## 1.1

$$\frac{dN}{dt} = R(T) = \Gamma N(t) - \beta N(t)^2 \tag{1}$$

$$N_0 = 1E5 = 100000$$

### A:

Taking $\beta$ to be 0,

$$\frac{dN}{dt} = \Gamma N(t) \tag{2}$$

$$\int \frac{dN}{N(t)} = \int \Gamma dt$$

$$N(t) = Ce^{\Gamma t}$$

Using the baoundary condition $N(0) = N_0, C = N_0$

$$N(t) = N_0 e^{\Gamma t} = N_0 e^{\frac{t}{\tau}} \tag{3}$$

Finding halflife $N(T_{1/2}) = 2N_0$

$$2N_0 = N_0 e^{\frac{T_{1/2}}{\tau}}$$

$$ln(2) = \frac{T_{1/2}}{\tau}$$

The relation between halflife and lifetime then becomes

$$\boxed{T_{1/2} = \tau ln(2)} \tag{4}$$

### B:

### C:

### D:

Starting at $Eq.1$

$$\int \frac{dN}{\Gamma N(t) - \beta N(t)^2} = \int dt$$

$$ln(\frac{\Gamma}{\Gamma - \beta N}) + ln(\frac{\Gamma - \beta N}{\Gamma} - 1) = \Gamma t + C$$

Solve for $N$,

$$ln(1 - \frac{\Gamma}{\Gamma - \beta N}) = \Gamma t + C$$

$$N(t) = \frac{\Gamma C e^{\Gamma t}}{\beta C e^{\Gamma t} - \beta}$$

Again using the boundary condition that $N(0) = N_0$, $C = \frac{N_0 \beta}{N_0 \beta - \Gamma}$

$$N(t) = \frac{\Gamma \frac{N_0 \beta}{N_0 \beta + \Gamma} e^{\Gamma t}}{\beta \frac{N_0 \beta}{N_0 \beta + \Gamma} e^{\Gamma t} - \beta} \tag{5}$$

Where $\beta = 4E - 8$. The equation for the asymptote is $R(t) = 0$ or

$$N(t) = \frac{\Gamma}{\beta} \tag{6}$$