

Predicting molecular shape, bond angles and polarity

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

Marks are given for the correct shape or value and for the reason. Explanations must mention lone pairs, symmetry or electronegativity as appropriate. Accept equivalent wording and bond angles within about two degrees.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB S2.2

Question 1 Shape of beryllium chloride (2 marks)

The molecule is **linear** with an angle of **180°**.

Marking: 1 for the shape; 1 for the angle.

Question 2 Water compared with methane (3 marks)

Both have four electron domains in a tetrahedral arrangement. Water has two lone pairs and methane has none. Lone pairs repel more than bonding pairs, so the **bond angle in water is smaller**.

Marking: 1 for four domains; 1 for lone pairs in water; 1 for greater repulsion.

Question 3 A non-polar molecule with polar bonds (3 marks)

Each C-X bond is polar because X is more electronegative than C, so the dipole points toward X. The molecule is a symmetrical tetrahedron, so the four equal dipoles **cancel** and the net dipole is zero.

Marking: 1 for polar bonds (difference in electronegativity); 1 for symmetry; 1 for cancellation.

Question 4 Bond polarity (2 marks)

$C-H = 0.4$; $C-O = 3.4 - 2.6 = 0.8$; $C-F = 4.0 - 2.6 = 1.4$. Order of increasing polarity: **C-H < C-O < C-F**.

Marking: 1 for three correct differences; 1 for the order.

Question 5 Ammonium and ammonia (3 marks)

NH_4^+ has four bonding pairs and is **tetrahedral, 109.5°**. NH_3 has three bonding pairs and one lone pair: **trigonal pyramidal, about 107°**. The lone pair repels more strongly.

Marking: 1 for each shape with angle; 1 for the lone pair explanation.

Question 6 Sulfur dioxide polarity (2 marks)

It is **polar**. The S=O bonds are polar and, because the molecule is bent, the dipoles do not cancel.

Marking: 1 for polar; 1 for the shape reason.

Question 7 Hydrogen iodide (2 marks)

Difference = $2.7 - 2.2 = 0.5$. Iodine is more electronegative, so **hydrogen carries $\delta+$** .

Marking: 1 for the difference; 1 for $\delta+$ on H.

Question 8 Boron trifluoride and ammonia (3 marks)

BF₃ has three bonding pairs and no lone pairs, so it is trigonal planar and symmetrical, and the B-F dipoles cancel. NH₃ has a lone pair, so it is pyramidal and the N-H dipoles **do not cancel**.

Marking: 1 for the BF₃ shape; 1 for NH₃ shape or lone pair; 1 for cancellation contrast.