No clickers & yes calculators.

Get the 22.2 notes Energy Transfer in Electric Circuits from the brown table.

Have out pg. 600 & 22.1 study guide.

Go to page 600 and do 17 - 21 all

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22.2 Using Electric Energy

Energy that is supplied to a circuit can be used in many different ways.
A motor converts electric energy to mechanical energy, and a lamp changes electric energy into light.

Unfortunately, not all of the energy delivered to a motor or a lamp ends up in a useful form.

Some of the electric energy is converted into thermal energy.
If a 100 W light bulb is 28 percent efficient, what does that mean? .28(100)

What percent is converted into thermal energy? .72(100)

Some devices are designed to convert as much energy as possible into thermal energy.

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Current moving through a resistor causes it to heat up because flowing electrons bump into the atoms in the resistor.

These collisions increase the atoms' kinetic energy and, thus, the temperature of the resistor.

A space heater, a hot plate, and the heating element in a hair dryer all are designed to convert electric energy into thermal energy. These and other household appliances act like resistors when they are in a circuit.

When charge, q, moves through a resistor, its potential difference is reduced by an amount, V.

The energy change is represented by qV.

In practical use, the rate at which energy is changed–the power, $P = E/t$–is more important.

Current is the rate at which charge flows, $I = q/t$, and that power dissipated in a resistor is represented by $P = IV$.

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For a resistor, $V = IR$.

Thus, if you know I and R, you can substitute $V = IR$ into the equation for electric power to obtain the following.

Power $$P = I^2R$$

Power is equal to current squared times resistance.

Thus, the power dissipated in a resistor is proportional to both the square of the current passing through it and to the resistance.

If you know V and R, but not I, you can substitute $I = V/R$ into $P = IV$ to obtain the following equation.

Power $$P = \frac{V^2}{R}$$

Power is equal to the voltage squared divided by the resistance.

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The power is the rate at which energy is converted from one form to another. Energy is changed from electric to thermal energy, and the temperature of the resistor rises.
If the resistor is an immersion heater or burner on an electric stovetop, for example, heat flows into cold water fast enough to bring the water to the boiling point in a few minutes.

If power continues to be dissipated at a uniform rate, then after time *t*, the energy converted to thermal energy will be $E = Pt$.

Because $P = I^2R$ and $P = V^2/R$, the total energy to be converted to thermal energy can be written in the following ways.

Thermal Energy

$$E = Pt$$
$$E = I^2Rt$$
$$E = \left(\frac{V^2}{R}\right)t$$

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Example 1:

A heater has a resistance of 10.0 Ω. It operates on 120.0 V.

a. What is the power dissipated by the heater?
b. What thermal energy is supplied by the heater in 10.0 s?

a) $P = I \cdot V$ or $\frac{V^2}{R} = \frac{120^2}{10} = 1.4 \times 10^3\,W$
1.44 kW

b) $E = P \cdot t = (1.44\,kW)(10\,s)$
14.4 kJ

Example 2:

A water heater operates at 240 V, and the resistance of its heating element is 12 Ω. How much current does it demand, and how much heat energy will it produce in 30 minutes?

$I = \frac{V}{R} = \frac{240}{12} = 20\,A$ $\quad 2 \times 10\,A$

$E = I^2 \cdot R \cdot t = 20^2 \cdot 12 \cdot 30 \cdot 60 =$
$8.6 \times 10^6\,J$
8.6 MJ

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Example 3:

A 100 W lightbulb is 34 percent efficient. This means the 34 percent of the electric energy is converted to light energy.

a. How many joules does the lightbulb convert into light each minute it is in operation?

b. How many joules of thermal energy does the lightbulb produce each minute?

100

a) $\mathcal{E} = .34(100)(1\,\text{min}) \cdot \frac{60\,\text{sec}}{1\,\text{min}}$

$2.04 \times 10^3\ \text{J}$

b) $\mathcal{E} = .66(100)(1\,\text{min}) \cdot \frac{60\,\text{sec}}{1\,\text{min}}$

$3.96 \times 10^3\ \text{J}$

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