CHRIST CHURCH GRAMMAR SCHOOL

YEAR 12 PHYSICS
MID YEAR EXAMINATION 2009

Stick Label Here

A		
B		
C		
Total		/ 175 = %

TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: Ten minutes
Working time for paper: Three hours

MATERIALS REQUIRED FOR THIS PAPER

Pens, pencils, eraser or correction fluid, ruler, highlighter and a calculator satisfying the conditions set by the Curriculum Council.

INSTRUCTIONS TO CANDIDATES.

This exam consists of three sections. The *Physics: Formulae, Constants and Data Sheet* is provided separately.

Write your answers in the space provided and explain or justify all your answers where appropriate.

Marks will be awarded for clear working even if an incorrect answer is obtained. If you cannot do a section and the answer is needed for a subsequent part assume a value and show all working.

Marks will be deducted for absent or incorrect units.

Answers to numerical questions should be given to the correct number of significant figures [usually three]. Estimations should be given to the appropriate accuracy.

SECTION A: Short Answer Section: [52 marks]
This section contains thirteen [13] questions of **equal value** and is worth 30%.

SECTION B: Longer Questions and Problems: [88 marks]
This contains eight [8] questions **not of equal value** and is worth 50%.

SECTION C: Comprehension and Interpretation Section: [35 marks]
This section contains two [2] questions **not of equal value** and is worth 20%.

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SECTION A

1. The sound level of a dog's bark is 50.0 dB. If the intensity of a rock concert is 1.00 x 10^5 times that of the dog's bark, determine the sound level of the rock concert.

[4]

2. Real transformers are constructed using laminated iron cores. Describe the construction of a laminated iron core and explain why its use is advantageous in a real transformer.

[4]

3. Some stringed instruments (such as the sitar of India) have two of the same string. When one string is plucked, the other one starts vibrating at the same frequency, even though it has not been touched. Name this phenomenon and explain why the string starts to vibrate.

4. A light aircraft is towing a banner by a metal cable that is 150 m long. If the plane is flying at 350 kmh^{-1} in a northerly direction over Perth, determine the potential difference induced in the cable and which side is at the higher potential. Assume the magnetic field is 5.80×10^{-5} T at 66.0° to the horizontal.

[4]

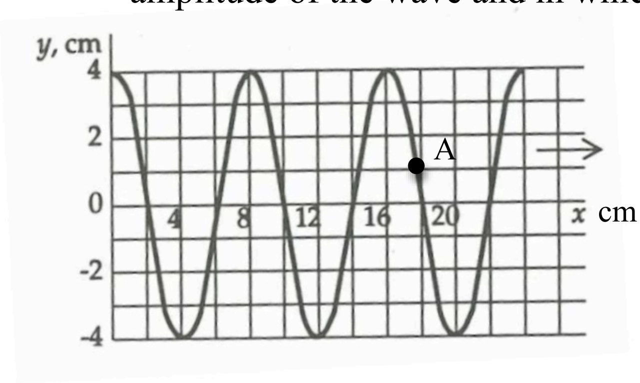
5. An object is moving to the right at a constant speed. Chose which of the following statements is correct and explain your choice.

[4]

(a) No forces are acting on the object.
(b) A larger number of forces is acting on the object to the right than to the left.
(c) The net force acting on the object is to the right.
(d) No net force is acting on the object.

6. The graph below shows a wave moving from left to right with a period of 50.0 ms. Determine the velocity of the wave, the amplitude of the wave and in which direction point A is moving.

[4]



7. Determine the voltage output of a transformer used for rechargeable flashlight batteries, if its primary has 500 turns, its secondary 8 turns and the input voltage is 118 V. Determine the input current required to produce a 4.00 A output.

[4]

8. Speakers in stereo systems have two colour-coded terminals in the back to indicate how to hook up the wires. If the wires are reversed, that speaker cone will move in a direction opposite to that of the correctly connected speaker. Explain why it is important to have both speakers connected the same way.

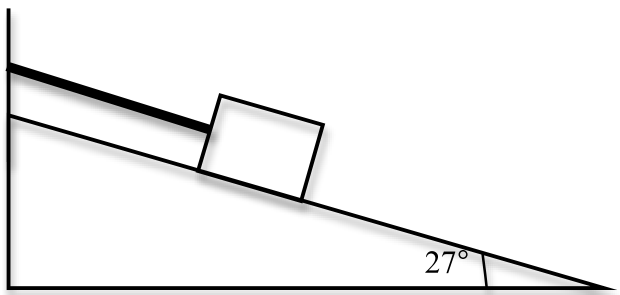
[4]

9. A power transmission line 50.0 km long has a total resistance of 0.60 Ω. A generator produces 100 V at 70.0 A. The voltage is stepped up with a transformer with a turns ratio of 100:1. What percentage of the original power is lost when the transformer is used?

[4]

10. A block of mass 15.0 kg is held by a cord on a frictionless 27.0° plane as shown in the diagram below. Determine the tension in the cord and the force the plane exerts on the mass.

[4]



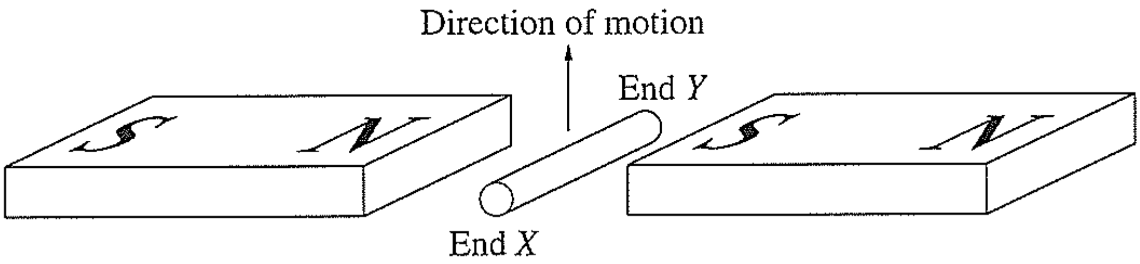
11. One end of a long metal pipe is struck by a hard blow. A listener at the other end hears two sounds, one from the wave that has travelled along the pipe and the other from the wave that has travelled through the air. If Δt (the time between the two sounds heard by the listener) is 1.00 s and the metal is brass, determine the length of the pipe.

[4]

12. A motorcyclist is travelling at 60.0 kmh^{-1} East down Stirling Highway and turns right onto Queenslea Drive. If he now travels in a Southerly direction at 40.0 kmh^{-1} determine his change in velocity.

[4]

13. When the metal rod is moved upwards through the magnetic field as shown in the diagram below, an emf is induced between the two ends.



State which end is at the lower potential and explain how the emf is produced in the rod.

[4]

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SECTION B

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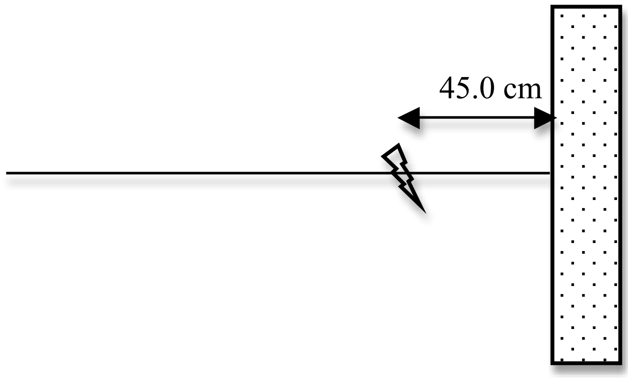
1. A boy is playing with a clothesline one end of which is attached to a vertical post. The boy holds the other end loosely in his hand so that the speed of the waves on the clothesline is a slow 0.72 ms^{-1}. The boy finds there are several frequencies at which he can oscillate his end so that a clothes peg 45.0 cm from the post doesn't move.



(a) Sketch diagrams to indicate the first 3 resonant positions where the conditions are met (draw from the clothes peg to the post).

[3]

(b) Determine the frequencies of these resonant positions.

[5]

(c) If a wind instrument, like the tuba, which is closed at one end has a fundamental frequency of 32.0 Hz, what are its first three overtones?

[3]

(d) Explain why a violin and viola sound different even when they are playing the same note.

[3]

2. Auroras are spectacular phenomena observed at the South and North Poles of the Earth.

(a) Sketch a diagram of the Earth's magnetic field.

[2]

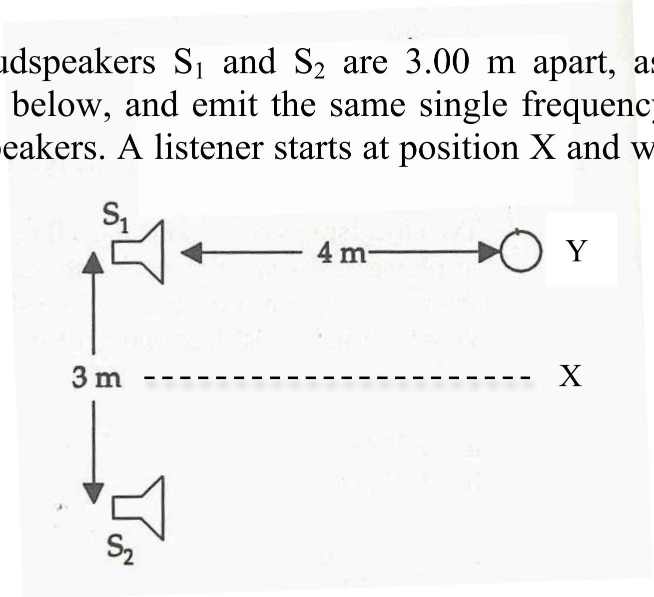
(b) Describe the formation of the aurora and explain why they are only seen at the poles of the Earth.

[4]

(c) An electron travelling due north with speed 4.00 x 10^5 ms^{-1} enters a region where the earth's magnetic field has the magnitude 5.00 x 10^{-5} T and is directed downward at 45° below the horizontal. Determine the force that acts on the electron.

[4]

3. Two loudspeakers S_1 and S_2 are 3.00 m apart, as shown in the diagram below, and emit the same single frequency tone in phase at the speakers. A listener starts at position X and walks to position Y.



(a) If the listener notes that there is a soft spot at Y and the listener passed through **3** other soft spots when walking to Y, determine the wavelength and frequency of the tone.

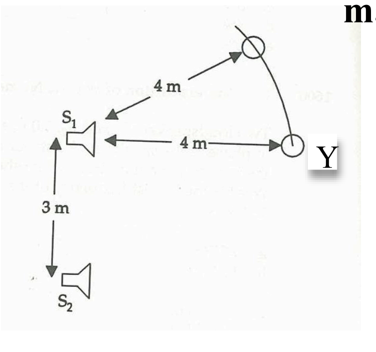
[4]

(b) Explain why there is a variation in the intensity of the sound as the listener walks from X to Y.

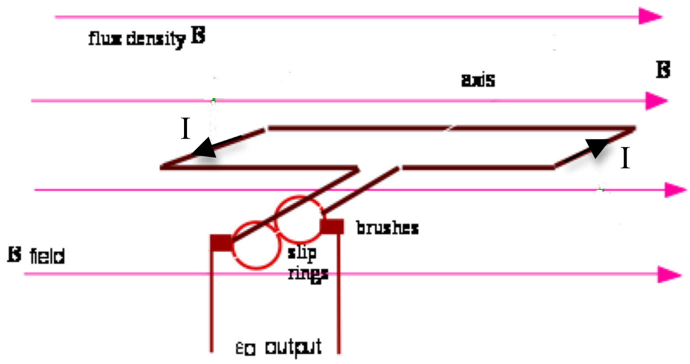
[3]

(c) If the listener now walks around speaker S_1 in an arc of a circle, staying 4.00 m from speaker S_1, determine how far he must be from speaker S_2 when he notices the next **maximum**.

[2]



4. A generator consisting of 100 turns of wire formed into a rectangular loop 50.0 cm by 30.0 cm in a uniform magnetic field of 3.50 T is shown in the diagram below.



(a) In which direction is the generator coil being turned? Explain your reasoning.

[3]

(b) What is the **maximum emf** produced when the loop is spun at 1000 revolutions per second?

[3]

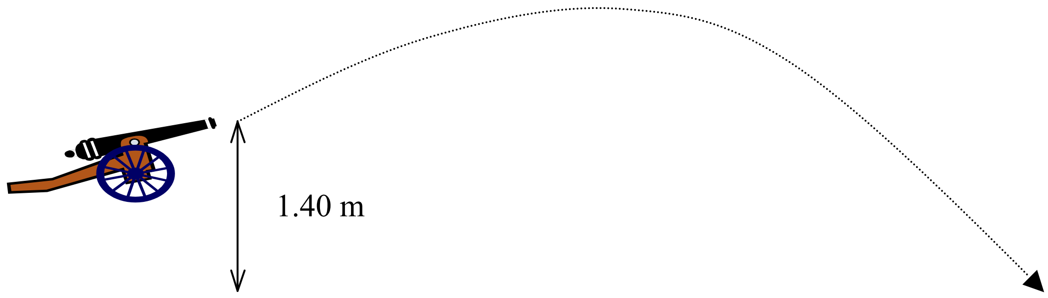
(c) What is the **average emf** produced by the generator?

[3]

(d) Determine the average power supplied by the generator if it is connected to a circuit of resistance 42.0 Ω.

[3]

5. Whilst filming a movie, a cannon fires an iron ball of mass 8.50 kg at angle of elevation 27.0° to the horizontal with a muzzle speed of 41.7 ms^{-1}. The end of the barrel is 1.40 m above the ground.



(a) Determine the horizontal and vertical components of the speed of the iron ball.

[2]

(b) Determine the time of flight for an iron ball that impacts at ground level.

[3]

(c) Determine the horizontal range of the iron ball.

[3]

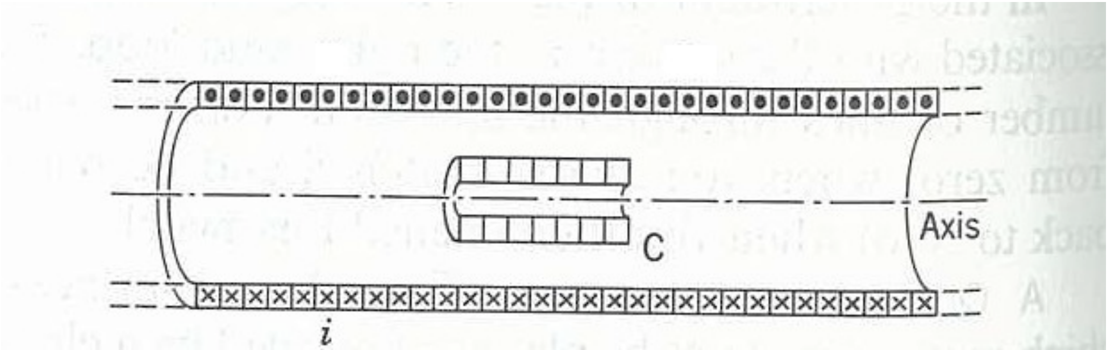
(d) What adjustment could be made to maximise the range for a target situated on a 1.40 m tall mound?

[1]

(e) What effect would air resistance have on the path of the iron ball?

[2]

6. A long solenoid has a diameter of 3.20 cm and carries a current of 1.50 A. At its centre is placed a 130 turn close packed coil of diameter 2.10 cm, as shown in the diagram below. The maximum magnetic field at the centre of the solenoid is 4.15×10^{-2} T.



(a) On the diagram above indicate the direction of the magnetic field induced in the solenoid by labelling the ends N and S.

[1]

(b) If the current in the solenoid is reduced to zero and then increased to 1.50 A in the other direction at a steady rate over a period of 50.0 ms. What is the value of the induced emf that appears in the central coil while the current is being changed.

[5]

(c) As the current is being decreased, indicate on the diagram above the direction of the induced current in the central coil.

[1]

(d) Explain the direction of the induced current.

[3]

7. Two whistles produce sounds with wavelengths 3.40 m and 3.30 m.

(a) If both whistles are sounded at the same time describe what a listener would hear.

[2]

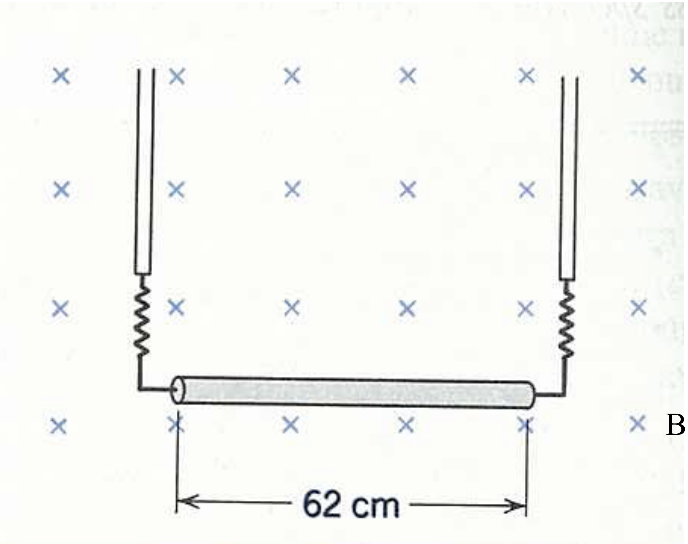
(b) Explain, with the aid of suitable diagrams, why the listener hears this.

[4]

(c) What is the beat frequency produced when the two whistles are sounded?

[3]

8. A wire of length 62.0 cm and mass 13.0 g is suspended by a pair of flexible leads in a magnetic field of 0.44 T.



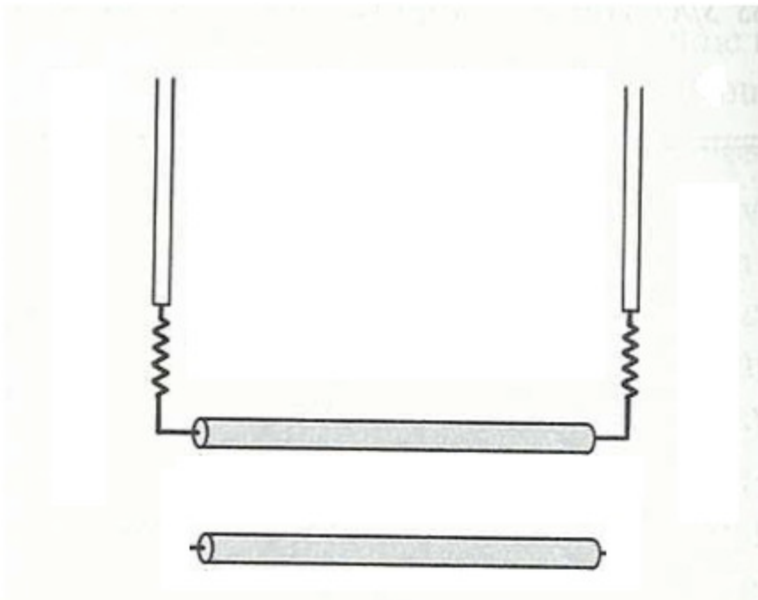
(a) In which direction would the current need to flow through the wire to remove the tension in the supporting leads. Indicate your answer with an arrow on the diagram.

[1]

(b) Determine the magnitude of the current required to remove the tension in the supporting leads.

[4]

The magnetic field is now removed and the current continues to flow in the wire same direction as indicated in (a). An identical wire of length 62.0 cm is now placed 10.0 cm beneath the original wire as shown in the diagram below.



(c) In which direction should current flow through this bottom wire to again remove the tension in the supporting leads of the top wire? Indicate your answer with an arrow on the diagram.

[1]

(d) Draw a diagram supporting your choice in (c) (this is a cut-through of the wires).

[3]

If the force between two parallel conductors is given by

$$\frac{F}{\ell} = \mu_o \frac{I_1 I_2}{2\pi r}$$

Where ℓ is the length of the current carrying conductors
μ_o is the permeability of free space = $4\pi \times 10^{-7}$ NA^{-2}
r is the distance between the two wires.

(e) Determine the current that should flow through both wires to remove the tension in the supporting wires.

[4]

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SECTION C

Name: ____________________________________

1. The Biot-Savart Law

The Biot-Savart Law gives the magnitude of a magnetic field at a perpendicular distance from a long straight wire carrying a current.

Biot-Savart Law: $$B = \frac{\mu_o I}{2\pi r}$$

Where μ_o is the permeability of free space = $4\pi \times 10^{-7}$ N
r is the distance from the long straight wire where the magnetic flux density is measured.

The data in the table below is for a long straight wire with an unknown current passing through it.

r (cm)	B (mT)	
2.0	15.0	
2.3	13.0	
2.6	12.0	
2.9	10.0	
3.2	9.00	
3.5	8.60	
3.8	7.90	

(a) What would you plot to obtain a straight line graph?
[2]

(b) Use the third column in the table above to process the data so you are able to plot your graph and label the column appropriately.
[2]

(c) Plot your graph on the graph paper provided.

[5]

(d) Determine the gradient of your graph.

[3]

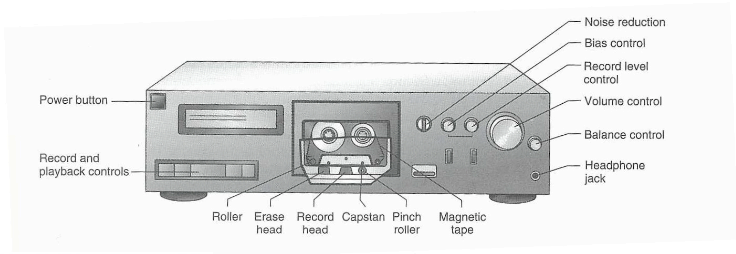
(e) Use the gradient of your graph to determine the current flowing in the long straight wire.

[3]

2. Tape Recorders

Adapted From: How Things Work: The Physics of Everyday Life
by Louis A. Bloomfield

Tape recorders save audio or video information on a thin plastic tape. Whilst not as commonplace today, the tape recorder was considered high technology in the 1970s and 1980s.



A tape recorder measures pressure fluctuations in order to recreate sound. Its microphone produces an electric current that's proportional to how much the local air pressure differs from the average value. When the air pressure is higher than average (a compression) the current flows in one direction and the when the air pressure is lower than average (a rarefaction) current flows in the opposite direction. When its time to recreate the sound, the tape recorder uses a speaker to compress and rarefy the air. But how is it possible to record the sound?

Magnetic Tape

Magnetic tape is a thin strip of plastic coated with a film of tiny permanent magnets. During recording, a strong magnetic field can interchange the poles of these particles, altering the tape in a way that can be detected during playback. This controlled modification of the tape, together with its detection at playback, is the basis for magnetic recording.

Magnetic tapes use hard magnetic materials, materials that can remain magnetised on their own. Examples of hard magnetic materials are γ-iron oxide, chromium dioxide, cobalt-coated iron oxide or pure iron. Each of these particles in these substances is so small that it contains only a single magnetic domain.

Each of these particles is therefore a tiny permanent magnet the poles of which can be interchanged by exposing it to a strong magnetic field. A tape recorder can set a particle's magnetic orientation during recording and expect it to remain that way indefinitely.

Magnetic tape is produced by coating a Mylar film with a mixture of these magnetic particles, a binder and a solvent. Immediately after coating, the wet film passes through a strong magnetic field which rotates all of the tiny magnetic particles so that they are aligned along the direction in which the tape normally moves. The tape is then dried and pressed so that its magnetic coating is dense, smooth and shiny. The final magnetic coating is about 5 microns thick on audio and video cassette tape. Only the outer micron or so of these coatings is actually used for recording.

Magnetic particles are rated according to the magnetic fields needed to interchange their magnetic poles. Particles that are resistant to interchange make better magnetic tapes. The conventional measure of this resistance to interchange is the *oersted*, with a higher number of oersteds meaning more resistance.

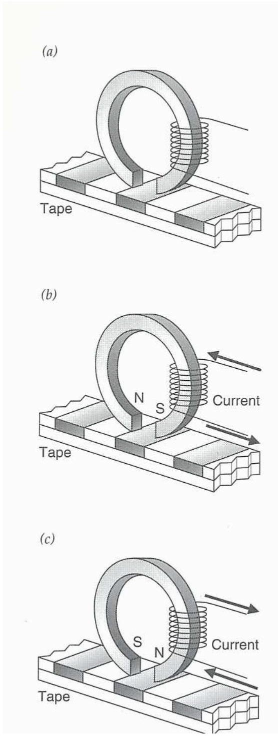
Type of Magnetic Particle	Resistance to Interchange of Poles (Oersetds)
γ-iron oxide	300
chromium dioxide	450
cobalt-coated iron oxide	600
pure iron	1500

<u>Recording Sound Onto A Magnetic Tape</u>
This is done by a miniature electromagnet, a tiny ring of soft magnetic material, with a coil wrapped around it in the recording head. When an electric current flows through the coil, the coil's magnetic field temporarily magnetises the ring.

The ring is actually incomplete. It has a tiny gap at the point where it touches the magnetic tape. During recording, sound is represented as a fluctuating current in the coil and therefore a fluctuating magnetic field in the ring's gap.

As the magnetic tape moves steadily past the recording head, the gap in the recording head magnetises regions of the tape's magnetic coating in one direction or the other (see Figure 2.1). The depth to which the coating is magnetised depends on the strength of the magnetic field in the gap, which is proportional to the current in the coil. Since that current represents sound and air pressure, the magnetisation depth is greatest during loud parts and least during soft parts.

Figure 2.1 →
The magnetic tape moves past the recording head. The ring is temporarily magnetised whenever a current flows through the coil and it permanently magnetises any hard magnetic material near the gap.



One problem with this type of recording is that the magnetisation of the tape is very sensitive to its previous magnetic history, even the effects of the signal recorded just ahead of it. To remove this magnetic history a high frequency bias signal is applied to the tape through the tape head along with the music signal to remove the effects of the magnetic history. This large bias signal (40 to 150 kHz) keeps 'stirring' the magnetisation so that each signal to be recorded encounters the same magnetic starting conditions

1. How would a speaker transfer information about the frequency of a sound?

[2]

2. When the only sound reaching a tape recorder's microphone is a pure 500 Hz tone, describe the current in the recording circuit.

[2]

3. Why would soft iron not be useful in a magnetic tape?

[2]

4. Explain how changes in the recording head magnetise the tape.

[4]

5. What does the direction of the magnetisation on the magnetic tape indicate?

[1]

6. What does the strength of magnetisation on the magnetic tape indicate?

[1]

7. Why is biasing particularly important when recording sounds of very low volume?

[3]

8. Why would choosing a material with a high Oersted value be important for recordings you wish to keep for a long time?

[2]

9. Video recorders often have a function called 'long play' where, for example, 6 hours of video can be taped onto a 3 hour tape. How could this be achieved and what affect would this have on the quality of the recording?

[3]