



VCE PHYSICS UNITS 3&4 [2020]

Unit 4 AOS 1 - How can waves explain the behaviour of light? - Topic Exam 1

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STRUCTURE OF EXAM

Section A - Short Answer

10 questions

37 marks

37 marks

WHEN YOU FINISH

Get your marks, and view solution videos that explain the answer to each question at:

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SECTION A – SHORT ANSWER**Question 1** (6 marks)

Two students set up a two-slit interference experiment with a source of laser light, as shown in Figure 2.

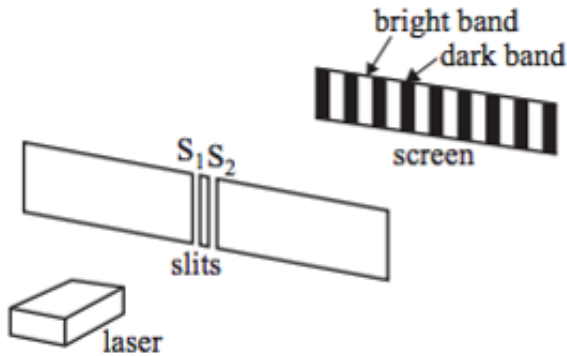


Figure 2
not to scale

The wavelength of the light from the laser is 612 nm. Figure 3 shows a sketch of the central section of the interference pattern that they obtain. The central band C, which is a bright band, is labeled.



Figure 3

Question 1.a

2 marks

Explain why the central band of the pattern at point C in Figure 3 is a bright band and not a dark band.

Question 1.b

2 marks

Another point on the pattern is further from slit S1 than from slit S2 by a distance of 2.142×10^{-6} m. Its position is to the right of point C in Figure 3.

Indicate where this point is in Figure 3 by writing the letter X above the point. You must show your working.

**Figure 3**

Question 1.c

2 marks

Another laser that produces light of a different wavelength is now used. The pattern is now spaced more closely. Figure 4a shows the new pattern and Figure 4b shows the original pattern. The second bright band to the left of C in the new pattern is at the position labeled Y in Figure 4a. In the original pattern (Figure 4b), this was the position of the second dark band to the left of C.



new pattern
Figure 4a



original pattern
Figure 4b

Calculate the wavelength of the light produced by this new laser.

Question 2 (1 mark)

The apparatus for a Young's double-slit experiment is shown in Figure 28.

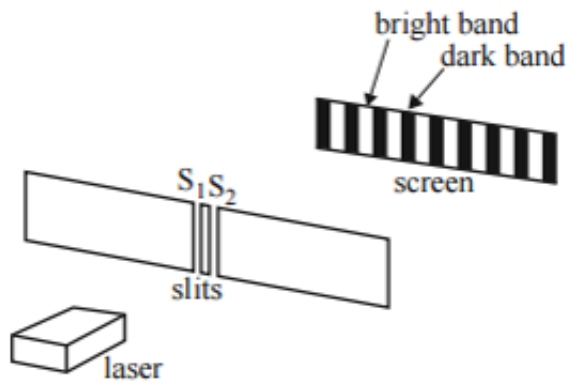


Figure 28
not to scale

A beam of green light ($\lambda = 550 \text{ nm}$) is incident on the slits. The beam is now replaced with light of a lower frequency. The second dark band from the center of the interference pattern would:

- A Become narrower
- B Remain in the same position
- C Move closer to the centre of the pattern
- D Move further away from the centre of the pattern

Question 3

2 marks

When light is passed through a particular lens it emerges plane polarised. Explain what can be concluded about visible light from this observation.

Question 4

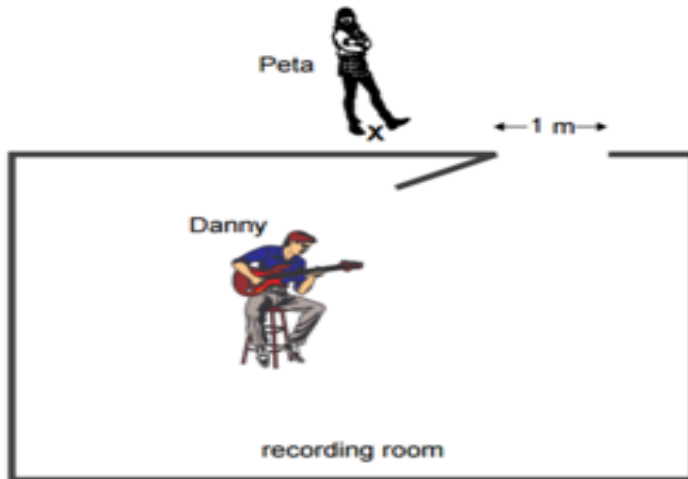
3 marks

Green light of frequency $560 \times 10^{12} \text{ Hz}$ is shone through a block of glass. It takes 2.1 ns for the light to travel 45 cm in the glass. Calculate the wavelength of this light when in the glass.

Question 5

4 marks

Peta and Danny are playing music in a soundproof recording room. Peta leaves the room while Danny is still playing. She notices that when she is standing at point X, as shown in Figure 3, with the door open, she can still hear the music. The music is not only softer, but some of the frequencies seem to be much softer. The door to the recording room is 1 m wide.

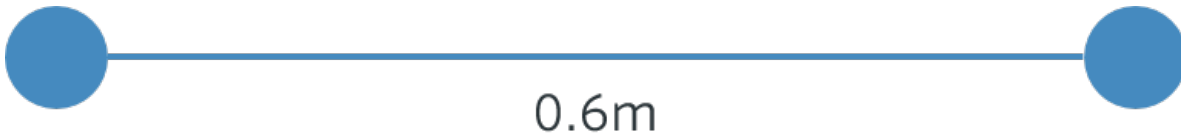
**Figure 3**

In the space below explain in what way the music sounds different, and why this is so. In the box provided give an estimate of the range of frequencies that are much reduced in intensity.

The speed of sound in air is 340 m s^{-1} .

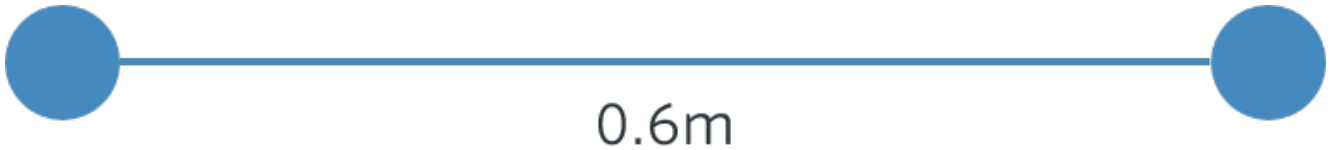
Question 6 (4 marks)

When a guitar string is plucked, it vibrates and forms a standing wave in the string. The string is attached between two points that are 0.6 m apart.

**Question 6.a**

2 marks

If the wavelength of the standing wave is 0.4 m, draw the standing wave on the diagram below, labelling one node and one antinode.



Question 6.b

2 marks

Explain how this standing wave is produced in the string. Your answer should include reference to superposition.

Question 7

2 marks

Two physics students are walking through a park and see a child whirling an object around her head on a piece of string. This object is producing a sound and as they listen they hear the tone increase and decrease as the object moves in a horizontal circle. When the child stops rotating the object, they hear the sound as a constant tone.

One of the students now borrows the toy from the child and spins it above his own head. Describe and explain what this student hears if he spins this object at a constant speed around his head. The distance between his ears can be ignored in this situation.

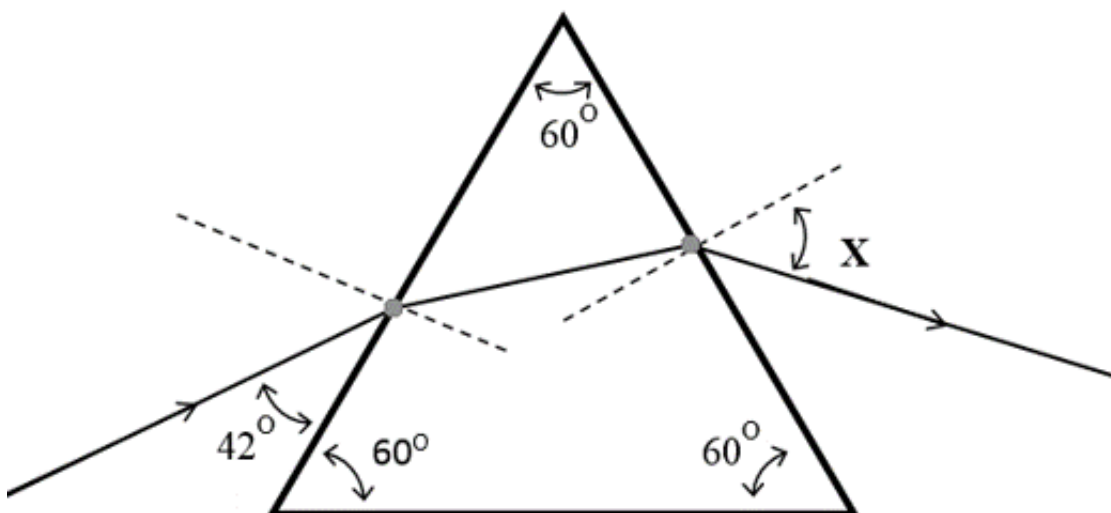
Question 8 (1 mark)

Identify the statement below that is most correct:

- A Visible light is produced when electrons travel very rapidly.
- B Visible light is produced when very fast moving electrons are accelerated.
- C Visible light is produced when very fast moving atoms are accelerated.
- D Visible light is always produced when electrons are accelerated.

Question 9 (8 marks)

A beam of light travelling through air ($n = 1.00$) is incident on a glass triangular prism ($n = 1.55$).



Question 9.a

1 mark

Determine the angle of incidence for the light entering the prism shown above.

Question 9.b

2 marks

Determine the angle of refraction for the light as it enters the prism shown above.

Question 9.c

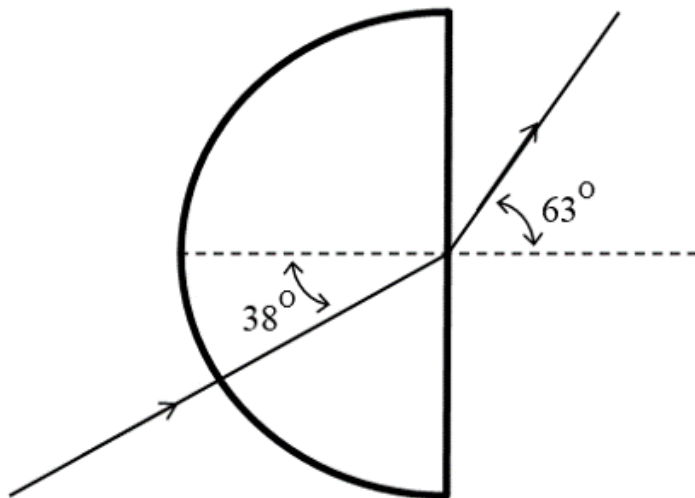
3 marks

Determine the angle of refraction (marked 'X') for the light exiting the prism shown above.

Question 9.d

2 marks

In the situation above it was observed that there was some dispersion of the white light as it exited the prism. Explain why dispersion occurs in this situation and identify which colour of the visible spectrum undergoes the greatest change in direction.

Question 10 (6 marks)**Question 10.a**

2 marks

Determine the refractive index for the semicircular prism shown above.

Question 10.b

2 marks

Determine the critical angle for the situation shown above with the semicircular prism.

Question 10.c

2 marks

Explain under which conditions Total Internal Reflection of visible light occurs and give a real world example of where this might be observed.
