

## ► Materials and Processing Questions

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1. Which combination of the following statements is **TRUE**?
  - (i) As the stiffness of a material increases, it will store more elastic energy for a given stress (below the yield stress).
  - (ii) As the stiffness of a material increases, it will deflect less under the application of a given load in the elastic regime.
  - (iii) The stiffness of a metal can be significantly increased by heat treatment.
  - (iv) The stiffness of a material depends on the strength of the bonds between atoms and the spacing between atoms.
  - (a) (ii) and (iv) only
  - (b) (ii) only
  - (c) (i), (ii) and (iv) only
  - (d) (ii), (iii) and (iv) only
2. A rod of 10 mm diameter is made of a metal with a yield stress of 150 MPa and is loaded axially (along the rod). At approximately what load will the rod begin to yield?
  - (a) 47.12 kN
  - (b) 11.78 kN
  - (c) 11.28 N
  - (d) 11.28 kN
3. Which combination of the following statements about dislocations is true?
  - (i) Dislocations are defects in the packing structure equivalent to a missing line of atoms.
  - (ii) Dislocations are able to move in metals, ceramics and polymers.
  - (iii) Dislocations reduce the stress needed to deform a material.
  - (iv) Hindering the motion of dislocations is a means of strengthening a material.

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- (a) (i), (iii) and (iv) only
- (b) (i), (ii) and (iv) only
- (c) (i) and (ii) only
- (d) (iii) and (iv) only

4. Which combination of the following statements about ceramics is true?

- (i) Ceramics do not yield in tension; instead they fracture due to the presence of cracks.
- (ii) Ceramics do not exhibit significant plastic deformation.
- (iii) In compression, ceramics are normally significantly stronger than in tension.
- (iv) In compression, ceramics are generally stronger than metals and polymers.

- (a) (i) and (iv) only
- (b) (i), (ii) and (iv) only
- (c) (i), (ii), (iii) and (iv)
- (d) (iv) only

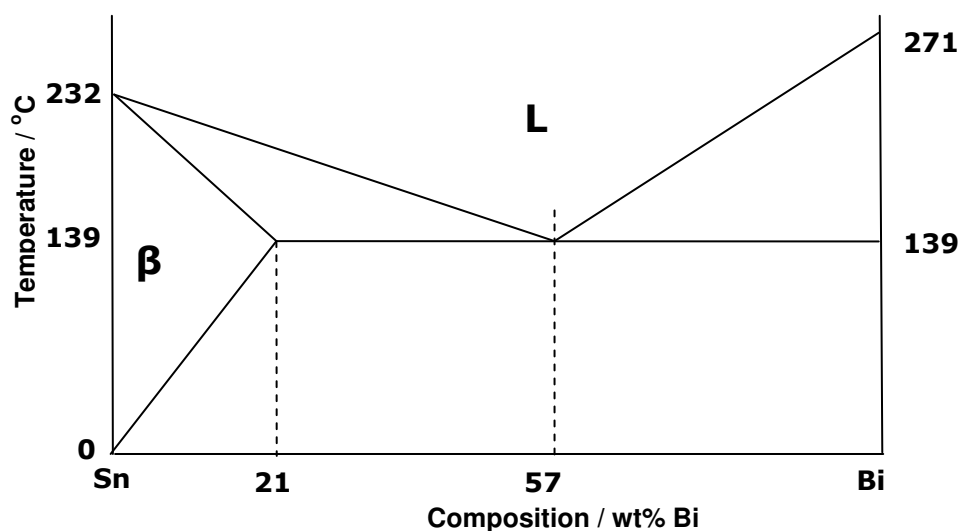
5. Which one or more of the following pairs of materials terms are the correct opposites?

- (i) Hard and Soft
- (ii) Strong and Brittle
- (iii) Tough and Brittle
- (iv) Ductile and Strong

- (a) (i), (ii) and (iii) only
- (b) (i) and (iii) only
- (c) (ii) and (iv) only
- (d) (i) only

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6. Which of the following processes is most commonly employed to form polymer tubing?
- (a) Extrusion blow moulding
  - (b) Injection moulding
  - (c) Extrusion
  - (d) Rotational moulding
7. Which one or more of these statements about thermal expansion are true?
- (i) The thermal expansion coefficient of materials generally decreases with increasing strength of interatomic bonds.
  - (ii) Polymers have lower coefficients of thermal expansion than metals and ceramics.
  - (iii) Thermal expansion can be a problem in manufacturing.
  - (iv) The thermal strain is the product of the coefficient of thermal expansion and the temperature change.
- (a) (i) and (iv) only
  - (b) (i) and (iii) only
  - (c) (ii) only
  - (d) (i), (iii) and (iv) only
8. Following cold drawing of a polymer, there are a number of changes which take place. Identify the combination of the following statements concerning a polymer following cold drawing which is **TRUE**.
- (i) In the draw direction, an increase in elastic modulus is observed.
  - (ii) No change in the elastic modulus is observed.
  - (iii) In the draw direction, an increase in ductility is observed.
  - (iv) In the draw direction, an increase in tensile strength is observed.
- (a) (i) and (iii) only
  - (b) (ii) and (iv) only
  - (c) (i) and (iv) only
  - (d) (ii) and (iii) only



**Figure 1** The phase diagram of the Sn-Bi system (Sn is the symbol for tin, Bi is the symbol for bismuth). The single phase regions are marked, namely liquid (L),  $\beta$  (a solid solution of bismuth dissolved in tin) and pure Bi (there is zero solubility of tin in bismuth).

**Questions 9 and 10 refer to Figure 1.**

9. An alloy of composition Sn-30wt%Bi is heated until it is fully liquid and then cooled. Which temperature is closest to that at which solid is first seen to appear on cooling?
  - (a) 139°C
  - (b) 165°C
  - (c) 183°C
  - (d) 232°C
  
10. An alloy of composition Sn-30wt%Bi is held **just below** 139°C. It consists of two phases,  $\beta$  + Bi. The composition of  $\beta$  will be Sn-30wt%Bi. The Bi will be pure bismuth (i.e 100% Bi). What will be the proportions of the two phases?
  - (a) 11.4 wt% Bi and 88.6 wt%  $\beta$
  - (b) 96.7 wt% Bi and 3.4 wt%  $\beta$
  - (c) 25.0 wt% Bi and 75.0 wt%  $\beta$
  - (d) 75.0 wt% Bi and 25.0 wt%  $\beta$