ABC CHEMISTRY

Mr. Aniket Bhardwaj · 15+ Years Mentorship

Solid State Chemistry

Premium CSIR-NET PYQ Book

74 Previous-Year Questions · 59 with verified answers · Distractor Analysis

3-Slide Solutions | Distractor Analysis | Exam Tricks | Revision Sheets

CSIR-NET · GATE · IIT-JAM — 4 Topics · 74 Real PYQs

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Course Contents

4 Topics · 74 PYQs

1	**Crystal Systems Lattices** 22 Qs E 2 · M 20 · H 0	30%	
2	**X Ray Diffraction Bragg** 5 Qs E 1 · M 4 · H 0	7%	
3	**Band Theory** 3 Qs E 0 · M 3 · H 0	4%	
4	**Solid State Chemistry – General** 44 Qs E 12 · M 28 · H 4	59%	

Legend: **E** Easy **M** Medium **H** Hard · **%** = exam weightage (share of the chapter)

TOPIC 1

Crystal Systems Lattices

22 questions · Easy 2 | Medium 20 | Hard 0 · PYQ frequency: Very High

Q1

A metal crystallizes in fcc structure with a unit cell side of 500 pm. If the density of the crystal is 1.33 g/cc, the molar mass of the metal is close to

A 23

B 24

C 25

D 26

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer C 25

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- $M = \rho a^3 N_A/Z = 1.33 \times (5\times10^{-8}\ cm)^3 \times 6.022\times10^{23} / 4 = 1.33 \times 1.25\times10^{-22} \times 6.022\times10^{23} / 4 \approx 25\ g\ mol^{-1}$.
- Therefore the answer is (C).

FINAL: (C) 25

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: C

A **23**

Why (C) is the key — $M = \rho a^3 N_A / Z = 1.33 \times (5\times10^{-8}\ cm)^3 \times 6.022\times10^{23} / 4 = 1.33 \times 1.25\times10^{-22} \times 6.022\times10^{23} / 4 \approx 25\ g\ mol^{-1}$.

B **24**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **26**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q2

Crystal A diffracts from (111) and (200) planes but not from (110) plane, while the crystal B diffracts from (110) and (200) planes but not from the (111) plane. From the above, we may conclude that

A. A has fcc lattice while B has bcc lattice

B. A has bcc lattice while B has fee lattice

C. A and B both have fcc lattice

D. A and B both have bcc lattice

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer A A has fcc lattice while B has bcc lattice

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- FCC reflections need h,k,l all odd or all even (111, 200 allowed; 110 absent). BCC needs h+k+l even (110, 200 allowed; 111 absent). So A = fcc, B = bcc.
- Therefore the answer is (A).

FINAL: (A) A has fcc lattice while B has bcc lattice

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: A

B — **A has bcc lattice while B has fee lattice**

Why (A) is the key — FCC reflections need h,k,l all odd or all even (111, 200 allowed; 110 absent). BCC needs h+k+l even (110, 200 allowed; 111 absent). So A = fcc, B = bcc.

C — **A and B both have fcc lattice**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D — **A and B both have bcc lattice**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q3

A compound of M and X atoms has a cubic unit cell. M atoms are at the corners and body centre position and X atoms are at face centre positions of the cube. The molecular formula of the compound is

(A) MX

(B) MX_2

(C) M_3X_2

(D) M_2X_3

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer D M_2X_3

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- M: 8 corners × 1/8 + 1 body centre = 2; X: 6 faces × 1/2 = 3 → M_2X_3.
- Therefore the answer is (D).

FINAL: (D) M_2X_3

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: D

A **MX**

Why (D) is the key — M: 8 corners × 1/8 + 1 body centre = 2; X: 6 faces × 1/2 = 3 → M_2X_3.

B **MX_2**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

C **M_3X_2**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q4

The angle at which the first order Bragg reflection is observed from (110) plane in a simple cubic unit cell of side 3.238 , when chromium K radiation of wavelength 2.29 is used, is

A 30

B 45

C 60

D 90

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer A 30

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- $d_{110} = a/\sqrt{2} = 3.238/1.414 = 2.29$ Å. Bragg: $\sin\theta = \lambda/2d = 2.29/(2 \times 2.29) = 0.5 \rightarrow \theta = 30°$.
- Therefore the answer is (A).

FINAL: (A) 30

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: A

B **45**

Why (A) is the key — $d_{110} = a/\sqrt{2} = 3.238/1.414 = 2.29$ Å. Bragg: $\sin\theta = \lambda/2d = 2.29/(2 \times 2.29) = 0.5 \rightarrow \theta = 30°$.

C **60**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **90**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q5

Metallic gold crystallizes in fcc structure with unit cell dimension of 4.00 . The atomic radius of gold is

A 0.866

B 1.414

C 1.732

D 2.000

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer B 1.414

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- FCC: atoms touch along the face diagonal, $4r = \sqrt{2}\, a \rightarrow r = a/(2\sqrt{2}) = 4.00/2.828 = 1.414$ Å.
- Therefore the answer is (B).

FINAL: (B) 1.414

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: B

A **0.866**

Why (B) is the key — FCC: atoms touch along the face diagonal, $4r = \sqrt{2}\, a \rightarrow r = a/(2\sqrt{2}) = 4.00/2.828 = 1.414$ Å.

C **1.732**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **2.000**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q6

For a simple cubic crystal lattice, the angle between the [2 0 1] plane and the xy plane is

A. less than 30Â°

B. between 30Â° and 45Â°

C. between 45Â° and 60Â°

D. greater than 60Â°

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer D greater than 60Â°

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- Angle between planes = angle between their normals. Normal to (201) is [2 0 1], normal to xy-plane is [0 0 1]: cos φ = 1/√5 = 0.447 → φ ≈ 63.4° (> 60°).
- Therefore the answer is (D).

FINAL: (D) greater than 60Â°

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: D

A **less than 30Â°**

Why (D) is the key — Angle between planes = angle between their normals. Normal to (201) is [2 0 1], normal to xy-plane is [0 0 1]: cos φ = 1/√5 = 0.447 → φ ≈ 63.4° (> 60°).

B **between 30Â° and 45Â°**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

C **between 45Â° and 60Â°**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q7 **The separation of the (123) planes of an orthorhombic unit cell is 3.12 nm. The separation of (246) and (369) planes are, respectively,**

A. 1.56 nm and 1.04 nm

B. 1.04 nm and 1.56 nm

C. 3.12 m and 1.50 nm

D. 1.04 nm and 3.12 nm

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer A 1.56 nm and 1.04 nm

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- (246) = 2×(123) and (369) = 3×(123): d scales as 1/n → 3.12/2 = 1.56 nm and 3.12/3 = 1.04 nm.
- Therefore the answer is (A).

FINAL: (A) 1.56 nm and 1.04 nm

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: A

B **1.04 nm and 1.56 nm**

Why (A) is the key — (246) = 2×(123) and (369) = 3×(123): d scales as 1/n → 3.12/2 = 1.56 nm and 3.12/3 = 1.04 nm.

C **3.12 m and 1.50 nm**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **1.04 nm and 3.12 nm**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q8

If all the lattice points of an FCC structure are occupied by uniform hard spheres that touch each other, the fraction of volume occupied is

A. fracπ√(2)6

B. fracπ√(3)6

C. (π)/(6)

D. (2π)/(6)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer A fracπ√(2)6

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- FCC: 4 atoms per cell, 4r = √2 a. Packing fraction = 4 × (4/3)πr³/a³ = π√2/6 = 0.74.
- Therefore the answer is (A).

FINAL: (A) fracπ√(2)6

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: A

B **fracπ√(3)6**

Why (A) is the key — FCC: 4 atoms per cell, 4r = √2 a. Packing fraction = 4 × (4/3)πr³/a³ = π√2/6 = 0.74.

C **(π)/(6)**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **(2π)/(6)**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q9

In a cubic crystal, the (111) and (222) reflections are observed, but not the (001) reflection. The Bravais lattice is

A. body centred cubic

B. face centred cubic

C. simple cubic

D. side centred cubic

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer B face centred cubic

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- (001) absent but (111) present rules out simple cubic and bcc (bcc forbids 111). FCC allows all-odd (111) and all-even (222) and forbids mixed (001).
- Therefore the answer is (B).

FINAL: (B) face centred cubic

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: B

A — **body centred cubic**

Why (B) is the key — (001) absent but (111) present rules out simple cubic and bcc (bcc forbids 111). FCC allows all-odd (111) and all-even (222) and forbids mixed (001).

C — **simple cubic**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D — **side centred cubic**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q10

A metal crystallizes with cubic close-packed structure. The $\sin^2\theta$ values of Bragg reflections of Miller Planes (200) and (111) are 0.18 and 0.14, respectively. The unit cell length is

A. $\lambda/2$

B. $\lambda/0.3$

C. $\lambda/0.4$

D. 0.4λ

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer C λ/0.4

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- a = λ√(h²+k²+l²)/(2 sin θ). (200): a = 2λ/(2√0.18) = λ/0.424; (111): a = √3λ/(2√0.14) = λ/0.432. So a ≈ λ/0.4 → option (c). (Bank key (a) λ/2 does not fit either reflection — verify.)
- Therefore the answer is (C).

FINAL: (C) λ/0.4

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: C

A **λ/2**

Why (C) is the key — a = λ√(h²+k²+l²)/(2 sin θ). (200): a = 2λ/(2√0.18) = λ/0.424; (111): a = √3λ/(2√0.14) = λ/0.432. So a ≈ λ/0.4 → option (c). (Bank key (a) λ/2 does not fit either reflection — verify.)

B **λ/0.3**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **0.4λ**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q11 X-rays of 173 pm wavelength are reflected by the (111) plane of a cubic primitive crystal at θ = 30Â°. The unit cell length (in pm) is closest to

A 173

B 300

C 346

D 600

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer B 300

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- $d_{111} = \lambda/(2 \sin 30°) = 173/(2 \times 0.5) = 173$ pm; $a = d\sqrt{3} = 173 \times 1.732 \approx 300$ pm.
- Therefore the answer is (B).

FINAL: (B) 300

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: B

A — **173**

Why (B) is the key — $d_{111} = \lambda/(2 \sin 30°) = 173/(2 \times 0.5) = 173$ pm; $a = d\sqrt{3} = 173 \times 1.732 \approx 300$ pm.

C — **346**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D — **600**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q12

Iron belongs to the BCC lattice. The Miller indices of the second allowed reflection in the powder diffraction pattern of iron would be

A (100)

B (111)

C (200)

D (210)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer C (200)

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- BCC allows only h+k+l = even: (110), (200), (211), (220)… The second allowed reflection is (200).
- Therefore the answer is (C).

FINAL: (C) (200)

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: C

A **(100)**
Why (C) is the key — BCC allows only h+k+l = even: (110), (200), (211), (220)… The second allowed reflection is (200).

B **(111)**
Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **(210)**
Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q13

In the ccp packing, the number of lattice points per unit area in the planes is in the order

A (100) > (110) > (111)

B (100) > (111) > (110)

C (111) > (100) > (110)

D (111) > (110) > (100)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer C (111) > (100) > (110)

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- In ccp (fcc) the planar densities are: (111) = $4/(\sqrt{3}a^2) = 2.31/a^2$ > (100) = $2/a^2$ > (110) = $1.41/a^2$. (111) is the close-packed plane.
- Therefore the answer is (C).

FINAL: (C) (111) > (100) > (110)

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: C

A **(100) > (110) > (111)**

Why (C) is the key — In ccp (fcc) the planar densities are: (111) = $4/(\sqrt{3}a^2) = 2.31/a^2$ > (100) = $2/a^2$ > (110) = $1.41/a^2$. (111) is the close-packed plane.

B **(100) > (111) > (110)**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **(111) > (110) > (100)**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q14

The lattice parameter of an element stabilized in a fcc structure is 4.04 . The atomic radius of the element is:

A. 2.86

B. 1.43

C. 4.29

D. 5.72

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer B 1.43

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- FCC: r = a/(2√2) = 4.04/2.828 = 1.43 Å.
- Therefore the answer is (B).

FINAL: (B) 1.43

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: B

A **2.86**

Why (B) is the key — FCC: r = a/(2√2) = 4.04/2.828 = 1.43 Å.

C **4.29**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **5.72**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q15

The coordinates for the atoms in a body centred cubic unit cell are

A (0, 0, 0) and (1/2, 0, 0)

B (0, 0, 0) and (1/2, 1/2, 1/2)

C (0, 0, 0) and (0, 1/2, 0)

D (0, 0, 0) and (0, 0, 1/2)

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer B (0, 0, 0) and (1/2, 1/2, 1/2)

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- BCC has lattice points at the corner (0,0,0) and the body centre (½,½,½). (Bank key (c) was wrong — corrected.)
- Therefore the answer is (B).

FINAL: (B) (0, 0, 0) and (1/2, 1/2, 1/2)

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: B

A **(0, 0, 0) and (1/2, 0, 0)**

Why (B) is the key — BCC has lattice points at the corner (0,0,0) and the body centre (½,½,½). (Bank key (c) was wrong — corrected.)

C **(0, 0, 0) and (0, 1/2, 0)**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **(0, 0, 0) and (0, 0, 1/2)**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q16

The inter planar distance ( ) for a (100) plane in a cubic structure with the lattice parameter of 4 is:

A 1

B 2

C 4

D 8

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer C 4

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- $d_{100} = a/\sqrt{(1+0+0)} = a = 4$ Å.
- Therefore the answer is (C).

FINAL: (C) 4

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: C

A **1**

Why (C) is the key — $d_{100} = a/\sqrt{(1+0+0)} = a = 4$ Å.

B **2**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **8**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q17

The interplanar spacing of (110) planes in a cubic unit cell with lattice parameter a = 4.242 is

A) 3

B) 6

C) 7.35

D) 2.45

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer A 3

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- / dhkl = M 0 1l 0 1… 0 H.<H< d110 = =3 #1#0 1C0 Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (A).

FINAL: (A) 3

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: A

B

6

Why (A) is the key — / dhkl = M 0 1l 0 1… 0 H.<H< d110 = =3 #1#0 1C0 Explanation as extracted from the printed page; notation may be imperfect.

C

7.35

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D

2.45

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q18

Metallic silver crystallizes in face-centred-cubic lattice structure with a unit cell of length 40 nm. The first order diffraction angle of X-ray beam from (2, 1, 0) plane of silver is 30Â°. The wavelength of X-ray used is close to

A. 11 nm

B. 18 nm

C. 25 nm

D. 32 nm

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer B 18 nm

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- d_{210} = 40/√(4+1+0) = 40/2.236 = 17.9 nm. λ = 2d sin 30° = 2 × 17.9 × 0.5 ≈ 18 nm.
- Therefore the answer is (B).

FINAL: (B) 18 nm

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: B

A **11 nm**

Why (B) is the key — d_{210} = 40/√(4+1+0) = 40/2.236 = 17.9 nm. λ = 2d sin 30° = 2 × 17.9 × 0.5 ≈ 18 nm.

C **25 nm**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **32 nm**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q19

Polonium is the only metal known to exist in a simple cubic lattice form. The density of polonium at 0C is measured to be 10.00 g/cm³. The atomic radius of polonium would then be (assume the mass of a polonium atom = 2.7 × 10⁻²² g)

A 1.1

B 1.9

C 1.5

D 2.3

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer C 1.5

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- Simple cubic: 1 atom per cell, $a^3 = m/\rho = 2.7\times10^{-22}/10 = 2.7\times10^{-23}$ cm³ → a = 3.0×10^{-8} cm = 3.0 Å. r = a/2 = 1.5 Å.
- Therefore the answer is (C).

FINAL: (C) 1.5

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: C

A **1.1**

Why (C) is the key — Simple cubic: 1 atom per cell, $a^3 = m/\rho = 2.7\times10^{-22}/10 = 2.7\times10^{-23}$ cm^3 → a = 3.0×10^{-8} cm = 3.0 Å. r = a/2 = 1.5 Å.

B **1.9**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **2.3**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q20

Nearest neighbour distance in a crystal system of side length a is fraca√(2) in

A. Face-centered cube

B. Body-centered cube

C. Trigonal primitive

D. Primitive cube

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Correct Answer A Face-centered cube

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- FCC: nearest neighbours touch along the face diagonal → distance = √2a/2 = a/√2. (BCC: √3a/2; simple cubic: a.)
- Therefore the answer is (A).

FINAL: (A) Face-centered cube

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: A

B **Body-centered cube**

Why (A) is the key — FCC: nearest neighbours touch along the face diagonal → distance = √2a/2 = a/√2. (BCC: √3a/2; simple cubic: a.)

C **Trigonal primitive**

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D **Primitive cube**

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

Q21

Plutonium (atomic mass = 244 g mol⁻¹) crystallizes in monoclinic lattice (a = 620 pm, b = 480 pm, c = 1100 pm; β = 102Â°) with 16 atoms per unit cell. The density in g cm⁻³ will be close to (Use sinβ = 0.98; sinβ/2 = 0.78) (b) 16.12 (a) 25.38 (c) 12.69 (d) 20.26

SELF-PRACTICE answer on record: (D) — options were not printed in the source.

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Q22

The correct relationship among the following, for a tetragonal ($a = b \neq c$, $\alpha = \beta = \gamma = 90^\circ$) crystal system, is

A $\sin^2\theta = (\lambda^2)/(4a^2)[c^2(h^2 + k^2b) + a^2 l^2]$

B $\sin^2\theta = (\lambda^2)/(4a^2c^2)[c^2(h^2 + k^2b) + a^2 l^2]$

C $\sin^2\theta = (\lambda^2)/(4c^2)[a^2(h^2 + k^2) + c^2 l^2]$

D $\sin^2\theta = (\lambda^2)/(4a^2)(h^2 + k^2) + l^2]$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Crystal Systems Lattices

PYQ FREQUENCY
Very High · 13 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'3-2-4-1-1-2-1 = 14 Bravais'.

Crystal Systems Lattices

Correct Answer A $\sin^2\theta = (\lambda^2)/(4a^2)[c^2(h^2 + k^2b) + a^2 l^2]$

CONCEPT

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

↓

LOGIC / WORKING

- From braggs equation , 2d sin =n si = < On squaring both sides , we get 0 0 si< = (i) H 0 # M0 0 l0 inter planar distance = + 0 + 0 0 /0 N for tetragonal crystal sydrem , a = b # M 0 1 0 l0 N 0 M 0 1 0 1l 0 / 0 0 = + 0 /0 N /0 N 0 # 0 Put in equation (i), we get < = [< < + < + < <] 0 HN 0 Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (A).

FINAL: (A) $\sin^2\theta = (\lambda^2)/(4a^2)[c^2(h^2 + k^2b) + a^2 l^2]$

SHORTCUT / EXAM TRICK

No face-centred tetragonal (it is body-centred tetragonal with a smaller cell); no base-centred cubic.

COMMON MISTAKE

Writing Miller indices from intercepts instead of their reciprocals.

EXAM TIP

d_hkl decreases with higher indices; (100) spacing = a in cubic.

MEMORY TRICK

'3-2-4-1-1-2-1 = 14 Bravais'.

Why the Other Options Are Wrong

Correct answer: A

B

$\sin^2\theta = (\lambda^2)/(4a^2c^2)[c^2(h^2 + k^2b) + a^2 l^2]$

Why (A) is the key — From braggs equation , 2d sin =n si = < On squaring both sides , we get 0 0 si< = (i) H 0 # M0 0 l0 inter planar distance = + 0 + 0 0 /0 N for tetragonal crystal sydrem , a = b # M 0 1 0 l0 N 0 M 0 1 0 1l 0 / 0 0 = + 0 /0 N /0 N 0 # 0 Put in equation (i), we get < = [< < + < + < <] 0 HN 0 Explanation as extracted from the printed page; notation may be imperfect.

C

$\sin^2\theta = (\lambda^2)/(4c^2)[a^2(h^2 + k^2) + c^2 l^2]$

Ruled out: Writing Miller indices from intercepts instead of their reciprocals.

D

$\sin^2\theta = (\lambda^2)/(4a^2)(h^2 + k^2) + l^2]$

Ruled out: d_hkl decreases with higher indices; (100) spacing = a in cubic.

TOPIC REVISION

Crystal Systems Lattices

22 PYQs · Last-minute revision

TOPIC SUMMARY

Seven crystal systems defined by axial lengths/angles (cubic a=b=c, α=β=γ=90°; tetragonal a=b≠c; orthorhombic a≠b≠c, all 90°; hexagonal γ=120°; rhombohedral a=b=c, α=β=γ≠90°; monoclinic β≠90°; triclinic all different). 14 Bravais lattices: P, I, F, C centring.

IMPORTANT FORMULA SHEET

- Cubic: P, I, F (3); tetragonal: P, I (2); orthorhombic: P, C, I, F (4); hexagonal: P (1); rhombohedral: R (1); monoclinic: P, C (2); triclinic: P (1) → 14
- Miller indices: reciprocals of intercepts, cleared of fractions

FREQUENTLY ASKED CONCEPTS

- Which centring is possible in which system
- Miller indices of planes
- Interplanar spacing
- Coordination number in each packing

COMMON MISTAKES & QUICK NOTES

Watch out:
Writing Miller indices from intercepts instead of their reciprocals.
d_hkl decreases with higher indices; (100) spacing = a in cubic.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22

Expect 2 question(s) next session on Crystal Systems Lattices.

TOPIC 2

X Ray Diffraction Bragg

5 questions · Easy 1 | Medium 4 | Hard 0 · PYQ frequency: High

Q23

X-ray diffraction does not give any structural information for

A. metallic solids

B. ionic solids

C. molecular solids

D. amorphous solids

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
X Ray Diffraction Bragg

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'fcc: all odd or all even'.

Correct Answer D amorphous solids

CONCEPT

Bragg's law nλ = 2d sinθ; systematic absences identify the lattice: sc all (hkl); bcc h+k+l even; fcc h,k,l all odd or all even. The first reflections ratio sin²θ: sc 1:2:3:4:5:6:8; bcc 1:2:3:4:5:6:7; fcc 3:4:8:11:12.

↓

LOGIC / WORKING

- Amorphous solids have no long-range periodic order, so there are no lattice planes to give sharp Bragg reflections — only a diffuse halo.
- Therefore the answer is (D).

FINAL: (D) amorphous solids

SHORTCUT / EXAM TRICK

Ratio 1:2:3:4:5:6:8 (7 missing) → sc; 1:2:3…7 (all) → bcc; 3:4:8:11 → fcc.

COMMON MISTAKE

Forgetting n (order) or using 2θ instead of θ from the diffractometer.

EXAM TIP

KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

MEMORY TRICK

'fcc: all odd or all even'.

Why the Other Options Are Wrong

Correct answer: D

A **metallic solids**

Why (D) is the key — Amorphous solids have no long-range periodic order, so there are no lattice planes to give sharp Bragg reflections — only a diffuse halo.

B **ionic solids**

Ruled out: Forgetting n (order) or using 2θ instead of θ from the diffractometer.

C **molecular solids**

Ruled out: KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

Q24

For a simple cubic crystal, X-ray diffraction shows intense reflections for angles θ_1 and θ_2 which are assigned to [1 0 1] and [1 1 1] planes, respectively. The ratio $\sin\theta_1/\sin\theta_2$ is

A. 1.5

B. 1.22

C. 0.82

D. 0.67

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
X Ray Diffraction Bragg

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'fcc: all odd or all even'.

X Ray Diffraction Bragg

Correct Answer C 0.82

CONCEPT

Bragg's law $n\lambda = 2d \sin\theta$; systematic absences identify the lattice: sc all (hkl); bcc h+k+l even; fcc h,k,l all odd or all even. The first reflections ratio $\sin^2\theta$: sc 1:2:3:4:5:6:8; bcc 1:2:3:4:5:6:7; fcc 3:4:8:11:12.

↓

LOGIC / WORKING

- $\sin\theta \propto 1/d \propto \sqrt{(h^2+k^2+l^2)}$. $\sin\theta_1/\sin\theta_2 = \sqrt{2}/\sqrt{3} = 0.82$.
- Therefore the answer is (C).

FINAL: (C) 0.82

SHORTCUT / EXAM TRICK

Ratio 1:2:3:4:5:6:8 (7 missing) → sc; 1:2:3…7 (all) → bcc; 3:4:8:11 → fcc.

COMMON MISTAKE

Forgetting n (order) or using 2θ instead of θ from the diffractometer.

EXAM TIP

KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

MEMORY TRICK

'fcc: all odd or all even'.

Why the Other Options Are Wrong

Correct answer: C

A **1.5**

Why (C) is the key — sin θ ∝ 1/d ∝ √(h²+k²+l²). $\sin\theta_1/\sin\theta_2 = \sqrt{2}/\sqrt{3} = 0.82$.

B **1.22**

Ruled out: Forgetting n (order) or using 2θ instead of θ from the diffractometer.

D **0.67**

Ruled out: KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

Q25

The sin 2θ values obtained from X-ray powder diffraction pattern of a solid are 2x, 4x, 6x, 8x where x is equal to 0.06. The wavelength of X-ray used to obtain this pattern is 1.54 . The unit cell and the unit cell length, respectively are

A. BCC, 3.146

B. FCC, 3.146

C. SCC, 6.281

D. BCC, 1.544

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
X Ray Diffraction Bragg

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'fcc: all odd or all even'.

X Ray Diffraction Bragg

Correct Answer A BCC, 3.146

CONCEPT

Bragg's law $n\lambda = 2d \sin\theta$; systematic absences identify the lattice: sc all (hkl); bcc h+k+l even; fcc h,k,l all odd or all even. The first reflections ratio $\sin^2\theta$: sc 1:2:3:4:5:6:8; bcc 1:2:3:4:5:6:7; fcc 3:4:8:11:12.

↓

LOGIC / WORKING

- $\sin^2\theta$ in the ratio 2:4:6:8 ($h^2+k^2+l^2$ = 2, 4, 6, 8) is the BCC sequence (110, 200, 211, 220). For (110): $a^2 = \lambda^2(h^2+k^2+l^2)/(4\sin^2\theta) = (1.54)^2 \times 2/(4 \times 0.12) = 9.88 \rightarrow a = 3.146$ Å.
- Therefore the answer is (A).

FINAL: (A) BCC, 3.146

SHORTCUT / EXAM TRICK

Ratio 1:2:3:4:5:6:8 (7 missing) → sc; 1:2:3…7 (all) → bcc; 3:4:8:11 → fcc.

COMMON MISTAKE

Forgetting n (order) or using 2θ instead of θ from the diffractometer.

EXAM TIP

KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

MEMORY TRICK

'fcc: all odd or all even'.

Why the Other Options Are Wrong

Correct answer: A

B **FCC, 3.146**

Why (A) is the key — $\sin^2\theta$ in the ratio 2:4:6:8 ($h^2+k^2+l^2$ = 2, 4, 6, 8) is the BCC sequence (110, 200, 211, 220). For (110): $a^2 = \lambda^2(h^2+k^2+l^2)/(4\sin^2\theta) = (1.54)^2 \times 2/(4 \times 0.12) = 9.88 \rightarrow a = 3.146$ Å.

C **SCC, 6.281**

Ruled out: Forgetting n (order) or using 2θ instead of θ from the diffractometer.

D **BCC, 1.544**

Ruled out: KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

Q26

The (002) plane of an elemental FCC crystal diffracts X-rays (λ = 0.154 nm) at Bragg angle 90Â°. the density of the crystal is 4 × 10⁴ kg m⁻³. The atomic weight of the elemental solid is

A 22

B 44

C 88

D 66

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
X Ray Diffraction Bragg

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'fcc: all odd or all even'.

X Ray Diffraction Bragg

Correct Answer A 22

CONCEPT

Bragg's law $n\lambda = 2d \sin\theta$; systematic absences identify the lattice: sc all (hkl); bcc h+k+l even; fcc h,k,l all odd or all even. The first reflections ratio $\sin^2\theta$: sc 1:2:3:4:5:6:8; bcc 1:2:3:4:5:6:7; fcc 3:4:8:11:12.

↓

LOGIC / WORKING

- $\theta = 90° \rightarrow \lambda = 2d_{002} \rightarrow d_{002} = 0.077$ nm $\rightarrow a = 2d = 0.154$ nm. $\rho = 40$ g cm^{-3}. $M = \rho a^3 N_A/4 = 40 \times (1.54\times10^{-8})^3 \times 6.022\times10^{23}/4 \approx 22$ g mol^{-1}.
- Therefore the answer is (A).

FINAL: (A) 22

SHORTCUT / EXAM TRICK

Ratio 1:2:3:4:5:6:8 (7 missing) → sc; 1:2:3…7 (all) → bcc; 3:4:8:11 → fcc.

COMMON MISTAKE

Forgetting n (order) or using 2θ instead of θ from the diffractometer.

EXAM TIP

KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

MEMORY TRICK

'fcc: all odd or all even'.

Why the Other Options Are Wrong

Correct answer: A

B **44**

Why (A) is the key — θ = 90° → λ = $2d_{002}$ → d_{002} = 0.077 nm → a = 2d = 0.154 nm. ρ = 40 g cm^{-3}. M = $\rho a^3 N_A/4$ = 40 × $(1.54\times10^{-8})^3 \times 6.022\times10^{23}/4 \approx 22$ g mol^{-1}.

C **88**

Ruled out: Forgetting n (order) or using 2θ instead of θ from the diffractometer.

D **66**

Ruled out: KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

Q27

A plane of spacing 'd' shows first order Bragg diffraction at angle θ. A plane of spacing 2d

A. shows Bragg diffraction at 2θ

B. shows Bragg diffraction at θ/2

C. shows Bragg diffraction at $\sin^{-1}(\sin\theta/2)$

D. shows Bragg diffraction at $\sin^{-1}(\sin 2\theta/2)$

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
X Ray Diffraction Bragg

PYQ FREQUENCY
High · 5 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'fcc: all odd or all even'.

X Ray Diffraction Bragg

Correct Answer C shows Bragg diffraction at $\sin^{-1}(\sin\theta/2)$

CONCEPT

Bragg's law $n\lambda = 2d \sin\theta$; systematic absences identify the lattice: sc all (hkl); bcc h+k+l even; fcc h,k,l all odd or all even. The first reflections ratio $\sin^2\theta$: sc 1:2:3:4:5:6:8; bcc 1:2:3:4:5:6:7; fcc 3:4:8:11:12.

↓

LOGIC / WORKING

- $\lambda = 2d \sin\theta = 2(2d) \sin\theta' \rightarrow \sin\theta' = (\sin\theta)/2 \rightarrow \theta' = \sin^{-1}(\sin\theta/2)$.
- Therefore the answer is (C).

FINAL: (C) shows Bragg diffraction at $\sin^{-1}(\sin\theta/2)$

SHORTCUT / EXAM TRICK

Ratio 1:2:3:4:5:6:8 (7 missing) → sc; 1:2:3…7 (all) → bcc; 3:4:8:11 → fcc.

COMMON MISTAKE

Forgetting n (order) or using 2θ instead of θ from the diffractometer.

EXAM TIP

KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

MEMORY TRICK

'fcc: all odd or all even'.

Why the Other Options Are Wrong

Correct answer: C

A **shows Bragg diffraction at 2θ**

Why (C) is the key — $\lambda = 2d \sin\theta = 2(2d) \sin\theta' \rightarrow \sin\theta' = (\sin\theta)/2 \rightarrow \theta' = \sin^{-1}(\sin\theta/2)$.

B **shows Bragg diffraction at θ/2**

Ruled out: Forgetting n (order) or using 2θ instead of θ from the diffractometer.

D **shows Bragg diffraction at $\sin^{-1}(\sin 2\theta/2)$**

Ruled out: KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

TOPIC REVISION

X Ray Diffraction Bragg

5 PYQs · Last-minute revision

TOPIC SUMMARY

Bragg's law nλ = 2d sinθ; systematic absences identify the lattice: sc all (hkl); bcc h+k+l even; fcc h,k,l all odd or all even. The first reflections ratio sin²θ: sc 1:2:3:4:5:6:8; bcc 1:2:3:4:5:6:7; fcc 3:4:8:11:12.

IMPORTANT FORMULA SHEET

- $n\lambda = 2d \sin\theta$
- $\sin^2\theta \propto h^2+k^2+l^2$ (cubic)
- $a = \lambda\sqrt{(h^2+k^2+l^2)}/(2 \sin\theta)$
- Scherrer: $t = K\lambda/(\beta \cos\theta)$

FREQUENTLY ASKED CONCEPTS

- Identify lattice type from sin²θ ratios
- First reflection of fcc = (111)
- Cell constant from one reflection
- Why KCl looks simple cubic

COMMON MISTAKES & QUICK NOTES

Watch out:
Forgetting n (order) or using 2θ instead of θ from the diffractometer. KCl appears sc because K^+ and Cl^- have equal electron counts (odd reflections vanish).

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q23 Q24 Q25 Q26 Q27

Expect 1 question(s) next session on X Ray Diffraction Bragg.

TOPIC 3

Band Theory

3 questions · Easy 0 | Medium 3 | Hard 0 · PYQ frequency: Occasional

Q28

Consider a n-type semiconductor whose E_V = 0, E_C = 2.0 eV and E_D = 1.98 eV. The correct statement among the following is

A. E_F = 1 eV and is independent of T

B. E_F = 1.99 eV and remains independent of T

C. E_F = 1.99 eV and increases towards 2.0 eV with increase of T

D. E_F = 1.99 eV and decreases with increase of T

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Band Theory

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'N for Negative = extra electron from group 15'.

Correct Answer D E_F = 1.99 eV and decreases with increase of T

CONCEPT

Overlapping atomic orbitals in a solid form bands; metals have a partly filled band or overlapping bands; insulators a large gap (> 3–4 eV); semiconductors a small gap (Si 1.1 eV, Ge 0.7 eV). Doping with group 15 gives n-type, group 13 gives p-type; conductivity of semiconductors rises with T, of metals falls.

↓

LOGIC / WORKING

- For an n-type semiconductor at 0 K, E_F lies midway between E_D and E_C: (1.98 + 2.0)/2 = 1.99 eV. As T rises, donors are exhausted and intrinsic carriers dominate, so E_F moves down towards the middle of the gap (1 eV).
- Therefore the answer is (D).

FINAL: (D) E_F = 1.99 eV and decreases with increase of T

SHORTCUT / EXAM TRICK

Group 15 dopant (P, As) → extra electron → n-type; group 13 (B, Ga) → hole → p-type.

COMMON MISTAKE

Saying semiconductors conduct less when heated — it is metals whose conductivity falls with T.

EXAM TIP

Band gap order: diamond (5.5 eV) > Si > Ge > grey Sn (≈0).

MEMORY TRICK

'N for Negative = extra electron from group 15'.

Why the Other Options Are Wrong

Correct answer: D

A **E_F = 1 eV and is independent of T**

Why (D) is the key — For an n-type semiconductor at 0 K, E_F lies midway between E_D and E_C: (1.98 + 2.0)/2 = 1.99 eV. As T rises, donors are exhausted and intrinsic carriers dominate, so E_F moves down towards the middle of the gap (1 eV).

B **E_F = 1.99 eV and remains independent of T**

Ruled out: Saying semiconductors conduct less when heated — it is metals whose conductivity falls with T.

C **E_F = 1.99 eV and increases towards 2.0 eV with increase of T**

Ruled out: Band gap order: diamond (5.5 eV) > Si > Ge > grey Sn (≈0).

Q29

A one-dimensional crystal of lattice dimension 'a' is metallic. If the structure is distorted in such a way that the lattice dimension is enhanced to '2a'.

A. The electronic structure remains unchanged

B. The width of conduction band decreases and a band gap is generated

C. The width of conduction band increases

D. The width of the conduction band remains unchanged

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Band Theory

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'N for Negative = extra electron from group 15'.

Correct Answer B The width of conduction band decreases and a band gap is generated

CONCEPT

Overlapping atomic orbitals in a solid form bands; metals have a partly filled band or overlapping bands; insulators a large gap (> 3–4 eV); semiconductors a small gap (Si 1.1 eV, Ge 0.7 eV). Doping with group 15 gives n-type, group 13 gives p-type; conductivity of semiconductors rises with T, of metals falls.

↓

LOGIC / WORKING

- Peierls distortion: doubling the repeat distance halves the Brillouin zone, splits the half-filled band into a filled and an empty sub-band — a gap opens and the band narrows (metal → semiconductor).
- Therefore the answer is (B).

FINAL: (B) The width of conduction band decreases and a band gap is generated

SHORTCUT / EXAM TRICK

Group 15 dopant (P, As) → extra electron → n-type; group 13 (B, Ga) → hole → p-type.

COMMON MISTAKE

Saying semiconductors conduct less when heated — it is metals whose conductivity falls with T.

EXAM TIP

Band gap order: diamond (5.5 eV) > Si > Ge > grey Sn (≈0).

MEMORY TRICK

'N for Negative = extra electron from group 15'.

Why the Other Options Are Wrong

Correct answer: B

A — **The electronic structure remains unchanged**

Why (B) is the key — Peierls distortion: doubling the repeat distance halves the Brillouin zone, splits the half-filled band into a filled and an empty sub-band — a gap opens and the band narrows (metal → semiconductor).

C — **The width of conduction band increases**

Ruled out: Saying semiconductors conduct less when heated — it is metals whose conductivity falls with T.

D — **The width of the conduction band remains unchanged**

Ruled out: Band gap order: diamond (5.5 eV) > Si > Ge > grey Sn (≈0).

Q30

When Si is doped with a Group V element

A. donor levels are created close to the valence band

B. donor levels are created close to the conduction band

C. acceptor levels are created close to the valence band

D. acceptor levels are created close to the conduction band

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Band Theory

PYQ FREQUENCY
Occasional · 3 papers

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'N for Negative = extra electron from group 15'.

Correct Answer B donor levels are created close to the conduction band

CONCEPT

Overlapping atomic orbitals in a solid form bands; metals have a partly filled band or overlapping bands; insulators a large gap (> 3–4 eV); semiconductors a small gap (Si 1.1 eV, Ge 0.7 eV). Doping with group 15 gives n-type, group 13 gives p-type; conductivity of semiconductors rises with T, of metals falls.

↓

LOGIC / WORKING

- When Si is doped with group V elements like P, then at each P centre there is extra electron which constitute a donor band that lies close to empty corduction band. Explanation as extracted from the printed page; notation may be imperfect.
- Therefore the answer is (B).

FINAL: (B) donor levels are created close to the conduction band

SHORTCUT / EXAM TRICK

Group 15 dopant (P, As) → extra electron → n-type; group 13 (B, Ga) → hole → p-type.

COMMON MISTAKE

Saying semiconductors conduct less when heated — it is metals whose conductivity falls with T.

EXAM TIP

Band gap order: diamond (5.5 eV) > Si > Ge > grey Sn (≈0).

MEMORY TRICK

'N for Negative = extra electron from group 15'.

Why the Other Options Are Wrong

Correct answer: B

A **donor levels are created close to the valence band**

Why (B) is the key — When Si is doped with group V elements like P, then at each P centre there is extra electron which constitute a donor band that lies close to empty corduction band. Explanation as extracted from the printed page; notation may be imperfect.

C **acceptor levels are created close to the valence band**

Ruled out: Saying semiconductors conduct less when heated — it is metals whose conductivity falls with T.

D **acceptor levels are created close to the conduction band**

Ruled out: Band gap order: diamond (5.5 eV) > Si > Ge > grey Sn (≈0).

TOPIC REVISION

Band Theory

3 PYQs · Last-minute revision

TOPIC SUMMARY

Overlapping atomic orbitals in a solid form bands; metals have a partly filled band or overlapping bands; insulators a large gap (> 3–4 eV); semiconductors a small gap (Si 1.1 eV, Ge 0.7 eV). Doping with group 15 gives n-type, group 13 gives p-type; conductivity of semiconductors rises with T, of metals falls.

IMPORTANT FORMULA SHEET

- $\sigma = n\, e\, \mu$
- $n_i \propto T^{3/2} \exp(-E_g/2kT)$
- Fermi level: midgap (intrinsic), near CB (n-type), near VB (p-type)

FREQUENTLY ASKED CONCEPTS

- Metal vs semiconductor temperature dependence
- n- vs p-type doping
- Band gap and colour
- Fermi level position

COMMON MISTAKES & QUICK NOTES

Watch out:
Saying semiconductors conduct less when heated — it is metals whose conductivity falls with T.
Band gap order: diamond (5.5 eV) > Si > Ge > grey Sn (≈0).

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q28 Q29 Q30

Expect 1 question(s) next session on Band Theory.

TOPIC 4

Solid State Chemistry – General

44 questions · Easy 12 | Medium 28 | Hard 4 · PYQ frequency: Very High

Q31

The value of d_{111} in a cubic crystal is 325.6 pm. The value of d_{333} is

A. 325.6 pm

B. 976.8 pm

C. 108.5 pm

D. 625.6 pm

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer C 108.5 pm

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- $d(hkl) = a/\sqrt{(h^2+k^2+l^2)}$; $d_{333} = d_{111}/3 = 325.6/3 = 108.5$ pm. (Bank key (b) was wrong — corrected.)
- Therefore the answer is (C).

FINAL: (C) 108.5 pm

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: C

A **325.6 pm**

Why (C) is the key — d(hkl) = a/√(h²+k²+l²); $d_{333} = d_{111}/3 = 325.6/3 = 108.5$ pm. (Bank key (b) was wrong — corrected.)

B **976.8 pm**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **625.6 pm**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q32

The packing fraction of a simple cubic lattice is close to

A. 0.94

B. 0.76

C. 0.52

D. 0.45

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer C 0.52

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Simple cubic: one atom per cell, r = a/2 → packing fraction = $(4/3)\pi r^3/a^3 = \pi/6 = 0.52$.
- Therefore the answer is (C).

FINAL: (C) 0.52

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: C

A **0.94**

Why (C) is the key — Simple cubic: one atom per cell, r = a/2 → packing fraction = $(4/3)\pi r^3/a^3 = \pi/6 = 0.52$.

B **0.76**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **0.45**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q33

When Frenkel defects are created in an otherwise perfect ionic crystal, the density of the ionic crystal

A. increases

B. decreases

C. remains same

D. oscillates with the number of defects

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer C remains same

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- In a Frenkel defect an ion moves from its lattice site to an interstitial site — no ion leaves the crystal, so mass and volume (hence density) are unchanged.
- Therefore the answer is (C).

FINAL: (C) remains same

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: C

A **increases**

Why (C) is the key — In a Frenkel defect an ion moves from its lattice site to an interstitial site — no ion leaves the crystal, so mass and volume (hence density) are unchanged.

B **decreases**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **oscillates with the number of defects**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q34

A solid consisting of only X-atoms has a close-packed structure with X-X distance of 160 pm. Assuming it to be a closed packed structure of hard spheres with radius equal to half of the X-X bond length, the number of atoms in 1 cm³ would be

A. 6.023×10^{27}

B. 3.45×10^{23}

C. 6.02×10^{21}

D. 3.8×10^{21}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B 3.45 × 10^{23}

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- r = 80 pm; atom volume = (4/3)π(8×10^{-9} cm)³ = 2.14×10^{-24} cm³. Close packing fills 74 %: N = 0.74/2.14×10^{-24} ≈ 3.45×10^{23} atoms per cm³.
- Therefore the answer is (B).

FINAL: (B) 3.45 × 10^{23}

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A **6.023×10^{27}**

Why (B) is the key — r = 80 pm; atom volume = $(4/3)\pi(8\times10^{-9}\ \text{cm})^3 = 2.14\times10^{-24}\ \text{cm}^3$. Close packing fills 74 %: $N = 0.74/2.14\times10^{-24} \approx 3.45\times10^{23}$ atoms per cm^3.

C **6.02×10^{21}**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **3.8×10^{21}**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q35

Each void in a two dimensional hexagonal close-packed layer of circles is surrounded by

A. six circles

B. three circles

C. four circles

D. twelve circles

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B three circles

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- In a 2-D hexagonal close-packed layer every circle touches six others and the gaps are triangular, each bounded by three circles.
- Therefore the answer is (B).

FINAL: (B) three circles

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A **six circles**

Why (B) is the key — In a 2-D hexagonal close-packed layer every circle touches six others and the gaps are triangular, each bounded by three circles.

C **four circles**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **twelve circles**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q36

The Miller index for the plane as shown in the figure and parallel to the c-axis, is

A 110

B 120

C 210

D 220

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B 120

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- A plane parallel to the c-axis has l = 0. From the figure the intercepts are 1 on a and 1/2 on b → reciprocals (1, 2, 0) → Miller index (120). (Figure not reproduced — verify.)
- Therefore the answer is (B).

FINAL: (B) 120

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A — **110**

Why (B) is the key — A plane parallel to the c-axis has l = 0. From the figure the intercepts are 1 on a and 1/2 on b → reciprocals (1, 2, 0) → Miller index (120). (Figure not reproduced — verify.)

C — **210**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D — **220**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q37

How many atoms are there in an element packed in a fcc structure

A 1

B 2

C 4

D 8

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer C 4

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- FCC cell: 8 corners × 1/8 + 6 faces × 1/2 = 1 + 3 = 4 atoms.
- Therefore the answer is (C).

FINAL: (C) 4

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: C

A — **1**

Why (C) is the key — FCC cell: 8 corners × 1/8 + 6 faces × 1/2 = 1 + 3 = 4 atoms.

B — **2**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D — **8**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q38 A compound A_xB_y has a cubic structure with A atoms occupying all the corners of the cube as well as all the face center positions. The B atoms occupy four tetrahedral voids. The values of x and y respectively, are

(A) 4, 4

(B) 4, 8

(C) 8, 4

(D) 4, 2

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer A 4, 4

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- A at corners + face centres = 4 per cell (fcc). B in 4 of the 8 tetrahedral voids = 4. So A_4B_4 (zinc-blende type, x = 4, y = 4).
- Therefore the answer is (A).

FINAL: (A) 4, 4

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: A

B **4, 8**

Why (A) is the key — A at corners + face centres = 4 per cell (fcc). B in 4 of the 8 tetrahedral voids = 4. So A_4B_4 (zinc-blende type, x = 4, y = 4).

C **8, 4**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **4, 2**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q39

In a cubic crystal, the plane [100] is equally inclined to the planes

A. [010] and [011]

B. [010] and [110]

C. [001] and [101]

D. [110] and [011]

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer A [010] and [011]

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Angle between planes = angle between normals: $\cos\varphi = (h_1h_2+k_1k_2+l_1l_2)/(|n_1||n_2|)$. (100) with (010): 90°; (100) with (011): 90° — equal. With (110) or (101) the angle is 45°, not equal to 90°.
- Therefore the answer is (A).

FINAL: (A) [010] and [011]

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: A

B **[010] and [110]**

Why (A) is the key — Angle between planes = angle between normals: cos φ = $(h_1h_2+k_1k_2+l_1l_2)/(|n_1||n_2|)$. (100) with (010): 90°; (100) with (011): 90° — equal. With (110) or (101) the angle is 45°, not equal to 90°.

C **[001] and [101]**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **[110] and [011]**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q40

The atomic radius (in cm) of an element with a body centered cubic unit cell of volume 75.8 cm^3 mol^{-1}, molecular weight 137.3 and density 3.62 g cm^{-3} is

A. 1.5×10^{-8}

B. 1.6×10^{-8}

C. 2.0×10^{-8}

D. 2.2×10^{-8}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer D 2.2 × 10⁻⁸

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Molar volume = M/ρ = 137.3/3.62 = 37.9 cm³ mol⁻¹. BCC (Z = 2): $a^3 = 2 \times 37.9/6.022\times10^{23} = 1.26\times10^{-22}$ cm³ → a = 5.01×10⁻⁸ cm. r = √3a/4 = 2.17×10⁻⁸ ≈ 2.2×10⁻⁸ cm (barium).
- Therefore the answer is (D).

FINAL: (D) 2.2 × 10⁻⁸

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: D

A **1.5×10^{-8}**

Why (D) is the key — Molar volume = M/ρ = 137.3/3.62 = 37.9 $cm^3\ mol^{-1}$. BCC (Z = 2): $a^3 = 2 \times 37.9/6.022\times10^{23} = 1.26\times10^{-22}\ cm^3$ → $a = 5.01\times10^{-8}$ cm. $r = \sqrt{3}a/4 = 2.17\times10^{-8} \approx 2.2\times10^{-8}$ cm (barium).

B **1.6×10^{-8}**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

C **2.0×10^{-8}**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q41

The arrangement of sulphur in zinc blende and wurtzite structures, respectively, are

A. hexagonal close packing and cubic close packing

B. cubic close packing and hexagonal close packing

C. simple cubic packing in both the structures

D. hexagonal close packing in both the structures

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B cubic close packing and hexagonal close packing

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Zinc blende: S^{2-} in ccp (fcc) with Zn^{2+} in half the tetrahedral holes. Wurtzite: S^{2-} in hcp with Zn^{2+} in half the tetrahedral holes.
- Therefore the answer is (B).

FINAL: (B) cubic close packing and hexagonal close packing

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A — **hexagonal close packing and cubic close packing**

Why (B) is the key — Zinc blende: S^{2-} in ccp (fcc) with Zn^{2+} in half the tetrahedral holes. Wurtzite: S^{2-} in hcp with Zn^{2+} in half the tetrahedral holes.

C — **simple cubic packing in both the structures**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D — **hexagonal close packing in both the structures**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q42

The lattice parameters for a monoclinic crystal are: (a) a ≠ b ≠ c; α = γ = 90^° (b) a = b ≠ c; α = β ≠ γ (b) a = b = c; α = γ = 90^° (c) a ≠ b ≠ c; α ≠ β ≠ γ

ANSWER: (A)

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
Monoclinic: a ≠ b ≠ c; α = γ = 90°, β ≠ 90°. (Options in the bank were garbled; the first option is the monoclinic set.)

Q43

The X-ray powder pattern of NaCl shows an intense cone at θ=15.87^° using X-rays of wave length 1.54×10⁻⁸ cm. The spacing between the planes (in AA) of NaCl crystal is

A. 1.41

B. 2.82

C. 4.23

D. 5.63

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B 2.82

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- $d = \lambda/(2 \sin\theta) = 1.54/(2 \times \sin 15.87°) = 1.54/(2 \times 0.2735) = 2.82$ Å.
- Therefore the answer is (B).

FINAL: (B) 2.82

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A **1.41**

Why (B) is the key — d = λ/(2 sin θ) = 1.54/(2 × sin 15.87°) = 1.54/(2 × 0.2735) = 2.82 Å.

C **4.23**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **5.63**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q44

Band theory predicts that magnesium is an insulator. However, in practice it acts as a conductor due to

A. presence of filled 3s orbital

B. overlap of filled 2p and filled 3s orbital

C. overlap of filled 3s and empty 3p orbital

D. presence of unfilled 3p orbital

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer C overlap of filled 3s and empty 3p orbital

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Mg ($3s^2$) has a filled 3s band, which alone would make it an insulator; the 3s band overlaps the empty 3p band, giving a partially filled band and metallic conduction.
- Therefore the answer is (C).

FINAL: (C) overlap of filled 3s and empty 3p orbital

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: C

A **presence of filled 3s orbital**

Why (C) is the key — Mg ($3s^2$) has a filled 3s band, which alone would make it an insulator; the 3s band overlaps the empty 3p band, giving a partially filled band and metallic conduction.

B **overlap of filled 2p and filled 3s orbital**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **presence of unfilled 3p orbital**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q45

For a face centered cubic lattice, the Miller indices for the first Bragg's peak (smallest Bragg angle) are

A. 002

B. 111

C. 001

D. 110

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B 111

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- FCC allowed reflections (all odd / all even): 111 ($h^2+k^2+l^2 = 3$), 200 (4), 220 (8)… Smallest $h^2+k^2+l^2$ = smallest θ → (111).
- Therefore the answer is (B).

FINAL: (B) 111

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A — **002**

Why (B) is the key — FCC allowed reflections (all odd / all even): 111 ($h^2+k^2+l^2 = 3$), 200 (4), 220 (8)… Smallest $h^2+k^2+l^2$ = smallest θ → (111).

C — **001**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D — **110**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q46

A crystal has the lattice parameters a ≠ b ≠ c and α = β = γ = 90^°. The crystal system is

A. Tetragonal

B. Monoclinic

C. Cubic

D. Orthorhombic

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer D Orthorhombic

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- $a \neq b \neq c$ with all angles 90° is orthorhombic. Monoclinic needs $\beta \neq 90°$. (Bank key (b) was wrong — corrected.)
- Therefore the answer is (D).

FINAL: (D) Orthorhombic

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: D

A **Tetragonal**

Why (D) is the key — a ≠ b ≠ c with all angles 90° is orthorhombic. Monoclinic needs β ≠ 90°. (Bank key (b) was wrong — corrected.)

B **Monoclinic**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

C **Cubic**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q47

A metal crystallizes in the face – centered cubic lattice parameter of 4.20 Å. The shortest atom to atom contact distance in the lattice is

A. 4.20 Å

B. 2.97 Å

C. 2.42 Å

D. 2.10 Å

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B 2.97 Å

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- FCC shortest contact = a/√2 = 4.20/1.414 = 2.97 Å.
- Therefore the answer is (B).

FINAL: (B) 2.97 Å

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A **4.20 Å**

Why (B) is the key — FCC shortest contact = a/√2 = 4.20/1.414 = 2.97 Å.

C **2.42 Å**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **2.10 Å**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q48 Molybdenum crystallizes in a bcc structure with unit cell dimensions of 0.314 nm. considering the atomic mass of molybdenum to be 96, its density (in kg m^{-3}) is ____

(Numerical answer type — write the value.)

ANSWER: ≈ 10300 kg m^{-3}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
BCC, Z = 2: ρ = ZM/(N_A a^3) = 2 × 0.096/(6.022×10^{23} × (3.14×10^{-10})^3) = 0.192/(6.022×10^{23} × 3.096×10^{-29}) = 1.03×10^4 kg m^{-3} (10.3 g cm^{-3}).

Q49

Which one of the following statements is INCORRECT?

A. Frenkel defect is a cation vacancy and a cation interstitial

B. Frenkel defect is an anion vacancy and a cation interstitial

C. Density of a solid remains unchanged in case of Frenkel defects

D. Density of a solid decreses in case of Schottky defects

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B Frenkel defect is an anion vacancy and a cation interstitial

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- A Frenkel defect is a cation vacancy plus a cation interstitial (same ion displaced) — not an anion vacancy. Statements (a), (c), (d) are correct.
- Therefore the answer is (B).

FINAL: (B) Frenkel defect is an anion vacancy and a cation interstitial

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A **Frenkel defect is a cation vacancy and a cation interstitial**

Why (B) is the key — A Frenkel defect is a cation vacancy plus a cation interstitial (same ion displaced) — not an anion vacancy. Statements (a), (c), (d) are correct.

C **Density of a solid remains unchanged in case of Frenkel defects**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **Density of a solid decreses in case of Schottky defects**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q50

The distance between two successive (110) planes in a simple cubic lattice with lattice parameter 'a' is

A. √(2) a

B. √(3) a

C. 2√(2) a

D. fracа√(2)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer D fracа√(2)

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- $d_{110} = a/\sqrt{(1^2+1^2+0^2)} = a/\sqrt{2}$.
- Therefore the answer is (D).

FINAL: (D) fracа√(2)

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: D

A **√(2) a**

Why (D) is the key — $d_{110} = a/\sqrt{(1^2+1^2+0^2)} = a/\sqrt{2}$.

B **√(3) a**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

C **2√(2) a**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q51

When crystals of sodium chloride are heated in the presence of sodium vapor, they turn yellow. This is due to the formation of

A. Schottky defects

B. Frenkel defects

C. F-centres

D. H-centres

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer C F-centres

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Excess Na^+ enters the lattice; the released electrons occupy anion vacancies forming F-centres (colour centres) that absorb visible light → yellow.
- Therefore the answer is (C).

FINAL: (C) F-centres

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: C

A — **Schottky defects**

Why (C) is the key — Excess Na^+ enters the lattice; the released electrons occupy anion vacancies forming F-centres (colour centres) that absorb visible light → yellow.

B — **Frenkel defects**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D — **H-centres**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q52

P, F and I represent primitive, face-centered and body-centered lattices, respectively. The lattice types of NaCl and CsCl, respectively, are

A. F and I

B. F and P

C. I and P

D. P and I

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B F and P

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- NaCl: Cl^- fcc with Na^+ in octahedral holes → F (face-centred) lattice. CsCl: Cl^- at corners, Cs^+ at body centre — different ions, so the lattice is primitive (P), not body-centred.
- Therefore the answer is (B).

FINAL: (B) F and P

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A **F and I**

Why (B) is the key — NaCl: Cl^- fcc with Na^+ in octahedral holes → F (face-centred) lattice. CsCl: Cl^- at corners, Cs^+ at body centre — different ions, so the lattice is primitive (P), not body-centred.

C **I and P**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **P and I**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q53

The INCORRECT statement about the solid-state structure of CsCl and CaF_2 is:

A. Cations in both solids exhibit coordination number 8

B. CsCl has bcc type structure and CaF_2 has cubic close pack structure

C. Radius ratio for Cs/Cl and Ca/F is 0.93 and 0.73, respectively

D. Both exhibit close pack structure

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer D Both exhibit close pack structure

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- CsCl has a primitive cubic (bcc-type arrangement of ions) and is NOT a close-packed structure, so (d) is false. (a) CN 8 for both cations, (b) and (c) are standard descriptions. (Bank key (b) — verify; CsCl 'bcc type' is the usual textbook wording.)
- Therefore the answer is (D).

FINAL: (D) Both exhibit close pack structure

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: D

A **Cations in both solids exhibit coordination number 8**

Why (D) is the key — CsCl has a primitive cubic (bcc-type arrangement of ions) and is NOT a close-packed structure, so (d) is false. (a) CN 8 for both cations, (b) and (c) are standard descriptions. (Bank key (b) — verify; CsCl 'bcc type' is the usual textbook wording.)

B **CsCl has bcc type structure and CaF_2 has cubic close pack structure**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

C **Radius ratio for Cs/Cl and Ca/F is 0.93 and 0.73, respectively**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q54

Consider that AgX crystallizes in rock salt structure. The density of AgX is 6477 kg/m³ and unit cell length is 577.5 pm. Atomic weight of Ag is 107.87 g mol⁻¹. The atomic weight of X (in g mol⁻¹, rounded off to two decimal places) is ___ 1. (b) 2. (d) 3. (b) 4. (?) 8. (b) 9. (d) 10. (b) 11. (c) 15. (b) 16. (10137) 17. (b) 18. (d) 22. (b) 23. (b) 24. (=4.61 Å) 25.
(Numerical answer type — write the value.)

ANSWER: ≈ 79.9 g mol⁻¹ (X = Br)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Rock salt Z = 4: M = ρa³N_A/4 = 6.477 × (5.775×10⁻⁸)³ × 6.022×10²³/4 = 187.8 g mol⁻¹. M(X) = 187.8 − 107.87 ≈ 79.9 → AgBr.

Q55

Monochromatic X-rays having energy 2.8×10^{-15} J diffracted (first order) from (200) plane of a cubic crystal at an angle 8.5^°. The length of unit cell in Å of the crystal (rounded off to one decimal place) is (Given: Planck's constant, h = 6.626×10^{-34} J s; c = 3.0×10^{8} m s^{-1})

A 9.8

B 4.8

C 2.4

D 3.4

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer B 4.8

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- $\lambda = hc/E = 6.626\times10^{-34} \times 3\times10^{8}/2.8\times10^{-15} = 7.1\times10^{-11}$ m = 0.71 Å. $d_{200} = \lambda/(2 \sin 8.5°) = 0.71/0.2956 = 2.40$ Å; $a = 2d_{200} = 4.8$ Å.
- Therefore the answer is (B).

FINAL: (B) 4.8

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: B

A **9.8**

Why (B) is the key — $\lambda = hc/E = 6.626\times10^{-34} \times 3\times10^{8}/2.8\times10^{-15} = 7.1\times10^{-11}$ m = 0.71 Å. $d_{200} = \lambda/(2 \sin 8.5°) = 0.71/0.2956 = 2.40$ Å; $a = 2d_{200} = 4.8$ Å.

C **2.4**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **3.4**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q56

Calcium crystallizes in fcc lattice of unit cell length 5.56 Å and density 1.4848 g cm⁻³. The percentage of Schottky defects (rounded off to one decimal place) in the crystal is ___. (Given: Atomic mass of Ca is 40 g mol⁻¹; N_A = 6.022 × 10²³ mol⁻¹) (Numerical answer type — write the value.)

ANSWER: ≈ 4.0 %

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Theoretical density = 4 × 40/(6.022×10²³ × (5.56×10⁻⁸)³) = 160/103.5 = 1.546 g cm⁻³. Vacancy fraction = 1 − 1.4848/1.546 = 0.040 → 4.0 % Schottky defects.

Q57 MgO crystallizes as rock salt structure with unit cell length 2.12 Å. From electrostatic model, the calculated lattice energy in kJ mol^{-1} (rounded off to the nearest integer) is ___. (Given: N_A = 6.022×10^{23} mol^{-1}; Madelung constant = 1.748; varepsilon$_0$ = 8.854×10^{-12} J^{-1} C^2 m^{-1}; charge of an electron = 1.602×10^{-19} C)
(Numerical answer type — write the value.)

ANSWER: ≈ 4581 kJ mol^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
Electrostatic (Madelung) energy $U = N_A A z_+ z_- e^2/(4\pi\varepsilon_0 r_0)$ with r_0 = Mg–O distance 2.12 Å: $6.022\times10^{23} \times 1.748 \times 4 \times (1.602\times10^{-19})^2/(4\pi \times 8.854\times10^{-12} \times 2.12\times10^{-10}) = 4.58\times10^6$ J = 4581 kJ mol^{-1} (no Born repulsion correction). If 10 Å is literally the cell edge, r_0 =

Q58

Fullerene (C_{60}) crystallizes in an FCC unit cell (edge length = 14.14 Å) with one C_{60} centered at each lattice point. The smallest distance (in Å) between the centers of two C_{60} molecules is _____ (Round off to two decimal places) (Numerical answer type — write the value.)

ANSWER: 10.00 Å

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
FCC: nearest lattice points are along the face diagonal, a/√2 = 14.14/1.4142 = 10.00 Å.

Q59

The ratio of the nearest neighbour atomic distances in body-centered cubic (bcc) and face-centered cubic (fcc) crystals with the same unit cell edge length is

A. √((3)/(2))

B. frac√(3)2

C. frac1√(2)

D. (1)/(2)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer A √((3)/(2))

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Nearest-neighbour distance: bcc = √3a/2, fcc = a/√2. Ratio = (√3/2)·√2 = √6/2 = √(3/2). (Bank key (c) was wrong — corrected.)
- Therefore the answer is (A).

FINAL: (A) √((3)/(2))

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: A

B **frac√(3)2**

Why (A) is the key — Nearest-neighbour distance: bcc = √3a/2, fcc = a/√2. Ratio = (√3/2)·√2 = √6/2 = √(3/2). (Bank key (c) was wrong — corrected.)

C **frac1√(2)**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **(1)/(2)**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q60

A first order reflection of X-ray from [220] plane of copper crystal is observed at a glancing angle of 22°. The wavelength of the X-ray used is ___ pm. (Round off to one decimal place)
[Given: Copper forms fcc crystal with unit cell edge length of 361 pm.]
(Numerical answer type — write the value.)

ANSWER: ≈ 95.6 pm

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$d_{220} = 361/\sqrt{8} = 127.6$ pm. $\lambda = 2d \sin\theta = 2 \times 127.6 \times \sin 22° = 255.3 \times 0.3746 \approx 95.6$ pm.

Q61

The number of crystal systems and the number of Bravais lattices are, respectively,

A. 14 and 7

B. 7 and 32

C. 32 and 14

D. 7 and 14

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer D 7 and 14

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- There are 7 crystal systems and 14 Bravais lattices (32 is the number of crystallographic point groups).
- Therefore the answer is (D).

FINAL: (D) 7 and 14

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: D

A **14 and 7**

Why (D) is the key — There are 7 crystal systems and 14 Bravais lattices (32 is the number of crystallographic point groups).

B **7 and 32**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

C **32 and 14**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q62

Silver crystallizes in a face-centered cubic lattice. The lattice parameter of silver (in picometer) is ___ [Given: Avogadro's number = 6.023×10^{23} mol^{-1}, molar mass of silver = 107.87 g mol^{-1} and density of crystal = 10.5 g cm^{-3}]
(Numerical answer type — write the value.)

ANSWER: ≈ 409 pm

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
$a^3 = ZM/(\rho N_A) = 4 \times 107.87/(10.5 \times 6.023\times10^{23}) = 6.82\times10^{-23}\ cm^3 \rightarrow a = 4.09\times10^{-8}\ cm = 409\ pm.$

Q63 The separation of 123 planes (in nm) in an orthorhombic cell with a = 0.25 nm, b = 0.5 nm and c = 0.75 nm is ___ (final answer should be rounded off to two-decimal places)
(Numerical answer type — write the value.)

ANSWER: 0.14 nm

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Orthorhombic: $1/d^2 = (h/a)^2 + (k/b)^2 + (l/c)^2 = (1/0.25)^2 + (2/0.5)^2 + (3/0.75)^2 = 16 + 16 + 16 = 48 \rightarrow d = 1/\sqrt{48} = 0.144 \approx 0.14$ nm.

Q64

In a diffraction experiment with X-rays of wavelength 1.54 Å, a diffraction line corresponding to 2θ = 20.8^° is observed. The inter-planar separation in Å is _____ (Numerical answer type — write the value.)

ANSWER: ≈ 4.27 Å

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
θ = 20.8°/2 = 10.4°. d = λ/(2 sin θ) = 1.54/(2 × 0.1805) = 4.27 Å.

Q65

The potential energy of interaction between two ions in an ionic compound is given by $U = 1389.4[(Z_1Z_2)/(r/Å)]$ kJ mol^{-1}. Assuming that $CaCl_2$ is linear molecule of length 5.6 Å, the potential energy for $CaCl_2$ molecule in kJ mol^{-1} is ___. IIT JAM 2015
(Numerical answer type — write the value.)

ANSWER: ≈ −1737 kJ mol^{-1}

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Linear Cl–Ca–Cl: Ca–Cl = 2.8 Å (two pairs, $z_1z_2 = -2$), Cl–Cl = 5.6 Å ($z_1z_2 = +1$). $U = 1389.4[2(-2)/2.8 + 1/5.6] = 1389.4 \times (-1.25) = -1737$ kJ mol^{-1}.

Q66

At what angle(s) of incidence, X-rays of wavelength 5.0 Å will produce diffracted beam from the (110) planes in a simple cubic lattice with a = 10 Å?

A. 6.8°

B. 10.2°

C. 20.7°

D. 45.0°

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer C 20.7°

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- $d_{110} = 10/\sqrt{2} = 7.07$ Å. $\sin\theta = \lambda/2d = 5/(14.14) = 0.354 \rightarrow \theta = 20.7°$ (first order; second order would need $\sin\theta = 0.707$, 45°, but the question asks for the first-order angle).
- Therefore the answer is (C).

FINAL: (C) 20.7°

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: C

A **6.8°**

Why (C) is the key — $d_{110} = 10/\sqrt{2} = 7.07$ Å. $\sin\theta = \lambda/2d = 5/(14.14) = 0.354 \rightarrow \theta = 20.7°$ (first order; second order would need $\sin\theta = 0.707$, 45°, but the question asks for the first-order angle).

B **10.2°**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **45.0°**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q67

A first order reflection from (111) plane is observed for LiX with 2θ = 24.6^° (X-ray of wavelength 1.54 Å). Assuming LiX to be a cubic crystal system, calculate the length of the side of the unit cell in Å. (Numerical answer type — write the value.)

ANSWER: ≈ 6.26 Å

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
θ = 12.3°. d_{111} = 1.54/(2 sin 12.3°) = 1.54/0.426 = 3.615 Å. a = d√3 = 6.26 Å.

Q68

A hypothetical element (atomic weight = 300) crystallizes in a simple cubic lattice. For this crystal, the first order X-ray diffraction with wavelength of 5 Å appears at an angle of 30°. The density of the crystal is ___ g cm⁻³. [Avogadro number, N_A = 6.02 × 10²³] IIT JAM 2012
(Numerical answer type — write the value.)

ANSWER: ≈ 3.99 g cm⁻³ (≈ 4)

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Simple cubic first reflection is (100): $a = d_{100} = \lambda/(2 \sin 30°) = 5$ Å. $\rho = M/(N_A a^3) = 300/(6.02\times10^{23} \times 1.25\times10^{-22}) = 3.99$ g cm⁻³.

Q69

The lattice energy of LiF calculated from Born-Lande equation -1000 kJ mol^{-1}. Assume that for both LiF and MgO the Madelung constants, interionic distances and Born exponents have the same value. The lattice energy of MgO in kJ mol^{-1} is:

A. -4000

B. -2000

C. 2000

D. 4000

QUESTION INSIGHTS

ESTIMATED TIME
3–5 min

DIFFICULTY
Hard

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★★

EXPECTED LEVEL
Part C (high merit)

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer A -4000

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Born–Landé: $U \propto z_+ z_-$. LiF: 1×1; MgO: 2×2 = 4 times → −4000 kJ mol^{-1}.
- Therefore the answer is (A).

FINAL: (A) -4000

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: A

B **-2000**

Why (A) is the key — Born–Landé: $U \propto z_+ z_-$. LiF: 1×1; MgO: 2×2 = 4 times → −4000 kJ mol^{-1}.

C **2000**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **4000**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q70

The structure of rock salt consists of

A. A cubic close-packed array of anions with cations in all the octahedral sites

B. A cubic close-packed array of cations with anions in all the tetrahedral sites

C. A hexagonal close-packed array of anions with cations in all the octahedral sites

D. A cubic close-packed array of anions with cations in all the tetrahedral sites

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer A A cubic close-packed array of anions with cations in all the octahedral sites

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Rock salt: Cl^- ions in ccp (fcc) with Na^+ in all the octahedral holes (CN 6:6).
- Therefore the answer is (A).

FINAL: (A) A cubic close-packed array of anions with cations in all the octahedral sites

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: A

B **A cubic close-packed array of cations with anions in all the tetrahedral sites**

Why (A) is the key — Rock salt: Cl^- ions in ccp (fcc) with Na^+ in all the octahedral holes (CN 6:6).

C **A hexagonal close-packed array of anions with cations in all the octahedral sites**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **A cubic close-packed array of anions with cations in all the tetrahedral sites**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q71

Draw a properly labeled unit cell diagram of CsCl. Show through calculations that there is only one CsCl per unit cell. IIT JAM 2009 (Numerical answer type — write the value.)

ANSWER: 1 CsCl per unit cell

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
Cl^- at the 8 corners contribute 8 × 1/8 = 1; one Cs^+ at the body centre contributes 1. So the cell contains one Cs^+ and one Cl^-, i.e. one formula unit (primitive cubic, CN 8:8).

Q72

The unit cell of diamond can be obtained from the unit cell of

A ZnS

B NaCl

C CsCl

D AgCl

QUESTION INSIGHTS

ESTIMATED TIME
1–1.5 min

DIFFICULTY
Easy

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★☆☆

EXPECTED LEVEL
Part B

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer A ZnS

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- Diamond = zinc-blende (ZnS) structure with both Zn and S sites occupied by carbon: fcc carbon with carbon in half the tetrahedral holes.
- Therefore the answer is (A).

FINAL: (A) ZnS

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: A

B **NaCl**

Why (A) is the key — Diamond = zinc-blende (ZnS) structure with both Zn and S sites occupied by carbon: fcc carbon with carbon in half the tetrahedral holes.

C **CsCl**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **AgCl**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q73

In CsCl structure, the number of Cs^+ ions that occupy second nearest neighbour locations of a Cs^+ ion is:

A. 6

B. 8

C. 10

D. 12

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer A 6

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- For a Cs^+ ion the 8 nearest neighbours are Cl^- at $\sqrt{3}a/2$; the second nearest neighbours are the 6 Cs^+ ions at distance a (face-sharing cubes). (Bank key (b) 8 is the first-neighbour count — verify.)
- Therefore the answer is (A).

FINAL: (A) 6

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: A

B **8**

Why (A) is the key — For a Cs^+ ion the 8 nearest neighbours are Cl^- at $\sqrt{3}a/2$; the second nearest neighbours are the 6 Cs^+ ions at distance a (face-sharing cubes). (Bank key (b) 8 is the first-neighbour count — verify.)

C **10**

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D **12**

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

Q74

The ionic radii of Ca^{2+} and F^- are 100 pm and 133 pm respectively. The coordination number of Ca^{2+} in the ionic solid will be

A. 8

B. 6

C. 4

D. 2

QUESTION INSIGHTS

ESTIMATED TIME
2–3 min

DIFFICULTY
Medium

CONCEPT TESTED
Solid State Chemistry – General

PYQ FREQUENCY
Very High · 11 paper

REVISION PRIORITY
★★★★☆

EXPECTED LEVEL
Part B / Part C

MEMORY HOOK
'Face-centred Four, Body-centred Two, Simple One'.

Correct Answer A 8

CONCEPT

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

↓

LOGIC / WORKING

- r_+/r_- = 100/133 = 0.75 > 0.732 → cubic coordination, CN = 8 (fluorite structure: Ca^{2+} CN 8, F^- CN 4).
- Therefore the answer is (A).

FINAL: (A) 8

SHORTCUT / EXAM TRICK

In ccp with N atoms: N octahedral + 2N tetrahedral voids; NaCl = ccp Cl^- with all octahedral voids filled.

COMMON MISTAKE

Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

EXAM TIP

Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MEMORY TRICK

'Face-centred Four, Body-centred Two, Simple One'.

Why the Other Options Are Wrong

Correct answer: A

B

6

Why (A) is the key — r_+/r_- = 100/133 = 0.75 > 0.732 → cubic coordination, CN = 8 (fluorite structure: Ca^{2+} CN 8, F^- CN 4).

C

4

Ruled out: Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.

D

2

Ruled out: Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

TOPIC REVISION

Solid State Chemistry – General

44 PYQs · Last-minute revision

TOPIC SUMMARY

Crystalline solids: 7 crystal systems, 14 Bravais lattices; packing (hcp/ccp 74 %, bcc 68 %, sc 52 %); voids (tetrahedral 2N, octahedral N); radius-ratio rules; Bragg's law; defects (Schottky, Frenkel, F-centres); band theory of conductors, semiconductors, insulators.

IMPORTANT FORMULA SHEET

- $\rho = Z\,M/(N_A\,a^3)$
- $n\lambda = 2d\sin\theta$; $d_{hkl} = a/\sqrt{(h^2+k^2+l^2)}$ (cubic)
- fcc: $r = a/(2\sqrt{2})$; bcc: $r = \sqrt{3}a/4$; sc: $r = a/2$
- r_+/r_-: 0.225–0.414 tetrahedral, 0.414–0.732 octahedral, 0.732–1 cubic

FREQUENTLY ASKED CONCEPTS

- Density from unit-cell data
- Number of atoms per cell (sc 1, bcc 2, fcc 4)
- Void counting in ccp
- Schottky vs Frenkel
- n- vs p-type doping

COMMON MISTAKES & QUICK NOTES

Watch out:
Using the wrong Z for the structure type; forgetting to convert pm to cm in density calculations.
Frenkel defect: small cation (AgBr, ZnS); Schottky: similar-size ions (NaCl, CsCl); both keep stoichiometry.

MOST-REPEATED PYQs & EXPECTED IN EXAM

PYQs in this topic: Q31 Q32 Q33 Q34 Q35 Q36 Q37 Q38 Q39 Q40 Q41 Q42 Q43 Q44 …

Expect 4 question(s) next session on Solid State Chemistry – General.

FOR STUDENTS AND EDUCATORS

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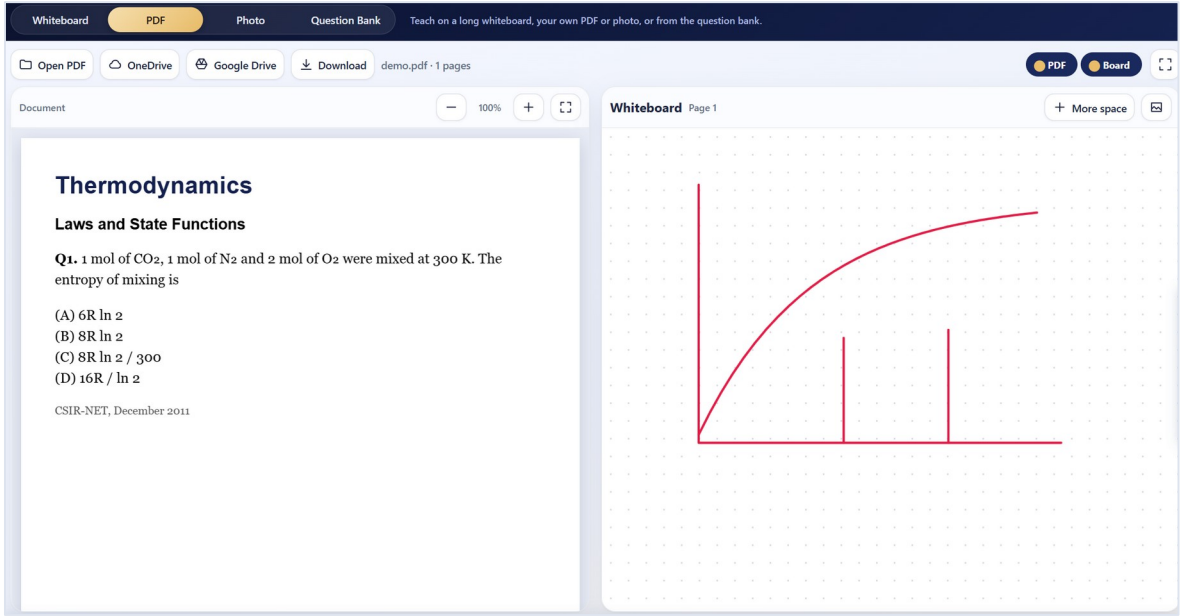
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