1. What are the differences between thermoplastics and thermosets? Give an example of a thermoplastic and of a thermoset.

2. Outline the processing principles and describe a particular fabrication process for **three** of the following materials, giving any advantages/disadvantages of the process where possible:
   a) Soda-lime (container) glass.
   b) Engineering ceramics (e.g. alumina, silicon nitride).
   c) Thermoplastics.
   d) Thermosets.
   e) Elastomers

3. The adjacent figure shows the Specific Volume as a function of Temperature for two ideal polymers; one is completely amorphous and the other is completely crystalline.

   a) Identify the following regions:

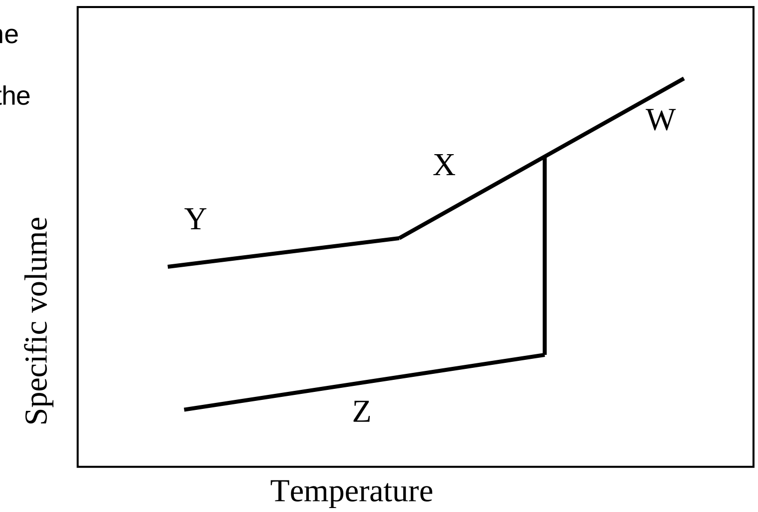
   W)

   X)

   Y)

   Z)

12 marks



   b) On the Figure indicate the Melting Point and the glass transition temperature.

   c) Explain what happens to each of the ideal polymers as they cool down from high temperature.

   d) Indicate on the graph the type of behaviour that you would expect from a semi-crystalline polymer.

   e) A sample of polymer has a density of 2.144 $g.cm^{-3}$ .The densities of the completely amorphous structure and the completely crystalline structure of this polymer are respectively, 2.000 $g.cm^{-3}$ and 2.301 $g.cm^{-3}$. What is the percentage crystallinity of the sample?

4. What is a copolymer? Describe three of the types of copolymers that can form (use diagrams to help your description).

5. Describe the tensile mechanical behaviour of the following materials at room temperature, using diagrams where necessary. Include factors such as stiffness, yielding, tensile strength, fracture, elastic and/or plastic deformation, etc.
   a) a typical metal
   b) a typical ceramic
   c) a typical thermoplastic.

8. Below are tabulated the tensile stress-strain data for several materials.

Material	Yield Strength (MPa)	Tensile Strength (MPa)	Strain at Fracture	Fracture Strength (MPa)	Elastic Modulus (GPa)
A	310	340	0.23	265	210
B	100	120	0.40	105	150
C	415	550	0.15	500	310
D	700	850	0.14	720	210
E	Fractures before yielding			650	350

a) Which of these materials will experience the greatest percent area reduction? Why?

b) Which of these materials is the strongest? Why?

c) Which of these materials is the toughest? Why?

d) Which of these materials is the stiffest? Why?

e) Which of these materials has the highest modulus of resilience? Why?

9 (i) Consider a 10 kg sample of an iron-carbon alloy and at a temperature just below the eutectoid temperature. In this sample the mass of total ferrite is 8.68 kg.

a) What is the proeutectoid phase in this alloy? Why?

b) Calculate the mass fraction of pearlite in this alloy at a temperature just below the eutectoid temperature.

c) Schematically sketch and label the microstructure.

(ii) Is it possible to have an iron-carbon alloy for which the mass fractions of total ferrite and proeutectoid ferrite are 0.966 and 0.692, respectively? Why or Why not?

10. A ceramic material, in the form of a circular bar with radius 5mm, is tested in 3pt flexure. The length between the support points is 50mm.

a) If the load required to cause fracture is 2380N, determine the flexure strength of this ceramic.

b) If this material has a fracture toughness K_{IC}, of 4.5 $MNm^{-3/2}$ what is the size of the longest internal deflect? Assume the geometric parameter Y is equal to 1.

c) If this material has value for σ_0 and n of 441MPa and 3.75 respectively, what is the fraction porosity of this material?

Knowing that the Modulus of Elasticity for the non porous material, E_0, is 400 GPa, what is the modulus of this porous ceramic?