Equilibrium: Propanoic acid + ethanol ⇌ ethyl propanoate + water

Question

A mixture was prepared using 2.0 mol of propanoic acid, 4.0 mol of ethanol and 4.0 mol of water. The mixture was allowed to come to equilibrium according to the following equation:

$$CH_3CH_2COOH + CH_3CH_2OH \quad CH_3CH_2COOCH_2CH_3 + H_2O$$

The equilibrium mixture contained 1.4mol of propanoic acid. Calculate K_c.

What is K_c and what is the problem?

$K_c = [CH_3CH_2COOCH_2CH_3][H_2O] / [CH_3CH_2COOH][CH_3CH_2OH]$

...but we are only given the equilibrium amount of the CH_3CH_2COOH

Let's have a look at the data we're given...

	Propanoic acid + ethanol		ethyl propanoate + water	
initial	2.0	4.0	0	4.0
equilibrium	1.4	?	?	?

Working through the example

How much propanoic acid has reacted?

	Propanoic acid + ethanol <=> ethyl propanoate + water			
initial	2.0	4.0	0	4.0
change				
equilibrium	1.4			

Extension

What if the ratio of reactants is not 1:1:1:1?

	2A	+	B	⇌	2C	+	D
ratio	2	:	1		2	:	1
initial	2.0		4.0		0		4.0

change	-0.6
equilibrium	1.4

Change in number of moles must match the ratio

Assessment

Work out the equilibrium amounts:

	A	+	B	<=>	C	+	D
ratio	1	:	1		1	:	1
initial	5		5		0		0
change							
equilibrium					2		

Answers [A] = 3, [B] = 3, [C] = 2, [D] = 2

change	-2	-2	+2	+2
equilibrium	3	3	2	2