

## Problem 1

(a)

Depth-first search

Action (state)	Frontier
Start (empty state)	$\{\}$ $\{D\}$
Pop D	$\{M\}$
Pop M	$\{J\}$ $\{T, J\}$ $\{X, T, J\}$ $\{V, X, T, J\}$ $\{P, V, X, T, J\}$ $\{F, P, V, X, T, J\}$ $\{B, F, P, V, X, T, J\}$
Pop B	$\{I, F, P, V, X, T, J\}$ $\{K, I, F, P, V, X, T, J\}$
Pop K	$\{B, I, F, P, V, X, T, J\}$ $\{H, B, I, F, P, V, X, T, J\}$ $\{R, H, B, I, F, P, V, X, T, J\}$ $\{V, R, H, B, I, F, P, V, X, T, J\}$
Pop V	$\{S, R, H, B, I, F, P, V, X, T, J\}$
Pop S	$\{R, H, B, I, F, P, V, X, T, J\}$ $\{J, R, H, B, I, F, P, V, X, T, J\}$ $\{L, J, R, H, B, I, F, P, V, X, T, J\}$ $\{H, L, J, R, H, B, I, F, P, V, X, T, J\}$
Pop H	$\{L, J, R, H, B, I, F, P, V, X, T, J\}$ $\{E, L, J, R, H, B, I, F, P, V, X, T, J\}$ $\{Q, E, L, J, R, H, B, I, F, P, V, X, T, J\}$ $\{A, Q, E, L, J, R, H, B, I, F, P, V, X, T, J\}$
Pop A	$\{Q, E, L, J, R, H, B, I, F, P, V, X, T, J\}$ $\{L, Q, E, L, J, R, H, B, I, F, P, V, X, T, J\}$
Pop L	$\{Q, E, L, J, R, H, B, I, F, P, V, X, T, J\}$ $\{C, Q, E, L, J, R, H, B, I, F, P, V, X, T, J\}$ $\{I, C, Q, E, L, J, R, H, B, I, F, P, V, X, T, J\}$ $\{W, I, C, Q, E, L, J, R, H, B, I, F, P, V, X, T, J\}$ $\{U, W, I, C, Q, E, L, J, R, H, B, I, F, P, V, X, T, J\}$

Pop U	{W,I,C,Q,E,L,J,R,H,B,I,F,P,V,X,T,J} {R,W,I,C,Q,E,L,J,R,H,B,I,F,P,V,X,T,J}
Pop R	SOLUTION! D -> M -> B -> K -> V -> S -> H -> A -> L -> U -> R

**(b)**

Iterative-Deepening Search

Expand node	Frontier list
	{D}
D not goal	{M}
M not goal	no expand
D no test	{M}
M no test	{B,F,P,V,X,T,J}
B not goal	{F,P,V,X,T,J}
F not goal	{P,V,X,T,J}
P not goal	{V,X,T,J}
V not goal	{X,T,J}
X not goal	{T,J}
T not goal	{J}
J not goal	{}
D no test	{M}
M no test	{B,F,P,V,X,T,J}
B no test	{K,I,F,P,V,X,T,J}
K not goal	{I,F,P,V,X,T,J}
I not goal	{F,P,V,X,T,J}
F no test	{Q,C,P,V,X,T,J}

Q not goal	{C,P,V,X,T,J}
C not goal	{P,V,X,T,J}
P no test	{W,V,X,T,J}
W not goal	{V,X,T,J}
V no test	{K,S,X,T,J}
K not goal	{S,X,T,J}
S not goal	{X,T,J}
X no test	{Q,T,J}
Q not goal	{T,J}
T no test	{I,W,J}
I not goal	{W,J}
W not goal	{J}
J no test	{C,S}
C not goal	{S}
S not goal	{}
D no test	{M}
M no test	{B,F,P,V,X,T,J}
B no test	{K,I,F,P,V,X,T,J}
K no test	{V,R,H,I,F,P,V,X,T,J}
V not goal	{R,H,I,F,P,V,X,T,J}
R goal!	Solution: D -> M -> B -> K -> R

**(c)**

If this heuristic is accepted, we could place the knight in (0,4) and the bishop in (4,0). This heuristic would be calculated as  $|0-4| + |4-0| = 8$ .

However, we could move the knight to the bishop in four steps like so: (1,2),

(2,0), (3,2), (4,0).

This means that we can have a lower-cost solution than the heuristic predicts, meaning that this is NOT an admissible heuristic for this board.

(d)

State (n)	Order	g(n)	h(n)	f(n)	Expanded	Frontier
D	1	0	4	4	{D}	{M}
M	2	1	1	2	{D,M}	{}
B		2	4	6		{B}
F		2	4	6		{B,F}
P		2	2	4		{P,B,F}
V		2	2	4		{P,V,B,F}
X		2	2	4		{P,V,X,B,F}
T		2	2	4		{P,T,V,X,B,F}
J		2	4	6		{P,T,V,X,B,F,J}
P	3	2	2	4	{D,M,P}	{T,V,X,B,F,J}
W		3	1	4		{T,V,W,X,B,F,J}
T	4	2	2	4	{D,M,P,T}	{V,W,X,B,F,J}
I		3	3	6		{V,W,X,B,F,I,J}
V	5	2	2	4	{D,M,P,T,V}	{W,X,B,F,I,J}
K		3	3	6		{W,X,B,F,I,J,K}
S		3	1	4		{S,W,X,B,F,I,J,K}
S	6	3	1	4	{D,M,P,T,V,S}	{W,X,B,F,I,J,K}
H		4	2	6		{W,X,B,F,H,I,J,K}
L		4	2	6		{W,X,B,F,H,I,J,K,L}

W	7	3	1	4	{D,M,P,T,V,S,W }	{X,B,F,H,I,J,K, L}
N		4	2	6		{X,B,F,H,I,J,K, L,N}
X	8	2	2	4	{D,M,P,T,V,S,W ,X}	{B,F,H,I,J,K,L, N}
Q		3	1	4		{Q,B,F,H,I,J,K, L,N}
Q	9	3	1	4	{D,M,P,T,V,S,W ,X,Q}	{B,F,H,I,J,K,L, N}
B	10	2	4	6	{D,M,P,T,V,S,W ,X,Q,B}	{F,H,I,J,K,L,N}
F	11	2	4	6	{D,M,P,T,V,S,W ,X,Q,B,F}	{H,I,J,K,L,N}
C		3	3	6		{C,H,I,J,K,L,N}
C	12	3	3	6	{D,M,P,T,V,S,W ,X,Q,B,F,C}	{H,I,J,K,L,N}
H	13	4	2	6	{D,M,P,T,V,S,W ,X,Q,B,F,C,H}	{I,J,K,L,N}
A		5	5	10		{I,J,K,L,N,A}
E		5	5	10		{I,J,K,L,N,A,E}
I	14	3	3	6	{D,M,P,T,V,S,W ,X,Q,B,F,C,H,I}	{J,K,L,N,A,E}
R		4	0	4		{R,J,K,L,N,A,E }
R	15	4	0	4	{D,M,P,T,V,S,W ,X,Q,B,F,C,H,I}	{J,K,L,N,A,E}
Succe ss!	D ->	M- >	T - >	I ->	R	