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The questions may help you, but it's not compulsory to answer all of them: you can simply explain a way
to solve an exercise, even if you can't find the solution*

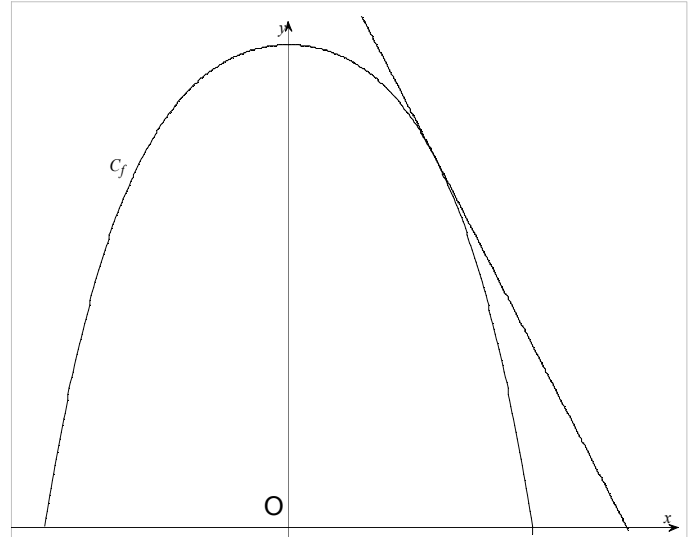
The Gateway Arch in St Louis, Missouri, was built as a monument to commemorate the pioneering spirit of the explorers who forged the westward expansion of the United States.

Let f be the function defined by :

$$f(x) = 212 - 10.5 (e^{0.03x} + e^{-0.03x})$$

We admit that the graph of this function drawn on the right is the model of the Gateway Arch.

(x and y are measured in metres).

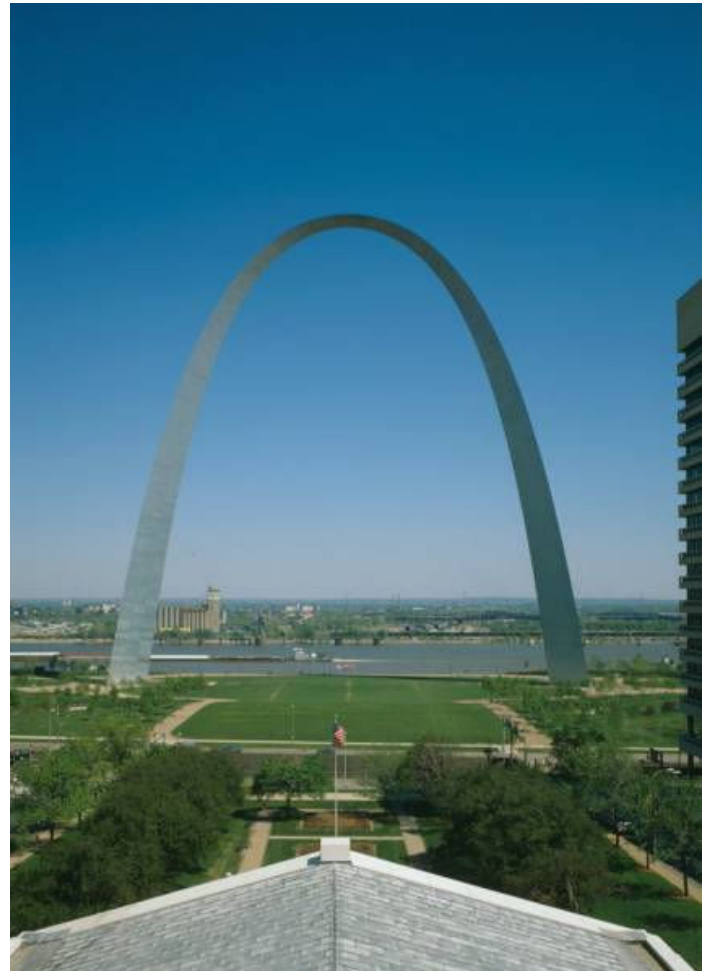


Introduction

- 1) Calculate the derivative of f .
- 2) Find the equation of the tangent to this curve at $x = 60$ (round the coefficients to one decimal place).

Questions:

- 1) Calculate the height of the Arch, in metres.
- 2) In order to renovate the Arch, a “big ladder” rests against it where $x = 60$. How far from the origin will be the base of the ladder?

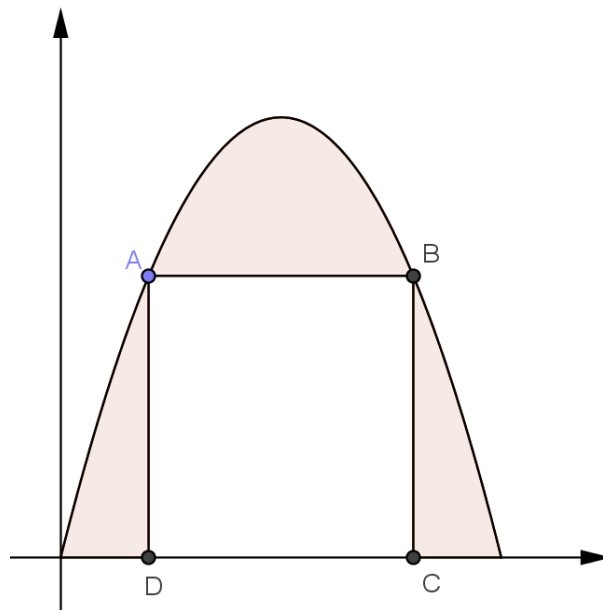


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The facade of a building has a parabolic shape.

Its equation is $y = -x^2 + 4x$ where x and y are measured in metres.

On this façade is a door (ABCD on the graph). This door is 2.56 metres high.



Introduction

What are the coordinates of points A, B, C and D?

Question

A painter has to paint all the façade (except the door).

How many litres of paint does he need knowing that 1 litre of paint covers 2 m^2 ?

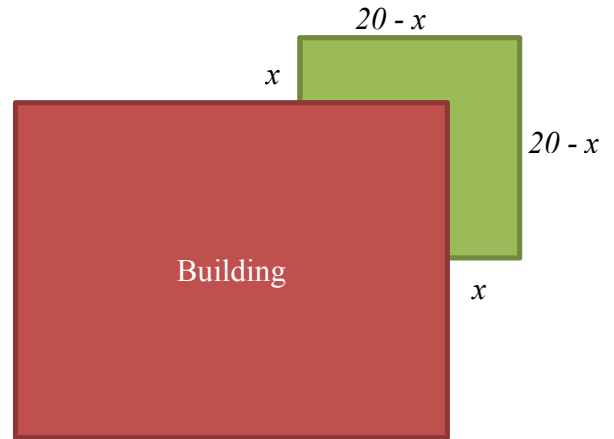
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Part 1:

A farmer has 40m of fencing with which to enclose a garden.

He decides to use a right-angled corner of a building, as in the diagram.

Show that the area which he can enclose is given by the expression $(40x - 3x^2)$ m² and deduce the maximum value of this area.



Part 2:

The Golden Ratio is the only positive solution of the equation: $1 + \frac{1}{\varphi} = \varphi$

- Find the value of φ .
- Do you know other fields of application where φ has been used?

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Twin brothers, Ed and Jim, deliver the evening newspaper six nights a week. Ed delivers on two nights, chosen at random, and Jim on the other nights. They ride by a house on their bicycle and throw the newspaper onto the porch.

The probability that Ed hits the door is $\frac{3}{5}$ and the probability that Jim hits the door is $\frac{1}{10}$.

- 1) What is the probability that it is Jim's night and that the newspaper doesn't crash against the door?
- 2) What is the probability that one night the newspaper crashes against the door?
- 3) One night, while Mr Jones is watching TV before dinner, he hears a paper crashing against the door. He sighs to Mrs Jones: "It must be Ed's night".

What is the probability that he is right?





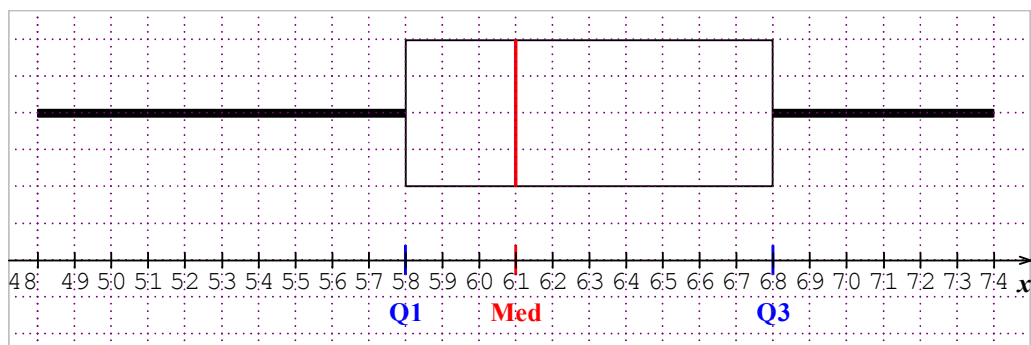
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- 1) A partial list of U.S Presidents and their respective ages when they took the charge of the White House are given.

President	Washington	Jackson	W.H.Harrison	Lincoln	A.Johnson	B.Harrison	J.Roosevelt	F.D.Roosevelt	Kennedy	Clinton	R. Reagan	G.W.Bush	B.Obama
Age	57	61	68	52	56	55	42	51	43	46	70	54	47

- How could you illustrate these ages?
- Find five key numbers to summarize those data.
- Was Bill Clinton in the youngest 25% in the given list?

- 2) Here is the box and whiskers plot of the ages of some french presidents, from 3rd, 4th and 5th republic, when they were elected.

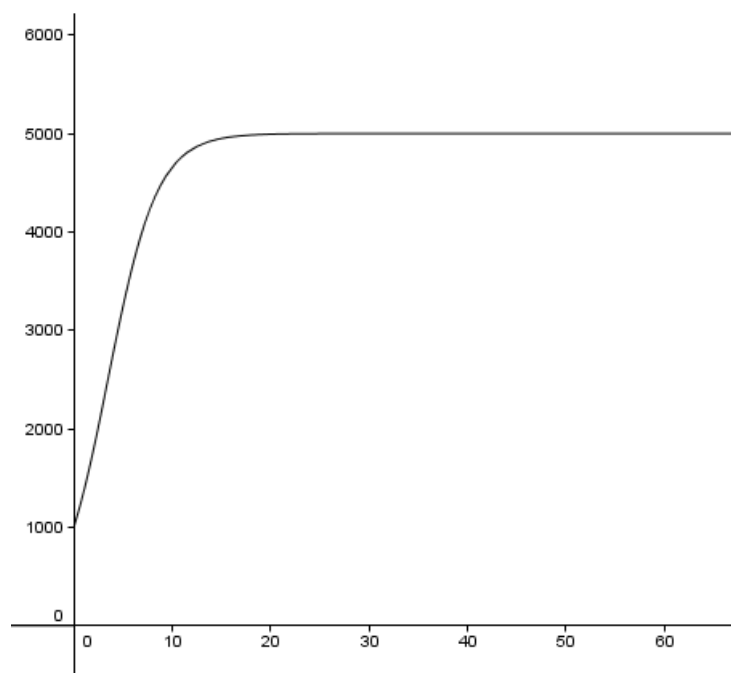


Compare the data of the two countries.

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An ecological study shows that a lake can host a maximum population of 5000 fish.

The logistic function that governs the fish population is $P(t) = \frac{5000}{1 + 4e^{-0,4t}}$ where t is measured in months. Its graph is given below.



- 1) How many fish were initially put in the lake?
- 2) How many fish are in the lake after 5 months?
- 3) What is the evolution of this population?
- 4) When will the number of fish be 70 percent of the maximum capacity?
- 5) How would you have answered each question without the graph?

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A piece of paper is 0.2 mm thick.

Let assume that it's possible to fold it as many times as desired. It means that after one fold, the thickness is 0.4 mm, after two folds 0.8 mm and so on.

- 1) Which kind of sequence describes this situation?
Give its characteristics.
- 2) How thick is the folded paper after 10 folds? After n folds?
- 3) How many times would it need to be folded so that the thickness reaches the moon
(about 400 000 km)?
- 4) Do you know, actually, how many times we can fold a normal sheet of paper?



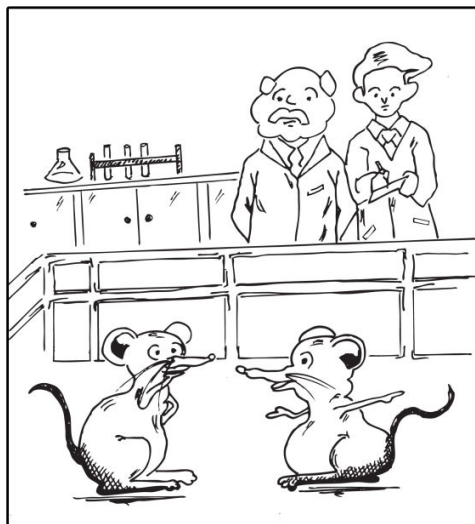
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- 1) A woman's house is infested by rats. There are 500 rats in the house and their number increases by 5% daily. The woman decides to fight back. Every day, she sets twenty rat-traps, each of which kills one rat without fail.
How long is it before the number of rats has doubled?

- 2) Her neighbor has the same problem, and she also decides to fight back. There are also 500 rats in her house increasing in number by 5% daily. Every day, she sets twenty rat-traps, each of which kills one rat without fail.
If u_n is the number of rats on day n , use the sequence (v_n) , where $v_n = u_n - 400$ to describe the evolution of the number of rats.

- 3) What happens if she kills 25 rats each day?

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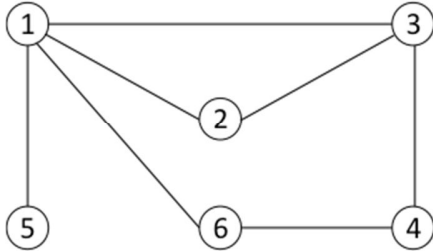


**I'M TELLING YOU FILBERT, PRESS THE RED BUTTON AND
THEY'LL DANCE AND GIVE US CHEESE EVERY TIME!**

<http://www.whatispsychology.biz/wp-content/uploads/2012/02/psych-comics-rats.jpg>

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1. Leaning on the following example and involving specific vocabulary, list as many sentences as you can about graphs and give the associated matrix.



2. Associating a graph to the following map of a part of Europe, explain how to color it so that two adjacent countries don't have the same color. What is the minimum number of colors required?



3. Is it possible to visit each country crossing each border once and only once?

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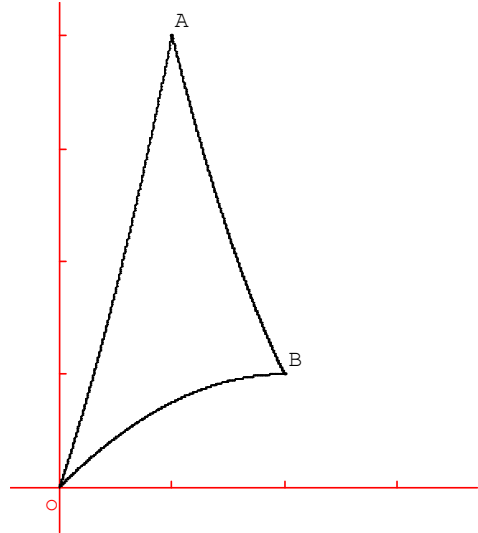
Inside the shape

We want to find the area inside this shape.

The coordinates of A and B are not known.

We have got three curves. Their equations are :

- $y = x(x+3)$
- $y = x - 0,25x^2$
- $y = x^2 - 6x + 9$



- 1) First of all identify which curve goes through O and A, which one through O and B, and which one through A and B.
- 2) Calculate the area. (it could be helpful to cut the shape in two parts).