3.091 OCW Scholar

Self-Assessment Exam
Organic Materials

Write your answers on these pages.

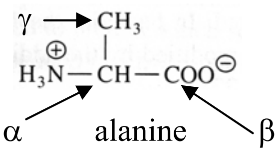
State your assumptions and show calculations that support your conclusions.

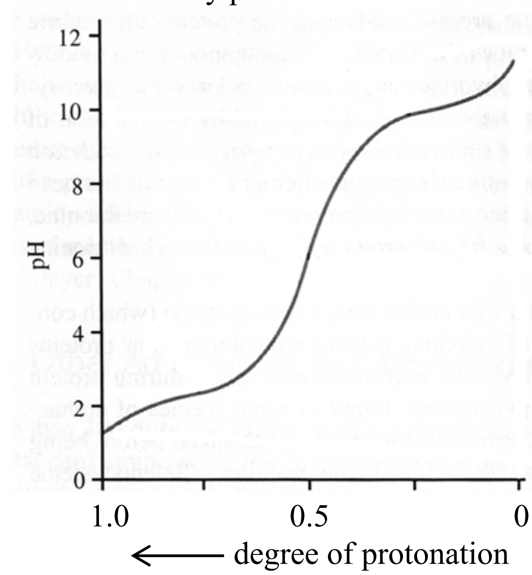
RESOURCES PERMITTED: PERIODIC TABLE OF THE ELEMENTS, TABLE OF CONSTANTS, AN AID SHEET (ONE PAGE 8½" × 11"), AND A CALCULATOR.

NO BOOKS OR OTHER NOTES ALLOWED.

Final Exam, Problem #5

The skeletal structure of the amino acid, alanine, is given below as it exists as the neutral zwitterion. To the right is shown its titration curve in aqueous solution. The abscissa expresses concentration in terms of degree of protonation, so that at a value of 0.5 the neutral zwitterion is the only species present, at a value of 0 alanine is totally deprotonated, and at a value of 1.0 alanine is totally protonated.





(a) What is the hybridization of each of the three carbons in alanine?

α

β

γ

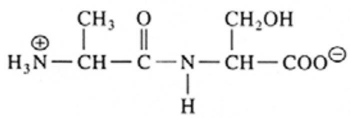
(b) Indicate on the titration curve (1) the pK_a for protonation of the zwitterion, (2) the pK_a for deprotonation of the zwitterion, and (3) the isoelectric point.

(c) Draw the skeletal structure of alanine when it is solvated in an aqueous solution at extreme acidity, i.e., $p\text{H} < 1$.

(d) For an aqueous solution of alanine calculate the ratio of the concentration of neutral alanine zwitterion to the concentration of deprotonated anion when the pH is 8.091.

Final Exam, Problem #6

(d) The dipeptide, alanylserine shown below, is derived from alanine and serine.

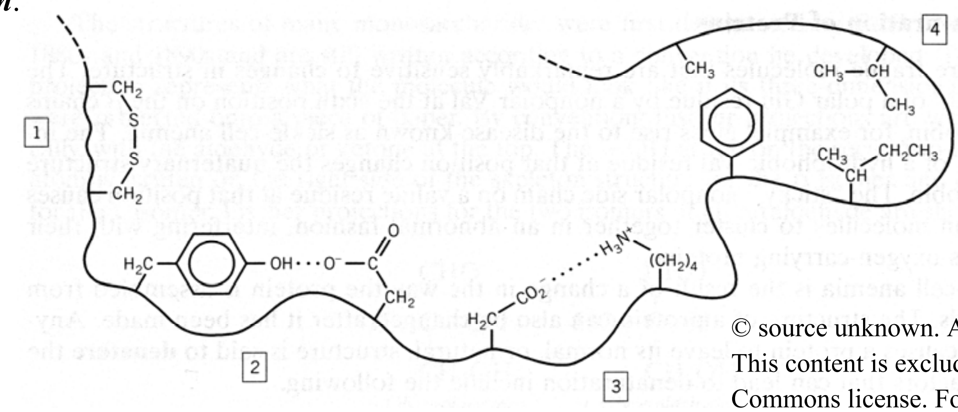


(i) Indicate the position of the peptide bond.

(ii) Draw the skeletal structure of each constituent amino acid as it would be present in an aqueous solution of extreme basicity, i.e., *p*H > 12.

alanine | serine

(e) The figure below shows various features of the tertiary structure along a length of protein ***in aqueous solution***.



At each of the four numbered positions, name one chemical change to the environment of the protein that would destabilize the associated feature in the tertiary structure. Explain the relevant chemistry.

(1)

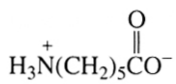
(2)

(3)

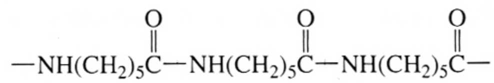
(4)

Final Exam, Problem #13

(a) Name the type of polymerization reaction that will convert 6-aminohexanoic acid into nylon 6.



6-aminohexanoic acid



nylon 6

(b) Write the reaction that converts two molecules of 6-aminohexanoic acid into a dimer of nylon 6.

(c) Calculate the molecular weight of nylon 6 for which the degree of polymerization, *n*, is 3091.

(d) Is it possible to convert nylon 6 into an elastomer? If so, describe how, i.e., specify the necessary change in the chemistry. If not, explain why this is the case.