

## Materials Science (XE - C)

Question Number : 34

Correct : 1 Wrong : -0.33

Which of the following is a Frenkel defect?

- (A) One Cl vacancy and one Na vacancy in NaCl
- (B) One Zn vacancy and one Zn interstitial in ZnO
- (C) K at the Na site in NaCl
- (D) None of the above

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**Question Number : 35****Correct : 1 Wrong : -0.33**

Which processing technique is best suited for manufacturing decorative PVC floor tiles?

- (A) Blow molding
- (B) Filament winding
- (C) Rotational molding
- (D) Calendering

**Question Number : 36****Correct : 1 Wrong : -0.33**

During deformation of a semi-crystalline polymer, with spherulitic morphology, stressed in tension, what happens to the amorphous and the crystalline regions at the later stages?

- (A) Amorphous regions remain intact and only crystallites experience bending and stretching of chains
- (B) Only amorphous regions elongate in the stress direction and crystallites remain intact
- (C) Amorphous regions elongate in the stress direction and crystallites experience bending and stretching of chains
- (D) None of the above

**Question Number : 37****Correct : 1 Wrong : -0.33**

Which of the following statement(s) is / are true regarding the structure-property correlation in polymers?

- (i) Polymers that are less coiled are more crystalline than those that are more coiled
- (ii) Branched polymers are more crystalline than the linear ones
- (iii) Polymers with inter-chain interactions have higher glass transition temperature than those without inter-chain interactions
- (iv) Polymers with inter-chain interactions are more crystalline than those without inter-chain interactions

- (A) (i) and (ii)
- (B) (i) and (iii)
- (C) (ii) and (iv)
- (D) (ii) and (iii)

**Question Number : 38****Correct : 1 Wrong : -0.33**

The contrast obtained in scanning electron microscope using back scattered electrons depends on

- (A) Atomic number of the specimen material
- (B) Accelerating voltage of the microscope
- (C) Working distance in the microscope
- (D) Type of the electron emitter in the microscope

**Question Number : 39**

**Correct : 1 Wrong : -0.33**

Ceramic materials fail at stresses much lower than their theoretical strength due to

- (A) Presence of dislocations
- (B) High elastic modulus
- (C) Presence of voids
- (D) Anisotropy in crystal structure

**Question Number : 40**

**Correct : 1 Wrong : -0.33**

The Miller indices of the first three Bragg peaks in the X-ray diffraction pattern obtained from a polycrystalline iron sample at room temperature are

- (A) (111), (200), (220)
- (B) (100), (110), (111)
- (C) (100), (110), (200)
- (D) (110), (200), (220)

**Question Number : 41**

**Correct : 1 Wrong : -0.33**

The number of close packed planes in the lattice of an FCC metal is

- (A) 2
- (B) 4
- (C) 6
- (D) 12

**Question Number : 42**

**Correct : 1 Wrong : -0.33**

Which of the following treatment(s) can increase the electrical conductivity of silicon

- (i) Heating
- (ii) Doping with arsenic
- (iii) Doping with aluminium
- (iv) Exposure to light

- (A) Only (i)
- (B) Only (i) and (ii)
- (C) Only (i), (ii) and (iv)
- (D) All (i), (ii), (iii) and (iv)



The unit cell volume of polyethylene (PE) is  $0.0933 \text{ nm}^3$ . Assuming two ethylene repeat units are contained within each unit cell, the density of a totally crystalline PE will be .....  $\text{g/cm}^3$  (Take the atomic weights for carbon and hydrogen as  $12.01 \text{ g/mol}$  and  $1.008 \text{ g/mol}$ , respectively and the Avogadro's number as  $6.023 \times 10^{23} \text{ repeat units/mol}$ )

A continuous, aligned carbon fibre (CF) reinforced polymer composite with 30 vol% of CF and rest resin was designed for a specific application. The modulus of elasticity of CF is  $170 \text{ GPa}$  and that of the resin is  $3.0 \text{ GPa}$ . The modulus of elasticity for this composite in the direction of fibre alignment is .....GPa.

Match the composites in Column I with the most suitable application in Column II

## Column I

- (P) Exfoliated silicates filled butyl rubber
- (Q) Fiber reinforced aluminium alloy
- (R) Silicon carbide whiskers reinforced alumina
- (S) Carbon particles reinforced plastic composites

- (A) P-4; Q-1; R-5; S-3
- (C) P-3; Q-5; R-5; S-3

## Column II

- (1) Automobile pistons
- (2) Contact lenses
- (3) Ski boards
- (4) Tennis balls
- (5) Cutting tool inserts for machining

- (B) P-2; Q-3; R-4; S-5
- (D) P-2; Q-1; R-3; S-5

Match the processes in Column I with products in Column II

Column I

- (P) Slip casting
- (Q) Zone refining
- (R) Sputtering
- (S) Atomization

Column II

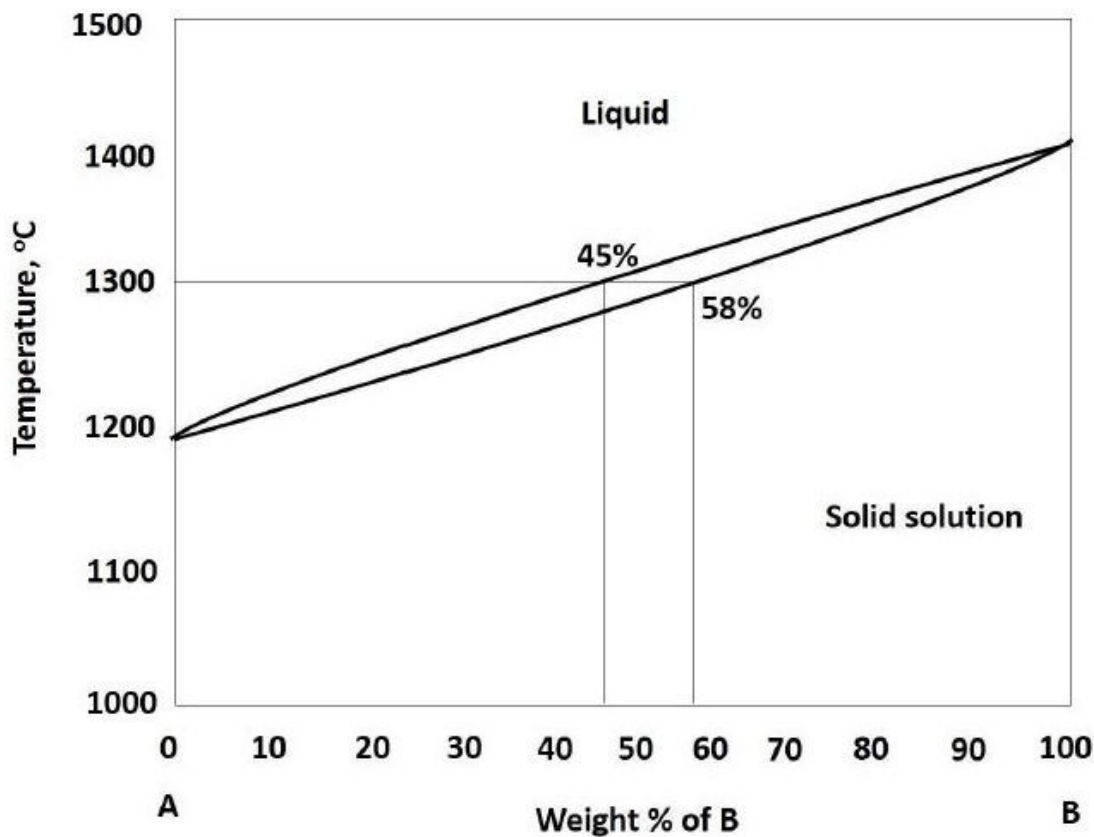
- (1) Metal powders
- (2) Thin films
- (3) Ceramic parts
- (4) Single crystal
- (5) Metal sheets

- (A) P-3; Q-4; R-2; S-1
- (C) P-3; Q-4; R-5; S-1

- (B) P-2; Q-1; R-2; S-1
- (D) P-3; Q-4; R-1; S-5

The value of diffusivity (D) for the diffusion of carbon (C) in  $\gamma$ -iron at 727 °C is..... $\times 10^{-13}$  m<sup>2</sup>/s  
(Given  $D_0 = 2 \times 10^{-5}$  m<sup>2</sup>/s; activation energy, Q = 142 kJ/mol; R = 8.314 J/mol. K)

Refer to the figure below:



If the alloy contains 47 wt. % of A and 53 wt. % of B at 1300 °C, the wt. % of liquid present in the alloy at this temperature will be .....

Which of the following statement(s) is/are true

- (i) All piezoelectric materials are necessarily ferroelectric
- (ii) All ferroelectric materials are necessarily piezoelectric
- (iii) All pyroelectric materials are necessarily piezoelectric
- (iv) All pyroelectric materials are necessarily ferroelectric

- (A) (i) and (ii)
- (B) (ii) and (iii)
- (C) (i) and (iv)
- (D) (ii) and (iv)



**Question Number : 50****Correct : 2 Wrong : 0**

If the energy of formation of vacancies in pure copper is 0.9 eV, the fraction of vacancies in pure copper at 27 °C will be ..... $\times 10^{-16}$  (Boltzmann's constant is  $8.62 \times 10^{-5}$  eV/K)

**Question Number : 51****Correct : 2 Wrong : 0**

A ceramic material with a critical flaw size of 30  $\mu\text{m}$  has fracture stress of 300 MPa. For the same material the fracture stress for a critical flaw size of 90  $\mu\text{m}$  will be .....MPa.

**Question Number : 52****Correct : 2 Wrong : -0.66**

An inorganic material that is transparent under solar light appears coloured when doped with transition metal ions. The possible reason(s) for the colour is/are

- (i) The electronic energy levels of the host material changes significantly by doping
- (ii) The doped element selectively absorbs certain wavelength of light other than the perceived colour
- (iii) The doped element emits radiation of specific wavelength

Which of the above statement(s) is/are true?

- (A) Only (i)                      (B) Both (i) and (ii)                      (C) Both (i) and (iii)                      (D) Both (ii) and (iii)

**Question Number : 53****Correct : 2 Wrong : 0**

Copper is an FCC metal with lattice parameter of 3.62 Å. Hall effect measurement shows electron mobility to be  $3.2 \times 10^{-3} \text{ m}^2 \text{V}^{-1} \text{s}^{-1}$ . Electrical resistivity of copper is  $1.7 \times 10^{-8} \Omega\text{m}$ . The average number of free electrons per atom in copper is .....(Charge of an electron:  $1.6 \times 10^{-19} \text{ C}$ )

Question Number : 54

Correct : 2 Wrong : -0.66

In an ionic solid the cation and the anion have ionic radii as  $0.8 \text{ \AA}$  and  $1.6 \text{ \AA}$  respectively. The maximum coordination number of the cation in the structure will be

- (A) 3                                      (B) 4                                      (C) 6                                      (D) 8

Question Number : 55

Correct : 2 Wrong : -0.66

Which of the following statement(s) is / are true regarding susceptibility of a material

- (i) Magnetic susceptibility is positive for a diamagnetic material
- (ii) Magnetic susceptibility is negative for a diamagnetic material
- (iii) Magnetic susceptibility is negative for an antiferromagnetic material
- (iv) Magnetic susceptibility is positive for a paramagnetic material

- (A) (ii) and (iv)  
(B) (i) and (iii)  
(C) (ii) and (iii)  
(D) (i) and (iv)

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## General Aptitude

Question Number : 166

Correct : 1 Wrong : -0.33

The event would have been successful if you \_\_\_\_\_ able to come.

- (A) are                      (B) had been                      (C) have been                      (D) would have been

Question Number : 167

Correct : 1 Wrong : -0.33

There was no doubt that their work was thorough.

Which of the words below is closest in meaning to the underlined word above?

- (A) pretty                      (B) complete                      (C) sloppy                      (D) haphazard

**Question Number : 168****Correct : 1 Wrong : -0.33**

Four cards lie on a table. Each card has a number printed on one side and a colour on the other. The faces visible on the cards are 2, 3, red, and blue.

Proposition: If a card has an even value on one side, then its opposite face is red.

The cards which MUST be turned over to verify the above proposition are

- (A) 2, red                      (B) 2, 3, red                      (C) 2, blue                      (D) 2, red, blue

**Question Number : 169****Correct : 1 Wrong : -0.33**

What is the value of  $x$  when  $81 \times \left(\frac{16}{25}\right)^{x+2} \div \left(\frac{3}{5}\right)^{2x+4} = 144$  ?

- (A) 1                      (B) -1                      (C) -2                      (D) Cannot be determined

**Question Number : 170****Correct : 1 Wrong : -0.33**

Two dice are thrown simultaneously. The probability that the product of the numbers appearing on the top faces of the dice is a perfect square is

- (A)  $1/9$                       (B)  $2/9$                       (C)  $1/3$                       (D)  $4/9$

**Question Number : 171****Correct : 2 Wrong : -0.66**

Bhaichung was observing the pattern of people entering and leaving a car service centre. There was a single window where customers were being served. He saw that people inevitably came out of the centre in the order that they went in. However, the time they spent inside seemed to vary a lot: some people came out in a matter of minutes while for others it took much longer.

From this, what can one conclude?

- (A) The centre operates on a first-come-first-served basis, but with variable service times, depending on specific customer needs.  
(B) Customers were served in an arbitrary order, since they took varying amounts of time for service completion in the centre.  
(C) Since some people came out within a few minutes of entering the centre, the system is likely to operate on a last-come-first-served basis.  
(D) Entering the centre early ensured that one would have shorter service times and most people attempted to do this.

A map shows the elevations of Darjeeling, Gangtok, Kalimpong, Pelling, and Siliguri. Kalimpong is at a lower elevation than Gangtok. Pelling is at a lower elevation than Gangtok. Pelling is at a higher elevation than Siliguri. Darjeeling is at a higher elevation than Gangtok.

Which of the following statements can be inferred from the paragraph above?

- i. Pelling is at a higher elevation than Kalimpong
- ii. Kalimpong is at a lower elevation than Darjeeling
- iii. Kalimpong is at a higher elevation than Siliguri
- iv. Siliguri is at a lower elevation than Gangtok

(A) Only ii                      (B) Only ii and iii                      (C) Only ii and iv                      (D) Only iii and iv

P, Q, R, S, T and U are seated around a circular table. R is seated two places to the right of Q. P is seated three places to the left of R. S is seated opposite U. If P and U now switch seats, which of the following must necessarily be true?

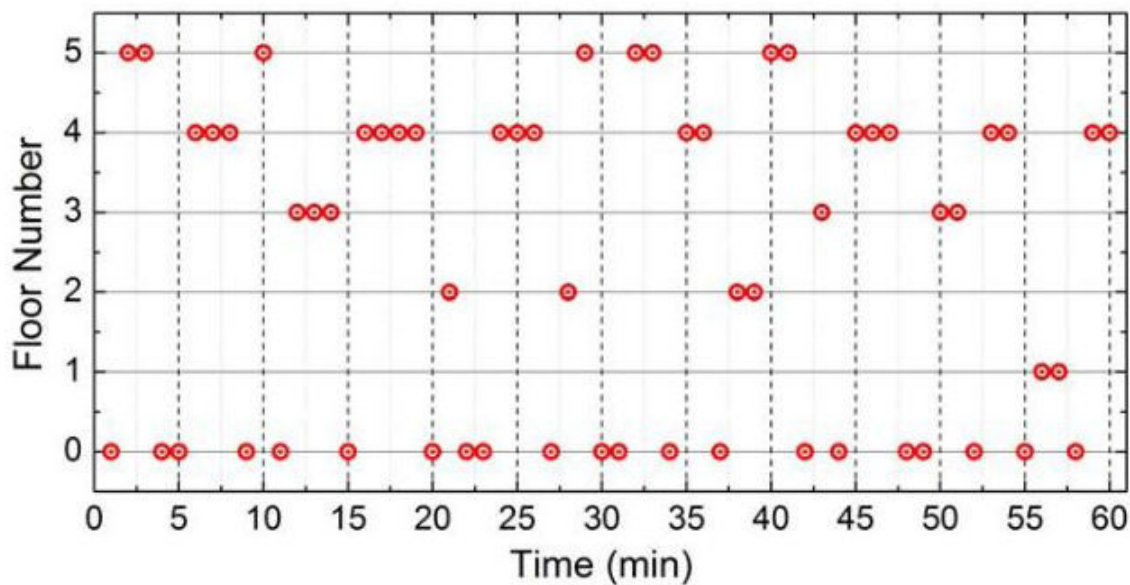
- (A) P is immediately to the right of R
- (B) T is immediately to the left of P
- (C) T is immediately to the left of P or P is immediately to the right of Q
- (D) U is immediately to the right of R or P is immediately to the left of T

Budhan covers a distance of 19 km in 2 hours by cycling one fourth of the time and walking the rest. The next day he cycles (at the same speed as before) for half the time and walks the rest (at the same speed as before) and covers 26 km in 2 hours. The speed in km/h at which Budhan walks is

(A) 1                      (B) 4                      (C) 5                      (D) 6



The points in the graph below represent the halts of a lift for durations of 1 minute, over a period of 1 hour.



Which of the following statements are correct?

- i. The elevator never moves directly from any non-ground floor to another non-ground floor over the one hour period
- ii. The elevator stays on the fourth floor for the longest duration over the one hour period

(A) ) Only i                      (B) Only ii                      (C) Both i and ii                      (D) Neither i nor ii