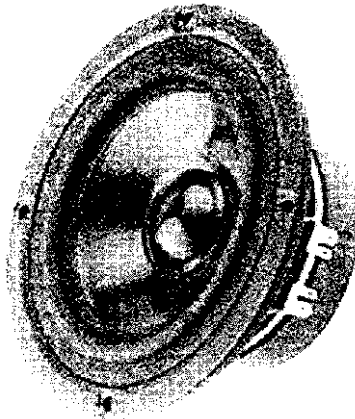# Questions on Oscillations

1. The speaker shown below is used to produce the bass notes in a music system.

The cone moves with simple harmonic motion and it emits a single-frequency sound of 100 Hz. When it is producing a loud sound, the cone moves through a maximum distance of 2.0 mm.

The equation that mathematically describes the displacement of the cone is
$x = 1.0 \times 10^{-3} \cos 628\, t$.

Show that the data for this speaker lead to the numbers in the equation above.

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(2)

Calculate

    (i)   the maximum acceleration of the cone

        ....

        ....

                              Maximum acceleration = ...

    (ii)   the maximum speed of the cone

        ....

        ....

                              Maximum speed = ...

(3)

On the grid below sketch the acceleration-time graph for two cycles of vibration of this speaker cone used under these conditions. Add suitable numerical scales to the two axes.

Acceleration

|
|
|
|
|_____ Time
|
|
|
|

(3)

Explain why designers ensure that bass speakers have a natural frequency of oscillation much greater than 100 Hz.

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(2)
(Total 10 marks)

2. The following invention will allow you to play your music at top volume without annoying the neighbours:

> A layer of small lead spheres is embedded into rubber. If you line your room with this material then the transmitted sound will be significantly reduced. This coating is particularly effective with low frequency sounds, the ones which most annoy the neighbours, as these cause the spheres to resonate.
>
> Adapted from *New Scientist*, Vol.167, Issue 2256

Explain the phenomenon of resonance in the context outlined above and describe how the intensity of the transmitted sound is reduced.

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(Total 5 marks)

3. The teacher of a class arranges a visit to the manufacturer of "bouncy castles". The class assume, naturally, that this will be a good excuse to jump up and down on a large rubber pillow of air. The teacher explains that there are some principles of physics associated with bouncy castles, such as energy changes and oscillations when children are bouncing on it.

The speed at which a child collides with the rubber pillows is typically about 2.5 m s^{-1}.
The time period of the oscillation is typically about 6 s.
Write an illustrated article explaining the relevance of the two topics above to bouncy castles.
You should include estimates of quantities and use them in appropriate equations to confirm the estimates given above.

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(Total 7 marks)

4. Debbie complains on the internet:

> I have the loudest neighbours you've ever heard and they seem to be able to stay up ALL night. Their dog barks all the time, but their three main weapons are the guitar, the stereo and SURPRISE! They also have an alarm clock that's so loud that it sounds as if it's attached to the stereo.

James replies:

> Noise can be blocked out nowadays, with electronics and good soundproofing. The electronic device is just some sort of microphone that can pick up and analyse a sound. The device can produce the opposite frequencies and/or wavelengths of these sounds to balance them out.

Consider the phrase **good soundproofing**.

(1)

What type of material is best for soundproofing?

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(1)

Explain what makes this type of material good for soundproofing.

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(1)

James' reply shows some confusion about how electronic soundproofing works. Rewrite a short reply correctly explaining the physics of electronic sound reduction.

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(4)

The noise level that Debbie hears may be made worse by resonance occurring in the building structure.

Explain what is meant by the term **resonance** in the context of high noise levels in buildings.

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(2)

Name the process that reduces the amount of sound transmitted in this way.

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(1)
(Total 9 marks)