Problem (1) [20 points]
You are going grocery shopping and have a $20 budget. You are trying to buy at least 1700 calories, 38g of protein and 120% iron. Assume the grocery store comes stocked with the items listed below (can buy multiple of each).

(1) Set this up as a constraint satisfaction problem. Then (2) describe whether you think using consistency constraints and inference or a more basic search is applicable to this problem.

- Potatoes. 110 calories, 3g protein and 6% iron for $1.
- Cereal (healthy-ish). 250 calories, 6g protein, 90% iron for $3
- Beef. 290 calories, 22g protein and 15% iron for $4
Problem (2) [20 points]
Perform local beam search with 2 beams on the graph below. The initial points are indicated by diamonds (Nodes A and H) and the goal is a square (Node J). Show enough work step-by-step so that we know you are actually running local beam search.

Heuristic:
A=10
B=7
C=8
D=11
E=6
F=5
G=33
H=9
I=8
J=0
Problem (3) [20 points]
The graph shown below is of a road network of cities in the state of Virginia. The goal is to reach Fredericksburg starting from Blacksburg.
(1) What is the path basic hill-climbing will find? (Show work.)
(2) If stochastic hill-climbing is used instead, what are all the potential paths that could be taken?
Problem (4) [20 points]
Below is a picture of a tree.
(1) Indicate which leaves nodes can be pruned using alpha-beta pruning if searching left-to-right. (Show work)
(2) If the value of two leaf nodes could be swapped, what swap should you do? How many additional nodes will this allow you to prune?
Problem (5) [20 points]
Find a single payoff matrix that has all of the three following properties:

- (1) The Nash equilibrium has player 1 doing action 1 40% of the time and action 2 60% of the time.
- (2) The Nash equilibrium has player 2 doing action 1 75% of the time and action 2 25% of the time.
- (3) All numbers in the payoff matrix are unique. (i.e. two rewards cannot both be “4” but it is okay to have one reward “1” and another reward “11”.)