9.12) FOR H_2 AT 293K a) FIND v_{mp}, THEN USE THE APPROXIMATION IN EXAMPLE 9.4 TO DETERMINE THE FRACTION OF MOLECULES IN THE RANGES 0.9 TO 1.1.
b) $0.8\,v_{mp}$ TO $1.2\,v_{mp}$, c) 0.5-$0.6\,v_{mp}$, AND d) 1.5-$1.6\,v_{mp}$

a) FOR A CLASSICAL GAS AND $M_{H_2} = 2(1.008\,u)(1.66\times10^{-27}) = 3.35\times10^{-27}\,kg$

$$v_{mp} = \sqrt{\frac{2kT}{m}} = \sqrt{\frac{2(1.38\times10^{-23})(293)}{3.35\times10^{-27}}} = 1553.7\ \frac{m}{s}$$

b) - d) USING THE APPROXIMATION

$$P = F(v)\,\Delta v\Big|_{v_0} = 4\pi\left(\frac{m}{2\pi kT}\right)^{3/2} e^{-\frac{1}{2}\left(\frac{mv^2}{kT}\right)} v^2\,\Delta v\Big|_{v_0}$$

EVALUATE FACTORS:

$$4\pi\left(\frac{m}{2\pi kT}\right)^{3/2} = 4\pi\left(\frac{3.35\times10^{-27}}{2\pi(1.38\times10^{-23})(293)}\right)^{3/2} = 4\pi\left(4.79\times10^{-11}\right)$$

$$= 6.02\times10^{-10}\ \frac{s^3}{m^3}$$

$$\left(\frac{m}{2kT}\right) = \frac{3.35\times10^{-27}}{4(1.38\times10^{-23})(293)} = 4.14\times10^{-7}\ \frac{s^2}{m^2}$$

$$\Rightarrow P = \left(6.01\times10^{-10}\right) e^{-(4.14\times10^{-7})v^2} v^2\,\Delta v\Big|_{v_0}$$

THEN FOR v_0 = THE CENTER OF EACH SPAN

b) $v_0 = v_{mp}$, $\Delta v = 0.1\,v_{mp}$

$$P_{0.95\text{-}1.05\,v_{mp}} = \left(6.01\times10^{-10}\right) e^{-(4.14\times10^{-7})(1553.7)^2} (1553.7)^2\,(155.4)$$

$$\boxed{P_{0.95\text{-}1.05\,v_{mp}} = 0.0830 \Rightarrow 8.3\%\ \text{OF PARTICLES IN THIS SPAN}}$$

c) $v_0 = 0.55\,v_{mp}$, $\Delta v = 0.1\,v_{mp}$

$$P_{0.5\text{-}0.6\,v_{mp}} = \left(6.01\times10^{-10}\right) e^{-(4.14\times10^{-7})(854.5)^2} (854.5)^2\,(155.4)$$

$$\boxed{P_{0.5\text{-}0.6\,v_{mp}} = 0.0504 \Rightarrow 5.04\%\ \text{OF PARTICLES IN THIS SPAN}}$$

d) $v_0 = 1.55\,v_{mp}$, $\Delta v = 0.1\,v_{mp}$

$$P_{1.5\text{-}1.6\,v_{mp}} = \left(6.01\times10^{-10}\right) e^{-(4.14\times10^{-7})(2408)^2} (2408)^2\,(155.4)$$

$$\boxed{P_{1.5\text{-}1.6\,v_{mp}} = 0.0491 \Rightarrow 4.9\%\ \text{OF PARTICLES IN THIS SPAN}}$$