Phys2023 Wave Physics February 2017

Last year, many students lost marks for not reading the question, and either answering a different question or omitting parts altogether. This year, in addition, students tried re-stating bits of the question, which wasn't rewarded either. Some again tried to rely upon memory rather than understanding; and again, their memories were poor. Definitions and phenomenology were mostly well answered, but vague answers to descriptive sections were scored appropriately.

Section A **mean 13.0/20**

A1 Travelling wave parameters **mean 2.6/4**

Most students could identify the wavelength and frequency from the given wave function. However, several forgot the units in parts a and b, with many stating the phase velocity for part b instead of differentiating to find the transverse speed. The final part stumped many students with several trying to differentiate the wave equation (not given) to show the answer.

A2 Dispersion **mean 3.0/4**

Students mostly understood what dispersion was, although some described the Young's slit experiment instead of dispersion (words beginning "di…"). Almost all students knew the group velocity, although only around half were able to manipulate the given angular frequency to get the group and phase velocities. Common problems included dividing by the wavenumber instead of differentiating by it, not explicitly working out the phase velocity, and not taking the square root to obtain the angular frequency.

A3 Transverse & longitudinal waves **mean 3.8/4**

This question was impeccably answered by the entire cohort. Students only lost marks if they were unclear about the type of wave they were describing or the example they were giving.

A4 Boundary conditions **mean 2.6/4**

This question was answered by most students, although a large fraction wrote down the boundary conditions for a guitar in the first part, rather than explaining what is physically meant by a boundary condition. The second part of this question asked about the harmonics in two different instruments: most could explain how all harmonics were produced in a violin, but many struggled with the clarinet.

A5 Mean frequency and standard deviation **mean 0.9/4**

Many students struggled with this question, often through not reading it properly. Many stopped after writing a definition of the standard deviation, or vaguely discussed averaging over the wavepacket to find the mean frequency – which several confused with the spectral peak. Some wrote about the uncertainty principle but could not relate it adequately to the question.

Section B **mean 19.0/40**

B1 Interference and the zone plate **67 attempts** **mean 5.9**

This unseen but simple example of two-path interference seemed to be a choice of desperation: those who tackled it scored on average 3.5-4.5 less than their colleagues on B2 and B3. Answers to opening sections were adequate but disappointing: few noted that interference can cause a total intensity to exceed the sum of the contributions, or mentioned the significance of phase.

There was a remarkably consistent inability to read and interpret the question: some read 'rings' and assumed them to be Newton's, and those who got a step further were stymied by the geometry of triangles and Pythagoras' theorem. Some nevertheless worked out that the etched screen worked as a lens, though they proved unable to explain how it did so; many attempted to rearrange the regime-defining inequality to determine the scaling of the focal length with wavelength, leading naturally to an incorrect answer. Few took the expression given in (c) and picked up from there. Almost any plausible application suggestion was awarded the full mark.

B2 Fourier transforms and radar **43 attempts mean 12.0**

Reassuringly reminiscent of a coursework exercise, this was generally well answered, though with apparent over-reliance on memory when students muddled sin and cos and fudged a recovery. Some assumed the pulse duration T to be $2\pi/\omega$, and consequently foundered; and many recalculated the bandwidth needed using the bandwidth theorem rather than the derived result. Graph sketching was almost universally dreadful: do none possess a ruler and pencil sharpener?

B3 Continuity conditions and ultrasound **94 attempts mean 12.2**

Again resembling a coursework exercise, this question was also often done well. Many answers hinted that students had a better understanding than they could express, but marks are unfortunately awarded for the answers given. Definitions of continuity conditions were generally poor, and often merely paraphrased the question; and results were stated when a derivation was required. Despite some very long answers, many omitted to give the wavenumbers in (d), or to calculate the intensity reflectivity in (f). 'Other considerations' often addressed different situations from that defined in the question. Curiously, when describing where one medium meets another, students without exception formed the plural by appending an 's': perhaps something they've picked up from social mediums.

B4 Sound from a Chinook helicopter **29 attempts score 6.5**

This more open-ended question produced some insightful answers, but also revealed shortcomings of exam technique: marks are given for content rather than length, but some gave single point answers to 4-6 mark sections, while others favoured content-free verbosity. Many omitted whole sections, while there were lots of digressions – some interesting, but none earning the allocated marks. Several misread the rotor speed as 225 Hz, and failed to spot its impracticality; some calculated that the fringe spacing would exceed the scale of the question, but made no comment or adjustment. Many did not use the numbers given for a quantitative analysis.