

## Efficiency measurement using a motor–dynamo module

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### Abstract

In this article, we describe a simple method which can be used to measure the efficiency of a low power dc motor, a motor-converted dynamo and a coupled motor–dynamo module as a function of the speed of rotation. The result can also be used to verify Faraday's law of electromagnetic induction.

### Introduction

The coupled motor–dynamo module (figure 1) consists of two identical motors with their axles aligned and coupled together by a short segment of rubber tubing. The production of the module is motivated by an intention to measure the energy efficiency of the 'raising and dropping a weight' experiment, also known as 'the pile driver experiment' in some older textbooks, which is commonly used to study energy conversion between gravitational potential energy and other forms of energy in junior science courses [1, 2].

In a simplified 'raising-and-dropping-a-weight' experiment, a motor with a spool fixed on its axle is connected to a dc power supply, and a weight is attached to the spool by a string (figure 2). When the motor is switched on, the weight is pulled up by the motor to a height of about 1.0 m. In terms of energy conversion, electrical energy is converted to mechanical energy and finally to the potential energy of the weight. The process can be reversed by connecting the motor, now treated as a dynamo, to a light bulb. When the weight is released from a height, its potential energy is converted back to electrical energy and finally to light energy given out by the bulb.



Figure 1. The motor–dynamo module.

To enhance student appreciation of physics at work in everyday life, this experiment can be used to simulate the operation of a hydroelectric pump storage system [3] (figure 3). Instead of lifting a solid weight, the surplus energy from a power station is used to pump water using a motor to a storage reservoir at a higher altitude. When energy is needed, water is allowed to run through a turbine generator to regenerate electricity.

### The circuit for efficiency measurement

In attempts to measure the efficiency of the 'weight-raising' and 'weight-dropping' processes,

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