	CRYSTALPHYSICS
	PART*A
Q.No.	**Questions**
1.	**Define the terms lattice points, lattice plane and basis. (May 2003, May 2004, June 2005, Jan 2009, Jan 2013, Dec 2015)** BTL1 Latticepoints Thepointsinwhichatomsarelocatedarecalledlatticepoints. Latticeplane The plane containing the lattice points is called as lattice plane.It is also called as atomic plane. Basis Theunit assemblyofatomsassociatedwitheverylatticepointiscalled basis. Crystalstructure Thespacelatticecombineswithbasisgivesthecrystalstructure. Spacelattice+Basis→Crystal
2	**Definethetermsunitcell.(May2003,Nov2003,May2004,Jan2010,Jan2011,Jan2012, Jan2014)**BTL1 UnitCell:Theunitcellisthesmallestgeometricfigureorvolumeofthesolidfromwhichthe entirecrystalstructurecanbebuiltby translationalrepetitioninthreedimensions.
3	**Define the terms co- ordination number, number of atoms per unit cell**. **(Dec 2010)** BTL1 Coordinationnumber:Itisthenumberofnearestequidistantneighboringatomsdirectly surroundingtoanatominanunitcell.(SC-6;BCC-8;FCC-12;HCP-12.DIAMOND–4; NaCl - 6) Number of atomsper unit cell :Itisthe total number of atomspossessedorsharedbyanunit cell. (SC-1;BCC-2;FCC-4;HCP-6;Diamond –8;NaCl-4)
4	**Definethetermsnearestneighboringdistance,atomicradiusandatomicpackingfactor. (Apr 2011, May 2012, May 2013)** BTL1 Neighboringdistance:Itisthedistancebetweenthecentersofthetwonearestneighboring atoms in a unit cell. Atomicradius:Itishalfofthenearestneighboring distance. Atomic packing factor or density of packing: It is the ratio of volume (v) occupied by all theatomsin unit cell to the volume of the unit cell. $APF = \frac{No.of\ atoms\ present\ in\ a\ unit\ cell \times Volume\ of\ one\ atom}{Volume\ of\ the\ unit\ cell}$ i.e.Atomicpackingfactor =v/V
5	**Differentiatecrystallinesolidandamorphoussolid.(Jan2015)**BTL4

S.No	Crystallinesolids	Amorphoussolids
1.	Atomsormoleculesarearranged inaregularandorderlymannerin athreedimensionalpattern	Atoms or molecules are arrangedin anirregularmanner

		2.	Possesinternalspatialsymmetry	Do not posses any spatial symmetry
		3.	Havedirectionalproperties	Havenodirectionalproperties
		4.	Also called as anisotropic substances	Also called as isotropic substances
		5.	Brokenpieceshaveregularshapes	Broken pieces irregular in shape
		6.	Egs:Cu,Ag,Au,Si,Ge,NaCl, Quartz etc.	Plastic,Glass,RubberEtc.

6	**Whatare Millerindices?Givethe procedure tofindMillerindices.(Apr 2002,May2003, May 2004, Jan 2009, Jan 2010, May 2010, Jan 2010, Jan 2011, Dec 2014)** BTL2 Themillerindicesarethethreesmallestpossibleintegerswhichhavethesameratiosasthe reciprocals of the intercepts of the plane concerned on the three axes. ➢ Theinterceptsmadebytheplaneonthereferencearetobefound.LetthesebeX',Y',Z' alongx,y,zaxes respectively. ➢ Reciprocaloftheseintercept aretaken. ➢ TakeLCMandthereciprocalsarereducedintowholenumbers. ➢ Write theintegersinparentheseswithoutcoma()togetthe millerindices.
7	**Defectsincrystalsarenotalwaysharmful.Justify.(Jan2012)**BTL1 Some properties of crystals are structure insensitive. ie., Stiffness and density are not affectedby the presence of defects. Hence defects in crystals are not always harmful.
8	**NametheCrystalstructureofthefollowing.(Dec 2003,Dec2008)**BTL2 Gold - Facecenteredcubic Germanium-Diamondcubic Barium - Body Centered cubic - Herxagonal close packed Sulphur -Orthorhombic Indium -Tetragonal Calcite -Trigonal Zinc Quartz, Tourmaline- Herxagonal closepacked
9	**Namethesevencrystalsystems.(Jan2010)**BTL3 ➢ Cubic ➢ Tetragonal ➢ Orthorhombic ➢ Monoclinic ➢ Triclinic ➢ Rhombohedral ➢ Hexagonal
10	**Mentionthevariouscrystalgrowingtechniques.**BTL1 ➢ MeltGrowth ➢ Lowtemperaturesolutiongrowth ➢ Hightemperaturesolutiongrowth(fluxgrowth) ➢ Hydrothermalgrowth ➢ Gelgrowth ➢ Growthfromvapour
11	**Statetheconditionsimposedonthecellparametersforcrystalsystemshavingtheleast number of bravais lattices and the least number of nearest neighbours. (Jan 2005)** BTL1 Crystal with least number of nearest neighbors is simple cubic structure. (6 neighbors) CrystalsystemwithlargenumberofBravaisLatticesisOrthorhombic(4Bravais Lattices) **Thereforethe cellparametersfororthorhombicisa≠b≠c,α=β=γ=90°**

12	**Givethe comparisonchartfor SC,BCC,FCC,HCPandDiamondstructures.(Jan2008,Jan 2009)** BTL1

S. No.	SYSTEM	SC	BCC	FCC	HCP	Dia Mond
1.	Atoms per unit cell	1	2	4	6	8
2.	Atomic radius	$\frac{a}{2}$	$\frac{a\sqrt{3}}{4}$	$\frac{a\sqrt{2}}{4}$	$\frac{a}{2}$	$\frac{a\sqrt{3}}{8}$
3.	Co-ordination number	6	8	12	12	4
4.	Atomic packing factor	$\frac{\pi}{6}=0.52$	$\frac{\pi\sqrt{3}}{8}=0.68$	$\frac{\pi\sqrt{2}}{6}=0.74$	$\frac{\pi}{3\sqrt{2}}=0.74$	$\frac{\pi\sqrt{3}}{16}=0.34$
5.	Packing density	52%	68%	74%	74%	34%
6.	Example	Polonium	Cr,Fe, Na, Ba, Tungsten	Pb,Ni,Ag, Cu, Al	Mg,Co,Ti, Zn, Quartz	Ge, Si, Carbon

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Whatarethedifferencesbetweenedgeandscrewdislocations?(Jan2011)BTL2

S.No.	Edgedislocation	Screwdislocation
1.	Thesedislocationsariseduetointroductionor elimination of extra atoms.	Screw dislocation results fromadisplacementofatoms in one part of a crystal relative to the rest of crystalsformingaspiral ramparoundthe dislocation line.
2.	Regionoflatticedisturbanceextendsalongan edge inside a crystal.	Regionoflatticedisturbance extends in two separate planes at right angles to eachother.
3.	Anedgedislocationcanglide and climb.	Ascrewdislocationcan glideonly.
4.	Burgervectorisalwaysperpendiculartothe dislocation line.	Burgervectorisparallel to the dislocation line.

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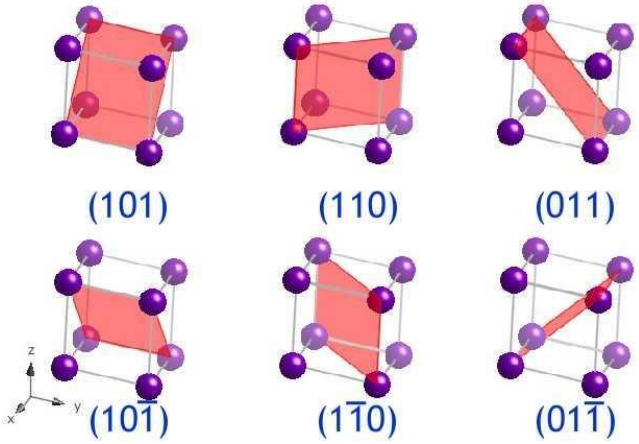
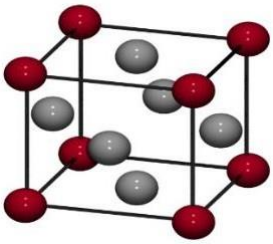
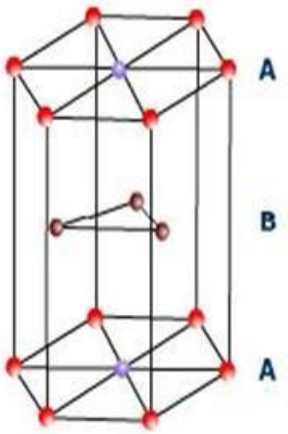
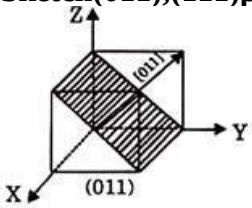
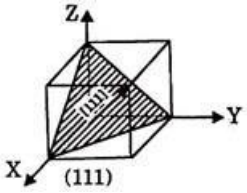
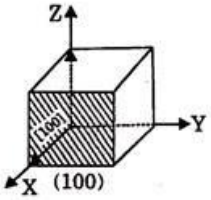
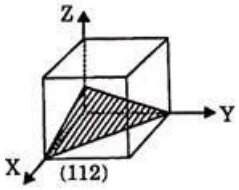
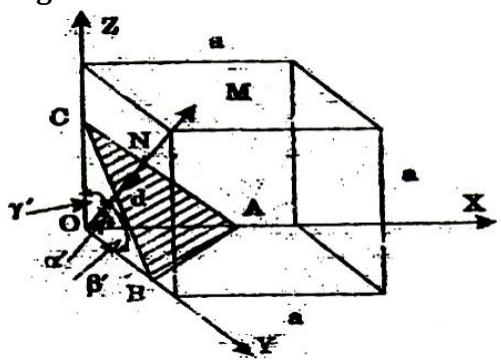
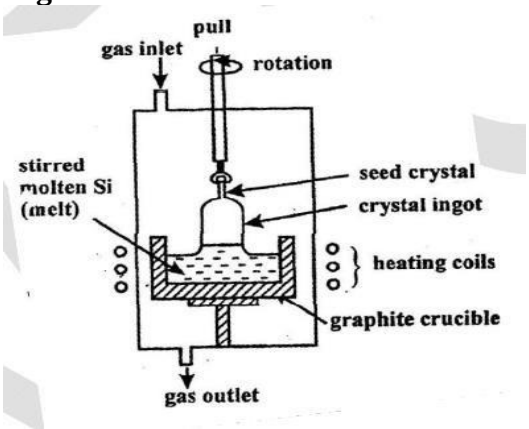
Whatarethevarioustypesofdefectsincrystals? BTL2

- Pointdefects
- Impuritydefects
  - Substitutionalimpuritydefect
  - Interstitialimpuritydefect
- Vacancies
  - Frenkeldefect
  - Schottkydefect
- Linedefects
  - Edgedislocation

	Screwdislocation ➢ Surfacedefects • Grainboundaries • Twinboundaries • Tiltboundaries • Stackingfaults ➢ Volumedefects Cavitiesorvoids Cracksandholes
15	**WhatisFrenkeldefect,SchottkydefectandBurger'svectorincrystaldefects?(Jan 2009,Jan2010, Jan2011, Dec2017,Jan. 2019)** BTL2 **Frenkeldefect:**AvacancyassociatedwithinterstitialimpurityiscalledFrenkeldefect. **Schottky defect**: If an atom is missing its lattice site, the vacancy is called Schottky defect. **Burger's vector**: The magnitude and the direction of the displacement due to edge dislocation are defined by a vector called Burger's vector.
16	**Draw(101),(110),(011),(10ī),(1ī0),(01ī)planesinacrystal.**BTL1 
18	**ObtainMillerindicesofaplanewhoseinterceptsarea,b/2,3cinasimplecubicunitcell. (Jan 2010)** BTL1 Actual intercepts area, b/2, 3c Numericalparametersare1,1/2,3 Reciprocals of the above 1, 2, 1/3 3, 6, 1 Millerindicesoftheplaneis (361).
19	**Definethetermspacelattice.(May2003,May2004,June2005,Jan2009,Jan2013,Dec 2015)**BTL1 Space lattice is defined as an array of points in three dimensional space in which the environment about each point is the same. i.e. every point has identical surroundings to that every other point in the array.
20	**DefinethetermBravaislattice.(May2003,May2004,June2005,Jan2009,Jan2013,Dec 2015)**BTL1 <u>Bravaislattice</u> There are only fourteen ways are arranging points in space such that the environment looks same fromeachpoint.i.e.therearefourteenpossibletypeofspacelatticesoutofthesevencrystal

	systems.Thesefourteenspacelatticesarecalled Bravaislattices.
21	**LatticeconstantofaBCCcrystalis0.36nm.Finditsatomicradius.(Jan.2013)** BTL1 **a=0.36x10^{-9}m** **ForBCC,r=a** $\sqrt{3}/2$ **r=0.36x10^{-9}x** $\sqrt{3}$**/4nm=0.16nm**
22	**CopperisFCCwhoseatomic radiusis1.26x10^{-10}m. Calculateitslattice constant.(May.2012)** BTL1 **r=1.26x10^{-10}m** **ForFCC,r=a** $\sqrt{2}$**/4** **a=4r/2**$\sqrt{}$ **4x1.26x10^{-10}/2**$\sqrt{}$ **a=3.56 A^{0}**
26	**Showtheatomicpositionsinfccandhcpcrystalstructuresinasketch.(Jan2019)** BTL4  **FCC-Lattice Structure**  **HCP-Lattice-Structure**
27	**Sketch(011),(111)planeforacubicstructure.(Dec2017)** BTL4  
28	**Sketch(100),(112)planeforacubicstructure.** BTL4  
7	**WhatareMillerindices?Deriveanexpressionford–spacingofacubiccrystalintermsof**

	latticeconstantandmillerindices.(Jan2010,Dec2017)(8M)BTL2 **Answer : Page : 7.59-7.101-Dr.P.MANI** ➢ **MillerIndices** (2M) Three smallest possible integers- same ratios- reciprocals of intercepts of plane -concerned on three axes. ➢ **Diagram** (2M)  ➢ **Derivation** (4M) $NM=d=\frac{a}{\sqrt{h^2+k^2+l^2}}$
8	**Explaintheprinciple,constructionandworkingofCzochralskiandBridgmancrystalgrowth techniques. (Jan 2014, Dec 2015, Dec 2017)(16 M)** BTL2 **Answer:Page:7.83-Dr.P.MANI** ➢ **CzochralskiMethod** ➢ **Principle** (2M) Crystalpullingmethod-monocrystallineseed-usedpullrod-meltfreezes-crystalgrows. ➢ **Diagram** (2M)  ➢ **Construction&Working** (3M) Crystalpullingtechnique-growingacrystalgradually-condensing melt-liquid-solid

phasetransition-seedcrystal-heaterswitchedON.

- **Advantages** (1M)

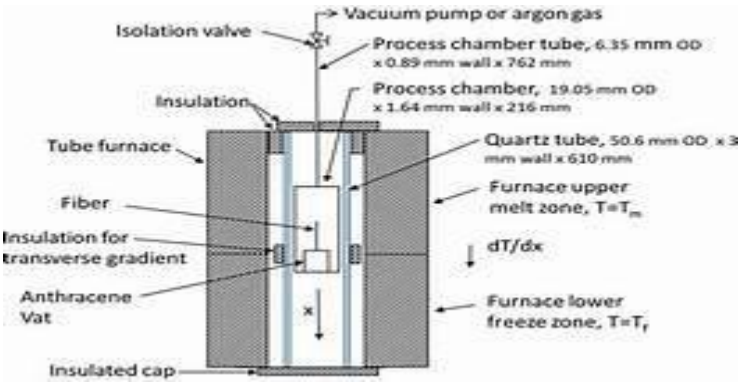
  Producelargecrystal-easycontrol-freefromcrystalgrowth.

- **BridgmannMethod**

- **Principle** (2M)

  Materialheated-moltenstate-temperaturegradient-crystalgrowth.

- **Diagram** (2M)



- **Construction&Working** (3M)

Crystal taken crucible-vertical container-Hot furnace(1)- Cold furnace(2)-material heated-molten state-crystalline starts-crystal growth.

- **Advantages** (1M)

  Cheaper-Easymethod-Goodcrystalformed.