

(i)

PIPELINING

ANALOGY:

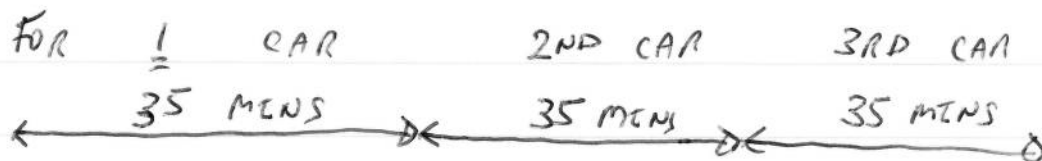
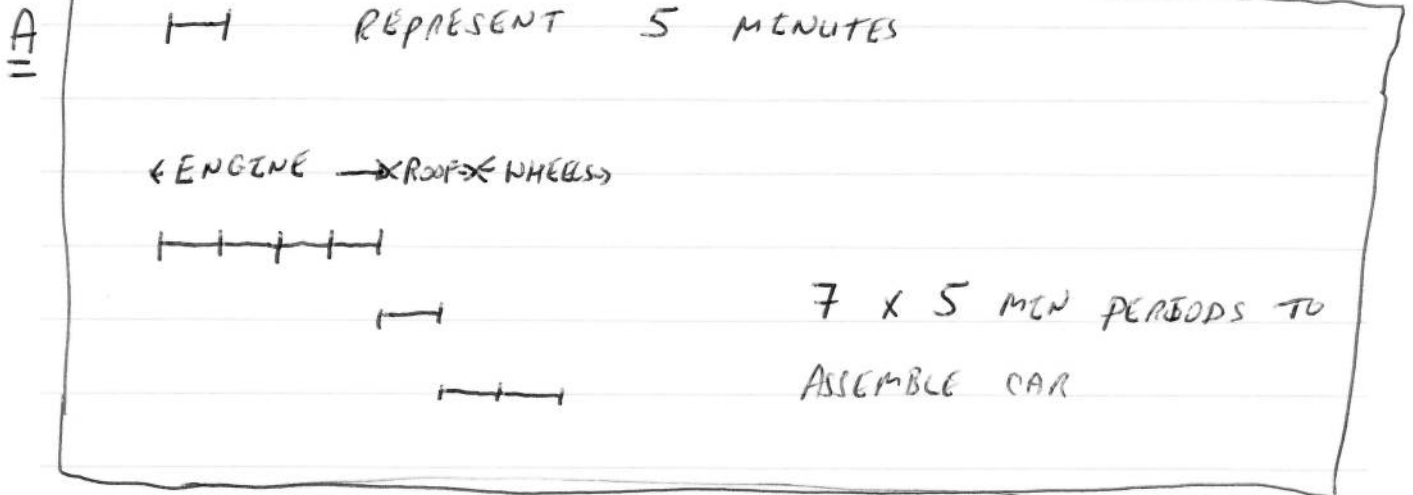
CAR MANUFACTURING

ENGINE : 20 MINS

ROOF : 5 MINS

WHEELS : 10 MINS

35 MINS TO ASSEMBLE ONE CAR



TOTAL FOR 3 CARS : 105 MINUTES


FETCH EXECUTE CYCLE

(2)

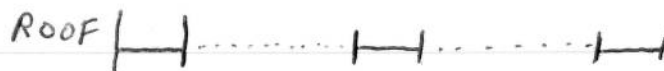
DO THE TASKS IN PARALLEL

B

ENGINE ① ENGINE ② ENGINE ③

A horizontal timeline with 12 tick marks. The first 5 tick marks are grouped under 'ENGINE ①', the next 5 under 'ENGINE ②', and the last 2 under 'ENGINE ③'.

ROOF

A horizontal timeline with 5 tick marks. The first tick mark is under the first tick mark of the engine timeline. The second tick mark is under the 5th tick mark of the engine timeline. The third tick mark is under the 10th tick mark of the engine timeline. The fourth tick mark is under the 11th tick mark of the engine timeline. The fifth tick mark is under the 12th tick mark of the engine timeline.

WHEELS

A horizontal timeline with 12 tick marks. The first tick mark is under the first tick mark of the engine timeline. The second tick mark is under the 5th tick mark of the engine timeline. The third tick mark is under the 10th tick mark of the engine timeline. The fourth tick mark is under the 11th tick mark of the engine timeline. The fifth tick mark is under the 12th tick mark of the engine timeline.

CAR ROLLING OFF EVERY 20 MINUTES —
LENGTH OF LONGEST TASK

HOW LONG DOES IT TAKE FOR 3 CARS ?

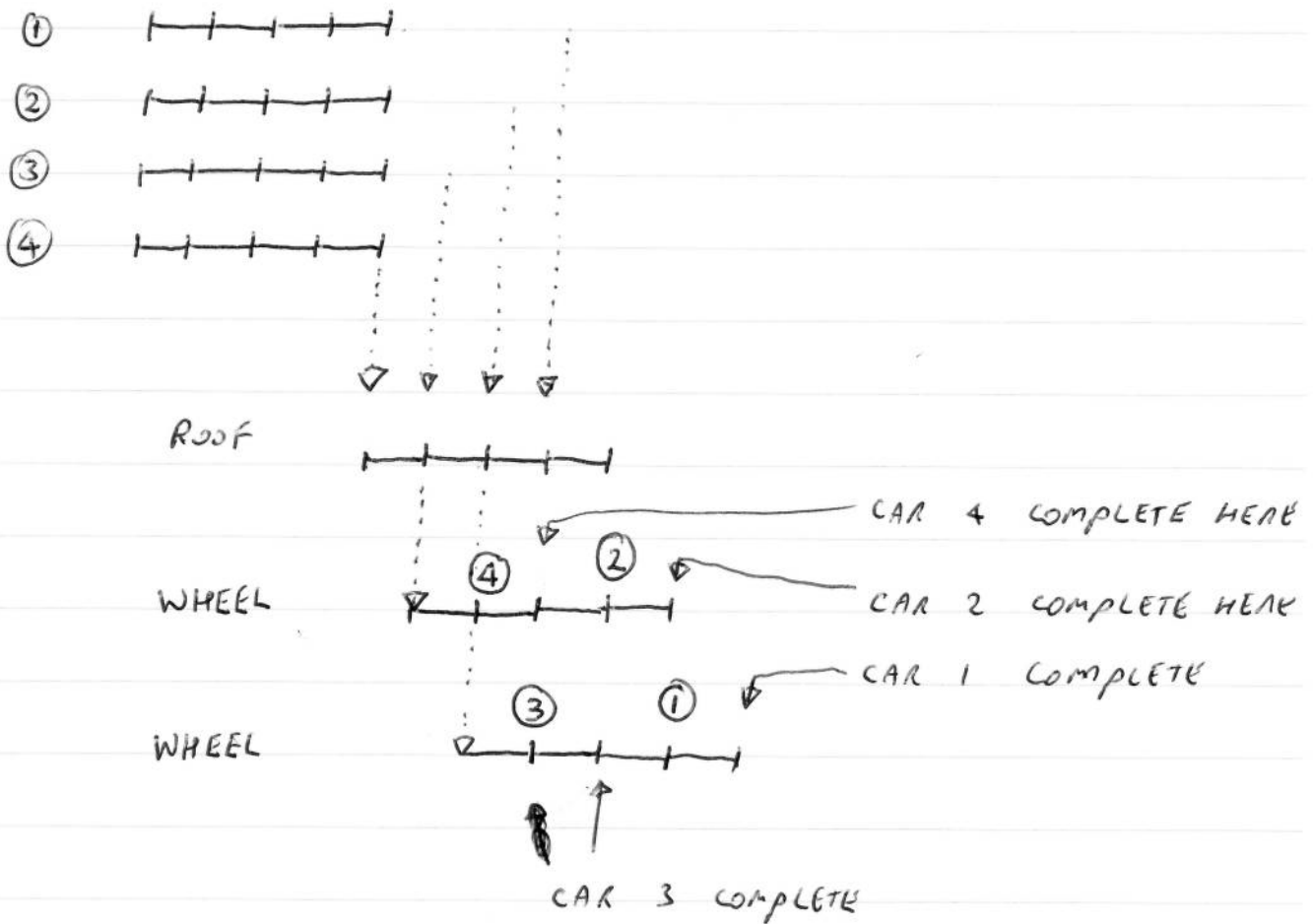
35 MINS + 20 MINS + 20 MINS = 75 MINS
1ST CAR ROLL OFF CAR 2 CAR 3

TOTAL FOR 3 CARS : 75 MINUTES

(3)

C SPEED THINGS UP BY EMPLOYING MORE RESOURCES,

ENGINE



HOW LONG FOR 3 CARS : 45 MINUTES
 " " " 4 CARS : 50 MINUTES

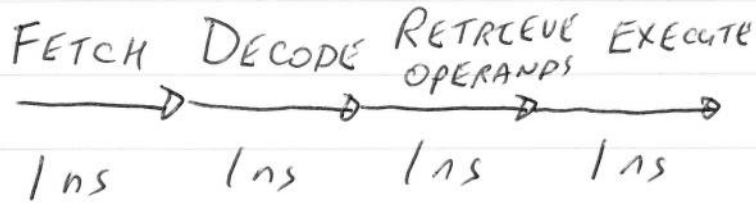
CAR ROLLING OFF EVERY 5 MINUTES.

HOW MANY CARS CAN WE DO NOW IN 105 MINUTES
 35 MINS FOR 1ST CAR + CAR ROLLING OFF
 EVERY 5 MINUTES
 \Rightarrow 15 CARS IN 105 MINUTES

CAN WE SPEED THINGS UP EVEN MORE?
HOW ARE WHEELS PUT ON IN FORMULA 1?

④

FETCH EXECUTE Cycle



4ns for 1
instruction



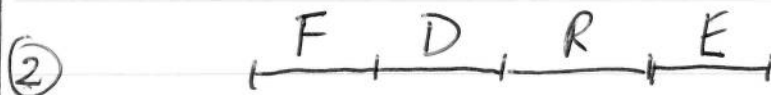
1 INSTRUCTION COMPLETE

HOW LONG FOR
IN 4 ns. 3 INST.
 $3 \times 4 = 12 \text{ ns}$

INSTA



HOW LONG
FOR 3 INSTR.



6 NANoseconds



PIPELINED EXECUTION