

Question 1

Requirements of material properties are

- Needs to be air tight to protect the food from atmospheric ~~water~~ water vapour
- Resistant to environment, to be able not loose the air tight seal and expose the food
- Non Reactive, any reactions might spoil the food
- Non toxic to health
- Cheap to manufacture

Potential material choices

② Glass - • glass could be a very good choice because it ~~is~~ doesn't react with the atmosphere, it is recyclable ~~if~~ therefore the packaging can be reused

- The cost is dependant ^{on} the value of the seal
- The glass can be hermetically ~~seal~~ sealed to

Plastic

- Plastics can be ~~sustainable~~ sustainable due to the fact that we can recycle them, ~~and~~
- Very light ~~and~~ ~~transportation~~ making the transportation efficient, example of this would be a flat less fuel would be used comparing to glass packaging
- Can be hermetically sealed

Robt Told

ALMA4000

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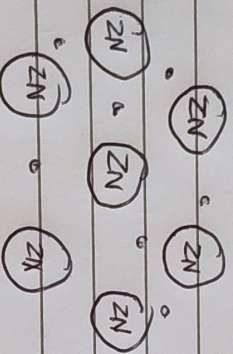
Steel and Aluminium ~~packaging~~ ~~either~~ are out of the question due to the cost of the raw materials, ~~get~~ being reactive to atmosphere and in general not suitable as packaging.

The ~~so~~ choice would ~~to~~ have to be between glass and plastics.

- To the reasons stated before I will have to add that plastics can be bio degradable so the impact of waste can be less than with glass, although glass also degrades but it takes millions of years
- manufacture of such ~~be~~ would be easier with plastic as glass would have to be formed into shape with elevated temperatures which in a long run can affect the environment.
- And lastly plastics are much cheaper than glass. which you need to cut down to sell your product at competitive price.

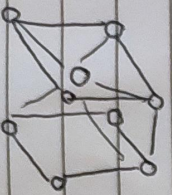
Question 2

- a) Metallic bonding consists of closely packed atoms which share electrons ~~for~~ with the other atoms. The ~~sets~~ outer shells of atoms overlaps each other causing them to share electrons, the electron are also free to move between atoms affecting the valency which can be different at any moment.

Diagram of Zinc

Metals with valency of 2 are stronger because they can bond with 2 ~~atoms~~ other atoms at any time comparing to ~~47~~ atoms with valency of 1.

b)

~~BCC~~ BCC

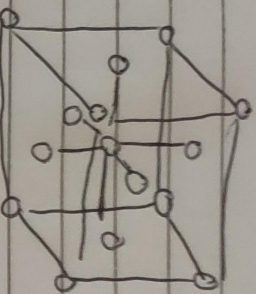
- Has 8 atoms in ~~at~~ each corner and one in the middle equalling to consist as 3 full atoms as atoms in the ~~corners~~ corners are counted as quarters

Roll Table

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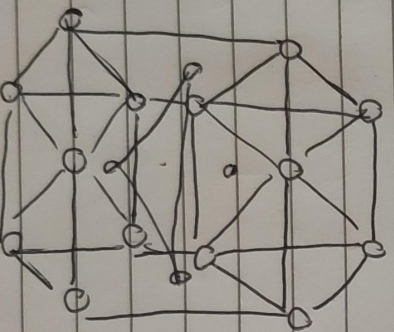
FCC



- Face centered cubic crystal structure consist of 8 atoms in each corner, 6 atoms on each faces and 1 atom in the middle
- Corner $8 \times \frac{1}{8} = 2$ atoms
- Face $6 \times \frac{1}{2} = 3$ atoms
- Center 1 atom

Expelling in 6 atoms

HCP



Plot Title

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c)

Packing ratio of HCP = 74%

Packing ratio of BCC = 68%

d)

Question 3

a) ~~Polymers~~ ^{Composites} Metals and composites

^{Composites} ~~Polymers~~ because they have a very good stiffness / Density ratio, for example materials such as carbon fibre is used in many racing application to bring the weight of the car down to minimum required while keeping the structural strength.

Metals are always a viable option although not as effective as some composites in judging by the stiffness / weight ratio ^{steel} they are much cheaper to ~~work~~ work with and more widely available.

b) Foams, elastomers, polymers and natural materials are out of the selection as they are too weak although their weight is also very low, it wouldn't be practical as the parts would have to be bigger (larger final volume) to even be ~~stronger~~ strong but it wouldn't come ~~even~~ even close to metals and composites

c) When building a racing car, you building it to be better than the competition, without compromises therefore cars used better and stronger parts made from ~~cost~~ more expensive materials to gain as much performance as possible

Carbon fibre allows the racing team cut the weight of the car while retaining the same strength and stiffness.

Pick Tojak

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Some other benefits of using carbon fibre are that it is corrosion resistant, x-ray transparent so it can be inspected for imperfections and have a low thermal expansion coefficient keeping the ~~dimensional~~ dimensional tolerances tight.

Steel is used when the consumer is the public and you want to squeeze out as much profit from selling the car. ~~a~~ ^{have} steels ~~are~~ the best price to strength ratio. Therefore they commonly used in products where price matters. ~~cost~~

Steels can be alloyed to give it ~~off~~ different properties and different grades of steel ~~used~~ to ~~use~~ give available when the application of the product is different.

d) Welding such as TIG welding introduces a lot of heat in the welded area changing the properties in a uncontrollable manner. The base metal can warp during welding making the joint around the weld dimensionally inaccurate.

Residual stress is common & with the weldline and can make some welds weak due to ~~being~~
~~distortion~~ contraction of hot zones in the weld.

Brazing is used because it doesn't affect the base metal because the filler metal has a lower melting point than the base metal. A important aspect of keeping the temperature low is that it keeps the base metal dimensionally accurate. ~~also~~ ~~specification~~
~~The~~ Brazing is much more difficult than try welding and that's why is ~~now~~ only used where you need to keep the base metal unaffected.

Pdr Total

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e)

Other option to join space frames is by rivetting or an permanent fasteners such as nuts and bolts.

For rivetting, holes need to be machined to accommodate the rivet therefore increasing the cost and complexity of the frames as holes can weaken the frames. There is more work needed ~~with~~ ^{as} when using bolts ~~as~~ ^{as} threads need to be machined for the bolts to ~~insert~~ ^{insert} into and also they have to be ~~several~~ ^{several} checked and replaced after some time.

They can't be used for thin frames as bolts have to be torqued to spec which can deform the mating surface if torqued incorrectly.

Pink Tolt

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Question 4

- a) • Needs to be ~~be~~ corrosion resistant
- Needs to be machinable to machine a thread for a valve or pressure regulator
 - Needs to withstand the pressure of the oxygen inside the tank
 - Needs to be castable to get the rough shape of the oxygen tank
 - ~~Needs to be~~ Buoyancy of the material has to be lower than water.
 - Density

b) If I were to choose a material from the 4 given. I would first look if it they can withstand the pressure of 20MPa, which call for of the material can. Then I would look at corrosion resistance and determine if the material would rust which could affect the properties of the material.

from the four materials below, a steel alloy (202) isn't corrosion resistant therefore removing it from my choice pool. Aluminum ~~can also~~ does react with oxygen creating aluminum oxide which is ~~a~~ like a thin shell that protects it from further reactions.

Thirdly I would go by density to keep the size or weight of the cylinder to minimum.

Aluminum has the lowest density at $2.7g/cm^3$ for comparison and carbon fibre breaking it at $1.74g/cm^3$

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And lastly machinability and costability is a big factor.
Aluminium is soft and easily machinable and is the best
choice when it comes to this.

Overall I think aluminium is the best choice
as it offers good enough yield strength and really
good density ratio to weight while keeping the
manufacture cost much lower than carbon fibre.