Chapter 4

1. Polymers do not crystallise easily because:
    a) they are long chain molecules
    b) they contain covalent bonds
    c) the molecules are interconnected with H-bonding

2. Explain briefly the difference between crystalline and amorphous regions in a polymer.

5. What is the molecular difference between thermosetting and thermoplastic polymers?

7. Indicate which of the following polymers could not exist as isotactic and syndiotactic stereo-isomers:
    a) PP
    b) PMMA
    c) polyvinylidene chloride
    d) PTFE
    e) PS

15. Indicate how to increase crystallinity in a vinyl polymer:
    a) change the tacticity from atactic to syndiotactic
    b) stretch it
    c) anneal it
    d) solidify from melt at a slow rate
    e) all of the above

16. Which of the following polymers is least likely to be optically transparent?
    a) isotactic polystyrene
    b) atactic polystyrene
    c) an ethylene/propylene block copolymer
    d) a styrene/butadiene random copolymer

18. A polypropylene sample is just buoyant in an alcohol of density r = 0.9 g cm^{-3}. Calculate its mass fraction crystallinity if the density of crystalline PP is 0.99 g cm^{-3} and that of amorphous PP is 0.85 g cm^{-3}.

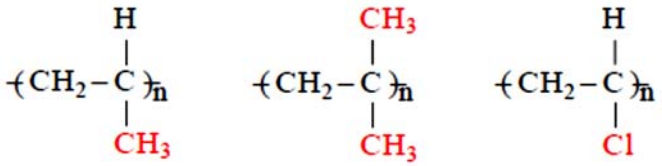
Chapter 5

8. A strip of elastomer was stretched in tension and elongation was held constant. After 10 min the tensile stress in the specimen dropped by 12%. Assuming that the elastomer behaves in accordance with the Maxwell model:
   - calculate the relaxation time (to the nearest whole number) (answer: $\tau = 78$ min)
   - show that it takes 22 min for the stress to drop to 75% of its initial value.

9. If you hang a weight from a strip of rubber so that it stretches about 300%, then heat the rubber, which of the following would happen?
   a) stretches some more
   b) contracts
   c) maintains the same length

11. Which of the following statements are true?
   a) all polymers have a crystalline melting point
   b) all polymers have a glass transition
   c) the glass transition is a first order transition that occurs at a well defined temperature
   d) the crystalline melting point is not affected by the presence of solvent.

12. Consider the following polymers, which will have the lowest T_g?



(a) (b) (c)

13. Which of the polymers in Q. 12 is polar in nature?

15. Poly(n-butyl acrylate) has a lower T_g than poly(methyl methacrylate), because of:
   a) weaker intermolecular attractions
   b) free volume effects due to the flexible side chain
   c) the stiffness of the side chain.

18. The presence of aromatic groups in a polymer chain results in
   a) intermolecular attraction
   b) potential for crosslinking
   c) increase in T_g and T_m
   d) tensile strength becomes maximum.

20. Illustrate, with chemical formulae, the influence of the size of the side groups of a polymer molecule on T_g.

24. Briefly explain the shortcomings of a Maxwell mechanical model in describing the real behaviour of polymeric materials.

27. At room temperature, classify the following materials as elastomers, TP or TS polymers:
    a) a lightly cross-linked copolymer with T_g = -45 ºC
    b) a branched polypropylene of T_g = -8 ºC
    c) epoxy resin matrix in advanced composites

Chapter 6

3. Sketch on the same graph paper (on the same plot) the stress-strain curves for:
   (a) atactic PS,
   (b) HDPE,
   (c) a copolymer of styrene and butadiene.

4. Draw stress-strain graphs for two polymers: one is stiffer than the other and exhibits a yield point and the other shows no clear yield point but is much tougher.

9. Why are some polymers hygroscopic? How are the mechanical properties affected by moisture, explain by giving specific examples of polymers and mechanical properties.

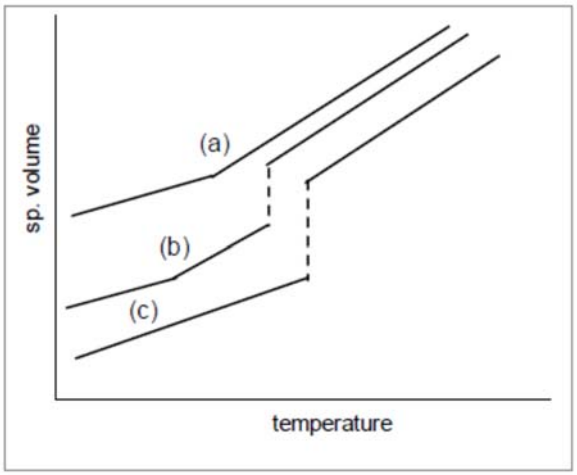
17. Distinguish between the pendulum impact tests of Charpy and Izod.

Chapter 7

1. On the same graph paper show how the heat flow during a DSC analysis and the elastic modulus of a polymeric material changes with temperature over a temperature range that passes through the glass-transition temperature of the polymer.

5. What is meant by the 'free volume' of a polymer?

7. Consider these three labelled specific volume vs. temperature plots that may be displayed by various types of materials. Indicate the one, which best describes the behaviour expected from PP with a spherulitic structure.



11. Which of the following correctly represents the sequential change in mechanical state with increasing temperature for an amorphous polymer?

a) viscous liquid; rubbery region, glass
b) glass; viscous liquid; rubbery solid
c) glass; rubbery solid; viscous liquid
d) rubbery solid; glass; viscous liquid

16. Indicate the thermal properties that can be determined using DSC. Make a definition of these properties.

20. Indicate which other analytical techniques TGA can be coupled with and what would be the advantages?

24. Describe, giving an example, how annealing affects the dynamic-mechanical thermal (DMT) properties of crystalline thermoplastics.

26. Compatible Polymers A and B are to be blended to achieve a glass-transition temperature of 60 ^{o}C. T_g's of Polymers A and B are 30 and 85 ^{o}C, respectively, using an appropriate equation determine the composition of the blend.