$$\frac{dy}{dt} = ky$$

$$\int \frac{1}{y}\frac{dy}{dt}\,dt = \int k\,dt$$

$$\int \frac{1}{y}\,dy = \int k\,dt$$

$$\ln|y| = kt + c$$

$$y = \pm e^{c} e^{kt} \qquad \text{Let } A = \pm e^{c}$$

$$y = Ae^{kt}$$

$$\frac{d^2y}{dx^2} = 2 - 6x$$

$y(0) = 1$

$y'(0) = 4$

$$\frac{dy}{dx} = 2x - 3x^2 + C$$

$$\frac{dy}{dx} = 2x - 3x^2 + 4$$

$$y = x^2 - x^3 + 4x + C$$

$$y = x^2 - x^3 + 4x + 1$$

$$\int \frac{9r^2}{\sqrt{1-r^3}}\,dr$$

$u = 1 - r^3$

$du = -3r^2\,dr$

$$-3\int \frac{1}{\sqrt{1-r^3}}(-3r^2\,dr)$$

$$-3\int \frac{1}{\sqrt{u}}\,du$$

$$-3\int u^{-\frac{1}{2}}\,du$$

$$-3\left(2\sqrt{1-r^3}\right)+C$$

$$-6\sqrt{1-r^3}+C$$

$$-\frac{1}{2}\int_0^1 -2r\sqrt{1-r^2}\,dr$$

$$-\frac{1}{2}\int_1^0 u^{\frac{1}{2}}\,du$$

$$-\frac{1}{2}\left[\frac{2}{3}u^{\frac{3}{2}}\right]_1^0$$

$$\frac{1}{3}$$

Let $u = 1-r^2$

$du = -2r\,dr$

$u = 1-0^2$

$= 1$

$u = 1-1^2$

$= 0$

$$y = y_0 e^{-kt}$$

$$y_0 e^{-kt} = \frac{1}{2} y_0$$

$$\frac{1}{2} = e^{-kt}$$

$$\ln \frac{1}{2} = -kt$$

$$\frac{\ln 2}{t} = k$$