Communicating Automata and Pi Calculus

Explain the notions of abstraction and concretion in the $\pi$-calculus. Explain the components of a commitment $P \xrightarrow{\alpha} A$, and say what it means for each form which $\alpha$ may take. (You need not give the rules of commitment.) Define strong bisimulation in terms of commitments. [5 marks]

Consider each pair of the three processes $(\text{new } x)\overline{x}(y)$, $(\text{new } x)\overline{y}(x)$, and 0. Are they structurally congruent ($\equiv$)? Are they strongly equivalent ($\sim$)? Briefly justify each of your six answers. [4 marks]

The following equations define the behaviour of a buffer cell which has the ability to cut itself out of a chain of similar cells:

\[
\begin{align*}
B(in, out, \ell, r) &\overset{\text{def}}{=} in(x) \cdot C(x, in, out, \ell, r) + \tau(in, \ell) \cdot 0 \\
C(x, in, out, \ell, r) &\overset{\text{def}}{=} \text{out}(x) \cdot B(in, out, \ell, r) + \ell(in', \ell') \cdot C(x, in', out, \ell', r)
\end{align*}
\]

Let $P = \text{new mid}_m (B(in, mid, \ell, m) \mid C(x, mid, out, m, r))$. Express $P$ as a summation up to $\sim$, i.e. $P \sim \Sigma \alpha_i A_i$. Use structural congruence to make the expression as simple as possible. Justify your expression. [6 marks]

Now suppose that the name out is replaced by in in the definition of $P$. What effect does this have upon the behaviour of $P$? Briefly justify your answer in terms of commitments. [5 marks]