Workshop P5: Non-Metals and Manufacturing

LEARNING OUTCOMES

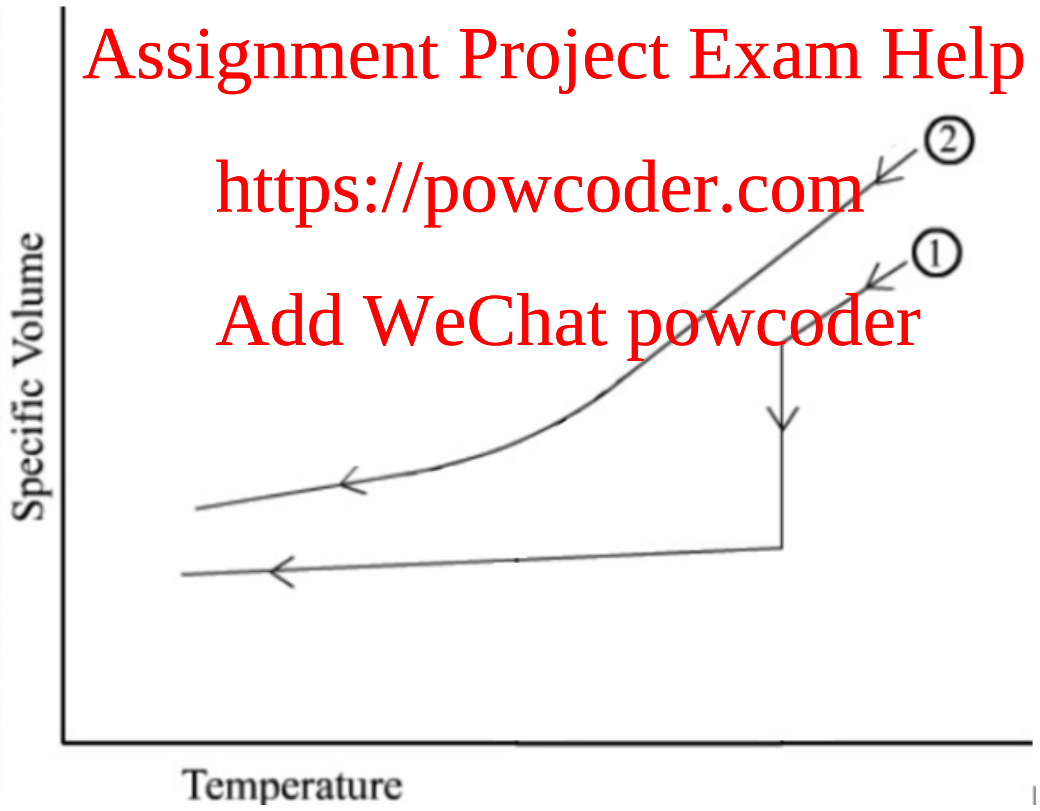
- Understand and identify the structures and behaviours of various non-metals
- Understand the initial concepts of materials manufacturing

Activity 1: Ceramics and Glasses (40 minutes)

a) On the sketch below of specific volume vs temperature, the cooling paths of a crystalline solid and an amorphous solid have been drawn. Use your mouse to move the list of labels to the correct positions and fill in the Table below.

Labels:

Supercooled liquid | Melting temperature, T | Amorphous solid | Crystalline solid | Glass transition temperature, T_g



	Amorphous solid	Crystalline solid
Structure upon cooling		
Change in specific volume		
Change in viscosity		

b) Using your sketch in part (a) to explain why glass may be drawn into fibres, whereas crystalline alumina may not.

c)

ate glasses and fused silica exhibit higher resistance to thermal shock, to some of the more day-to-day glasses and ceramics. Why is this so?

d) Watch the first minute of this video:
https://www.youtube.com/watch?v=7EgAUhsiRQs

For a car windscreen made from tempered glass, explain why the windscreen suffers no significant damage when it undergoes a *light* impact force, but it will suffer catastrophic failure producing fragments of a particular, yet safer geometry, when the windscreen undergoes a more *substantial* impact force. (Hint: A comprehensive answer to this question should include reference to the

s of the tempered glass).

Activity 2: Composite Materials (15 minutes)

A continuous and aligned fibre-reinforced composite material is to be produced consisting of 39 vol% glass fibres and 61 vol% of an epoxy matrix. The mechanical characteristics of these two materials are as follows:

Material	Modulus of elasticity (GPa)	Fracture strength (MPa)
Glass Fibre	**76**	**2512**
Epoxy	**3.3**	**59**

For this composite material, state the law that applies and use it to calculate the following:

i. the longitudinal tensile strength
ii. the longitudinal modulus of elasticity

Law:

Working:

Tensile strength (value, units):

Modulus of elasticity (value, units):

Activity 3: Forming Processes (20 minutes)

Watch the following videos, and use them to match the forming processes of *wire drawing* and *conventional extrusion,* with respect to the listed parameters below.

A. Wire Drawing: https://youtu.be/Qbk45lL7czQ and https://youtu.be/VVewNWWBVjs

B. Conventional Extrusion: https://youtu.be/Y75lQksBb0M and https://youtu.be/1WALD1ZJwho

Process Speed	Low speeds, due to large amount of deformation that occurs	A/B
	High speeds, due to large surface area and small volumes	A/B
Temperature	High temperatures	A/B
	Mainly room temperature	A/B
Continuity	Continuous – particularly if various segments can be butt welded	A/B
	Non continuous, due to finite size of work piece	A/B
Reduction in Area	Massive reductions possible – up to 400 to 1, due to hot working operation	A/B
	Limited reductions due to work hardening of material in process. Generally typical reductions between 20% and 50%	A/B
Possible materials	Almost all ductile materials	A/B
	For most ferrous and nonferrous materials hotwork and a limited range for coldwork	A/B
Product size ranges	100 mm diameter to 1 mm	A/B
	5 mm diameter down to 0.025 mm	A/B

Activity 4: Manufacturing Processes (20 minutes)

Work with your group to select an appropriate manufacturing method (primary and secondary processes), for the following products 1-5. Each group will provide a summary.

Primary	Sand casting	Die casting	Forging	Extrusion	Rolling	Drawing
Secondary	Welding	Bending	Blanking	Machining		

Then work individually to do the same for products 6 and 7, giving a reason for your choices.

#	Ongoing production of:	Primary process(es)	Secondary process(es)
1	an automobile crankshaft 		
2	a bronze ship propeller 		
3	an aluminium window frame 		
4	a heavy gauge helical spring 		
5	a steel bicycle frame 		

The following 2 products will be marked, and you need to give a reason:

#	Ongoing production of:	Primary process(es)	Secondary process(es)	Reason
6	a base plate for a household steam iron 			

7	monetary coins