CHRIST CHURCH GRAMMAR SCHOOL

YEAR 12 PHYSICS
MID YEAR EXAMINATION 2009

Solutions

A		
B		
C		
Total		/ 176 = %

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: [36 marks]
This section contains two [2] questions **not of equal value** and is worth 20%.

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YEAR 12 PHYSICS
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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]

$$\beta = 10\log\left(\frac{I}{I_0}\right) \quad (1)$$

$$50 = 10\log\left(\frac{I}{1\times10^{-12}}\right)$$

$$I = 1\times10^{-7}\ Wm^{-2} \quad (1)$$

$$(1\times10^{5})(1\times10^{-7})$$

$$= 0.01 \quad (1)$$

$$\beta = 10\log\left(\frac{0.01}{1\times10^{-12}}\right)$$

$$= 100\ dB \quad (1)$$

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]

- Construction - thin sheets of soft iron metal are covered with a non-conducting material and joined together.
- Changing magnetic fields induced in the iron core lead to the induction of eddy currents in the core.
- Eddy currents produce heat and lead to power losses and reduce the efficiency of the transformer.
- Laminations reduce the magnitude of eddy currents by limiting the space in which they can form (may also get cancellation of eddy currents in adjoining laminations).

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]

- The phenomena is called resonance.
- The vibrating string sends pressure waves through the air at a certain frequency.
- These waves transfer energy to the second string which begins to vibrate (forced vibration).
- If these waves are at the same or close to the natural frequency of the second string, large amplitude oscillations will occur.

4. A light aircraft with a wingspan of 12.0 m is flying at 350 kmh^{-1} in a northerly direction over Perth, where the Earth's magnetic field is 5.50×10^{-5} T at 66.0° above the horizontal. Determine the potential difference induced in the wings and which side of the wings is at the higher potential.

[4]

$350\ kmh^{-1} = 97.2 ms^{-1}$ (1)

$\varepsilon = v\ell B$

$= (97.2)(12)(5.50 \times 10^{-5})(\sin 66)$ (1)

$= 5.87 \times 10^{-2}\ V$ (1)

right wing is at the higher potential (1)

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

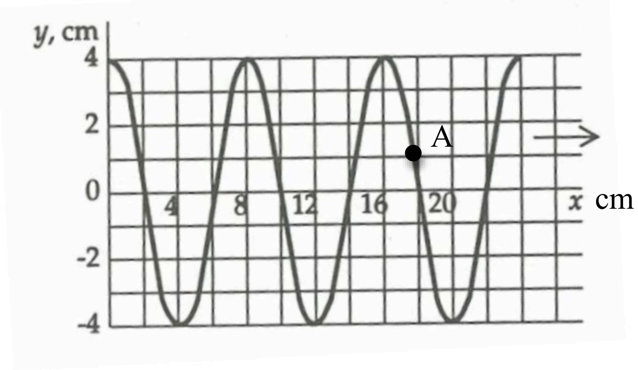
[4]

(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.

- Newton's 1st law states that an object will move in a state of constant motion unless acted upon by a net external force.
- As the object is moving to the right at constant speed, there is no change in direction or speed.
- Therefore there is no net force (there may be forces acting, but no net force because there is no acceleration).

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]



$T = 50.0 \times 10^{-3} s$

$v = f\lambda = \frac{\lambda}{T}$

$= \frac{8.00 \times 10^{-2}}{50.0 \times 10^{-3}}$ 1

$= 1.60\ ms^{-1}$ 1

- Amplitude = 4.00 cm 1
- Point A is moving upwards 1

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]

$$\frac{V_P}{V_S} = \frac{N_P}{N_S} = \frac{I_S}{I_P}$$ (1)

$$\frac{500}{8} = \frac{4}{I_P}$$ (1)

or alternative working

$$I_P = 6.40 \times 10^{-2} A$$ (1)

$V_S = 1.88$ V (1)

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]

- If the speaker cones move in opposite directions the pressure waves emitted will be 180° out of phase.
- This will mean there will be destructive interference between the speakers.
- This will lower the amplitude of sound from the speakers (e.g. baffle boards).
- This will affect bass frequencies the most as with long wavelengths they are unlikely to come back into phase even after reflection from walls, higher frequencies when reflected may come back into phase.

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]

$$\frac{I_S}{I_P} = \frac{N_P}{N_S} \quad (0.5)$$

$$\frac{I_S}{70} = \frac{1}{100}$$

$$I_s = 0.70\ A \quad (1)$$

$$P_{lost} = I^2R \quad (0.5)$$

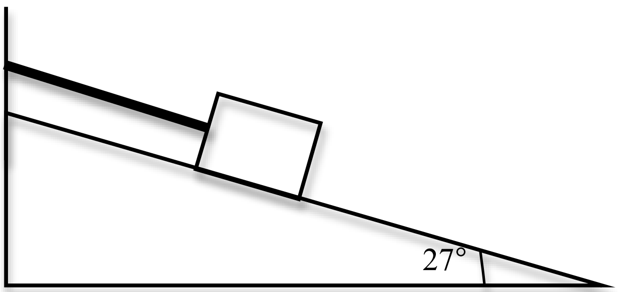
$$= (0.70^2)(0.60)$$

$$= 0.294\ W \quad (1)$$

$$\% = \frac{P_{lost}}{P_{original}} = \frac{0.294}{(100)(70)} * 100 = 4.20 \times 10^{-3}\ \% \quad (1)$$

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 magnitude of the tension in the cord and the magnitude of force the plane exerts on the mass.

[4]



$$\sum F_{parallel\ to\ plane} = T - mg\sin\theta = 0$$

$$T = mg\sin\theta \quad (1)$$

$$= (15)(9.8)(\sin 27)$$

$$= 66.7\ N \quad (1)$$

$$\sum F_{perpendicular\ to\ plane} = F_N - mg\cos\theta = 0$$

$$F_N = mg\cos\theta \quad (1)$$

$$= (15)(9.8)(\cos 27)$$

$$= 131\ N \quad (1)$$

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]

$$s = t_{air} v_{air}$$

$$s = t_{brass} v_{brass}$$

$$t_{air} = t_{brass} + 1$$

$$s = (t_{brass} + 1) v_{air}$$ (3)

$$s = \left(\frac{s}{v_{brass}} + 1 \right) v_{air}$$

$$s = \frac{v_{air}}{1 - \frac{v_{air}}{v_{brass}}}$$

$$= 384\ m$$ (1)

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]

$$v = \sqrt{60^2 + 40^2}$$ (1)

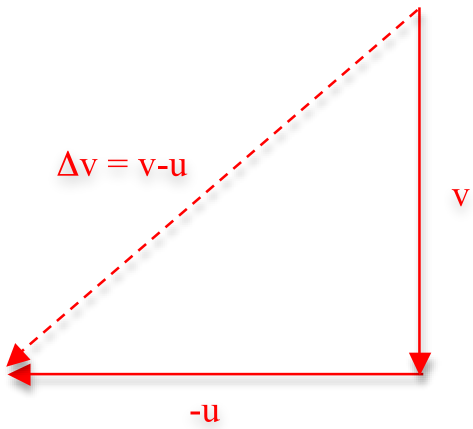
$$= 72.1\ kmh^{-1}$$

$$\tan\theta = \frac{60}{40}$$ (1)

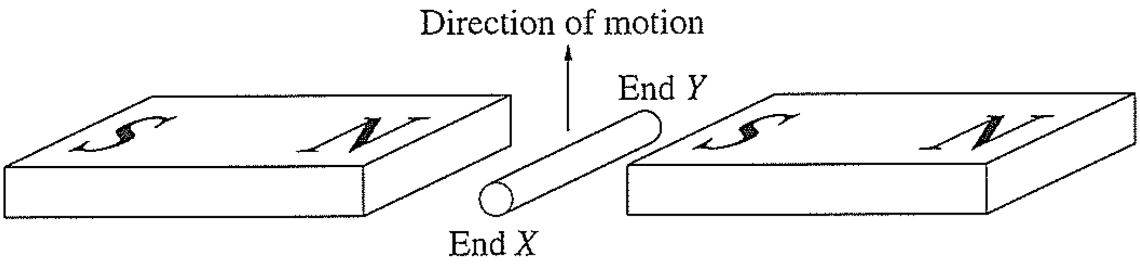
$$\theta = 56.3^\circ$$

$$ie\ 72.1\ kmh^{-1}\ S56.3^\circ W$$ (1)

(1)



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]

- End X
- As the metal rod moves through the magnetic field, the charged particles experience a force.
- The positively charged particles are pushed towards End Y and the negatively charged particles are pushed towards End X (electrons move to End X leaving a lack of electrons (+ve charge) at End Y).
- This leads to a separation of charge which can be used as a source of potential difference (emf).

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YEAR 12 PHYSICS
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SECTION B

Name: ________________________________

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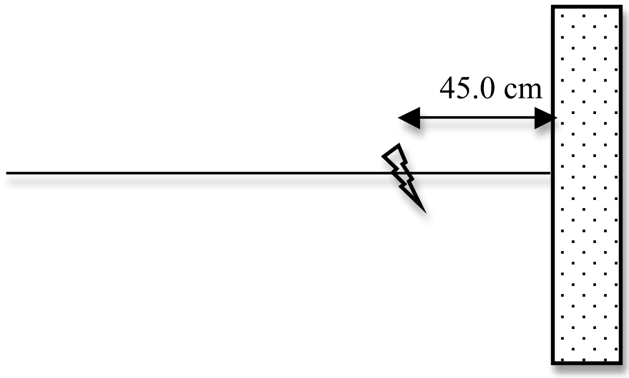
1. A boy is playing with a clothesline one end of which is attached to a vertical post. The boy holds the other end loosely in his hand so that the speed of the waves on the clothesline is a slow 0.72 ms^{-1}. The boy finds there are several frequencies at which he can oscillate his end so that a clothes 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]

(1) $f_1 = \frac{v}{2L} = \frac{0.72}{(2)(0.45)}$ (1)

$= 0.80\ Hz$ (1)

$f_2 = 2f_1 = 1.60\ Hz$ (1)

$f_3 = 3f_1 = 2.40\ Hz$ (1)

(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]

$$f_3 = 3 \times 32 = 96.0\ Hz$$
$$f_5 = 5 \times 32 = 160\ Hz$$
$$f_7 = 7 \times 32 = 224\ Hz$$

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

[3]

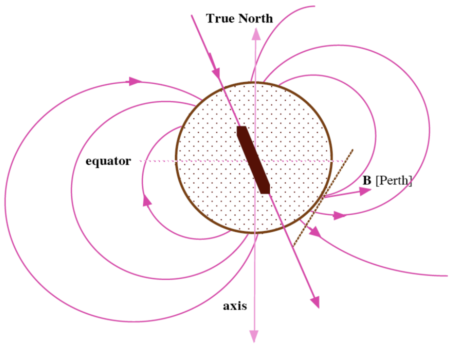
- The violin and viola are different sizes – thus have different shaped and sized sound boxes. Different sound boxes will excite different resonant frequencies.
- Thus the violin and viola will have different timbres.
- Timbre relates to the sound of an instrument and is a measure of the number of harmonics sounded and their relative intensities.

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]

shape 0.5 marks
arrows correct direction 1 mark
slightly offset from vertical 0.5 mark
Unclear labelling -0.5 to 1 mark.



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

[4]

- Charged particles are brought in by the solar winds and are trapped in the non-uniform field lines of the Earth's magnetic field.
- They spiral towards areas of greatest flux line density ie the poles (which pole depends on the charge of the particle).
- At the poles they interact with the Earth's atmosphere and excited particles emit visible light.
- This phenomena only occurs at the poles because it is here the magnetic flux lines predominantly cut the atmosphere.

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

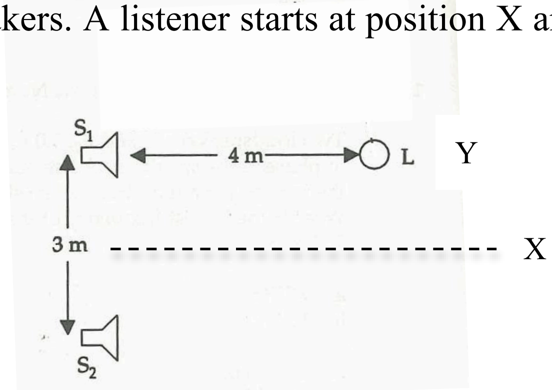
[4]

$F = qVB$ (1)

$= (1.60 \times 10^{-19})(4.00 \times 10^{5})(5.00 \times 10^{-5})(\sin 45)$ (1)

$= 2.26 \times 10^{-18} N$ (1) *East* (1)

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]

$S_1Y = 4.00\ m$

$S_2Y = \sqrt{3^2 + 4^2} = 5.00\ m$

$PD = S_2Y - S_1Y = 1.00\ m$ (1)

$Soft\ Spot\ PD = n\frac{\lambda}{2}\ where\ n = 1,3,5,....$

$1.00 = 7\frac{\lambda}{2}$ (1)

$= 2.86 \times 10^{-1} m$ (1)

$v = f\lambda$

$346 = (f)(0.286)$

$f = 1210\ Hz$ (1)

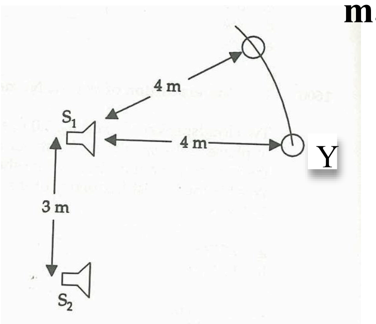
(b) Explain why there is a variation in the intensity of the sound as the listener walks from X to Y.

[3]

- The sound waves travel different distances from the speakers to the listener, thus the path difference of the sound from the speakers from X to Y varies.
- As the path difference varies the sound waves become alternately in phase and 180° out of phase.
- When in phase – constructive interference – loud spot, 180° out of phase - destructive interference – soft spot. In between - partial destructive interference.

(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]



$loudspot\quad PD = n\lambda\quad where\ n = 0,1,2,3....$

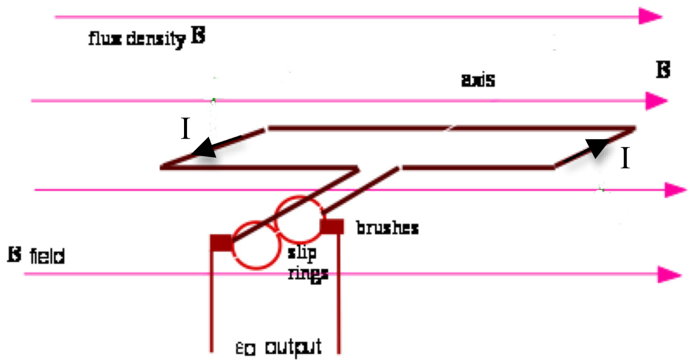
$next\ loudspot\ n = 4$

$PD = (4)(0.286) = 1.144m$ (1)

$1.144 = S_2Z - 4$

$S_2Z = 5.14\ m$ (1)

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]

- Anticlockwise.
- Torque on coil due to forces on induced current in the B field is in a clockwise direction.
- This torque must be opposing the change that caused it and therefore in the opposite direction to the direction of rotation of the coil.

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

[3]

$$\varepsilon = v\ell B = 2\pi BANf \quad (1)$$
$$= (2\pi)(3.50)(0.50 \times 0.30)(100)(1000) \quad (1)$$
$$= 3.30 \times 10^{5}\ V \quad (1)$$

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

[3]

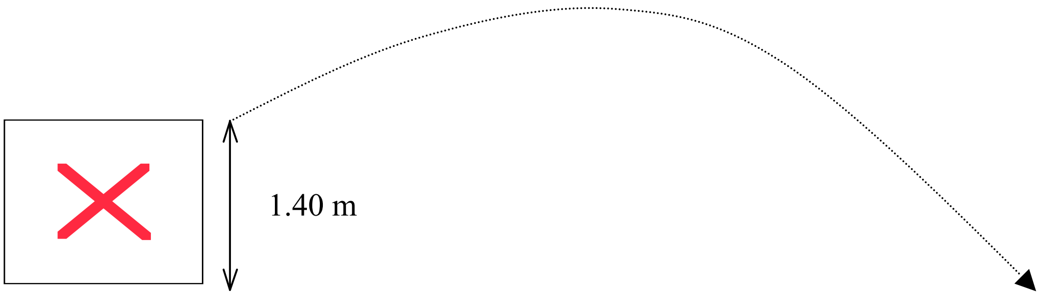
$$\frac{1}{4}\ cycle = \frac{T}{4} = \frac{1 \times 10^{-3}}{4} = 2.50 \times 10^{-4} \quad (1)$$
$$(1)\ \varepsilon = N\frac{\Delta\Phi}{\Delta t} = 100\left(\frac{(3.5)(0.50 \times 0.30) - 0}{2.50 \times 10^{-4}}\right)$$
$$= 210\ kV \quad (1)$$

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

[3]

$$(1)\ P = \frac{V^2}{R} = \frac{(210 \times 10^3)^2}{42} \quad (1)$$
$$= 1.05 \times 10^{9}\ W \quad (1)$$

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]

$$u_h = u\cos\theta = (41.7)(\cos 27) = 37.2\ ms^{-1}$$

$$u_v = u\sin\theta = (41.7)(\sin 27) = 18.9\ ms^{-1}$$

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

[3]

$$s = ut + \frac{1}{2}at^2$$ (1)

$$-1.40 = (18.9)(t) + \frac{1}{2}(-9.8)(t^2)$$ (1)

$$t = 3.93\ s$$ (1)

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

[3]

$$s = tv$$ (1)

$$= (3.93)(37.2)$$ (1)

$$= 146\ m$$ (1)

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

[1]

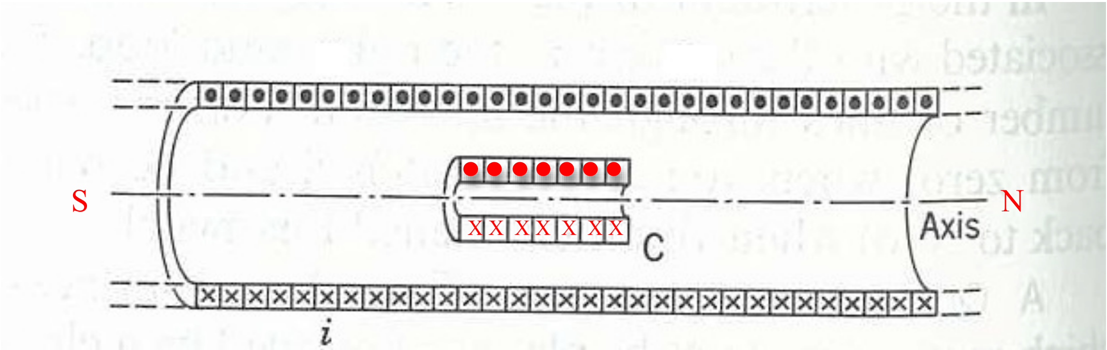
- Set angle to 45°.

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

[2]

- Air resistance will decrease horizontal range.
- Air resistance will decrease maximum vertical height.
- Decreases flight time.
- Descent becomes steeper (no longer parabolic).

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]

$$\varepsilon = N\frac{\Delta\phi}{\Delta t} = (130)\frac{(4.15\times10^{-2})(\pi)(1.05\times10^{-2})^2 - ((-4.15\times10^{-2})(\pi)(1.05\times10^{-2})^2}{50\times10^{-3}}$$ (1) (3)

$$= 7.47\times10^{-2}V$$ (1)

(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]

- As the magnetic flux through the central coil begins to drop, there will be an induced emf (and hence current) in the coil.
- This emf will be in such a direction so as to oppose the change that is occurring (the decrease in flux).
- Therefore the induced current will have a magnetic field associated with it that is pointing to the right (ie current in same direction as in large coil.

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.

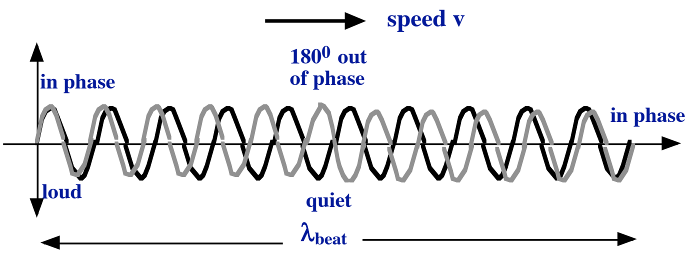
[2]

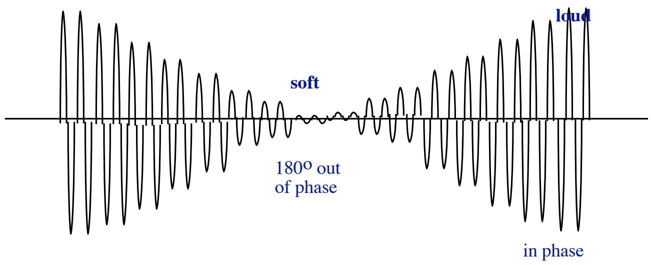
- Fluctuating increase and decrease in loudness
- At a regular intervals.

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

[4]

- The two waves of slightly different frequency will be alternately in phase and 180° out of phase.
- The superposition of the waves will lead to reinforcement (when in phase) and cancellation (when 180° out of phase) at regular intervals.
- A variation in the intensity of the sound is heard (loudest when in phase, soft when out of phase).





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

[3]

$v = f\lambda$

$346 = (f_1)(3.40)$

$f_1 = 102\,Hz$ (1)

$v = f\lambda$

$346 = (f_2)(3.30)$

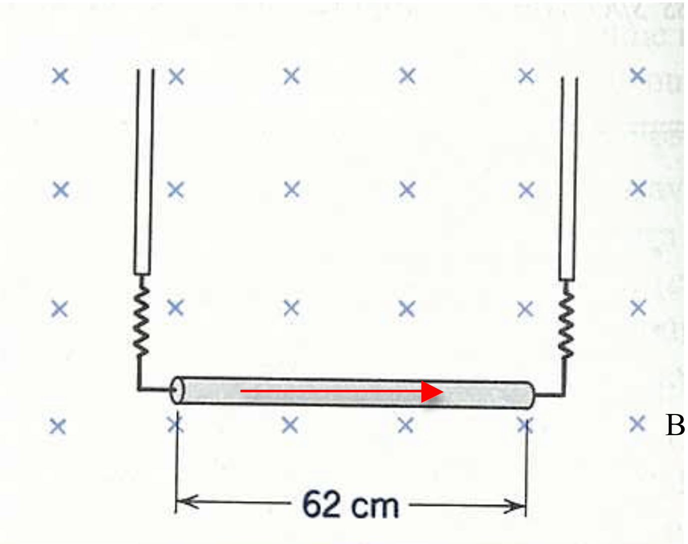
$f_2 = 105\,Hz$ (1)

$f_{beat} = |f_1 - f_2|$

$= |102 - 105|$

$f_{beat} = 3.00\ Hz$ (1)

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]

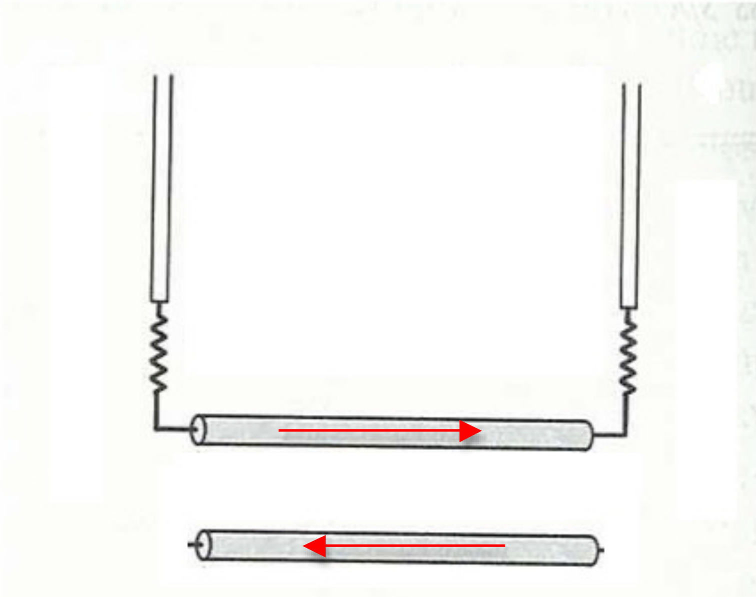
$F_B = F_g$

$I\ell B = mg$ (2)

$(I)(0.62)(0.44) = (0.013)(9.8)$ (1)

$I = 4.67 \times 10^{-1} A$ (1)

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.

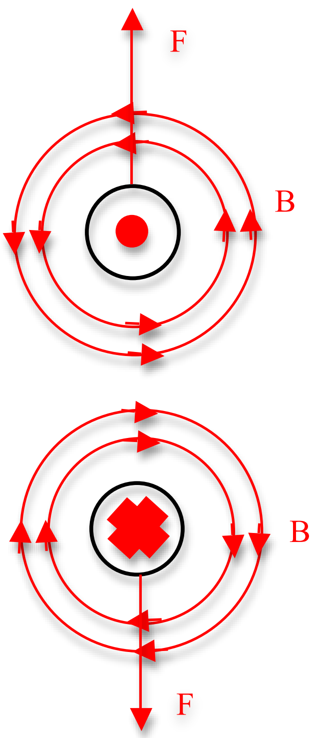
[1]

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

[3]

- Direction of Current 0.5 each
- Direction of B field 0.5 each
- Direction of Force 0.5 each
- Appropriate Labels -0.5 each

omission.



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]

$$\frac{F}{\ell} = \mu_o \frac{I_1 I_2}{2\pi r} \quad (1)$$

$$\frac{(0.013)(9.8)}{0.62} = (4\pi \times 10^{-7}) \frac{I^2}{2\pi(0.10)} \quad (2)$$

$$I = 321\ A \quad (1)$$

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YEAR 12 PHYSICS
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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)	1/r (m^{-1})
2.0	15.0	50
2.3	13.0	43.5
2.6	12.0	38.5
2.9	10.0	34.5
3.2	9.00	31.3
3.5	8.60	28.6
3.8	7.90	26.3

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

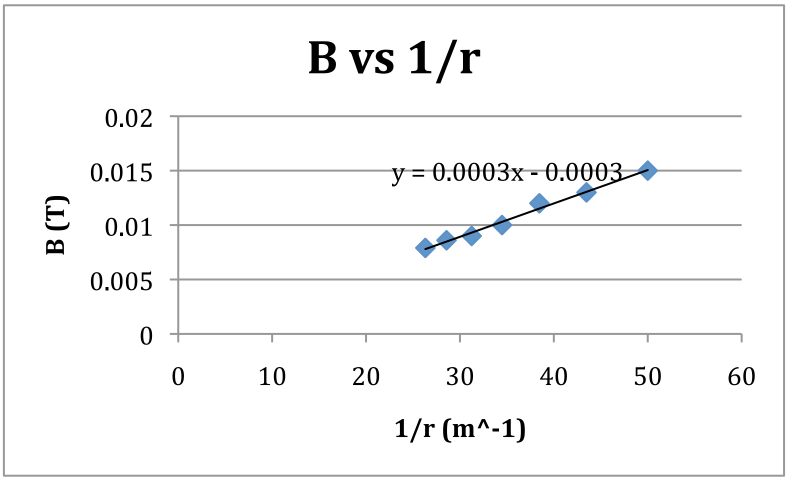
B vs 1/r

(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]

- Column Label & Units 1 mark
- Correct values and to 3 sf 1 mark

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

[6]



Title	1 mark
Axes Labels & Units	2 mark
Correct Points Plotted	1 mark
Linear Scales	1 mark
Line of Best Fit	1 mark
Axes Swapped	-1 mark

(d) Determine the gradient of your graph.

[3]

- 0.0003 Tm
- triangle on graph -1
- accuracy of value – 1
- units -1

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

[3]

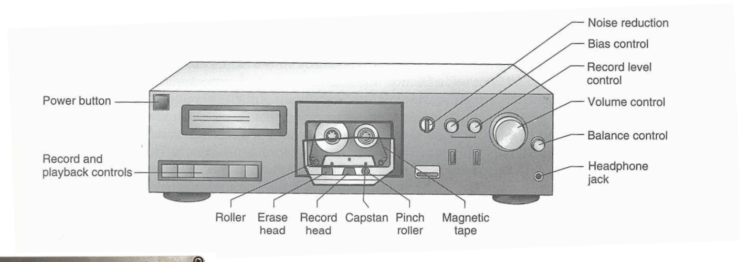
$$0.0003 = \frac{\mu_o I}{2\pi} \quad (1)$$

$$0.0003 = \frac{(4\pi \times 10^{-7})(I)}{2\pi} \quad (1)$$

$$I = 1.50 \times 10^{3} A \quad (1)$$

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

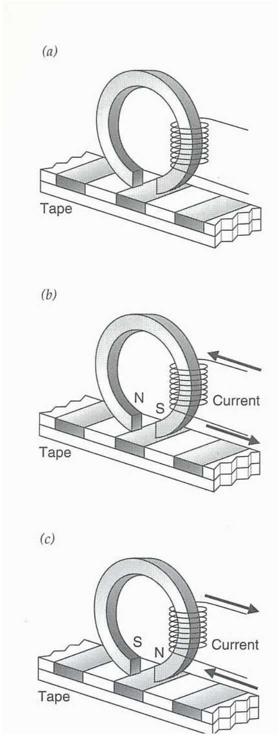
<u>Recording Sound Onto A Magnetic Tape</u>

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]

- The speaker compresses and rarefies the air in front of it to produce a pressure wave in the air.
- The rate at which the speaker moves in and out to produce the compressions and rarefactions will provide information about frequency.

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]

- The current in the recording circuit would change direction
- 500 times every second.

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

[2]

- Soft iron is easy to demagnetise and does not exhibit permanent magnetisation.
- And would not be able to maintain recording information for any period of time.

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

[4]

- A fluctuating current flows through the electromagnet.
- As there is a gap in the ring, the magnetic tape under the gap is magnetised in the same direction as the direction as is the current direction of the magnetic field of the electromagnet.
- When the current in the electromagnet changes direction, the direction of the magnetisation changes.
- The stronger the current, the greater the magnetic flux density and the deeper the magnetisation of the magnetic tape.

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

[1]

- Difference in pressure compared to average pressure (ie whether it is a compression or rarefaction)

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

[1]

- Loudness of the sound

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

[3]

- Magnetic tape is very sensitive to previous magnetic history (remnant magnetisation).
- Sounds of low volume will not magnetise the magnetic tape to a great depth.
- If the magnetic tape is not biased the remnant magnetisation may be to a greater depth than the current magnetisation and may override the current recording.

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

[2]

- The Oersted is a measure of the resistance to interchange of magnetic poles.
- To maintain longevity of recordings it is important that magnetic poles are not swapped and hence a high Oersted value is important.

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]

- The tape would be run slower through the recorder.
- This means there will be less domains to record each section of audio over.
- This would degrade the quality of the recording.