VANCOUVER COMMUNITY COLLEGE

Frequency, Period & Waves

DEFINITIONS

frequency the number of cycles (the number of times something happens) per unit of time; if the unit of time is 1 s, then the unit for frequency is Hertz (Hz). In terms of base SI units, the Hertz is equivalent to s^{-1} or $\frac{1}{s}$.

period the time required for one cycle, normally measured in s; for longer periods, it may be appropriate to use units like the hour (h), day (d), . . .

wavelength the distance from one point on a wave (such as the crest) to the equivalent point on the next wave

FORMULAS

frequency: $f = \frac{\text{number of cycles}}{\text{time}} = \frac{1}{T}$

period: $T = \frac{\text{time}}{\text{number of cycles}} = \frac{1}{f}$

simple pendulum: $T = 2\pi\sqrt{\frac{l}{g}}$,

where l = length of the pendulum and g = acceleration due to gravity (10 $\frac{m}{s^2}$ for Phys 11).

wave speed: $v = f\lambda$, where λ = wavelength

EXERCISES

A. 1) If the frequency of a wave is 60.0 Hz, what is the period?

2) If the period of an event is 0.050 s, what is the frequency?

B. A pendulum makes exactly 40 oscillations in 25 s. Determine:

1) frequency 2) period

C. Determine the frequency of:

1) a ball bouncing 50 times in 38 s

2) an atom vibrating 1.3×10^{10} times in 2.5 s

3) a sound wave from a guitar string with a period of 3.50×10^{-3} s

4) a tuning fork which completes 2048 cycles in 8.00 s

5) an electric jigsaw making 3200 slices per minute

Authored by Gordon Wong

D. Determine the period of:

1) a pendulum swinging back and forth exactly 40 times in 30 s
2) a light wave with a frequency of 5.5×10^{14} Hz
3) the moon, which travels around the Earth six times in 163.8 d
4) forty waves striking the Seawall in Stanley Park in 2.0 min
5) the pulse from a human heartbeat which is heard 35 times in 12 s

E. Determine the period for these pendulums:

1) a pendulum having a length of 0.65 m
2) a pendulum suspended from the CN Tower by a light string 495 m long
3) a 75 cm-pendulum on the moon, where the acceleration due to gravity is 1.6 $^{m}/_{s^2}$

F. On a particular planet, the period of a 0.50 m pendulum is 1.8 s. What is the acceleration due to gravity on this planet?

G. Find the length of a pendulum which has a period of 2.5 s.

H. A pendulum makes 20 complete oscillations in 40 s. Find the pendulum's length.

I. A grandfather clock has a pendulum exactly 1.00 m long and kept perfect time. A spoiled brat broke the pendulum. When it was repaired, the pendulum was 98.0 cm.

1) What was the original period?
2) What is the new period?
3) Did the repaired clock lose time or gain time?
4) What would be the accumulated error after one day of operation?

J. The wavelength of a water wave in a ripple tank is 0.085 m. If the wave frequency is 3.5 Hz, what is its speed?

K. The distance between successive crests in a series of water waves is 5.0 m and the crests travel 10.0 m in 5.5 s. What is the frequency of the waves?

L. It is 24 m from trough to trough in a system of water waves. If 10 waves pass a given point each minute, determine the speed of the waves.

M. The period of a sound wave from a piano is 1.25×10^{-3} s. If the speed of the wave in air is 340 m/s, what is the wavelength?

N. A source with a frequency of 40 Hz produces water waves that have a wavelength of 1.5 cm. What is the speed of the wave?

O. A wave in a rope travels at a speed of 4.5 m/s. if the wavelength is 2.6 m, what is the period of the wave?

P. A given crest of a water wave requires 4.8 s to travel between two points on a fishing wharf 17 m apart. It is noted in a series of waves that 20 crests pass the first point in 15 s. What is the wavelength of the waves?

Q. A local pop radio station broadcasts with a frequency of 95.3 MHz. If these radio waves travel with a speed on 3.00×10^8 m/s, what is their wavelength?

SOLUTIONS

A. (1) $\frac{1}{60}$ s = 0.0167 s (2) 20 Hz B. (1) 1.6 Hz (2) 0.63 s
C. (1) 1.3 Hz (2) 5.2×10^9 Hz (3) 286 Hz (4) 256 Hz (5) 53 Hz
D. (1) 0.75 s (2) 1.8×10^{-15} s (3) 27.30 d (4) 3.0 s (5) 0.34 s
E. (1) 1.6 s (2) 44.2 s (3) 4.3 s F. 6.1 m/s² G. 1.6 m H. 1.0 m
I. (1) 1.99 s (2) 1.97 s (3) The clock is gaining time, since the pendulum is too fast. (4) 14 min 37 s (877 s, 14.6 min)
J. 0.30 m/s K. 0.36 Hz L. 4.0 m/s M. 0.425 m N. 0.60 m/s O. 0.58 s P. 2.7 m
Q. 3.15 m