

Academic Physics - 12.A Hooke's Law

1. The largest meteorite of lunar origin reportedly has a mass of 19 g. If the meteorite placed on a scale whose spring constant is 83 N/m, what is the compression of the spring?
2. In 1952, a great rainfall hit the island of Reunion in the Indian Ocean. In less than 24 h, 187 kg of rain fell on each square meter of soil. If a 187 kg mass is placed on a scale that has a spring constant of  $1.53 \times 10^4$  N/m, how far is the spring compressed?
3. The largest cats are the Siberian tigers. Male Siberian tigers are reported to have an average mass of about 389 kg. By contrast, a variety of very small cat that is native to India has an average adult mass of only 1.5 kg. Suppose this small cat is placed on a spring scale, causing the spring to be extended from its equilibrium position by 1.2 mm. How far would the spring be extended if a typical male Siberian tiger were placed on the same scale?
4. The largest known crab is a giant spider crab that had a mass of 18.6 kg. The distance from the end of one of this crab's claws to the end of the other claw measured about 3.7 m. If this particular giant spider crab were hung from an elastic band so that the elongation of the band was equal to the crab's claw span, what would be the spring constant of the elastic band?
5. The CN Tower in Toronto, Canada, is 533 m tall, making it the world's tallest free-standing structure. Suppose an unusually long bungee cord is attached to the top of the CN Tower. The equilibrium length of the cord is equal to one-third the height of the tower. When a test mass of 70.0 kg is attached, the cord stretches to a length that equals two-thirds of the tower's height. From this information, determine the spring constant of the bungee cord.
6. The largest ruby in the world may be found in New York. This ruby is 109 mm long, 91 mm wide, and 58 mm thick, making its volume about  $575 \text{ cm}^3$ . (By comparison, the world's largest diamond, the Star of Africa, has a volume of just over  $30 \text{ cm}^3$ .)
  - a. If the ruby is attached to a vertically hanging spring with a spring constant of 200 N/m so that the spring is stretched 15.8 cm what is the gravitational force pulling the spring?
  - b. What is the mass of the jewel?
7. Mauna Kea on the island of Hawaii stands 4200 m above sea level. However, when measured from the island's sea-submerged base, Mauna Kea has a height of 10,200 m, making it the tallest single mountain in the world. If you have a  $4.20 \times 10^3$  m elastic cord with a spring constant of  $3.20 \times 10^{-2}$  N/m, what force can stretch the spring to  $1.02 \times 10^4$  m?
8. Rising 348 m above the ground, La Gran Piedra in Cuba is the tallest rock on Earth. Suppose an elastic band 200 m long hangs vertically off the top of La Gran Piedra. If the band's spring constant is 25.0 N/m, how large must a mass be if, when it is attached to the band, it causes the band to stretch all the way to the ground?

Academic Physics - 12.B Pendulum

1. A simple pendulum with a length of 0.3 m would have a period of 1.16 s on Venus. Calculate the acceleration of gravity on Venus.
2. On Mars, a simple pendulum with a length of 65.0 cm would have a period of 2.62 s. Calculate the acceleration of gravity on Mars.
3. On Mercury, a simple pendulum with a length of 1.14 m would have a period of 3.55 s. What is the acceleration of gravity on Mercury?
4. A simple pendulum with a length of 50.0 cm would have a period of 2.99 s on Pluto. Calculate the acceleration of gravity on Pluto.
5. Find the length of a pendulum that oscillates with a frequency of 1.0 Hz.
6. Find the length of a pendulum that oscillates with a frequency of 0.50 Hz.
7. Find the length of a pendulum that oscillates with a frequency of 2.5 Hz.
8. Calculate the period and frequency of a 6.200 m long pendulum in Oslo, Norway, where  $g = 9.819 \text{ m/s}^2$ .
9. Calculate the period and frequency of a 2.500 m long pendulum in Quito, Ecuador, where  $g = 9.780 \text{ m/s}^2$ .
10. Calculate the period and frequency of a 3.120 m long pendulum in Cairo, Egypt, where  $g = 9.793 \text{ m/s}^2$ .

Academic Physics - 12.C Mass-Spring

1. Honeybee scouts inform other honeybees where to find food by flapping their wings and “waggle-dancing.” During part of the dance, a scout bee’s wings flap with a maximum frequency of 300 Hz. Suppose a mass is attached to a spring with a spring constant of  $8.65 \times 10^4$  N/m. How large is the mass if its oscillation frequency is the same as the wings of a waggle-dancing bee?
2. On Halloween, you see an “alien” that has one antenna made of a glittery foam ball connected to a spring. The springs oscillate with a period of 0.079 s, and have a spring constant of 63 N/m. Find the mass of the ball.
3. A farmer rides over a bumpy field on his tractor. The tractor seat is supported by a spring with a spring constant of 2031 N/m. As the farmer drives over a bump, the seat oscillates at a frequency of 0.79 Hz. For the first few seconds, the vibration approximates simple harmonic motion. Find the farmer’s mass if the tractor seat acts like a spring scale.
4. A 32 N sack of potatoes vibrates with a period of 0.42 s placed on a spring scale. What is the spring constant?
5. A 66 N pumpkin vibrates with a period of 2.9 s when attached to the end of a spring scale. What is the spring constant?
6. As the wind moves the bough of a tree, it oscillates up and down. During the first few seconds, it approximates simple harmonic motion. If the bough has a weight of 87 N and oscillates with a period of 0.64 s, what is the spring constant of the bough?
7. A certain trampoline acts like a single spring with a spring constant of 364 N/m. If a 24kg child jumps on the trampoline, what would be the period of oscillation?
8. Two children jump on their parent’s bed (when the parents are not looking). The combined mass of both kids is 55 kg. The mattress is supported by 36 springs, each with a spring constant of 458 N/m. If the children jump at the same time, what would be the period of oscillation?
9. An 8.2 kg infant is placed in a jumper that is made of a seat that is suspended from a door frame by a spring. If the spring has a spring constant of 221 N/m. Calculate the period of oscillation.
10. Your friend’s key chain is coiled like a spring. Three keys, each with a mass of 24 g, are on the chain. When your friend removes the keys from a pocket, the keys bob up and down. If the key chain has a spring constant of 99 N/m, what is the frequency of oscillation?

Academic Physics - General Wave Questions

1. The speed of sound in sea water is about 1530 m/s. If a sound wave has a frequency of 250 Hz, what is its wavelength in sea water?
2. Cicadas produce a sound that has a frequency of 123 Hz. What is the wavelength of this sound in the air? The speed of sound in air is 341 m/s.
3. Human fingers are very sensitive, detecting vibrations with amplitudes as low as  $2.0 \times 10^{-5}$  m. Consider a sound wave with a wavelength exactly 1000 times greater than the lowest amplitude detectable by fingers. What is this wave's frequency?
4. A nineteenth-century fisherman's cottage in England is only 2.54 m long. Suppose a fisherman whistles inside the cottage, producing a note that has a wavelength that exactly matches the length of the house. What is the whistle's frequency? The speed of sound in air is 334 m/s.
5. The lowest vocal note in the classical repertoire is low D ( $f = 73.4$  Hz), which occurs in an aria in Mozart's opera *Die Entführung aus dem Serail*. If low D has a wavelength of 4.50 m, what is the speed of sound in air?
6. Dolphins can hear ultrasound with frequencies up to 280 kHz. What is the speed of sound in water if the wavelength of ultrasound with a frequency of  $2.80 \times 10^5$  Hz is 0.510 cm? How long would it take this sound wave to travel to a dolphin 3.00 km away?
7. A dolphin can hear sounds with frequencies up to 280 kHz. What is the speed of sound in water if a wave with this frequency has a wavelength of 0.51 cm?
8. Waves in a lake are 6.0 m apart and pass a person on a raft every 2.0 s. What is the speed of the waves?
9. Sonar is a device that uses reflected sound waves to measure underwater depths. If a sonar signal has a frequency of 288 Hz, and the wavelength is 5.00 m, what is the speed of the sonar signal in water?
10. A buoy on the ocean bobs up and down. The waves have a wavelength of 2.5 m, and a frequency of 1.6 Hz. What is the speed of the waves?
11. A dog whistle is designed to produce a sound with a frequency beyond that which can be heard by humans (between 20 000 Hz and 27 000 Hz). If a particular whistle produces a sound with a frequency of  $2.5 \times 10^4$  Hz, what is the sound's wavelength? Assume the speed of sound in air to be 341 m/s.
12. The lowest pitch that the average human can hear has a frequency of 20.0 Hz. If sound with this frequency travels through air with a speed of 341 m/s, what is its wavelength?