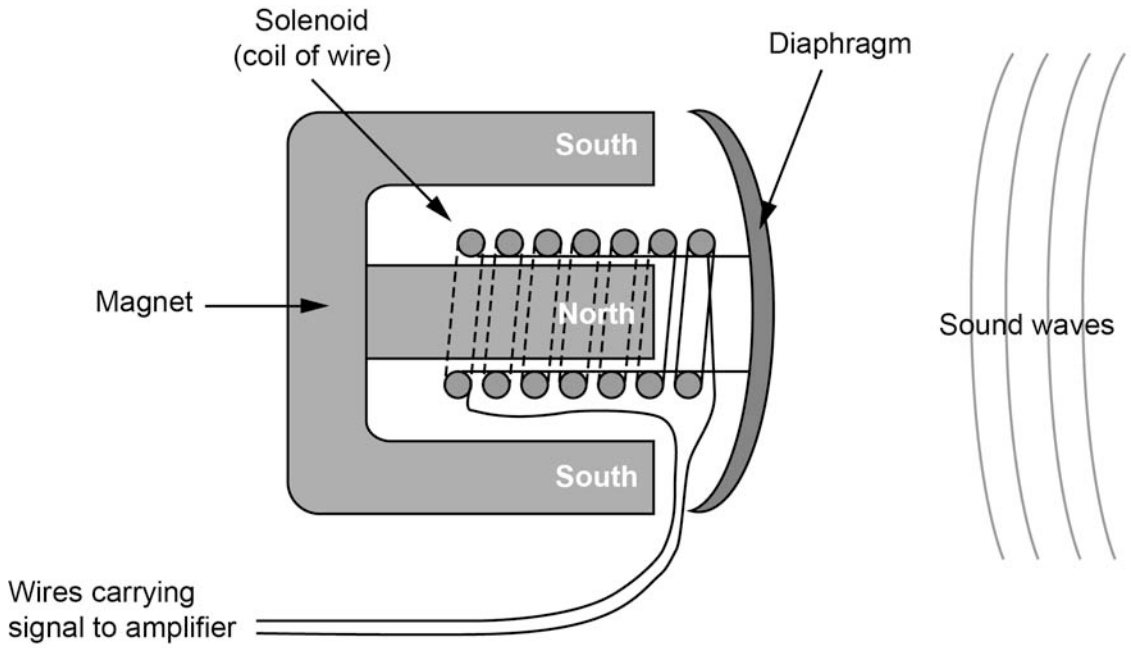
Question 11 **(4 marks)**

The diagram below shows a cross-section of a simple dynamic microphone. Describe how a musical note played near the diaphragm of the microphone can be detected by an amplifier. Your description should include an explanation of how the sound is converted to an electrical signal.



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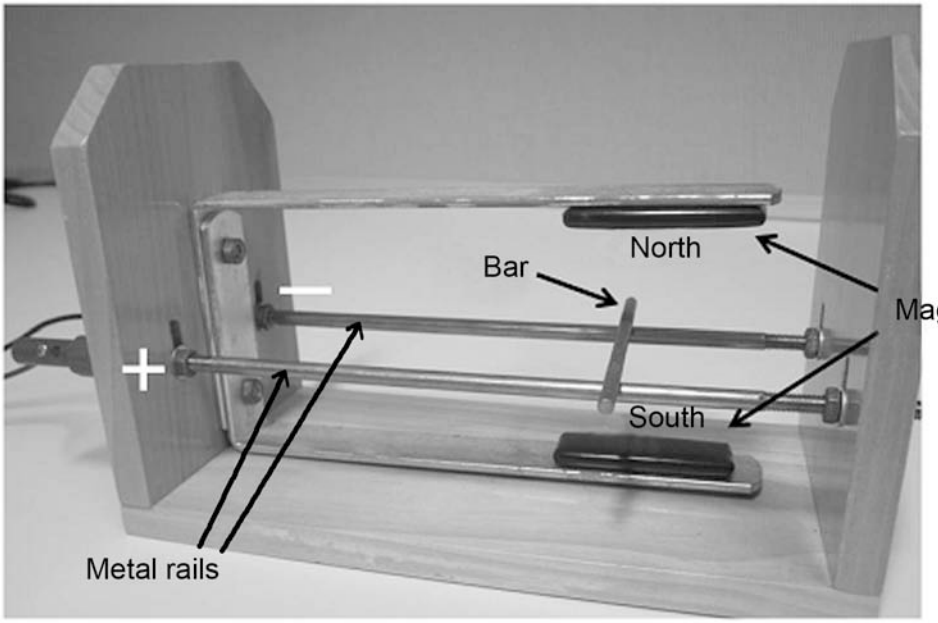
Question 16 **(10 marks)**

An apparatus that demonstrates the interactions between a current and a magnetic field is shown below. There are two metal rails on which a metal bar is free to roll. Contact between the rails and bar allows a current to flow through them from the power pack attached to the metal rails. Two magnets provide a uniform magnetic field around the bar.



(a) Draw the magnetic fields associated with the following situations. (4 marks)

The bar carrying current into the page	The current carrying bar in a uniform magnetic field
X	north X south

(b) The rails are 8.50 cm apart and the magnetic field strength due to the magnets is $B = 1.50 \times 10^{-3}$ T.

Calculate the magnitude of the force acting on the bar when an electric current of 5.00 A is passed through the bar.

Draw and label on the photograph on page 18 the direction of the force and current. (4 marks)

(c) The apparatus in the photograph is then tilted at a small angle to the horizontal by lifting the left side when the current is flowing. The bar rolls toward the right-hand side, away from where the power supply is connected, due to the effects of gravity acting on the bar.

Describe two changes that could be made, either to the circuit or apparatus, to enable the force due to the current's interaction with the magnetic field to hold the bar stationary. (2 marks)

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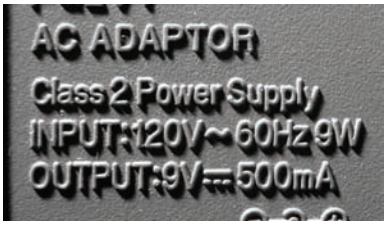
Question 18 **(13 marks)**

This photograph shows the information on a compliance plate on the outside of a small transformer used in a house in another country.



(a) Determine the ratio of windings of primary:secondary coils in the transformer. (2 marks)

(b) Using the information on the compliance plate, calculate the power output of the transformer and use this information to determine the percentage efficiency of the transformer.

(3 marks)

(c) Explain why the input voltage must consist of an alternating current rather than direct current. (2 marks)

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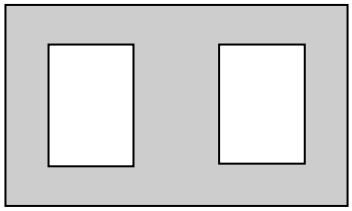
(d) The following photograph shows the coils and core inside the transformer case.

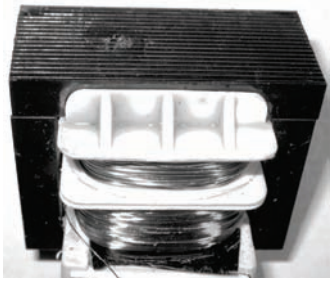
For small commercial transformers, the coils are placed around the centre pillar of the core, which is shaped like this:



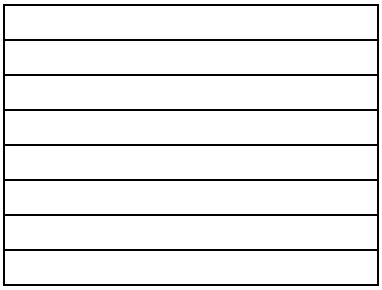
Describe the purpose and properties of the core. (2 marks)

(e) The photograph below shows the laminae (a number of thin iron sheets separated by non-electrically conductive material, such as plastic) that make up the core. These laminae are used to reduce 'eddy currents' or 'back emf' and make transformers more efficient.

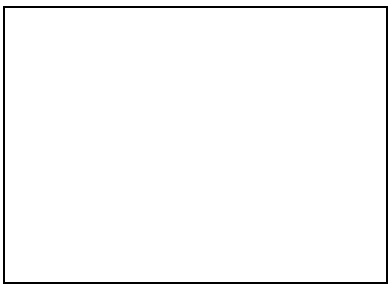
Use the following diagrams representing the centre pillar of the transformer and any relevant formula to explain why a transformer with a laminated core is more efficient than a transformer with a solid core. (4 marks)



Laminated core



Solid core



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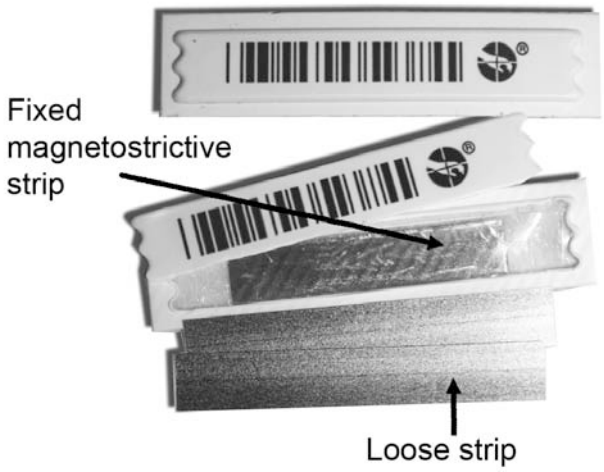
Question 20 **(7 marks)**

Acousto-magnetic tags (pictured) are commonly used in stores for security purposes. A radio transmitter near the front door emits an electromagnetic pulse of 58.0 kHz. A fixed metal strip made of magnetostrictive material (metal that shrinks when in a magnetic field) contained in a tag vibrates at this frequency due to the changing magnetic field.



When the magnetostrictive strip vibrates it causes loose metal strips in the tag to vibrate and produce a sound. The frequency of the transmitter corresponds to the resonant frequency of the metal strips in the tag. A nearby receiver, on detecting a sound of 58.0 kHz frequency shortly after the transmitter has finished sending the electromagnetic pulse, activates the alarm.

(a) The metal strips are 37.0 mm long. In the rectangle below draw the fundamental harmonic representing the wave formed in the metal strip and calculate the speed of sound in the metal. (3 marks)

(b) All radio frequencies cause the magnetostrictive material to vibrate at the same frequency as the radio signal. Explain why only a frequency of 58.0 kHz will activate the alarm. (4 marks)

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