

STEP III, 2013 , Q11 MS

11. As the distance from the vertex to the centre of the equilateral triangle is a , the extended length of each spring is $\frac{a}{\cos \theta}$ giving the tension in each as $kmg \frac{\left(\frac{a}{\cos \theta} - a\right)}{a}$ which simplifies to the given result. Resolving vertically $3T \sin \theta = 3mg$, and using the result for T , substituting $\theta = \frac{\pi}{6}$, and rationalising the denominator gives the required value for k . Conserving energy, when $\theta = \frac{\pi}{3}$,

gravitational potential energy is $-3mga \tan \frac{\pi}{3}$, elastic potential energy is $\frac{3}{2} kmg \frac{\left(\frac{a}{\cos \frac{\pi}{3}} - a\right)^2}{a} = \frac{3}{2} kmga \left(\frac{1}{\cos \frac{\pi}{3}} - 1\right)^2$, whereas when $\theta = \frac{\pi}{6}$, gravitational potential energy is $-3mga \tan \frac{\pi}{6}$, elastic potential energy is $\frac{3}{2} kmga \left(\frac{1}{\cos \frac{\pi}{6}} - 1\right)^2$, and kinetic energy is $\frac{3}{2} mV^2$ hence giving V^2 .



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