Lecture 35

Test 3 Covers * Waves, Light, Photons

* Ch 9.1 - 9.6 , 12.1 → 12.3
* Lectures 28 - 35
* HW 8,9

Study: 2022 Test 3 Q1 - Q8
2023 Test 3 Q1 - Q10

Bring: Calculator

Given: Formulas on Front Sheet.

HW 8 Q 3 Solution

Open animation and set up as asked

a) Use 5cm distance time = 3.86s

$\Rightarrow$ speed = $\frac{\text{distance}}{\text{time}} = \frac{5\text{cm}}{3.86\text{s}} = 1.3\text{cm/s}$.

b) Measure 4.2cm

c) Takes 16.8s for 5 to pass. $\rightsquigarrow$ time from one to next = $\frac{16.8\text{s}}{5}$

$\therefore$ period = 3.36s

frequency = $\frac{1}{\text{period}} = \frac{1}{3.36\text{s}} = 0.30\text{Hz}$

f) wavelength x freq = 4.2cm x 0.30Hz = 1.25cm/s close to speed.

Ch 9 Waves

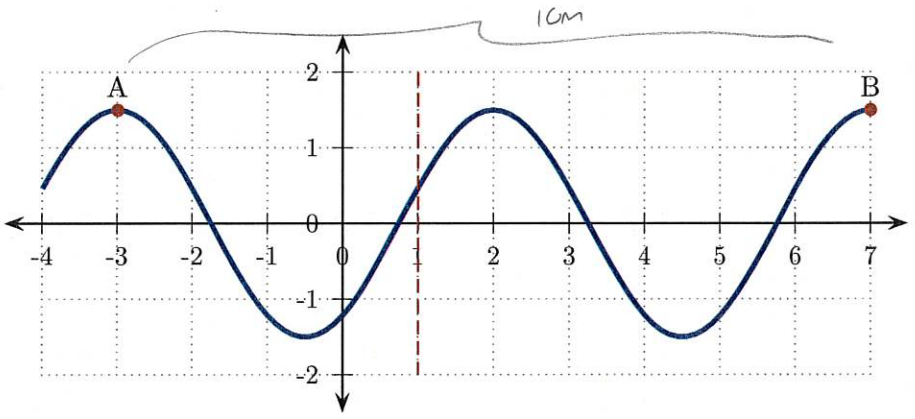
Know * terminology - wavelength
- period
- frequency
- speed

* interference
* evidence for wave picture of light - double slit experiments.

Quiz 1 90%

1 Continuous waves

A snapshot of a wave on a string at a particular instant a segment of the string is illustrated.



The crest labeled A takes 1.0 s to arrive at the point labeled B.

a) Determine the wavelength of the wave.

b) Determine the speed of the wave.

c) Determine the frequency of the wave.

d) How many crests pass the dashed line in 10 s?

Answers: a) Distance from one crest to next = 5m

b) speed = $\frac{\text{distance traveled}}{\text{time}} = \frac{10\text{m}}{1\text{s}} = 10\text{m/s}$

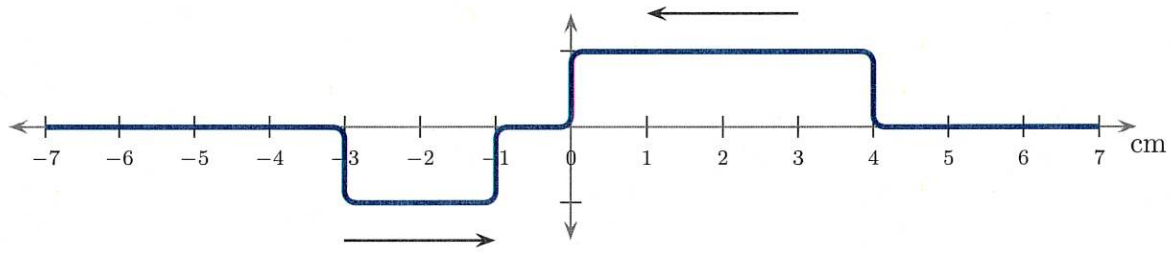
c) frequency = speed / wavelength = $\frac{10\text{m/s}}{5\text{m}} = 2\text{Hz}$

d) The frequency is the number of crests that pass in 1s. So there will be

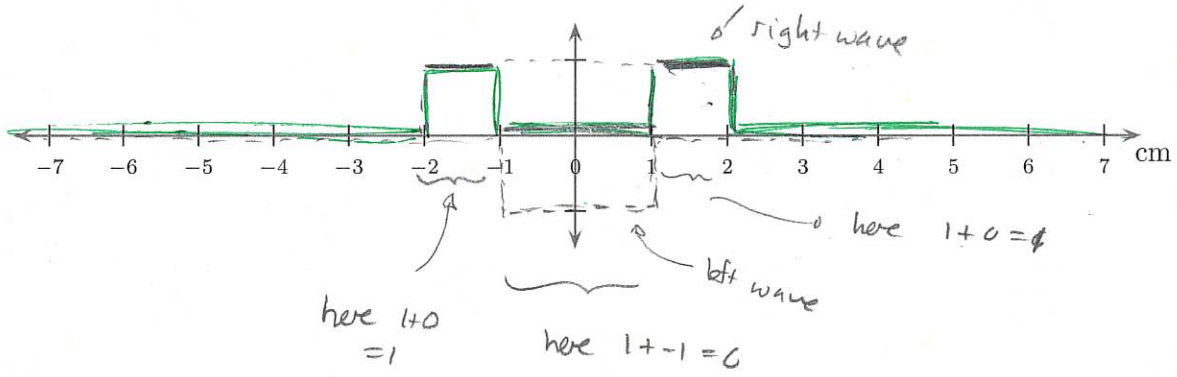
$2\text{Hz} \times 10\text{s} = 20\text{crests}$.

2 Interference of waves on a string

Two rectangular wave pulses move along a string with speeds 1 cm/s. Initially the string appears as illustrated.



Use the axes below to illustrate the appearance of the string after 2 s has passed.



Quiz 2 90%

Quiz 3 + Solution −60%

3 Hydrogen radiation from stars

Hydrogen emits radio waves (type of electromagnetic waves) with a wavelength of 21 cm = 0.21 m.

a) Determine the frequency of these waves.

b) Suppose that such waves take 10 years to travel from a star to Earth. Determine the distance from the star to Earth.

c) Determine how many crests from these waves arrive at the Earth in one minute.

Answer: a) $\text{frequency} = \frac{\text{speed}}{\text{wavelength}} = \frac{3 \times 10^8 \text{ m/s}}{0.21 \text{ m}} = 1.4 \times 10^9 \text{ Hz}$

b) distance = speed × time (in seconds)

$= 3.0 \times 10^8 \text{ m/s} \times \text{time}$

↳ $365 \text{ days} \times 24 \text{ hrs} \times 60 \text{ min} \times 60 \text{ s} \times 10$

$= 3.2 \times 10^8$

$= 9.5 \times 10^{16} \text{ m}$

c) frequency = number of crests/s

⇒ number = frequency × 60 s = 8.4×10^{10}

Ch 12

know * photon model of light – evidence for this.

* meaning of photon energy.
* photons in interference
* probabilities

Quiz 4 90%

4 Green photons

A green light bulb produces light with wavelength 560 nm = 5.60×10^{-7} m. The bulb produces 60 J of energy every second.

a) Determine the energy of each photon.

b) Determine the number of photons produced every second.

Answer: a) energy = 6.63×10^{-34} J·s × frequency

$$\text{frequency} = \frac{\text{speed}}{\text{wavelength}} = \frac{3.0 \times 10^{8}\ \text{m/s}}{5.6 \times 10^{-7}\ \text{m}}$$

$$= 5.4 \times 10^{14}\ \text{Hz}$$

$$\text{energy} = 6.63 \times 10^{-34}\ \text{J·s} \times 5.4 \times 10^{14}$$

energy one photon = 3.6×10^{-19} J

$$\text{b) Number} = \frac{\text{total energy}}{\text{energy for one}} = \frac{60\ \text{J}}{3.6 \times 10^{-19}\ \text{J}} = 1.7 \times 10^{20}$$

Quiz 5