1. **Translations**
   Consider the following propositions:
   - \( p \): There is an iceberg in the harbour
   - \( q \): Whales are spotted near Signal Hill
   - \( r \): Boat tours are sold out.
   - \( s \): Tourists are shopping.

   Using these propositions as definitions of \( p, q, r \) and \( s \), answer the following questions.
   (a) Using propositions above, write an English sentence corresponding to \((q \rightarrow \neg s)\)
   (b) Write, in English, a contrapositive of the statement in (a).
   (c) Write, in English, a negation of the statement in (a).
   (d) Write the following statement in the logic notation using \( p, q, r, s \) above: If tourists are shopping and boat tours are sold out, then there is an iceberg in the harbour and whales are spotted near Signal Hill.
   (e) Write in logic notation the negation of your statement from (d). Then move all negations to variables using DeMorgan’s law, definition of \( \rightarrow \) and double negation (don’t simplify it further).
   (f) Write an English sentence corresponding to the resulting (with negations on variables) formula from your previous subquestion.
   (g) Suppose that the statement in (d) is false. Is this enough information to figure out whether whales are spotted near Signal Hill? What about the truth of \( r \) and \( s \)? Explain your answer.
   (h) List all scenarios where the statement in (d) is true, and there is no iceberg in the harbour.
   (i) Give an English sentence with these propositions that is a tautology.

2. **Knights and knaves**
   Recall the island of knights and knaves, where knights never lie; knaves lie always (that is, every statement made by a knight is true, every statement made by a knave is false).
   (a) You meet three inhabitants of the island (call them Alan, Bob and Charlie).
      Alan says: ”Bob is a knave”.
      Bob says: ”Alan and Charlie are the same” (here, same = both knights or both knaves).
      Can you tell if Charlie is a knight or a knave? Use a truth table to get your answer.
   (b) Now you see three other islanders, Darlene, Emmy and Gale. Darlene says: ”Emmy and Gale are the same”. You ask Gale: ”Are Darlene and Emmy the same?” What is Gale going to answer (and why)?

3. **Simplifications**
   Simplify the following sentences using the table of logical equivalences and definition of \( \rightarrow \). Indicate which equivalences you are using at each step.
   (a) \((p \land \neg(\neg p \lor q)) \lor (p \land q)\)
   (b) \(\neg((p \lor q \lor r \land \neg s) \land \neg(q \rightarrow \neg r) \rightarrow r)\)