

Question 1

a. Bio ethanol is made using yeast fermentation and distillation. It can then be mixed with regular petrol allowing for most existing vehicles to run on it and negating any need for infrastructure changes. During production of bioethanol high protein animal feed can also be produced as a by product. Furthermore the plants will absorb CO₂ emissions whilst growing.

Hydrogen Combustion can be up to 30% more efficient than the gasoline equivalent

b. Bio ethanol requires almost no change to current infrastructure with only a few vehicles requiring any modification to run on petrol and bioethanol blends. This will mean that people do not have to make any large lifestyle changes or purchases. This will mean the technology can be deployed on a large scale and adopted by the masses.

Hydrogen power is already being implemented across the UK with several fueling stations being built. The main issue with hydrogen is storage as the element is extremely reactive. However the process of filling a car with hydrogen

Benjamin Silber (2027) Anthropogenic Warming and Sustainability
Act A 6012 13/05/2027 page 2

Question 1

b. It is very similar to the process of refueling a petrol or diesel vehicle meaning it will be easy for people to adopt. The issues will be finding a filling station until infrastructure is improved making it less practical now.

c. To implement bio ethanol very few changes to infrastructure are required as the current petrol fuelling stations can be used to distribute the fuel to customers. The main issue with bio ethanol is finding space to grow the crop as demand increases. Furthermore if crops are lost to harsh weather or natural disaster this can greatly impact the supply chain.

Hydrogen implementation requires massive changes to current infrastructure with fuelling stations required to distribute and store the fuel. In addition, the production of hydrogen and hydrogen powered vehicles must increase to meet global demand.

Section B

Question 2

a. Ionic bonding is when atoms transfer electrons between each other to complete their outer shells. This process requires a donor and receiver, generally a metal donor and non metal receiver.

Covalent bonding is when atoms share electrons without a permanent transfer. This often takes place between atoms of the same element and is rare in metal elements. Metals and non metals can form a covalent bond.

Metallic bonding is when metal atoms shed electrons from their outer shell, creating positively charged ions and delocalised electrons. The ions then form a closely packed lattice structure with electrons filling the gaps.

Question 2

B. $a = \frac{4R}{\sqrt{3}}$

$a = 2\sqrt{2}R$

~~$R = \frac{a}{2\sqrt{2}}$~~

$R = \frac{a}{2\sqrt{2}}$

~~$R = \frac{0.362 \times 10^{-9} \sqrt{3}}{2}$~~

~~$R = \frac{0.362 \times 10^{-9}}{2\sqrt{2}}$~~

~~$R = \frac{0.362 \times 10^{-9}}{2\sqrt{2}}$~~

$R = 0.362 \times 10^{-9} / 2\sqrt{2}$

~~$R = 0.128 \text{ nm}$~~ $R = 1.28 \times 10^{-10} \text{ m}$

$L = 0.128 \text{ nm}$

Question 2

C. Point defects occur when missing atoms in the lattice leave vacancies in the structure, allowing distortion of surrounding atoms. Vacancies occur naturally in crystalline structure and the amount of vacancies depends on the temperature up to the melting point.

Another form of point defect occurs when an atom becomes positioned between the normal lattice structure, known as a self-interstitial defect. The final type of point defect is known as substitutional, this is when one atom in the lattice is replaced by a different type of atom.

Line defects can be caused by dislocation of the lattice. This allows layers of the lattice to slip relative to their adjacent layers. This movement causes bonds to break and new bonds to form once the movement is complete and produces a permanent plastic deformation.

Area defects are created by grain boundaries in the crystalline structure. Grain boundaries are boundaries between crystals in a material, where the orientation of crystals changes. Grain boundaries can impede dislocations.

Question 2

d. To protect from creep the thermal conditions can be changed to apply a thermal barrier coating to reduce the component temperature or where possible internally ventilate the component to lower the temperature of the material.

Question 4

a.i. Zinc is the main alloying element in 7xxx grade aluminium alloy. This allows for the material to be heat treated for increased strength. However, the material also becomes very brittle.

a.ii. 1045 grade steel

1 = indicates that the steel type is Carbon steel

~~45~~

45 = indicates the percentage of Carbon content. in this case 0.45%.

Question 4

b. Composites can generally be classified into three main groups: Particle-Reinforced, Fiber-Reinforced and Structural.

Particle-Reinforced ~~in~~ involves the use of particulates that are harder and stiffer than the matrix material. These particulates are of macro-, micro- or nano-Scopic Scale and the interface bonding determines the improvement of the mechanical behaviour. There are two groups of particle reinforced composites known as large particle and Dispersion Strengthened.

Large particle simply means that the interaction with the matrix material is not on an atomic level. The most common example of this composite is concrete. For best effectiveness the particles should be small, ~~and~~ evenly distributed and of consistent size. Volume fraction of the matrix and particles determines the mechanical properties of the ~~matrix~~ material.

Dispersion Strengthened Composites feature much smaller particles usually in a size range of $0.01 - 0.1$ microns, that form bonds on an atomic or molecular level to the surrounding matrix.

Question 4

b. ~~Fibre~~ - Reinforced Composites aim to achieve high strength or stiffness for a relatively low weight. The most common examples are Carbon fibre and fibreglass. The fibres in these composites are often brittle and fail with minimal plastic deformation while the matrix material is often ductile giving the composite material aspects of plastic manner. The fibres in this composite can be aligned in different ways to achieve different properties and give the material strength or allow deformation in different directions.

Structural Composites are made up of both composite and homogenous materials combined to create a material with properties of both.

The composite properties also depend on the geometric construction of the composite.

These composites can be structured different ways. Laminar composites are made up of material sheets. The direction and orientation of each sheet can be controlled to achieve different finishes for the composite. This process is commonly used for carbon fibre.

Sandwich panel composites consist of faces and cores. Faces are made from a strong material to absorb most of the in plane loading. The core on the other hand, is made from less dense material often arranged in

Benjamin Gilbert 160127 Automotive materials and Sustainability
ACMA 6012 13/05/2022 page 8

an interlocking honey comb ~~Study~~ Structure made up of hexagonal cells. The core is designed to resist perpendicular deformation to the faces and bending. A common example of this is aluminium honey comb.

Question 4

L volume F 0.45

modulus elasticity ~~Wton~~ 65 GPa

modulus of elasticity ~~Wton~~ 3.2 GPa

$$A = 300 \text{ mm}^2$$

$$= 0.0003 \text{ m}^2$$

Stress 30 MPa

$$F_c = \sigma A = 30 \times 10^6 \times 0.0003 = 9000 \text{ N}$$

$$F_c = F_f + F_m$$

$$\frac{F_f}{F_m} = \frac{E_f V_f}{E_m V_m} \quad F_f = \frac{E_f V_f}{E_m V_m} \times F_m \quad F_f = \left(\frac{65 \times 10^9 \times 0.45}{3.2 \times 10^9 \times 0.55} \right) \times F_m$$

$$F_f = 16.62 F_m \text{ N}$$

Benjamin Gilbert 1627 Avenue University of Saskatchewan
Acta Coiz 13 06 2022 page 9

Question 4

$$C. \quad 1000 = 16.62 F_m + F_m$$

$$1000 = 17.62 F_m$$

$$F_m = \frac{1000}{17.62}$$

$$F_m = 510.78 \text{ N} \quad \text{2dp}$$

$$F_f = 16.62 \times 510.78$$

$$F_f = 8484.16 \text{ N} \quad \text{2dp}$$

Hgcweakbjchw qweg chwcbhjwbc bwqchbcbqwe cqewvhc b c2ecwe bcmew kgh2cvekuc2qe xw
yku2edjdc qw g ykuv2ec qcb v h3gc3qhgc twenty pissing words