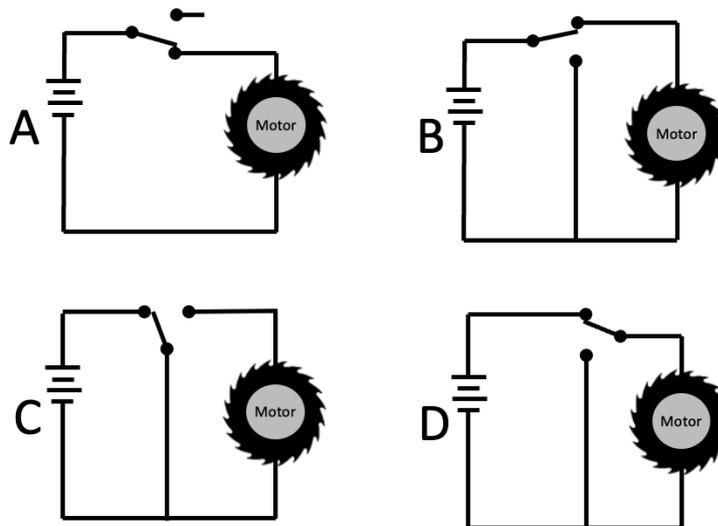


A circular saw consists of a DC electric motor connected to a circular saw blade, which continues to spin for a while after the switch is opened. To make the blade slow more quickly (and reduce the chance of accidental injury) a manufacturer proposes using electromagnetic braking when the switch is in the “off” position.

Q4220

Which circuit would operate the saw in the “on” position and slow the saw more quickly using electromagnetic braking in the “off” position?

In all options below, the switch is drawn in the “on” position.



Q4220

This is a challenging question and intended to be so.

This question, while mentioning electromagnetic braking, is probing a different aspect of electromagnetism – especially Lenz’s law.... and also the concept of a DC generator. A DC motor IS already a DC generator with no physical alteration needed.

It is also drawing on your assumed knowledge of circuits from Year 11. While this particular switch (called a single-pole-double-throw switch) might be new, interpreting how it works is part of the assumed understanding of simple circuit diagrams. Being able to transfer your knowledge to a new context is part of the “problem solving skills” in the Working Scientifically set of skills.

You will recall that an electric motor acts also as a generator. Indeed, the emf induced when running with an applied EMF is what is called “back EMF” because it is backwards compared to the supply EMF. However, “back” EMF is the same EMF that becomes the “forward” EMF when a DC motor is a generator. “back” and “forward” are relative terms.

When the motor is slowing down (and acting as a generator) it will induce an EMF (voltage) but without a current flowing the second half of Lenz’s law does not eventuate. It is only a *current* that creates flux lines to oppose the original change in flux.

For there to be a slowing down force, a current must flow and for this, there needs to be an electric circuit from one terminal of the motor to the other. Only options C and D create a circuit around the motor when the switch is in the off position.

Option C though will not run the motor as there is a short circuit which would be a fault situation. Regardless, no current travels from the battery and through the motor. So, while this circuit would give rise the EM braking in the “off” position of the switch, it does not operate the saw normally in the “on” position.

I have this DC (battery powered) drop saw (circular saw), and the difference in slow-down is significant compared to my old drop saw which didn't have this feature. It truly does make it safer! Most saws on the market in the last few years have this EM braking safety feature. Interesting it has taken more than 100 years since the physics was known to apply this physics to add a safety feature to a common tool. BTW, the principle works the same for AC motors as well.

New technology build from imagination, creativity and a knowledge of (often quite old) physics is happening all the time – what could you invent?