1. (3 marks) Consider the following rules regarding whether a car will start or not:

- If there is an electrical problem then the engine won’t turn over and the headlights won’t go on.
- If the battery is flat or there is a problem with the starter motor, then there is an electrical problem.
- If there is no gas then the car won’t start.
- If the engine doesn’t turn over then the car won’t start.

Please use the following abbreviations:

- $ep$ – there is an electrical problem
- $to$ – the engine turns over
- $l$ – the headlights go on
- $fb$ – the battery is flat
- $sm$ – there is a problem with the starter motor
- $g$ – there is gas in the tank
- $s$ – the car starts

Let the hypotheses (assumables) be $\{fb, sm, g\}$.

Express this as an abduction diagnosis problem (using prime implicates).

(a) What are the diagnoses given that $\neg s$ is observed?

(b) What are the diagnoses given that $\neg s$ and $l$ are observed?

2. (3 marks) Express the following assertions in ASP, and run your program:

- Canadians are typically not francophones.
- All Québécois are Canadian.
- Québécois are typically francophone.
- If someone is from Montréal you can’t conclude anything about their being francophone.
- Robert is a Québécois
• Mireille is from Montréal

What can be concluded about Robert and Mireille being francophone?

Notes:
• The easiest way to use ASP at the command line is via:
  clingo program.lp
  As well,
  gringo program.lp | clasp
  does the same thing.
• To get all answer sets, use
  clingo 0 program.lp or gringo program.lp | clasp 0

3. (4 marks) Let \( G = (V, E) \) be an undirected graph. \( G \) is a bipartite graph if there is a binary partition of the vertices of \( V \), say \((V_1, V_2)\), such that for every \((v_1, v_2) \in E\), \( v_1 \in V_1 \) iff \( v_2 \in V_2 \). Informally, every edge has one vertex in \( V_1 \) and the other on \( V_2 \).

Write an ASP program to determine whether a given graph is bipartite.

Test your program on (at least) the following graphs:
• \( V = \{v_1, v_2, v_3, v_4, v_5\} \)
  \( E = \{(v_1, v_3), (v_1, v_4), (v_2, v_3), (v_2, v_4)\} \).
• \( V = \{v_1, v_2, v_3, v_4, v_5\} \)
  \( E = \{(v_1, v_2), (v_2, v_3), (v_3, v_4), (v_4, v_5), (v_5, v_1)\} \).

Feel free to label vertices as you wish. For example the vertices could be labelled with the numbers 1, 2, \ldots or letters \( a, b, \ldots \).