4.5 Standing Waves

Question Paper

Course	DP IB Physics
Section	4. Waves
Topic	4.5 Standing Waves
Difficulty	Hard

Time allowed: 20

Score: /10

Percentage: /100

Question 1

A standing wave is set up on a string with both ends fixed. The frequency of the first harmonic is 150 Hz.

Determine the approximate length of the string, *L* and for the second harmonic, the approximate distances between two successive nodes, *N* and two successive antinodes, *A*.

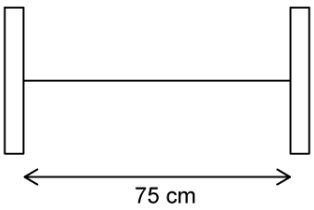
The speed of sound is air = 340 m s^{-1} and the speed of sound on the string = 250 m s^{-1}.

	***L* / m**	***N* / m**	***A* / m**
A.	1.10	0.55	0.55
B.	1.10	0.24	0.55
C.	0.84	0.42	0.42
D.	0.84	0.42	0.56

[1 mark]

Question 2

A guitar string is stretched and fixed at each end so that the length is 75 cm. It is found to vibrate with resonant frequencies at 240 Hz and 360 Hz. There are no other resonant points between these two.



What is the lowest resonant frequency which can oscillate on the guitar string?

A. 60 Hz

B. 120 Hz

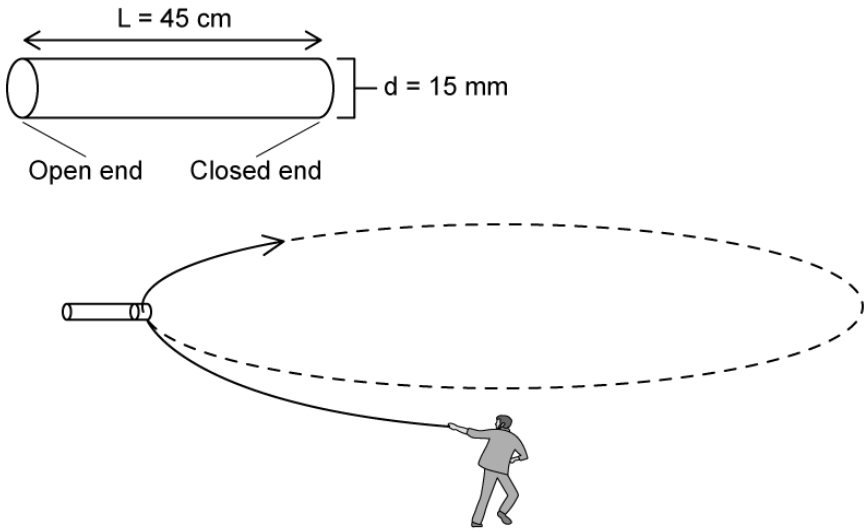
C. 180 Hz

D. 240 Hz

[1 mark]

Question 3

A copper pipe of diameter 15 mm and length 45 cm is sealed closed at one end. A string is attached such that the copper pipe can be quickly spun around, causing the effect of a wind blowing across the open end at different frequencies.



What is the wavelength of the third harmonic?

A. 30 cm

B. 34 cm

C. 45 cm

D. 60 cm

[1 mark]

Question 4

A standing wave on a string between two fixed points sounds its second harmonic at frequency *f*.

Which expression, where *n* is an integer, gives the frequencies of harmonics that have an antinode at the centre of the string?

A. $\frac{1}{2}nf$

B. nf

C. $2nf$

D. $(2n + 1)\ f$

[1 mark]

Question 5

A pipe of length L_1 has one open end and one closed end. A second pipe, of length L_2 is open at both ends. The frequency of the first harmonic of both pipes is the same.

What is the ratio $\frac{L_1}{L_2}$?

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. $\frac{3}{2}$

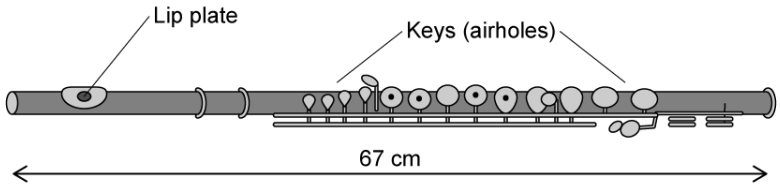
D. 2

[1 mark]

Question 6

A flute is a musical instrument with a typical length, L, of 67 cm. It has a hole in the lip plate at one end which the musician blows across, and is open at the other end.

The length of the air column is varied by opening and closing a series of keys along the side. The velocity of the air entering the lip plate is controlled by the musician.



To create a frequency f the musician creates a wave with velocity v, holding down the keys such that the column of air is half the available length.

If she wants to increase the frequency to three times the original pitch, which changes to would achieve this?

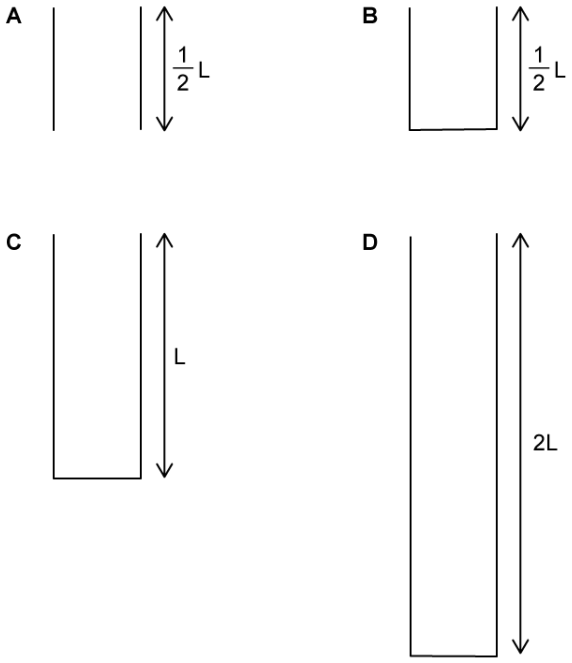
	v	L
A.	$\times 9$	$\times 2$
B.	$\times 3$	$\times \frac{1}{2}$
C.	stays the same	$\times 3$
D.	$\times \frac{1}{2}$	$\times \frac{1}{6}$

[1 mark]

Question 7

A thin wire is held at tension with length *L* so that the speed of the waves on the string is equal to the speed of sound in air. At this tension the fundamental frequency of oscillation produces resonance in a pipe which is closed at one end.

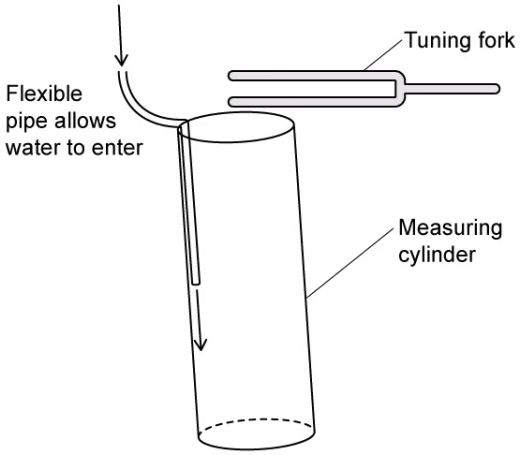
Which of the pipes shown resonates?



[1 mark]

Question 8

A very long, empty measuring cylinder of cross sectional area 2.5×10^{-3} m^2 is set up so that water can be slowly run into it through a narrow, flexible tube.



A tuning fork is made to oscillate and held over the open end. A resonant frequency is heard early on in the experiment and then again after a further 5.5×10^{-3} m^3 of water has run into the cylinder.

What is the wavelength of the wave produced by the tuning fork?

A. 0.70 m

B. 1.40 m

C. 2.20 m

D. 4.40 m

[1 mark]

Question 9

A string is stretched to a length where $L = 300$ cm. At this length and tension it has resonant frequencies at 360 Hz and subsequently at 420 Hz.

What is the speed of the standing waves on the string?

A. 18 m s^{-1}

B. 36 m s^{-1}

C. 180 m s^{-1}

D. 360 m s^{-1}

[1 mark]

Question 10

Two microwave transmitters are set up to emit microwaves so that a stationary wave is created between them. The microwaves have a frequency of 300 MHz.

Which line correctly gives both the formula which represents the the distance between two adjacent nodes in the standing wave and the value for the distance?

	Formula	Distance
A.	$\frac{c}{2f}$	50 cm
B.	$\frac{f}{2c}$	2.0 m
C.	$\frac{c}{2f}$	5.0 m
D.	$\frac{f}{2c}$	20 cm

[1 mark]