1. a) $\frac{dx}{dt}+\frac{dy}{dt}+\frac{dz}{dt}=rxz+ryz-rxz-ryz=0$

b) $\frac{dx}{dt}=rx(N-x-y)$

$\frac{dy}{dt}=ry(N-x-y)$

c) $0=rx(N-x-y)$ when $x=0$ or $x+y=N$

$0=ry(N-x-y)$ when $y=0$ or $x+y=N$

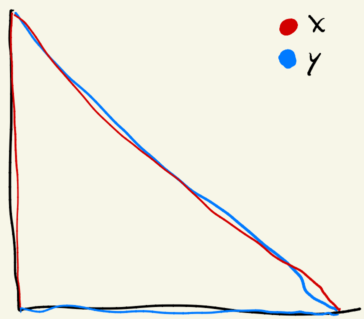
Steady when $x=y=0$ or $x+y=N$

d) $J=\begin{bmatrix} rN-2rx-ry & rx \\ ry & rN-2ry-rx \end{bmatrix}$

$J_{0,0}=\begin{bmatrix} rN & 0 \\ 0 & rN \end{bmatrix}$

$\lambda=rN$ (0,0) is stable when $r<0$

e)



f) when $r>0$ $x+y=N$ is stable meaning everyone will become radical

when $r<0$ $x=y=0$ is stable meaning everyone will become centrist

when $r=0$ all points are stable meaning nothing will change

2. a) The first term makes the lovers tend towards Ø

The second term is a constant increase in love. The first and second term cause the lovers to tend towards $A_{S,R}$

The third term represents a preference for a lovers partner to be around 1

b) when $S=0$ & $R>0$

$\frac{dS}{dt}=0+A_S+kRe^{-R}$ is positive
$\quad\quad + \quad +$

$\frac{dR}{dt}=0+A_R+kSe^{-S}$ is positive
$\quad\quad + \quad +$

neither axis can be crossed from the 1st quadrent

c) $J=\begin{bmatrix} -1 & k(1-S)e^{-S} \\ k(1-R)e^{-R} & -1 \end{bmatrix}$

$J_{0,0}=\begin{bmatrix} -1 & k \\ k & -1 \end{bmatrix}$

$\lambda^2+2\lambda+1-k^2$

$\frac{-\cancel{2}\pm\sqrt{\cancel{4-4}+\cancel{4}k^2}}{\cancel{2}}$

$-1\pm k$ if $k>1$, unstable

$k<1$, stable