

- Phenylketonuria is an inherited disorder in which phenylacetic acid,  $C_6H_5CH_2COOH$ , (simplified here to HPac) accumulates in the blood. A study of the acid shows that the pH of a 0.12 M HPac solution is 2.60. What is the  $pK_a$  of phenylacetic acid?

As HPac is a weak acid, the equilibrium for its dissociation can be studied using an 'ICE' table:

	HPac	$\rightleftharpoons$	Pac <sup>-</sup>	H <sup>+</sup>
<b>initial</b>	<b>0.12</b>		<b>0</b>	<b>0</b>
<b>change</b>	<b>-x</b>		<b>+x</b>	<b>+x</b>
<b>final</b>	<b>0.12 - x</b>		<b>x</b>	<b>x</b>

By definition,  $pH = -\log_{10}[H^+(aq)]$  so  $[H^+(aq)] = 10^{-2.60}$  M. From the reaction table,  $x = [H^+(aq)]_{eq}$  so:

$$[HPac]_{eq} = 0.12 - x = (0.12 - 10^{-2.60}) \text{ M} = 0.12 \text{ M (to 2 s.f.)}$$

$$[H^+(aq)]_{eq} = x = 10^{-2.60} \text{ M}$$

$$[Pac^-(aq)]_{eq} = x = 10^{-2.60} \text{ M}$$

The equilibrium constant  $K_a$  is given by:

$$K_a = \frac{[HPac^-][H^+]}{[HPac]} = \frac{(10^{-2.60})(10^{-2.60})}{(0.12)} = 5.26 \times 10^{-5}$$

By definition,  $pK_a = -\log_{10}K_a$  so:

$$pK_a = -\log_{10}(5.26 \times 10^{-5}) = 4.28$$

Answer: **4.28**