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Materials + Introduction to processes
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1. This product has got many requirements to meet for expectations. One of the requirements of the material will be that it's non-toxic because it's going to store a snack inside which the consumer is going to eat so wouldn't want to cause harm to the buyer.

Another requirement would be that the product would be recyclable because the target audience is for outdoor people and they would like a product which could be recycled and not harm the environment.

The material would also have to be ~~light~~ light weight one to save on transporting costs to store but also if the target audience is someone who's out doors all the time and travelling they wouldn't want a big heavy product.

The material must be air tight also to help preserve the snack and help keep it fresh for the consumer. It will also act as a protection for the food so it wouldn't get damaged in someone's bag.

The first choice would be plastic with foil on the inside, this choice would meet most of the requirements as it would be light weight and easily transportable. The packet could be air sealed as well which would help preserve the snacks and protect them from damage during transportation. The foil inside the packet also would help prevent any moisture getting inside the packet and further preserve the

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1. Snock. The problem with plastic is that it needs to be recycled if it isn't disposed of correctly it causes great harm to the environment. Lots of plastic waste ends up in the sea and kills lots of wildlife and damages coral reefs which has a knock on effect to the carbon cycle and food cycle. So it might appeal to the outdoor type market. Plastic can display eye catching displays on with nearly any colour possible giving it a ~~great~~ ~~potential~~ ~~2~~ ~~type~~ great advantage over a lot of other solutions.

Another solution could be cardboard this could be used by itself or depending on the product use with a plastic film on top, but with the manufacturer wanting to preserve shelf life and reduce costs it would be better to use the plastic film. The plastic film will not have as great of effect on the environment compared to ~~reusable~~ just single use plastic. The cardboard ~~would~~ would have to be treated or coated in something to keep the product air tight as without it, the product's shelf life wouldn't be great. The product would be non-toxic and light so would appeal greatly to the consumer, I also think that the product is 90% biodegradable would be a massive selling point and attract the attention of those outdoor consumers who want to take care of the environment. The cardboard would give a solid feel to the product.

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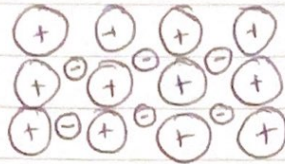
- 1 and allow the designers to add eye catching colours and designs.

A downfall with using cardboard is it could be easily damaged if its made too thin and you'd want it thin to keep it light weight, so some products could be broke/damaged during transport.

A third solution could be an aluminium can, this could help preserve the snack shelf life for alot longer as its structure is robust and air tight and water proof. The problem would be that aluminium is one expensive way to store food so would cost more to store and transport but the money could potentially be earned back with the life shelf life being extended on the product. Aluminium is also heavier compared to the cardboard and plastic solution which would make it less desirable to consumers. With the profit margin being tight the company doesn't want to be spending extra money of packaging and transporting heavy aluminium cans. The cans would be able to help eye catching and bright designs which is a good factor, these could be painted or rolled straight onto the can in a quick and easy process.

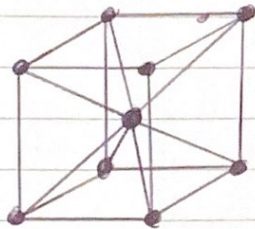
2.

a)



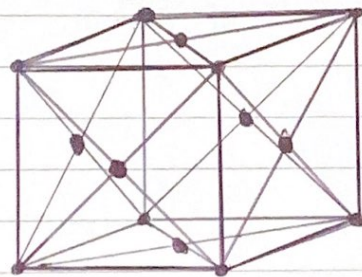
Metallic bonding is a type of bonding that is formed from negative electrons and positively charged metal ions.

b)



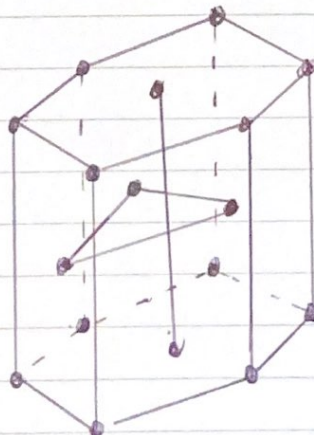
BCC - Body centre cubic

this has one lattice point in the centre of the unit cell with 8 points on the corners



FCC - Face centre cubic

Lattice points on the face of the cube, gives exactly half a contribution, ~~gives~~ and has a coordination number of 12.



HCP - Hexagonal close packed

HCP is lattice visualised as top and bottom plane of 7 atoms, forming a regular hexagon around a central atom

2c) Packing Ratios

$$FCC = \frac{\pi\sqrt{2}}{6} = 0.74048048$$

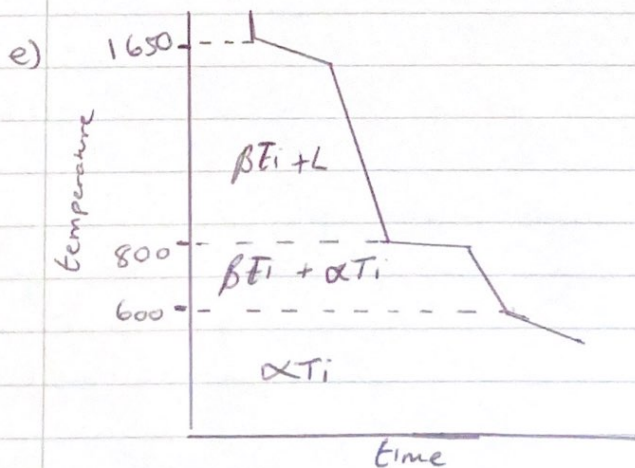
$$BCC = \frac{\pi\sqrt{3}}{8} = 0.680174762$$

$$HCP = \frac{\pi}{3\sqrt{2}} = 0.74048048$$

d) Titanium powder is a liquid at 1800° degrees

As the mixture cools from 1650° beta and liquid both exist and crystals start to form as the cooling continues it turns to a solid in beta titanium which is a BCC.

At 800° both ~~delta~~ ^{alpha} and beta titanium exist until the substance further cools down to 600° where just ~~delta~~ ^{alpha} titanium exists with a HCP structure.



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3. One class I would not consider would be foam

→ b) this class does not have the strength to withstand the loads of the car and would not be stiff enough for the car to have a good ride or steering. The cyclic loading of the car suspension would be too much for the foam and cause it to have permanent deformation.

a) will be below
In that group you also have flexible polymer foam with a suspension system on a race car you need firm suspension so the car can "dig" into the corners the foam suspension wouldn't allow that and give a very poor handling.

Wrong

order → a) The classes which should be considered should be metal and technical ceramics, both these classes have a high strength to density ratio. In the metal class you should look at zinc alloys this is because its strength to density ratio is the best, you want the component to be strong to withstand the extreme loads and cyclic loading but also light to make the ~~car~~ faster and also more efficient so wouldn't have to pit as often.

From the technical ~~ceramic~~ ceramics I would consider Al_2O_3 or Si_3N_4 both have excellent ~~strength~~ strength to density ratio so would make the ideal material; the Al_2O_3 has a higher ~~weight~~ strength to density ratio than Si_3N_4 but depending on what forces

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3a) and loads they are going to go under might be better to go for the ~~light~~ lighter option

3c) Carbon fibre is expensive because of the process to manufacture it, its very difficult and time consuming compared to the steel frame. Carbon fibre is extremely light and strong making it perfect for an expensive race car material. for practice race cars a good selection would be to use steel frames as these are alot cheaper and heavier, if the car could perform well during the practice with heavy components they know that the car can perform even better with lighter parts, This is when they could then spend extra money upgrading to carbon fibre component. The lead time is long for carbon fibre part so why would you spend all that money and time on a component when it might not affect the car that much. During practice cars could get damaged and parts would have to be replaced if using steel components it wouldnt be an expensive fix

d) When welding the base will undergo stress caused by contraction of the hot zones in the weld, this will cause the material to be under a lot more stress and reduce the ^{amount of} fatigue stress ~~on the base plate~~ and the base plate can take and make it more rigid and wont be able to bend and twist as much.

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d) Brazing is better because it uses a 3rd material with a lower melting point so won't put as much stress on the other two materials. Brazing also gives a lot better finish compared to a weld so it is more aesthetically pleasing.

e) Another approach to joining the two metals could be prep by having the areas cleaned ready to be glued or some sort of adhesive to make the bond together. This process wouldn't affect the properties or dimensions of the metals which would be good for race car, but the joint might be strong enough.

Fastening and riveting the frame together could also be another option, this would either be designed in or it would be a long and inaccurate process to rivet all the components. Having to service or change a component would be a nightmare as the part would have to be cut or grinded out and holes redrilled.

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- a) The scuba diving tank is going to be used under water so the first requirement would be that the materials won't corrode after being exposed to salt water. The tank would also have to be air tight so not air can escape while under water. Its also vital the tank ^{has a high tensile strength} ~~is strong~~ because it will under go a great deal of pressure from storing the gas inside and then also the pressure from the depth of the sea. The material must be machinable as it will need to be worked into the correct shape and have thread ~~attached~~ ^{for} machined in to attach the nose. The tank would have to be as light weight as possible to carry to the sea, and heavy enough to keep buoyant.
- b) Aluminium ^{wouldnt have the} ~~wouldnt have the~~ 'high' tensile strength to with stand the pressures of which the tank would be experience.

Steel alloy - this would also be the same as the aluminium the yield strength is too low and would break under pressure and has a high density for low strength.

Stainless steel - this could potentially store the pressure of the but has density which would make it heavy to carry. ~~and also be too expensive~~.

Pre-fragrated carbon - this has the best strength to density but would not be suitable for a tank as the gas would escape through the carbon.

My choice would have to be stainless steel as it would be corrosion resistant, strong enough keep the gases trapped inside and heavy enough to keep the diver balanced.

4

c)

$$\sigma = \frac{Pd}{4t}$$

$$\sigma = \frac{20 \times 10^6 \times 0.6}{4 \times 8000 \times 5}$$

$$\sigma = 6000000$$

$$= 6000 \text{ kgf/m}^2$$

$$t = \frac{2 \times 20 \times 10^6 \times 0.6}{510 \times 10^6}$$

$$t = 0.0078 \text{ m}$$

the 2 gives the ~~thick~~ thickness a factor of safety of 2 meaning the wall is twice as thick as it needs to be just in case of extreme pressures.

d) i) the wall thickness would be 0.0078m

ii) mass of a cylinder = $\rho \times \pi \times r^2 \times h$

$$= 79 \times \pi \times 0.5^2 \times 0.6$$

$$= 3.72 \text{ kg}$$

$$+ 2 \text{ kg}$$

$$= 5.72 \text{ kg}$$