Reflection, Diffraction & Doppler Effect

Question Paper 1

Level	International A Level
Subject	Physics
Exam Board	Edexcel
Topic	Waves
Sub Topic	Reflection, Diffraction & Doppler Effect
Booklet	Question Paper 1

Time Allowed: **57 minutes**

Score: **/47**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 A source of sound is moving at a constant speed away from an observer.
Select the row of the table which correctly describes the amplitude and frequency of the sound heard by the observer compared to the emitted sound.

	Amplitude	Frequency
☒ **A**	smaller	smaller
☒ **B**	smaller	greater
☒ **C**	greater	smaller
☒ **D**	greater	greater

(Total for Question 1 = 1 mark)

2 Diffraction is the spreading of a wave after passing through a gap or around an obstacle.

Which of the following statements is correct?

☒ **A** Diffraction can be used to demonstrate the wave property of electrons.

☒ **B** Diffraction only occurs when the size of the gap is equal to the wavelength.

☒ **C** Microwaves show more significant diffraction around hills than radio waves.

☒ **D** Sound waves cannot be diffracted.

(Total for Question 2 = 1 mark)

3 The level of detail in an ultrasound scan can be increased by using a

☒ **A** higher frequency.

☒ **B** higher wave speed.

☒ **C** longer pulse duration.

☒ **D** longer wavelength.

(Total for Question 3 = 1 mark)

4 An ambulance is moving towards an observer with its siren sounding.

Which row of the table correctly describes the apparent changes in wave properties of the sound from the siren caused by the Doppler effect?

	Wave speed	Frequency	Wavelength
☒ **A**	no change	increases	decreases
☒ **B**	decreases	decreases	increases
☒ **C**	no change	decreases	increases
☒ **D**	increases	increases	decreases

(Total for Question 4 = 1 mark)

5 Electron diffraction is evidence that

☒ **A** electrons sometimes behave as particles.

☒ **B** photons sometimes behave as particles.

☒ **C** electrons sometimes behave as waves.

☒ **D** photons sometimes behave as waves.

(Total for Question 5 = 1 mark)

6 S is a source of sound of frequency f_S. S is accelerating towards an observer O.

The frequency f_O of the sound heard by O will be

☒ **A** greater than f_S and decreasing.

☒ **B** greater than f_S and increasing.

☒ **C** smaller than f_S and decreasing.

☒ **D** smaller than f_S and increasing.

(Total for Question 6 = 1 mark)

---

7 Which of the following types of wave **cannot** be plane polarised?

☒ **A** light

☒ **B** microwaves

☒ **C** ultrasound

☒ **D** ultraviolet

(Total for Question 7 = 1 mark)

---

8 Which of the following would allow the level of detail in an ultrasound scan to be increased?

☒ **A** increasing the duration of the pulses

☒ **B** increasing the frequency of the ultrasound

☒ **C** increasing the intensity of the ultrasound

☒ **D** increasing the wavelength of the ultrasound

(Total for Question 8 = 1 mark)

9 In plane polarised light, the oscillations of the electric field are

☒ **A** in a single plane, which includes the direction of energy transfer.

☒ **B** in a single plane, which is perpendicular to the direction of energy transfer.

☒ **C** in perpendicular planes, which are perpendicular to the direction of energy transfer.

☒ **D** in perpendicular planes, which include the direction of energy transfer.

(Total for Question 9 = 1 mark)

10 Polarising sunglasses are designed to reduce glare.

(a) State what is meant by polarised light.

(2)

(b) A student is viewing the screen of an electronic device through polarising sunglasses. When viewing the screen in landscape mode the screen looks bright. He gradually rotates the device through 90° into portrait mode. He notices that the screen becomes gradually darker until, in portrait mode, the screen is completely dark.

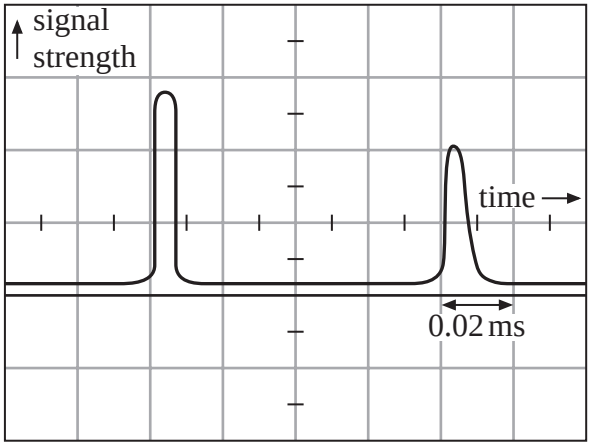
Explain these observations.

(4)

(Total for Question 10 = 6 marks)

11 Ultrasound may be used to scan organs of the body and to determine the speed of the blood.

(a) An ultrasound pulse is used to measure the size of the heart. Two reflected pulses are received at the ultrasound transducer, one from the front surface of the heart and one from the rear surface. An oscilloscope trace of these pulses is shown.



(i) Calculate the distance from the front surface of the heart to the rear surface of the heart.

speed of ultrasound in the heart = 1500 m s^{-1}

(3)

.....

.....

.....

.....

Distance = ...

(ii) State two reasons why the amplitude of the second pulse is less than the amplitude of the first pulse.

(2)

.....

.....

.....

.....

(b) Ultrasound can also be used to measure the speed of the blood using the Doppler effect.

State the measurements that need to be made to determine the speed of the blood.

(1)

.....

.....

(Total for Question 11 = 6 marks)

12 Surveyors sometimes use laser rangefinders to measure the distance to objects such as buildings and trees.

A reflector is placed on the object. The rangefinder emits pulses of light and detects them when they return after being reflected.

(a) State why the laser light is emitted in pulses.

(1)

.....

.....

(b) The rangefinder measures distances between 50 cm and 1 km.

Calculate the longest pulse duration that would allow this range of measurements.

(3)

.....

.....

.....

.....

Pulse duration = ...

(c) Distances inside buildings, such as the length of a room, are often measured using ultrasound.

Suggest a reason why a laser rangefinder would be more suitable than one using ultrasound for measuring the distance to a tree 1 km away.

(1)

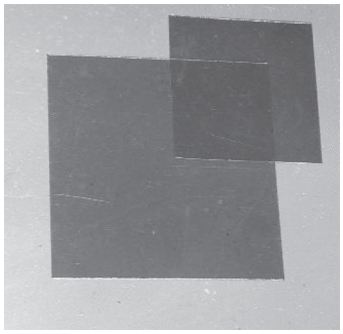
.....

.....

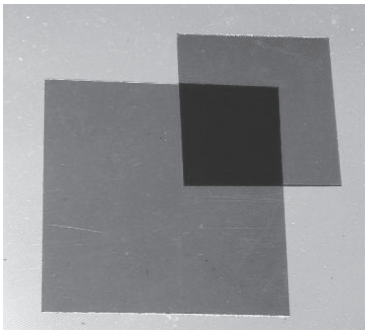
.....

(Total for Question 12 = 5 marks)

***13** The photographs show two polarising filters on a light background.
Between Photograph 1 and Photograph 2 being taken, one of the polarising filters is rotated through 90°.



Photograph 1



Photograph 2

State what is meant by polarisation and explain the observed difference between the appearance of the polarising filters in the two photographs.

(5)

(Total for Question 13 = 5 marks)

14 Over 40 years ago, the Apollo astronauts placed reflectors on the surface of the Moon. These are still used by a number of observatories on Earth to monitor the distance to the Moon by reflecting pulses of laser light from them and detecting the reflected signal.

Scientists have determined that the Moon is at a distance of 363 104 km at its closest and 405 696 km at its furthest. It has also been determined that the Moon is getting about 3.8 cm further away from the Earth each year.

(a) Describe how the reflected pulses can be used to determine the distance to the Moon.

(2)

.....

.....

.....

.....

(b) An observatory sends out pulses of laser light of duration 2.0×10^{-10} s when it is determining the distance to the Moon.

(i) Calculate the pulse length.

(2)

.....

.....

.....

.....

Pulse length = ...

(ii) Discuss whether the levels of precision quoted for the distance to the Moon and its rate of increasing distance from the Earth are justified.

(2)

.....

.....

.....

.....

.....

(iii) The round trip for the light pulses takes about 2.5 seconds. As many as 10 pulses per second may be used.

State why pulses are used rather than a continuous beam.

(1)

.....

.....

(c) Another observatory uses a higher power laser.

(i) This laser produces a pulse of duration 1.0×10^{-10} s. The energy of the pulse is 115 mJ.

Calculate the power of this laser.

(2)

.....

.....

.....

Power = ...

(ii) The wavelength of light produced by this laser is 5.32×10^{-7} m. The light is emitted from an aperture of diameter 75 cm.

Suggest, using the concept of diffraction, why such a large aperture is necessary.

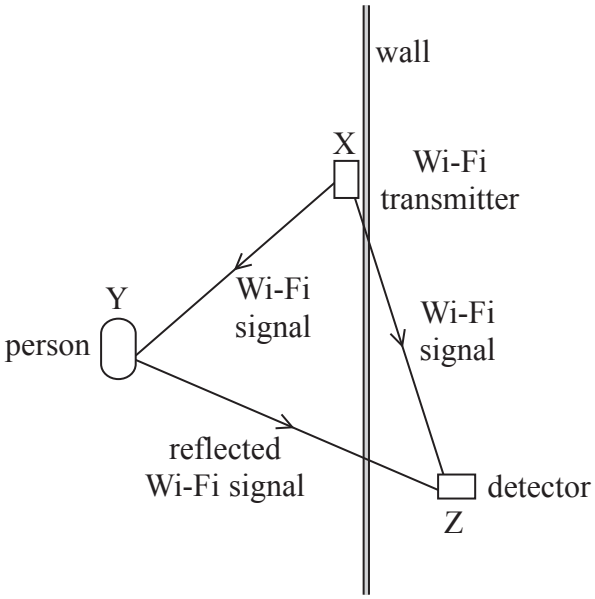
(3)

(Total for Question 14 = 12 marks)

15 Engineers are developing a system, using the Doppler effect, which will detect the movement of people in a room during a hostage situation.

The system makes use of the Wi-Fi transmitter already in a building, rather than needing a separate transmitter.

The system is shown in the diagram.



A detector placed outside the room receives signals directly from the Wi-Fi transmitter, along path XZ. It also receives signals reflected by the person in the room, which have travelled along path XYZ.

(a) Explain how the system uses the Doppler effect to detect the motion of the person.

(3)

.....

.....

.....

.....

.....

.....

(b) Suggest an advantage of a pulse-echo technique over this system.

(1)

.....

.....

(Total for Question 15 = 4 marks)