1. Problem 1
   a.

Q1(A,1)	Q1(A,2)	Q1(A,3)	Q1(B,1)	Q1(B,2)	Q1(B,3)
0	2	0	6	0	3
Q2(A,1)	Q2(A,2)	Q2(A,3)	Q2(B,1)	Q2(B,2)	Q2(B,3)
6	4	4	10	2	7

   b. Let $\pi^*(s) = argmax_a Q^*(s,a)$

   The optimal policy at the ith iteration is the highest q-state utility starting at an action a

   $\pi_1(A) = 2$, $Q_1(A,2)$ has the max of 2

   $\pi_2(B) = 1$, $Q_1(B,1)$ has the max of 6

   $\pi_1(A) = 1$, $Q_1(A,1)$ has the max of 6

   $\pi_2(B) = 1$, $Q_1(B,1)$ has the max of 10

2. Problem 2

$Q(s,a) = (1-\alpha) * Q(s,a) + \alpha * [R + Y max_a Q(s',a')]$

$Q(s_1, up) = .2 * 4 + .8 * [0 + .3 * 8] = 2.72$

$Q(s_4, right) = .2 * 8 + .8 * [0 + .3 * 16] = 5.44$

$Q(s_5, down) = .2 * 4 + .8 * [0 + .3 * 10] = 3.2$

$Q(s_2, right) = .2 * 10 + .8 * [0 + .3 * 20] = 6.8$

$Q(s_3, up) = .2 * 20 + .8 * [20 + .3 * 0] = 20.0$

3. Problem 3
   a. $P(A) = P(X_1 = A) = P(X_1 = A|X_0 = A) * P(X_0 = A) + P(X_1 = A|X_0 = B) * P(X_0 = B) = 0.7$

      $P(B) = P(X_1 = B) = P(X_1 = B|X_0 = A) * P(X_0 = A) + P(X_1 = B|X_0 = B) * P(X_0 = B) = 0.3$

   b. $P(A) = P(X = A) = P(X = A|X_{-1} = A) * P(X = A) + P(X = A|X_{-1} = B) * P(X = B)$

      $P(B) = P(X = B) = P(X = B|X_{-1} = A) * P(X = A) + P(X = B|X_{-1} = B) * P(X = B)$

   $P(X = A|X_{-1} = A) + P(X = A|X_{-1} = B)\frac{P(X=B)}{P(X=A)} = 1$

   $P(X = B|X_{-1} = A) * \frac{P(X=A)}{P(X=B)} + P(X = B|X_{-1} = B) = 1$

   $.8 + .6 * \frac{P(X=B)}{P(X=A)} = .4 + .2\frac{P(X=A)}{P(X=B)}$

   $P(A) = 3P(B)$, $P(A) + P(B) = 1$

   $P(A) = .75,\ P(B) = .25$

4. Problem 4
   a. $P(Y|X) = \frac{P(Y) * P(X|Y)}{P(X)}$

      $P((x_1, x_2)|Y)\ P(x_1|Y)\ P(x_2|Y)$

      $P((x_1, x_2)) = P(x_1) * P(x_2)$

      $P(Y|(x_1, x_2)) = \frac{P(x_1|Y) * P(x_2|Y) * P(Y)}{P(x_1) * P(x_2)}$

      $P(Y = 1|x_1 = 1, x_2 = 1) = 2 * p_1 * p_2$

b. $P(X|Y) = \frac{count(X|Y)}{count(Y)}$

$count(x_1 = 1|Y = 1) = 2$

$count(Y = 1) = 3$

max likelihood of p1 is $\frac{1}{3}$

max likelihood of p2 is $\frac{1}{3}$

max likelihood of q is $\frac{3}{10}$

5. Problem 5

$W_0 = (0, 0) = 0 * 1 + 0 * 0 = 0 -> 1$ correct classification

$W_1 = (0, 0) = 0 * 4 + 0 * 2 = 0 -> 1$ correct classification

$W_2 = (0, 0) = 0 * 0 + 0 * -1 = 0 -> 1$ incorrect, so update

$W_3 = (-4, -2) = (-4 * -1) - (2 * -1) = 6 -> 1$ incorrect, so update

$W_4 = (-3, -1) = (-3 * -2) + (-1 * 1) = 5 -> 1$ incorrect, so update

$W_5 = (-1, -2)$