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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 2 Physics 2024

91173 Demonstrate understanding of electricity and electromagnetism

Credits: Six

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of electricity and electromagnetism.	Demonstrate in-depth understanding of electricity and electromagnetism.	Demonstrate comprehensive understanding of electricity and electromagnetism.

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 Sheet L2–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 2–16 in the correct order and that none of these pages is blank.

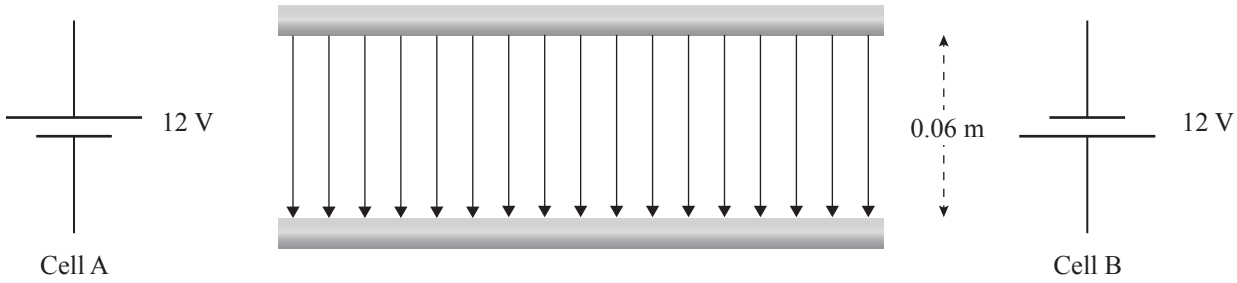
Do not write in the margins (⁄⁄⁄). This area will be cut off when the booklet is marked.

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

QUESTION ONE: PARALLEL PLATES

There is an electric field between two parallel plates 0.06 m apart.

(a) On the diagram below, **select** one of the 12 V cells labelled A and B, and **correctly connect** the cell to the plates so that it produces the field shown.



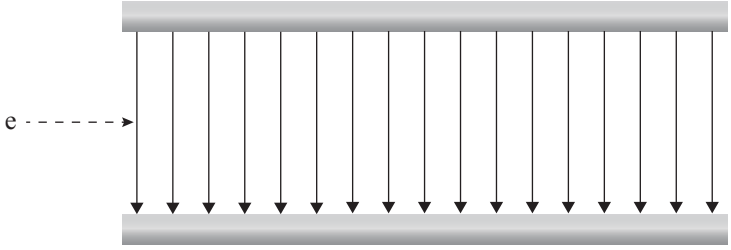
If you need to redraw your response, use the diagram on page 11.

(b) An electron is released from the negative plate.

Ignoring the effect of gravity, calculate the speed of the electron when it reaches the positive plate.

(c) An electron moves into the electric field from left to right.

(i) On the diagram below, again ignoring the effects of gravity, draw the path of the electron inside the field.

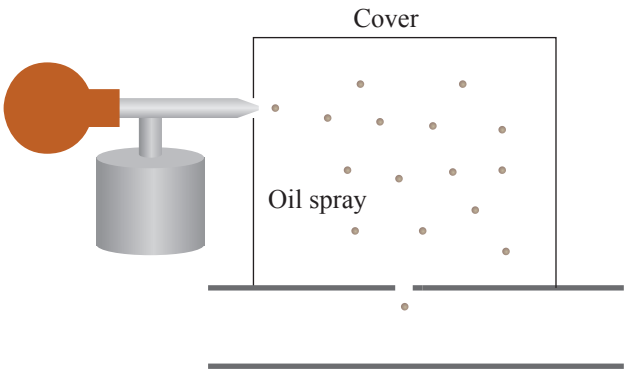


If you need to redraw your response, use the diagram on page 11.

(ii) Use physics principles to explain the path you have drawn in part (i).

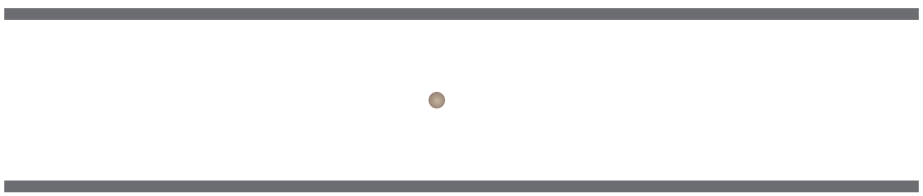
Your answer should refer to any relevant force(s) acting on the electron, including giving their directions.

(d) A simplified version of Millikan's oil drop apparatus is shown below.



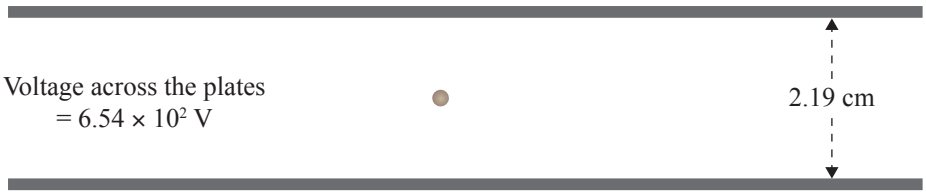
In his experiment, Millikan placed negatively charged oil drops inside an electric field and adjusted the voltage across the plates until they were held stationary.

(i) On the enlarged diagram below, add labelled arrows to show the two forces acting on the negatively charged oil drop to keep it stationary.



If you need to redraw your response, use the diagram on page 11.

(ii) In one experiment an oil drop, of mass 1.95×10^{-15} kg, with charge q, was held stationary between the plates, as below.



Calculate the number of excess electrons on the oil droplet.

Give your answer to the nearest whole number.

Use $g = 9.8$ m s^{-2}

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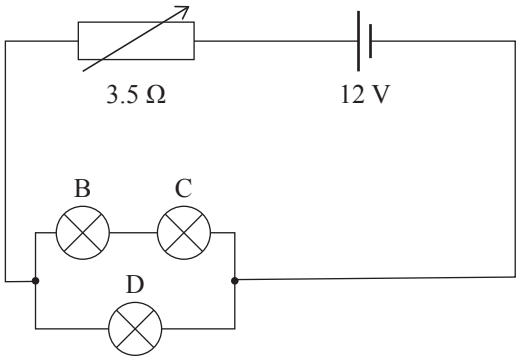
The assessment continues on the following page.

QUESTION TWO: CIRCUITS

Modern harvesters contain many warning lamps. A simplified version of a circuit connecting some of the lamps is shown below.



Source: www.farmtrader.co.nz/features/1905/top-tips-for-buying-a-combine-harvester

The circuit has three identical lamps labelled B, C, and D.

A dimmer switch represented by the variable resistor is initially set to 3.5 Ω.

When all the lamps are operating, the current in lamp D is 1.4 A.

(a) Explain why the current in lamp B is 0.70 A.

(b) Show the resistance of a single lamp is 3.3 Ω.

(c) Explain what would happen to the brightness of lamp D if lamp B were to stop working.

(d) With all three lamps working again, the variable resistor is adjusted so that lamp D converts 530 J of energy into light every minute.

Calculate the total current in the circuit.

Start by working out the power of lamp D.

QUESTION THREE: ELECTROMAGNETISM

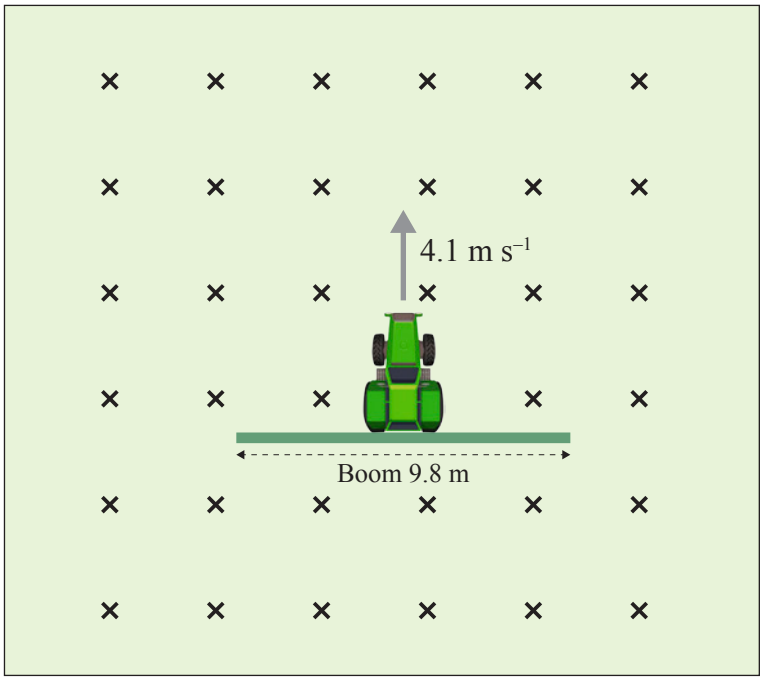
A tractor with a 9.8 m-long metal sprayer boom moves at 4.1 m s^{-1} across a paddock.

Source: www.researchgate.net/publication/339652802_A_Perception_System_for_an_Autonomous_Pesticide_Boom_Sprayer/figures?lo=1

Vertical component of the earth's magnetic field = 31 × 10^{-6} T.

(a) On the diagram below, clearly label the negative end of the sprayer boom.

View from above



If you need to redraw your response, use the diagram on page 12.

(b) Calculate the voltage induced between the ends of the sprayer boom.

(c) Use physics principles to explain how the voltage is induced between the ends of the sprayer boom.

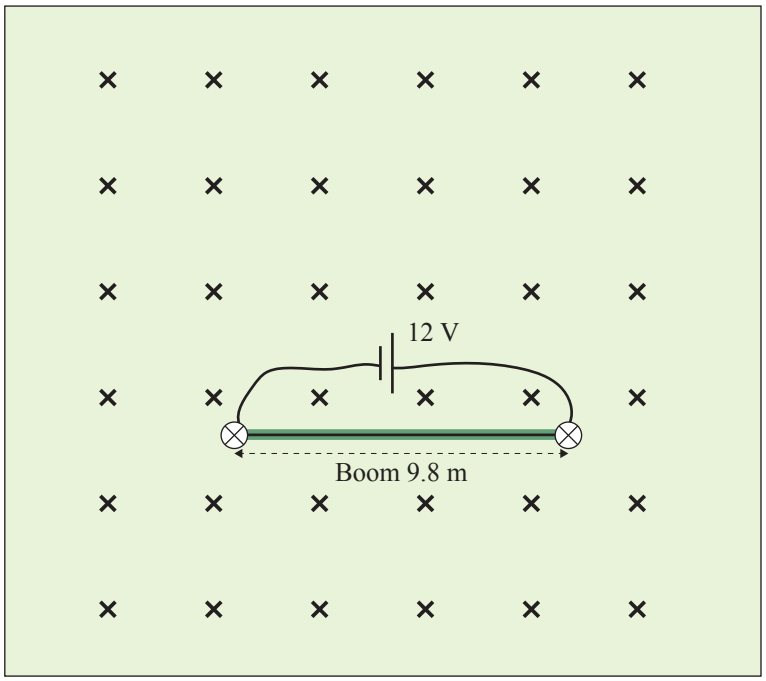
Question Three continues on the next page.

(d) A wire runs along the whole length of the sprayer boom connecting it to a warning lamp at each end. The wire is also connected to the 12 V tractor battery. Each lamp is labelled 6 V 3 W.

While stationary, the warning lights are activated.

(i) Clearly indicate the direction of the electromagnetic force on that part of the wire which runs along the sprayer boom by adding an arrow to the diagram below.

View from above

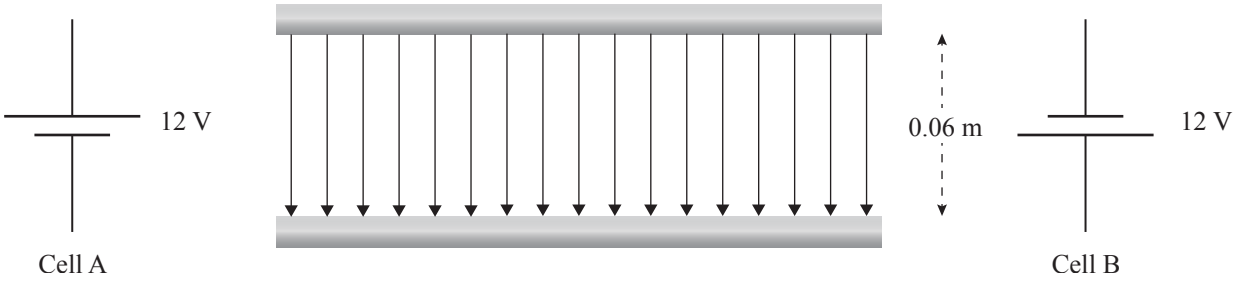


If you need to redraw your response, use the diagram on page 12.

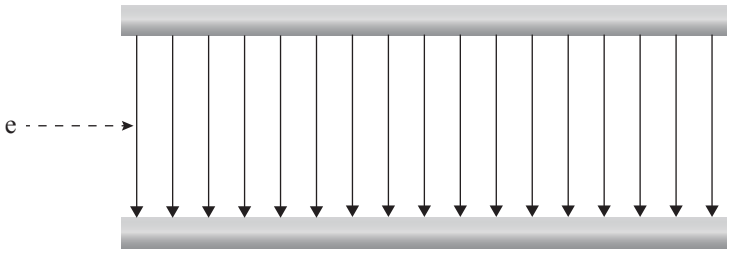
(ii) Calculate the electromagnetic force acting on the part of the wire running along the sprayer boom.

SPARE DIAGRAMS

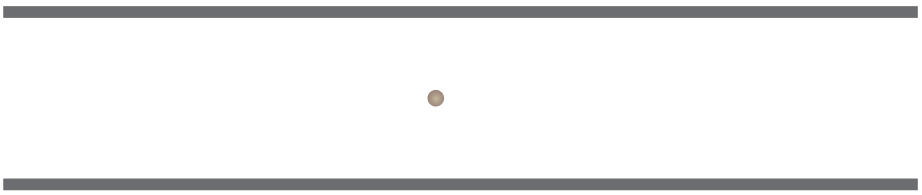
If you need to redraw your response to Question One (a), use the diagram below. Make sure it is clear which answer you want marked.



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

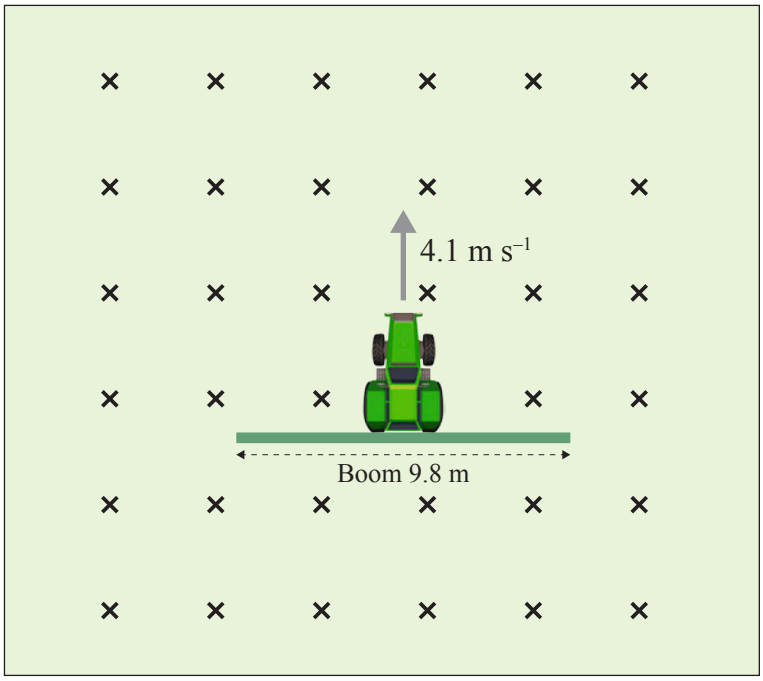


If you need to redraw your response to Question One (d)(i), use the diagram below. Make sure it is clear which answer you want marked.



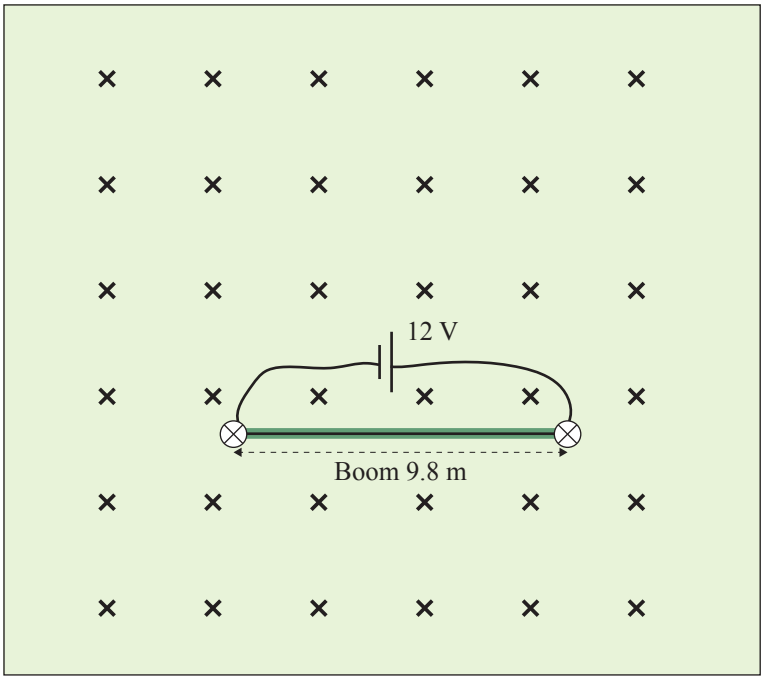
If you need to redraw your response to Question Three (a), use the diagram below. Make sure it is clear which answer you want marked.

View from above



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

View from above



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