



AP[®] Physics B 2003 Sample Student Responses Form B

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2. (15 points)

A student is asked to design a circuit to supply an electric motor with 1.0 mA of current at 3.0 V potential difference.

(a) Determine the power to be supplied to the motor.

$$I = 1.0 \times 10^{-3} \text{ A} \quad V = 3.0 \text{ V}$$

$$P = IV = 1.0 \times 10^{-3} \times 3 = 3.0 \times 10^{-3} \text{ W}$$

(b) Determine the electrical energy to be supplied to the motor in 60 s.

$$\text{energy} = P \cdot t = 3.0 \times 10^{-3} \frac{\text{J}}{\text{s}} \times 60 \text{ s} = \underline{0.18 \text{ J}}$$

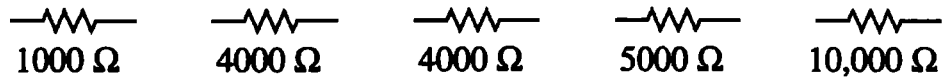
(c) Operating as designed above, the motor can lift a 0.012 kg mass a distance of 1.0 m in 60 s at constant velocity. Determine the efficiency of the motor.

$$\text{Work} = F \cdot d = 0.012 \text{ kg} \times 9.8 \frac{\text{m}}{\text{s}^2} \times 1.0 \text{ m} = 0.118 \text{ J}$$

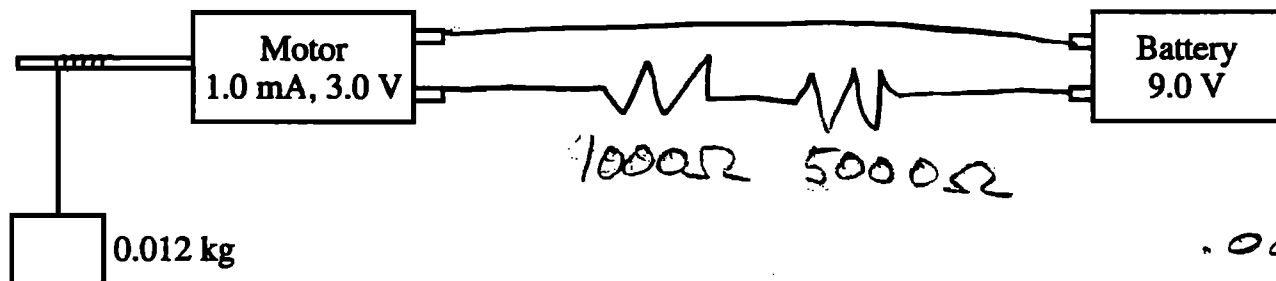
$$\frac{0.118}{0.18} \times 100 \text{ the engine is } 66\% \text{ efficient}$$

GO ON TO THE NEXT PAGE.

To operate the motor, the student has available only a 9.0 V battery to use as the power source and the following five resistors.



(d) In the space below, complete a schematic diagram of a circuit that shows how one or more of these resistors can be connected to the battery and motor so that 1.0 mA of current and 3.0 V of potential difference are supplied to the motor. Be sure to label each resistor in the circuit with the correct value of its resistance.



$$V = IR$$

$$\rightarrow I = \frac{V}{R} = \frac{9V}{9000\Omega} = 1mA$$

.001 A
Voltage drop
needs to be
6V

$$\text{so } R = \frac{V}{I} = \frac{6V}{.001A} = 6000\Omega$$

To make 6000 Ω resistor, put a 5000 Ω and 1000 Ω resistors in series.

GO ON TO THE NEXT PAGE.

2. (15 points)

A student is asked to design a circuit to supply an electric motor with 1.0 mA of current at 3.0 V potential difference.

(a) Determine the power to be supplied to the motor.

$$\begin{aligned}
 P &= IV \\
 &= 1 \times 10^{-3} \times 3 \\
 P &= 3 \times 10^{-3} \text{ W} \\
 &3.0 \times 10^{-3} \text{ W}
 \end{aligned}$$

(b) Determine the electrical energy to be supplied to the motor in 60 s.

$$\begin{aligned}
 Q &= It \quad \cancel{1.0 \times 10^{-3} \times 60 = 0.06 \text{ C}} \\
 W &= QV \\
 W &= ItV \quad W = 1.0 \times 10^{-3} \times 60 \times 3 = 0.18 \text{ J}
 \end{aligned}$$

(c) Operating as designed above, the motor can lift a 0.012 kg mass a distance of 1.0 m in 60 s at constant velocity. Determine the efficiency of the motor.

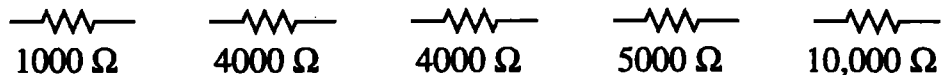
$$\text{Energy} = mgh = 0.012 \times 9.8 \times 1 = 0.1176 \text{ J}$$

but energy supplied is 0.18 J

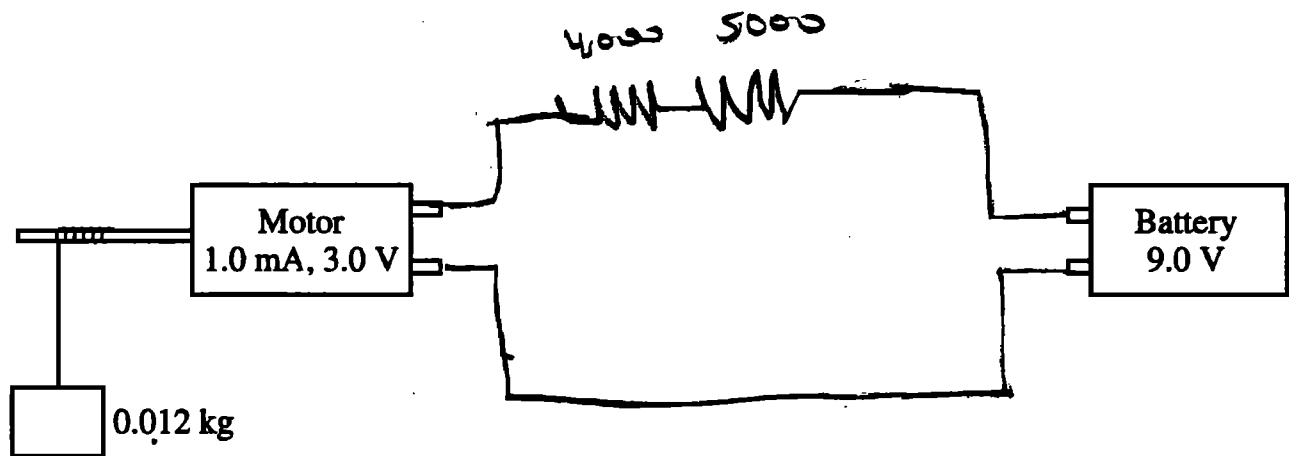
$$\text{efficiency} = \frac{0.1176}{0.18} \times 100 = 65.33\%$$

GO ON TO THE NEXT PAGE.

To operate the motor, the student has available only a 9.0 V battery to use as the power source and the following five resistors.



(d) In the space below, complete a schematic diagram of a circuit that shows how one or more of these resistors can be connected to the battery and motor so that 1.0 mA of current and 3.0 V of potential difference are supplied to the motor. Be sure to label each resistor in the circuit with the correct value of its resistance.



We need two resistors of (4,000 Ω and 5,000 Ω) in series to get a total of 9,000 Ω

$$V = IR$$

$$9 = (1.0 \times 10^{-3}) R$$

$$R = 9000 \Omega$$

GO ON TO THE NEXT PAGE.