1. $G_0 = r(s_0,a_0) + \gamma r(s_1,a_1) + \gamma^2 r(s_2,a_2) + \gamma^3 r(s_3,a_3)$
$= 2 + (0.9)(0) + (0.9)^2(-1) + (0.9)^3(5)$
$= 2 + (0.9)^2(-1 + 0.9(5))$
$= 4.835$

$G_0 = 4.835$
$G_1 = 3.15$
$G_2 = 3.5$
$G_3 = 5$

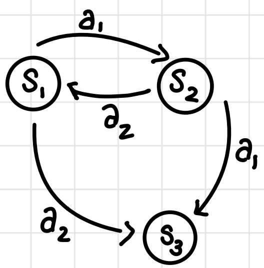
$G_1 = r(s_1,a_1) + \gamma r(s_2,a_2) + \gamma^2 r(s_3,a_3)$
$= 0 + (0.9)(-1) + (0.9)^2(5)$
$= 0.9(-1 + 0.9(5))$
$= 3.15$

$G_2 = r(s_2,a_2) + \gamma r(s_3,a_3)$
$= -1 + (0.9)(5)$
$= 3.5$

$G_3 = r(s_3,a_3) = 5$

2. Not always. If a state has more than one action that can be taken from it, and at least two of those options are equally optimal (and the most optimal), there could be two or more optimal policies. For example, if State s_0 has action 1 and action 2 such that $v_1(s_1) = \max[2,2]$, the there are 2 optimal policies (not 1 unique one).

3.



$v_k(s_3) = 0$; all $v_k(s) = 0$ initial

$V_1(s_1) = 5$
$V_1(s_2) = 2$
$V_1(s_3) = 0$

$$v_1(s_1) = \max\left[\overset{a_1}{(5 + 0.9 V_0(s_2))}, \overset{a_2}{(3 + 0.9 V_0(s_3))}\right]$$
$$= \max[(5 + 0.9 \cdot 0), (3 + 0.9 \cdot 0)]$$
$$= 5$$

$$v_1(s_2) = \max\left[\overset{a_1}{(2 + 0.9 V_0(s_3))}, \overset{a_2}{(0 + 0.9 V_0(s_1))}\right]$$
$$= \max[(2 + 0.9 \cdot 0), (0 + 0.9 \cdot 0)]$$
$$= 2$$