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NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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SUPERVISOR'S USE ONLY

Level 3 Physics, 2013

91526 Demonstrate understanding of electrical systems

2.00 pm Monday 25 November 2013
Credits: Six

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of electrical systems.	Demonstrate in-depth understanding of electrical systems.	Demonstrate comprehensive understanding of electrical systems.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Make sure that you have Resource Booklet L3–PHYSR.

In your answers use clear numerical working, words and / or diagrams as required.

Numerical answers should be given with an SI unit, to an appropriate number of significant figures.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

TOTAL

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You are advised to spend 60 minutes answering the questions in this booklet.

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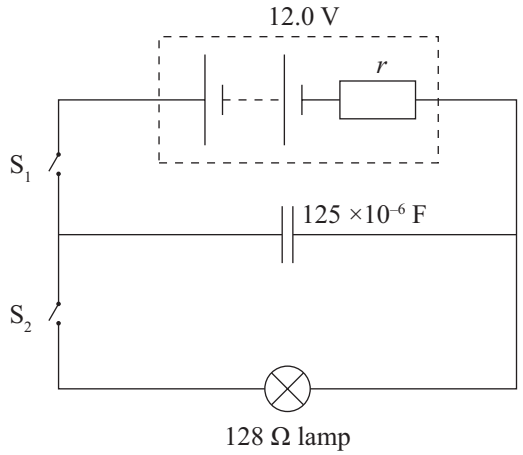
QUESTION ONE: USING A CAPACITOR TO PRODUCE A FLASH OF LIGHT

The circuit below can be used to produce a flash of light from a lamp with a fixed resistance of 128 Ω.



Switch 1 is closed and the capacitor charges up.

(a) Calculate the charge stored in the capacitor when it is fully charged.

(b) The internal resistance, *r*, of the battery is 1.80 Ω.

Explain why the charging is almost instantaneous.

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Switch 1 is opened and switch 2 is closed so the capacitor discharges through the lamp.

(c) On the graph below, mark values on the axes and plot a curve with at least 3 points to show how the charge in the capacitor changes during the discharge process.

(d) The lamp will glow at normal brightness if the voltage across it is between 9.00 V and 12.0 V.

Use the graph to estimate the length of time that the lamp is glowing at its normal brightness.

A second, identical capacitor is connected in series with the one shown.

(e) Show that the total capacitance of the two capacitors is 62.5×10^{-6} F.

(f) Explain, using physical principles, the effect of the new capacitor arrangement on the time constant of the circuit.

QUESTION TWO: USING AN INDUCTOR TO PRODUCE A SPARK

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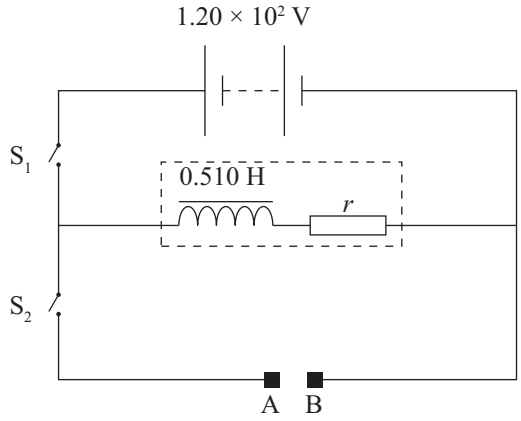
In the circuit below, for a spark to be produced between the gap AB, the voltage across AB must be greater than 1.20×10^2 V.



Switch 1 is closed and the current in the circuit rises to a constant value of 1.70 A.

(a) Calculate the energy stored in the inductor when the current has risen to its maximum value.

(b) Calculate the value of *r* shown on the diagram, AND explain its effect on the maximum current.

(c) Explain the effect of inductance on the time it takes for the current to rise to its maximum value.

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(d) Switch 2 is closed in addition to switch 1.

Explain what happens to the voltage across the inductor.

(e) Switch 1 is opened, leaving switch 2 closed.

Explain why a spark could be produced across the gap.

QUESTION THREE: USING A CAPACITOR AND AN INDUCTOR TO PRODUCE A BURST OF SOUND

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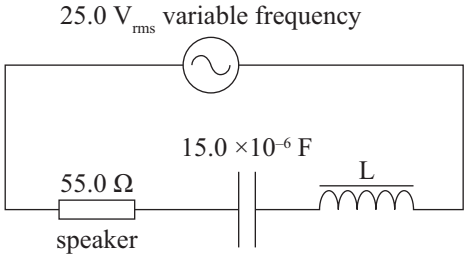
In the circuit below, the speaker will produce a sound that will depend on the magnitude and frequency of the current through it. The frequency of the supply is set to 4.50×10^2 Hz. At this frequency, the total impedance of the circuit is 93.0 Ω.



(a) Calculate the reactance of the capacitor at this frequency.

(b) The supply voltage leads the current by an angle θ.

Calculate the value of θ.

(c) Show that the reactance of the inductor at this frequency is 98.6 Ω.

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(d) Explain what must be done to the frequency of the supply to bring the circuit to resonance.

(e) The resonant frequency is 2.20×10^2 Hz.

By considering the resonance condition or any other method, calculate the inductance of the inductor.

(f) Explain how the frequency of the supply can be altered to produce a short burst of sound from the speaker.

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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