Neap:

# PHYSICS VCE UNITS 3&4
# DIAGNOSTIC TOPIC TESTS 2017

## TEST 7: HOW CAN WAVES EXPLAIN THE BEHAVIOUR OF LIGHT? (I)

## SUGGESTED SOLUTIONS AND MARKING SCHEME

**Question 1** (3 marks)

The particles oscillate horizontally about a mean position for wave A (longitudinal), but they oscillate vertically about a mean position for wave B (transverse). 1 mark

Both waves carry energy. 1 mark

**AND**

*Any one of:*

- Both waves have a wavelength (length of a cycle).
- Both waves have a period (time to travel one wavelength). 1 mark

**Question 2** (7 marks)

**a.** A = distance of one cycle 1 mark

**b.** D = vertical distance from axis to peak or trough 1 mark

**c.** $v = f \times \lambda$

$\lambda = \frac{v}{f}$

$\lambda = \frac{3.0 \times 10^{8}}{5.0 \times 10^{14}}$ 1 mark

$= 6.0 \times 10^{-7}$ m 1 mark

**d.** It takes two periods ($2T$).

$T = \frac{1}{f}$

$= \frac{1}{5.0 \times 10^{14}}$ 1 mark

$= 2.0 \times 10^{-15}$

$2T = 4.0 \times 10^{-15}$ s 1 mark

**e.** **D** 1 mark

The wave moves to the right and its profile moves down at point 1 and up at point 2.

**Question 3** (4 marks)

**a.** If they meet constructively, then distance travelled by wave $S_1$ – distance travelled by wave $S_2 = n\lambda$. 1 mark

$n = 1, 2, 3\ldots$

Thus the extra distance = 2.0 cm, 4.0 cm, 6.0 cm… 1 mark

**b.** This time the extra distance is given by $\frac{1}{2}\lambda, 1\frac{1}{2}\lambda, 2\frac{1}{2}\lambda\ldots$ 1 mark

Thus the possibilities are 1.0 cm, 3.0 cm, 5.0 cm… 1 mark

**Question 4** (8 marks)

**a.** At position A, a crest from one source meets a trough from the other source 1 mark
and so they will destructively interfere. 1 mark

**b.** At position B, a crest from one source meets a crest from the other source 1 mark
and so constructive interference occurs. 1 mark

**c.** C lies at a position where constructive interference occurs.

At A, path difference = $1\lambda$ 1 mark

= 3.0 cm 1 mark

**d.** D lies at a position where destructive interference occurs.

At C, path difference = $1\frac{1}{2}\lambda$ 1 mark

$= 1.5 \times 3.0$

= 4.5 cm 1 mark

**Question 5** (4 marks)

**a.** As the car approaches the man, the wavelength of the sound is reduced and so the frequency is increased compared to the car being stationary. 1 mark

As the car passes the man, the wavelength of the sound is increased and so the frequency of the sound is decreased. 1 mark

**b.** The speed of sound in air is constant.

As the car approaches the man, the cycles of the sound from the horn are released closer together producing a smaller wavelength, and consequently higher frequency of sound. 1 mark

As the car moves away from the man, the cycles of sound from the horn are released farther apart producing a higher wavelength and consequently lower frequency of sound. 1 mark

This is known as the Doppler effect.

**Question 6** (7 marks)

**a.** As the string is plucked, energy is passed along the string in both directions in the form of a wave. 1 mark

As the waves reflect off both ends, they meet and interfere to produce a standing wave. 1 mark

The standing wave has fixed positions of maximum oscillation (called antinodes) and fixed positions of zero oscillation (called nodes). 1 mark

Only particular frequencies will resonate in the string based on its length giving the particular note(s). 1 mark

**b.** The single simplest note is the fundamental or first harmonic, $f_1$.

In a string, $f_n = nf_1$, $n = 1, 2, 3...$

$f_1 = 150$ Hz

$\therefore f_2 = 2 \times 150$

$= 300$ Hz 1 mark

**c.** The three longest wavelengths correspond to the three smallest (first) frequencies.

$f_n = \dfrac{nv}{4L}$, $n = 1, 3, 5\ldots$

$v$ = speed of wave

$L$ = length of rope

$\dfrac{v}{\lambda_n} = \dfrac{nv}{4L}$

$\lambda_n = \dfrac{4L}{n}$

$\lambda_1 = \dfrac{4 \times 3.0}{1}$

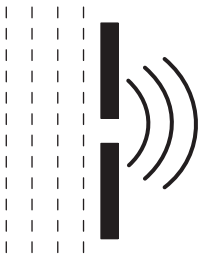
$= 12.0$ m 1 mark

$\lambda_3 = \dfrac{4 \times 3.0}{3}$

$= 3.0$ m 1 mark

**Question 7** (4 marks)

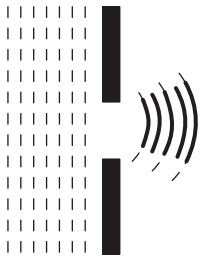
**a.**



2 marks

*1 mark for same wavefront spacing.*
*1 mark for greater bending around the sides.*

**b.**



2 marks

*1 mark for lesser bending and waves being more central.*
*1 mark for showing closer wavefronts.*

**Question 8** (4 marks)

**a.** Light consists of sinusoidally oscillating electric and magnetic fields. 1 mark

These fields are at right angles to each other and move as transverse waves at the speed of light in a vacuum with the same period and wavelength. 1 mark

**b.** Electrons in atomic energy levels that have risen to a higher level eventually fall back to the lower energy level at their origin. 1 mark

In returning to a lower energy level, they release the difference of energy as light. 1 mark

**Question 9** (4 marks)

**a.**

| long wavelength | | | | | | short wavelength |
|---|---|---|---|---|---|---|
| **radio** | **microwave** | **infrared** | visible light | **ultraviolet** | **X-ray** | **gamma** |

2 marks

*Award full marks for all correct.*
*Award 1 mark for partially correct.*

**b.** **i.** infrared

In nature this is experienced as heat. 1 mark

OR

In electronics communication these are used in sensing and information transmission.

**ii.** gamma

This is high-energy light usually released from nuclear radioactive decay. 1 mark

OR

This is used in medicine to kill cancer cells, or as radioactive tracers in medical diagnostics, or
in medical equipment sterilisation.