IGCSE Coordinated Science: Sound

Sound

1. Describe the production of sound from vibrating sources.

Sound travels through a wave: that is, a periodic disturbance in space and time. Mechanical vibrations (oscillation pf particles) cause a periodic disturbance in space and time, producing a wave.

2. Describe the transmission of sound in air in terms of compressions and rarefactions

1) Vibrations from the source of the sound compress the air, giving it kinetic energy. The KE in the air particles cause them to move from its equilibrium position, exerting a force on adjacent air particles. The vibrations propagate through a series of perfectly elastic collisions.
2) This is why sound is a form of energy. (E=hf)
3) After KE is transfered, the original particles experience a resultant force (cf. Newton's 3rd law) and move back to its equilibrium position. This creates a rarefraction in the wave.
4) These Compressions and Rarefractions comprise of the sound wave. When it reaches the ear, the vibrations of the air particles are translated into sound.

These compressions are a periodic disturbance (oscillation) that travels parallel to the direction of the wave. (longitudinal wave)

The pitch depends on how fast the particles vibrate, and therefore how often a cycle of compression-rarefraction happens (frequency)

3. State the approximate human range of audible frequencies

- 20Hz to 20,000 Hz
- Remember this as 20-20: 20 Hz to 20 kHz

4. Demonstrate understanding that a medium is needed to transmit sound waves

From the above explaination of sound waves:

A sound wave is really a bunch of oscillating air particles (particles of any other medium). When there are no particles to vibrate, there is no sound wave.

5. Describe and interpret an experiment to determine the speed of sound in air

1) Stand a measured distance from a wall, x.
2) Make a short, loud burst of sound, start timing.
3) When you hear the echo, stop timing. let the value obtained be x.
4) The sound wave has traveled 2x.
5) Since v =ds/dt
6) substituting values
7) v = 2x/t = ~330 ms^-1

Interpretation:

1) rearrange the equation. In the form y=mx+c
2) ds = vdt
3) y = mx+c
4) If s is the independent variable and t is the dependent, plotting a linear graph, v will be the gradient.

6. State the order of magnitude of the speed of sound in air, liquids and solids

- Solids – Fastest
- Liquids – Middle
- Gases – Slowest

Explaination: in terms of the atomic theory of matter, solids are the densest and gases are the least dense of the 3 states. Since sound travels by oscillating atoms (propagated through collisions), the denser the medium, the faster the speed.

7. Relate the loudness and pitch of sound waves to amplitude and frequency

- Amplitude: the maximum extent of a vibration or oscillation, measured from equilibrium. The higher the value, the more kinetic energy in the atom, which causes higher pressure in the medium, which translates to loudness when it reaches the ear.
- Frequency: the number of occurances of a repeating event per unit time (e.g. 1 compression and 1 rarefraction). For a given wave, all particles in the medium vibrate in the same frequency. Since these vibrations cause

pressure in the medium, the higher the frequency, the faster the pressure fluctuation. The human ear detects these fluctuations as pitch.

8. Describe how the reflection of sound may produce an echo.

When a sound wave is reflected, it has the same magnitude and different direction (sometimes moving back to the source). Since the wavelength and frequency is still the same, the observer perceives this as the same sound as the original. This is an echo.