Answers to Coursebook questions – Chapter 4.4

1 Since the wavelength is of the same order of magnitude as the opening there will be appreciable diffraction as in **Figure 4.2** (see page 239 in *Physics for the IB Diploma*).

2 The wavelength is now very small compared to the aperture size and so no appreciable diffraction will take place (see **Figure 4.1** on page 238 in *Physics for the IB Diploma*).

3 Reflection and diffraction. By placing a mirror somewhere.

4 At M the waves from the two speakers arrive without any path difference and so interfere constructively, leading to a loud sound.
At P there is a path difference between the two waves equal to 4.00 m. When this path difference is a half integral of the wavelength we will get destructive interference. Thus $4.00 = (n+\frac{1}{2})\lambda$. The largest wavelength corresponds to $n=0$ and so $\lambda = 8.00\text{ m}$.

5 There is poor reception because of destructive interference between the waves reaching the antenna directly and those reflecting off the mountain. Assuming no phase shifts upon reflection, the path difference is double the distance between the house and the mountain. Then $2d = (n+\frac{1}{2})\lambda$.
The smallest *d* corresponds to $n=0$ and so $d = 400\text{ m}$.

6 The wavelength of the radio waves is $\lambda = \frac{3.0\times 10^8}{90\times 10^6} = 3.3\text{ m}$.
The path difference at A is zero and at B it is $2(AB)$.
Then $2(AB) = (n+\frac{1}{2})\lambda$ and so the minimum distance *AB* is $AB = \frac{\lambda}{4} = 0.83\text{ m}$.

7 The wavelength of sound is $\lambda = \frac{340}{850} = 0.40\text{ m}$.

a The path difference is $9.0 - 8.2 = 0.80\text{ m}$.

$\frac{\text{path difference}}{\lambda} = \frac{0.80}{0.40} = 2$, an integer, so we have constructive interference, a loud sound.

b The path difference now is $8.7 - 8.1 = 0.60\text{ m}$ and so $\frac{\text{path difference}}{\lambda} = \frac{0.60}{0.40} = 1.5$, a half integer and so destructive interference, no sound.

8 Superposition means that when two waves arrive at the same point in space the resulting displacement of the wave is the algebraic sum of the displacements of the individual waves. For illustrations see diagrams (see page 241 in *Physics for the IB Diploma*).