18 The photograph shows a bee in flight.

(Source: Image Broker/ardea.com)

The movement of a bee's wings can be modelled as simple harmonic motion.

(a) State what is meant by simple harmonic motion.

(2)

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(b) A bee's wings are oscillating with a frequency of 240 Hz. The wing tips have a maximum speed of 2.25 m s^{-1}.

(i) Show that the amplitude of the motion of the wing tip is about 1.5 mm.

(3)

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(ii) Calculate the maximum acceleration of the wing tip.

(2)

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Maximum acceleration of wing tip = ...

(c) Where the wings join the body of the bee, there is a region of elastic material. The vibrating wing muscles set the elastic material into resonance.

(i) State what is meant by an elastic material.

(1)

(ii) Explain what is meant by resonance.

(3)

(iii) The bee's wings oscillate at a frequency of 240 Hz, but the muscles only oscillate at a frequency of 60 Hz.

Suggest how impulses applied at 60 Hz can maintain an oscillation at 240 Hz.

(2)

(Total for Question 18 = 13 marks)