ME40358 – Assessment 1a

Analytical Otimisation Problem 2020/21

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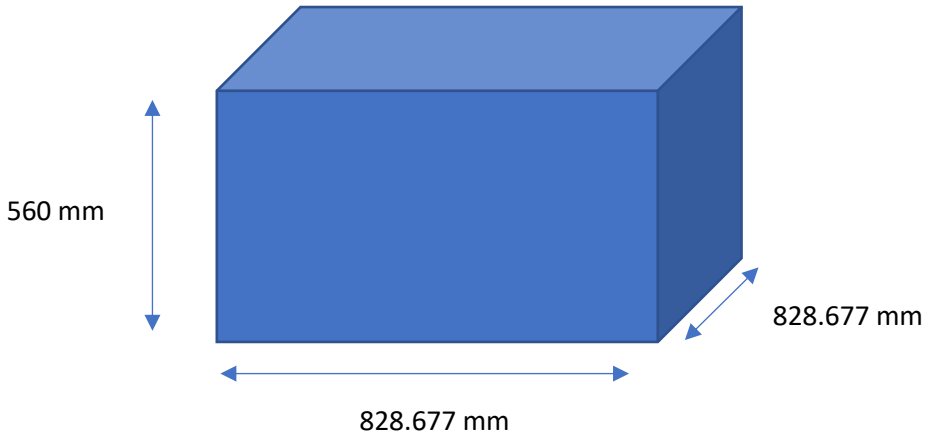
Background Information

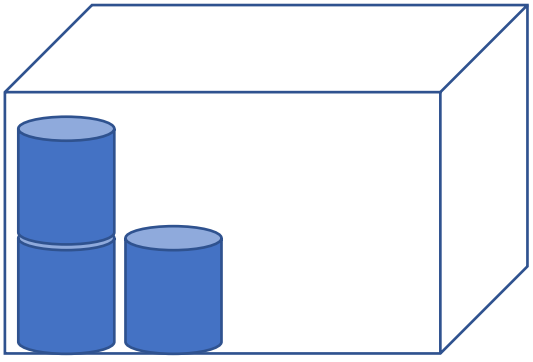
A manufacturer supplies bearings to wind turbine producers. They also supply lubricant for these bearings and this lubricant is to be stored in cylindrical cans. They are now deciding how best to size these cans to minimise the amount of material they need for each can, and also to make their shipping more efficient.

The dimensions of each can is specified according to its radius, r, and its height, h. For this entire assignment you can assume that the thickness of the can walls (side walls, base and lid) are zero mm. All cans can be completely filled and must hold a volume of 500 mL of lubricant.

The supplier already has crates being manufactured for some of their other components and they insist on using this crate to ship the lubricant cans. All orders for lubricant will be placed on a per-crate basis. The crate itself has a square base and the internal dimensions of the crate are shown in the figure below.



For structural reasons, the cans must be stored in the crate standing on their cylindrical bases. Cans can be stacked on top of each other, as shown below.



For this part of the assignment, you must calculate and show your working for the following:

i. What is the optimal radius of each can?
ii. What is the optimal height of each can?
iii. How many cans can you fit within the crate?

There is no need to write a formal report, so you can dispense with introduction, aims etc. for this part of the report. Simply show all calculation steps and all of your working. At the end of this report section, please clearly show your answers to (i), (ii) and (iii) in a table.

You are welcome to use any means at your disposal to solve this problem. However, you should note that this can be solved directly using algebra and calculus. As a final hint, I will tell you that a little research may help you when identifying the number of cans that will fit in a crate… if you can search for the right thing. I can also tell you that overfilling the crate (specifying a number too high for (iii)) will cost you more marks than a more conservative value that can definitely fit within the crate… c'est la vie.