(a) Diffusion time $t_D \cong \dfrac{x^2}{4\alpha}$

Using $x \cong \dfrac{R}{2} = 0.05m, \quad \alpha = \dfrac{K}{\rho c} = \dfrac{0.68}{1000 \times 4180} = 1.63 \times 10^{-7} m^2/s$

$$t_D \cong \frac{0.05^2}{4 \times 1.63 \times 10^{-7}} = 3{,}840\ s = \underline{\underline{64\,\text{min}}}$$

This is comparable to "normal cooking times", so the heat is diffusing throughout this time, and an <u>isothermal</u> model would not be right. In fact, we expect the outside to be better cooked than the inside, which sounds right.

(b) $M_{chicken.} = \dfrac{4}{3}\pi R^3 \rho = \dfrac{4}{3}\pi \times 0.1^3 \times 1000 = 4.19kg$

$$M_{ch.} c \frac{dT}{dt} = Q \qquad \text{(heat input)}$$

Take $c = 4180 \dfrac{J}{KgK}, Q = 1000W$, integrate

$$T - T_o = \frac{Q}{M_{ch} c} t$$

$$t_{cook} = \frac{M_{ch} c (T - To)}{Q} = \frac{4.19 \times 4180 \times (373 - 273)}{1000} = 1750s = \underline{\underline{29.2\,\text{min}}}$$

(c) In the Microwave case, t_{cook} is indeed proportional to chicken mass. But for the regular radiant oven, $t_D \sim R^2 \sim M_{ch}^{2/3}$. Doubling the mass increases the cooking time only by $2^{2/3} = 1.68$, so if you follow the cookbook guidelines, your turkey will be overdone.