



FORMULA STUDENT AUSTRIA

2020 Quiz Answer Key

Note on numeric answers

The quiz scores the number independently of the format - so 0001.5000 is equivalent to 1.5

Usually, there is also a bit of tolerance around the least significant digit, e.g. for the first question (6.50) 6.4-6.6 was accepted.

Ground Clearance

At the “no help zone” line on the acceleration is a ditch that is 15mm deep and wide enough for your 13” outer diameter tire to completely reach the bottom.

The surrounding surface is flat and level. Your wheelbase is as short as possible and the front wing is built to the maximum dimensions as allowed in the Rules. You are rolling slowly so you can assume your suspension to be stiff.

What’s the minimum ground clearance (in mm) that remains while driving across that ditch?

Please use the following format: 12.34

Answer

	Correct [%]	Median Time [s]
C	34	343
E	46	361

Your car loses a wheel while you are going 72Km/h

and the wheel continues rolling straight ahead for 40m with a rolling resistance of 10N before it reaches the press area.

How fast is the tire going at that point? (in m/s, rounded to full number)

Wheel data: 16.2" outer diameter, mass=5kg, rotational inertia $I_{yy}=0.093\text{Kgm}^2$

Please use the following format: 12.34

Answer 17|

	Correct [%]	Median Time [s]
C	11	354
E	18	355

Which Rule is violated in the following picture?



- T10.4.2
- T3.4.4
- T5.5.4
- EV4.5.9

	Correct [%]	Median Time [s]
C	79	81,5
E	82	75,5

A thin-walled brake line

made out of steel with the modulus of elasticity 210000MPa, an inner diameter of 4.75mm, and a wall thickness of 1mm is under an internal gauge pressure of 120bar.

What are the circumferential stress (σ) and the expansion (Δd_o) of the outer diameter?

- $\sigma=285\text{MPa}$, $\Delta d_o= 0.00645\text{mm}$
- $\sigma=28.5\text{MPa}$, $\Delta d_o=0.00064\text{mm}$
- $\sigma=285\text{MPa}$, $\Delta d_o=0.00780\text{mm}$
- $\sigma=28.5\text{MPa}$, $\Delta d_o=0.00078\text{mm}$

	Correct [%]	Median Time [s]
C	33	236
E	35	237

Calculate the maximum possible cornering speed

for the following FSAE car when going thru a 20m radius corner (in kph)

Overall mass = 260kg;

Product of coefficient of lift, frontal area and air density ($c_l * A * \rho_{air}$) = -6kg/m;

Tire coefficient of friction = 1.5

Gravity acc. $g=9.81\text{m/s}^2$

(Hint: the vehicle can be treated as a point mass, driving resistances neglected); Round to 1 decimal

Please use the following format: 12.34

Answer

	Correct [%]	Median Time [s]
C	20	315
E	44	295,5

The front track width of your FSAE car is 1240mm.

In which range must the rear track width be in order to be compliant with the rules?

- 930mm - 1550mm
- 992mm - 1653mm
- 992mm - 1550mm
- 930mm - 1653mm.

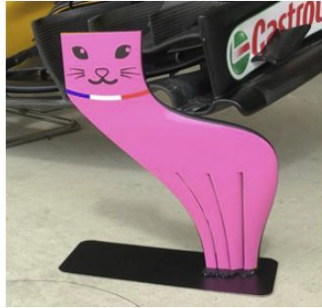
	Correct [%]	Median Time [s]
C	55	79
E	55	75

Your car is equipped with a front- and rear wing.

The aerodynamic balance is given as 46:54 (front : rear), the weight distribution is 50:50 (front : rear).

During the testing phase of your team, you have encountered a magical animal that can produce aerodynamic downforce without raising the car's drag.

On which position of the car would you place the aerocat, in order to increase the maximum corner potential of the car in a left turn?



- Front wing right side
- Front wing left side
- Front wing middle

	Correct [%]	Median Time [s]
C	74	70
E	76	68,5

Your team is offered to do a wind tunnel test

in order to validate your CFD-simulation and improve the aerodynamic development process.
The resulting wind tunnel test model is a 60% scale model, featuring all the details of the actual car.
At which airspeed (in kph) should you run the wind tunnel in order to directly compare the results with the 80% scale CFD simulation @ 65kph?

Please use the following format: 12.34

Answer

	Correct [%]	Median Time [s]
C	45	145
E	56	146,5

What is not a 'system' in the Cost Reports Bill of Material?

- Electrical
- Battery
- Brake System
- Steering System

	Correct [%]	Median Time [s]
C	99	18
E	83	24

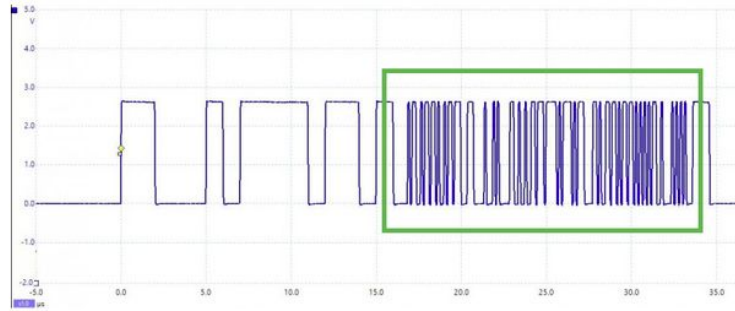
What is the maximum presentation time during the Business Plan Presentation?

- 5 Minutes
- 12 Minutes
- 10 Minutes
- There is none

	Correct [%]	Median Time [s]
C	99	12
E	86	15

You capture this CAN Frame with your scope

What happened in the marked section?



- It's a CAN FD Transmission
- During transmission, a collision with another transmitting node occurred
- There is EMI/Noise coupled onto your CAN bus lines
- Nothing special, this is a standard CAN 2.0 frame with a bit rate of 1 Mbit/s
- Probably a broken Transceiver on the sending node

	Correct [%]	Median Time [s]
C	63	86
E	74	76,5

A device consumes 30 Amps at 12 Volts

according to the datasheet (ohmic behavior).

The device is supplied by a Li-Ion accumulator (4s) with 14.4 Volts and an inner resistance of 0.1 Ohm.

What is the power loss caused by the inner resistance of the accumulator? (in Watt, 1 decimal)

Please use the following format: 12.34

Answer

	Correct [%]	Median Time [s]
C	23	139
E	32	147,5

The LV system of your car consists of following electrical consumers:

ECU: 2 Amps

Water pump: 6 Amps

Fan: 10 Amps

other devices: 4 Amps

All devices draw constant current, but the fan is only active 75% of the time.

Endurance is expected to last exactly 25 minutes.

What is the absolute minimum battery capacity (in Ah) required in order to finish the endurance on battery charge alone? Round to 3 decimals.

Please use the following format: 12.34

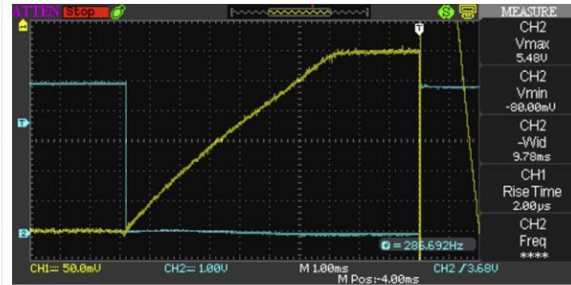
Answer

	Correct [%]	Median Time [s]
C	83	99
E	82	84

You are on the engine dyno adjusting your ECU calibration.

To tune the ignition dwell time, you hooked up a current probe to the primary side of coil #1 (yellow trace) and the voltage probe to the ignition output of the ECU (blue trace).

What information can you pull from the graph?



- Your ECU ignition output (power stage) is faulty
- The battery voltage is low
- Your ignition advance is quite low
- dwell time could be decreased by ~3ms without losing spark energy
- dwell time should be increased by at least 2 ms
- You run around 7 ms of dwell, which is correct
- you need bigger ignition coils

	Correct [%]	Median Time [s]
C	68	180,5
E	-	-

How high is the compression ratio

if your engine total volume (displacement plus combustion chamber) is 649 ccm and it has a stroke of 15 cm?

The gauge pressure inside the cylinder is 80 bar at the highest point, a force of $3.1728 \cdot 10^4 \text{ N}$ acting on the piston.

- 11
- 12
- 1/12
- 1/11

	Correct [%]	Median Time [s]
C	64	257,5
E	-	-

What is true regarding the configuration of the tractive system energy storage?

- The maintenance plugs may only be removable by using insulated tools.
- When cell stacks are held in place by the container walls and the lid, it is sufficient to comply with the minimum material requirements in EV 5.5.4.
- The complete load path from the cells to the chassis has to be considered in the structural equivalency documentation.
- When using composite materials in the container structure, only the inside skin has to be fire retardant according to UL94 V-0 or FAR 25.853(a)(1)(i).

	Correct [%]	Median Time [s]
C	-	-
E	40	133,5

You have an electric car

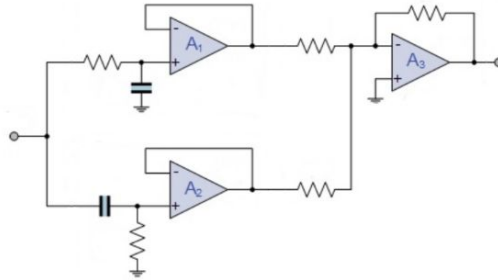
and always when your cat visits the workshop she runs away when you turn on the car.

You think she is afraid of the inverter switching frequency, which is 18kHz.

You want to design noise-cancelling headphones for your cat where you want to integrate a band stop filter.

You want to reject frequencies from 17 to 19kHz (-3dB Points) with your circuit. Consider all resistors with a nominal value of 10kOhm.

What capacitors do you need? (round to integer)



- C1p= 936pF , C2p=838pF
- C1p= 5263pF, C2p=5882pF
- C1p= 838pF , C2p=939pF
- C1p=5882pF , C2p=5263pF

	Correct [%]	Median Time [s]
C	-	-
E	69	205,5