Phys2023 Wave Physics February 2007

Overall, most marks were lost for

- omitting parts of a question
- failure to read the question; answering a question different from that set
- offering a description in place of a derivation
- lack of logic, care and rigour

Section A **mean 14.2/20**

A1 Sinusoidal wave parameters **mean 3.4**

This was really a first year question, so was generally well answered – though calculating 120/40 presented problems for several students; others muddled degrees and radians, and a few determined a distance rather than a phase.

A2 Refraction and coastal waves **mean 2.4**

With a big clue from the first part that it might involve refraction, this question required students to *think* about a rather simple and familiar situation. Answers were often poor and incoherent; many omitted the requested sketch, and several straightened the coastline rendering the problem rather pointless. A number of students focused on the breaking of the waves – beyond the scope of the course, not covered in lectures, and unlikely to happen in the situation described. Several considered high wave speeds a problem (probably the converse), and a number didn't associate refraction with a change of wave direction.

A3 Dispersion and wave velocities **mean 3.1**

Mostly well answered, although several failed to find the *relationship* between the phase and group velocities, and some had problems concluding $v_g = 2v_p$ and not $v_p/2$. A few mentioned 'separation into frequency components', which begs considerable qualification. Some wrote extensively without really saying anything, and should enjoy success in middle management.

A4 Sinusoidal and complex exponential waves **mean 2.3**

Most marks lost here were for omissions and errors in the mathematical relationships.

A5 Interference and the Michelson interferometer **mean 3.0**

Most students could discuss interference, but few mentioned its result: a modulation of the wave strength or intensity, manifest optically as a variation in intensity. Several referred to waves *interacting*, which (in a linear system) they don't. A popular application of the Michelson interferometer was measurement of the speed of light, which it cannot do unless part of a more complex apparatus, for there is no timing reference within (it can, however, demonstrate a *variation* in the speed of light with reference frame – the Michelson-Morley experiment). The usual use is in the measurement of an optical wavelength or spectrum.

Section B **mean 17.0/40**

B1 The frequency spectrum **4 attempts** **mean 8.3**

This unpopular question produced some good attempts, with most marks lost for parts omitted. The question gave considerable guidance, but students confused themselves with untidy answers and a general lack of care and rigour.

B2 The plucked guitar string **55 attempts** **mean 6.3**

Most students attempted this question, suggesting that they thought they would do well. Sadly, they were wrong. The motion after release was more often described than derived, and some equated the triangle to a single sinusoidal component. The initial conditions are the initial shape and velocity – not merely the positions of the ends and the centre. Unsolicited derivations of the wave equations were not rewarded.

B3 Fraunhofer diffraction and towed-array sonar **12 attempts** **mean 5.5**

This practical example – virtually a copy of an earlier exercise – demonstrated that without a diagram, care and rigour, poor marks can be obtained even from a helpful question. Virtually none showed a systematic, logical approach; several proved how the memory alone can be unreliable.

B4 Acoustic reflection and the fish finder **55 attempts** **score 11.7**

Mainly well answered, with marks lost where sections were omitted – though some derivations of the wave equation were still flaky and a few students went into a tizzy when calculating the reflectivity. Almost any suggestion for the final part was rewarded generously.

The overwhelming impression given by the 64 scripts was of an extreme and lamentably widespread reluctance to undertake the process of logical deduction that physics fundamentally concerns. Still more alarming is the feeling that many students still fail to recognize this to be expected and required. When prompted to provide a derivation, many offer an impressionistic collage of vaguely appropriate equations, devoid of the connecting logic that constitutes a scientific proof. Since this in many cases led inevitably to false conclusions, nothing remained upon which to base later working. This was despite considerable guidance within the questions themselves, suggesting that many students fell at the 'read the question' stage.

Exam technique let down many, who omitted huge sections which, if attempted, would usually have provided at least a few marks. Several wrote great dissertations where only a mark or two was allocated; others merely re-phrased parts of the question, which naturally scored nothing.

Basic mathematics continues to be a problem for a fair number of students: application of the chain rule for differentiation, and derivation of the derivative itself, were commonly flawed, and several students thought $f(u)$ to mean the product $f.u$. The standard of literacy also seemed rather worse than in previous years, with some students virtually unable to express themselves, and several answers that required huge patience and much giving of the benefit of the doubt.