1.)

a.) $y' = -2 - y$

we know this because the slope at $y = -2$ must be zero
$y > -2$ must have a negative slope,
$y < -2$ must have a positive slope

$y = -2$	0
$y > 2$	$-$
$y < 2$	$+$

b.) $y' = 1 - 2y$

Slope at $y = 0.5$ must be zero.
$y > 0.5$ must be negative
$y < 0.5$ must be positive

$y = 0.5$	0
$y < 0.5$	$+$
$y > 0.5$	$-$

2.)

a.) see attached figure

b.) as t becomes larger, solutions aproach the general solution.

c.)

$$\frac{dy}{dx} + 2y = t \quad \therefore \mu = e^{\int 2\, dt} = e^{2t}$$

$$\frac{d}{dx}\left(e^{2t} y\right) = e^{2t} t \quad \therefore \quad u = t \quad v = e^{2t}/2$$

$$du = 1 \quad dv = e^{2t}$$

$$\left(e^{2t} y\right) = \int e^{2t} t$$

$$\int e^{2t} t = \frac{e^{2t}}{2} t - \int \frac{e^{2t}}{2}$$

$$= \frac{t}{2} e^{2t} - \frac{1}{4} e^{2t} + C$$

$$= e^{2t}\left(\frac{t}{2} - \frac{1}{4}\right) + C$$

$$e^{2t} y = e^{2t}\left(\frac{t}{2} - \frac{1}{4}\right) + C$$

$$y = Ae^{-2t} + \frac{t}{2} - \frac{1}{4}$$

d.) as $t \to +\infty$, Ae^{-2t} will vanish to zero, and the term $\frac{t}{2}$ will go to $+\infty$. This means all other solutions will move towards the general solution.

3.)

a.)

$$y' = 3y - 3$$

$$y' = 3(y-1)$$

$$\frac{1}{y-1} y' = 3$$

$$\boxed{\frac{d}{dt}\left(\ln|y-1|\right) = 3}$$

b.)

$$\frac{d}{dt}\left(\ln|y-1|\right) = 3$$

$$\ln|y-1| = 3t + C$$

$$|y-1| = e^{3t+C}$$

$$y-1 = Ae^{3t}$$

$$\boxed{y = 1 + Ae^{3t}}$$

c.) The constant C must be arbitrary for us to be able to remove the absolute value sign around $|y-1|$, because if $C \in [0, +\infty)$, then $y-1$ could never be negative.

d.) Sub $y = 1 + Ae^{3t}$ into $y' = 3(y-1)$

$$\boxed{y' = 3Ae^{3t} = 3(Ae^{3t} + 1 - 1) \therefore 3Ae^{3t} = 3Ae^{3t}}$$

e.) Sub in $y(0) = 3$

$$3 = 1 + Ae^{3\times 0}$$

$$3 = 1 + A$$

$$A = 2 \quad \therefore \boxed{y = 1 + 2e^{3t}}$$

Figure 1.