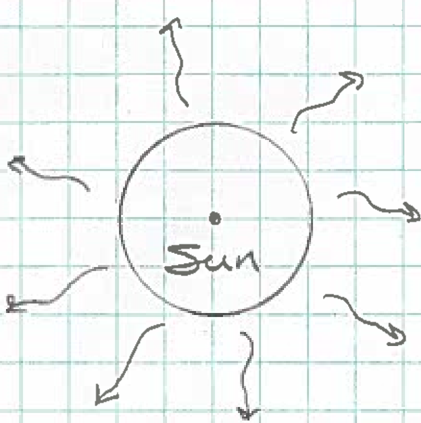

$L_\odot = 3.8 \times 10^{26}$ W

$M_\odot = 2 \times 10^{30}$ kg

a.) The energy of the sun is from fusion which converts mass into energy according to:

$$E = mc^2$$

So

$$\frac{dE}{dt} = L_\odot = c^2 \frac{dm}{dt}$$

$$\frac{dm}{dt} = \frac{L_\odot}{c^2} = 4.22 \times 10^9 \frac{\text{kg}}{\text{s}} \left(\frac{3600\text{s}}{1\text{hr}}\right)\left(\frac{24\text{ hr}}{1\text{ day}}\right)\left(\frac{365.25\text{d}}{1\text{y}}\right)$$

$$= 1.33 \times 10^{17} \frac{\text{kg}}{\text{year}}$$

b.) In one year, the fraction of total mass lost is:

$$\frac{1.33 \times 10^{17}\text{ kg}}{M_\odot} = 6.66 \times 10^{-14} = 6.66 \times 10^{-12}\ \%$$

c.) At this rate, the Sun will fuse all of its hydrogen in time

$$T = \frac{M_\odot}{dm/dt} = \underline{1.50\times10^{13}\ \text{years}}$$

However, for a star the size of the Sun, not all of hydrogen fuses. Only the hydrogen in core fuses, and this will be used up in a time of ~10 billion years which is ~5 billion years from now. The Sun will expand into its Red Giant phase after that.

However, using the rather imprecise numbers here:

Amount of H fused, $M_H = 0.001\,M_\odot = 2\times10^{27}$ kg

at the rate: $\frac{dm}{dt} = 1.33\times10^{17}$ kg/y

Given, $\text{Lifetime} = \frac{M_H}{dm/dt} = 1.5\times10^{10}$ y $= 15$ billion y