6 An electric guitar uses electromagnetic pickups to detect the vibration of its strings, which are made from steel. Each pickup consists of a coil of wire wrapped around a permanent magnet as shown in Fig. 6.1. When the string vibrates near the pickup, an alternating electromotive force (e.m.f.) is induced in the coil (which is channelled to an output amplifier and speaker)

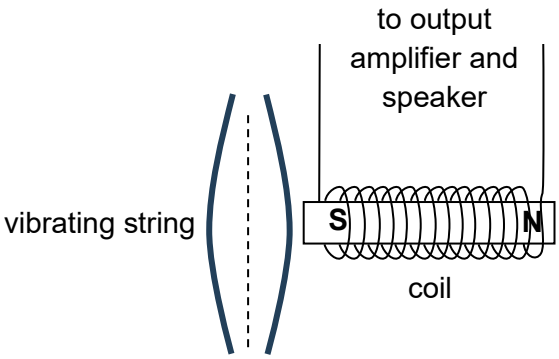

Fig. 6.1

(a) Explain how the vibration of the steel string leads to the generation of an alternating e.m.f. in the coil of the pickup.

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.....[4]

(b) A guitarist plucks a string more strongly, causing it to vibrate with the same frequency but larger amplitude. Explain how this affects the e.m.f. induced in the coil.

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.....[2]

(c) A guitar string vibrates in a magnetic field, where the field strength at the coil fluctuates between maximum and minimum with a difference of field strength of 5.0×10^{-2} T at a frequency of 880 Hz. The coil has a cross-sectional area of 1.0×10^{-6} m^2. It is desired that the average e.m.f. of the pickup coil is about 0.20 V.

Estimate the number of turns the coil must have.

number of turns = ... [2]

[Total: 8]