

Question 6.

State Newton's second law of motion.

The equation $F = -ks$, where k is a constant, is an expression for a law that governs the motion of a body.

Name this law and give a statement of it.

Give the name for this type of motion and describe the motion.

A mass at the end of a spring is an example of a system that obeys this law. Give two other examples of systems that obey this law.

The springs of a mountain bike are compressed vertically by 5 mm when a cyclist of mass 60 kg sits on it. When the cyclist rides the bike over a bump on a track, the frame of the bike and the cyclist oscillate up and down.

Using the formula $F = -ks$, calculate the value of k , the constant for the springs of the bike.

The total mass of the frame of the bike and the cyclist is 80 kg. Calculate (i) the period of oscillation of the cyclist, (ii) the number of oscillations of the cyclist per second.

(Acceleration due to gravity = 9.8 m s^{-2})



State Newton's second law of motion.

If a resultant force act on a body, the magnitude of the resultant force is proportional to the rate of change of the body's momentum and its direction is the direction of the momentum change.

The equation $F = -ks$, where k is a constant, is an expression for a law that governs the motion of a body. Name this law and give a statement of it.

Hooke's law.

The extension of a spring is proportional to the applied load.

Give the name for this type of motion and describe the motion.

Simple harmonic motion.

In SHM the acceleration of a body is proportional to its displacement from a fixed point and is directed towards that point. ($a = -\omega^2 s$)

A mass at the end of a spring is an example of a system that obeys this law. Give two other examples of systems that obey this law.

A simple pendulum, springs of a car, an object bobbing up and down in the sea, the atoms vibrating about their fixed position in a crystal lattice.

The springs of a mountain bike are compressed vertically by 5 mm when a cyclist of mass 60 kg sits on it. When the cyclist rides the bike over a bump on a track, the frame of the bike and the cyclist oscillate up and down. Using the formula $F = -ks$, calculate the value of k , the constant for the springs of the bike

$$\begin{aligned} F &= -ks \\ 60 \times 9.8 &= -k (.005) \\ k &= 1.2 \times 10^5 \text{ N m}^{-1} \end{aligned}$$

The total mass of the frame of the bike and the cyclist is 80 kg. Calculate (i) the period of oscillation of the cyclist,

Since $T = 2\pi/\omega$, we need to find ω to work out the period;

$$F = -ks \quad \Rightarrow \quad ma = -ks \quad \Rightarrow \quad m(-\omega^2 s) = -ks$$

$$\Rightarrow \omega^2 = \frac{k}{m} = \frac{1.2 \times 10^5}{80} = 1.5 \times 10^3$$

$$\Rightarrow \omega = 39 \text{ s}^{-1}$$

$$\text{Now, } T = \frac{2\pi}{\omega} = \frac{2\pi}{39} = 0.16 \text{ s}$$

(ii) the number of oscillations of the cyclist per second.

$$\text{Since } f = \frac{1}{T}$$

$$f = \frac{1}{0.16} = 6.25 \text{ oscillations per sec}$$