



PART 1: GENERAL COMPREHENSION

Watch the video

<https://www.youtube.com/watch?v=Kas0tIxDvrg&feature=youtu.be>

from the World Health Organization (you are allowed to add English subtitles), then **answer** the following questions.

1. Frames at 0'04", 0'15", 0'27" present different graphs, what are the differences?
2. What does exponential growth mean?
3. In the diffusion of a virus what brings new cases?
4. What do the symbols N_d , E and p mean in this video?
5. What aspect of the equation $\Delta N = E \cdot p \cdot N$ implies a fast growth of N ?
6. The graphs in frame 1'57" is still different from the ones seen before, what is changing now? How does the exponential growth change in this new graph?
7. What is the (average) period after which the number of infected is multiplied by 10?
8. Does the speaker consider the approximation of the curve to a straight line as excellent?
9. Take into consideration the data suggested by the speaker: if at the same time a country has 4 100 infected and another one has 4 infected, how many days is the second behind the first one?
10. Why can't the curve of infected people grow indefinitely?
11. How should the term p be corrected in order to have a more realistic model taking into consideration that, at a certain moment, most of the people are already infected and for such people the probability that contacts bring to infection is zero?
12. Taking into account this last correction, one gets the curve which best approximates the behaviour of the infection. What is the name of the curve?
13. In which period the curve is indistinguishable from exponential growth? What does it happen out of the period?
14. The point where the curve leaves the exponential behaviour has a special name. What is it? Geometrically speaking, what happens to the curve before and after that point? What does it mean for the number of infections?
15. How is the "growth factor" defined?
16. Approximately how much is the growth factor near the Inflection Point?
17. The assumption that people shuffle randomly around the world is realistic or not? If yes explain why. If not, explain which assumption is realistic and how it has an influence on the law of growth.
18. Which parameter decreases if people stop travelling and gathering? Which parameter decreases if people increase personal care? Which effect has a small decreasing of such parameters on contagions?
19. What should we worry about when fear decreases?

Write an essay (190 words) explaining the role and importance of science in the present period with particular attention to mathematical aspects.

Pay attention to grammar, spelling, cohesion, coherence and layout (introduction, development, conclusion) as it will be assessed by the teacher of English as well.

PART 2: MATHEMATICAL INSIGHTS

Watch the video

<https://www.youtube.com/watch?v=Kas0tlxDvrg&feature=youtu.be>

(same as Part 1) from the World Health Organization, then **answer** the following questions.

1. What kind of transformation should be performed to the Cartesian plane so that an exponential curve becomes a straight line? Which transformation should be used to make a parabola (consider simply $y = x^2$) straight? And what about a cubic function ($f(x) = x^3$)? Is it the same transformation as the quadratic function?
2. Where does the differential equation¹

$$N' = c \cdot \left(1 - \frac{N}{T}\right) \cdot N \quad (1)$$

appear in the video?

Find all the solutions of the equation (1).

Detailed explanations of every single passage are needed.

3. Find the solution to equation (1) which satisfies the condition of having N_0 infected people at the day d_0 , that is to say, satisfying the condition

$$N(d_0) = N_0 .$$

4. Use Geogebra to plot the solution found in point 3. depending on the parameters (c , T , d_0 and N_0) defining a slider for each one of them. Describe the effects of changing the various parameters on the curve from the mathematical point of view and from the real point of view.

¹ T stands for total population, N represents the number of infected and it is a function of time, so the derivative is made with respect to the variable t .