

General Questions

Question 1:

A team is competing in the Skidpad event at FSN. If the coefficient of friction is $\mu_f = 0.87$, what is the maximum velocity in order for the car to stay in track without losing contact with the ground?

Assume that the car is racing in the centerline of the track width.

$$g = 9.81 \text{ m/sec}^2$$

- A) **31.75 km/h**
- B) 8.82 km/h
- C) 37.15 km/h
- D) 43.26 km/h

Question 2:

A team is in the process of validating the compliance of the shoulder harness bar used in their car. Choose the part in which their configuration is noncompliant:

- A. The steel tube has a thickness of 2 mm, and a 0.26% in carbon and 1.7% manganese content.
- B. **The bar is bent (not straight) and the team uses an analysis method of inducing 7 kN to each attachment in the horizontal plane to prove compliance.**
- C. The attachments are positioned 220 mm apart, measured center to center, and have a thickness of 1.7 mm.
- D. From the driver's shoulders rearwards to the mounting point or structural guide, the shoulder harness is 8° above the horizontal.

Question 3:

A team is evaluating if they can save weight by shortening some of their critical fasteners. Are you allowed to shorten bolts?

- A. No
- B. Yes, as long as the bolts exceed metric grade 8.8
- C. **Yes, as long as a minimum of two full threads project from the lock nut**
- D. Yes, unless the bolts are used in the brake system

Question 4:

Question 4 has an error in the phrasing. Work should have been Power. Therefore, question 4 will be removed from the quiz. Any time spend on this question will be deducted from the total time.

~~A team is competing in the Acceleration event at FSN. The car has a mass of 183 kg. What is the work needed in order for the car to finish in 3.8 sec with a speed of 133 km/h?~~

- ~~A) 124.8 kW~~
- B) 32.8 kW**
- ~~C) 12.4 kW~~
- ~~D) 38.3 kW~~

Question 5:

What is the minimum static ground clearance of a vehicle including a driver?

- A. 25 mm
- B. 30 mm**
- C. 40 mm
- D. 50 mm

Question 6:

The weight distribution of a car is 44% to the front and 56% to the rear axle. The wheelbase of the car is 1570 mm. In what distance, measuring from the rear axle, is the CoG located?

- A) 0.69 m**
- B) 0.87 m
- C) 1.17 m
- D) 1.32 m

Question 7:

What is true about the documentation for the Cost & Manufacturing event?

- A. "Systems" are not part of the Detailed Bill of Material
- B. "sub-assemblies" are only part of the Detailed Bill of Material
- C. For every material in the Costed Bill of Material, a receipt is required
- D. Overhead costs must be taken into account in the Costed Bill of Material**

Question 8:

Which of the following is correct about the Driver's Harness Attachment?

- A. A minimum cross-sectional area of 60 mm^2 of the same steel used in the car must be physically tested to prove structural rigidity.
- B. A belt can be regionally exposed to the engine or any other significant heat source, as long as it is not passing through the firewall.
- C. **Where lap belts and anti-submarine belts use the same attachment point, the tab or bracket to which they are attached, must have a minimum cross sectional area of 90 mm^2 of steel to be sheared if failed in tension at any point of the tab.**
- D. An attachment welded to a steel structure must be able to carry 13 kN for shoulder and lap belts, and 6.5 kN for anti-submarine belts

CV Class Questions

CV Question 9:

If a full cylinder has a Moment of Inertia of $J = 1,08 \text{ kg/m}^2$, what is the Moment of Inertia of a full cylinder with the same mass but half the diameter?

- A. 0.16 kg/m^2
- B. 0.27 kg/m^2**
- C. 0.73 kg/m^2
- D. 0.84 kg/m^2

CV Question 10:

Your team is at the design event during FSN2020 and it's quite cold for this time of the year, 18 degrees C. To impress the judges, you decide to make some tea for them.

What is the minimum required time to prepare the tea, knowing that you have to boil 8 tea cups of 150ml each and you have an electrical heater with a power of 0.86kW.

- A. 60 seconds
- B. 106 seconds
- C. 351 seconds
- D. 479 seconds**

CV Question 11:

Which of the following statements about the Fuel System is correct ?

- A. The fuel tank must be located within the surface envelope
- B. The fuel tank must be securely attached to the vehicle structure with mountings that do not allow flexibility such that chassis flex cannot unintentionally load the fuel tank.
- C. The fuel tank can be made of flexible material.**
- D. The fuel tank must be made of a rigid material to prevent failure under loading.

CV Question 12:

Please read these two statements concerning the Fuel Filler Neck for CV Class at FSN2020.

1. Fuel Filler Necks are considered part of the fuel tank
2. A minimum inner diameter of 35mm is required.

- A. Both statements are correct**
- B. Only statement 1 is correct
- C. Only statement 2 is correct
- D. Both statements are incorrect

EV Class Questions

EV Question 9:

Your team is considering two languages, Verilog and VHDL, for programming an FPGA. Which language(s) could be used?

- A. Both**
- B. Only Verilog
- C. Only VHDL
- D. None of these options

EV Question 10:

You have a conductor with a resistivity of 10 Ohm, a length of 10 meter and a current of 12 Ampere. How many coulombs of charge flow through in 1 minute?

- A. 10 C
- B. 72 C
- C. 720 C**
- D. 1000 C

EV Question 11:

Which of the following oscillators is not of sinusoidal nature?

- A. Negative-resistance Oscillator
- B. RC phase shift oscillator
- C. Relaxation oscillator**
- D. Crystal oscillator

EV Question 12:

A system has 4 resistors in parallel (25 Ohm, 80 Ohm, 50 Ohm and an unknown value) and the supply in series. The current through the 80 Ohm resistance is 1.25A. The total current of the supply is 10A. What is the value of the resistor with the unknown value?

- A. 36.36 Ohm**
- B. 40.25 Ohm
- C. 66.66 Ohm
- D. 76.66 Ohm

EV Question 13:

Which of the following is an example of a piezoelectric material?

- A. Copper
- B. Lead zirconate titanate**
- C. Magnesiochromite
- D. Potassium carbonate

EV Question 14:

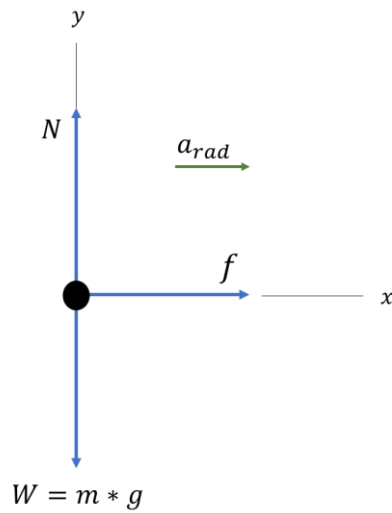
A solenoid has a length of 30 centimeter and a diameter of 3 centimeter. It is wound with 1000 turns of wire carrying a current of 10A. What is the total amount of energy inside the magnetic field?

There are no additional magnetic fields beside the one that is generated by the solenoid.

- A. 0.015 Joule
- B. 0.03 Joule
- C. 0.15 Joule**
- D. 0.3 Joule

Answers

Q1: A



$$R = \frac{15.25}{2} + \frac{3}{2} = 9.125 \text{ m}$$

$$a_{rad} = \frac{U^2}{R}$$

$$\Sigma F_x = f_{static} = m * a_{rad} = m * \frac{U^2}{R} \quad (1)$$

$$\Sigma F_y = N + (-m * g) = 0 \rightarrow N = m * g$$

$$\text{Max Friction} = f_{max} = \mu_f * N = \mu_f * m * g \quad (2)$$

Thus (1)^(2) produce

$$\mu_s * m * g = m * \frac{U^2_{max}}{R} \quad \text{and thus}$$

$$U_{max} = \sqrt{\mu_s * g * R} = \sqrt{0.87 * 9.81 * 9.125} = 8.82 \text{ m/sec} = 31.75 \text{ km/h}$$

Q2: B

See **T5.5.2**

Q3: C

See **T10.1.5/T10.2.3**

Q4: B

$$W = \frac{1}{2}m(U_2^2 - U_1^2) = \frac{1}{2} * 183 \left[\left(\frac{133000}{3600} \right)^2 - 0^2 \right] * \frac{1 \frac{kJ}{kg}}{\frac{1000 m^2}{sec^2}} = 124.8 kJ$$

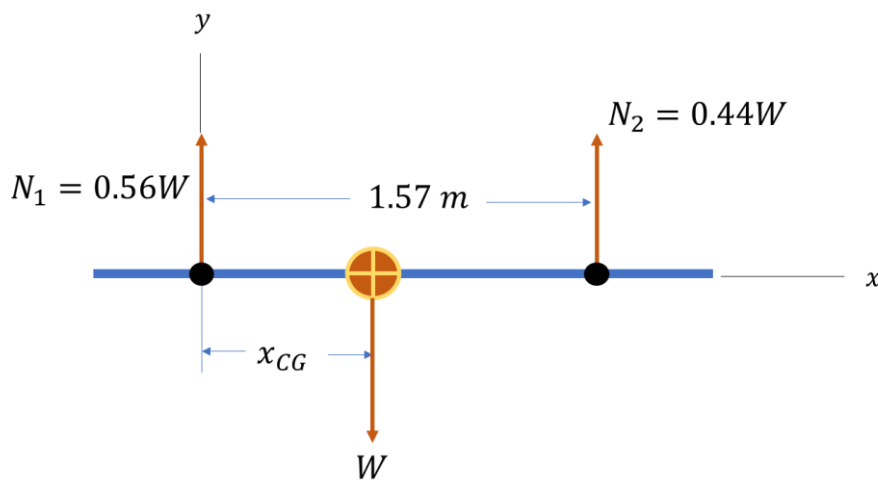
$$\dot{W} = \frac{W}{\Delta t} = \frac{124.8}{3.8} = 32.84 kW$$

Q5: B

T 2.3.2 The minimum static ground clearance of any portion of the vehicle, other than the tires, including a driver, must be a minimum of 30 mm.

Q6: A

Answer:



Using Moments

$$\Sigma M = 0.56 * W * 0 - W * x_{CG} + 0.44 * W * 1.57 = 0$$

$$x_{CG} = 0.69 m$$

Q7: D

See **S2.6.8**

Q8: C

See (T5.3.2)

Q CV 9: B

The moment of inertia of cylinder is $J = \frac{1}{2} * m * R^2$

$$J_1 = \frac{1}{2} m * \left(\frac{D_1}{2}\right)^2 = 1.08 \frac{kg}{m^2}$$

$$J_2 = \frac{1}{2} m * \left(\frac{D_1}{4}\right)^2$$

$$\frac{J_1}{J_2} = \frac{\frac{1}{2} m * \left(\frac{D_1}{2}\right)^2}{\frac{1}{2} m * \left(\frac{D_1}{4}\right)^2} = \frac{\frac{D_1^2}{4}}{\frac{D_1^2}{16}} = 4 \rightarrow J_2 = \frac{J_1}{4} = \frac{1.08}{4} = \mathbf{0.27} \frac{kg}{m^2}$$

Q CV 10: D

$$Q = m * c * \Delta T$$

$$P * t = Q$$

$$t = \frac{m * c * \Delta T}{P} = \frac{1.2 * 4186 * 82}{860} = 478.956 [s] \rightarrow 7'58''$$

Q CV 11: C

(CV2.3.1)

Q CV 12: A

See CV2.6.1 and FSN Grey Area clarification document

Q EV 9: A

Explanation

Verilog and VHDL are the hardware description languages that are used for the programming of FPGAs. Both of these languages are case-insensitive in nature.

Q EV 10: C

1 Ampere current means flowing of 1 Coulomb charge per second. That means 12 A current in 1 minute or 60 seconds implies $12 \times 60 = 720$ coulombs.

Q EV 11: C

Explanation:

Relaxation oscillator is basically a non-sinusoidal oscillator which is used to generate square, triangular or pulse waveforms. The rest of the oscillators are sinusoidal oscillators producing sinusoidal output.

Q EV 12: A

Explanation:

Voltage drop across each parallel branch = $85 \times 1.25 = 100\text{V}$ Total current is 10A. So the equivalent resistance is 10 Ohm. Therefore $1/10 = 1/80 + 1/25 + 1/50 + 1/R \rightarrow R = 36.36 \text{ Ohm}$

Q EV 13: B

Explanation:

Lead zirconate titanate, $\{\text{Pb}[\text{Zr}_x\text{Ti}_{1-x}]\text{O}_3 \ (0 \leq x \leq 1)\}$, an inter metallic, inorganic compound is the most common piezoelectric ceramic use today.

Q EV 14: C

Explanation:

Since we know that,

$$L = N^2 \times \rho$$

given

$N = 1000$ turns diameter

$= 3 \text{ cm}$, $L = 30 \text{ cm}$.

$$\rho = \frac{\mu_0 A}{L} = \frac{4\pi \times 10^{-7} \times \pi \times (1.5 \times 10^{-2})^2}{0.3}$$

$$= 29.6088 \times 10^{-10}$$

$$L = 29.6088 \times 10^{-10} \times (10^3)^2 = 29.6088 \times 10^{-4} \text{ H}$$

$$W = \frac{1}{2} L I^2 = \frac{1}{2} \times 29.6088 \times 10^{-4} \times (10)^2 = 0.148 \approx 0.15 \text{ J}.$$