In a factory a paternoster elevator (see figure 1) is used to transport rectangular bins from the ceiling to the floor. This is a chain-elevator with product carriers (each carrier can hold at most one bin) at a certain fixed distance. The number of carriers between the ceiling and the floor is 4. Every time a carrier reaches the ceiling (and, simultaneously, another one reaches the floor) the elevator stops 2 seconds. This is exactly the time a bin needs to enter or leave the carrier. Subsequently the elevator starts to move again till the next carrier reaches the ceiling. This takes exactly 3 seconds. Then it waits for 2 seconds, moves again, and so on. The process of waiting and moving goes on continuously. Note that a bin, finding on arrival an empty carrier positioned in front of it, cannot enter the carrier, because the residual time till the carrier start to move again is less than 2 seconds. The bin has to wait till the next carrier arrives.

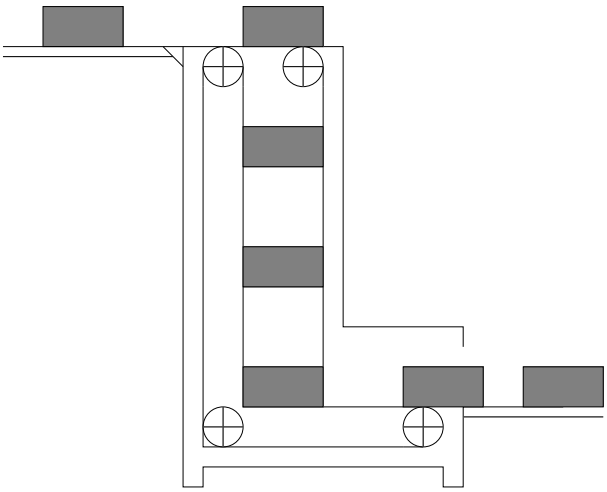

Figure 1: Paternoster elevator

Bins arrive according to a Poisson process with a rate of 10 bins per minute.

(i) Determine the mean waiting time of a bin in front of the elevator.

(ii) Determine the mean time that elapses from the arrival of a bin till the moment the bin leaves the elevator downstairs.