1. Fill in the steps of the argument below to show that $(\neg p \to q) \wedge \neg p \equiv q \wedge \neg p$. Each step is labeled with the name of a propositional law. Fill in each blank with a proposition so that each proposition can be obtained from the one before it by applying the stated law.

$(\neg p \to q) \wedge \neg p$	Start
	Conditional Identity
	Involution law
	Distributive law
	Complement law
$q \wedge \neg p$	Identity law

2. The domain of discourse is a group working on a project at a company. One of the members of the group is named Sam. Define the following predicates:

   - P(x, y): x knows y's phone number. *(A person may or may not know their own phone number).*
   - D(x): x missed the deadline.
   - N(x): x is a new employee.

   Give a logical expression for each of the following sentences:

   (a) Someone knows everyone's phone number.

   (b) Everyone knows someone's phone number.

   (c) There is at least one new employee who missed the deadline.

   (d) Sam knows the phone number of everyone who missed the deadline.

3. This problem refers to the predicates and domain defined in the previous question. Consider a situation in which there are five people in the group. The table below gives values for the predicates D and N for each member of the group. For example, Bert did not miss the deadline because the truth value in the row labeled Bert and the column labeled D(x) is F. Using these values, circle the quantified expressions that evaluate to true.

Name	$D(x)$	$N(x)$
Sam	T	F
Beth	T	T
Melanie	F	T
Al	T	T
Bert	F	T

(a) $\forall x(D(x) \vee N(x))$
(b) $\exists x((x \neq \text{Al}) \to N(x))$
(c) $\exists x(\neg D(x) \wedge \neg N(x))$
(d) $\exists x(\neg D(x) \to \neg N(x))$.
(e) $N(\text{Bert}) \to D(\text{Bert})$.
(f) $\forall x(\neg N(x) \to D(x))$
(g) $\forall x((x \neq \text{Sam}) \to N(x))$
(h) $\forall x(D(x) \to N(x))$
(i) $\exists x(D(x) \leftrightarrow N(x))$
(j) $D(\text{Sam}) \wedge N(\text{Sam})$