

FSCH Test Quiz 2023 V1.0

Q1

The basic purpose of providing caster angle on wheels is to:

- a) Prevent uneven tyre wear
- b) Maintain or increase directional control
- c) Bring the road contact of the tyre under the point of the load
- d) Compensate for wear in the steering linkage

Answer: b)

Q2

Which of the following is the transfer function of a 1st order low pass filter with cutoff frequency ω_0 ?

- a) $\frac{s}{s+\omega_0}$
- b) $\frac{\omega_0}{s+\omega_0}$
- c) $\frac{1}{s+\omega_0}$
- d) $\omega_0 \cdot \frac{1}{s+1}$
- e) $\frac{\omega_0}{s-\omega_0}$
- f) $\frac{s}{s-\omega_0}$

Answer: b)

Q3

Which of the following is not a possible sequence for technical inspection regarding the beginning of the respective inspection?

- a) Mechanical Inspection, Accumulator Inspection, Pre-Inspection, Electrical Inspection, Tilt Test, Rain Test, Brake Test
- b) Pre-Inspection, Mechanical Inspection, Accumulator Inspection, Electrical Inspection, Tilt Test, Rain Test, Brake Test
- c) Accumulator Inspection, Electrical Inspection, Mechanical Inspection, Tilt Test, Pre-Inspection, Rain Test, Brake Test
- d) Accumulator Inspection, Electrical Inspection, Pre-Inspection, Mechanical Inspection, Tilt Test, Rain Test, Brake Test

Answer: c)

Q4

You want to design your aluminium Bus Bars to have the same electrical Resistance/length as your high voltage cables. Your high voltage cables have a diameter of 10mm and are made from copper. The thickness of your Busbar is 5mm. What must be the width of the Busbar?

Answer in mm.

Use the following format: 12.34

Hint: $\rho_{Al} = 0.0265 \Omega \cdot \frac{mm^2}{m^2}$ $\rho_{Cu} = 0.0172 \Omega \cdot \frac{mm^2}{m^2}$)

Answer: 24.20

$$\frac{\rho_{Cu}}{\pi \cdot \frac{D_{HV}^2}{4}} = \frac{\rho_{Al}}{t \cdot b} \rightarrow b = \frac{\rho_{Al}}{\rho_{Cu}} \cdot \frac{\pi \cdot D_{HV}^2}{4 \cdot t} = 24.20 \text{ mm}$$

Q5

In the last Event, you were driving at the minimal allowed ground clearance. The COG of your car was 258mm above the ground. Your sprung mass is 187kg, while the unsprung mass is 35kg. For the next Event you know there will be a lot of bumps, therefore you increase your ground clearance to 55mm. How much will be the new COG of your car?

Answer in mm.

Use the following format: 12.345

Answer: 279.059

$$COG_{z,new} = COG_{z,old} + \frac{m_{suspended} \cdot (55mm - 30mm)}{m_{suspended} + m_{unsuspended}} = 279.059mm$$

Q6

Which statements about the TSAL are wrong?

- 1) Be red in color and flash continuously with a frequency between 2Hz and 5Hz only if the TS is active.
 - 2) Be green in color and continuously illuminated only if the TS is deactivated, see EV4.10.3
 - 3) The TSAL and all needed circuitry must be hard wired electronics. Software control is not permitted
 - 4) The voltage outside of the TS accumulator must at least be measured independently across DC-link capacitors in each housing with DC-link capacitors and at the vehicle side of the AIRs inside the accumulator container
- a) 1) + 2)
 - b) 1) + 3)
 - c) 2) + 3)
 - d) 3) + 4)
 - e) all
 - f) none

Answer: a)

Q7

You participate in the Acceleration event. On your second run, you set your best time of 4.80s, after passing the finish line the car comes to a complete stop after 32m. Assume acceleration and deceleration are both linear. What is the average velocity of the vehicle between the start and the complete stop on this run?

- a) 6.666 m/s
- b) 79.2 km/h
- c) 2952.76 ft/min
- d) 69.345 mph

Answer: c)

$$v = 75\text{m}/4.8\text{s} = 15.625 \text{ m/s} = 2952.76 \text{ ft/min}$$

Q8

Your slot for electrical inspection is 10:20. You notice a critical error at 10:00 and inform the officials immediately (10:02), that you will not be able to attend for your electrical inspection time slot. What are the consequences?

- a) You receive a new time slot at the end of the inspection order and 5 points will be deducted from your overall score.
- b) You must queue for Re-Inspection when you are ready for electrical inspection
- c) You receive a new time slot at the end of the inspection order.
- d) You must queue for Re-Inspection when you are ready for electrical inspection and 5 points will be deducted from your overall score.

Answer: c)

Q9

Which of the following statements about steel tubes alloy 30CrMoV5-3 is not against the rules?

- a) May be used in the primary structure without additional testing.
- b) May be used in the primary structure except roll hoops if physical testing is applied to show equivalency.
- c) May be used in the primary structure if physical testing is applied to show equivalency.
- d) May never be used in the primary structure.

Answer: c)

Q10

The COP is 0.1m behind the COG and at the same height. Your car has a 50/50 weight distribution and the height of the COG from the ground is 30cm. The car is currently driving at 100km/h. Calculate the normal force on the front left tire assuming no weight transfer. You can use the following values in your calculations.

m = 240 kg, g = 9.81 m/s², c_D = 1.1, A = 1 m², ρ = 1.225 kg/m³, wheelbase: L = 1.53m

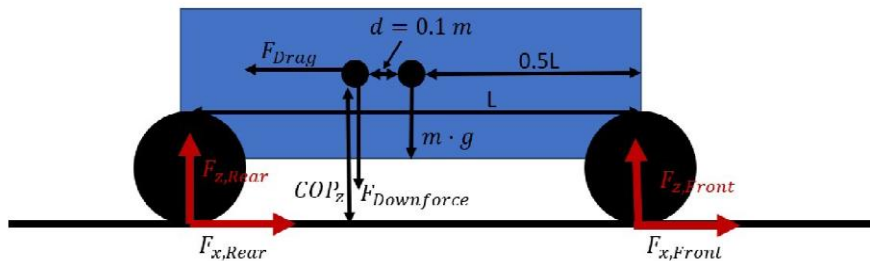
WOULD NOT COUNT IN REAL QUIZ AS EARTH GRAVITY NOT SPECIFIED (g=9.81 in calc)

Answer in N.
Use the following format: 12

Answer: 838

$$F_{z,FL} = \frac{1}{4} \cdot m \cdot g + \frac{1}{2} \cdot \rho \cdot A \cdot c_L \cdot v^2 \cdot \frac{1}{2} \cdot \left(0.5 - \frac{0.1}{L}\right) - \frac{1}{2} \cdot \rho \cdot A \cdot c_D \cdot v^2 \cdot \frac{1}{2} \cdot \left(\frac{COG_z}{L}\right)$$

$$= 588.6 \text{ N} + 295.1 \text{ N} - 45.8 \text{ N} = 837.9 \text{ N}$$



Q11

The previous season you could recuperate only 20% of your initially stored energy, but this season a big improvement in your drivetrain allows you to recuperate 60% of the initially stored energy. Knowing that you consumed 8 kWh during the endurances of last season, how much energy does your new accumulator need?

Answer in kWh.

Use the following format: 12

Answer: 6

$$E_{new} = E_{old} \cdot \frac{1+0.2}{1+0.6} = 6 \text{ kWh}$$

Q12

Which of the following helmets are compliant to the rules?



- a) 1) + 2)
- b) 2)
- c) 3)
- d) 3) + 4)
- e) 4)

Answer: b)

- 1) not OK
- 2) OK
- 3) Not OK
- 4) Not OK

Q13

An electrical load is connected to a 12V battery via a copper cable. The copper cable has an inductance of $L=1\mu\text{H}$ and a resistance $R=10\text{m}\Omega$. In steady state ($t_0 \dots t_1$), the load draws a current of 2A. At t_1 , the characteristics of the load change and the current starts rising with $2\text{A}/\mu\text{s}$. What is the voltage across the load in the moment directly after the change?

Answer in V.

Use the following format: 12.3

Answer: 8.0

$$U_{\text{load}} = U_0 - R \cdot I_{\text{load}} - L \cdot \frac{\partial I}{\partial t} = 12\text{V} - 10\text{m}\Omega \cdot 2\text{A} - 1\mu\text{H} \cdot 2 \frac{\text{A}}{\mu\text{s}} = 8\text{V}$$

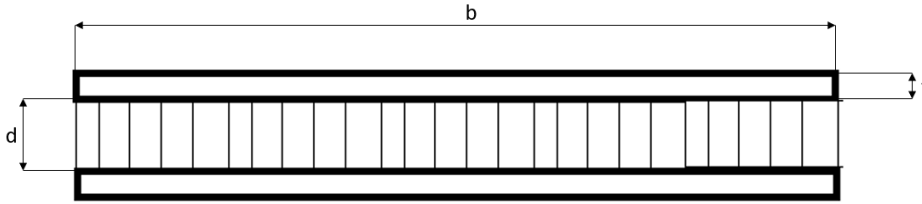
Q14

Which measure/s have to be taken if the power to the motors is $>10\text{kW}$ and braking hard is detected for more than 500ms at the same time? The pedal travel signals 0Nm torque.

- a) Open shutdown circuit.
- b) 0 Nm torque request to the motor controller.
- c) Open shutdown circuit and 0Nm torque request to the motor controller.

Answer: a)

Q15



Calculate the area moment of inertia of the composite structure above. You can assume, the core has no contribution to the moment of inertia. Use the following number for the calculation:

$$b = 0.2m \quad t = 1mm \quad d = 10mm$$

Answer in cm^4 .

Use the following format: 12.34

Answer: 1.21

$$I = 2 \cdot \left(\frac{1}{12} \cdot b \cdot t^3 + \left(\frac{d+t}{2} \right)^2 \cdot b \cdot t \right) = 1.21 \text{ cm}^4$$

Q16

You decide to do a test run with a new driver. After you signal the driver to start the run, the car sits idle for 3 seconds, then accelerates for 5 seconds at $4m/s^2$, then continues at that velocity for 5 seconds. What is the displacement of the car?

- a) 50000 mm
- b) 3937.01 inch
- c) 164.042 yd
- d) 0.2 km

Answer: c)

$$d_1 = v_1 t + \frac{1}{2} a t^2 = (0)(5) + \frac{1}{2} (4)(5)^2 = 50 \text{ m}$$

$$d_2 = v_1 t = (20 \text{ m/s})(5 \text{ s}) = 100 \text{ m}; \quad d_{\text{total}} = 100 + 50 = 150 \text{ m} = 164,042 \text{ yd}$$

Q17

Is the following statement true? It is not required to install AIRs in a 52V AC RMS accumulator for the tractive system.

- a) Yes
- b) Only if lithium based batteries used
- c) No

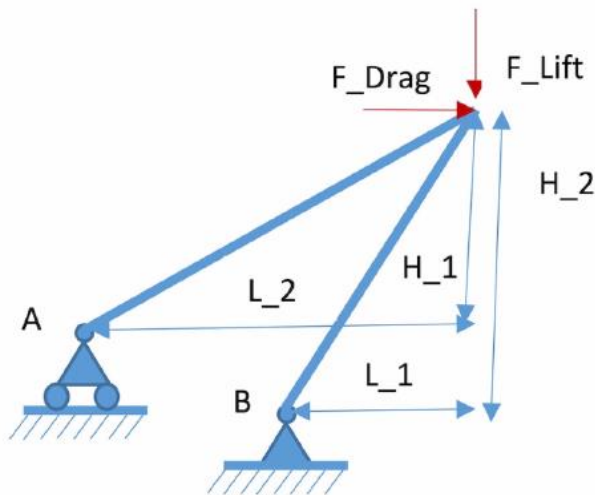
Answers: c)

Q18

During last years' acceleration a top speed of 100 km/h was reached. Due to a big improvement in the new drivetrain, the new vehicle reaches a top speed of 120 km/h. The aerodynamics chief has some worries about the stability of the rear wing bracing due the higher aerodynamic loads. Given the geometry below, by how much % does the bearing force in point A changes in comparison to last year. (The aerodynamic package did not change and therefore the same values can be assumed for both vehicles). All the useful parameters are given below:

$$c_L = 3.8 \quad c_D = 1.2 \quad A = 1 \text{ m}^2 \quad \rho = 1.1 \frac{\text{kg}}{\text{m}^3} \quad L_1 = 50\text{mm} \quad L_2 = 100\text{mm}$$

$$H_1 = 125\text{mm} \quad H_2 = 165\text{mm}$$



Answer in %.

Use the following format: 12

Answer: 44

$$F_A \propto F_{Aero} \propto v^2 \quad \frac{F_{A,2}}{F_{A,1}} = \frac{v_2^2}{v_1^2} = 1,44 \quad \text{Change: 44\%}$$

Q19

All phases of a PMSM and an induction motor are independently shorted at standstill. The torque of which motor is higher if remanence is neglected and the rotors start to spin:

- Induction motor
- PMSM
- Both are 0
- Equally
- Depends on Motor parameters

Answer: b)

Q20

How do you have to choose the damping constant in a suspension system, if you want to have a critical damped system?

$$m = 240 \text{ kg} \quad k = 100 \text{ N/mm}$$

Answer in Ns/mm

Use the following format: 12.3

Answer: 9.8

$$d = 2 \cdot \sqrt{k \cdot m} = 2 * 4.89 \dots \frac{\text{Ns}}{\text{mm}} = 9.79 \dots \frac{\text{Ns}}{\text{mm}}$$