Losing CO_2: Decarboxylation, Kolbe Electrolysis and Reduction

How the –COOH group itself changes: soda lime removes it as CO_2 (one carbon less), Kolbe electrolysis joins two alkyl groups, and $LiAlH_4$ or diborane reduces it to a primary alcohol, while $NaBH_4$ cannot.

Name: Date: Score: ____ / 15

A. Fill in the blanks

1. Soda lime is a mixture of NaOH and ____.

2. Sodium acetate heated with soda lime gives ____.

3. Kolbe electrolysis of sodium acetate gives ____.

4. $LiAlH_4$ reduces a carboxylic acid to a ____ alcohol.

B. True or False

5. Decarboxylation with soda lime gives an alkane with one carbon less. True / False

6. $NaBH_4$ reduces carboxylic acids to alcohols. True / False

7. In Kolbe electrolysis the alkane forms at the cathode. True / False

C. Assertion and reason

8. Assertion (A): Sodium butanoate gives propane with soda lime.
Reason (R): One carbon is removed as CO_2.

(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): Kolbe electrolysis doubles the alkyl chain.
Reason (R): Two alkyl radicals formed at the anode join.

(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 by-product of soda-lime decarboxylation is:

(a) Na_2CO_3
(b) NaCl
(c) $CaCO_3$ only
(d) H_2

Answer: _____

11. Kolbe electrolysis of sodium propanoate gives:

(a) ethane
(b) propane
(c) butane
(d) hexane

Answer: _____

12. Diborane converts CH_3COOH into:

(a) CH_3CHO (b) CH_3CH_2OH

(c) CH_4 (d) C_2H_6

Answer: _____

E. Numerical problems

13. How many carbons are in the alkane from Kolbe electrolysis of sodium acetate?

F. Short answer questions

14. Write the anode reactions in the Kolbe electrolysis of sodium acetate.

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. soda lime, heat	(a) alkane, one C less	1 → ____
2. Kolbe electrolysis	(b) R–R	2 → ____
3. $LiAlH_4$	(c) no reduction of COOH	3 → ____
4. $NaBH_4$	(d) 1° alcohol	4 → ____

Detailed solutions

1. CaO

2. methane

3. ethane

4. primary

5. True. The carboxyl carbon leaves as CO_2.

6. False. $NaBH_4$ does not reduce –COOH.

7. False. It forms at the anode.

8. (a) R explains A.

9. (a) R explains A.

10. (a) Na_2CO_3. $RCOONa + NaOH \rightarrow RH + Na_2CO_3$.

11. (c) butane. Two ethyl groups: $CH_3CH_2–CH_2CH_3$.

12. (b) CH_3CH_2OH. Reduction to the primary alcohol.

13. $CH_3–CH_3$. **Answer: 2**

14. $CH_3COO^- - e^- \rightarrow CH_3COO\cdot$; $CH_3COO\cdot \rightarrow CH_3\cdot + CO_2$; $CH_3\cdot + \cdot CH_3 \rightarrow C_2H_6$.

15. 1 → (a), 2 → (b), 3 → (d), 4 → (c). Each reagent matches what it does to RCOOH.