Question 7

Sometimes it is possible to predict the future population in a city using a function. The population in Sapphire City, over time, can be predicted using the following function:

$$p(t) = Se^{0.1t} \times 10^6.$$

The population in Avalon, over time, can be predicted using the following function:

$$q(t) = 3 \cdot 9e^{kt} \times 10^6.$$

In the functions above, t is time, in years; t = 0 is the beginning of 2010; and both S and k are constants.

(a) The population in Sapphire City at the beginning of 2010 is 1 100 000 people. Find the value of S.



(b) Find the predicted population in Sapphire City at the beginning of 2015.



(c) Find the predicted change in the population in Sapphire City during 2015.



(d) The predicted population in Avalon at the beginning of 2011 is 3 709 795 people. Write down and solve an equation in k to show that k = -0.05, correct to 2 decimal places.

(e) Find the year during which the populations in both cities will be equal.



(f) Find the predicted average population in Avalon from the beginning of 2010 to the beginning of 2025.



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(g) Use the function $q(t) = 3 \cdot 9e^{-0 \cdot 05t} \times 10^6$ to find the predicted rate of change of the population in Avalon at the beginning of 2018.