LONDON SCIENCE COLLEGE

MARK SCHEME

PHYSICS

AS-Level

WAVES

TEST 3

Mark schemes

1 (a) (i) one ‘loop’ (accept single line only, accept single dashed line)

+ nodes at each bridge (± length of arrowhead)

+ antinode at centre **(1)**

1

(ii) $\lambda_0 = 2L$ or $\lambda = 0.64 \times 2$ **(1)**

= 1.3 (m) **(1)** (1.28)

2

(iii) ($c = f\lambda$) = 108 × (a)(ii) **(1)**

= 138 to 140(.4) (m s^{-1}) **(1)** ecf from (a) (ii)

2

(b) (i) four antinodes **(1)** (single or double line)

first node on 0.16 m (within width of arrowhead)

+ middle node between the decimal point and the centre of the ‘m’ in ‘0.64 m’

+ middle 3 nodes labelled ‘N’, ‘n’ or ‘node’ **(1)**

2

(ii) ($4 f_0$ =) 430 (Hz) **(1)** (432)

or use of $f = \frac{v}{\lambda}$ gives 430 to 440 Hz correct answer only, no ecf

1

(c) decrease the length/increase tension/tighten string **(1)**

1

[9]

2 (a) (i) 0.4(0) m **(1)**

(ii) speed (= frequency × wavelength) = 22 × 0.4(0) ecf **(1)**
= 8.8 (m s^{-1}) **(1)**

(ii) 90 or 450 (1) ° or **degrees (1)**
or 0.5π or 2.5π or 5π/2 **(1) rad**(ians)
or **r** or $^{\mathbf{r}}$ **(1)** no R, Rad, etc

5

(b) displacement of Y will be a **positive (or ‘up’) maximum** at 1/4 of a period (or cycle) (0.0114 s) **(1)**

returns to original position (at 0.5 of a period or cycle) (owtte) **(1)**

2

[7]

3 transverse yes

B1

transverse yes

B1

longitudinal no

B1

[3]

4 (a) (progressive waves travel from centre) to ends and reflect **(1)**

two (progressive) waves travel in opposite directions along the string **(1)**

waves have the same frequency (or wavelength) **(1)**

waves have the same (or similar) **amplitude (1)**

superposition (accept 'interference') **(1)**

max 3

(b) (i) wavelength (= 2 × PQ = 2 × 1.20 m) = 2.4 m **(1)**

speed (= wavelength × frequency = 2.4 × 150) = 360 m s^{-1} **(1)**

(answer only gets both marks)

(ii) diagram to show three 'loops' **(1) and** of equal length and good shape **(1)** (or loop of one third length **(1)**)

4

[7]

5 (a) reflection implied/2 waves in opposite directions/fixed end (not ends) **(1)**

similar amplitude/little energy loss at wall **(1)**

frequency constant **or** same frequency/wavelength **or** correct wavelength condition specified **(1)**

3

(b) displacement perpendicular to rest/average/mean position of string

or string displacement perpendicular to energy propagation direction owtte **(1)**

1

(c) A larger than B **(1)**

A 180° (or π rad) out of phase with B (owtte) **(1)**

2

(d) $\lambda = 1.2$ **(1)**

$c = f\lambda$; allow e.c.f from wrong λ **(1)**

$f = 6.2/1.2 = 5.2$ Hz **(1)**

3

(e) (i) diagram correct (6 loops) **(1)**

(ii) Q and R correctly in phase with P; must be a position where movement occurs **(1)**

2

[11]

6 A

[1]

7 C

[1]

8 B

[1]

9 C

[1]

10 D

[1]

11 B

[1]

12 C

[1]

13 A

[1]

14 D

[1]

15 A

[1]

16 A

[1]

17 B

[1]

18 A

[1]

19 D [1]

20 C [1]

21 D [1]

22 B [1]

23 B [1]

24 C [1]

25 B [1]

26 C [1]

Examiner reports

1 In part (a) (i), about 60% of candidates drew one 'loop' and picked up the mark. However, we were fairly lenient on the shape of the 'loop' and students need to practice drawing these shapes.

Part (a) (ii) was expected to be a little easier than it was. 42% scored no marks on this despite the benefit of an error carried forward from an incorrect part (a) (i). Many did not realise the wavelength was found from the length of the string and knowledge of the shape of the fundamental. Some candidates used $\lambda = v/f$ with v = speed of light. In contrast, most candidates found part (a) (iii) a very easy calculation.

The majority of candidates got four antinodes in part (b) (i), but then nearly half of those lost the second mark by either not sketching the curve carefully enough or, more commonly, forgetting to label the antinodes.

In part (c), the vast majority correctly suggested tightening or shortening the string. A few thought that plucking harder would increase the pitch and some suggested increasing the length, using a thinner string, increasing the wave speed, or even 'play faster'.

2 Most picked up full marks to parts (a) (i) and (ii).

Candidates tended to successfully state the phase difference and the unit to part (iii). A few confused path difference with phase difference and gave an answer as a number of wavelengths.

Part (b) should have been a fairly easy question, but was quite poorly answered by many candidates. There was much confusion over the meaning of displacement. Many thought point Y goes down then up. Few stated that a positive peak is reached after ¼ period. Many referred to wavelength rather than period or think that this is a stationary wave and the 'node' would not move. Many believed point Y would move horizontally.

3 This question was answered well by many, who understood that all electromagnetic waves are transverse and therefore can be polarised whilst ultrasound, like sound, is longitudinal and therefore cannot be polarised.

4 A large number of candidates struggled with part (a). This was mainly due to a lack of understanding of the fact that two waves must be travelling in opposite directions in order for a standing wave to form. They seemed to be describing one wave reflecting back and forth. Those who understood how the stationary wave formed and added further detail went on to score two or three marks fairly easily.

Some candidates in part (b) (i) did not multiply by two and only scored one mark out of the two available.

A majority gained two marks in part (b) (ii). A few candidates knew what to do but their sketch lacked acceptable accuracy, for example, the 'loops' were not of similar length. Only a quarter of candidates got the wavelength wrong.

17 This question was answered correctly by 58% of the candidates. Lack of understanding of radian measure when considering phase difference probably accounted for 27% of the candidates choosing distractor D ($3\pi/2$), rather than $\pi/2$.