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Level 2 Physics, 2017

91173 Demonstrate understanding of electricity and electromagnetism

2.00 p.m. Friday 10 November 2017
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 space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 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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QUESTION ONE: ELECTROSTATIC SPEAKERS

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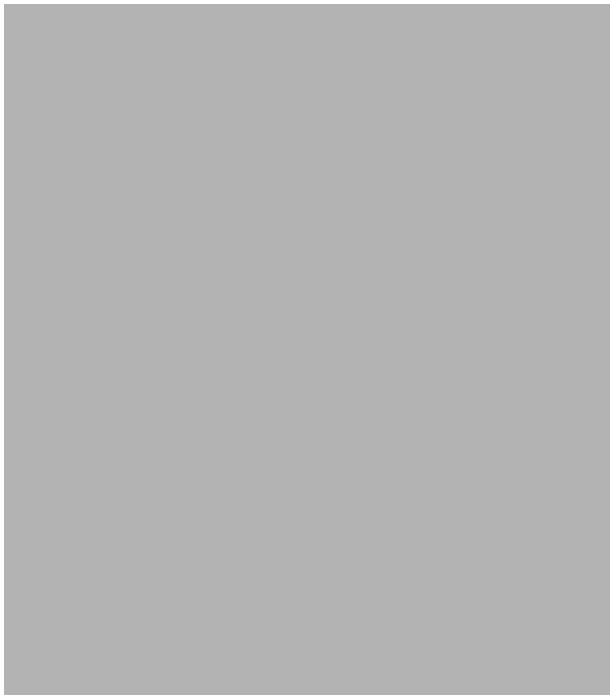
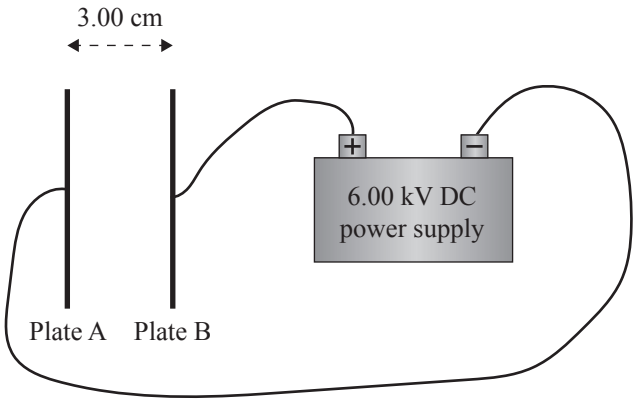
Sam has recently purchased an electrostatic speaker that produces sound by moving a diaphragm (thin sheet of polyester film) between two conducting plates that are 3.00 cm apart.

A simplified diagram of an electrostatic speaker is shown below. The plates are connected to a 6.00 kV high-voltage DC power supply.

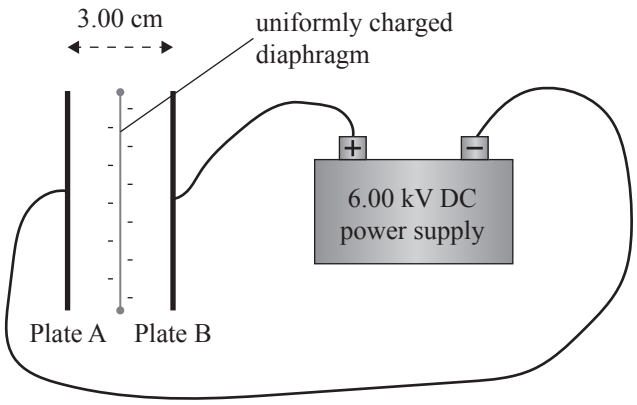




http://electronics.howstuffworks.com/question713.htm

(a) Show the strength of the electric field between plates A and B is $2.00 \times 10^5\ \text{Vm}^{-1}$.

(b) The initially neutral diaphragm, centrally placed between the plates, is charged by adding 3.70×10^{12} electrons onto it.



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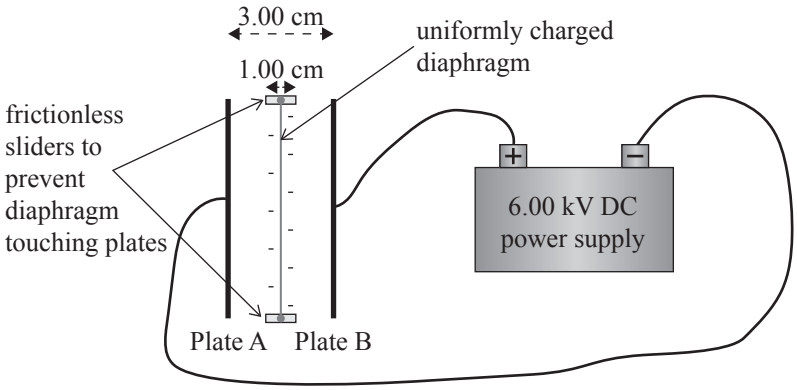
Calculate the total charge and the size of the total force (including direction) experienced by the charged diaphragm.

(c) The uniformly charged diaphragm is fixed at the top and bottom to smooth (frictionless) sliders, which allows it to move to the left or right by a total distance of 1.00 cm.



Explain why the size of the force on the diaphragm remains constant, and no bending occurs, as the diaphragm moves within the sliders.

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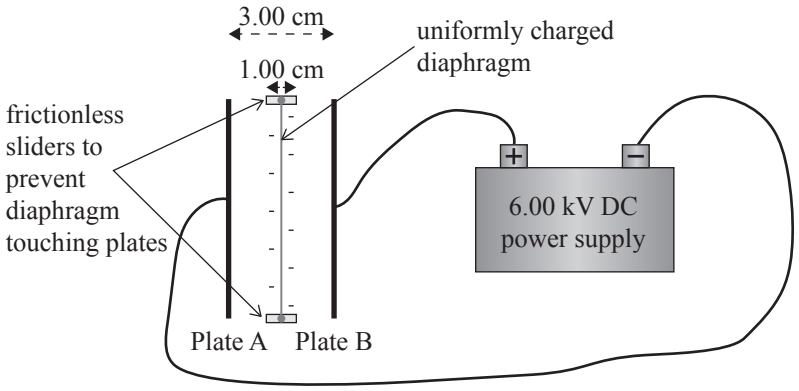
(d) The diagram below is repeated from the previous page.



At one point the stationary diaphragm has a uniform negative charge of -4.20×10^{-5} C, and is initially located in the middle of the slider. The mass of the diaphragm is 5.80×10^{-5} kg, and the width of the slider is 1.00 cm. The conducting plates are 3.00 cm apart.

Find the maximum speed the diaphragm will have before it is stopped by the edge of the slider.

State any assumptions you make.

QUESTION TWO: LIGHT BULBS

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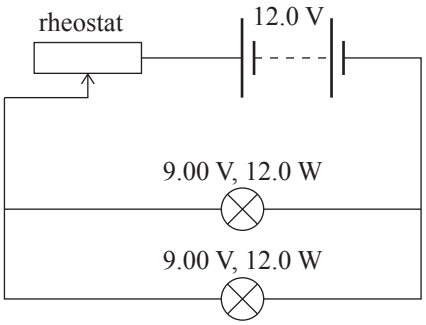
Sam is using a light bulb rated as 9.00 V, 12.0 W.

(a) Calculate the current flowing through the bulb when it is working at the stated voltage of 9.00 V.

Sam then connects two identical 9.00 V, 12.0 W bulbs, a 12.0 V battery, and a rheostat (variable resistor) as shown below:

www.electronics-tutorials.ws/resistor/slider-rheostat.jpg?x98918



(b) Explain how increasing the resistance of the rheostat affects the voltage across each bulb.

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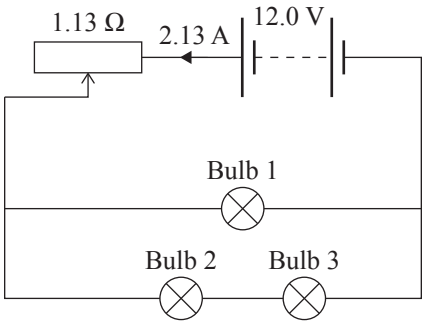
(c) Show that the resistance of the rheostat must be 1.13 Ω, in order for each bulb to be operating at 9.00 V.

(d) Some time later Sam modifies the circuit in part (a) by adding one more identical bulb. A current of 2.13 A is drawn from the battery when the circuit is connected.



Explain how the addition of Bulb 3 affects the brightness of Bulb 1. In your answer, explain if any of the bulbs are now more likely to 'blow'.

QUESTION THREE: THE FLYING FOX

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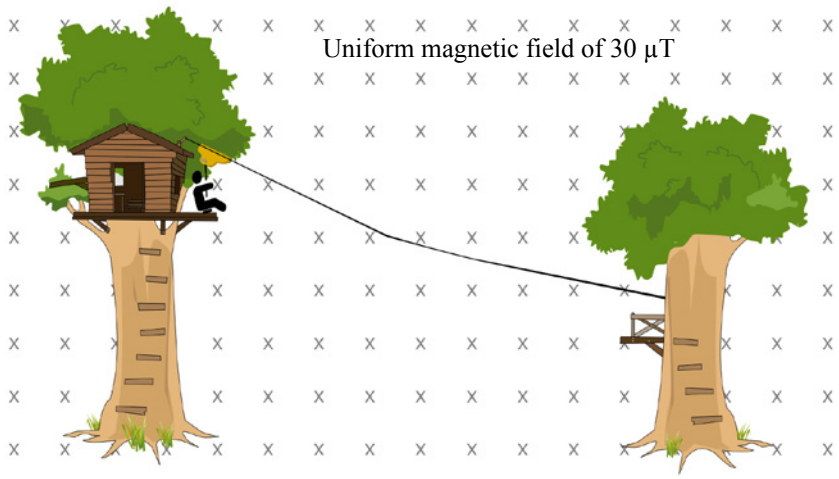
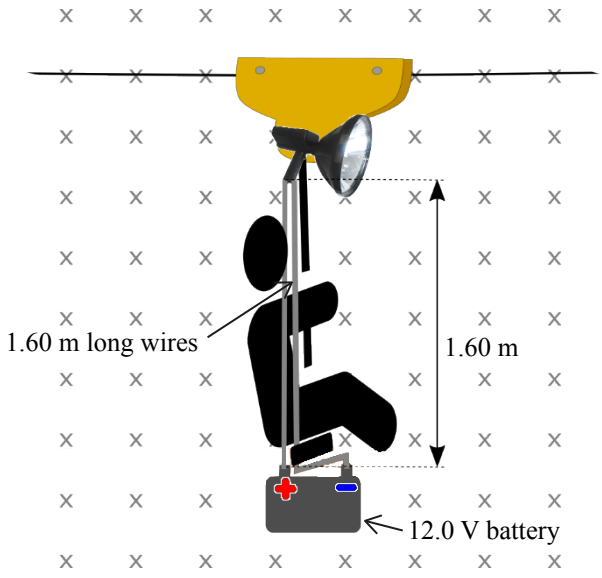
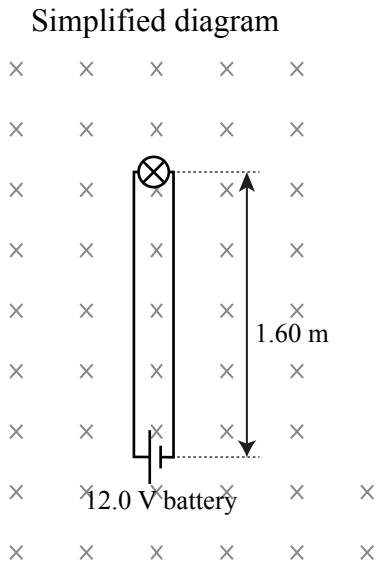
Sam has a flying fox (zip line) that he wants to use in the dark.



Sam connects a 12.0 V battery to a spotlight, using two 1.60-metre-long wires. The light and wires have a combined resistance of 2.40 Ω. Sam sits stationary at the top of the flying fox inside the earth's magnetic field, which is horizontal and has a magnetic field strength of 30.0×10^{-6} T.





(a) Calculate the force (including direction), due to the earth's magnetic field, on the 1.60-metre-long wire connected to the positive terminal of the battery. The lower end of the left-hand wire is connected to the positive end of the battery.

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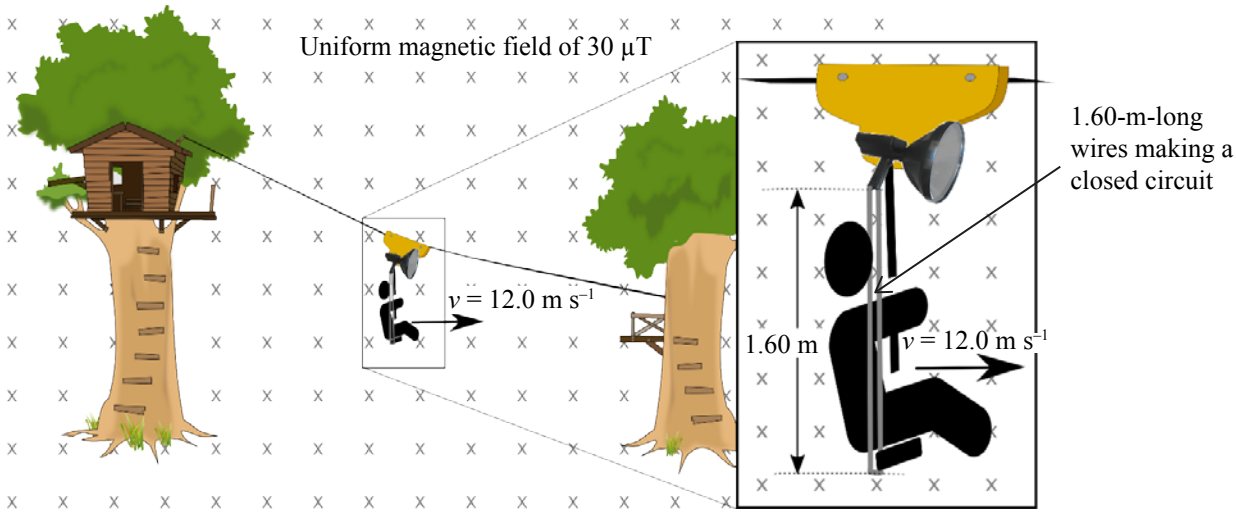
(b) Describe the effect the magnetic force from both wires has on the time it takes Sam to complete the run down the flying fox.

Later in the evening Sam removes the battery. He then connects the wires where the battery was. At one point he is travelling purely horizontally at 12.0 m s^{-1} across the earth's magnetic field.



(c) Calculate the voltage induced in the left-hand wire.

(d) (i) Explain in detail why there is a voltage induced in the left-hand wire as Sam moves.

(ii) Explain why no current flows in the closed circuit of wires and a bulb.

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

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