

1. Fish are hung on a spring scale to determine their mass
(a) What is the force constant of the spring in such a scale if it the spring stretches 8 cm for a 10 kg load?
(b) What is the mass of a fish that stretches the spring 5.5 cm?
(c) How far apart are the half-kilogram marks on the scale?
 $k=1.23 \times 10^3$ N/m, 6.88 kg, 4 mm

8. If your heart rate is 150 beats per minute during strenuous exercise, what is the time per beat in units of seconds? 0.4 s

15. A 0.5 kg mass suspended from a spring oscillates with a period of 1.5 s. How much mass must be added to the object to change the period to 2 s? .389 kg

17. Suppose you attach the object with mass m to a vertical spring originally at rest, and let it bounce up and down. You release the object from rest at the spring's original rest length.
(a) Show that the spring exerts an upward force of $2mg$ on the object at its lowest point. (b) If the spring has a force constant of 10 N/m and a 0.25 kg mass object is set in motion as described, find the amplitude of the oscillations.
(c) Find the maximum velocity.
 $A=.245$ m; $v=1.55$ m/s

24. What is the period of a 1 m long pendulum? 2.01 s

34. If a pendulum-driven clock gains 5 s/day, what fractional change in pendulum length must be made for it to keep perfect time? 0.0116%

35. The length of nylon rope from which a mountain climber is suspended has a force constant of 1.4×10^4 N/m .

(a) What is the frequency at which he bounces, given his mass plus and the mass of his equipment is 90 kg?

(b) How much would this rope stretch to break the climber's fall if he free-falls 2 m before the rope runs out of slack?

$y = -.569$ m; $f = 1.99$ Hz

54. Radio waves transmitted through space at 3×10^8 m/s by the Voyager spacecraft have a wavelength of 0.12 m.

What is their frequency? $f = 2.5 \times 10^9$ Hz

61. A wave traveling on a Slinky that is stretched to 4 m takes 2.4 s to travel the length of the Slinky and back again.

(a) What is the speed of the wave? (b) Using the same Slinky stretched to the same length, a standing wave is created which consists of three antinodes and four nodes. At what frequency must the Slinky be oscillating?

$v = 3.33$ m/s, $f = 1.25$ Hz

62. Three adjacent keys on a piano (F, F-sharp and G) are struck simultaneously, producing frequencies of 349, 370, and 392 Hz. What beat frequencies are produced by this discordant combination?

21, 22, 43 Hz

A string is strung between two supports 1.5 m apart and then the tension is adjusted so that the wave speed is 250 m/s. When the string is vibrating in the standing wave pattern shown below:

(A) What is the wavelength? (B) What is the frequency of the fundamental? (C) Directly on the below diagram label an anti-node and show one amplitude.

wavelength = .6 m ($f = 417$ Hz), fundamental = 83.3 Hz

41. A piano tuner hears a beat every 2 s when listening to a 264 Hz tuning fork and a single piano string. What are the two possible frequencies of the string? 263.5, 264.5

64. The low frequency speaker of a stereo set has a surface area of 0.05 m^2 and produces 1 W of acoustical power. What is the intensity at the speaker? If the speaker projects sound uniformly in all directions, at what distance from the speaker is the intensity 0.1 W/m^2 ?
 20 W/m^2 ; $r = .892 \text{ m}$

$I = (\Delta p)^2 / 2\rho v$; $I_0 = 1 \text{e-}12 \text{ W/m}^2$; $\text{decibel} = 10 \log_{10}(I/I_0)$

18. (a) What is the decibel level of a sound that is twice as intense as a 90 dB sound? (b) What is the decibel level of a sound that is one-fifth as intense as a 90 dB sound?
93, 83

19. (a) What is the intensity of a sound that has a level 7 dB lower than a $4 \text{e-}9 \text{ W/m}^2$ sound? (b) What is the intensity of a sound that is 3 dB higher than a $4 \text{e-}9 \text{ W/m}^2$ sound? $7.9 \text{e-}10 \text{ W/m}^2$, $7.9 \text{e-}9 \text{ W/m}^2$

30. (a) What frequency is received by a person watching an oncoming ambulance moving at 110 km/h and emitting a steady 800 Hz sound from its siren? The speed of sound on this day is 345 m/s. (b) What frequency does she receive after the ambulance has passed?
 $\Delta f/f = 9\%$

37. What is the minimum speed at which a source must travel toward you for you to be able to hear that its frequency is Doppler shifted? That is, what speed produces a shift of 6% (semitone) on a day when the speed of sound is 331 m/s?
 $20 \text{ m/s} = 45 \text{ mph}$