3. (Sec. 1.5 p. 12) Let $I(x)$ be the statement “$x$ has an Internet connection” and $C(x, y)$ be the statement “$x$ and $y$ have chatted over the Internet”, where the domain for the variables $x$ and $y$ consists of all students in your class. Use quantifiers to express each of these statements.

(a) No one in the class has chatted with Bob.
   \[ \neg \exists x C(x, \text{Bob}) \equiv \forall x \neg C(x, \text{Bob}) \]

(b) Sanjay has chatted with everyone except Joseph.
   \[ \forall x ((x \neq \text{Joseph}) \leftrightarrow C(\text{Sanjay}, x)) \]

(c) Someone in your class does not have an Internet connection.
   \[ \exists x \neg I(x) \]

(d) Not everyone in your class has an Internet connection.
   \[ \neg \forall x I(x) \]

(e) Exactly one student in your class has an Internet connection.
   \[ \exists! x I(x) \]

(f) Everyone in your class with an Internet connection has chatted over the Internet with at least one other student in your class.
   \[ \forall x (I(x) \rightarrow \exists y ((y \neq x) \land C(x, y))) \]

(g) There are two students in your class who have not chatted with each other over the Internet.
   \[ \exists x \exists y ((x \neq y) \land \neg C(x, y)) \]

(h) There are two students in your class who between them have chatted with everyone else in the class.
   \[ \exists x \exists y ((x \neq y) \land \forall z (C(x, z) \lor C(y, z))) \]

4. (Sec. 1.5 p. 2) Translate these statements into English, where the domain for each variable consists of all real numbers.

(a) $\exists x \forall y (xy = y)$
   The real numbers have a multiplicative identity.

(b) $\forall x \forall y (((x \geq 0) \land (y < 0)) \rightarrow (x - y > 0))$
   A non-negative number minus a negative number is positive.

(c) $\forall x \forall y \exists z (x = y + z)$
   For every real number $x$ and for every real number $y$, there exists a real number $z$ such at $x = y + z$. 