Test Series: CSIR NET/JRF Exam

Physical Sciences

Test Paper: Solid State Physics

Instructions: 1. Attempt all Questions. **Max Marks: 75**

2. There is a negative marking of 1/4 for each wrong answer.

3. Each Question carry 5 marks.

Q.1: Assume Carbon atom sit in the (1/2,1/2,0) position in BCC structure metal, using radius of carbon atom r_c=0.77 A^0 and radius of metal atom r_m=1.24 A^0. By what distance each of nearest metal atom be displaced to accommodate the carbon atom?

(a) 0.40 A^0 (b) 0.75 A^0 (c) 0.60 A^0 (d) 0.80 A^0

Q.2: The planer packing factor of (111) plane in FCC and (110) plane in BCC lattice respectively are-

(a) 0.91, 0.83 (b) 0.91, 0.78 (c) 0.86, 0.72 (d) 0.74, 0.68

Q.3: What is the Bragg's diffraction condition when X-Rays of wavelength λ are incident on a sample which has interplaner spacing d, for first order diffraction?

(a) $\frac{\lambda}{2} \geq d$ (b) $\lambda \leq d$ (c) $\frac{\lambda}{2} \leq d$ (d) $\lambda \leq \frac{d}{2}$

Q.4: The third peak from the lower angle side in the X-Ray diffraction pattern of an FCC crystal was observed at 2Θ= 64^0 using CuKα radiation of wavelength 0.15405nm.What is the interplaner

spacing & lattice constant? (Use $\sin 32^0$=0.52)

(a) 0.231nm, 0.321nm (b) 0.426nm, 0.755nm (c) 0.426nm, 0.965nm (d) 0.829nm, 0.965nm

Q.5: Consider a 2d triangular lattice described by two primitive vectors in an orthogonal co-ordinate system a_1= a(1,0) & a_2= a(1/2, √3/2). What is the two primitive lattice vectors b_1 & b_2 respectively describing the reciprocal lattice?

(a) $\frac{4\pi}{\sqrt{3}a}i\hat{}$, $\frac{2\pi}{a}(i\hat{}-\frac{1}{\sqrt{3}}j\hat{})$ (b) $\frac{2\pi}{\sqrt{3}a}i\hat{}$, $\frac{2\pi}{a}(i\hat{}-\frac{1}{\sqrt{3}}j\hat{})$ (c) $\frac{2\pi}{a}i\hat{}$, $\frac{2\pi}{a}(\frac{1}{2}i\hat{}-\frac{1}{\sqrt{3}}j\hat{})$ (d) $\frac{2\pi}{a}i\hat{}$, $\frac{2\pi}{a}(i\hat{}-\frac{1}{\sqrt{3}}j\hat{})$

Q.6: In Q.5, what is the area of 1st Brillouin Zone?

(a) $\frac{8\pi^2}{\sqrt{3}a^2}k\hat{}$ (b) $\frac{8\pi^2}{\sqrt{3}a^2}j\hat{}$ (c) $\frac{4\pi^2}{\sqrt{3}a^2}k\hat{}$ (d) $\frac{4\pi^2}{\sqrt{3}a^2}j\hat{}$

Q.7: Direct lattice vectors of Graphene are given as **a** = $\frac{3a}{2}(i\hat{}+\frac{1}{\sqrt{3}}j\hat{})$ & **b** = $\frac{3a}{2}(i\hat{}-\frac{1}{\sqrt{3}}j\hat{})$. What are their corresponding reciprocal lattice vectors respectively?

(a) $\frac{2\pi}{a}(i\hat{}+\frac{1}{\sqrt{3}}j\hat{})$, $\frac{2\pi}{a}(i\hat{}-\frac{1}{\sqrt{3}}j\hat{})$ (b) $\frac{2\pi}{3a}(i\hat{}+\sqrt{3}j\hat{})$, $\frac{2\pi}{3a}(i\hat{}-\sqrt{3}j\hat{})$

(c) $\frac{4\pi}{a}(i\hat{}+\frac{1}{\sqrt{3}}j\hat{})$, $\frac{4\pi}{a}(i\hat{}-\frac{1}{\sqrt{3}}j\hat{})$ (d) $\frac{4\pi}{a}(i\hat{}+\sqrt{3}j\hat{})$, $\frac{4\pi}{a}(i\hat{}-\sqrt{3}j\hat{})$

Q.8: The energy electronic excitation in 2d sheet of Graphene is given by

E(k)= $\hbar v k^2$, where v is the velocity of excitation, the density of states is proportional to

(a) E (B) E^2 (C) $E^{1/2}$ (D) constant

Q.9: The dispersion relation of phonons in a solid is given by

ω^2(k)= $w_0{}^2$(3-cos$k_x a$-cos$k_y a$-cosk_za). The group velocity of phonons at zone boundary k= $\frac{\pi}{a}$ is-

(a) $\frac{w_0}{\sqrt{3}}a$ (b) $\omega_0 a$ (c) $\frac{w_0}{\sqrt{2}}a$ (d) 0

Q.10: While studying diatomic lattice vibrations, the mass of atoms are m & M where m<M, a be the lattice spacing between two unidentical atoms. When m decreases, which of the following

statement is incoorect?

(a) As m decreases optical branch move upward & acoustical branch does not affected.

(b) As m tends to zero optical branch disappears & lattice becomes monoatomic lattice with lattice constant 2a.

(c) As M increases optical branch unaffected & acoustical branch yields downwards.

(d) As M tends to infinite optical branch becomes parallel to k-axis & acoustical branch becomes co-inside with k-axis

Q.11: Giving the tight binding dispersion relation E(k)=E_0+ A sin2ka, where E_0 & A are the constants and a is the lattice parameter. What is the group velocity at the first Brillouin zone boundary?

(a) 0 (b)πaA/h (c) 2πaA/h (d) 4πaA/h

Q.12: The energy of a hole in a crystal for a particle in k-direction has the form

E(k)= A- B cos2ka, where A & B are positive constants. The hole has electron like behaviour over the following range of k-

(a) $\frac{\pi}{4}$<ka<$\frac{3\pi}{4}$ (b) $\frac{\pi}{2}$<ka<π (c) 0<ka<$\frac{\pi}{4}$ (d) $\frac{\pi}{2}$<ka<$\frac{3\pi}{4}$

Q.13: A current of I amperes flows in a cylindrical superconducting wire of radius r cm. When the field produced by the current immediately outside the wire is H_C (in gauss) then the critical current is

(a) 2πrH_C (b) 2rH_C (c) 5πrH_C (d) 5rH_C

Q.14: The critical temperature for lead is 7.18K and $H_C(0)$= 6.5 ×10^4 A/m. What is the critical current for a cylindrical wire of lead having diameter of 1mm at 4.2K?

(a) 85A (b) 96A (c) 107A (d) 114A

Q.15: The penetration equation is written as $\lambda^2\nabla^2 B = B$, where λ is the penetration depth. What is B(x) inside the super conducting plate perpendicular to the x axis and of thickness δ (where B_a is the field outside the plate and parallel to it, here x=0 is the centre of the plate)?

(a) B(x)=$2B_a \frac{\cosh(x/\lambda)}{\cosh(\delta/2\lambda)}$ (b) B(x)= $B_a \frac{\cosh(x/\lambda)}{\cosh(\delta/2\lambda)}$ (c) B(x)= $2B_a \frac{\cosh(x/\lambda)}{\cosh(\delta/\lambda)}$ (d) B(x)= $B_a \frac{\cosh(x/\lambda)}{\cosh(\delta/\lambda)}$