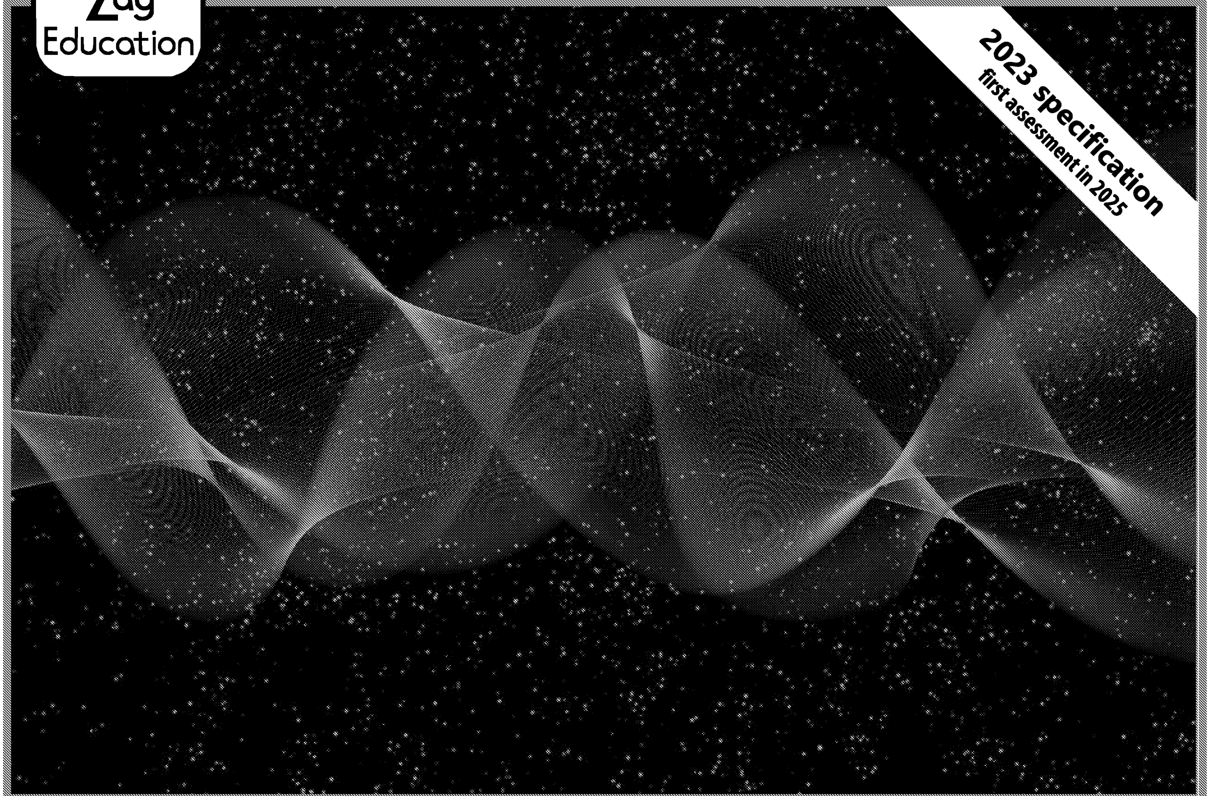
Physics International Baccalaureate Diploma Programme



Topic Tests
for IB Physics
C. Wave Behaviour

zigzageducation.co.uk
POD 12580

Contents

Teacher's Introduction

These topic tests have been designed to help you and your students assess their knowledge of a topic after you have taught each part of **Theme C – Wave behaviour (Topics C.1–C.5)** for the **IB Physics Diploma Programme (standard level and higher level)**. This part of the course includes the following topics:

C.1 Simple harmonic motion
C.2 Wave model
C.3 Wave phenomena
C.4 Standing waves and resonance
C.5 Doppler effect

Each topic test closely follows the content of the specification and includes:

- **Multiple-choice questions**: These are not in exam style, and the purpose of these is to test different elements, knowledge and skills from the specification in a variety of styles. Question types include general recall, explanation of key concepts, and application questions.
- **Structured-answer questions**: Where appropriate, topics may contain one or more extended-response questions to prepare students for what they might meet in the exam, and to test exam skills. Question types include long-form explanations and fact recall.

Mathematical skills are also covered in these topic tests.

The table below shows the content, specification reference and number of marks allocated to each test. Tests have been provided in both write-on and non-write-on formats.

<table>
<tr><th>Topic</th><th>Test title</th><th>Marks per section (SL)</th><th>Marks per section (HL)</th></tr>
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<tr><td>Structured-answer section</td><td>13</td><td>35</td></tr>
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<tr><td rowspan="3">C.3 Wave phenomena</td><td>Multiple-choice questions</td><td>7</td><td>9</td></tr>
<tr><td>Structured-answer section</td><td>24</td><td>31</td></tr>
<tr><td>Total</td><td>31</td><td>40</td></tr>
<tr><td rowspan="3">C.4 Standing waves and resonance</td><td>Multiple-choice questions</td><td colspan="2">6</td></tr>
<tr><td>Structured-answer section</td><td colspan="2">37</td></tr>
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<tr><td rowspan="3">C.5 Doppler effect</td><td>Multiple-choice questions</td><td>3</td><td>6</td></tr>
<tr><td>Structured-answer section</td><td>15</td><td>24</td></tr>
<tr><td>Total</td><td>18</td><td>30</td></tr>
</table>

Tests have been designed to take approximately 30–45 minutes to complete, although some are shorter than others. Students are able to see the number of marks awarded for each question, allowing them to gauge the level of detail they will require for the answers. Full answers with marks are included at the end of each test. Additionally, it makes the resource a suitable tool for students to use independently.

The topic tests are suitable for a classroom assessment, revision aid or homework task and are, therefore, suitable for use immediately after a topic is completed in class or at the end of teaching the course.

It is recommended that students have access to a calculator to complete the questions.

We hope you find these tests useful during your teaching.

September 2024

C.1 Simple harmonic motion

Multiple-choice questions

1. Which of the following can be considered to be performing simple har
   (i) a mass oscillating vertically on a spring
   (ii) a mass oscillating horizontally on a spring
   (iii) the ocean tides
   (iv) a marble bouncing horizontally between two stretched elastic ban

   A. (i) only ☐ C. (i), (ii) and (i
   B. (i[illegible]ii) only ☐ D. (i), (iii) and (

2. Which of the following is a condition for the oscillations of a simple pend
   A. It only works within certain length constraints – too long or too sh
   B. The mass of the bob must be small for SHM
   C. The amplitude of oscillation must be small
   D. It only works on Earth – oscillations of the pendulum will not be sim on other planets.

3. A simple pendulum oscillates with a period of 2 seconds and an ampli
   Which statement below is correct?
   A. The acceleration is a maximum at the equilibrium position ☐
   B. The velocity is a maximum at the equilibrium position ☐
   C. The amplitude is a maximum at the equilibrium position ☐
   D. The frequency is a maximum at the equilibrium position ☐

4. A simple pendulum, made of a bob of mass m kg, on a string of length
   At one instant, the string makes an angle of θ° with the vertical. The te
   Which expression for the acceleration, a, of the bob is generally correct
   A. $a = gL$ ☐ C. $a = g\tan\theta$
   B. $a = \frac{S\cos\theta}{m}$ ☐ D. $a = g\theta$

5. A mass m kg performs SHM on the end of a spring of stiffness k Nm^{-1},
   Which expression for the maximum acceleration, a ms^{-2}, of the mass is
   A. $-\frac{k}{m}A$ ☐ C. $-\sqrt{\frac{k}{m}}A$ ☐
   B. $\frac{k}{m}A$ ☐ D. $\sqrt{\frac{k}{m}}A$ ☐

6. Which of the following sets of data could be collected from a body per
   A. $x =$ [illegible] $v = 3$ ms^{-1} $a = -4$ ms^{-2} ☐ C. $x = 7$ cm
   B. $x = -12$ cm $v = 4$ ms^{-1} $a = -7$ ms^{-2} ☐ D. $x = -8$ cm

7. Which of the following describes the energy changes during one oscill starting our consideration as it moves through the equilibrium positio
   A. elastic potential energy → kinetic → gravitational potential → kin
   B. elastic potential and kinetic energy → kinetic → gravitational potenti elastic potential
   C. elastic potential and kinetic energy → gravitational potential → ki and kinetic energy
   D. elastic potential, gravitational potential and kinetic energy → grav elastic potential, gravitational potential and kinetic energy → elast elastic potential, gravitational potential and kinetic energy

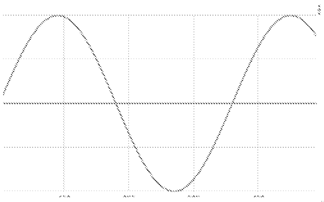
8. A simple pendulum, length l (m) and a mass m (kg) on a spring of stiff period. Which of the following expressions is correct for l?
   A. $l = \frac{mg}{k}$ ☐
   B. $l = \frac{km}{g}$ ☐
   C. $l = \frac{kg}{m}$ ☐
   D. $l = \frac{km}{\pi g}$ ☐

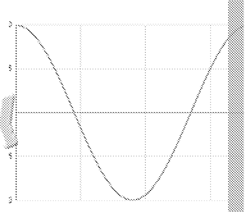
9. A mass, m kg, is oscillating vertically on a spring of stiffness k Nm^{-1}. A below the equilibrium position, x_0, at a displacement x m. Taking the a g ms^{-2}, which of the following expressions is correct for the acceleratio
   A. $\frac{k(x_0 + x) - mg}{m}$ ☐
   B. $\frac{k(x_0 - x) - mg}{m}$ ☐
   C. $\frac{k(x_0 - x) + mg}{m}$
   D. $\frac{k(x_0 + x) + mg}{m}$

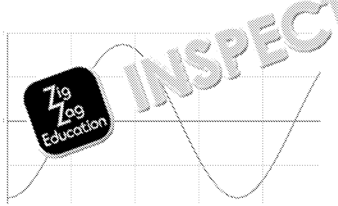
Additional higher level (HL)

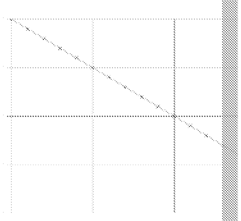
10. What is the phase relationship between displacement and acceleration simple harmonic motion?
    A. 0 radians ☐
    B. $\frac{\pi}{2}$ radians ☐
    C. π radians
    D. $\frac{3\pi}{2}$ radians

11. Which of the following represents the relationship between the acceler performing SHM and its displacement from the equilibrium position?

A. 

B. 

C.  ☐

D. 

12. A mass of 50 g on a spring of stiffness 5 Nm^{-1} performs simple harmon amplitude of 10 cm. What will the velocity of the mass be when the di the equilibrium position?

A. 1.0 ms^{-1} ☐ C. 0.9 ms^{-1}
B. 0.06 ms^{-1} ☐ D. 0.08 ms^{-1}

13. A simple pendulum performs simple harmonic motion with a period amplitude of 3 cm. Which of the following is the displacement after 12

A. 3 cm ☐ C. 0.8 cm
B. 0 cm ☐ D. 0.07 cm

14. Which of the following expressions is valid for the displacement of an performing simple harmonic motion with a frequency f Hz and potent

A. $x = \sqrt{\frac{E_P}{8\pi f^2 m}}$ ☐ C. $x = \sqrt{\frac{E_P}{\pi f^2 m}}$
B. $x = \sqrt{\frac{E_P}{4\pi f^2 m}}$ ☐ D. $x = \sqrt{\frac{E_P}{2\pi f^2 m}}$

Total for se

Structured-answer section

1. Define simple harmonic motion.

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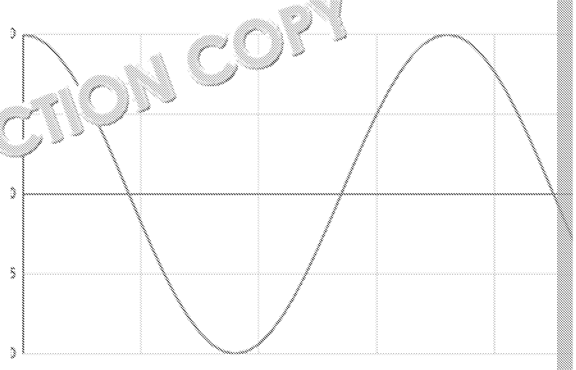
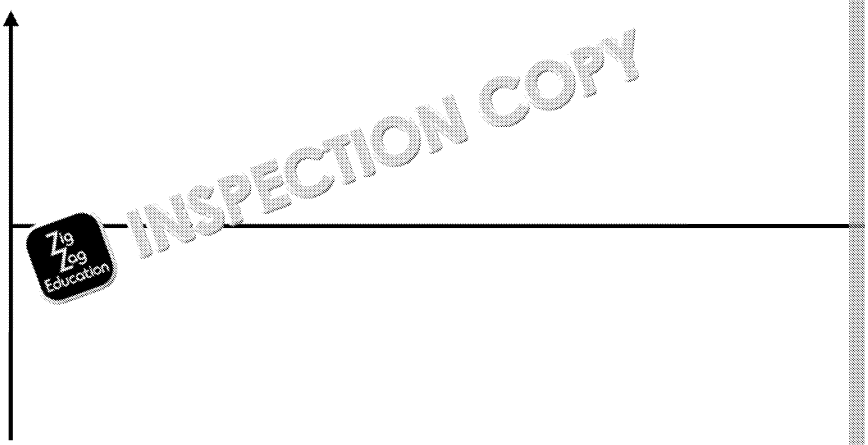
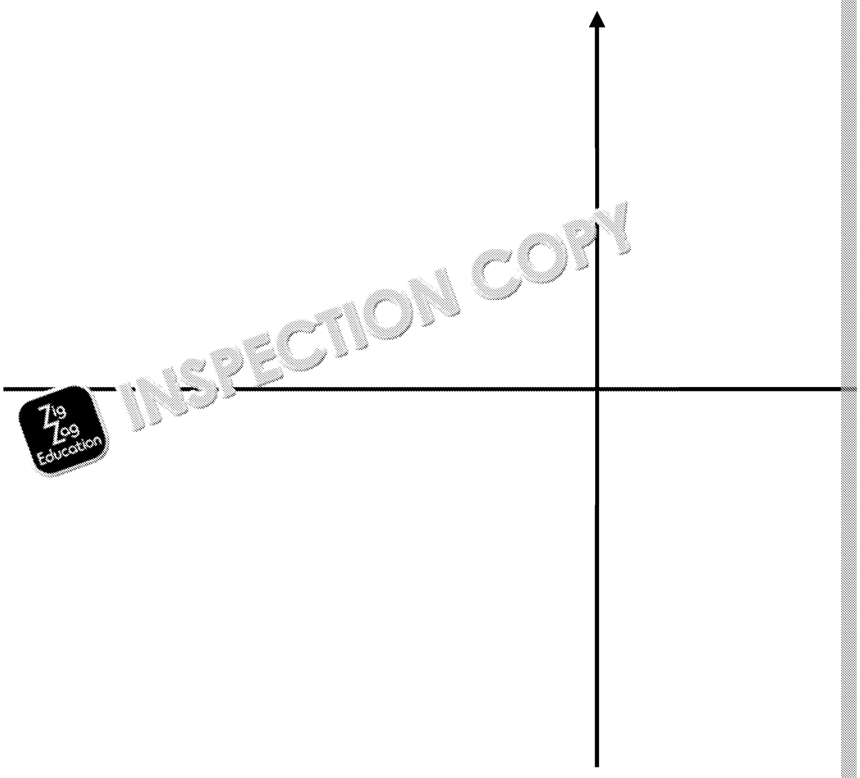
2. The graph below shows the variation of velocity with time of an object p motion. Sketch on the axes a graph to represent the **acceleration** of the c



3. a) A spring, of stiffness 5 Ncm^{-1}, is fixed at one end from the ceiling a
suspended from the other end. It is pulled down 5 cm from the eq
released at the same instant as a stop clock is started. Sketch a dis
the motion of the mass over at least three oscillations.



b) Sketch a graph of acceleration against displacement for the mass-s



Higher

Additional higher level (HL)

4. A model to illustrate simple harmonic motion involves projecting the r
   a vertical circle on to the vertical diameter of that circle.

   The table below shows data collected from one such demonstration. T
   1.20 m and the period of rotation is 3.00 seconds. The timing began w
   '12:00' position and the rotation is anticlockwise. Displacement above
   taken as positive.

   Complete the table by calculating the missing values.

Time (s)	Angle (rad)	Displacement on diameter, y (m)	Velocit diamete
0.00			
0.25			
0.50			
0.75			
1.00			
1.25			
1.50			
1.75			
[illegible]			
2.25			
2.50			
2.75			
3.00			

5. a) Plot a graph using the data from question 4 to verify whether this along the vertical diameter is indeed simple harmonic.

b) E h your graph supports or refutes the hypothesis that th si armonic.

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6. a) State the expression for the total energy, E_T, of an object mass m kg harmonic motion with a period T seconds and amplitude x_0 metres

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b) The period of the oscillation is 2 seconds with an amplitude of 1 m

Calculate the displacement of the body after 3 seconds.

c) Calculate the maximum kinetic energy of the object if the mass is 2

Total for se

To

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Preview of Questions Ends Here

This is a limited inspection copy. Sample of questions ends here to avoid students previewing questions before they are set. See contents page for details of the rest of the resource.

C.2 Wave model

Question	Answer
	Multiple-choice questions
1	A – 400 ps
2	C – (i), (ii) and (iii) only
3	C – 0.885 Wm^{-2}
4	A – 19.9 m
5	C – 16 : 4[illegible]
6	[illegible] Sound waves diffract at the partially open doorway
7	[illegible] (i), (ii), (iii) and (iv)
8	C – (ii), (iii) and (iv) only
	Structured-answer section
1 a)	A wave in which the oscillation causing the wave [1] and the directi by the wave [1] are at right angles / orthogonal / perpendicular [1]
1 b)	The distance between two consecutive points [1] that are in phase [1
1 c)	Conversion of 300 MHz to Hz = 300 000 000 [1] Substitution into equation: 300 000 000 = 300 000 000 × wavelength and rearrangement to give wavelength = 1 [1] Units metres (m) [1]
1 d)	Any three from: • Sound is longitudinal, radio is transverse [1] • Sound is mechanical, radio is electromagnetic [1] • Sound requires a medium to propagate, radio does not [1] • Sound travels much slower than radio (or converse) [1]
1 e)	Wavelength of sound: $\frac{330}{4000}$ = 0.0825 m [1] Ratio of radio wavelength : sound wavelength: 1 : 12 [1]
2 a)	Time taken for one complete oscillation [1]
2 b)	Frequency = 1/period [1]
2 c)	The student: • did not perform the conversion of 100 kHz to Hz = 100 000 [1] • did not make the correct substitution into equation: 330 = 100 0 made an incorrect rearrangement of the equation [1] (should have calculated wavelength = 3.3×10^{-3}) • did not use the correct units, metres (m) [1]
2 d)	100 kHz [1]
2 e)	Ratio of speed gives ratio of wavelengths, or calculate wavelength i wavelength in air [1] Factor: 4.54 [1] Bigger in water than air [1]

Preview of Answers Ends Here

This is a limited inspection copy. Sample of answers ends here to stop students looking up answers to their assessments. See contents page for details of the rest of the resource.