

## Level 4 materials exam

ACMA  
Course code - ~~(AMCA)~~ 4000

1)

a) Material properties:

- Non-reactive
- Non-toxic
- Light in terms of weight
- Tear resistant
- Tensile strength

• Packaging requirements:

- Maintain Freshness
- Printable
- ~~(Light)~~ • Small
- Recyclable
- Affordable
- Condensation proof

Potential materials:

- Polystyrene ~~(the most recyclable, size & weight)~~
- Polypropylene
- Metalized polypropylene

Polystyrene is a plastic used in the food industry due to it ~~(being)~~ being light, non-reactive, non-toxic, ~~(small)~~ easily sizeable to suit any packaging, it can help maintain freshness and is recyclable.

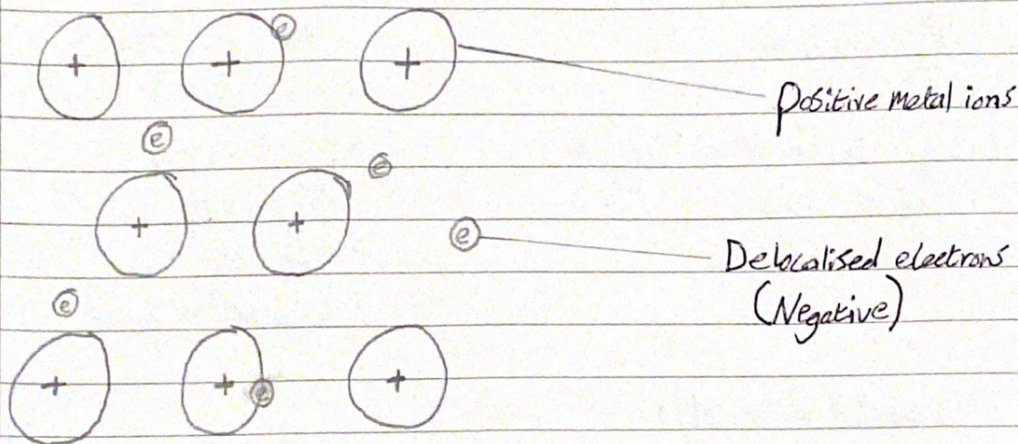
Polypropylene is a potential solution for most of the reasons stated above, however it is not a easily printable.

Metalized polypropylene has the same properties as polypropylene, except it is more easily printable and is better at protecting products from oxygen moisture and water vapor.

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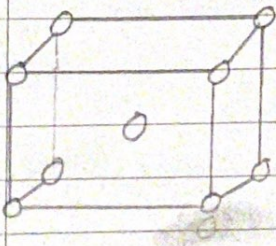
2)

- a) Metallic bonding is the attraction between the positive ions in a 'regular lattice' and the 'delocalised electrons'. Delocalised electrons are free to move throughout the whole structure.



Metals with a valency of two are generally stronger than those with a valency of one because they have more electrons in their outer structures.

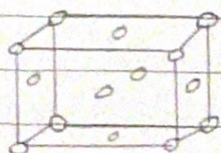
b) BCC



Body centred cubic structure has atoms at each of the eight corners of a cube plus one atom in the middle.

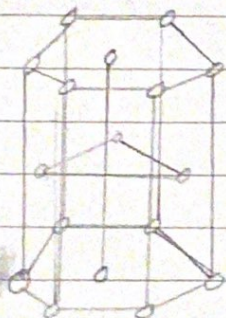
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FCC



Face centered cubic structure has atoms located at each corner of the cubic structure, plus an atom on each face.

HCP



Hexagonal close packed refers to layers packed so that spheres in alternating layers are in contact.

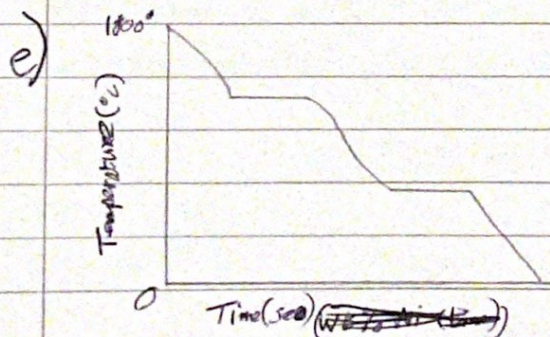
- c) HCP - 0.74 : 0.26  
BCC - 0.68 : 0.32

d) Liquid

At  $1850^\circ$  the metal will still be a liquid.

At  $800^\circ$  the metal will be going through its transition phase to become a solid.

At  $600^\circ$  the metal will be cool enough to be a solid.



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3)

a) I would choose the classes 'metals' and 'Technical ceramics' for the reason that they have the highest stiffness and density out of all the other classes.

b) I would not consider Foams as they generally have low density.

c) Merits of using Carbon Fibre ~~for~~ For race car chassis include the following:

- Strength
- Density
- Heat conductivity

Steel also has these properties, however carbon fibre is much lighter in weight which can benefit the performance of a race car even further.

d) In the welding process, ~~(metal)~~ the base metal is melted which makes it softer. This in turn makes it more ductile and lowers fatigue strength. Brazing is deemed a higher quality process due to ~~its flexibility and~~ it using a third metal to join two other metals so that any properties are not affected.

e) Other approaches to joining chassis to each other are:

- ~~(Binding)~~ Riveting
- Soldering

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4)

a) For a diving cylinder, I believe that there are a lot of crucial requirements that need to be met in terms of (designing) design. One is that the material used must be light in terms of weight so that the diver is able to have mobility underwater. Another is that it needs to be able to hold the pressure of air to allow respiration underwater. Finally, it needs to be able to withstand the pressure of depths underwater as well as the air inside of it.

b) The first choice is aluminium. It has a low yield strength, low density and has a various amount of applications.  
The second choice is steel alloy. It has the lowest yield strength, one of the highest densities and is used in a limited amount of other applications.  
Next, there is stainless steel. It has a higher yield strength, one of the highest densities and has a lot of other applications.  
Finally, there is pre-pregated carbon fibre. It has the highest yield strength, the lowest density and also able of other applications.

~~Out of all of these materials, I would choose to make my cylinder out of aluminium due to it being lightest one of the lightest in terms of weight and also unlike carbon fibre, it is not conductive therefore making it safer.~~

Out of all of these materials, I would choose the pre-pregated carbon fibre composite as it is the strongest and lightest in terms of weight. It also does not corrode when submerged.

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Harveer Singh

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c)  ~~$\sigma = \frac{P d}{4 t}$~~

~~(pressure = 0.02 pa  
diameter = 100 mm  
Hoop stress =~~

~~(I do not think this for)~~

i) d)  $t = \frac{2 P d}{\sigma_{\text{yield}}}$

$\sigma = 0.185$   
 $P = 0.02 \text{ pa}$   
 $d = 100 \text{ mm}$   
 $\sigma_{\text{yield}} = 1.74 \text{ g/cm}^3$

~~$\sigma = \frac{P d}{4 t}$~~

$\frac{2(0.185)(100)}{1.74} = \underline{\underline{21.26 \text{ mm}}}$

~~$\frac{2(0.185)(100)}{200} =$~~