1. Here is a logical argument concerning Bob the robot (expressed in English):

   If the table is in the bedroom, Bob cannot be in the sitting room. Bob is either in the sitting room or in the study. The table is in the bedroom. Therefore, Bob is in the study.

   (a) Using proposition letters $p$, $q$ and $r$ to represent appropriate states of affairs, formalise the argument using the propositional calculus.

   (b) Using the technique of resolution refutation, demonstrate that the argument is sound.

2. Consider the following statements:

   - "If Mozart composed *Così fan tutte*, then Verdi didn't."
   - "Mozart composed *Così fan tutte* or *Rigoletto*."
   - "If Mozart composed *Rigoletto*, Verdi composed *Aida*."
   - "Therefore, if Verdi composed *Così fan tutte,* he composed *Aida*."

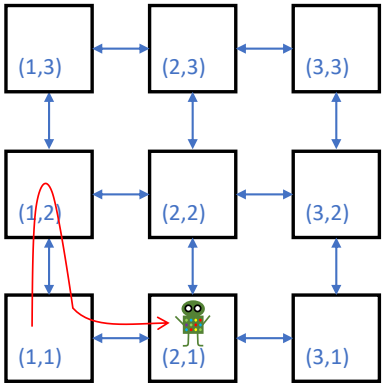
   (a) Express each of these statements using an appropriate logical notation.

   (b) Identify the conclusion of the argument and explain why this is special in terms of a resolution proof.

   (c) Demonstrate that the conclusion is valid by using the technique of resolution refutation.

   (d) Comment on the validity of the conclusion given that, in reality, Mozart composed *Così fan tutte.*

3. A robot is seaching a maze. It knows that it must not fall into a pit, and also that pits cause breezes in adjacent rooms, breezes that it can detect. It also knows there are 9 rooms in the maze, connected in a grid pattern.



Initially the robot is in room $(1, 1)$. It detects no breeze there, so moves to room $(1, 2)$. Detecting a breeze in that room, it backtracks to room $(2, 1)$. In room $(2, 1)$ it does not detect a breeze.

(a) Using suitable proposition letters and appropriate rule(s) and fact(s), represent the state of the problem when the robot is in room $(2, 1)$. Try to use a minimal representation (fewest facts and rules). Justify your choices.

(b) By applying the technique of resolution refutation to the knowledge base you created in (i) above, show that it is safe for the robot to move to room $(2, 2)$.