The Carbonyl Group: Structure and Polarity

Why the carbon of C=O is every nucleophile's target: an sp², planar carbon, a π bond from sideways p–p overlap, and a polar C=O with δ^+ carbon and δ^- oxygen, explained by resonance.

Name: Date: Score: ____ / 15

A. Fill in the blanks

1. The carbonyl carbon is ____ hybridised.

2. The bond angles around the carbonyl carbon are about ____ degrees.

3. In C=O, the oxygen carries a partial ____ charge.

4. The π bond of C=O forms by sideways overlap of ____ orbitals.

B. True or False

5. The carbonyl group is planar. True / False

6. The carbonyl oxygen is electrophilic. True / False

7. Carbonyl compounds are more polar than ethers. True / False

C. Assertion and reason

8. Assertion (A): The carbonyl carbon is electrophilic.
Reason (R): Oxygen pulls the C=O electrons towards itself.

(a) Both A and R are true, and R explains A
(b) Both A and R are true, but R does not explain A
(c) A is true, R is false
(d) A is false, R is true

Answer: _____

9. Assertion (A): The carbonyl group is planar.
Reason (R): The carbonyl carbon is sp² hybridised.

(a) Both A and R are true, and R explains A
(b) Both A and R are true, but R does not explain A
(c) A is true, R is false
(d) A is false, R is true

Answer: _____

D. Choose the correct option

10. The carbonyl carbon forms how many σ bonds?

(a) two
(b) three
(c) four
(d) one

Answer: _____

11. Nucleophiles attack the carbonyl:

(a) oxygen
(b) carbon
(c) hydrogen
(d) lone pair

Answer: _____

12. The dipolar resonance structure of C=O is:

(a) $C^{-}–O^{+}$ (b) $C^{+}–O^{-}$

(c) $C=O^{+}$ (d) $C^{-}=O$

Answer: _____

E. Numerical problems

13. How many lone pairs does the carbonyl oxygen carry?

F. Short answer questions

14. Why do nucleophiles attack the carbon of a carbonyl group?

G. Match the columns

15. Match each item in Column A with the correct item in Column B.

Column A	Column B	Your answer
1. sp^2 carbon	(a) δ^{+}, electrophilic	1 → ____
2. p–p sideways overlap	(b) planar, 120°	2 → ____
3. oxygen	(c) δ^{-}, nucleophilic	3 → ____
4. carbon	(d) π bond	4 → ____

Detailed solutions

1. sp^2

2. 120

3. negative

4. p

5. True. The carbon and the three atoms on it lie in one plane.

6. False. The oxygen is δ^- and nucleophilic; the carbon is electrophilic.

7. True. C=O is strongly polarised.

8. (a) R explains A.

9. (a) R explains A.

10. (b) three. sp^2 carbon: three σ bonds and one π bond.

11. (b) carbon. The δ^+ carbon.

12. (b) $C^+–O^-$. The π electrons move onto oxygen.

13. Oxygen in C=O. **Answer: 2**

14. Oxygen is more electronegative, so the carbon is δ^+ (electron-poor, electrophilic); the dipolar resonance structure $C^+–O^-$ shows it too.

15. 1 → (b), 2 → (d), 3 → (c), 4 → (a). Each feature matches what it gives the carbonyl group.