1) Prove that $\phi \vdash \neg\neg\phi$. [Hint: You might want to first prove $\neg\neg\neg\phi \vdash \neg\phi$.]

2) Show that the following version of the contraposition inference rule is derivable.

$$
\Gamma, \neg \phi \vdash \neg \psi \\
\hline
\Gamma, \psi \vdash \phi
$$

3) Show that the following two inference rules using $\land$ are derivable. [Hint: You will need to use that $(\phi \land \psi)$ is an abbreviation for $\neg(\neg\phi \lor \neg\psi)$.

a) $\Gamma \vdash (\phi \land \psi) \\
\hline
\Gamma \vdash \phi$

b) $\Gamma \vdash \phi \quad \Gamma \vdash \psi \\
\hline
\Gamma \vdash (\phi \land \psi)$

4) Show that the following inference rule is derivable.

$$
\Gamma \vdash \forall x \phi \\
\hline
\Gamma \vdash \phi$$