Worksheet: Wave Speed Calculations ($v = f\lambda$) PhysicsSheets

Specification: GCSE Physics (AQA 4.6.1.2 / Edexcel SP4)

Core Equation: Wave Speed

$v = f \times \lambda$ where:
v = Wave speed (**m/s**)
f = Frequency (**Hz**)
λ = Wavelength (**m**)

Rearranged Forms:

$f = \frac{v}{\lambda}$ $\lambda = \frac{v}{f}$

Section A: Units, Conversions & Rearranging

1. Complete the table below by stating the correct SI unit and its symbol for each variable in the wave speed equation.

Variable	SI Unit	Symbol
Wave speed (v)	**metres per second**	**m/s**
Frequency (f)	**Hertz**	**Hz**
Wavelength (λ)	**metre**	**m**

2. Rearrange the wave speed equation ($v = f \times \lambda$) to make f and λ the subject:

a) $f = v/\lambda$

b) $\lambda = v/f$

3. Perform the following unit conversions. Show your working where appropriate.

a) Convert 25 cm to metres.

Model Answer:
0.25 m

b) Convert 5 kHz to Hertz.

Model Answer:
5000 Hz

c) Convert 1.5 MHz to Hertz.

Model Answer:
1,500,000 Hz

d) Convert 3.0 km/s to metres per second.

Model Answer:
3000 m/s

e) Convert 250 ms to seconds.

Model Answer:
0.25 s

f) Convert 650 nm to metres (express in standard form).

Model Answer:
$\underline{6.5 \times 10^{-7}\ \mathbf{m}}$

Section B: Practice Calculations

Remember to show your working clearly, including the equation, substitution, and final answer with units.

1. Calculate the missing values in the following scenarios:

a) A wave has a frequency of 20 Hz and a wavelength of 0.5 m. Calculate its wave speed.

Model Answer:
$v = f \times \lambda$
$v = 20\,\text{Hz} \times 0.5\,\text{m}$
$v = 10\,\text{m/s}$

b) A sound wave travels through a medium with a frequency of 500 Hz and a wavelength of 0.02 m. What is the speed of this sound wave?

Model Answer:
$v = f \times \lambda$
$v = 500\,\text{Hz} \times 0.02\,\text{m}$
$v = 10\,\text{m/s}$

c) A water wave travels at 1.2 m/s and has a wavelength of 0.8 m. Calculate its frequency.

Model Answer:
$f = \frac{v}{\lambda}$
$f = \frac{1.2\,\text{m/s}}{0.8\,\text{m}}$
$f = 1.5\,\text{Hz}$

d) A radio wave travels at 3.0×10^8 m/s and has a frequency of 150 kHz. Calculate its wavelength.

Model Answer:
First, convert frequency: $150\,\text{kHz} = 150 \times 1000\,\text{Hz} = 150,000\,\text{Hz}$
$\lambda = \frac{3.0 \times 10^8\,\text{m/s}}{150,000\,\text{Hz}}$
$\lambda = 2000\,\text{m}$

Section C: Challenge Context & Practical Application

Figure 1 shows an experimental setup used by a student to measure the speed of sound in air. A signal generator produces sound waves, which are detected by two microphones connected to an oscilloscope.

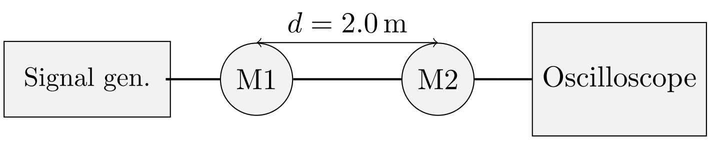

Figure 1: Setup for measuring the speed of sound

1. Answer the following questions based on the experiment in Figure 1:

a) The signal generator is set to a frequency of 440 Hz. The oscilloscope shows the sound wave reaching the second microphone 6.0 ms after the first. The microphones are placed 2.0 m apart. Calculate the wavelength of the sound wave. Show all your working, including any unit conversions, and give your answer to an appropriate number of significant figures.

Model Answer:

Step 1: Convert time to seconds.

$t = 6.0\,\mathrm{ms} = 6.0 \times 10^{-3}\,\mathrm{s} = 0.006\,\mathrm{s}$

Step 2: Calculate the speed of sound ($v = d/t$).

$v = \dfrac{2.0\,\mathrm{m}}{0.006\,\mathrm{s}} = 333.33...\,\mathrm{m/s}$

Step 3: Calculate the wavelength ($\lambda = v/f$).

$\lambda = \dfrac{333.33...\,\mathrm{m/s}}{440\,\mathrm{Hz}} = 0.7575...\,\mathrm{m}$

Final Answer (to 2 SF, matching input values): $\lambda = 0.76\,\mathrm{m}$

b) Explain how the student could improve the accuracy of their measurement of the speed of sound in this experiment. Refer to specific changes in the experimental setup or procedure.

Model Answer:

- **Increase the distance between microphones:** A larger distance (d) would lead to a larger time difference (t), reducing the percentage uncertainty in the time measurement.
- **Take multiple readings and calculate an average:** This helps to reduce the impact of random errors in measuring the time difference.
- **Use a more precise method for measuring time:** For example, using a data logger with higher sampling rate or a more sensitive oscilloscope to get a more accurate time difference.
- **Repeat the experiment at different distances/frequencies:** To check for consistency and identify any systematic errors.