1. Justify each equivalence below by providing a derivation from one expression to the other (with a brief justification for each step of your derivation), or show that the equivalence does not hold (warning; you cannot use a derivation to show non-equivalence).

   (a) \((P \Rightarrow Q) \land (P \Rightarrow R) \iff P \Rightarrow (Q \land R)\)

   (b) \((P \Rightarrow R) \land (Q \Rightarrow R) \iff (P \land Q) \Rightarrow R\)

   (c) \(P \iff Q \iff (P \land Q) \lor (\neg P \land \neg Q)\)
2. An “interpretation” for a logical statement consists of a domain of elements and a meaning for each predicate symbol. (When the statement contains no quantifiers or open variables, an interpretation consists simply of a truth value (True/False) for each predicate symbol.) For each statement below, provide an interpretation under which the statement is true and another interpretation under which the statement is false — if either case is not possible, clearly explain why.

(a) \( \forall x \in D, \forall y \in D, P(x, y) \)

(b) \( (P \land Q) \Rightarrow (P \lor Q) \)

(c) \( \forall x \in D, \exists y \in D, P(x, y) \Rightarrow \exists y \in D, \forall x \in D, P(x, y) \)