STRIPS– Solution

1) Formulate in STRIPS the planning problem of transforming the given start configuration of the eight-puzzle to the given goal configuration. (In the eight-puzzle, the empty tile can be swapped with its North, South, East or West neighbor.)

1	2	3
7		4
8	6	5

(a) Start configuration.

1	2	3
4	5	6
7	8	

(b) Goal configuration.

Answer:
We use T1, T2, . . . , T8 to denote the tiles and L1, L2, . . . , L9 to denote the possible locations for those tiles. We use the following predicates:

At(X,Y): Tile X is at location Y.

Blank(X): There is no tile at location X.

Adjacent(X,Y): Location X is adjacent to location Y.

Our only action is Move(X,Y,Z), which moves tile X from its current location Y to an adjacent location Z. It is defined as follows:

```
Action Move(X,Y,Z):
Preconditions = {At(X,Y), Blank(Z), Adjacent(Y,Z)};
Effects = {-At(X,Y), -Blank(Z), At(X,Z), Blank(Y)};
```

Start configuration:

```
At(T1, L1), At(T2, L2), At(T3, L3),
At(T7, L4), Blank(L5), At(T4, L6),
At(T8, L7), At(T6, L8), At(T5, L9),
Adjacent(L1, L2), Adjacent(L2, L3), Adjacent(L4, L5),
Adjacent(L5, L6), Adjacent(L7, L8), Adjacent(L8, L9),
Adjacent(L1, L4), Adjacent(L4, L7), Adjacent(L2, L5),
Adjacent(L5, L8), Adjacent(L3, L6), Adjacent(L6, L9),
... and the reverse of each adjacency, that is, Adjacent (L2,L1) ...
```

Goal configuration:

```
At(T1, L1), At(T2, L2), At(T3, L3),
At(T4, L4), At(T5, L5), At(T6, L6),
At(T7, L7), At(T8, L8).
```

It is also okay to add Blank(L9) to the goal configuration, even though it is not necessary. This is because our Move action always swaps the blank tile with an adjacent tile and, if the initial configuration is valid (each tile is at a different location and one location is blank), any configuration we reach from the initial configuration is also valid.

2) In the Tower of Hanoi game (`http://en.wikipedia.org/wiki/Tower_of_Hanoi`) there are three rods (pegs) and a number of disks of different sizes which can slide onto any rod. In the initial state, the disks are stacked on the first rod in ascending order of size, with the smallest on top. In the goal state, the disks are stacked on the third rod in the same order. At each turn, the player can take the topmost disk on a stack and place it on top of another stack. However, a disk may not be placed on top of a smaller disk. Formulate in STRIPS the Tower of Hanoi game played with three disks.

Answer:
We use D1, D2, D3 to denote the disks (D3 being the largest), and P1, P2, P3 to denote the pegs. We use the following predicates:

On(X,Y): Disk X is on disk/peg Y. For instance, On(D3, P1) means that the largest disk is the lowermost disk on the first peg.

Clear(X): There is no disk on top of disk/peg X.

Smaller(X,Y): Disk X is smaller than disk/peg Y (disk X can be placed on top of disk/peg Y). Notice that Y can be a peg, since any disk can be placed on any empty peg.

Our only action is Move(X,Y,Z), which moves disk X from its current position (on top of Y) to the top of Z. It is defined as follows:

```
Action Move(X,Y,Z):
Preconditions = {Clear(X), On(X,Y), Clear(Z), Smaller(X,Z)};
Effects = {-On(X,Y), Clear(Y), On(X,Z), -Clear(Z)};
```

Start configuration:

```
On(D1, D2), On(D2, D3), On(D3, P1),
clear(D1), clear(P2), clear(P3),
Smaller(D1, D2), Smaller(D1, D3), Smaller(D2, D3),
Smaller(D1, P1), Smaller(D1, P2), Smaller(D1, P3),
Smaller(D2, P1), Smaller(D2, P2), Smaller(D2, P3),
Smaller(D3, P1), Smaller(D3, P2), Smaller(D3, P3).
```

Note that we have also specified that any disk is smaller than any peg.

Goal configuration:

```
On(D1, D2), On(D2, D3), On(D3, P3).
```

It is also okay to add Clear(D1), Clear(P1), Clear(P2) to the goal configuration, even though it is not necessary (similar to Problem 1).