Figure 4 is a plot of the hearing sensitivity response of an average person. It represents the minimum sound intensity that can be heard as a function of frequency.

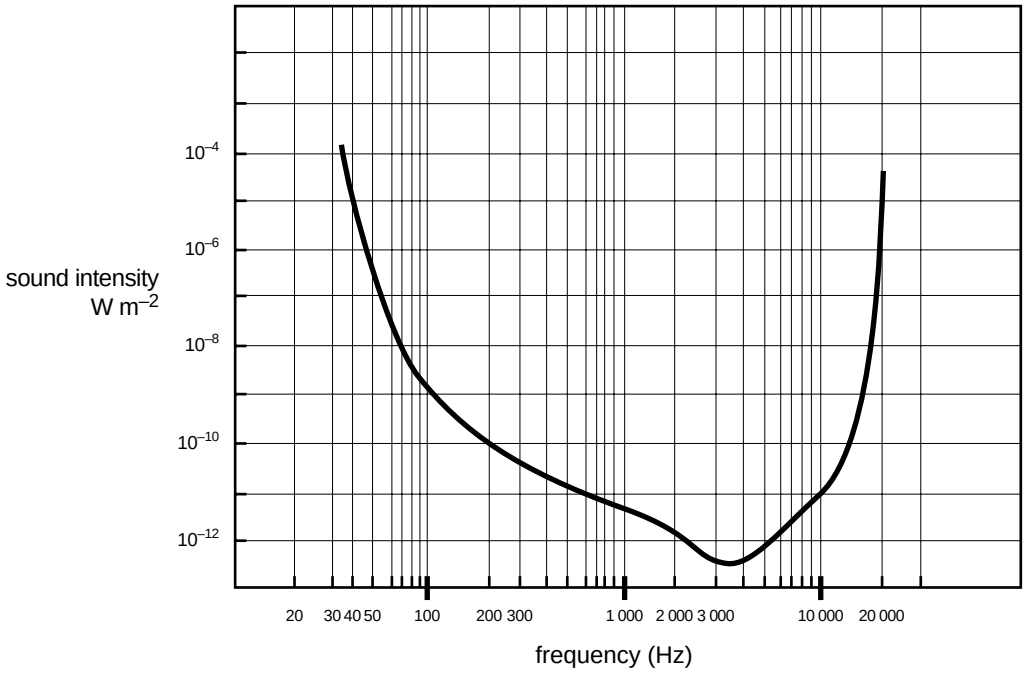

Figure 4

Abdul is listening to music with the volume of his stereo turned very high, such that the sound intensity at his ears is 10^{-5} W m^{-2}.

Question 7

What are the lowest and highest frequencies that he can hear?

Lowest Hz	Highest Hz

2 marks

However, his mother comes in and turns down the volume, so that the sound intensity at his ears is now only 10^{-9} W m^{-2}.

Question 8

By how many decibel was the sound intensity level reduced?

dB

2 marks

Figure 10 below shows the threshold of hearing as a function of frequency for a number of animals, including humans. The curves represent the minimum sound intensity level at the ear, for which the sound can be heard.

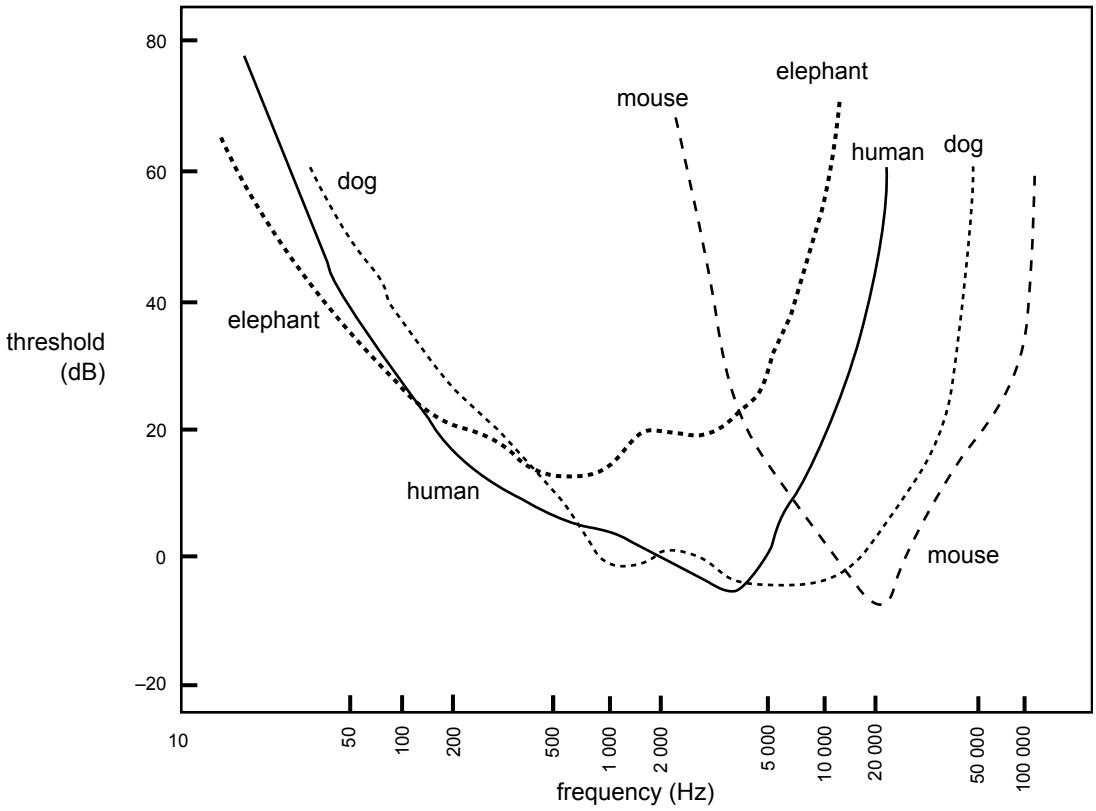

Figure 10

In a laboratory test, a sound source of frequency 20 000 Hz, and intensity level 20 dB, was placed at one ear of each animal.

Question 11

Tick the boxes corresponding to the animal or animals that could hear the sound.

human	
dog	
mouse	
elephant	

2 marks

Use the following information to answer Questions 6 and 7.

The graph in Figure 1 shows the relationship between sound intensity level (dB), frequency (Hz) and loudness (phon).

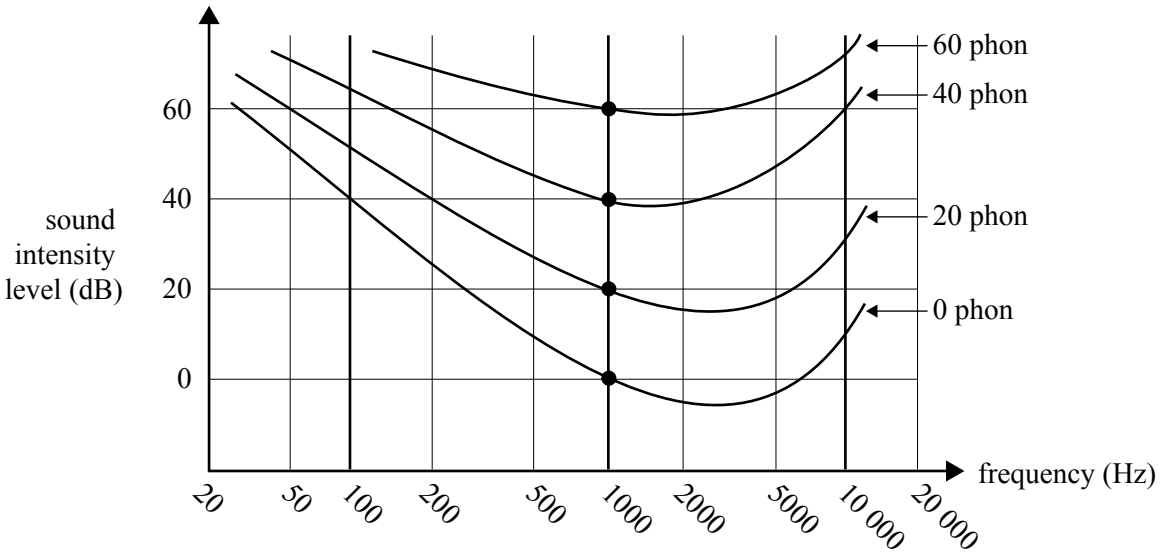

Figure 1

The sound intensity level (dB) of a note of 10 000 Hz is measured by a sound meter to be 60 dB.

Question 6

Which one of the values below best gives the loudness in phon at this point?

A. 20 phon

B. 40 phon

C. 60 phon

D 80 phon

Question 7

The loudness scale (phon) specifically takes account of which one of the following factors?

A. Intensity of sound, as perceived by human hearing, is inversely proportional to distance from the source.

B. The perception of sound by human hearing is logarithmic, rather than linear, compared to sound intensity.

C. The perception of the intensity of sound by human hearing varies with frequency.

D. Human hearing has a very limited range of frequencies that it can hear.

The following information relates to Questions 8 and 9.

The graph in Figure 5 shows the relationship between sound intensity level (dB), frequency (Hz) and loudness (phon).

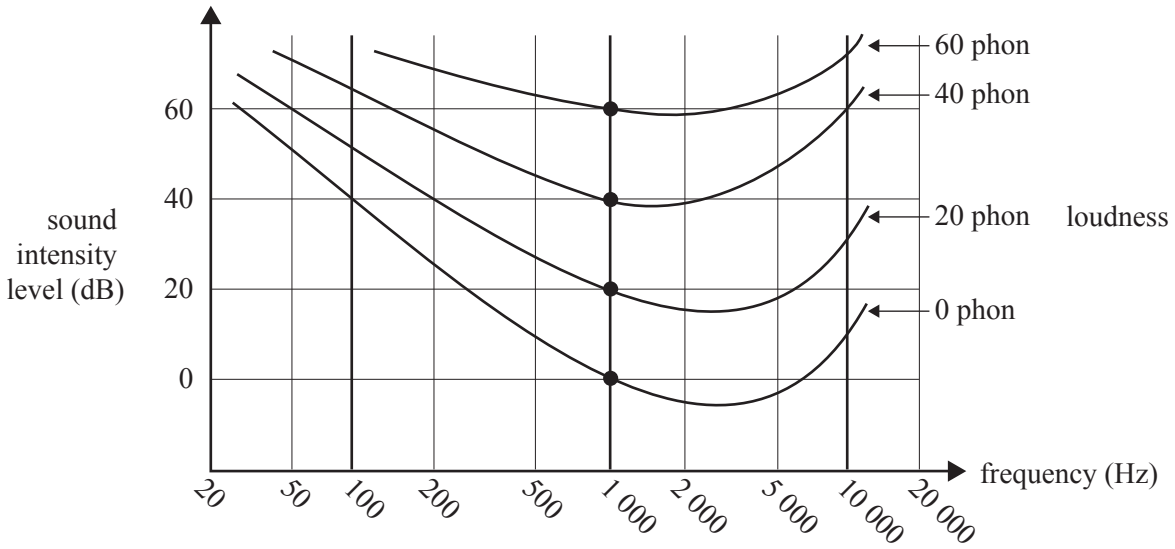

Figure 5

A frequency generator emits a sound of 200 Hz. The sound intensity level (dB) of this sound is measured at a particular point by a sound-level meter to be 40 dB.

Question 8

Which one of the following is the best estimate of the sound intensity of this sound in W m^{-2}?

A. 4.0×10^{-12} W m^{-2}

B. 1.0×10^{-4} W m^{-2}

C. 1.0×10^{-8} W m^{-2}

D. 1.0×10^{4} W m^{-2}

Question 9

Which one of the values below best gives the loudness in phon at this point?

A. 0 phon

B. 20 phon

C. 40 phon

D. 60 phon

Question 5

The graph in Figure 2 shows the relationship between sound intensity level (dB), frequency (Hz) and loudness (phon) for the human ear.

In a hearing test for Melanie, a sound source emits a steady tone of 200 Hz at a sound intensity level of 40 dB. Melanie hears this at a loudness of 20 phon.

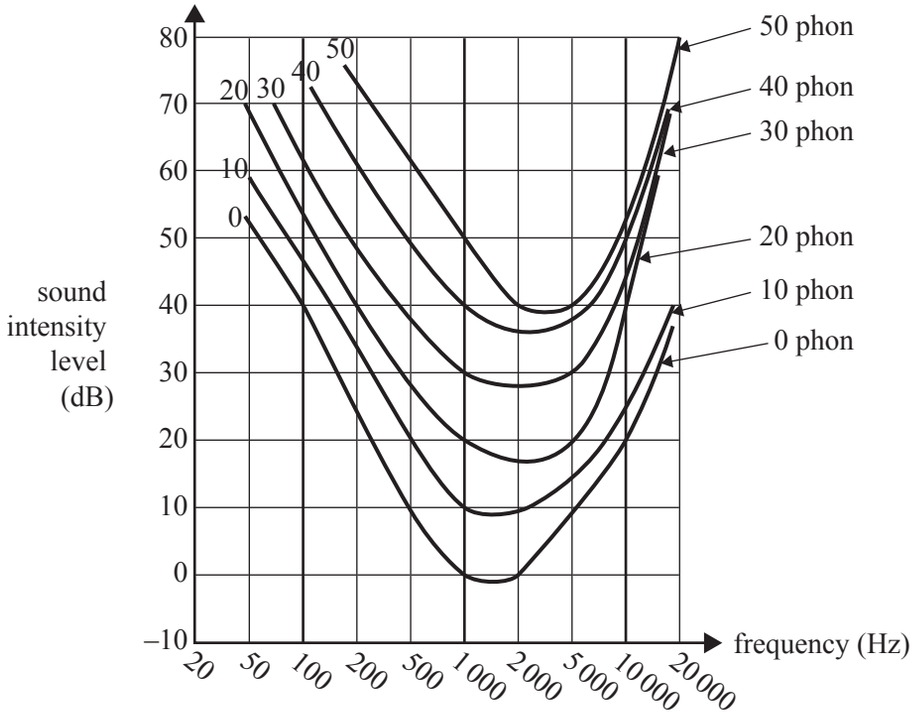

Figure 2

The frequency is now increased to 2000 Hz. The same sound intensity level is maintained.

Which of the following is the best estimate of the loudness at which Melanie will now hear the sound?

A. 20 phon

B. 40 phon

C. 50 phon

D. 80 phon

NO WRITING ALLOWED IN THIS AREA

Use the following information to answer Questions 4 and 5.

Ashley is doing an experiment at school using audio equipment. The equipment includes an oscillator that provides signals of adjustable frequency and amplitude, an amplifier and a high-quality loudspeaker, as shown in Figure 2.

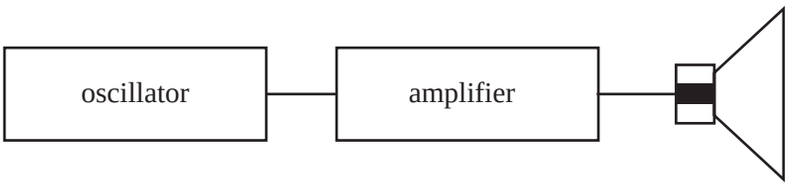

Figure 2

The frequency response curve for Ashley's hearing is shown in Figure 3 below.

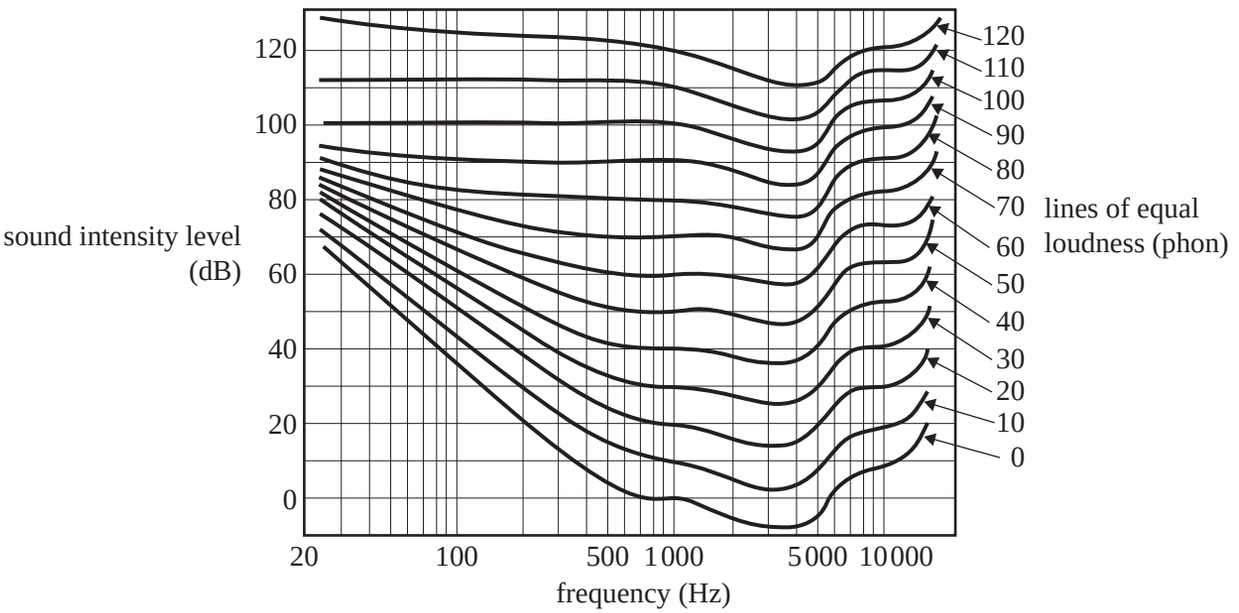

Figure 3

Question 4

With the frequency set to 3 000 Hz, the amplifier gain is adjusted to give a sound intensity level of 40 dB at Ashley's ear.

Which of the following best gives the loudness, in phons, which Ashley will hear?

A. 30

B. 37

C. 40

D. 43

NO WRITING ALLOWED IN THIS AREA

NO WRITING ALLOWED IN THIS AREA

Someone adjusts the oscillator to a frequency of 100 Hz.

Question 5

Which of the following gives the best estimate of the sound intensity level (dB) for Ashley to hear the sound at 20 phon?

A. 20 dB

B. 35 dB

C. 50 dB

D. 80 dB