must reach 100 °C in order to boil. The temperature, T, of 100 mL of water t minutes after being placed in an oven set to T_0 °C can be modelled by the equation below.

$$T(t) = T_0 - 175e^{-0.07t}$$

In a preliminary experiment, the chef placed a 100 mL bowl of water into an oven that had been heated to $T_0 = 200$ °C.

(a)   What is the temperature of the water at the moment it is placed into the oven?   (1 mark)

(b)   What is the temperature of the water five minutes after being placed in the oven?

(1 mark)

(c)   What change could be made to the temperature at which the oven is set in order to achieve the five-minute boiling requirement?   (2 marks)

Assume that T_0 is still 200 °C.

(d)   Determine the rate of increase in temperature of the water five minutes after being placed in the oven. Give your answer rounded to two decimal places.   (2 marks)

(e)   Explain what happens to the rate of change in the temperature of the water as time increases and how this relates to the temperature of the water.   (3 marks)