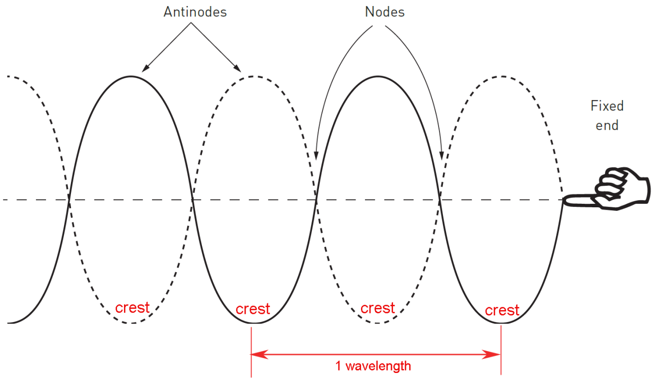
Assess Quizzes from the o-book – Explanations for the answers.

Chapter 15 Review – Support

Q	Reason
1	They can pass through any material in which the particles can vibrate (including a solid, but not a vacuum).
2	One wavelength is from successive crests such as B on the diagram. ‘Successive’ just means nearest to each other.
3	This is set to trap you. It is twice the distance between crests because the neighbouring crests are not present at the same time. The crests that are there together at the same time are one wavelength apart, and so are neighbouring nodes. So, it is twice the nodal distance. See Figure 5 page 396. 
4	$Closed: L = \frac{\lambda}{4} = \frac{v}{4f_c}$ $Open: L = \frac{\lambda}{2} = \frac{v}{2f_o}$ $\frac{v}{4f_c} = \frac{v}{2f_o}$ $f_o = 2f_c$
5	Frequency doesn’t change, so the period (T = 1/f) doesn’t change.
6	Amplitude varies as the string vibrates from side to side of the equilibrium (rest) position. Energy is transferred along the string; and nodal points are at either end.
7	$L = \frac{n\lambda_n}{2}$ $(1st\ harmonic, n = 1)$ $String\ formula$ $L = \frac{1 \times \lambda_1}{2}$ $\lambda_1 = 2L = 2 \times 0.86 = 1.72\,m$

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8	There are two correct options for this question, unfortunately. Sorry about that. Will fix. One correct answer is to "halve the length of the tube" (given as 'correct' in the marking). $L = \frac{n\lambda}{2} = \frac{nv}{2f}$ [*open pipe formula*] $f = \frac{nv}{2L}$ $f_{L_1} = \frac{1v}{2L_1}$ [1*st harmonic*, $n = 1$] $f_{L_{new}} = \frac{1v}{2L_{new}}$ [new length $L_{\text{new}} = \frac{1}{2}L_1$] $f_{L_{new}} = \frac{1v}{2\times\frac{1}{2}L_1} = \frac{2v}{2L_1}$ $f_{L_{new}} = 2\times\frac{1v}{2L_1}$ $f_{L_{new}} = 2f_{L_1}$ That is, the new frequency is twice the old frequency. The other correct answer is to "close one of the open ends" and make it a closed pipe instead of an open pipe. $L_{(open)} = \frac{n\lambda}{2} = \frac{nv}{2f}$ [*open pipe formula*] $f_{n(open)} = \frac{nv}{2L}$ $f_{1(open)} = \frac{1v}{2L}$ [1*st harmonic*, $n = 1$] $L_{(closed)} = \frac{(2n-1)\lambda}{4} = \frac{(2n-1)v}{4f}$ [*closed pipe formula*] $f_{n(closed)} = \frac{(2n-1)v}{4L}$ $f_{1(closed)} = \frac{(2\times1-1)v}{4L}$ (1*st harmonic*, $n = 1$) $f_{1(closed)} = \frac{1v}{4L}$ $f_{1(open)} = 2f_{1(closed)}$ [*because* $\frac{v}{2L} = 2\times\frac{v}{4L}$]

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9	Strings produce all harmonics: f_1, $f_2 = 2f_1$, $f_3=3f_1$, $f_4 = 4f_1$. Thus, if $f_1 = 200$ Hz, the second harmonic (f_2) is 400 Hz.
10	$L_{open} = \frac{n\lambda_n}{2}$ *open pipe formula* $\lambda_n = \frac{2L_{open}}{n}$ $\lambda_{1(open)} = \frac{2L_{open}}{1}$ $(1st\ harmonic, n = 1)$ $= 2L_{open}$ $L_{closed} = \frac{(2n-1)\lambda_n}{4}$ *closed pipe formula* $\lambda_n = \frac{4L_{closed}}{(2n-1)}$ $\lambda_{1(closed)} = \frac{4L_{closed}}{(2\times 1-1)}$ $(1st\ harmonic, n = 1)$ $= 4L_{closed}$ $\lambda_{1(open)} = \lambda_{1(closed)}$ $2L_{open} = 4L_{closed}$ $L_{closed} = \frac{L_{open}}{2} = \frac{L}{2}$

Chapter 15 Review – Consolidate

Q	Reason
1	We can see from the diagram that one full wavelength is two-thirds of the length shown on the diagram. You can always use the fact that the wavelength is twice the distance between nodes for a standing wave. $\lambda = \frac{2}{3}\times 1.5 = 1.0\,m$ $v = f\lambda = 30\times 1.0 = 30\,m\,s^{-1}$
2	Again, as in Q1, we can see from the diagram that one full wavelength is two-thirds of the length shown on the diagram. You can always use the fact that the wavelength is twice the distance between nodes for a standing wave.

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<table>
<tr><td></td><td>$\lambda = \frac{2}{3} \times 1.5 = 1.0\,m$
$v = f\lambda = 30 \times 1.0 = 30\,m\,s^{-1}$
The question is: which harmonic is it (which mode, that is, what is the value of n?)
We can use the string/open pipe equation to determine the fundamental frequency. The fundamental wavelength (n = 1) is calculated from:
$L = \frac{n\lambda}{2}$
$\lambda = \frac{2L}{n}$
$= 2L\ (fundamental\ n = 1)$
$= 2 \times 1.5 = 3.0\,m$
$f = \frac{v}{\lambda} = \frac{30}{3.0} = 10\,Hz$</td></tr>
<tr><td>3</td><td>'Louder' means the amplitude of the wave is greater, but the frequency, wavelength and speed are the same. Amplitude is a measure of energy so the trumpet would sound out more energy per second (that is, *energy at a greater rate*) than the clarinet.</td></tr>
<tr><td>4</td><td>A closed pipe produces *odd* harmonics, so if the 1st harmonic is 440 Hz, the next one is the 3rd harmonic ($f = 3f_1$) so its frequency is 3 × 440 = 1320 Hz. This can be shown mathematically. The length of the pipe is constant, so we need to consider the fundamental mode (n = 1) and the second mode for the closed pipe (n = 2):
$f = \frac{(2n-1)v}{4L}\ (general\ formula)$
$f_{n=1} = \frac{(2\times 1-1)v}{4L} = \frac{1v}{4L} = 440\,Hz$
$f_{n=2} = \frac{(2\times 2-1)v}{4L} = \frac{3v}{4L} = 3\times f_{n=1} = 3\times 440 = 1320\,Hz$</td></tr>
<tr><td>5</td><td>The image is of a closed pipe resonating in its 2nd mode (n = 2). Hence, as closed pipes produce standing waves (resonate) in odd harmonics, this must be the 3rd harmonic (n =2) for a closed pipe. Mathematically,</td></tr>
</table>

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	$L = \frac{3}{4}\lambda\ (by\,inspection)$ $L = (2n-1)\frac{\lambda}{4}$ (general formula for closed pipe) $\frac{3}{4}\lambda = (2n-1)\frac{\lambda}{4}$ $3 = 2n-1$ (cancel down) $n = 2$ $f_n = (2n-1)f_1$ $= (2\times 2-1)f_1$ $= 3f_1\ (hence, 3rd\ harmonic)$

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Chapter 15 Review – Extend

Q	Reason
1	Closed pipe (by inspection). It is resonating in its fundamental mode (n = 1): $f_n = (2n-1)f_1$ $= (2\times 2-1)f_1$ $= 3f_1\,(hence, 3rd\ harmonic)$ We can also prove that the diagram shows the fundamental mode for a closed pipe: $L = \frac{1}{4}\lambda\ (by\ inspection)$ $L = (2n-1)\frac{\lambda}{4}$(general formula for closed pipe) $\frac{1}{4}\lambda = (2n-1)\frac{\lambda}{4}$(cancel down) $1 = 2n-1$ $n = 1$ (fundamental mode)
2	$v = 331 + 0.6\times 25 = 346\,m\,s^{-1}$ $\lambda = \frac{v}{f} = \frac{346}{440} = 0.78\,m$
3	For the fundament mode of a string n = 1: $L = \frac{n\lambda}{2}$ $\lambda = \frac{2L}{n} = \frac{2L}{1} = 2L$ $= 2\times 0.60 = 1.20\,m$ (this is teh wavelength of the wave in the string) $f = \frac{v}{\lambda} = \frac{33}{1.20} = 27.5\,Hz$ (33 m s^{-1} is the speed of wave in the string, not in air) We can now calculate the wavelength of this sound in air: $v_{air} = f\lambda_{air}$ $\lambda_{air} = \frac{330}{27.5} = 12.0\,m = 1200\,cm$
4	Strings produce all harmonics.

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	$f_1 = \frac{v}{\lambda_1} = \frac{300}{1.5} = 200\,Hz\ (for\ n=1)$ $f_{n=2} = nf_1 = 2\times 200 = 400\,Hz$
5	When dipped in water it becomes a closed pipe. If the length of the open pipe is L_o, then the length of the closed pipe (L_c) is L_o /2. The open pipe is resonating in its fundamental frequency *f* where (n = 1): $f = \frac{nv}{2L}(general)$ $f = \frac{1v}{2L_o}$ For a closed pipe, the general formula is: $f = \frac{(2n-1)v}{4L}(general)$ $f = \frac{1v}{4L_c} = \frac{1v}{4\frac{L_o}{2}} = \frac{1v}{2L_o}$ This is the same as the frequency for the open pipe, hence f_{closed} = 1f