1. To paraphrase Mitt Romney:

   > I am not concerned about the very poor. I am not concerned about the very rich. I am concerned about the rest.

   Let $P(x)$ mean x is very poor. Let $R(x)$ mean x is very rich. Let $C(x)$ mean Romney is concerned about x. You can assume that the domain consists of the very poor, the very rich, and the rest.

   (a) Translate what Romney said into predicate logic. Do not simplify.

   (b) Simplify.

2. Let $E(n)$ mean that n is an even number, and $P(n)$ mean that n is a prime number, Write the following statements in predicate logic, and say whether they are true or false.

   (a) There exists at least one positive, even, prime number.

   (b) There exists at exactly one positive, even, prime number.

   (c) There exists at least two positive, even, prime numbers.

   (d) There exists at exactly two positive, even, prime numbers.

3. For each entry in the table say whether it is true or false that the item in the left column implies the item in the top row under all possible interpretations (of sets X, Y where $x \in X$, $y \in Y$, and predicate P). Some entries have been filled in already. *Note that X, Y can be empty.*

	$\forall x \forall y P(x,y)$	$\forall x \exists y P(x,y)$	$\forall y \exists x P(x,y)$	$\exists x \forall y P(x,y)$	$\exists y \forall x P(x,y)$	$\exists x \exists y P(x,y)$
$\forall x \forall y P(x,y)$	T					
$\forall x \exists y P(x,y)$		T				
$\exists x \forall y P(x,y)$				T		
$\exists x \exists y P(x,y)$						T

4. Do the same problem as above but assume X, Y are not empty.

	$\forall x \forall y P(x,y)$	$\forall x \exists y P(x,y)$	$\forall y \exists x P(x,y)$	$\exists x \forall y P(x,y)$	$\exists y \forall x P(x,y)$	$\exists x \exists y P(x,y)$
$\forall x \forall y P(x,y)$	T					
$\forall x \exists y P(x,y)$		T				
$\exists x \forall y P(x,y)$				T		
$\exists x \exists y P(x,y)$						T

5. Assume X, Y are both infinite. For each of these formulas (taken from the third column of the above tables) circle whether it is true or false over all possible interpretations. If it is false give a counterexample where X and Y are the integers. You must provide the predicate P, state values for x and y where the antecedent is true but the consequent is false, and (if not obvious) why.

   (a) $\forall x \forall y P(x, y) \rightarrow \forall y \exists x P(x, y)$ T F

   (b) $\forall x \exists y P(x, y) \rightarrow \forall y \exists x P(x, y)$ T F

   (c) $\exists x \forall y P(x, y) \rightarrow \forall y \exists x P(x, y)$ T F

   (d) $\exists x \exists y P(x, y) \rightarrow \forall y \exists x P(x, y)$ T F