

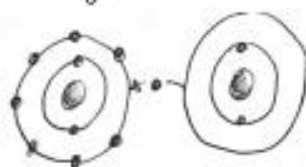
SECTION B, QUESTION 2.

a). Ionic Bonding: This is the transfer of electrons from one atom to the other, the donor atom gains a ~~charge~~ positive charge and becomes an Ion, the same happens to the receiving atom, - but with a negative charge.

Covalent Bonding: This is the sharing of electrons between atoms, no charges are formed, however the atoms are bonded because they share electrons.

Metallic Bonding: Metallic bonding involves the metallic atoms arranged in a lattice structure with ~~electron~~ delocalized electrons flowing freely between - explaining the ability to conduct electricity.

Valency: Atoms have a finite number of electrons on their shells, where atoms ~~are~~ have incomplete shells, they have a ~~valency~~ need to gain electrons - valency. Other atoms with spare electrons on empty outer shells transfer these electrons.



b) 4 atoms/unit = FCC

$$R = ?$$

$$a = 0.362 \text{ nm}$$

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

$$\frac{a}{2\sqrt{2}} = R = \frac{0.362}{2\sqrt{2}}$$

$$R = 0.127$$

SECTION B, QUESTION 2

c) Point defects.

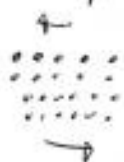


Vacancy: Where an atom is missing from a structure

Self-interstitial: Where an extra atom is lodged between the others.

Substitutive: Where an atom of another element is in the structure.

Line defects.



Translation: This is where entire rows of atoms are displaced from equilibrium. Forming water bands as a result.

Area Defects.



Grain boundary: Where different atom structures converge at different angles. The boundaries are called grain boundaries and are the location of most cracks, defects and impurities.

- d). @ Creep has 3 stages, Primary - grain rotation/alignment, Secondary - grain distortion, Tertiary - failure. The ductility under ~~pressure~~ heat controls the amount of distortion in this phase.

SECTION B, QUESTION 3.

a). Casting: This is a well-developed technique that involves pouring molten metal into a cast. It is suitable for high-melting point metals and complex shapes are achievable, however there is poor dimensional control and machining is required.

Forging: This is using heat and pressure to form a part into a shape, it is best for ductile materials and forms better grain structure. However initial costs are expensive and a long production run is needed for viability.

Pressing: This involves using hydraulic presses to stamp a sheet metal part into shape. Thin materials are needed and they can produce high strength for low material and weight, however, tooling costs are astronomically high and no one-off parts can be made.

b) Detection (likelihood): The detection factor is how likely an issue is to be discovered. Ranked 1-10 with 10 being undetectable.

Probability of Occurrence: ~~There~~ ~~The~~ ~~probability~~ This is how likely the fault is to occur with 10 being certain.

Severity: This is how severe the consequence of the fault is, with 10 being death.

$$\text{RPN} = \text{Detection} \times \text{Probability} \times \text{Severity}.$$

RISK PRIORITY NUMBER

Elton Johnson
1902940

4/5

$$D = 0.01 \text{ m}$$

$$d =$$

$$h = 1.9 \text{ mm} \rightarrow 0.0019 \text{ m}$$

$$n = 0.0005 \text{ m}$$

$$\sigma = 55 \text{ Pa}$$

$$h/n = 3.8$$

$$\frac{2h}{D} = 0.38$$

$$K_t = C_1 + C_2 \left(\frac{2h}{D}\right) + C_3 \left(\frac{2h}{D}\right)^2 + C_4 \left(\frac{2h}{D}\right)^3$$

$$C_1 = \cancel{8.2538} \quad 4.6969$$

$$C_2 = \cancel{-2.5054} \quad -10.6094$$

$$C_3 = 13.4577$$

$$C_4 = -5.6266$$

$$\boxed{K_t = 2.3.}$$

$$\cancel{F = \sigma \times A} \quad \cancel{\frac{F}{A} = \sigma} \quad \frac{F}{A} = \sigma$$

$$\cancel{K_t \times \sigma} = 2.3 \times 55 = \boxed{126.5 \text{ Pa}}$$

d).

$$a = 3.9 \rightarrow 0.0039 \text{ m}$$

$$G = 625000000 \text{ Pa}$$

$$E = 200,000,000,000 \text{ Pa}$$

$$K = 69181067.19$$

$$K_c = \sigma \sqrt{\pi a}$$

$$K_c = \sqrt{G_c E}$$

$$\cancel{\frac{K_c^2}{G_c E} = G_c} \quad \frac{K_c^2}{E} = G_c$$

$$\frac{69181067.19^2}{200 \times 10^9} = \boxed{23930.1 \text{ Pa} \cdot \text{m}}$$

Section A

cheaper.

Proposed

Bio-butanol is a ~~proposed~~ alternative to petrol, it is produced from Corn that can be naturally grown as a sustainable ~~source~~ source. The new emissions regulations use the WLTP cycle, a more accurate representation of vehicle drive cycles ~~over~~ the older NEDC. In addition, PEMS (portable emissions measurement systems) are even more accurate to real life.

Bio-butanol is sustainably produced meaning that it offsets some of the damage that it produces, this is good for government policy and global warming initiative, however it does nothing for the emissions standards that do not account for this. Bio-butanol does produce less CO₂ than conventional fuels, however this is not significant.

There are flex-fuel vehicles in existence that are capable of running on a variety of fuels, therefore it may not be too much of an issue to accommodate a more sustainable fuel. It is the infrastructure that is a large issue, with all manufacturing geared towards petrol and diesel, there ~~is~~ ~~are~~ large sweeping changes that would be needed to produce bio-butanol especially to production which is much different to conventional means. However, butanol is still a liquid which means that much of the transport infrastructure would need little change.

Another alternative is LPG, this is a gaseous fuel that is an already established alternative to petrol/diesel. It produces around 30% less CO₂ than ~~bio-butanol~~ petrol, this is good for emissions tests, ~~alternatively~~, unfortunately, the fuel is still fossil based unlike bio-butanol which removes the wider environmental benefits.

The conversion for the user to LPG is expensive - up to £1500. This is likely the reason why it is not widely adopted, ~~although~~ ^{but} ~~then~~ ^{conversion} costs are substantially lower compared to petrol/diesel - making it more of a long term investment. If LPG was to be widely adopted, the production ~~conversion~~ ^{conversion} was already developed, only needing up-scaling, however transportation will need very expensive upgrades to accommodate for gaseous fuels.