Section B (Use a separate answer book for this section)

2 Figure 1 is an instance of the Wumpus World, with one Wumpus (W), two pits (P) and a heap of gold (G). The agent can only perceive whether a square is breezy (b) or smelly (s). As usual, the squares surrounding a pit are breezy and those surrounding the Wumpus are smelly.

The agent can move to any of the adjacent squares from where she finds herself. If she reaches the square with the Wumpus she dies, getting utility -100. If she reaches the square with the gold she wins, getting utility +100.

The game ends if the agent dies or wins.

Initially the pits are *random*: if the agent enters a square with a random pit, she does not die immediately, but gets sent with probability $\frac{1}{6}$ to **any** square in the grid (comprising the pit square itself). After the random pit fires, it transforms into a standard pit. If the agent enters a square with a standard pit then she dies and gets utility -100.

Squares with no pit, Wumpus or gold have utility 0.

Square number [x,y] denotes the square corresponding to the x-th row and y-th column, starting counting from the bottom left corner.
The agent starts at square [1,1].

Hitting the wall has the effect of leaving the agent in the same square.

	G (b)	P (s)
(b)	P (s)	W (b)

Fig. 1: Wumpus World

a Calculate the expected utility of moving to the right from the starting square, showing the procedure you use to get to your result. Assume that the agent has perfect knowledge of the environment (i.e., she knows she is playing on the grid depicted above) and the discounting factor is 1.
[**Hint**: when entering a random pit, calculate what happens **after** the pit fires.]

b Consider now the case in which the agent starts at square $[1, 1]$, but it has only explored that one square. Calculate the expected utility of moving to the right, considering the fact that the agent knows the shape of the grid, and that there are two random pits, one Wumpus and one heap of gold scattered around and they are all in four separate squares. The agent assumes that all possible grid

configurations consistent with her knowledge have equal probability, and has a discounting factor of 1. Show the procedure you use to get to your result. [**Hint**: make use of the previous result.]

c Assume our agent moves stochastically: when she decides to move in one direction, she gets sent with probability 0.1 to any of the other directions (and thus moves where intended with probability 0.7). Assume the random pits have already fired, thus are both standard, and assume that the agent has perfect knowledge of the environment. Finally, assume a discounting factor of 0.5. Calculate the expected utility of the plan $[Right, Right]$. Again, show the procedure you use to get to your result.

The three parts carry, respectively, 35%, 35%, and 30% of the marks.