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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 3 Physics 2026

91526 Demonstrate understanding of electrical systems

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 appropriate SI unit.

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 2–12 in the correct order and that none of these pages is blank.

Do not write in the margins (////). This area will be cut off when the booklet is marked.

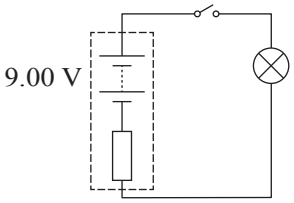
YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

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QUESTION ONE: CIRCUITS AND CAPACITORS

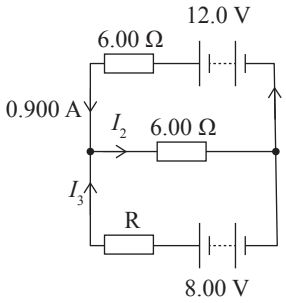
A group of students is comparing the use of batteries and capacitors in circuits.

They initially test a bulb in a circuit with a 9.00 V battery, set up as shown. When the switch is closed, a current of 0.150 A flows, but the battery's terminal voltage drops to 7.50 V.



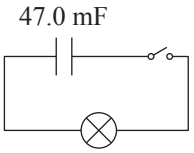
(a) Calculate the internal resistance of the battery.

(b) A circuit is set up, as shown.



Use Kirchhoff's Laws to show that the value of the unknown resistance, R is 7.00 Ω.

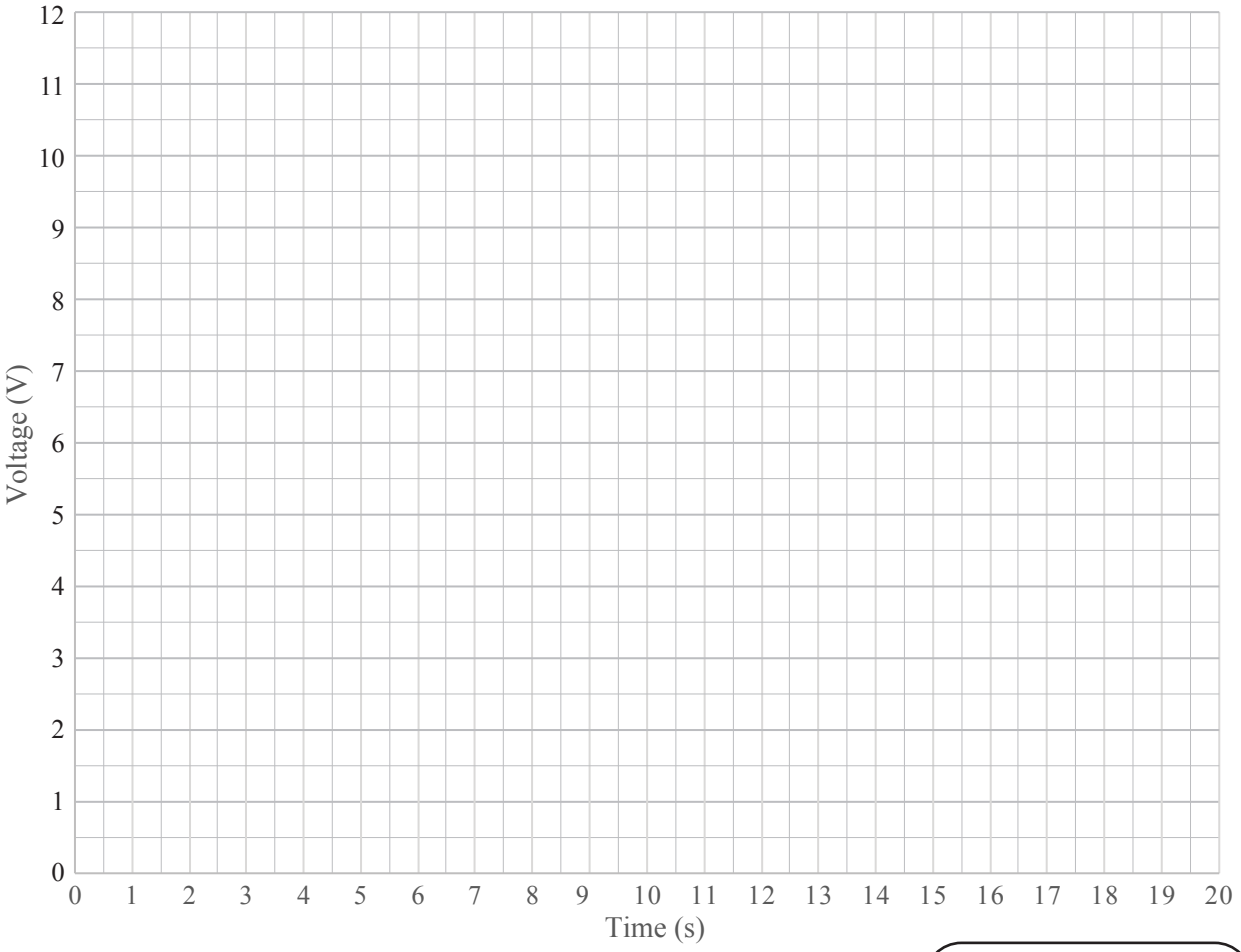
(c) The students set up the circuit as shown to investigate the length of time that a charged capacitor (47.0 mF) can operate a 100 Ω bulb. Once the capacitor is charged to 10.0 V, the students close the switch. The bulb stops working when the voltage drops below 2.00 V.



Determine the maximum operating time for the bulb.

Start by calculating the time constant for the capacitor.

An appropriate graph may help you in your response.

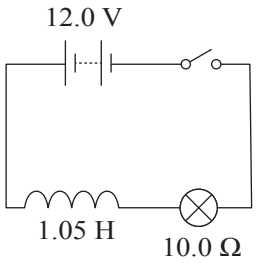


If you need to redraw your response, use the grid on page 10.

(d) Another group of students has two identical 220 μF capacitors, and an ideal 12.0 V power supply.

Explain which arrangement of capacitors, either in series or parallel, will allow the students to store the most energy.

QUESTION TWO: INDUCTORS



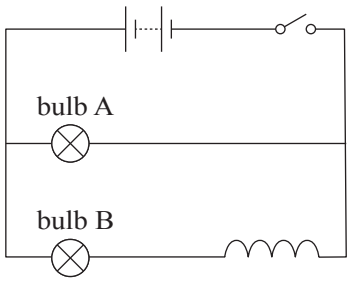
A circuit is used to investigate inductors. The circuit is set up as shown with a power supply of 12.0 V, a 10.0 Ω bulb and an ideal 1.05 H inductor with no internal resistance.

The switch is closed to complete the circuit.

(a) State the EMF across the inductor the instant the switch is first closed.

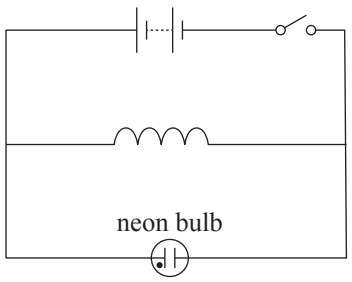
(b) By first determining the steady-state current in the circuit, calculate the energy stored in the inductor after steady state has been achieved.

(c) The circuit shown is built to test the effect of a parallel circuit on the flow of current through two light bulbs. When the switch is closed, bulb A lights up immediately, but bulb B takes time to reach the same brightness.



Explain the change in brightness of both bulbs over time.

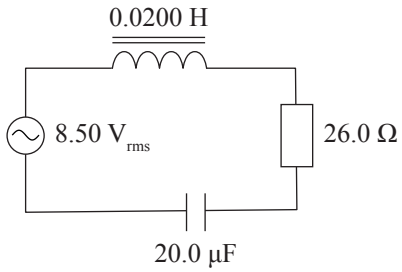
(d) A neon bulb, which requires at least 90.0 V to glow, is placed in parallel with a different inductor in a 12.0 V DC circuit, as shown on the right. When the switch is closed, the neon bulb remains off; when the switch is open, it flashes brightly and then goes out.



Explain why the neon bulb remains unlit while the switch is closed, yet produces a brief, bright flash the moment the switch is opened.

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The assessment continues on the following page.

QUESTION THREE: AC CIRCUITS

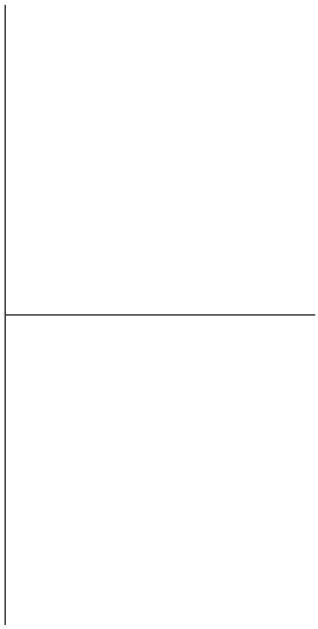


The students investigate LCR circuits, setting up the circuit as shown, with a frequency of 600 Hz, a resistor of 26.0 Ω, and a 8.50 V_{rms} AC supply. The capacitor has capacitance of 20.0 μF, and the inductor has an iron core and an inductance of 0.0200 H.

(a) Show that the reactance of the capacitor is 13.3 Ω.

(b) Explain the effect the iron core has on the reactance of the inductor.

(c) By considering relevant resistance and reactance values, draw labelled phasors for X_L, X_C, and R. Calculate the impedance of the circuit, and find the value of the rms current in the circuit.



If you need to redraw your response, use the diagram on page 10.

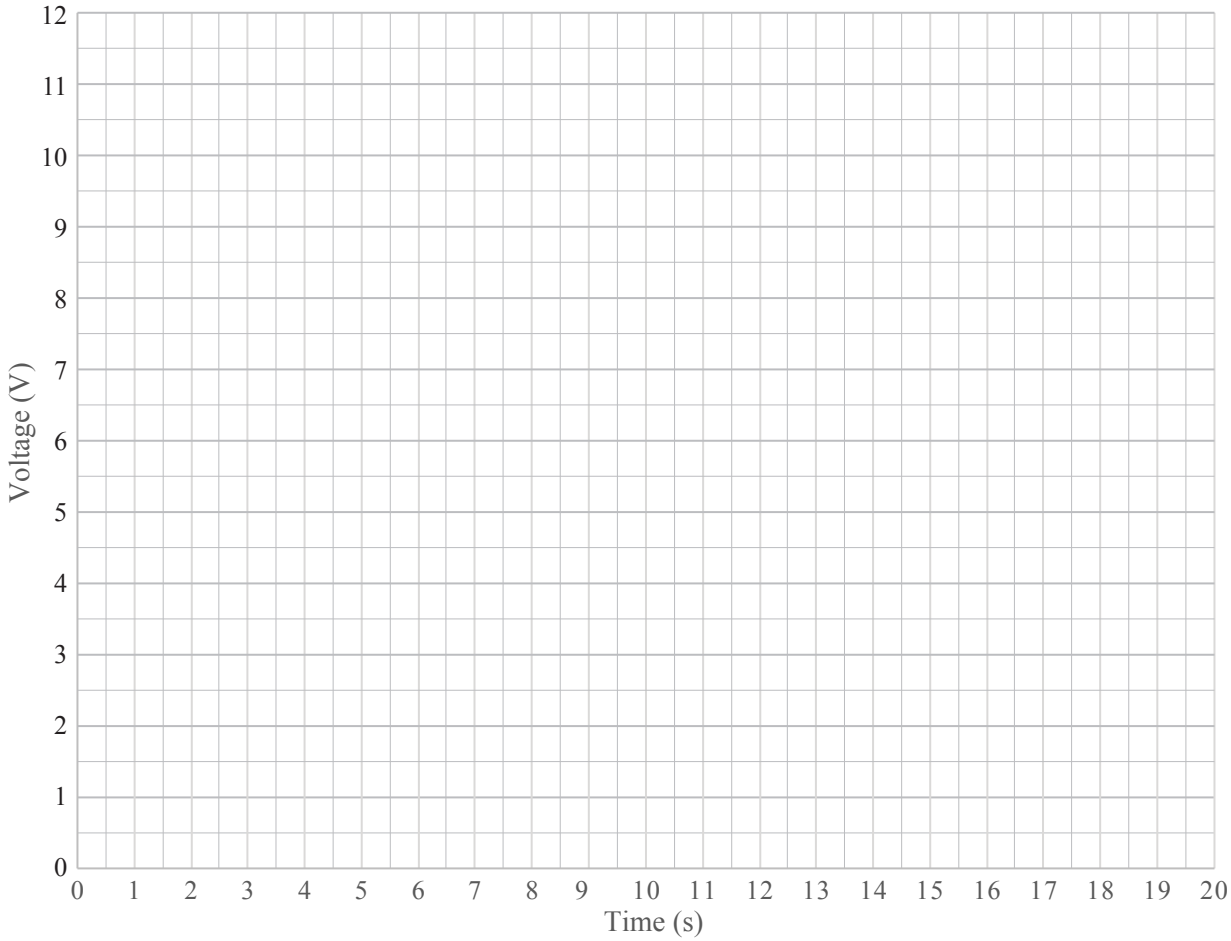
(d) The students want to get the maximum possible current flowing through the circuit.

(i) Explain the conditions for resonance and show that the original resonant frequency of the circuit is 252 Hz.

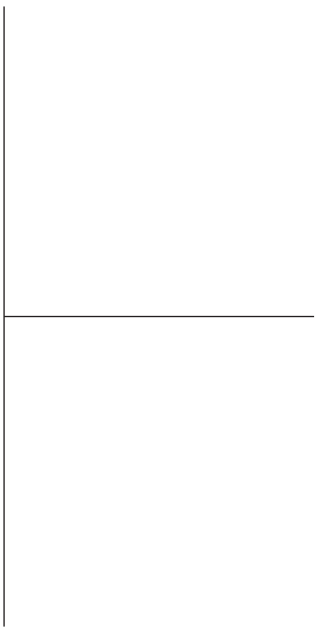
(ii) Explain how you would adjust the capacitance to make a new resonant frequency of 600 Hz.

SPARE DIAGRAMS

If you need to redraw your response to Question One (c), use the grid below. Make sure it is clear which answer you want marked.



If you need to redraw your response to Question Three (c), use the diagram below. Make sure it is clear which answer you want marked.



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

QUESTION NUMBER

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

QUESTION NUMBER