NAME:…………………………………………………………………………………… NEPTUN code:…………………………..

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

1)HISTORY (10p)

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	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>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. **Explain his "combined form" concept with the help of a sketch in your answer! Why was it revolutionary?**

Denote and sketch at least three famous vehicles designed based on his idea!

SKETCH	NAME

3)BASICS (10p)

The $\underline{F}_{ae}$ aerodynamic force acting on a vehicle is defined as being the sum of the $\underline{F}_p$ pressure-based force term and the $\underline{F}_f'$ viscous (friction) force term:

$$\underline{F}_{ae} = \underline{F}_p + \underline{F}_f'$$

Starting with the above equation, with short explanations on each main derivation steps, please show how the pressure coefficient and the wall (skin) friction coefficient and the reference parameters (flow velocity, ambient pressure and density of fluid) are included in the formulation!

The final form of the equation must contain both the pressure coefficient and the skin friction coefficient.

Define the c_p pressure coefficient and the c_f' wall friction coefficient with their <u>formula</u> and indicate their range, magnitude, min/max. limits, if any!

| pressure coefficient	wall (skin) friction coefficient
$c_p =$	$c_f' =$
Its range, magnitude, min/max limit values:	Its range, magnitude, min/max limit values:

4)BASICS (10p)

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

5)BASICS (10p)

The change of <u>drag area</u> ($c_D \cdot A_{proj}$) is the proper parameter to use if we need to analyse the aerodynamic redesign of a vehicle. Explain why it is better to use the drag area instead of the drag coefficient in vehicle aerodynamics!
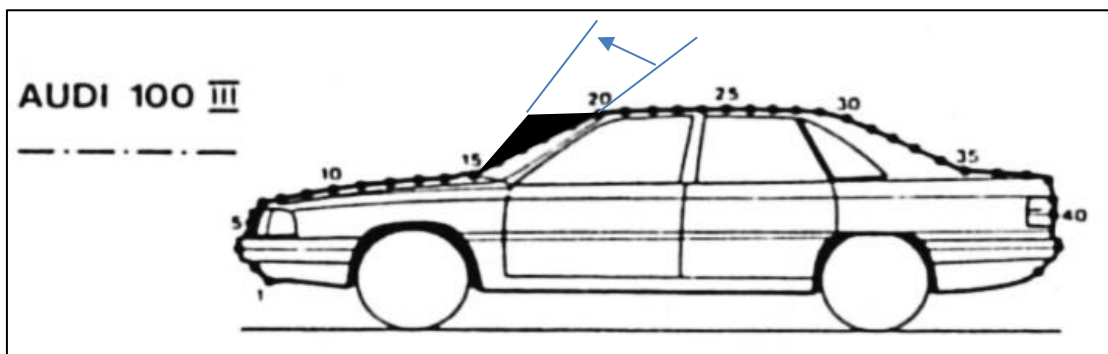
6)PASSENGER CARS (10p)

Draw in the diagram below the **typical pressure coefficient distribution curve** for the upper body silhouette, measured in the vertical mid plane of a passenger car!

AUDI 100 III
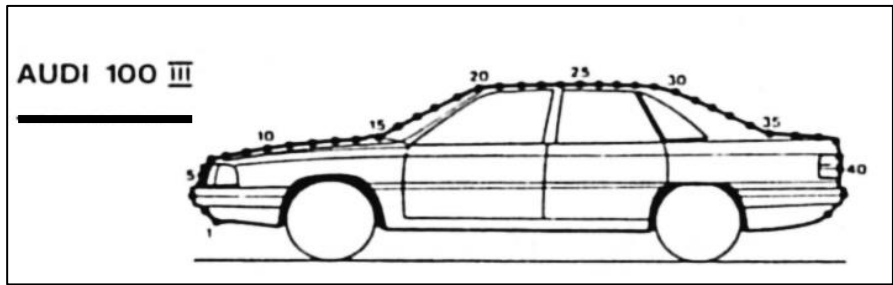
Point Nr.3. is in stagnation point (on the front bumper), point Nr.42. is on the rear bumper.

c_p

| 1 | 10 | 20 | 30 | 40 42 |
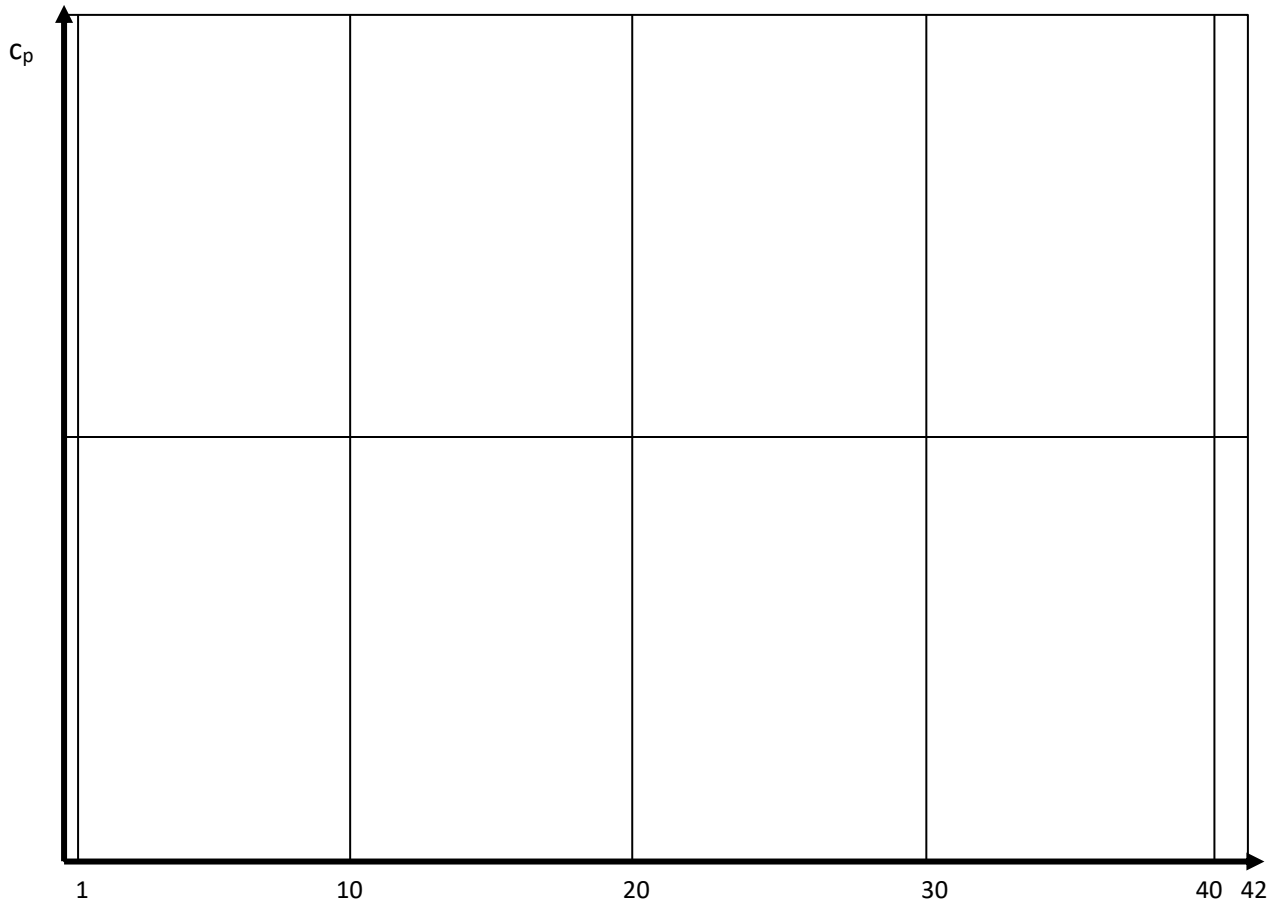
Indicate in your diagram how the cp curve is modified if we change the windshield angle to a smaller value! See the modification below:

AUDI 100 III
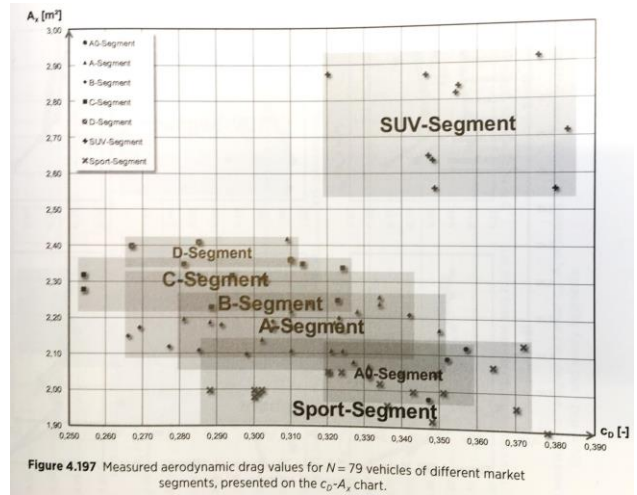
7)PASSENGER CARS (20p)

USE THE GIVEN VEHICLE CARD

1) List at least 3 solutions visible on our card that is used in order to lower drag!

2) List at least 3 solutions visible on our card that is used in order to increase downforce!

3) **Give an estimated value of the drag coefficient** of your vehicle! (the data diagram may help)

c_D=……………………………

4) **Calculate the aerodynamic power loss** (P_{ae} [W]) and its relative value (P_{ae}/P_{max}[%]) for the maximum speed of the vehicle! (see data on the card)
(p_0=101325Pa, t_0=20°C, R=287 J/(kgK)

Figure 4.197 Measured aerodynamic drag values for N = 79 vehicles of different market segments, presented on the c_D-A_x chart.

5A)_If fuel consumption is given on the card:_

Calculate the absolute (Δb) and relative ($\Delta b/b_0$) values for the change in fuel consumption if - after a redesign – your new drag coefficient is 20% lower than the original estimated one (P_{ae} [W]) at the maximum speed of the vehicle! Use κ=0,2 (see on the card)

5B)_If the vehicle mass is given on the card:_

Calculate the lift coefficient (c_L) of the vehicle if we know that the lift force is the 5% of the weight of the car (see mass of the car on the card)
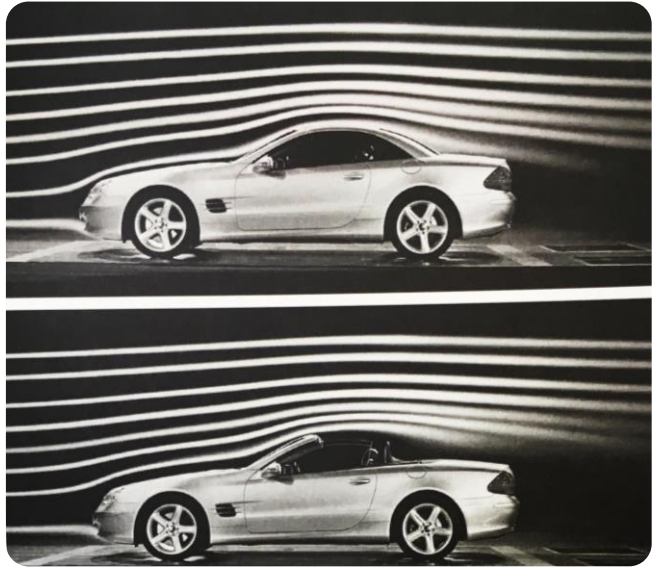
8)PASSENGER CARS (10p)

Evaluate the influences (advantages/disadvantages) of the roof cambering! (Think about both aerodynamic performance and passenger comfort.)
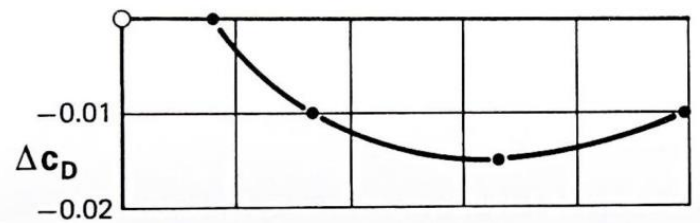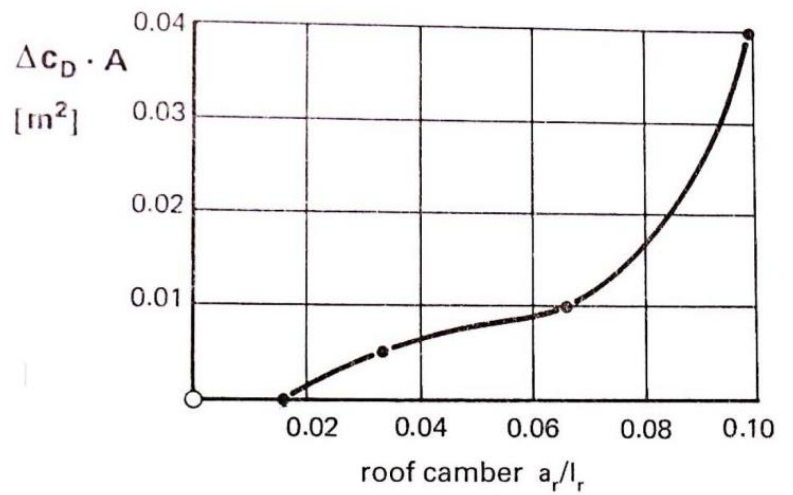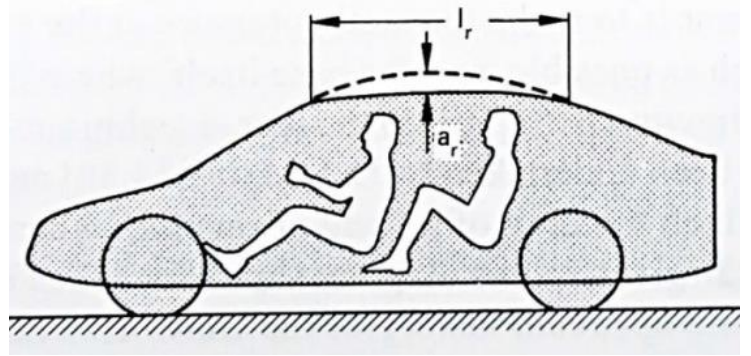
9)PASSENGER CARS (10p)

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

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

Explain the aerodynamics of the wind deflector!