**Question 23** (Answer: **B**)

- Loudness is set by the amplitude and pitch by the frequency.
- The loudness does not change, so the amplitude is constant.
- The pitch varies, so it is the frequency that is changing.

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**Question 23** (Answer: **C**)

- Sound is longitudinal, so the particles bunch up and spread out along the direction of travel.
- In a compression the particles are closer together, so the pressure is higher.
- In a rarefaction they are further apart, so the pressure is lower – the wavelength is the same throughout.

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**Question 23** (Answer: **D**)

- Amplitude controls loudness, so a smaller amplitude makes the sound quieter.
- Frequency controls pitch, so a lower frequency makes the pitch lower.
- Both decrease here, so the sound is quieter *and* lower.

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<table>
<tr><td>5(a)</td><td>(speed of sound in air =) 330 m / s ⩽ value ⩽ 350 m / s<br>AND<br>(speed of sound in water) is faster</td></tr>
<tr><td rowspan="2">5(b)</td><td>Yes AND (normal) human hearing range is 20 Hz to 20 kHz (and all dolphin sounds lie in this range)</td></tr>
<tr><td>Yes AND all the dolphin sounds are in the range of human hearing</td></tr>
<tr><td>5(c)</td><td><table><tr><td>Frequency kHz</td><td>amplitude</td><td>loudness</td><td>pitch</td></tr><tr><td>14</td><td>Large</td><td>loud</td><td>high</td></tr><tr><td>8</td><td>small</td><td>soft / quiet</td><td>low</td></tr></table>one mark for each column correct</td></tr>
<tr><td>5(d)</td><td>Particles</td></tr>
<tr><td rowspan="2">5(d)</td><td>high pressure<br>AND<br>low pressure</td></tr>
<tr><td>Parallel</td></tr>
</table>

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**Question 23** (Answer: **D**)

- The frequency is fixed by the source, so it does not change when the wave enters the steel.
- Sound travels much faster in a solid than in air.
- Since $v = f\lambda$ with $f$ unchanged, a higher speed means a longer wavelength.



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**Question 22** (Answer: **C**)

- A compression and the nearest rarefaction are *half* a wavelength apart.
- So $\lambda = 2 \times 2.5 = 5.0$ cm $= 0.050$ m.
- $f = v/\lambda = 330/0.050 = 6600$ Hz.

**Question 23** (Answer: **D**)

- Medical scanning of soft tissue uses ultrasound.
- It reflects at boundaries between tissues, and unlike X-rays it does not ionise.
- That makes it safe for scanning a fetus.

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**Question 22** (Answer: **A**)

- Light reaches Y effectively instantly, so the delay is entirely the sound's travel time.
- $t = d/v = 100/340$.
- $= 0.29$ s.