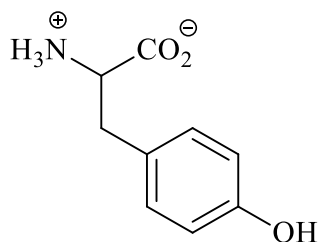


The  $pK_a$  values of tyrosine are  $pK_{a1} = 2.20$  ( $\alpha$ -COOH),  $pK_{a2} = 9.11$  ( $\alpha$ -NH<sub>3</sub><sup>⊕</sup>) and  $pK_{a3} = 10.07$  (-CH<sub>2</sub>C<sub>6</sub>H<sub>4</sub>OH). Draw the structure of the zwitterionic form of tyrosine.

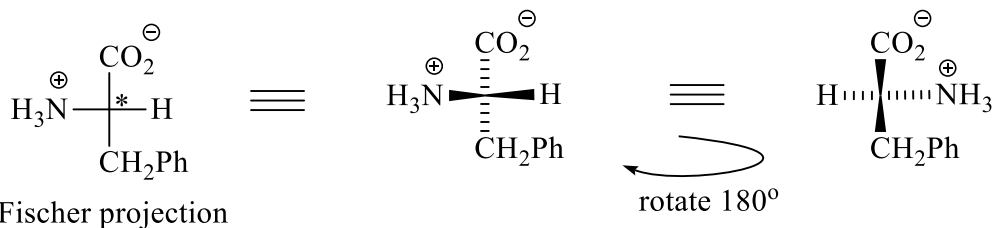
Marks  
4



At what pH will this be the predominant species in aqueous solution?

**5.66**  
**(halfway**  
**between  $pK_{a1}$**   
**and  $pK_{a2}$ )**

The naturally occurring isomer of phenylalanine is (L)-phenylalanine. Draw the zwitterionic structure of (L)-phenylalanine and indicate the stereogenic centre with an asterisk (\*). Determine whether this amino acid has the (*R*) or (*S*) configuration. Show your working.



**Horizontal bonds in Fischer projections are out of the paper, vertical bonds are into the paper. Order of priority of substituents is  $NH_3^+ > CO_2^- > CH_2Ph > H$ . Reorient the molecule so that the lowest priority group (H) is at the back. Viewing down the C-H bond, the orientation of  $NH_3^+ \rightarrow CO_2^- \rightarrow CH_2Ph$  is anticlockwise. Therefore (L)-phenylalanine has (*S*) configuration.**

**THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.**