4.3 Wave Characteristics

Question Paper

Course	DP IB Physics
Section	4. Waves
Topic	4.3 Wave Characteristics
Difficulty	Easy

Time allowed: 60

Score: /43

Percentage: /100

Question 1a

(a)

Outline what is meant by the terms

    (i)
Wavefront

[2]

    (ii)
Ray

[1]

[3 marks]

Question 1b

(b)

Complete the following sentence by placing a tick (✓) next to the correct answer:

The distance between two consecutive wavefronts is equal to the:

	wavelength
	frequency
	amplitude

[1]

[1 mark]

Question 1c

(c)
On the grid below, draw scale diagrams showing the wavefronts for

(i)
A plane wave with a wavelength of 1 cm.

[2]

(ii)
A circular wave with a wavelength of 1 cm.

[2]

On both diagrams, show with arrows, the direction of propagation.

[4 marks]

Question 1d

(d)

Complete the following sentences by circling the correct word:

The higher the frequency of an oscillation, the **longer / shorter** the wavelength and the **closer / further apart** the wavefronts are **to / from** one another.

The lower the frequency of the oscillation, the **longer / shorter** the wavelength and the **closer / further apart** the wavefronts are **to / from** one another.

[2]

[2 marks]

Question 2a

(a)

Match the terms power and intensity to their correct definitions and SI units.

Power	The rate of energy transfer per unit area
Intensity	$J\ s^{-1}$
	$J\ s^{-1}\ m^{-2}$
	The rate of energy transfer

[2]

[2 marks]

Question 2b

A point source radiates light waves in all directions. The intensity, I, of the waves is related to the power, P, by the equation:

$$I = \frac{P}{4\pi r^2}$$

The relationship between the distance from the point source, r, and the intensity of the wave are shown to follow an inverse square law.

(b)
Describe what is meant by the term inverse square law in this context.
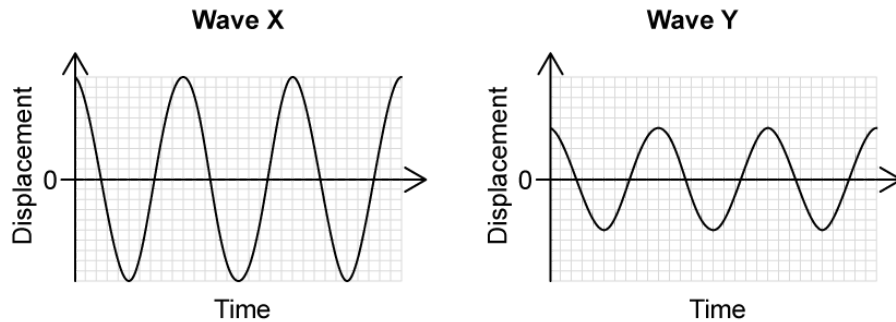
[2]

[2 marks]

Question 2c

(c)
Describe the relationship between intensity, I, and amplitude, A.

[2]

[2 marks]

Question 2d

Two students are investigating the relationship between intensity and amplitude. The graphs below show the variation of the displacement of a particle with time when two progressive waves X and Y pass separately through a medium.

Wave X

Wave Y

The intensity of wave X is I_0. Student 1 says that the intensity of wave Y must be $\dfrac{I_0}{2}$ but Student 2 thinks it must be $\dfrac{I_0}{4}$.

(d)
Determine, using the relationship from part (c), which student is correct.
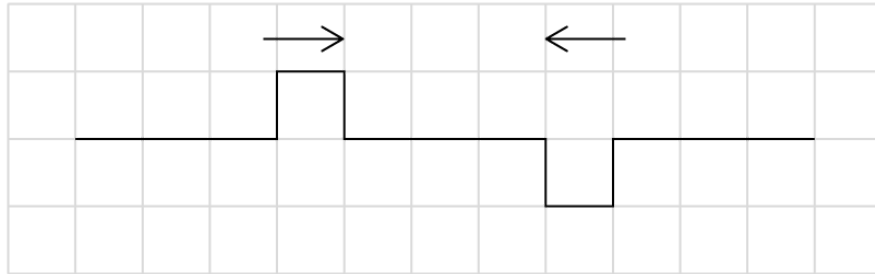
[2]

[2 marks]

Question 3a

(a)
Outline what is meant by the principle of superposition.

[2]

[2 marks]

Question 3b

Two pulses travel toward one another as shown in the diagram.
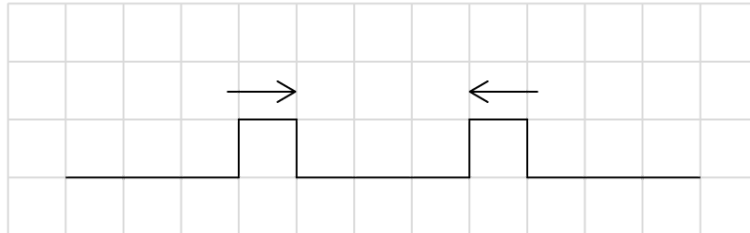

(b)
Sketch the resultant displacement as the pulses superpose.

[1]

[1 mark]

Question 3c

Two pulses travel in opposing directions as shown in the diagram. When the pulses meet, they superpose.

(c)
Draw the resultant peak as the pulses superpose.

[1]

[1 mark]

Question 3d

(d)
Distinguish between the terms constructive interference and destructive interference.

[4]

[4 marks]

Question 4a

(a)
Distinguish between the terms polarised and unpolarised light.
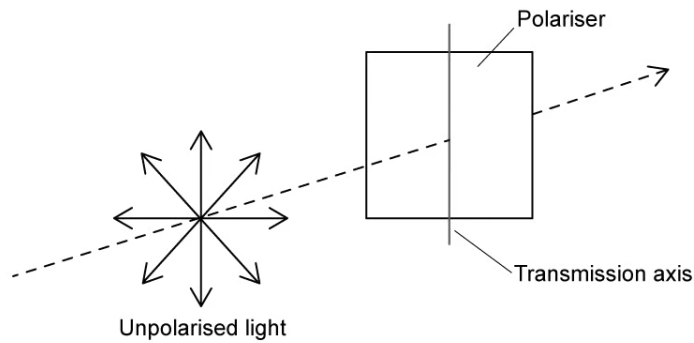
[2]

[2 marks]

Question 4b

(b)
Outline the reason why a sound wave cannot be polarised.

[2]

[2 marks]

Question 4c

Unpolarised light is passed through a polariser as shown in the diagram.
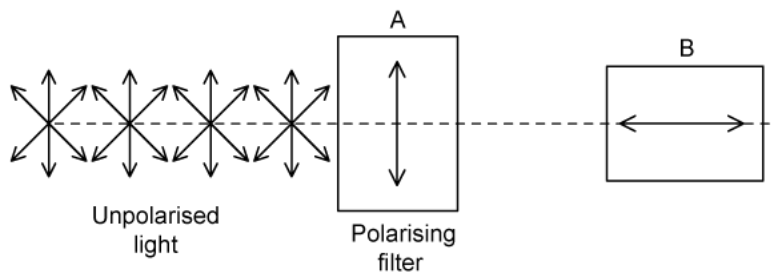

(c)
Draw a double-headed arrow to indicate the resultant orientation of the polarised light.

[1]

[1 mark]

Question 4d

Polarised light is passed through polarising filter A as shown in the diagram.

An identical polarising filter B is placed directly after A at 90°.

(d)
State and explain what happens to the intensity of the light after it is incident on polarising filter B.
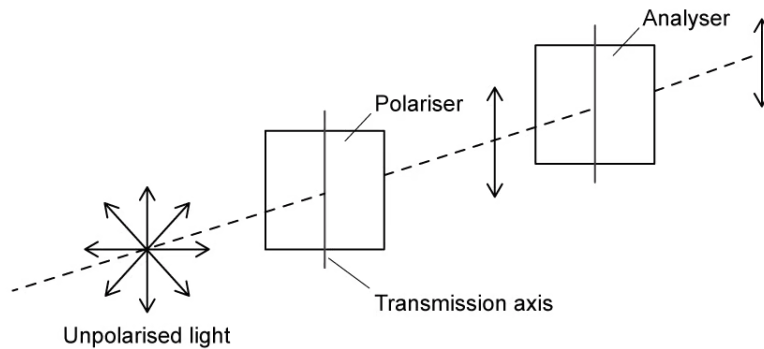
[3]

[3 marks]

Question 5a

(a)
Outline the change in intensity of the incident unpolarised light as it passes through a polariser.

[1]

[1 mark]

Question 5b

Unpolarised light is passed through a polarising filter as shown in the diagram. A second polarising filter called an analyser is placed in sequence.
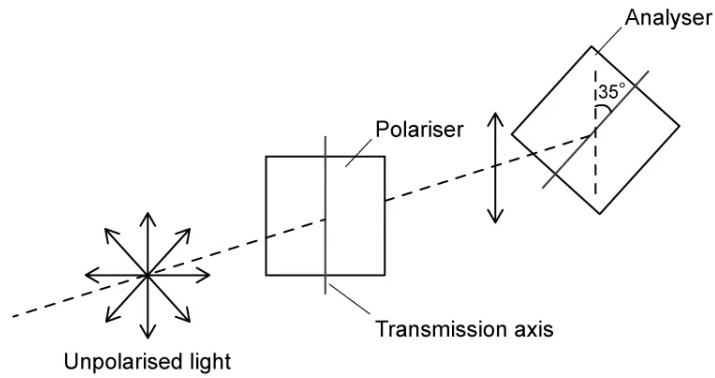

(b)
Compare the intensity of the analysed light to the intensity of the unpolarised light.

[1]

[1 mark]

Question 5c

Unpolarised light with intensity $I_0 = 20\ \text{W m}^{-2}$ is incident on the polariser. The analyser is rotated so that the transmission axis is at an angle of 35° compared to the vertical axis of the polariser.

(c)
Calculate the intensity of the analysed light.

[3]

[3 marks]

Question 5d

Polaroid sunglasses use polarisation to reduce glare.

(d)
Choose suitable words and phrases to complete the following passage:

When unpolarised light is **reflected / refracted** from smooth non-metallic surfaces, **partial / total** plane polarisation occurs. Light is then polarised in a plane **perpendicular / parallel** to that surface.

Most surfaces around us are horizontal, therefore, most of the **reflected / refracted** light is polarised in the **vertical / horizontal** plane.

Polaroid sunglasses have a vertical transmission axis, which means that only light oscillating in the **vertical / horizontal** plane will be transmitted.

This greatly reduces the glare from **reflective / refractive** surfaces, such as water, allowing the wearer to see objects beneath the surface of the water more clearly.

[4]

[4 marks]