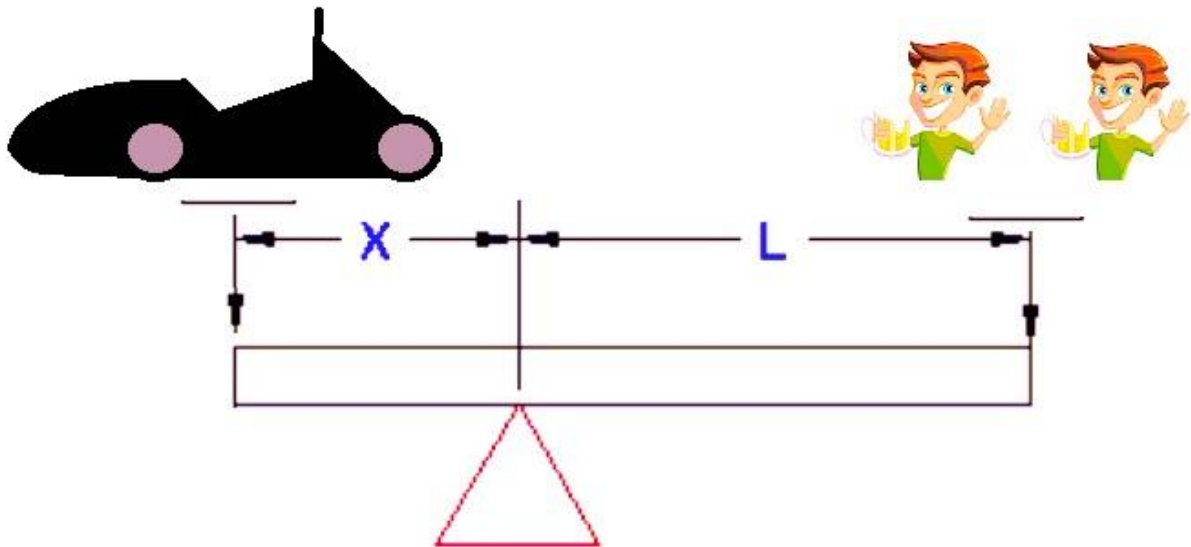


1. You are at the FSBk after-party, and you want to win the mechanical advantage competition.
Mechanical advantage.

Use as many team members as you consider bringing the lever to equilibrium.



CW (car weight) = 275.5 kg

$X = 1.1216$ m

$L = 2$ m

You've decided to use two team members, $TM1 = 71.3$ kg ; $TM2 = 78.6$ kg.

Rules of the game:

- the lever needs to be in equilibrium (level with the ground)
- you can lose weight (murder, and dismemberment are prohibited)
- you can gain weight only by drinking beer $1l=1kg$
- you can have one beer 0.5kg in hand while on the lever

Knowing the above-mentioned, $TM1$ can drink 1.9 l/h; $TM2$ can drink 2.4 l/h, being a competition, they need to drink fast.

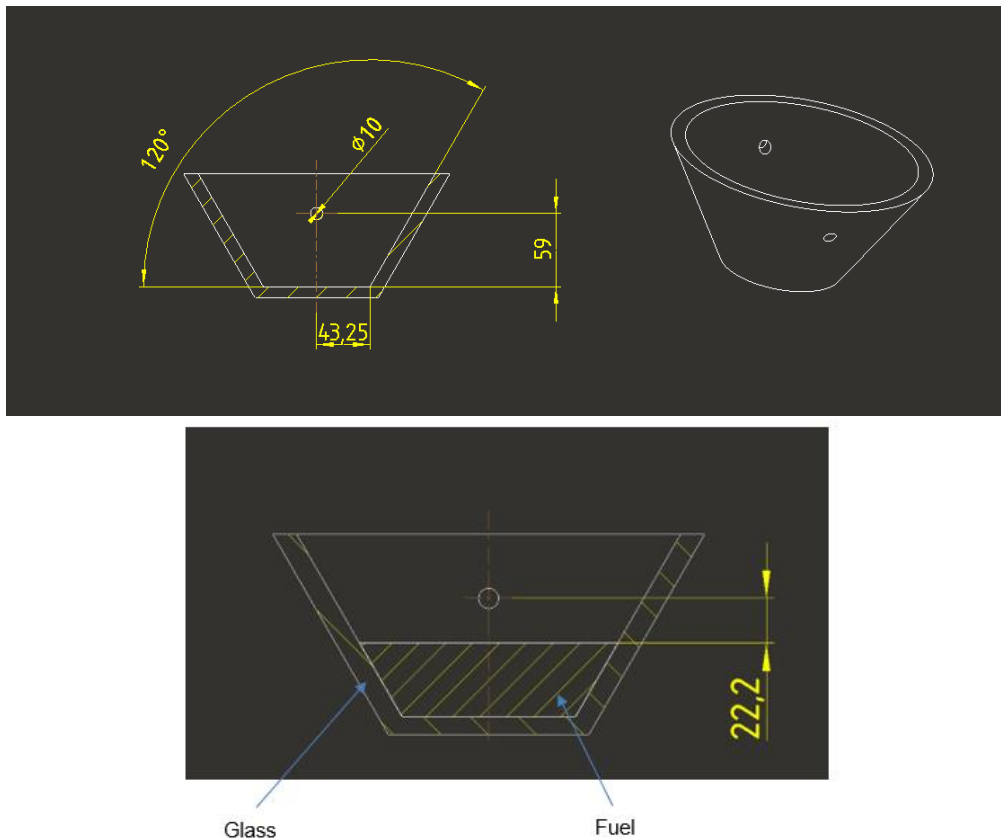
How many beers do they need to drink in the shortest time possible to bring the lever in equilibrium?

- a) **Two beers each – 27.9 min**
 - b) One beer each – 29.9 min
 - c) Four beers each – 26.9 min
 - d) Three beers each – 27.9 min
2. If the driver is using a HANS (Head and Neck Support) system, what is the minimum allowable width of the shoulder straps?
- a) 75
 - b) HANS is not used in Formula Student
 - c) 60
 - d) **50**

3. Your team is running in FSBk Endurance event and at the finish, your telemetry shows that you have an increase of temperature in your tires by 25°C . Calculate the new pressure in your tire knowing that you measured with a manometer in the morning (at 25°C and 735mmHg) the initial pressure of 0.8 bar, and the total volume of the air inside the tire is 0.01 m^3 . (neglect the expansion of the air volume in the tire)
- a) 0.84 bar
 - b) 0.95 bar**
 - c) 1.22 bar
 - d) 1.09 bar
4. When designing a rear wing, which statement regarding the relation between chord length and aerodynamic performance is false:
- a) Higher chord means higher Re number which can force turbulent flow on the airfoil, allowing for a higher CL_{max} .
 - b) Shorter chord allows for better boundary layer control usually results in lower drag.
 - c) The longer the chord the smaller the drag due to the boundary layer vortices energizing the flow.**
 - d) Reducing the chord, although it reduces Re number and may allow for a laminar flow wing, may not always reduce drag as many other geometric parameters influence it.



5. Your car just finished endurance, but because this is squid „formula student” game a special cup with a hole inside is used to fill the car. The marshals fill your car with it five times and on the sixth time the fuel was like in the image below. In all other cases the fuel was always near the hole level when filling the car. You must accurately calculate the fuel that your car used during the endurance event. Calculate the fuel level in liters to the nearest decimal of x.000 L



Accepted answers: 3.324 till 3.326 L

6. Considering an Auto Cross event in which one of the hairpin turns is at the minimum allowed turning diameter of 9 m, will a formula student vehicle with the inside corner wheel steer angle $\delta_{wi} = 26^\circ$ and the outside corner wheel steer angle $\delta_{wo} = 23^\circ$, a wheelbase $W = 1600\text{mm}$, tire width $T_w = 200\text{ mm}$ be able to drive around the turn without hitting the cones with any of its 4 wheels?

- a) **YES, with all 4 wheels**
- b) NO, only two wheels
- c) NO, only one wheel
- d) NO, all 4 wheels outside

7. A formula student vehicle with the following characteristics is given:

Wheelbase $W = 1539\text{ mm}$

Distance from rear axle centerline to the center of mass $b = 935\text{ mm}$

Inside corner front wheel steer angle $\delta_{wi} = 24^\circ$

Outside corner front wheel steer angle $\delta_{wo} = 28^\circ$

Tire width $T_w = 200\text{ mm}$

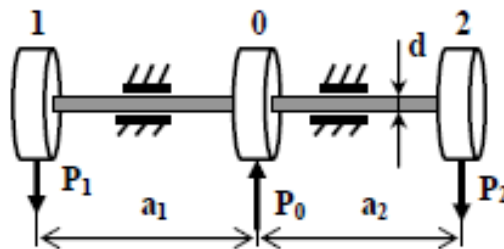
Write in ascending order the values of the following parameters: turning radius of center of mass, turning radius of outside corner wheel, turning radius of inside corner wheel. Use meters as final unit of measurement for comparison.

- a) 2.9 m, 3.678 m, 4.284 m
- b) 2.1 m, 3.595 m, 4.105 m
- c) 3.2 m, 3.378 m, 4.105 m
- d) 2.4 m, 3.378 m, 3.884 m**

8. What is true about the driver change:

- a) The driver change time will start once the vehicle is stopped in the driver change area and the first driver has climbed out of the vehicle.
- b) If the driver change takes longer than 3 minutes, extra time will be penalized with -40 points to the overall score.
- c) You will get a penalty of 2 minutes if you make suspension adjustments to the vehicle.**
- d) The driver change time is stopped when the second driver is inside the vehicle. Team members are not allowed to secure him from this moment, he will have to secure himself.

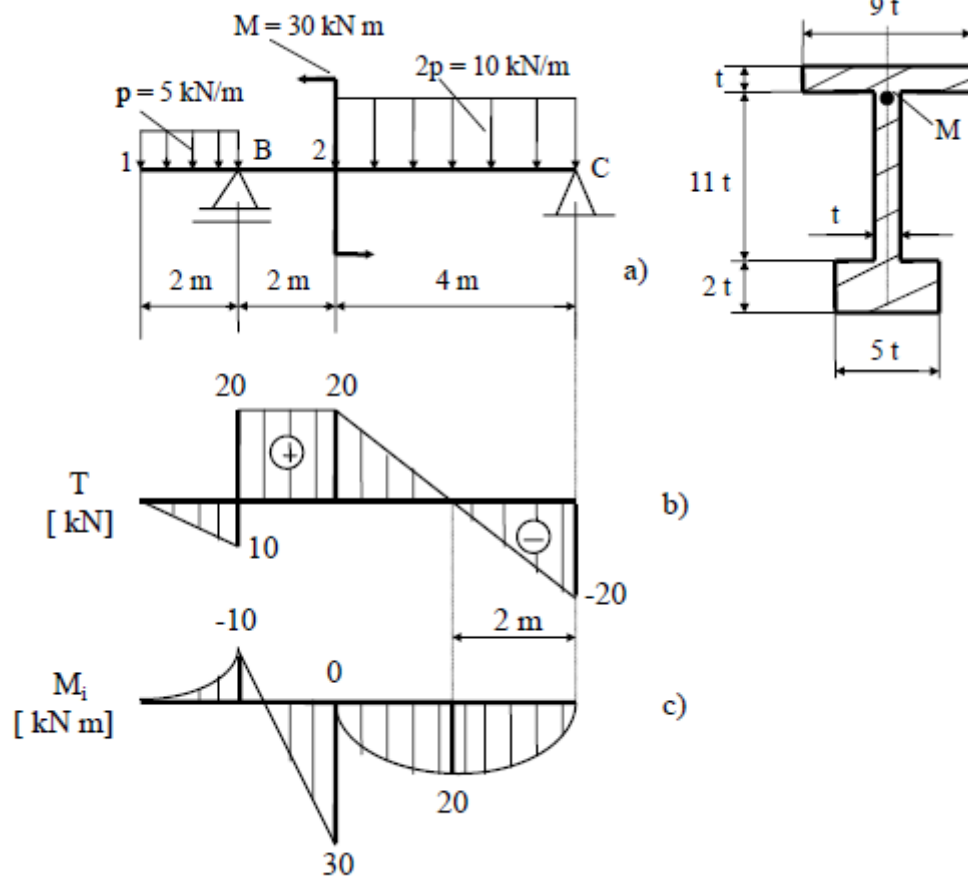
9. A shaft is driven by pulley "0" by a motor with a power output of $P_0=70$ kW at a rotational speed of $n=300$ rpm. It distributes the power through pulleys 1 and 2 to two consuming machines with power requirements of $P_1=30$ kW and $P_2=40$ kW, respectively. Calculate the shaft diameter on the two sections for $\tau_a=40$ MPa.



- a) $d_{1-0} = 50$ mm; $d_{0-2} = 55$ mm**
- b) $d_{1-0} = 45$ mm; $d_{0-2} = 45$ mm
- c) $d_{1-0} = 55$ mm; $d_{0-2} = 55$ mm
- d) $d_{1-0} = 35$ mm; $d_{0-2} = 45$ mm

10. For the steel beam with the cross-sectional shape and loading shown in figure, calculate the dimensions of the cross-section ($t=?$ mm) for $\sigma_a=150$ MPa.

(answer format round to nearest integer eg: 10.00)



Correct answer: 12 mm