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Level 2 Physics, 2019

91173 Demonstrate understanding of electricity and electromagnetism

9.30 a.m. Friday 8 November 2019
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 2–11 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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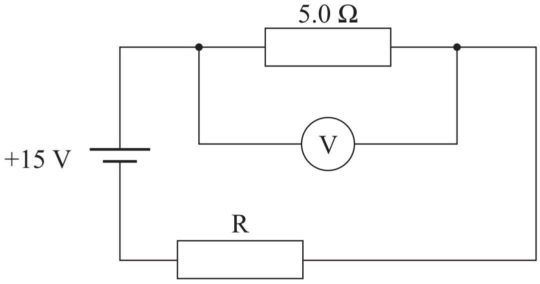
QUESTION ONE: THE BICYCLE LAMP

Jason needs to buy a lamp for his bike. When he pulls apart an old lamp, he finds some circuits. A simplified version of a circuit found in Jason's bike lamp is shown below.

www.gearbest.com/led-flashlight/pp_425412.html

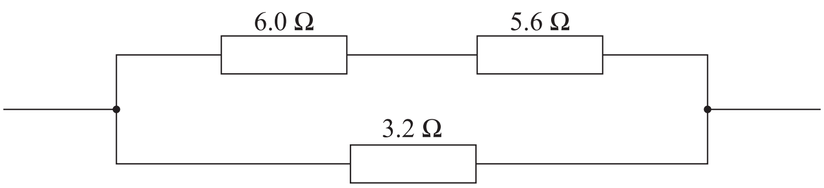


(a) The voltmeter reads 4.0 V.

Show that the circuit current is 0.80 A.

(b) Calculate the heat energy dissipated in 2 minutes by the resistor marked R.

(c) Another part of a circuit in the lamp is shown below.

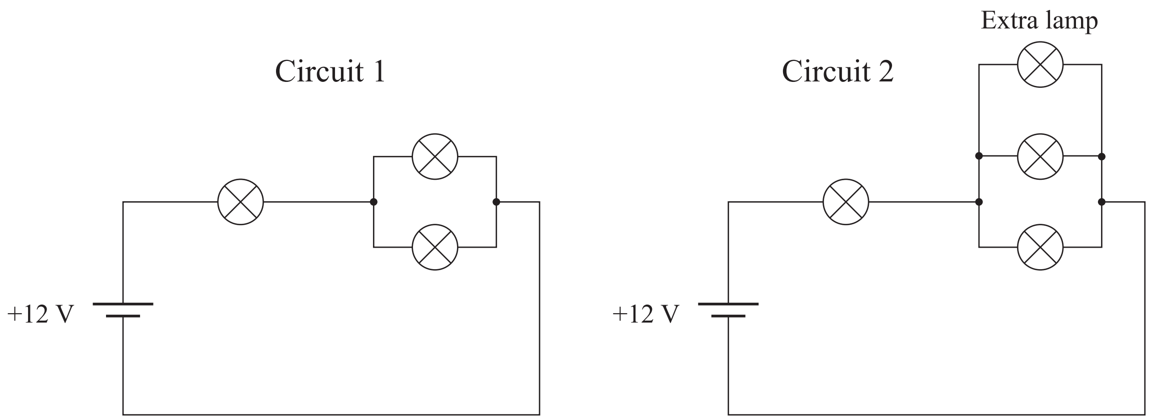


Calculate the total resistance of this circuit.

(d) Jason's friend Deborah designs the following lighting circuits, and Jason wonders which circuit would give out the most light.

All lamps are identical. Circuit 2 has an extra lamp.

By considering the combined brightness of all the lamps in the circuit, give a comprehensive explanation comparing the total brightness of Circuit 1 to Circuit 2.



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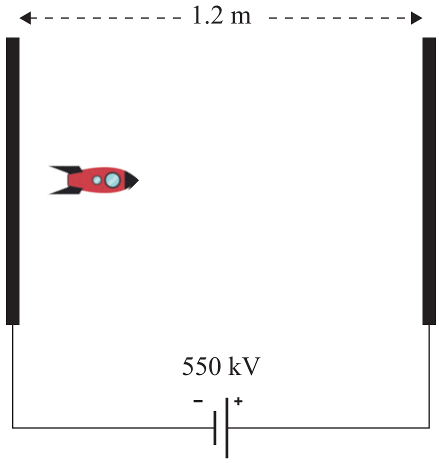
QUESTION TWO: A MODEL SPACE ROCKET



Manu thinks that he could use an electric field in space to slow down a rocket ship. He models his idea by setting up a pair of parallel plates 1.2 m apart. He connects them to a 550 kV supply, and uses a small toy rocket as a trial.

The mass of the toy rocket is 130 g.

The rocket moves from left to right.

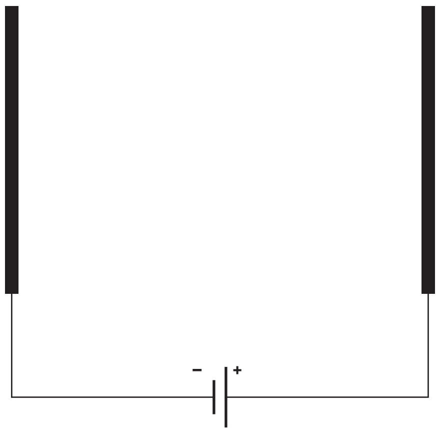
The charge on the rocket is 3.5×10^{-6} C.

(a) Calculate the strength of the electric field between the plates.

(b) During one test, the rocket was initially moving at speed *v*, and was stopped in a distance *d*.

Explain in depth what would happen to the stopping distance if the rocket was tested again at double the initial speed (2*v*) and the same charge.

(c) Draw the field lines between the two plates.



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(d) The maximum stopping distance for the given setup is 1.2 m.

What is the maximum speed that a rocket can initially be moving and still be stopped by this apparatus?

QUESTION THREE: MAGNETIC FIELDS

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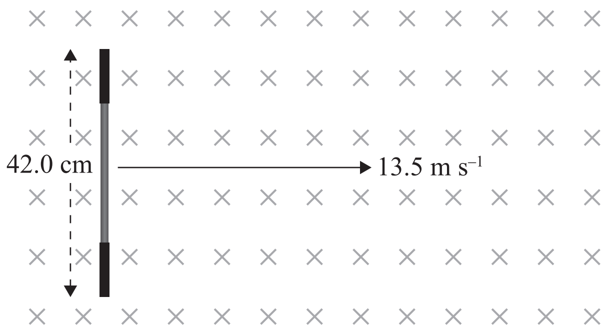
The Magnetic North Pole (also known as the *North Dip Pole*) is a point on Ellesmere Island in northern Canada. Here the Earth's magnetic field lines enter the ground vertically.

The strength of the magnetic field there was measured at 47.3×10^{-6} T.

A bicycle has metal handlebars that are 42.0 cm wide. A student riding the bicycle on the island rides on flat ground at 13.5 m s^{-1}.

www.kisspng.com/png
-bicycle-mountain-bike-cycling
-car-shimano-cycle-998870/preview.html

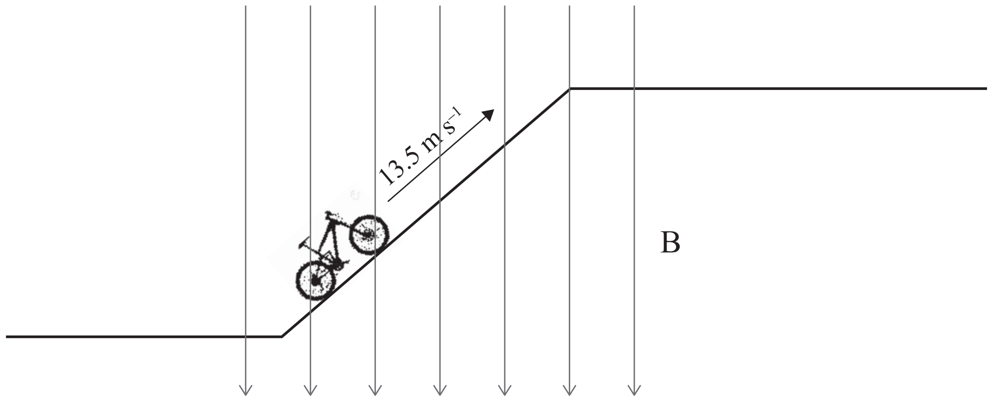
Plan view of the bicycle handlebars



(a) Show that the voltage induced across the handlebars is 2.68×10^{-4} V.

(b) Give an in-depth explanation of how a voltage is induced across the ends of the handlebars.

(c) The student then rides up a steep hill at 13.5 m s^{-1}.



(i) What is the effect of riding up this hill on the value of the induced voltage?

Circle one: Voltage **is less**, **is unchanged**, **is greater**.

(ii) Explain fully your answer to part (i) above.

Question Three continues on the following page.

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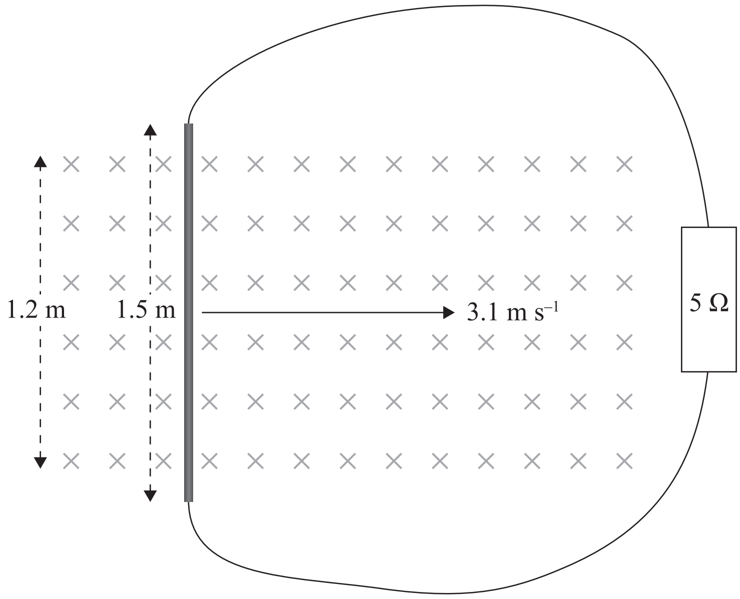
(d) The student has an after-school job at a junkyard. While there they move a 1.5 m steel pipe through a 0.8 T magnetic field of width 1.2 m, at right angles to the field. The ends of the pipe are connected to a circuit that is outside the magnetic field. The circuit has resistance of 5 Ω.



Calculate the force that the student needs to exert in order to keep the pipe moving at 3.1 m s^{-1} at right angles to the field.

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

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