Problem 10.88 (14th ed.), 10.90 (13th ed.), 10.92 (12th ed.), 10.82 (11th ed.), 10.80 (10th ed.)

We can relate the rates of effusion of two gases to their molar masses and temperatures:

$$\left(\frac{r_2}{r_1}\right) = \left(\frac{M_1 * T_2}{M_2 * T_1}\right)^{1/2} \qquad \text{Eqn 1:}$$

You can relate rate to the time it takes to effuse (inversely related)
- using volume/time (L/t) as our rate we get the following:

$$\left(\frac{r_2}{r_1}\right) = \left(\frac{(L_2 / t_2)}{(L_1 / t_1)}\right) = \left(\frac{(L_2 * t_1)}{(L_1 * t_2)}\right) \qquad \text{Eqn 2:}$$

Since in this case the volumes effusing are the same, $L_2 = L_1$, we get the following:

$$\left(\frac{r_2}{r_1}\right) = \left(\frac{t_1}{t_2}\right) = \left(\frac{M_1 * T_2}{M_2 * T_1}\right)^{1/2} \qquad \text{Eqn 3:}$$

Since the temperatures are equal, we get the following:

$$\left(\frac{r_2}{r_1}\right) = \left(\frac{t_1}{t_2}\right) = \left(\frac{M_1}{M_2}\right)^{1/2} \qquad \text{Eqn 4:}$$

This is the step where the manual made a mistake by putting t2/t1 initially, although it "self-corrected" in the next step.

$$\left(\frac{r_X}{r_{O2}}\right) = \left(\frac{t_{O2}}{t_X}\right) = \left(\frac{M_{O2}}{M_X}\right)^{1/2} \qquad \text{Eqn 5:}$$

This then rearranges to the following, which is what the solutions manual does have.

$$M_X = \left(\frac{t_X}{t_{O2}}\right)^2 M_{O2} = \left(\frac{105s}{31s}\right)^2 (32.00) = 367 = 3.7x10^2$$