Phys2023 Wave Physics February 2010

This was a most disappointing performance, demonstrating a common inability to apply general principles to any unrehearsed questions. Overall, most marks were lost for

- omitting parts of a question
- reliance upon memory in place of true derivation
- lack of care and rigour and a failure to check one's working
- inability to perform common mathematical operations
- misunderstanding common terms
- failure to read the question, or answering a question different from that set

Literacy, legibility and graph plotting were notably poorer than in previous years.

Section A **mean 11.8/20**

A1 Microwave oven **mean 1.9**

There were many good answers, but as many omitted to mention standing waves in the cavity or consider the microwave wavelength. Many described ray reflection or simply a vague heat flux, despite the gentle clue in the course title. A fair number had no real idea, and should be dissuaded from safety-critical occupations.

A2 Frequency operator **mean 2.4**

This question produced many good answers, although a number concluded by equating the operator to the observed frequency, and rather too many were confused or unconvincing about the problems of applying the operator to a real sinusoidal wave.

A3 Oscilloscope trace analysis **mean 1.9**

Most successfully eliminated the cosine series, but rather fewer continued their logical analysis to the correct answer, and those who guessed tended intriguingly to pick the wrong sine series. Lack of logical ability was rarely accompanied by any reluctance to express a confident opinion.

A4 Speed of sound **mean 2.8**

This was generally well answered, although many plucked the expression for the wave velocity from thin air and calculated it to unjustified precision.

A5 Acoustic refraction **mean 2.8**

The first part of this question presented problems only to the careless, but sketching demonstrated some very confused thinking, an inability to deduce from the information given, and remarkably poor curve sketching including an utter lack of labels or axes. There were few correct and clear answers.

Section B **mean 21.5/40**

B1 Longitudinal waves and tin can telephone **95 attempts mean 12.7**

This was a popular question, either because it came first or because it tempted candidates with a familiar figure accompanying derivation of the longitudinal wave equation. Sadly, this oft-repeated core exercise still flummoxed a significant minority, and many declined to start from Hooke's law or a comparable definition of elasticity.

There were few good summaries of continuity conditions. Some stated that waves wouldn't propagate if the conditions weren't met (rather than that the conditions determine how they proceed); other descriptions were utterly devoid of meaning. Some gave examples of discontinuities, rather than of continuity conditions, several thought they were related to linearity, and rather too many confused 'equal' with 'constant' and 'e.g.' with 'i.e.'. There was a common tendency to interpret, rather than derive or justify; and a general inclination to write ill-considered rot in between parts which were otherwise more sensible and correct.

Many, asked for a diameter, stopped at the cross-sectional area; and there persists a reluctance to leave expressions in algebraic form and substitute specific values only at the end.

B2 Doppler flow measurement **61 attempts mean 8.7**

Most could describe travelling and standing waves, although there were some disappointing descriptions and several, curiously, seemed to misunderstand and overuse 'propagation'.

Most, too, could insert the travelling form into the wave equation, although rather too many relied upon memory and guesswork for chain rule differentiation. Boundary conditions were occasionally mistaken for initial or continuity conditions, and there was a tendency to brain-dump rather more about musical instruments than 2 marks would merit.

The rest of the question guided students through a straightforward analysis, and the main problem was in following instructions: several set off on their own upon reading the word 'Doppler', while many others analysed a different arrangement of transducers. In this question, as the obedient discovered, the Doppler effect leads to a shift in phase but not frequency. There was a disappointing reluctance to apply mathematical analysis to a new situation, even with great guidance; and a tendency to give up at the first hurdle, thus discarding the easier marks that came later.

B3 Diffraction grating-tuned laser **7 attempts mean 3.8**

It is astonishing how mere reference to a practical device scares off students: this straight-forward question was tacked by only a handful of the weakest students (mean score <10 for section B). Many showed poor knowledge or communication of the Huygens principle and its application to diffraction (one described Fermat's principle; another addressed refraction), and subsequent analysis was often restricted to unthinkingly grabbing a poorly memorized equation.

B4 Dispersion and Gaussian wave packets **59 attempts score 10.6**

This mathematical question was generally well tried, although careless mistakes lost a fair few marks. Curve sketching was attrocious, and only one student spotted and dealt with the complex nature of the variable plotted. Although there were again some very dodgy attempts to apply the chain rule to $\partial^2 y/\partial x^2$ in the early analysis, most of those who tackled the tricky final part made reasonable headway, though none reached the conclusion.