

# Assignment 5

EE24BTECH11049

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1 CARRY TWO MARKS EACH

- 1) A student performed X-rays diffraction experiment on a FCC polycrystalline pure metal. The following  $\sin^2 \theta$  values were calculated from the diffraction peaks.

$$\sin^2 \theta = 0.136, 0.185, 0.504, 0.544$$

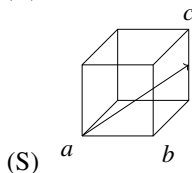
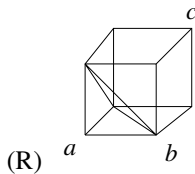
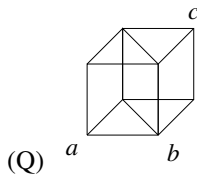
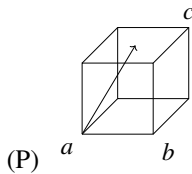
However, the student was negligent and missed noting one of the peaks. Which one of the following Miller indices corresponds to the missing peak?

(XE 2023)

- a) (200)                      b) (220)                      c) (311)                      d) (222)

- 2) Match the lattice planes and directions (in Column I) with the corresponding Miller indices (in Column I)

**Column I**



**Column II**

- 1  $(\bar{1}11)$   
 2  $(\bar{1}12)$   
 3  $(\bar{2}21)$   
 4  $(\bar{1}10)$

- a) P-2, Q-4, R-1, S-3
- b) P-3, Q-1, R-4, S-2
- c) P-2, Q-4, R-3, S-1
- d) P-3, Q-4, R-2, S-1

3) Match the hardness test (in Column I) with its indenter type (in Column II)

**Column I**

P Brinell  
Q Rockwell  
R Vickers

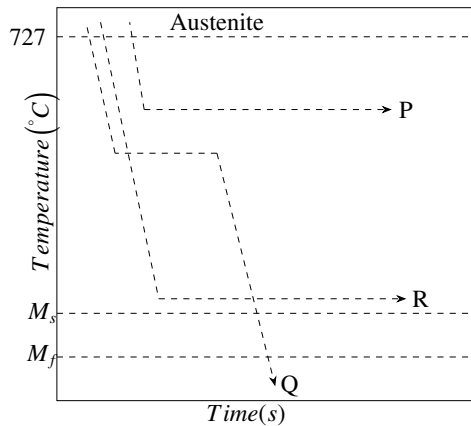
**Column II**

1 Diamond pyramidal  
2 Diamond cone  
3 Tungsten carbide sphere  
4 Steel sphere

(XE 2023)

- a) P-2, Q-4, R-1
- b) P-4, Q-2, R-3
- c) P-3, Q-4, R-2
- d) P-4, Q-2, R-1

4) TTT diagram of a eutectoid steel is shown below. Match the heat treatment cycle (in Column I) with its microstructure (in Column II)



**Column I**

- a) P
- b) Q
- c) R

**Column II**

1 Bainite only  
2 Pearlite only  
3 Pearlite + Bainite + Martensite  
4 Pearlite + Martensite

(XE 2023)

- a) P-1, Q-2, R-4

- b) P-2, Q-3, R-2
- c) P-2, Q-4, R-1
- d) P-2, Q-3, R-1

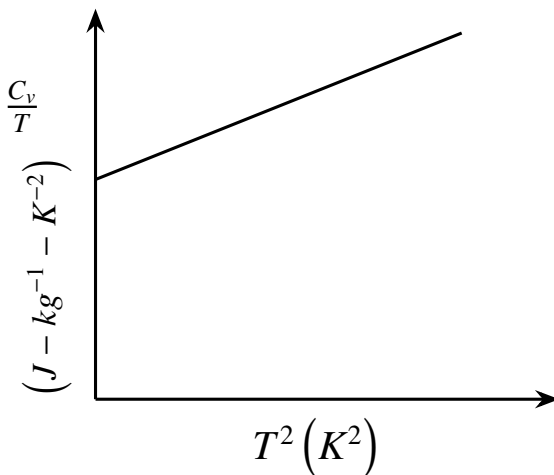
5) Which of the following statement(s) is/are true for an optical microscope?

(XE 2023)

- a) Increasing the aperture of the objective lens deteriorates the resolution
  - b) Reducing the wavelength of illuminating light improves the resolution
  - c) Increasing the refractive index of the medium in between the sample and the objective lens improves the resolution
  - d) Reducing the wavelength of illuminating light decreases the depth of field
- 6) Among the 14 Bravais lattices, there is no base centred cubic unit cell. Which of the following statement(s) is/are true?

(XE 2023)

- a) The base-centred cubic unit cell is same as the simple tetragonal unit cell
  - b) The base-centred cubic unit cell is same as the body centred tetragonal unit cell
  - c) The base-centred cubic unit cell is same as the simple orthorhombic unit cell
  - d) The base-centred cubic unit cell does not have any 3-fold rotation axis
- 7) Specific heat ( $C_v$ ) of a material was found to depend on temperature as shown below. Which of the following statement(s) is/are true



(XE 2023)

- a) The material is metallic
  - b) The material is insulating
  - c) The material is three dimensional
  - d) The material is one dimensional
- 8) A pure Silicon wafer is doped with Boron by exposing it to  $B_2O_3$  vapour at an elevated temperature. It takes 1000 seconds to reach a Boron con-

centration of  $10^{20} \text{ atoms} - \text{m}^{-3}$  at a depth of  $1\mu\text{m}$  is (in seconds):\_\_\_\_\_ (rounded off to nearest integer)

Given: Boron concentration on the wafer surface remains constant.

(XE 2023)

- 9) The Young's modulus of a quartz piezoelectric crystal is  $100\text{GPa}$ . The uniaxial stress required to change its polarization by % is (give absolute value in  $\text{GPa}$ )\_\_\_\_\_ (rounded off to nearest integer)

(XE 2023)

- 10) A one-dimensional nanowire has a linear electron density of  $10^8 \text{ electrons} - \text{cm}^{-1}$ . The Fermi energy of the system is (in  $\text{eV}$ )\_\_\_\_\_ (rounded off to two decimal places)

Given:  $\frac{\hbar^2}{2m} = 0.24 (\text{eV})^2 - \text{s}^2 - \text{kg}^{-1}$  where ' $m$ ' is the mass of an electron

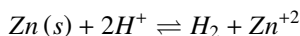
(XE 2023)

- 11) Two moles of a monoatomic ideal gas at  $10\text{atm}$  and  $300\text{K}$  is expanded isothermally and reversibly to a pressure of  $2\text{atm}$ . The absolute value of work done by the system is (in  $\text{kJ}$ ) \_\_\_\_\_ (rounded off to two decimal places)

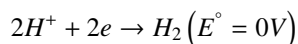
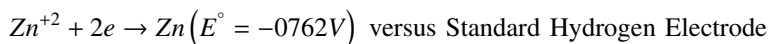
Given:  $R = 8.31\text{J} - \text{mol}^{-1}\text{K}^{-1}$ ,  $1\text{atm} = 101\text{kPa}$

(XE 2023)

- 12) An electrochemical cell consists of pure  $\text{Zn}$  electrode (anode) and a hydrogen electrode (cathode) in dilute  $\text{Zn}^{+2}$  solution. The overall reaction:



If the overall cell potential is  $+0.690\text{V}$ , then the value of  $\ln \frac{[\text{Zn}^{+2}]}{[\text{H}^+]^2}$  is \_\_\_\_\_ (rounded off to two decimal places) Given: Pressure of hydrogen gas =  $1\text{atm}$ ; Temperature =  $298\text{K}$ ;  $\frac{RT}{F} = 0.0256\text{V}$ , where  $R$  is gas constant and  $F$  is Faraday constant  
The standard reduction potential of:



(XE 2023)

- 13) In a Raman spectroscopy experiment done at  $300\text{K}$ , a Raman line is observed at  $200\text{cm}^{-1}$  ( $25\text{meV}$ ). The ratio of the intensity of the Stokes line to that of the Anti-Stokes line is \_\_\_\_\_ (rounded off to two decimal places)

Given: Boltzmann constant,  $k = 8.62 \times 10^{-5} \text{eV} - \text{K}^{-1}$

(XE 2023)