Waves on a rope

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Solution: *a. We have,*

$$v = \lambda_n f_n = \frac{2L}{n} f_n \ .$$

Hence, $v_1 = 2Lf_1 = 2$ *km/s.*
b. To calculate the frequency, we let,

$$v' = \lambda_3 f_3 = \frac{2L}{3} f_3 \ .$$

Hence, $f_3 = \frac{3v_1'}{2L} = 3$ *kHz.*
c. We have,

$$v' = \sqrt{\frac{m'g}{\mu}} = \sqrt{2}\sqrt{\frac{mg}{\mu}} = \sqrt{2}v \ .$$

Hence, $v_1' = 2.82$ *km/s.*
d. We have,

$$3 = \frac{v'}{v} = \sqrt{\frac{m'g}{\mu}\frac{\mu}{mg}} = \sqrt{\frac{m'}{m}} \ .$$

Hence, $m' = 9m \approx 9$ *kg.*