2.

1) 只考虑 X_n

状态空间 $\{-2, -1, 0, 1, 2\}$

其中 2 和 -2 为终止态

	-2	-1	0	1	2
-2	1	0	0	0	0
-1	q	r	p	0	0
0	0	q	r	p	0
1	0	0	q	r	p
2	0	0	0	0	1

(为1表示状态不再变化，即游戏结束。

从整体考虑：

状态空间：(甲, 乙)：(0, 0)
(1, -1)
(-1, 1)
(2, -2)
(-2, 2)

状态转移矩阵

	(-2, 2)	(-1, 1)	(0, 0)	(1, -1)	(2, -2)
(-2, 2)	1	0	0	0	0
(-1, 1)	q	r	p	0	0
(0, 0)	0	q	r	p	0
(1, -1)	0	0	q	r	p
(2, -2)	0	0	0	0	1

(为1表示状态不再变化，即游戏结束。

2). 只能为甲一平一胜：$P(\text{两局结束}) = pr$

3.

$$G_1 = R_2 + \gamma R_3 + \cdots = 6(1+r+r^2+\cdots) = \frac{6}{1-r} = 60$$

$$G_0 = R_1 + \gamma R_2 + \cdots = R_1 + \gamma G_1 = 2 + 0.9 \times 60 = 56$$

4.

由对称性，可设：

$$V_\pi(1) = V_\pi(3) = V_\pi(5) = V_\pi(7) = m \qquad V_\pi(2) = V_\pi(6) = n \qquad V_\pi(4) = t$$

$$\begin{aligned} V_\pi(3) &= -1 + \tfrac{1}{4}[0 + V_\pi(3) + V_\pi(4) + V_\pi(6)] \\ V_\pi(4) &= -1 + \tfrac{1}{4}[V_\pi(1) + V_\pi(3) + V_\pi(5) + V_\pi(7)] \\ V_\pi(6) &= -1 + \tfrac{1}{4}[V_\pi(6) + V_\pi(6) + V_\pi(3) + V_\pi(7)] \end{aligned} \Rightarrow \begin{cases} m = -1 + \frac{1}{4}(m+t+n) \\ t = -1 + m \\ n = -1 + \frac{1}{2}m + \frac{1}{2}n \end{cases} \Rightarrow \begin{cases} m = -7 \\ t = -8 \\ n = -9 \end{cases}$$

$$q_\pi(4, \text{left}) = -1 + V_\pi(3) = -1 - 7 = -8$$

$$q_\pi(7, \text{right}) = -1 + 0 = -1$$