Nucleophilic Addition to the Carbonyl Group

Most reactions of aldehydes and ketones begin with one move. How a nucleophile attacks the polar C=O, and why aldehydes react faster than ketones.

Name: Date: Score: ____ / 18

A. Fill in the blanks

1. In C=O, carbon carries delta ____.

2. In C=O, oxygen carries delta ____.

3. A nucleophile is electron-____.

4. During addition, carbon changes from sp^2 to ____.

5. HCN adds to carbonyl compounds to give a ____.

B. True or False

6. The nucleophile attacks the carbonyl oxygen. True / False

7. The alkoxide intermediate is tetrahedral at carbon. True / False

8. Aldehydes are generally more reactive than ketones. True / False

9. Alkyl groups increase the positive charge on the carbonyl carbon. True / False

C. Assertion and reason

10. Assertion (A): Aldehydes react faster than ketones.
Reason (R): Ketones have two alkyl groups around the carbonyl carbon.

(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: _____

11. Assertion (A): The carbonyl carbon is attacked by nucleophiles.
Reason (R): Oxygen pulls electrons and leaves carbon delta plus.

(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

12. The first step of the mechanism is:

(a) proton loss
(b) nucleophile attack on carbon
(c) oxygen leaving
(d) ring closing

Answer: _____

13. The geometry at carbon changes from:

(a) tetrahedral to flat
(b) flat to tetrahedral
(c) linear to flat
(d) flat to linear

Answer: _____

14. Which is most reactive?

(a) Propanone
(b) Ethanal
(c) Butanone
(d) Pentan-3-one

Answer: _____

15. The alkoxide intermediate then:

(a) loses CO_2
(b) takes a proton
(c) forms a ring
(d) loses carbon

Answer: _____

E. Short answer questions

16. Write the steps of nucleophilic addition in order.

17. Give two reasons why aldehydes are more reactive than ketones.

F. Match the columns

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

Column A	Column B	Your answer
1. sp^2	(a) tetrahedral	1 → ____
2. sp^3	(b) flat	2 → ____
3. HCN	(c) electron-rich	3 → ____
4. Nu^-	(d) cyanohydrin	4 → ____

Detailed solutions

1. plus

2. minus

3. rich

4. sp^3

5. cyanohydrin

6. False. It attacks the electrophilic carbon.

7. True. Carbon is sp^3.

8. True. Less hindered, more electrophilic.

9. False. They release electrons and reduce it.

10. (a) R explains A.

11. (a) R explains A.

12. (b) nucleophile attack on carbon. The nucleophile attacks the delta plus carbon.

13. (b) flat to tetrahedral. sp^2 to sp^3.

14. (b) Ethanal. Ethanal is an aldehyde.

15. (b) takes a proton. It gives the product.

16. Nucleophile attacks the carbon, pi electrons move to oxygen, a tetrahedral alkoxide forms, it takes a proton.

17. Steric: less crowding. Electronic: fewer electron-releasing alkyl groups, so carbon is more positive.

18. 1 → (b), 2 → (a), 3 → (d), 4 → (c). Each term matches its partner.