This problem sheet is about computational complexity [1].

1. Explain what a decision problem is.
2. Explain what the P computational complexity class is, and give an example of a problem in P.
3. Explain what a decision problem is.
4. Explain what the NP complexity class is.
5. Explain the terms conjunctive normal form and disjunctive normal form.
6. Convert the following expressions to Conjunctive Normal Form.
   (a) $a \vee b$
   (b) $a \wedge b$
   (c) $((a \wedge b) \vee (\neg b \wedge c)) \vee \neg d$
   (d) $(a \wedge b) \vee (c \wedge d)$
   (e) $(a \vee b) \wedge (c \vee d)$
7. Convert the following expressions to Disjunctive Normal Form.
   (a) $a \vee b$
   (b) $a \wedge b$
   (c) $((a \wedge b) \vee (\neg b \wedge c)) \vee \neg d$
   (d) $(a \wedge b) \vee (c \wedge d)$
   (e) $(a \vee b) \wedge (c \vee d)$
8. Determine if there is a setting of the variables in the following expression that makes the evaluation of the expression true.
   (a) $a \vee b$
   (b) $a \wedge b$
   (c) $((a \wedge b) \vee (\neg b \wedge c)) \vee \neg d$
   (d) $(a \wedge b) \vee (c \wedge d)$
   (e) $(a \vee b) \wedge (c \vee d)$
9. Explain how to prove that a problem is NP-complete.
10. Prove that 3-SAT is NP-complete. You may assume that SAT is NP-complete.

References

[1] Michael Sipser. *Introduction to the Theory of Computation.* International Thomson Publishing, 3rd edition, 1996.