

Oxford Resources for IB

Physics – 2023 Edition

Answers

Theme C – Wave behaviour

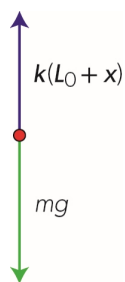
C.1 – Simple harmonic motion

Practice questions – Page 371

- 1 A
- 2 1.7 ms
- 3 a. 2.5 Hz
b. 3.0 cm

Practice questions – Page 376–377

- 4 B
- 5 a. 1.8 s
b. 1.4 m
- 6 a. 1.2 s
b. 1.8 N
- 7 12 N m^{-1}
- 8 a. 0.17 m
b.



- c. $kL_0 = mg$, hence $F = (\text{spring force}) - (\text{weight}) = k(L_0 + x) - mg = kx$
- d. The equation of motion is $ma = -kx$ which is the same as for the horizontal system, hence the period is the same.
- e. 0.83 s

Practice questions – Page 381–382

- 9 a. i. 8.0 ms ii. 12 ms
b. i. -4.2 m s^{-1} ii. 5.6 m s^{-1}
c. $2.3 \times 10^3 \text{ m s}^{-2}$

- 10 a. 2.5 s
b. 4.8 cm
c. 2.8 cm
- 11 a. 1.4 Hz
b. 1.1 m s^{-1}
c. 0.92 m s^{-1}

Practice questions – Page 384

- 12 a. $x_0 = 3.0 \text{ cm}$, $\omega = 26 \text{ rad s}^{-1}$
- $$\phi = -\frac{\pi}{3} \approx -1.0 \text{ rad}$$
- b. 79 cm s^{-1}
c. $v = 39 \text{ cm s}^{-1}$, $a = 1.8 \times 10^3 \text{ cm s}^{-2}$
- 13 a. 12.6 s
b. 3.24 cm s^{-1}

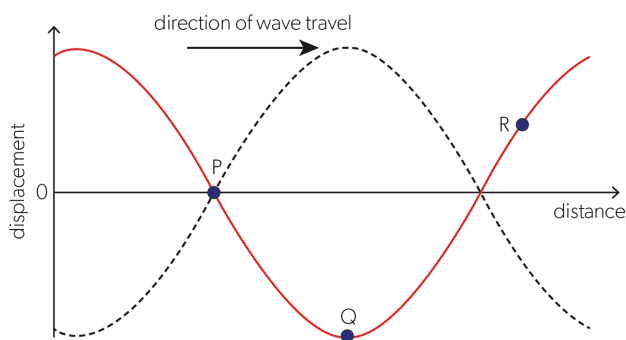
Practice questions – Page 386

- 14 a. 0.19 J
b. 0.99 J
- 15 a. 0.41 m s^{-1}
b. i. 1.5 s ii. 12 N m^{-1}
- 16 a. 15.1 J
b. 0.259 m
- 17 C

C.2 – Wave model

Practice questions – Page 396

- 1 a. P: positive, Q: zero, R: negative
b.



- 2 a. 10 mm
b. S; the particles immediately to the left of S are displaced towards it, and so are the particles immediately to the right of S.
c. Q: -10 mm , R: zero, S: $+10 \text{ mm}$

- 3 D
4 a. 16.7 Hz
b. π
c. 30 cm

Practice questions – Page 398

- 5 a. 8.0 ms
b. 0.24 m
6 a. 0.44 m
b. 0.22 m
7 20 m s^{-1}

Practice questions – Page 400

- 8 370 m s^{-1}
9 a. At 100 Hz the timer cannot measure processes shorter than 10 ms but the expected time of travel between the microphones is about 5.3 ms.
b. At 5 kHz the resolution of the timer is 0.2 ms so the expected percentage uncertainty of time measurement is

$$\frac{0.2}{5.3} \times 100 \approx 4\%$$

If the percentage error of the distance between the microphones is not greater than 1%, then the overall uncertainty of 5% can be achieved.

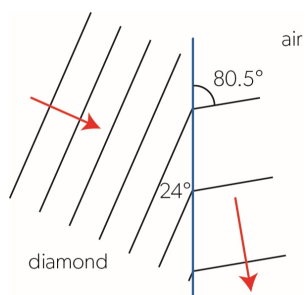
Practice questions – Page 405

- 10 20 cm, microwaves
11 $4.6 \times 10^{14} \text{ Hz}$
12 390 000 km

C.3 – Wave phenomena

Practice questions – Page 413

- 1 a. 1.13
b. 22°
2 a. 2.42
b. 186 nm
c. i. 80.5°
ii.

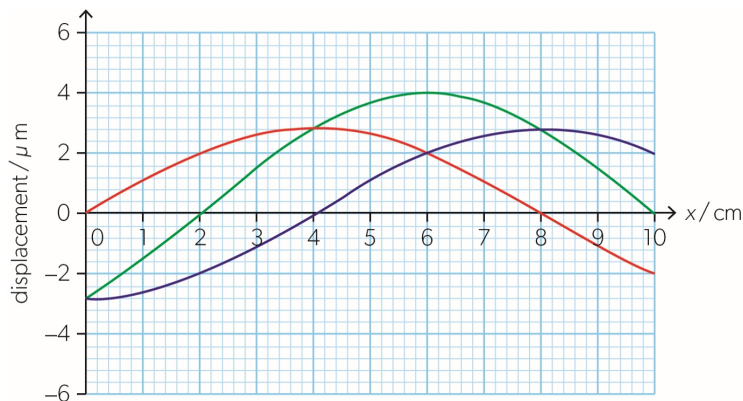


Practice questions – Page 415

- 3 a. 50°
 b. 30°
 c. The angle of incidence on AB will be $90 - 30 = 60^\circ$, which is greater than the critical angle.
 d. 57°
- 4 13°

Practice questions – Page 417

- 5 B
- 6 a. $-2.8 \mu\text{m}$
 b. i. 2.0 cm, 10 cm ii. 6.0 cm
 c. $4.0 \mu\text{m}$
 d.



Practice questions – Page 423

- 7 a. 8.0×10^{-3} rad
 b. 19 mm
- 8 C
- 9 B

Practice questions – Page 427

- 10 a. 592 nm
 b. 2.25 mm
- 11 a. The path difference between the waves arriving at the screen from both slits is a half-integer multiple of the wavelength, so destructive interference occurs.
 b. 0.25 mm
- 12 C

Practice questions – Page 430

- 13 a. 0.26 mm
 b. 1.3 mm
- 14 A

Practice questions – Page 434

- 15 a. 300
b. 11
c. 45.2°
- 16 a. 60°
b. 555 nm

C.4 – Standing waves and resonance**Practice questions – Page 441**

- 1 a. 8.0 cm
b. 30 cm
c. 0.10 s

Practice questions – Page 445

- 2 a. 500 m s^{-1}
b. 52 cm
- 3 a. 950 Hz
b. π
- 4 D
- 5 B
- 6 2800 m s^{-1}

Practice questions – Page 449

- 7 352 m s^{-1}
- 8 a. 340 Hz, 680 Hz
b. 170 Hz, 510 Hz
- 9 a. the wavelength is only determined by the length of the pipe, so it remains unchanged (ignoring minute effects of thermal expansion).
b. for a given wavelength, the frequency is proportional to the speed of sound so it will increase with the temperature.

C.5 – Doppler effect**Practice questions – Page 461**

- 1 Maximum 880 Hz, minimum 820 Hz
- 2 25 m s^{-1}
- 3 D

Practice questions – Page 462

- 4 a. 820 Hz
b. 21 m s^{-1}
- 5 88.9 kHz



Practice questions – Page 465

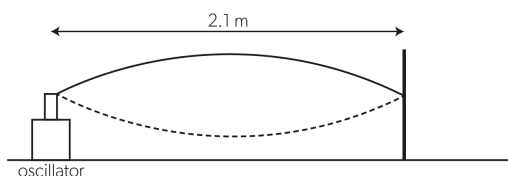
- 6 a. $0.012c$, moving away
b. 533.3 nm
- 7 2.94 MHz

Practice questions – Page 469

- 8 0.42 nm
- 9 a. 12 GHz
b. 18 kHz
- 10 a. the speed of blood cells is much less than the speed of ultrasound, so both the incident and the reflected beam will experience approximately the same frequency shift of u/v .
b. 9.9 cm s^{-1}

End-of-theme questions – Pages 470–471

- 1 a. Path difference is 1.8 m which is a half-integer multiple of the wavelength of 0.40 m .
b. There will be a series of four maxima and minima of sound between P and Q, and one more maximum detected at Q.
c. i. The microphone is moving away from the stationary source so the speed of sound relative to the microphone is less, and the microphone will cross fewer wavefronts in unit time.
ii. 2.00 m s^{-1}
- 2 a. i. 250 m s^{-1} ii. 830 Hz
b. Q has a larger magnitude of acceleration, because it has a larger displacement and the acceleration is proportional to displacement.
c.

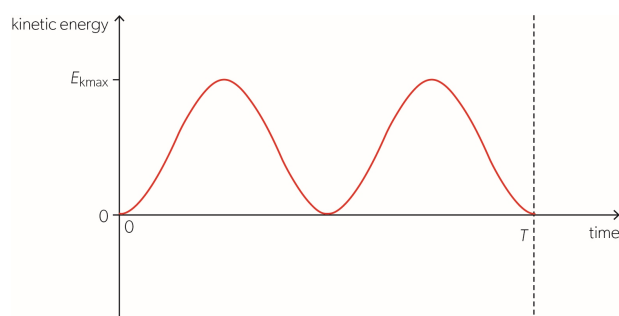


- 3 a. Because the vertical force on the cylinder is proportional to displacement.
b. From the defining equation of SHM:

$$\omega^2 = -\frac{a}{x} = -\frac{F}{mx} = \frac{\rho Ag}{m}$$

$$\omega = \sqrt{\frac{1.03 \times 10^3 \times 2.29 \times 10^{-1} \times 9.8}{118}} = 4.43 \text{ rad s}^{-1}$$

- c. i.



- ii. 71.4 J

- 4 a. 5.7 m s^{-2}
b. 2.6°
c. 1.4 m
d. i. 1400 Hz ii. 0.24 m
- 5 a. 560 nm
b. i. The interference pattern will be modulated by single slit diffraction, so the intensity of the maxima will decrease away from the central maximum.
ii. The angular position of this point is 0.01867 rad which coincides with the first minimum of the diffraction envelope.