1. Paul, Quincy, and Rachel are in class together. Let $p$ represent “Paul will pass,” $q$ represent “Quincy will pass,” and $r$ represent “Rachel will pass.” Translate each of the following into English:
   a. $p \land q \land r$  [All of them will pass]
   b. $(p \land \neg q \land \neg r) \lor (\neg p \land q \land \neg r) \lor (\neg p \land \neg q \land r)$  [Only one of them will pass]
   c. $(q \lor r) \rightarrow p$  [If either Quincy or Rachel pass, then Paul will pass]

2. Let $p$ represent “You drive over the speed limit,” and let $q$ represent “You get a speeding ticket.”
   a. If you do not drive over the speed limit, then you will not get a speeding ticket. $[\neg p \rightarrow \neg q]$ implies not
   b. Driving over the speed limit is sufficient for getting a speeding ticket. $[p \rightarrow q]$
   c. Whenever you get a speeding ticket, you are driving over the speed limit. $[q \rightarrow p]$

3. For each of the following propositions, indicate whether it is a tautology, a contradiction, or neither. If neither, provide two truth value assignments which demonstrate that this is the case (i.e., provide one set of assignments that makes the proposition true and one that makes it false). You can use a truth table to decide which of these categories the proposition belongs.
   a. $(p \land (p \rightarrow q)) \rightarrow q$  [Tautology]
   b. $p \land (\neg p)$  [Contradiction]
   c. $(p \land q) \leftrightarrow (p \lor q)$  [Neither. It’s contingent. If $p$ and $q$ are both True, then the proposition is True. If one of $p$ and $q$ is False (but not both of them), then the proposition is False.]
4. Give the converse and the contrapositive of each of the following English sentences:
   a. If you study, you get good grades.
      i. Converse: If you get good grades, you study.
      ii. Contrapositive: If you do not get good grades, then you do not study.
   b. If you have more than two suitcases, then you need to pay extra.
      i. Converse: If you pay extra, then you have more than two suitcases.
      ii. Contrapositive: If you do not pay extra, then you do not have more than two suitcases.
   c. If I have a choice, I don’t eat meat.
      i. Converse: If I do not eat meat, then I have a choice.
      ii. Contrapositive: If I eat meat, then I do not have a choice.

5. For each of the following pairs of propositions, show that the two propositions are logically equivalent by finding a chain of equivalences from one to the other. State which definition or law of logic justifies each equivalence in the chain.
   a. \( p \land (q \land p) , p \land q \)
      i. \( p \land (q \land p) \equiv p \land (p \land q) \) [Commutative law]
      ii. \( \equiv (p \land p) \land q \) [Associative law]
      iii. \( \equiv p \land q \) [Idempotent law]
   b. \( (p \lor q) \land \neg q , p \land \neg q \)
      i. \( (p \lor q) \land \neg q \equiv (p \land \neg q) \lor (q \land \neg q) \) [Distributive law]
      ii. \( \equiv (p \land \neg q) \lor F \) [Contradiction]
      iii. \( \equiv (p \land \neg q) \) [Identity law]
   c. \( (p \rightarrow q) \land (q \rightarrow r) , (p \lor q) \rightarrow r \)
      i. \( (p \rightarrow q) \land (q \rightarrow r) \equiv (\neg p \lor r) \land (q \rightarrow r) \) [Definition of \( p \rightarrow q \)]
      ii. \( \equiv (\neg p \lor r) \land (\neg q \lor r) \) [Definition of \( p \rightarrow q \)]
      iii. \( \equiv (\neg p \land \neg q) \lor r \) [Distributive law]
      iv. \( \equiv \neg(p \lor q) \lor r \) [DeMorgan’s law]
      v. \( \equiv (p \lor q) \rightarrow r \) [Definition of \( p \rightarrow q \)]