

Evan Morcom 1802426 Automotive Materials and Sustainability

ACHA6012

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Section A

- a) The two alternative types of Fuel I have chosen is a Synthetic BioFuel and Hydrogen.

As in 2025, the Euro VII emissions Standards will be released and are likely to be even more stringent than the current vehicle emissions Standards.

Synthetic Fuels Such as Audi^{*} and Joule Fuels "SunFlow-E" which is ethanol, produce less CO and NO_x than the normal pump ES Fuel.

* using Algae

~~Hydrogen~~ Hydrogen in theory only produces water as a waste product however in a hot burn, NO_x can be produced. Euro VI currently demands 1.0g/km of CO & 0.06g/km of NO_x.

- b) Implementation of these Fuels may require a large & infrastructure change. Older vehicles fuel lines and c) other pieces of rubber in the fuel system may ~~deteriorate~~ deteriorate with increased usage of ethanol. The same can be said for fuel stations, new pumps will have to be installed for the higher demand in ethanol.

As hydrogen systems add an average of 100kg, mainly fuel tanks and plumbing, manufacturers must redesign other aspects such as tyres and suspension to deal with the added mass.

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Hydrogen^{engines} also produces less power than petrol engines. This may result in customers wanting more and let down by a manufacture.

Due to the ^{hydrogen} system ^{being} expensive, this will increase the buy price roughly by 10%.

Although, ethanol production can be changed due to converting CO₂ to ethanol by applying 1.2V to CO₂ dissolved in water, ~~into~~ ~~eth~~ This produced a yield of 63% of ethanol.

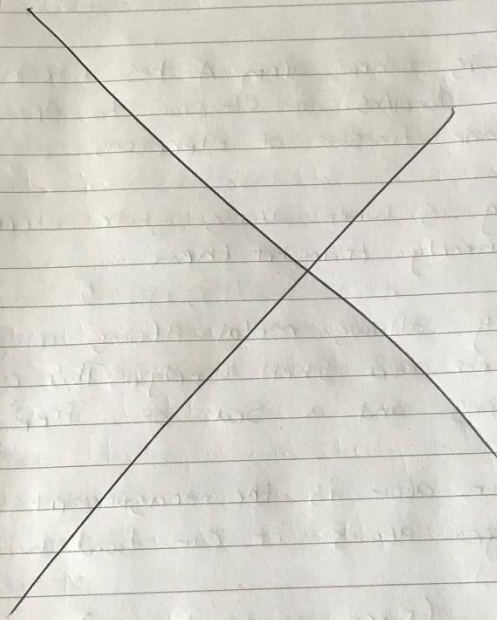
The storage of ethanol is no problem however hydrogen can be very difficult to store. Converting to a liquid is a costly process or the usage of metal hydride tanks, though these tanks weigh around the 280kg mark.

Hydrogen is ~~seen~~ perceived as dangerous by the public however the biggest hurdle is the production of hydrogen. If more vehicles use the fuel, the demand will quickly overwhelm the supply.

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Section B

Question 2.

- a) Ionic Bonding is when atom A has a complete outer shell and donates an electron to Atom B. It is the simple transfer of electrons.

Covalent bonding is when atoms share electrons but don't permanently transfer them.

Metallic bonding allows metal atoms to shed electrons from their outer shell freely. This creates positively charged ions and a sea of "free" electrons.

The valency of an atom is the measurement of how many hydrogen atoms it can bond with.

- b. Cell of Copper (Face centered cell)

R = atomic radius $\approx 0.362 \text{ nm}$.

$$a = 2\sqrt{2}R \quad R = \frac{a}{2\sqrt{2}} \quad R = \frac{0.362 \times 10^{-8}}{2\sqrt{2}}$$

$$R = 1.279 \times 10^{-9} \text{ m}.$$

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c) There is 3 main groups of defects in crystalline structures:

- Point defects
- Line defects
- Area defects

Point defect is when missing atoms when the lattice forms leaving vacancies in the structure, allowing distortion of surrounding atoms.

Line defects are caused by dislocations in the lattice, these are layers of the lattice 'slipping' relative to their adjacent layers. This produces permanent plastic deformation.

Area defects are within the grain boundary. This is the boundaries between the crystals in a material. The orientation will always be different and can help impede dislocations.

d) The secondary phase is dislocation movement.

Dislocations move towards the grain boundaries under load. Due to these being the weakest section, either modifying the grain size to be more fine or adding refractory metals to the base metal can slow the speed of the ~~creep~~ creep in the secondary phase.

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Question 4.

a) i) Zinc is the main alloying element in the Aluminium 7xxx Series group. It is heat treatable for increased strength however, the alloy becomes very brittle and is rarely used alone.

ii) ~~cast~~

In the case of Steel 1045, the 1 tells it is a carbon steel and 4 & 5 indicates the carbon content, this would be 0.45%.

b.

Composites can be broken down into 3 groups.

- Particle Reinforced
- Fibre Reinforced
- Structural.

Particle Reinforced ~~for~~ Composites, the particles are harder and stiffer than the matrix material. Within this there are large particle & dispersion strengthened. They aren't dimensionally large and it restricts plastic deformation. Mainly best known composite using large particle is concrete.

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Fibre reinforced are the most technologically important composites. Mostly use in Fibreglass and Carbon Fibre. They can be subclassified by Fibre length and Orientation:

- Aligned
- Random
- Woven

Fibres are often brittle and fail with minimum plastic deformation.

Structural composites are made up of both composite and homogeneous materials. Commonly used as multi ply carbon fibre and Aluminium honeycomb. Split into two;

- Laminar
- Structural

Laminar composites are made up of sheets of material and Structural Panel Composites consist of 'Faces' and 'Cores'.

Faces are made from a strong material such as carbon fibre or aluminium.

Cores are made from a less dense material such as a foam or Nomex.

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$$C. \frac{F_F}{F_m} = \frac{E_F V_F}{E_m V_m}$$

$$F_c = F_F + F_m$$

$$F_c = \sigma \times A$$

$$\frac{F_F}{F_m} = \frac{65 \times 10^9 \times 0.45}{3.2 \times 10^9 \times 0.55}$$

$$\frac{F_F}{F_m} = \frac{2.925 \times 10^{10}}{1.76 \times 10^9}$$

$$\frac{F_F}{F_m} = 16.62$$

$$F_F = 16.62 F_m$$

$$F_c = F_F + F_m$$

$$30 \times 10^6 = 16.62 F_m + F_m$$

$$30 \times 10^6 = 17.62 F_m$$

$$F_m = \frac{30 \times 10^6}{17.62} = 170.2 \text{ KN}$$

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$$F_p = 16.62 \text{ Fr}$$

$$F_p = 16.62 \times (70.2 \times 10^5)$$

$$F_p = 2828724 \text{ N}$$

$$F_c = \sigma \times A$$

$$F_c = 30 \times 10^6 \times 0.3$$

$$F_c = 9 \times 10^6 \text{ N}$$

