Solution to Problem 10.80

The rate of effusion is inversely proportional to the time a given amount of gas takes to effuse. Thus,

$$\frac{v_1}{v_2} = \sqrt{\frac{M_2}{M_1}} = \frac{t_2}{t_1}$$

For this problem, we can write,

$$\frac{t_x}{t_{O_2}} = \sqrt{\frac{M_x}{M_{O_2}}}$$

Squaring both sides and solving for the molar mass of the unknown gas, we have

$$M_x = \left(\frac{t_x}{t_{O_2}}\right)^2 M_{O_2}$$

From this it follows

$$M_x = \left(\frac{105\,\text{s}}{31\,\text{s}}\right)^2 (32.0\,\text{g/mol}) = (3.3_{87})^2(32.0\,\text{g/mol}) = 367\,\text{g/mol} = 3.7\times10^2\,\text{g/mol}$$

The answer should have two significant figures, owing to the two significant figures of 31 s.