Level 3 Physics: practice paper 2026

AS 91523 Demonstrate understanding of wave systems · Vertex Academy practice paper, not an NZQA paper

Attempt ALL the questions. Show ALL working. Write your answers on lined paper, or in the space under each question.

QUESTION ONE

(a) A guitar string is 0.65 m long between its two fixed ends. Played open, its fundamental frequency is 196 Hz.
Use $v = f\lambda$.
Calculate the wavelength of the fundamental and the speed of the waves on the string.

(b) The guitar string in part (a) (fundamental 196 Hz) can also vibrate in its third harmonic.
Calculate the frequency of the third harmonic, and describe the pattern of nodes and antinodes on the string.

(c) An organ pipe is closed at one end and open at the other. Its air column is 0.40 m long, and the speed of sound is 343 m s^{-1}. Ignore any end correction.
Use $v = f\lambda$.
Calculate the fundamental frequency and the next frequency the pipe can sound, and explain why a pipe closed at one end has only odd harmonics.

(d) A guitarist tunes the string from part (a) against a 196 Hz tuning fork. Played together, the string and fork give 3 beats per second. When she tightens the string slightly, the beats get faster.
Determine the string's frequency before she tightened it, and explain your reasoning. Explain what she should do to tune the string, and by what percentage the wave speed on the string must change.

QUESTION TWO

(a) An ambulance's siren sounds at 960 Hz. It drives straight towards a person on the footpath at 25.0 m s^{-1}. The speed of sound is 343 m s^{-1}.

Use $f' = f \frac{v}{v - vs}$.

Calculate the frequency the person hears.

(b) After passing the person, the ambulance in part (a) (siren 960 Hz, 25.0 m s^{-1}) drives straight away. The speed of sound is 343 m s^{-1}.

Use $f' = f \frac{v}{v + vs}$.

Calculate the frequency the person now hears.

(c) The ambulance's 960 Hz siren sounds higher to the person while it approaches at 25.0 m s^{-1}. The speed of sound is 343 m s^{-1}.

Explain, using wavefronts, why the frequency heard is higher while the ambulance approaches.

Calculate the wavelength of the sound in front of the ambulance and compare it with the wavelength when the ambulance is still.

(d) A student by the road records a passing fire engine's siren. As it approaches she measures 1020 Hz, and as it drives away 900 Hz. The fire engine travels at a steady speed and the speed of sound is 343 m s^{-1}.

Use $f' = f \frac{v}{v - vs}$ and $f' = f \frac{v}{v + vs}$.

Calculate the speed of the fire engine and the true frequency of its siren.

QUESTION THREE

(a) A green laser of wavelength 532 nm shines at right angles onto a diffraction grating with 600 lines per mm.

Use $n\lambda = d \sin \theta$.

Calculate the slit spacing d and the angle of the first-order bright spot.

(b) The 532 nm laser shines on the grating with $d = 1.67 \times 10^{-6}$ m.

Use $n\lambda = d \sin \theta$.

Calculate the highest order of bright spot that can be seen, and how many bright spots appear on a very wide screen.

(c) A red laser (λ = 650 nm) shines on two narrow slits 0.25 mm apart. Bright and dark fringes appear on a screen 2.0 m away.

Use $x = \lambda L \div d$.

Calculate the spacing between neighbouring bright fringes, and explain why a bright fringe forms where it does.

(d) White light (wavelengths from 400 nm to 700 nm) shines on the grating with 600 lines per mm ($d = 1.67 \times 10^{-6}$ m).

Use $n\lambda = d \sin \theta$.

Explain why the grating makes a spectrum, and calculate the angles at which the first-order spectrum starts and ends. Show that the second-order and third-order spectra overlap.

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