RAQ Challenge

Difficulty: ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Read and think about the questions carefully. Solve time: 1 hour 30 minutes

There are three cars, *Car A, Car B* and *Car C*, each 5m long, on a two-lane road.

In the first lane, *Car A* is 2m in front of *Car B*.
In the second lane, *Car C* is moving alongside *Car B*.

Both lanes are 4.8m wide, and cars have 1.5m of space on either side.

All three cars are moving straight at a constant speed of 20m/s.

Car B wants to switch lanes and end up in front of *Car C* without colliding with any car. The switch will take exactly 3 seconds and involves the following steps in order.

1. *Car B* changes its direction and increases its speed. (0 seconds)
2. *Car B* maintains a constant speed, faster than its original one, and continues in its new direction for 3 seconds. (3 seconds)
3. After 3 seconds, *Car B* straightens its direction to align with the lane and reduces its speed back to 20m/s. (0 seconds)

Questions:

(a) Work out the slowest constant speed *Car B* must accelerate to when changing lane to ensure it ends up in front of *Car C* (with any gap size between them) and has an equal amount of space on both of its sides.

(b) Find out the percentage by which the speed of *Car B* during a 3 second lane change at the fastest constant speed exceeds the speed of *Car B* during a 3 second lane change at the lowest constant speed.

(c) Assuming *Car B* loses 8L of fuel per 100km, find out the difference in fuel consumption when *Car B* is at its fastest constant speed compared to when it is at its slowest constant speed during the 3 second lane change, given that it stops right after switching lanes.

Keep in mind:
Cars are not allowed to collide with another.

Parts of cars can move outside lane boundaries when changing lanes, as long as the car's centre remains within the road.

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