Subject:	Mathematics 281
Assessment:	Assignment 3
Due date:	2023-06-23
Total:	45 Marks

Introduction: Cockroach on an Elastic Tightrope

The instantaneous rate of change measures the rate of change, or slope, of a curve at a certain instant. Thus, the instantaneous rate of change is given by the derivative.

Outline

Question 1

Suppose you are standing on an elastic rope b metres from the left end and c metres from the right end. The rope is then stretched uniformly, increasing its length by d metres. How far are you from each end? Show all your calculations.

Question 2

Suppose a cockroach starts at one end of a 1000 metre tightrope and runs towards the other end at a speed of one metre per second. At the end of every second, the tightrope stretches uniformly and instantaneously, increasing its length by 1000 metres each time.

1. Does the roach ever reach the other end?
2. If so, how long does it take?

To answer these questions, proceed as follows. Consider the sequence $(d_i)_{i=1}^{\infty}$ where d_i represents the distance the roach still has to go after i seconds, but before the rope does its instantaneous stretch. Find a formula for d_i and then simplify it. Prove that your formula is valid for all i using the technique of mathematical induction. Read about mathematical induction in a precalculus or calculus book if you are not familiar with it. Show all your calculations.

Question 3

To generalize the problem, suppose you don't know how long the rope is initially, nor how fast the roach runs, nor how much longer the rope gets after every second. All you know is that the roach maintains a constant speed, and that the rope stretches uniformly and instantaneously by some fixed amount after every second. Answer the same two questions as for Question 2. Show all your calculations.

Mark Allocation

Criteria	Weight
Question 1	5
Question 2	20
Question 3	20
Total	**45**

Additional Information

- All work must be done on your own.
- Belgium Campus have software that can **scan for plagiarism** and a student caught doing this will get 0 for this assignment.
- Late assignments will not be accepted; missing the deadline is an automatic 0.
- Round off to 3 decimal figures (3.d.p).