



Sharp Test Series — Sample Paper

Chapter Test

QUESTION PAPER CODE
SMPLTHY-2026-000113

MODEL ANSWERS & MARKING SCHEME

Total Questions 14	Subjects Chemistry	Maximum Marks 30	Time 1 Hour 30 Minutes
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For examiners

The model answer and the marking points for every question are given below. Award the same marks for a different but correct method — the marking points say what to check, not the exact words.

SECTION A — Multiple Choice Questions

[5]

Attempt **all** questions. Each question carries 1 mark.

Q.1 The number of atoms (z) per unit cell of a BODY-CENTRED cubic (bcc) lattice is

[1]

Answer: (C) 2

$8 \times \frac{1}{8}$ (corners) + 1 (body centre) = 2 atoms.

Q.2 The coordination number of each atom in a SIMPLE cubic structure is

[1]

Answer: (C) 6

A simple-cubic atom touches 6 neighbours - one along each axis direction.

Q.3 Sodium chloride is an example of

[1]

Answer: (B) an ionic solid

NaCl consists of Na^+ and Cl^- ions held by electrostatic attraction - an ionic crystal.

Q.4 The MOST efficient packing of identical spheres is achieved in the

[1]

Answer: (C) ccp (fcc) and hcp close-packed structures

Both ccp and hcp reach the maximum 74 percent packing efficiency with CN = 12.

Q.5 Diamond and quartz (SiO_2) are examples of

[1]

Answer: (A) covalent (network) solids

Their atoms are joined by a continuous three-dimensional network of covalent bonds.

SECTION B — Short Answer Questions

[8]

Attempt **all** questions. Each question carries 2 marks.

Q.6 What is an impurity defect? Explain it with the example of SrCl_2 added to NaCl . [2]

An impurity defect arises when a foreign ion of different charge replaces a host ion in an ionic crystal. When a small amount of SrCl_2 is added to molten NaCl and the mixture is crystallised, each Sr^{2+} ion replaces two Na^+ ions but occupies only one Na^+ site; the other site remains vacant to keep the crystal electrically neutral. Thus one cationic vacancy is created per Sr^{2+} ion, and the number of vacancies equals the number of Sr^{2+} ions added.

Marking scheme: Foreign ion of different charge replaces host ion — 1; Sr^{2+} replaces two Na^+ , occupies one site, one cationic vacancy per Sr^{2+} — 1

Q.7 Explain Frenkel defect with a suitable example. [2]

In a Frenkel defect the smaller ion (usually the cation) leaves its normal lattice site and occupies an interstitial site, creating a vacancy at the original site. It is a dislocation defect. Since no ion leaves the crystal, the density remains unchanged. It occurs in crystals where the cation is much smaller than the anion. Examples: ZnS , AgCl , AgBr , AgI .

Marking scheme: Displacement of smaller ion to interstitial site — 1; density unchanged + example — 1

Q.8 Give any two differences between Schottky defect and Frenkel defect. [2]

Schottky defect: (i) equal numbers of cations and anions are missing from the lattice; (ii) density of the crystal decreases; (iii) shown by crystals whose cation and anion are of similar size, e.g. NaCl , KCl , CsCl .

Frenkel defect: (i) an ion (usually the cation) shifts from its lattice site to an interstitial site; (ii) density remains unchanged; (iii) shown by crystals with a large difference in ion size, e.g. ZnS , AgCl , AgBr .

Marking scheme: Any two correct differences — 1 each

Q.9 Distinguish between crystalline and amorphous solids on any two points. [2]

Crystalline solids: (i) long-range, regular arrangement of particles; (ii) sharp melting point; (iii) anisotropic — properties differ with direction; (iv) true solids. Examples: NaCl , diamond, sugar.

Amorphous solids: (i) only short-range order; (ii) melt over a range of temperature; (iii) isotropic; (iv) pseudo-solids / supercooled liquids. Examples: glass, rubber, plastic.

Marking scheme: Any two correct points of difference — 1 each

SECTION C — Short Answer Questions

[9]

Attempt **all** questions. Each question carries 3 marks.

- Q.10** What are unit cell parameters? Using them, state the axial lengths and axial angles of the cubic, tetragonal and orthorhombic crystal systems. [3]

Unit cell parameters are the three axial lengths a , b , c along the three edges of the unit cell and the three axial angles α (between b and c), β (between a and c) and γ (between a and b). These six quantities fix the shape of the unit cell, and the seven possible combinations give the seven crystal systems.

Cubic: $a = b = c$ and $\alpha = \beta = \gamma = 90^\circ$

Tetragonal: $a = b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$

Orthorhombic: $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$

Marking scheme: Meaning of the six parameters a , b , c and α , β , γ — 1; cubic and tetragonal correct — 1; orthorhombic correct — 1

- Q.11** Aluminium crystallises in a face-centred cubic lattice. Its molar mass is 27 g mol^{-1} and its density is 2.7 g cm^{-3} . Calculate (a) the number of unit cells present in 1 g of aluminium and (b) the edge length of its unit cell. ($N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$) [3]

(a) Number of Al atoms in 1 g = (mass / molar mass) $\times N_A = (1 / 27) \times 6.022 \times 10^{23} = 2.230 \times 10^{22}$ atoms

For a face-centred cubic lattice, $z = 4$, i.e. each unit cell contains 4 atoms.

Number of unit cells = number of atoms / 4 = $2.230 \times 10^{22} / 4 = 5.576 \times 10^{21}$ unit cells

(b) From $\rho = z M / (a^3 N_A)$: $a^3 = z M / (\rho N_A) = (4 \times 27) / (2.7 \times 6.022 \times 10^{23}) = 6.642 \times 10^{-23} \text{ cm}^3$
 $a = (6.642 \times 10^{-23})^{1/3} = 4.050 \times 10^{-8} \text{ cm} = 405.0 \text{ pm}$

Marking scheme: (a) atoms in 1 g = 2.23×10^{22} and $z = 4$, giving 5.58×10^{21} unit cells — 1; (b) $a^3 = zM/(\rho N_A) = 6.64 \times 10^{-23} \text{ cm}^3$ — 1; $a = 405.0 \text{ pm}$ with unit — 1

- Q.12** Molecular solids are of three types. Name them, state the force that holds the molecules together in each, and give one example of each. [3]

1. Non-polar molecular solids: the molecules have no dipole moment and are held together only by weak London (dispersion) forces. e.g. solid H_2 , Cl_2 , I_2 , CO_2 .

2. Polar molecular solids: the molecules have a permanent dipole moment and are held by dipole-dipole forces, which are stronger than London forces. e.g. solid HCl , SO_2 , solid NH_3 .

3. Hydrogen-bonded molecular solids: the molecules contain H bonded to a highly electronegative atom (F, O or N) and are held by hydrogen bonds, the strongest of the three. e.g. ice (H_2O), solid HF .

Marking scheme: Non-polar — London forces + example — 1; polar — dipole-dipole + example — 1; hydrogen-bonded — hydrogen bonds + example — 1

SECTION D — Long Answer Questions

[8]

Attempt **all** questions. Each question carries 4 marks.

- Q.13** What is the origin of magnetism in solids? Classify solids on the basis of their magnetic properties and explain each type with one example. [4]

Origin: every electron is a tiny magnet because of its spin and its orbital motion around the nucleus. A paired electron's magnetic moment is cancelled by its partner with opposite spin; an unpaired electron gives the substance a net magnetic moment. So the magnetic behaviour of a solid depends on whether it has unpaired electrons and how their moments are aligned.

1. Diamagnetic solids: all electrons paired, so no net magnetic moment; weakly repelled by an external magnetic field. e.g. N_2 , H_2O , NaCl , benzene.
2. Paramagnetic solids: contain unpaired electrons whose moments are randomly oriented; weakly attracted by a magnetic field, and the moments align with it; the magnetism is lost as soon as the field is removed. e.g. O_2 , Cu^{2+} , Fe^{3+} , Cr^{3+} .
3. Ferromagnetic solids: unpaired electrons in small regions called domains; in a magnetic field all domains align in the same direction, so the solid is strongly attracted and stays magnetised even after the field is removed (permanent magnet). e.g. Fe , Co , Ni , CrO_2 .

Marking scheme: Origin — unpaired electron spin / orbital motion — 1; diamagnetic with example — 1; paramagnetic with example — 1; ferromagnetic (domains, permanent) with example — 1

- Q.14** Explain (a) Schottky defect and (b) metal-excess defect due to anionic vacancies. Mention the effect of each on the properties of the crystal. [4]

(a) Schottky defect: a stoichiometric vacancy defect in which an equal number of cations and anions are missing from their lattice sites, so electrical neutrality is maintained. It occurs in ionic crystals whose cation and anion are of nearly equal size and which have high coordination number, e.g. NaCl , KCl , CsCl , AgBr . Effect: the mass of the crystal decreases while its volume is unchanged, so the density decreases; the crystal shows slight electrical conductivity because ions can move into the vacancies.

(b) Metal-excess defect due to anionic vacancies: an anion is missing from its lattice site and the site is occupied by an electron to maintain neutrality. Such electron-filled anionic vacancies are called F-centres (from German Farbe = colour). It arises when an alkali-metal halide is heated in the vapour of the metal: excess metal atoms deposit on the surface, halide ions diffuse out to combine with them, and the electrons released occupy the vacancies. Effect: the crystal becomes coloured ($\text{NaCl} \rightarrow$ yellow, $\text{KCl} \rightarrow$ violet, $\text{LiCl} \rightarrow$ pink) and paramagnetic due to the unpaired electrons.

Marking scheme: Schottky: equal cation & anion missing, example — 1; effect: density decreases — 1; metal-excess: anion vacancy occupied by electron, F-centre, how formed — 1; effect: colour (example) / paramagnetism — 1