# It wouldn't do any harm to drive $60 \mathrm{~km} / \mathrm{h}$ in a city instead of $50 \mathrm{~km} / \mathrm{h}$ would it? 

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## Task description

In most European countries, a fifth all of two-car accidents are caused by an unsuitable safety distance between the two cars. Failing to keep distance is especially dangerous on high-speed and heavy-traffic roads where the risks of pile-up accidents are high. But also in city-areas it is crucial to keep a safe distance.

Typically, road traffic acts do not specify a fixed measure of safety distance. The Danish traffic act, for example states, that "the distance to the driver in front of you must be adjusted in a manner which poses no danger of collision if the vehicle ahead stops or reduces its velocity". Do you know the regulations in this respect in your country?

In any case, a suitably safe distance to a vehicle ahead of you is at least a bit longer than the braking distance of your car (i.e. the distance between the where the car begins to decelerate to where the car finally stops) at the velocity you are driving.

Assignment 1: Suppose a car travels on a freeway. Some information about that car and how it moves are given by the graph in picture 1 . Discuss/do the following:

- Explain in words what happens.
- According to the graph, what is the manner in which the car decelerates?
- How would you determine the distance covered by the car when it begins to decelerate? How would you determine how long the braking distance of the car is?

Assignment 2: Suppose now that in the lane next to the car there is a faster moving but similar car which drives 2 times as fast as the first car. This means that the ratio of the velocity of the fast car to the velocity of the slow car is 2 .

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\frac{v_{\text {fast car }}}{v_{\text {slow car }}}=2
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Both drivers hit the brake at the same time, and the cars have identical decelerations. Plot this information into the graph. What is the ratio of the braking distance of the fast car to the braking distance of the slow car?

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\frac{b_{\text {fast car }}}{b_{\text {slow car }}}=\text { ? }
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Discuss/do the following:

- What is the ratio of the two braking distances if the fast car travels 1.5 times faster than the slow car?
- What if the fast car travels 3 times faster than the slower car?
- Find a way to determine the ratio of the two braking distances at a random ratio of the two velocities, and draw a graph of the ratio of the two braking distances as the ratio of velocities increases.
- What does this graph tell you about the relation between speed and braking distance?

Assignment 3: A car's braking ability is an expression of how much the velocity of the car is reduced per second when the brakes are applied fully. Look at picture 1 again and explain what happens if the braking ability becomes better or worse? Does braking ability have any effect of the ratios which you worked with in assignment 2 ?

Assignment 4: A typical family car which drives on a dry and stable surface has a braking ability of approximately $8 \mathrm{~m} / \mathrm{s}^{2}$ - that means that each second during the braking process the velocity of the car is reduced by $8 \mathrm{~m} / \mathrm{s}$. Consider the following scenario. In a city, a car - car $A$ - moves at $50 \mathrm{~km} / \mathrm{h}$ and the driver suddenly sees a red light some 30 meters ahead. The driver applies the brakes fully upon seeing that. The same scenario happens to another car - car $B$ - which moves at $60 \mathrm{~km} / \mathrm{h}$. Can you construct a model which can predict whether any of the cars pass the red light?

Assignment 5: The reaction time (the time it takes for a person to react to a visual input by e.g. applying the brakes) for most people is approximately 0,2 seconds. But in traffic the time is much longer, since the driver has to orient him-/herself and make decisions such as to brake. The reaction time in traffic of a fit and focused driver is typically between 0,8 and 1.5 seconds. Discuss the correctness and predictions of the model which you constructed in the last assignment in light of this.

Assignment 6: Assume that both drives have a reaction time of 0,8 seconds. What is the braking distance of car $A$ ? At what velocity does car $B$ move after the braking distance of car $A$ ? Use this to discuss the speeding limits in city areas. You can also discuss what happens to the predictions of your model if the cars drive on icy surfaces (typically the braking ability of a car on icy surfaces is only $1 / 4$ of its standard braking ability).
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## Pictures



Picture 1 - This graph provides some information about the movement of a car.

