**TITLE OF ASSIGNMENT:** Mathematics II- Assignment 3

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**TOPIC:** Cockroach on an Elastic Tightrope (Option 1)

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# Question 1:

The given variables were as follows:

b = distance from the left

c = distance from the right

d = amount that the rope is stretched

b P c

Therefore, the following diagram represents the distances after the rope has stretched:

b + 1/2d P c + 1/2d

∴ Distance from the left = b + 0.5d

and Distance from the right = c + 0.5d

# Question 2:

* 1. To prove the given scenario, we can set up the following variables:

c = rope length (original)

a = motion of cockroach  
v = increase of the rope length

We can create a table to represent distance per unit of time as follows:

|  |  |  |
| --- | --- | --- |
| **Second:** | **Cockroach’s coverage:** | **The proportion of the rope:** |
| 1st | a | c + v |
| 2nd | a | c + 2v |
| 3rd | a | c + 3v |
| kth | a | c + kv |

Now we can establish a relationship between this function and one that will always have a smaller value, which can be obtained by also multiplying c by k in the denominator such that:

By transforming the series on the right with respect to the famous Harmonic series (as shown in red), we obtain:

We already know that the highlighted series is divergent and will eventually reach a value of 1. Therefore, our expression will be greater than 1.

Since it is greater than 1, the proportion covered is 1/1th of the distance.

**∴ Yes, the cockroach will reach the end eventually.**

* 1. We can create the following variables to represent the given quantities from the question:

n = target point

a = cockroach’s motion

d = speed of rope increase

∴ x= n+vt represents the point of a given time interval t.

The speed of the ant can then be represented by the following function:

Therefore, the proportional time can be transformed into a separate function:

By integrating this function, we get the position function for the cockroach to reach the target point.

To reach the end of the rope, the proportional speed of the cockroach must equal to 1. This will mean that it covered 1/1th of its percentage, which is the entire path.

∴

Using the given values:

After simplifying this value, this is how long it will take to reach the end of the rope:

# Question 3:

In answer 3, we take into account a hypothetical situation in which the rope's initial length (L), roach's speed (s), and rate of stretch (d) are all unknown. If the roach ever makes it to the other end, we want to know how long it takes.

Let's study the relationship between the length of the rope after i seconds (Li) and the distance the roach must travel after i seconds (di) in order to comprehend this scenario.

We determine that the roach's required travel distance, this can be expressed by the equation:

di = L - s - (i - 1) d

Finding a n for which dn = 0 — a sign that the roach has reached the end — is necessary to establish whether the roach reaches the opposite end.

With dn set to 0, we arrive at the formula (L - s) / d + 1 = n. This expression must result in a positive integer n in order for the roach to go to the other end.

To sum up, the roach will only reach the other end of the generalized scenario in Question 3 if the expression (L - s) / d + 1 evaluates to a positive integer. If it doesn't, the required amount of time is endless, and the roach will never reach the other end.

In conclusion, the precise values of L, s, and d, which are not given, determine whether the roach reaches the other end and how long it takes in the generalized case.