

► Materials and Processing Questions

Correct answers are given in **bold**.

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.

(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

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(a) (i), (ii) and (iii) only

(b) (i) and (iii) only

(c) (ii) and (iv) only

(d) (i) only

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

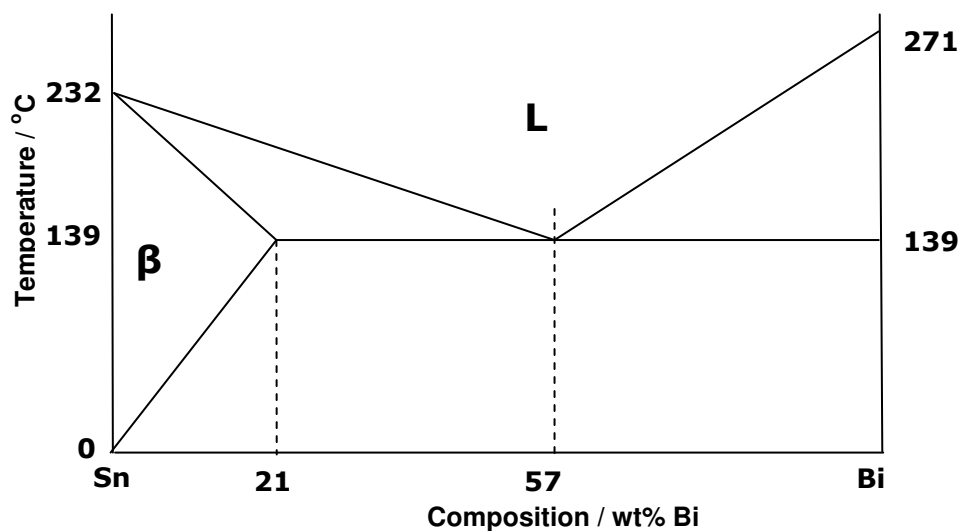


Figure 1 The phase diagram of the Sn-Bi system (Sn is the symbol for tin, Bi is the symbol for bismuth). The single phase regions are marked, namely liquid (L), β (a solid solution of bismuth dissolved in tin) and pure Bi (there is zero solubility of tin in bismuth).

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, β + Bi. The composition of β 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% β

(b) 96.7 wt% Bi and 3.4 wt% β

(c) 25.0 wt% Bi and 75.0 wt% β

(d) 75.0 wt% Bi and 25.0 wt% β