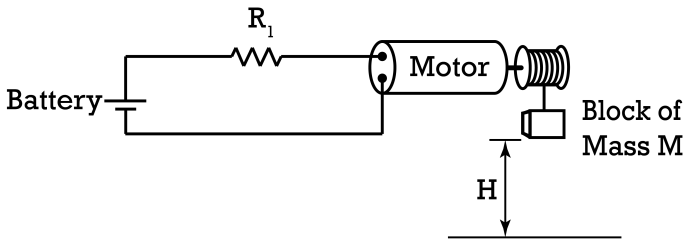
Flipping Physics Lecture Notes:

2019 #4 Free Response Question - AP Physics 1 - Exam Solution
http://www.flippingphysics.com/ap1-2019-frq4.html

This Paragraph Argument Short Answer question is also good for AP Physics C: Electricity and Magnetism.



A motor is a device that when connected to a battery converts electrical energy into mechanical energy. The motor shown above is used to lift a block of mass M at constant speed from the ground to a height H above the ground in a time interval Δt. The motor has constant resistance and is connected in series with a resistor of resistance R_1 and a battery.

Mechanical power, the rate at which mechanical work is done on the block, increases if the potential difference (voltage drop) between the two terminals of the motor increases.

(a) Determine an expression for the mechanical power in terms of M, H, Δt, and physical constants, as appropriate.

At a constant velocity the force of tension and force of gravity acting on the block are equal in magnitude.

$$P_{F_T} = \frac{W_{F_T}}{\Delta t} = \frac{F_T d \cos\theta}{\Delta t} = \frac{F_g H \cos(0)}{\Delta t} = \frac{MgH}{\Delta t}$$

(b) Without M or H being changed, the time interval Δt can be decreased by adding one resistor of resistance R_2 , where $R_2 > R_1$, to the circuit shown above. How should the resistor of resistance R_2 be added to the circuit to decrease Δt?

___ In parallel with the battery _X_ In parallel with R_1 ___ In parallel with the motor ___ In series with the battery, R_1, and the motor

In a clear, coherent, paragraph-length response that may also contain figures and/or equations, justify why your selection would decrease Δt.

Because power equals work over change in time, Δt needs to be decreased, and the work will be constant because M, g, and H are all constants; the mechanical power needs to be increased. From the problem statement we know mechanical power increases if the electric potential difference between the two terminals of the motor increases. Therefore, we know we need to increase the electric potential difference across the motor. Because electric potential difference equals current times resistance and the resistance of the motor is constant, we need to increase the current through the motor. Placing R_2 in parallel with R_1 will decrease the equivalent resistance of the circuit and therefore increase the current in the circuit. Because the current in the circuit is also the current through the motor, the current through the motor will be increased and Δt will be decreased.