1. The classic Tower of Hanoi puzzle consists of three poles and a set of n disks of different sizes which can slide onto any pole. The puzzle starts with the disks stacked in ascending order of size on one pole (the source pole), with the smallest disk on top. The objective is to move the entire stack to another pole (the target pole) with the help of the third pole (the helper pole), following these rules: (i) Only one disk can be moved at a time, (ii) A disk can only be moved if it is the top disk on a pole, (iii) No disk may be placed on top of a smaller disk.
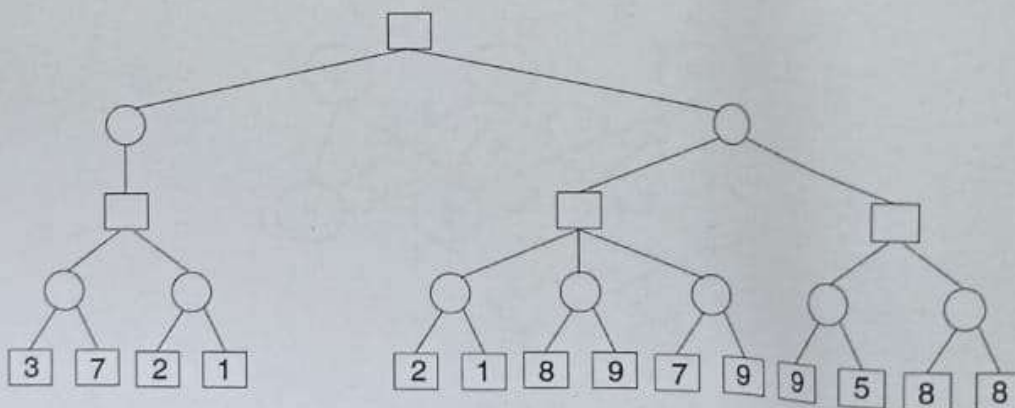
Formulate this puzzle as an AI search problem by defining:
   a. State representation: What does each state represent?
   b. Initial state and Goal State.
   c. Actions: Define the possible moves from one state to another and corresponding costs.

Draw the search tree for the first two levels of the search space starting from the initial state.

(2+1+2+2)

2. Apply a-☐ pruning on the following tree. Show the (a, ☐) value of each node and indicate which branches to prune and why. The rectangles indicate "Max" nodes and circles indicate "Min" nodes.   (5)
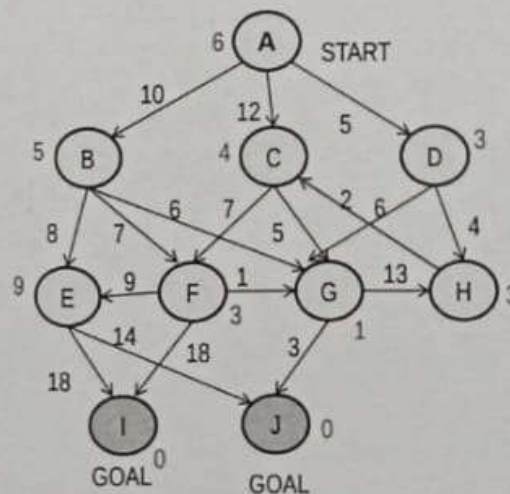

3. Let's say, you are going to spend a month in the wilderness. The only thing you are carrying is the backpack which can hold a maximum weight of 40 kg. Now you have different survival items, each having its own "Survival Points" (which are given for each item in the table). Some of the items are so essential that if you do not take them, you incur some additional penalty.

Here is the table giving details about each item.

Item	Weight	Survival Value	Penalty if not taken
Sleeping Bag	30	20	0
Rope	10	10	0
Bottle	5	20	0
Torch+Battery	15	25	-20
Glucose	5	30	0
Pocket Knife	10	15	-10
Umbrella	20	10	0

Formulate this as a genetic algorithm problem where your objective is to maximize the survival points. Write how you would represent the chromosomes, fitness function, crossover and mutation.   (3+2+2+1)

4. The following is a representation of a search problem. There is a heuristics h which is marked beside every node whereas the path costs are marked beside every edge. Run A* on this search space and show the final path with steps.   (6)

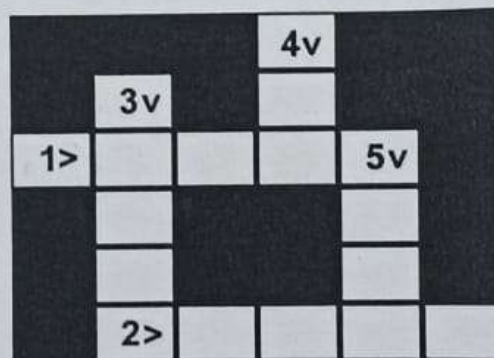Clarification: h(A)=6, h(B)=5, h(C)=4, h(D)=3, h(E)=9, h(F)=3, h(G)=1, h(H)=3, h(I)=h(J)=0

5. Consider the following axioms:
   a. All hounds howl at night.
   b. Anyone who has any cats will not have any mice.
   c. Light sleepers do not have anything which howls at night.
   d. John has either a cat or a hound.
   e. (Conclusion) If John is a light sleeper, then John does not have any mice.

Prove the conclusion using the resolution refutation method. Show all required steps like conversion to CNF, skolemization etc.   (10)

6: Consider the following crossword puzzle. The arrow direction shows whether it needs to be filled horizontally and vertically from that position - for instance five letters horizontally from position 1, four letters vertically from position 5 etc. All positions should have distinct words. From each position, you need to fill up the maximum number of positions in the given direction i.e. from position 1 you have to fill up five letters horizontally, not three or four letters.

Available words: {aft, ale, eel, force, heel, hike, keel, knot, laser, lee, line, rose, roses, sails, sheet, steer, tie}

a. Define the variables and their domains.
b. Draw the constraint graph.
c. Run ARC consistency (show steps) and after that the updated domains of each variable.
d. Select the first variable to assign and which value to assign.

(2+2+4+2)