Waves - 1

Exercise A

1.

The wave profile in Figure 8 shows several particles at $t = 0$. The wave has a period of 4.0 seconds.

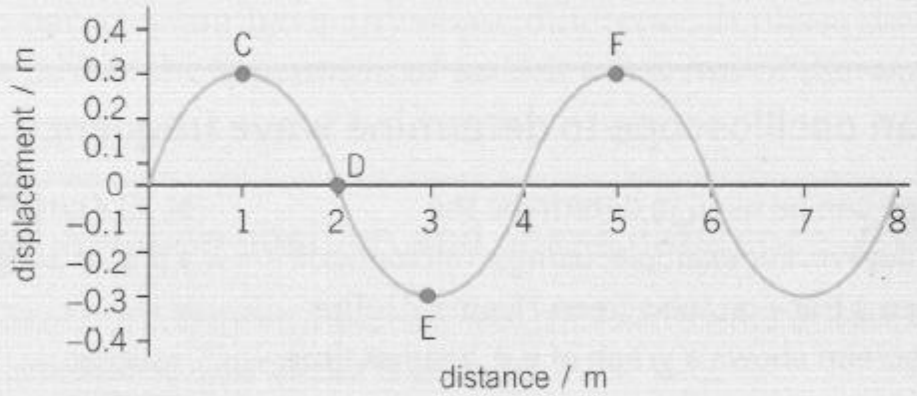

Figure 8

a Sketch a wave profile showing the positions of the particles after:
i 1.0 s; ii 2.0 s. (4 marks)

b Determine the displacement of particle C after:
i 4.0 s; ii 11 s; iii 1 minute. (4 marks)

2.

Determine the phase difference in degrees and radians between the following particles in Figure 8 ($360° = 2\pi$ radians)

a CD; b CE; c DF. (3 marks)

(Exercise B is on the next page)

Exercise B

1 Explain why it is not possible to polarise a sound wave. (2 marks)

2 Give two examples of a wave that can be plane polarised. (2 marks)

3 Explain why the diffraction of sound is regularly observed, but the diffraction of light is observed less frequently. (2 marks)

4 Two different waves pass through a 3.0 m gap. The first wave has a wavelength of 3.0 cm, the second wave 3.0 m. Describe the effect of the gap on each wave. (3 marks)

5 Explain why it is possible to receive long-wavelength radio signals at the bottom of some valleys in which the higher-frequency TV signal cannot be received. (3 marks)

6 Sound waves are directed towards a slit of width 0.30 m. The speed of sound in air is 340 m s^{-1}. State and explain whether or not each of the following frequency sound waves will be diffracted significantly at this slit:

a 1200 Hz; (2 marks)

b 1.0 MHz. (2 marks)

Exercise C

1 State what happens to the intensity of a wave when the amplitude:

a increases by a factor of 3; b decreases by a factor of 4. (2 marks)

2 Calculate the intensity when a power of 400 W is received over a cross-sectional area of 20 m^2. (2 marks)

3 Calculate the intensity 20 m from a source of light with a power of 60 W. (3 marks)

4.

A satellite in orbit around the Earth uses two solar panels for power. The intensity of sunlight received at the height of the satellite is 1.4 kW m^{-2}. The surface area of each solar panel is 8.0 m^2. Calculate the total energy transferred to the panel in a period of 2.0 hours. (4 marks)

5.

At a distance of 15 m from a point source the intensity of a sound wave is $1.0 \times 10^{-4}\,\text{W m}^{-2}$.

a Show that the intensity 120 m from the source is approximately $1.6 \times 10^{-6}\,\text{W m}^{-2}$. *(3 marks)*

b Discuss how the amplitude of the wave has changed. *(2 marks)*

Exercise D

1 State why the polarisation of light supports the view that light is a transverse wave. *(1 mark)*

2 Look at Figure 3. Explain why the maximum intensity occurs at 0°, 180°, and 360° and the minimum at 90° and 270°. *(2 marks)*

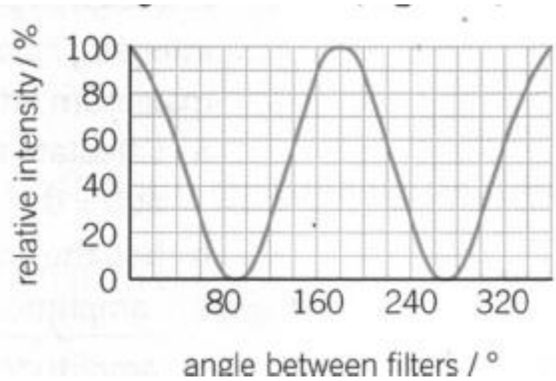

Figure 3 *Change in the intensity of the light transmitted through a pair of Polaroid filters as their relative orientation is rotated through 360°*

3 A student holds a polarising filter in front of a laptop screen and then rotates it. At a particular angle, the laptop screen appears to go dark.

a Suggest what you can deduce about the nature of light emitted from the laptop screen from the student's observation. *(1 mark)*

b Explain how the laptop screen can be viewed once again though the filter. *(3 marks)*

Question 4 is on the next page.

4 A beam of polarised light is directed normally at a polarising filter of cross-sectional area $9.0 \times 10^{-4}\ m^2$. The polarising filter is slowly rotated in a plane at right angles to the beam. The transmitted intensity I plotted against the angle θ resembles Figure 3, with a maximum intensity of $20\ W\ m^{-2}$.

a Calculate the power of light transmitted through the filter at $\theta = 0°$.

b Use the graph to calculate the ratio:

$$\frac{\text{amplitude of light at } 0°}{\text{amplitude of light at } 60°}.$$

(2 marks)