MID-TERM BMEGEÁTNW19 Vehicle Aerodynamics (6th Dec. 2023, WED 14:15, KM34, 90 min)

NAME:…… NEPTUN code:……..

PLEASE READ THE QUESTIONS CAREFULLY! TAKE CARE OF YOUR HANDWRITING! GIVE YOUR ANSWER IN A SHORT & CLEAR FORMAT! USE SKETCHES IF NEEDED!

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1)HISTORY (10p)

1.1)Fill in the table below with the <u>names</u> of the four main periods in the history of aerodynamic developments and indicate the approximate <u>time intervals</u>, too!

PERIODs	NAME of the PERIOD	Approx. time interval from-to year/decade
I.		
II.		
III.		
IV.		

The first documented attempt at streamlining a passenger car is the Alfa Romeo from 1914. The ALFA 40-60 HP Castagna Aerodinamica was known also as „Siluro Ricotti" (=Ricotti's Torpedo). It was built by the coach builder Carlo (Marco?) Castagna (Carrozzeria Castagna, Milan, Italy) for the Italian Count Ricotti.

<u>1.2)Explain the few main DISADVANTAGES of the airship shape used for ground vehicles!</u>

2)HISTORY (10p)

Pál (Paul) Járay is the most famous aerodynamicist of the II. period in the history of aerodynamic developments.

Sketch his “combined form” concept car and explain why it was revolutionary!

3)BASICS (10p)

The aerodynamic force vector is defined as being the sum of the pressure-based and viscous (friction) force terms.

$$\underline{F_{ae}} = \underline{F_p} + \underline{F_f'}$$

Starting with the above, derive the final form of $\underline{F_{ae}}$ that contains both the pressure coefficient and the skin friction coefficient! Give a short explanation of each main derivation step!

What are the range (values, magnitude, min/max. limits, if any) of the pressure coefficient and the wall friction coefficient? (Explanation is not needed)

pressure coefficient	wall (skin) friction coefficient

4)BASICS (10p)

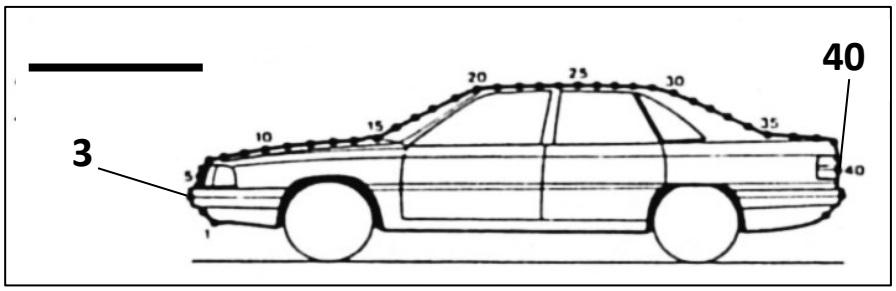
What do you know about the “slenderness ratio” and what the “optimum slenderness” is?

5)BASICS (10p)

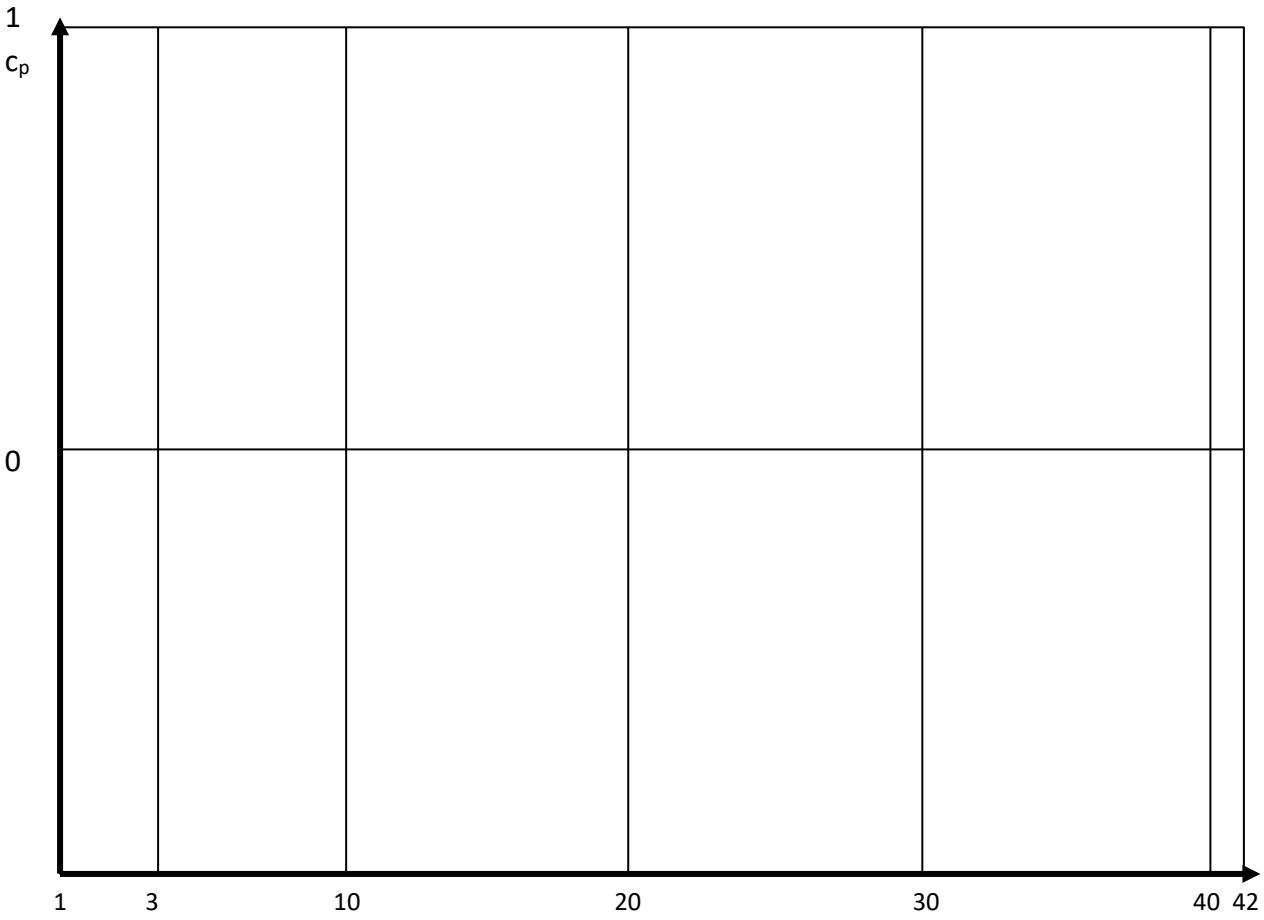
Please explain why the drag area is the proper parameter (better than the drag coefficient) when we compare two vehicles!

6)PASSENGER CARS (10p)

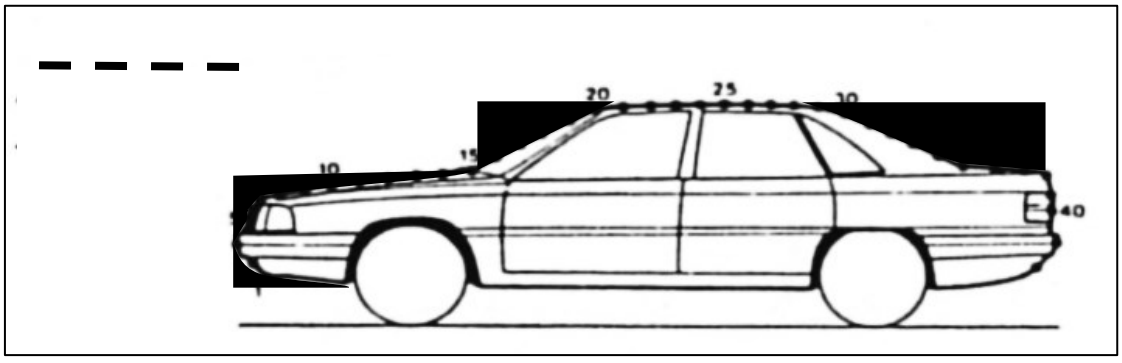
Draw in the diagram below with <u>continuous line</u> the **typical pressure coefficient curve** measured along the upper body surface, in the vertical mid-plane of a passenger car.



Start at point Nr.3. (in stagnation point), and finish at point Nr.40. (rear surface, tail light).



Indicate in your diagram with **<u>dashed line</u>** how the c_p curve is modified if the vehicle body shape is changed to a sharp-edged square-shaped front & rear with a vertical windshield! See the modification with black block extensions below:



7)PASSENGER CARS (20p)

The „*Schlörwagen*" was designed by a German engineer, Karl Schlör in 1939. At no wind condition, when the car is moving on a horizontal plane ground motorway at a constant speed of v=135,2 km/h, the vehicle's drag coefficient is 0,15.

DATA:

$A_{proj,vehicle}$	=	2,65	m^2;
ρ_{air}	=	1,2	kg/m^3
ν_{air}	=	$15 \cdot 10^{-6}$	m^2/s;
p_0	=	10^5	Pa
g	=	10	N/kg

QUESTIONS:

A) Calculate the dynamic pressure, the stagnation pressure, and the Reynolds-number.

B) Calculate the drag force and drag area.

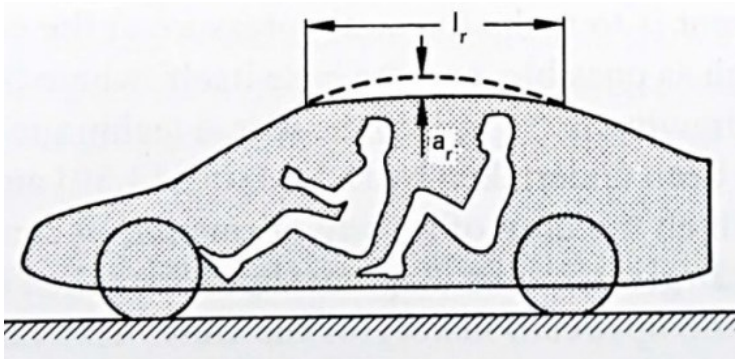
C) Calculate the lift coefficient if we know that the lift force is 673N.

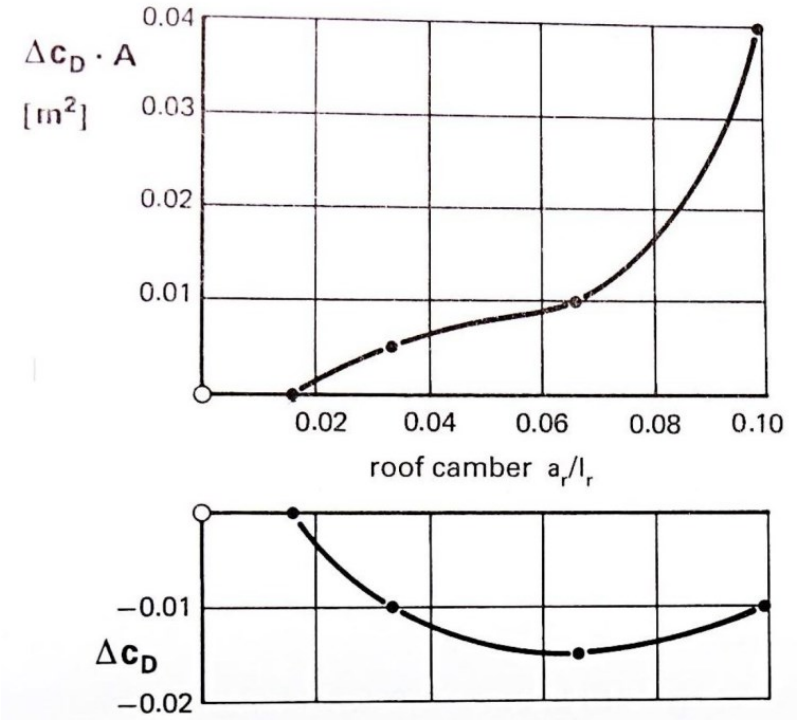
D) Calculate the engine's power, if we know that the aerodynamic power loss at this given speed was 85 % of that.

E) Calculate the vehicle speed, drag force and and lift force for the case when the aerodynamic power loss is twice as large that is calculated in question D)! (Assume that the force coefficients remain the same at that speed.)

8)PASSENGER CARS (10p)

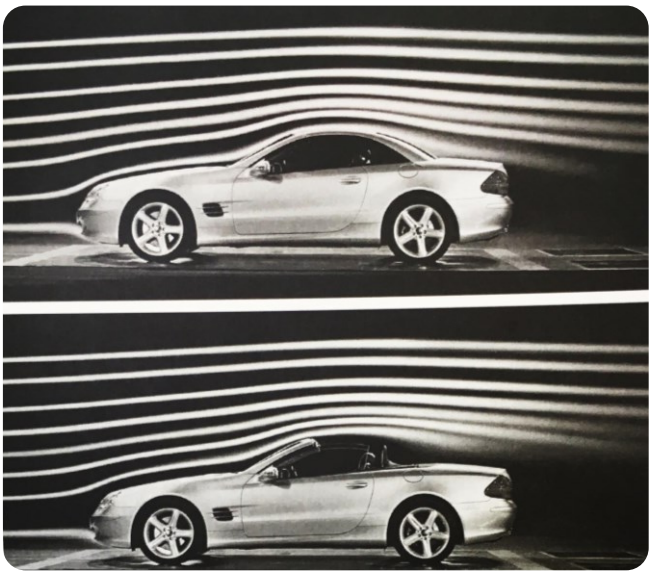
Evaluate the influences (advantages/disadvantages) of the roof cambering! (Think about both aerodynamic performance and passenger comfort.)





9)PASSENGER CARS (10p)

What are the aerodynamic consequences of an open passenger compartment? (drag, lift, passenger comfort, noise?



What is the solution for improving the flow condition for the open passenger compartment?

Explain the aerodynamic benefit of the wind deflector!