MARK SCHEME

PHYSICS

AS-Level

WAVES

TEST 1

Mark schemes

1 (a) Initially the path difference is zero/the two waves are in phase when they meet/the (resultant) displacement is a maximum ✓

Alternative:

Constructive interference occurs when the path difference is a whole number of wavelengths and the waves are in phase

1

As the movable tube is pulled out, the path difference increases and the two waves are no longer in phase, so the displacement and loudness decrease ✓

Destructive interference occurs when the path difference is an odd number of half wavelengths and the waves are in antiphase

1

When the path difference is one half wavelength, the two are in antiphase and sound is at its quietest. ✓

Initially the path difference is zero and the sound is loud

1

As the path difference continues to increase, the two waves become more in phase and the sound gets louder again. ✓

As the pipe is pulled out the path difference gradually increases, changing the phase relationship and hence the loudness of the sound

1

(b) Use of *wavelength = speed / frequency*

The first mark is for calculating the wavelength

1

To give: 340 / 800 = 0.425 m ✓

Path difference = one half wavelength = 0.21 m ✓

The second mark is for relating the wavelength to the path difference

Path difference = 2 ($d_2 - d_1$) = 2 (distance moved by movable tube)

1

Distance moved by movable tube = 0.10 m. ✓

The final mark is for relating this to the distance moved by the tube and working out the final answer.

1

(c) Start with d1 = d2

(Alternative mark scheme involving changing frequency and measuring to first min for each one can gain equal credit)

Measure distance moved by movable tube for each successive minima and maxima✓

Start with d1 = d2

Measure distance moved by movable tube for first minimum.

1

Each change in distance is equal to one quarter wavelength. ✓

Distance is equal to one quarter wavelength

1

Continue until tube is at greatest distance or repeat readings for decreasing distance back to starting point. ✓

Repeat for different measured frequencies.

1

Use speed = frequency x wavelength ✓

Use speed = frequency x wavelength)

1

[11]

2 (a) 6.5×10^{10} Pa ✓

1

(b) kg m^{-1} s^{-2} ✓

1

(c) Direction of movement of particles in transverse wave perpendicular to energy propagation direction✓

1

Parallel for longitudinal✓

1

(d) $\rho_1 c_1 = \rho_2 c_2$✓

$E = \rho c^2$ or $\rho c = \frac{E}{c}$ seen

1

$\left[\frac{E_1}{c_1} = \frac{E_2}{c_2}\right]$

1

(e) $[\frac{\rho_x}{\rho_y} = \frac{c_y}{c_x}$ and $c_x = 2c_y$]

0.5✓

1

(f) speed of the wave in seawater is less than speed of the wave in glass✓

1

argument to show that ${}_{water}n_{glass} < 1$✓

1

so tir could be observed when wave moves from water to glass ✓ 1

[10]

3 D

[1]

4 B

[1]

5 D

[1]

6 C

[1]

7 C

[1]

8 C

[1]

9 (a) waves are <u>reflected</u> (from the oven wall) ✓ 1

and superpose/interfere with wave travelling in opposite direction/incident waves/transmitted wave ✓

NOT superimpose 1

(b) energy/amplitude is maximum ✓ 1

(chocolate melts at) antinode ✓

if refer to node can still be awarded first mark 1

(c) clear evidence that used first and third antinode ✓

can be from diagram

1

distance from first to third antinodes = 0.118 ± 0.001 (m) OR
distance between two adjacent antinodes = 0.059 ± 0.001(m) ✓

mark for either value

carry their value forward for subsequent marks even if outside tolerance

1

wavelength = 0.118 (m) ✓

mark for using their wavelength (range 0.112 to 0.124)

1

frequency = 3.0×10^8 /0.118 ✓

mark for use of $v = f\lambda$ *allow this mark if use 0.059*

1

frequency = 2.5×10^9 (Hz) ✓

must *be in range* $2.40 \times 10^9 - 2.60 \times 10^9$

if use 330 for speed lose last 2 marks

1

(d) position of antinode/maximum energy/maximum amplitude/nodes (in food) continually changes ✓

must be clear antinode maximum energy/maximum amplitude changes location

1

[10]

10 C

[1]

11 A

[1]

12 (a) A wave transfers energy <u>from one point to another</u> ✓
without transferring material / (causing permanent displacement of the medium) ✓ owtte

2

(b) (i) 0.6 (mm) or 0.60 (mm) ✓

1

(ii) 0.080 (m) ✓

Allow 1 sig fig

1

(iii) $f = 1/T = 1/0.044 = 23$ (Hz) ✓ (22.7 Hz)

1

(iv) $v = f\lambda = 22.7 \times 0.080 = 1.8$ (m s^{-1}) ✓ (1.82 m s^{-1})

allow CE v = (biii) × (bii) but working must be shown

1 sig fig not acceptable

1

(c)

sound waves are transverse	sound waves are longitudinal	sound waves can interfere	sound waves can be polarised
	√	√	

1

(d) the wavelength would be smaller
smaller spread in main peak or more peaks (between A and B)
the central peak is higher (owtte)
as the energy is concentrated over a smaller area (owtte)
reference to ($\sin \theta_{min} = \lambda/d$)
✓ ✓ ✓ any 3 lines max 3

Note that the marks here are for use of knowledge rather than performing calculations.

No bod if writing does not make <u>in</u>crease or <u>de</u>crease clearly distinct.

Marking should be lenient.

3

[10]

Examiner reports

9 This question about the formation of stationary waves in a microwave oven was answered well by a good proportion of students. In part (a) the idea of reflection taking place was clearly stated in the majority of answers. The second marking point explaining how this resulted in the reflected and incident wave superposing was more discriminating. A significant proportion of students stated that the waves superimposed rather than superposed. Part (b) was only fully answered by those students who, having identified the melted chocolate positions as antinodes were then able to explain that this is where the amplitude of the wave was a maximum. Weaker responses tended to identify these positions as nodes or did not link the melted chocolate to stationary waves at all. Part (c) was a five mark calculation and this produced very good discrimination. About a third of students were awarded 4 or 5 marks. To obtain full marks students were required to give a clear indication, either on the diagram or in their working, that they had measured the distance between the first and third dot rather than measuring from the first to second dot and then doubling. It was sometimes hard to establish exactly what students had measured and it should be appreciated that showing full working in these extended calculations is very important. A lot of vague answers were seen to question 2.4 and it was the physics that needed to be explained. A common response was ‘to cook the food evenly’ and this was not seen as a physics explanation.

10 This question required students to work out the wavelength of the sound wave, and then calculate the phase difference of two parts a certain distance apart. 45% of students correctly identified the correct answer. Approximately 35% thought A was correct, using π, rather than 2π, as the phase difference for two points a whole wavelength apart, perhaps.

11 This proved to be one of the more demanding questions on the paper, with 39% of students being correct, despite the equation being in the data booklet. The most popular distractor was C, chosen by students having difficulty dividing $\sqrt{2}$ by 2 perhaps. Unsurprisingly B was also popular, the answer obtained if the two changes cancelled out.

12 (a) For a majority this was a piece of work that was never committed to memory and the marks were low. Only about half the students scored the mark about the wave being able to transport energy from one place to another. Then only a small subgroup of these students referred to matter not being transported.

(b) (i) Almost all students found this basic question straightforward.

(ii) Almost all students found this basic question straightforward.

(iii) Again the vast majority of students had no problems but a few got into difficulty in reading the time scale correctly.

(iv) The equation for velocity was known by almost all the students and most scored the mark.

(c) A majority of students chose the correct responses but there was a significant number tempted away by one or more of the distractors.

(d) This question discriminated between students very effectively. Many did appreciate that a higher frequency meant a shorter wavelength. This in turn had the effect of compressing the diffraction pattern. Students had some difficulty in expressing this idea. Instead of simply saying the central peak was narrower they might say the wave is shorter. Only the very able students obtained a third mark. Most said the pattern shown would have the same height because the amplitude was the same.