

Q1)

By law the product needs to be labelled, when choosing a material this needs to be the top priority as if the packaging is not labelled a law is broken.

Taking the labelling into account the material needs to have the ability to have a label printed on or a secondary process of having a sticker type label stuck on.

Another requirement to improve shelf life is to be totally isolated from atmospheric water vapour so should need to be sealed but easy for the customer to open.

With these core requirements needed a material would need to be light for the customer to carry, impervious so that water vapour cannot enter the packaging, non-corrosive so that be appealing to outdoor buyers to enjoy the snack in all weathers, recyclable to help the environmental impact & should also not poison the customer!

The cost is a major factor in choosing a material, for both cost of material but also for the manufacturing process.

- Foil - using foil similar to a crisp packet can easily be printed on, the packet can be sealed in the same way as a crisp packet to make it impervious to atmospheric water vapour, it is light, non-corrosive, recyclable & cheap
- Plastic / Foil lid - The main body of the packaging could be an injection moulded plastic with a secondary material such as foil for the lid, such as a yoghurt pot style. Again the label can be easily printed onto the lid & sealed the same way as a yoghurt pot to make it impervious to atmospheric water it will also be very light, non-corrosive, recyclable. This option may be a bit more extensive due to the manufacturing process.

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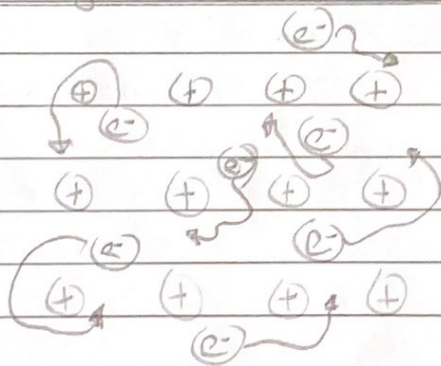
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• Aluminium can - using a tin/can style packaging with a ring pull would be a good option. The label can be printed directly onto the material so there is no secondary process to add the label, the ring pull feature has a good sealing feature to protect the contents making the packaging impervious to atmosphere, water vapour, it is light, non-corrosive & recyclable. It is also very cheap.

Q2) a)

Metallic bonding is a force that holds atoms together in a metallic substance. Such a solid consists of closely packed atoms. In most cases, the outer most electron shell of each of the metal atoms overlaps with a large number of neighbouring atoms. As a consequence, the valence electrons move from one atom to another. The atoms that the electrons leave behind become positive ions, and the interaction between such ions and valence electrons give rise to the bonding force. Metals with a valency of 2 are generally stronger than metals with a valency of 1 because there are more electron bonds making the material stronger.



metallic structure showing possible electrons (e^-) paths around nuclei of metal atom (+). metallic bonding can be thought of as a cloud of positively charged ions immersed in a cloud of valence electrons.

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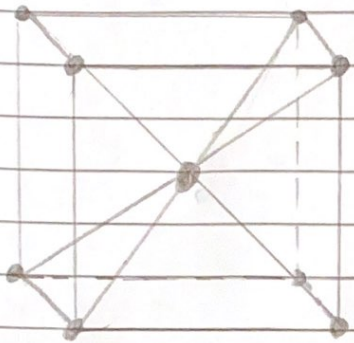
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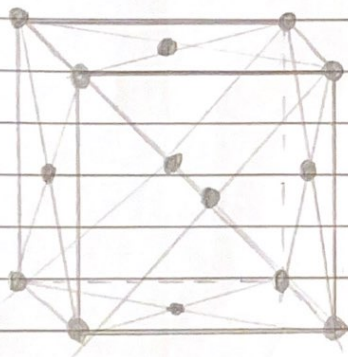
Q2) b)

Body centred cubic (BCC)



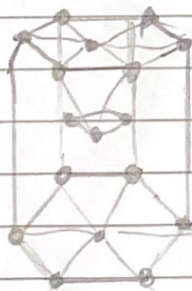
The BCC unit cell has atoms at each of the 8 corners of a cube plus one atom in the centre. The BCC structure is often the high temp form of metals that are closer packed at lower temperatures. Some of the materials that have a BCC structure are - lithium, sodium & potassium.

Face centred cubic (FCC)



The FCC structure has atoms located at each of the corners and at the centre of all cubic faces. The FCC structure can pack closer together than the BCC structure. Each corner atom is the corner of another cube so the corner atoms are shared among 8 unit cells. Some materials which have FCC structure are - aluminium, copper & gold.

Hexagonal close packed (HCP)



The HCP structure of alternating layers is shifted so its atoms are aligned to the gaps of the preceding layer. Some materials that have a HCP structure are - lithium & zinc.

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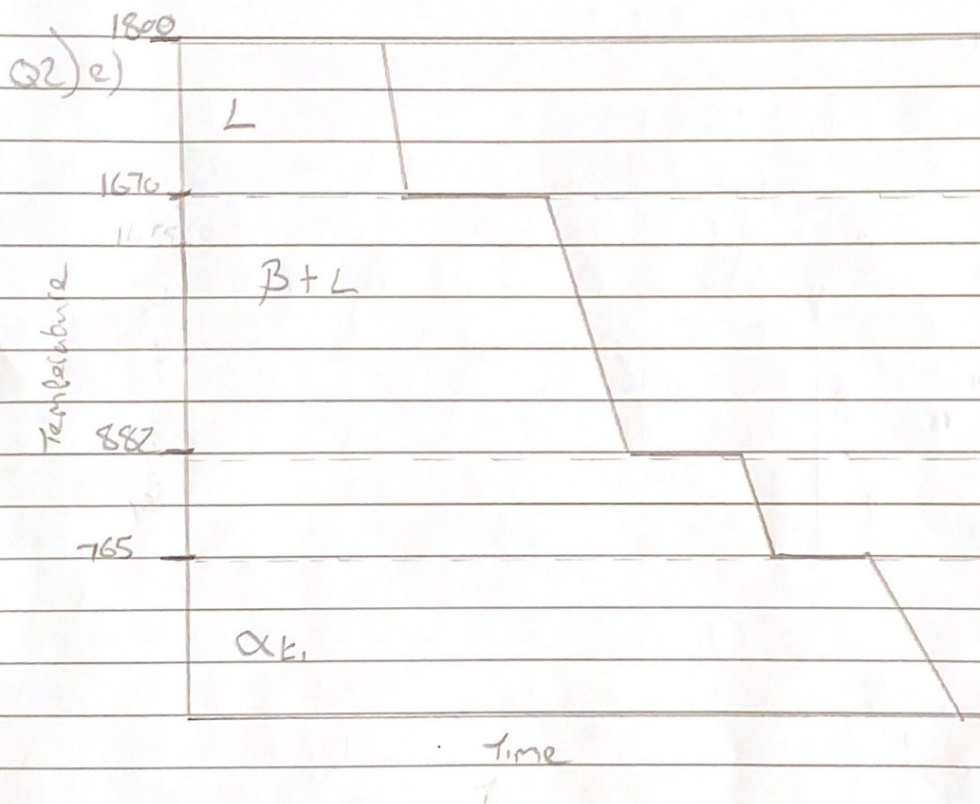
Q2)c) Hexagonal close packed (HCP) = 0.74 or 74%
Body centred cubic (BCC) = 0.68 or 68%

Q2)d) Liquid

a) 1600°C the material is 46 beta & Liquid

a) 800°C the material is 46 alpha & beta titanium

a) 600°C the material is 46 alpha titanium



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Q3) a)

For this application I would be designing for stiffness & density. By using the Material Selection map this shows a range of values for each property. For the purpose of stiffness & density I would choose carbon fibre reinforced composites. This material scores high on the density axis & has a low young's modulus score which is ideal for maximising stiffness & stiffness.

b) I would not choose ceramics because of impact toughness. The chassis would be put under a cyclic loading & impact. The materials in the ceramic class do not have the characteristics set out in the design specification for stiffness & density.

c) carbon fibre - it is an extremely light material, it also has good toughness properties, good vibration damping and is very strong & corrosion resistant. All of these properties are ideal for the use in a chassis.

Steel - is also very strong, it is heavier than carbon fibre & would also need to be treated in a non corrosive solution this is probably why it is cheaper.

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Q3) d) The base material in welding^{is} the metal to be joined to another material. The ductility of the material will be less once welding occurs & the fatigue strength won't be as strong.

c) Other alternatives for joining can be bonding & fastening

Q4) a) The requirements for the material for a scuba diving cylinder would be tough, strong, corrosion resistant, fatigue strength because it will be compressed at high pressures.

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