Exercise 1: Jahob Integrated Proof Language

Consider the following class\textsuperscript{1}

```java
class Ex11 {  
/*:
    public ghost specvar P :: "obj => bool";
    public ghost specvar Q :: "obj => bool";
*/

class Ex11 {
  public static void test() {  
      requires "ALL x. P x --\rightarrow Q x"  
      ensures "ALL u v. P u \& v=u --\rightarrow Q v"
      {  
        //: pickAny u::obj, v :: obj suchThat cond: "P u \& v=u";
        //: noteThat p1: "P v" from cond;
        //: noteThat p2: "Q v" from Precondition forSuch u, v;
      }
  }
}
```

(a) Which formula does this class try to prove?

(b) Explain why the proof does not succeed.

(c) Fix the proof.

\textsuperscript{1}This is a slightly modified version of a test class that comes with the Jahob distribution
Exercise 2: Graph Search
Consider the following graph and heuristic function.

(a) For each search technique covered in the lecture (DFS, BFS, Greedy, and A*) give the order in which the nodes are closed. If multiple decisions are possible at a step, choose one and make this choice explicit (i.e., state the choice you made).

(b) Is the heuristic admissible if node $q_8$ is the goal state? Justify your claim.

Exercise 3: JVM Instructions
The Java Virtual Machine has a lot of instructions, but no instruction to branch on doubles. Explain how such a branch can be realized with the available instructions.