Answer on Question 60519, Physics, Mechanics, Relativity

Question:

When a mass of $40\ g$ is attached to a vertically hanging spring it extends by $0.4\ cm$. Find:

1) Force constant of the spring.

2) The extension when $100\ g$ weight is attached to it.

3) The time period of oscillation of $100\ g$ weight on it.

4) The time period and force constant if the spring is cut in three equal parts and $100\ g$ weight is made to oscillate on one part.

Solution:

1) We can find the force constant of the spring from the Hooke's law:

$$F = kx,$$

here, F is the force acting on the spring, k is the spring constant (force constant of the spring), x is the extension of the spring.

From the other hand, $F = mg$, and substituting it into the first equation we get :

$$mg = kx,$$

$$k = \frac{mg}{x} = \frac{0.04\ kg \cdot 9.8\ \frac{m}{s^2}}{0.004\ m} = 98\ \frac{N}{m}.$$

2) As we know the force constant of the spring, we can find from the previous formula the extension of the spring when $100\ g$ weight is attached to it:

$$x = \frac{mg}{k} = \frac{0.1\ kg \cdot 9.8\ \frac{m}{s^2}}{98\ \frac{N}{m}} = 0.01\ m.$$

3) We can find the time period of oscillation of $100\ g$ weight from the formula:

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{0.1\ kg}{98\ \frac{N}{m}}} = 0.2\ s.$$

4) Let's assume, that $F = k_{big}x_{big}$ is the force that act on the spring. Then, the spring is divided to three equal small springs. The force that act on each of these small springs is the same (equal to the force that act on the whole spring) and must be equal to $F = k_{small}x_{small}$. Because $x_{small} = \frac{x_{big}}{3}$ we get:

$$k_{big}x_{big} = k_{small}x_{small},$$

$$k_{big}x_{big} = k_{small}\frac{x_{big}}{3},$$

$$k_{big} = \frac{k_{small}}{3},$$

$$k_{small} = 3k_{big} = 3 \cdot 98\ \frac{N}{m} = 294\ \frac{N}{m}.$$

Then, we can find the time period:

$$T_{new} = 2\pi\sqrt{\frac{m}{3k_{big}}} = 2\pi\sqrt{\frac{0.1\ kg}{3 \cdot 98\ \frac{N}{m}}} = 0.11\ s.$$

Answer:

1) $k = 98\ \frac{N}{m}$.

2) $x = 0.01\ m$.

3) $T = 0.2\ s$.

4) $k_{small} = 294\ \frac{N}{m}$, $T_{new} = 0.11\ s$.