

Exercise walk-through

Shapes of organic molecules; σ and π bonds ■ 13.3

eXercise

You must be able to

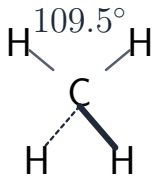
- describe organic molecules as straight-chained, branched or cyclic
- describe and explain the shape and bond angles at sp , sp^2 and sp^3 carbons
- describe the arrangement of σ and π bonds

Method — Hybridisation and shape

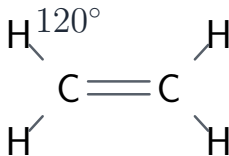
hybridisation	bonds	shape	angle
sp^3	4 single	tetrahedral	109.5°
sp^2	1 double + 2 single	planar	120°
sp	1 triple	linear	180°

Every single bond is a σ **bond** (direct overlap); a double bond is one σ + one π **bond** (sideways p-orbital overlap). Ethene is **planar** because its carbons are sp^2 .

Method — Hybridisation and shape



sp³: 4 single bonds
tetrahedral

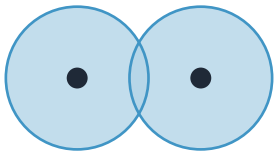


sp²: 1 double + 2 single
planar (flat)

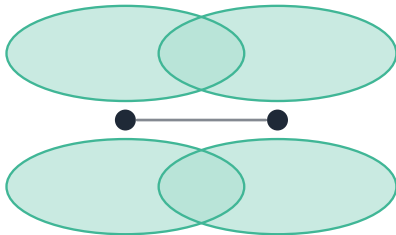


sp: 1 triple bond
linear

Method — Hybridisation and shape



σ bond:
head-on overlap



π bond: sideways overlap
of p orbitals

Hybridisation builds sigma and pi bonds

Practice 2.1 ■ 2 marks

State the shape and bond angle around an sp^3 carbon.

Solution 2.1

Method: Hybridisation and shape

Worked steps

tetrahedral **B1**; 109.5° **B1**.

Practice 2.2 ■ 2 marks

State how many σ and π bonds make up a $\text{C}=\text{C}$ double bond.

Solution 2.2

Method: Hybridisation and shape

Worked steps

1 σ bond and 1 π bond **B1** *each*.

Exam-style 3.1 ■ 1 mark

The carbon atoms in ethene, C_2H_4 , are:

- A** sp hybridised, linear
- B** sp^2 hybridised, planar
- C** sp^3 hybridised, tetrahedral
- D** sp^3 hybridised, planar

Solution 3.1

- A sp hybridised, linear
- B sp^2 hybridised, planar
- C sp^3 hybridised, tetrahedral
- D sp^3 hybridised, planar



Worked steps

- B. Ethene's carbons are sp^2 hybridised and the molecule is planar.

Exam-style 3.2 ■ 1 mark

The bond angle around the carbon in methane is:

A 90°

B 104.5°

C 109.5°

D 120°

Solution 3.2

Method: Hybridisation and shape

A 90°

B 104.5°

C 109.5°



D 120°

Worked steps

C. Methane's bond angle is 109.5° .

Exam-style 3.3 ■ 2 marks

- (a) State the shape and bond angle around each carbon in ethyne, C_2H_2 .
- (b) Explain why ethene is a planar molecule.

Solution 3.3

Method: Hybridisation and shape

Worked steps

(a) linear (M1); 180° (A1).

(b) the carbons are sp^2 hybridised with 120° bond angles (M1); all the atoms lie in one plane around the $C=C$ double bond, so it is planar (A1).

Exam-style 3.4 ■ 2 marks

Describe the σ and π bonds present in a molecule of ethene, C_2H_4 .

Solution 3.4

Method: Hybridisation and shape

Worked steps

five σ bonds (4 C–H and 1 C–C) formed by direct overlap **M1**; one π bond from sideways overlap of p orbitals above and below the C=C **A1**.