
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

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

1 mark

d. It takes two periods (2T).

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

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

1 mark

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

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

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
 $n = 1, 2, 3 \dots$
Thus the extra distance = 2.0 cm, 4.0 cm, 6.0 cm... 1 mark
- b. This time the extra distance is given by $\frac{1}{2}\lambda, 1\frac{1}{2}\lambda, 2\frac{1}{2}\lambda \dots$ 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 = 1λ 1 mark
 $= 3.0 \text{ cm}$ 1 mark
- d. D lies at a position where destructive interference occurs.
At C, path difference = $1\frac{1}{2}\lambda$ 1 mark
 $= 1.5 \times 3.0$
 $= 4.5 \text{ cm}$ 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, $f_n = nf_1$, $n = 1, 2, 3...$

$$f_1 = 150 \text{ Hz}$$

$$\therefore f_2 = 2 \times 150$$

$$= 300 \text{ Hz}$$

1 mark

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

$$f_n = \frac{nv}{4L}, \quad n = 1, 3, 5 \dots$$

v = speed of wave

L = length of rope

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

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

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

$$= 12.0 \text{ m}$$

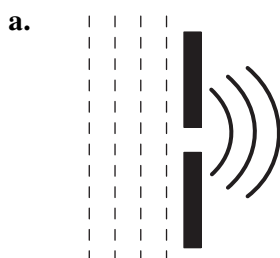
1 mark

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

$$= 3.0 \text{ m}$$

1 mark

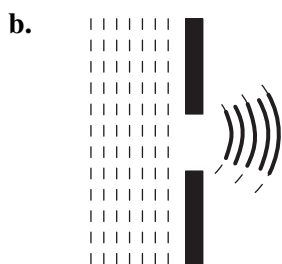
Question 7 (4 marks)



2 marks

1 mark for same wavefront spacing.

1 mark for greater bending around the sides.



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 1 mark
In nature this is experienced as heat.
OR
In electronics communication these are used in sensing and information transmission.
- ii. gamma 1 mark
This is high-energy light usually released from nuclear radioactive decay.
OR
This is used in medicine to kill cancer cells, or as radioactive tracers in medical diagnostics, or in medical equipment sterilisation.