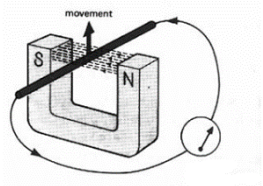
Electrical Generators

Definitions

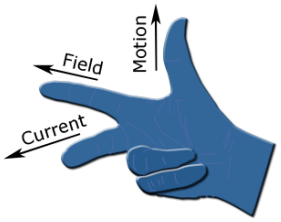
Moving a current-carrying conductor through a magnetic field can induce a Voltage (more correctly termed an EMF) – this may be calculated by

$$V = BvL$$



Equations

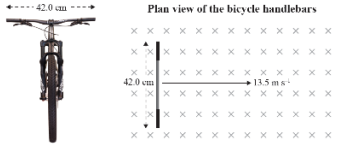
$V = BvL$	Voltage	V	V
	Magnetic Field Strength	B	T
	Velocity	v	m s^{-1}
	Length	L	m
$V = IR$	Voltage	V	V
	Current	I	A
	Resistance	R	Ω



Questions

MAGNETIC FIELDS (2019;2)

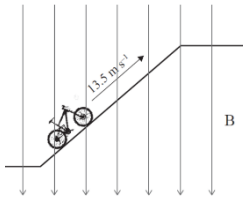
The Magnetic North Pole (also known as the North Dip Pole) is a point on Ellesmere Island in northern Canada. Here the Earth's magnetic field lines enter the ground vertically. The strength of the magnetic field there was measured at 47.3 × 10^{-6} T. A bicycle has metal handlebars that are 42.0 cm wide. A student riding the bicycle on the island rides on flat ground at 13.5 m s^{-1}.



(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}. What is the effect of riding up this hill on the value of the induced voltage? Fully explain your answer.



Terms

Electric generator: A Mechanical device that uses wire loops rotating in a magnetic field to produce electromagnetic induction in order to generate electricity.

Electromagnetic induction: Process in which current is induced by moving a loop of wire in a magnetic field or by changing the magnetic field.

Tips

- Do not forget that physics equations only work when SI units are used – do not forget to convert values from e.g., cm into m
- Don't be afraid to draw a hand to help explain Flemings right-hand rule.
- Flemings right-hand rule (at this level) explains interactions at right angles ("perpendicular") to each other of 3 things – you should be able to narrow down a prediction of one to a 50-50 chance (and if needs be you should guess). The interaction at right angles induces maximum voltage.
- You may have to use Ohm's law and V = B v L if you are given the current and not the voltage
- There is more than one way to explain this - we have chosen not to discuss the slap rules (but your teacher may have done)

Answers

(a) $$V = BvL = 4.73\times10^{-6}\times13.5\times0.42$$
$$= 2.68\times10^{-4}\ \text{V}$$

(b) The electrons are cutting the magnetic field as the handlebars move. There is a force on the electrons that causes a charge separation. The two ideas are movement across field and charge separation.Not "**in or entering** a magnetic field"

(c) Voltage is less. Because the component of the velocity at 90° to the magnetic field hasdecreased. Must refer to movement.