

1)

For the Packaging

In this Section of the exam I will discuss the different options for materials which are suitable for making my Snack. The Packaging needs to be isolated from the atmosphere to help the Shelf life. The Packaging also needs to be eye catching, ~~and~~ cost and environmentally friendly. Also needs to be light, ductile and non-magnetic.

Here are some options.

Glass

Pros include no chemicals used to manufacture the glass, glass is BPA. Glass is easy to clean. Glass is a lot more eco-friendly than say plastic. Glass is a lot easier to recycle. As long as glass is sealed it will keep the product fresh.

Some cons of glass include that it is a heavy material. Glass is also more costly to manufacture than plastic. and is also a lot more brittle and breaks easily.

Glass's toughness is a lot lower than some of the other materials I have considered.

Plastic

Pros include, less expensive compared to either glass or metal. Plastic is a lot more durable and will last longer. Plastic is a light material and isn't really dense. When sealed plastic is great at keeping out any atmosphere and is also lighter.

Cons include, More chemicals are used in the process of manufacturing. Plastic is harder to recycle. Plastic will decompose a lot slower than metal or glass.

Aluminium Cans

Pros include, Aluminium is a light weight material. Corrosion resistant, non magnetic, impermeable and odorless. Easy to manufacture, will allow for no atmosphere to enter the can once sealed, allowing for years of freshness.

Cons include. Aluminium is expensive, Aluminium is sensitive to heat.

Labelling

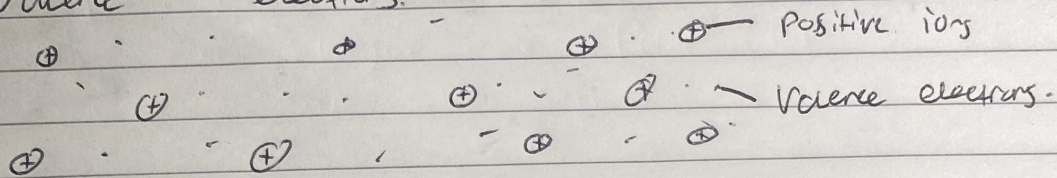
For Labelling I would Print bright Coloured labels onto pieces of Paper using cruelty free Vegan ink. Paper has a low impact on the environment and comes in an array of different colours which will catch the attention of the customers.

Conclusion.

In conclusion I would choose an aluminium can with a paper label. The reason for this is because Aluminium is the most durable, light weight and toughest choice. Aluminium may be the most expensive but it's the best material for the environment. I feel as if people will walk away if the material is plastic as plastic is harmful to the environment. People venting away from the product will hurt the profit margins. Also, a sealed aluminium can will give the best decrease to the atmosphere.

2)

a) Metallic bonding is seen as a cloud of positively charged ions within a cloud of valence electrons.



The Valency determines the number of atoms that are reacting with each other in compounds. Metals with a valency of ~~one~~ ^{two} are generally stronger than those that have one. This is due to having more 'free electrons' and are capable of adding more to the metallic bond, therefore strengthening the metal.

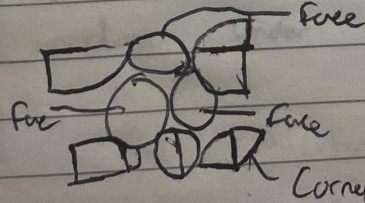
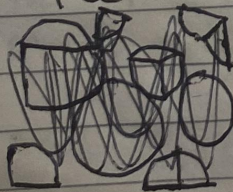
b)

BCC (Body-centred Cubic)



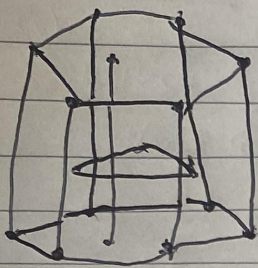
The BCC unit Cell will have atoms in each corner plus one full atom in the centre of the cube.

FCC (Face-centred Cubic)



FCC are where atoms at each corner of the cube and six atoms at face of the cube.

HCP. Hexagonal ^{Closest} ~~Closest~~ Package.



A HCP has a coordination of 12 and contains 6 atoms per unit cell.

C)

$$FCC = 0.74$$

$$HCP = 1.633$$

$$BCC = 0.68.$$

D) The temperature would be liquid.

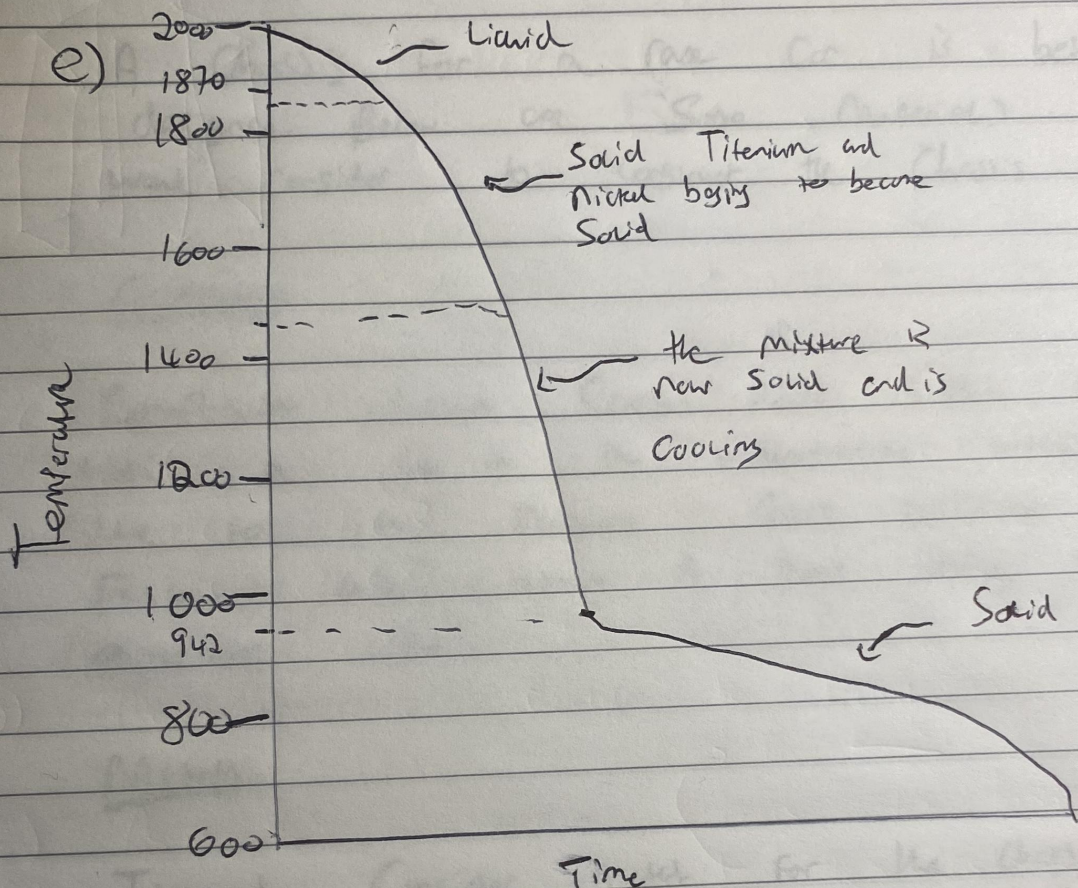
As the temperature ^{the titanium will begin to become solid.} ~~cools~~ ^{But ~~begin~~} to 1650°C the ~~liquid~~ ^{mixture.} will remain as a liquid. Then as the mixture is cooled to 800°C where an eutectic $L \rightarrow \beta + \text{Ti}_2\text{Ni}$ occurs with a concentration of ~~80%~~ ^{80%} of Ni. Thus decreasing

the melting point of pure titanium and ^(1670°C) conforming temperature. ~~Alloys~~ ^{Alloys} with 15 and 20% of nickel will develop a microstructure composed of pre-eutectic precipitates or the β phase in the eutectic matrix although the melting is done under equilibrium conditions.

At 600°C the mixture is solid.

2)

Cooling Curve.



4

A)

A Chassis for a race car is being designed. Below are some materials I would consider to construct the chassis.

Composites

Composites include Carbon fibre. Carbon fibre is used a lot in the automotive industry. This is due to its properties. Good resistance to creep, fatigue and corrosion. A hard wearing material and extremely light.

Metals.

I would consider metal for the chassis. Metal is cheap, easily available and comes with a range of properties. These include, strength and toughness, alloy formations, thermal and electricity conductivity.

Also metal is hard wearing and easy to repair. Ideal for a race car that will be seeing a lot of action during races.

metal is also extremely dense and will give good chassis stiffness if manufactured correctly.

B) ~~Forms~~

Here are some classes I would not consider.

Forms

I would not choose forms due to its properties. The form will be too weak to hold the weight of the rest of the car and would not be able to withstand an impact from another vehicle.

Polymers

Considering Polymers is a light weight material it still will not be able to withstand an impact from another vehicle. Also Polymers will not give the stiffness the designer needs due to its flexibility.

C)

I will now discuss the merits of both Carbon fibre tubes and Steel Space frames.

Carbon fibre tubes

Carbon fibre tubes are used by ~~Super~~ race teams all across the globe. Some of the merits of these include, light weight material. The ability to be moulded into the required shape. Super Strong when it comes to stiffness and impacts and also looks cool.

Some of the cons include, Not repairable, if damaged will require a full replacement. Also Carbon fibre is expensive so will only be available to the richer teams.

Metal Steel Space Frames

Metal Space frames will give the stiffness required if they are manufactured correctly. Using steel is also a lot cheaper than Carbon fibre. Also after a crash steel is repairable through welding etc.

Some of the cons include, Not corrosion resistant, a lot heavier than Carbon fibre and overall is weaker.

When constructing a race chassis I would choose Carbon fibre tubes over Steel Space frames. The light weight properties and corrosion resistance is unmatched.

d)

Joining causes problems with structural integrity. When welding the steel, ~~for weaker~~ steel can become weakened in the HAZ zone or heat affected zone. Welding two metals together creates tensile residual stress from the contraction of the weld once it cools, which weakens the steel's fatigue strength. One way to improve the fatigue strength is introducing compressive residual stress. Welding is a high heat process which melts two pieces of metal together with added filler material.

Brazing is considered a higher quality as it does not melt the metal. This means no high temperatures are used so the fatigue strength is not affected - creating a higher quality product.

Brazing ^{works} is done by heating two pieces of metal. A filler is then brought into contact with the heated parts and is drawn by the heat is drawn by capillary action completely through the joint.

e).

Riveting

Riveting can be used as a joining method. The rivet is deformed by pounding the tail, which makes the material flatter and causes the tail to expand. When finished the tail has an appearance of a drumhead completely filling the rivet joint. The joint is usually heated before application for ease. Riveting is cheap and effective.

Hardware Assembly

Hardware assembly consists of joining two pieces of metals with hardware such as nuts and bolts. An advantage of this is the hardware is cheap, effective and readily available.

4).

a)

For a Scuba divers tank I would say the tank should be made from either Steel or Aluminium. The tank should be light but strong enough to hold pressures of up to 200psi. The Tank should be tough enough to withstand bumps and wear and tear from bits of Coral etc. The material should be repairable and ductile.

b) 6062 T6 Aluminium.

Aluminium is a light weight and ductile material. The Yield Strength is high enough to withstand the pressure needed. It's also light with a density of 2.7 g/cm^3 . The material is used for Aircraft fuselage skin, meaning it has good heat and pressure resistance.

Steel Alloy 1020 - Hot rolled.

This Steel Alloy will withstand the pressure needed but will be heavy overall with a density of 7.9 g/cm^3 . Also does have the risk of Corroding due to the salt water. Which means it will potentially break under pressure.

304 Stainless Steel

Again Salt water can Corrode Stainless Steel. Meaning after time the tank will break under pressure. The material can withstand the pressure but again will be too heavy.

Pre-Pressured Carbon Fibre Composite

Will With Stand the Pressure and is Light enough. But the Cost of creating a tank will be too extreme with a density of 1.74 g/cm^3 it is by far the most light weight.

Conclusion

In conclusion, I would choose the 6061 T6 Aluminium. This is because it can handle the pressure. It is light weight enough to make a tank. Resistant to salt water and cheaper.

c)

$$t = \frac{2Pd}{\sigma_{\text{yield}}} = \frac{2 \times 20 \times 100}{45.45} = 88.90$$

$$\sigma = \frac{Pd}{4t} = 45.45$$

$$t = \frac{2Pd}{\sigma_{\text{yield}}} = \frac{2 \times 20 \times 100}{45.45 \times 2} = 0.365 \times 100 = 36.5 \text{ mm}$$

According to internet research the thickness of a soda tank wall is approximately 11mm.

d)

i) ~~0.365~~ 36.5 mm

ii) $\overset{0.6}{0.0} \times \overset{0.1}{0.0} \times \overset{0.365}{0.365} : 0.0219 \times 2.7 = 0.059 + 2 \text{ Kg}$

$\approx 2.059 \text{ Kg}$