Marks 3

- Phenylketonuria is an inherited disorder in which phenylacetic acid, $C_6H_5CH_2COOH$, (simplified here to HPAc) accumulates in the blood. If untreated, it can cause mental retardation and death. 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	⇌	PAc^-	H^+
initial	**0.12**		**0**	**0**
change	**$-x$**		**$+x$**	**$+x$**
final	**$0.12 - x$**		**x**	**x**

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

$[HPAc]_{eq} = 0.12 - x = (0.12 - 10^{-2.60})$ M = 0.12 M (to 2 s.f.)
$[H^+(aq)]_{eq} = x = 10^{-2.60}$ M
$[PAc^-(aq)]_{eq} = x = 10^{-2.60}$ 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**