Power: The Rate at which Energy is Used

* Rate at which ­ spend their energy when they encounter a load or resistance
* Depends upon two things.

1. The greater the \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ across a load, the \_\_\_\_\_\_\_\_\_\_\_\_\_ the \_\_\_\_\_\_\_\_\_\_\_\_ converted to heat and light.
2. The more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ passing through a load, the \_\_\_\_\_\_\_\_\_\_\_ the energy is converted.

* **Metric Units** - One \_\_\_\_\_\_\_\_\_\_\_ is a rate of converting one \_\_\_\_\_\_\_ of energy to another form per second. **P = E / t**

# **Power (Watts) = \_\_\_\_\_\_\_\_\_\_\_\_\_ (volts) x \_\_\_\_\_\_\_ (amperes)**

**P = V I**

**Practice Problem:** A current of 13.6 A passes through an electric baseboard heater when it is connected to a 110 V wall outlet. What is the power of the heater?

Efficiency

When we transfer energy from gas, wind, or water into \_\_\_\_\_\_\_\_\_\_\_\_\_, not all of the energy is transferred into electricity. A large portion is **lost** in the form of \_\_\_\_\_\_\_\_. This is also true when we transfer the electrical energy back into \_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_, or \_\_\_\_\_\_\_\_\_\_\_ energy to make our lights and appliances function.

Efficiency is a measure of how much comes out of a device, compared to how much \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_goes in.

Most appliances make use of only a portion of the input energy. Some appliances are better at using ­­­­­­­­\_\_\_\_\_\_\_\_ of the electrical energy that it receives. They are said to be more ­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

The joule(J) is a relatively small unit of electrical energy, so energy consumption is often measured in kilowatt.hours (kW.h), derived from the power formula

* Power = Energy/time
* Energy = Power(kW) x time(h)

We can calculate of an appliance or power plant by comparing the **energy output that is useful** with the **total energy input**.

|  |  |
| --- | --- |
| **Machine** | **Efficiency** |
| Electric heater | 99% |
| Home gas furnace | 85% |
| Wind generator | 60% |
| Nuclear power plant | 30% |
| Car engine | 26% |
| Fluorescent light | 20% |
| Silicon solar cell | 12% |
| Steam locomotive | 9% |
| Incandescent lamp | 2% |

**% Efficiency** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ x 100

**Practice Problem:**

Determine the % efficiency of a 60 W fluorescent light bulb that uses 2000 J of electrical energy to produce 400 J of light energy.

Where did the other go?

**Cost of Electricity**

All electricity entering your house or apartment is measured using a smart meter. A Smart meter measures the amount of energy entering your house as well as the time of day that it is being used. In Ontario we have different rates for electricity usage, depending on the season and time of day. When you use an electrical appliance or device, the energy passes through the meter first and is recorded for your bill. Electricity cost is billed as ¢ / kW.h (cents per kilowatt hour)

Cost to operate = energy used x cost of energy

Cost to operate = (power x time) x cost of energy

Practice Problem

Last summer the school changed from fluorescent bulbs to LED for the lighting of the school. Each of the old ceiling light fixtures had 4 fluorescent bulbs and were replaced with fixtures containing 2 LED’s which provides the same amount of light. Let’s calculate how much money the school will save in a year.

Assumptions:

Cost to run the old fluorescent bulbs

Cost to run the new LED bulbs

Savings per year

**Power Practice Problems:**

1. How much energy is used up by a 40 W bulb lift on for 45 seconds?
2. A 4 kW heater is operated for 30 seconds. How much energy is released?
3. A 2.2kW heater is left on for a week. How many Joules are expended?
4. A motor uses up 4000 J of energy in 20 seconds. What is the motor’s power?
5. Assume it takes Usain Bolt 4 seconds to reach his maximum speed (around 10 m/s). If his maximum energy at top speed is 55000 J, find his average power in getting to top speed.
6. How long would it take a 100 W light bulb to use up 8000 J of energy?
7. A portable hair dryer, plugged into a 110 V outlet, has a current of 10 A flowing through it. What is the power rating of the hair dryer?
8. A current of 0.50 A flows through a light bulb connected to a 110 V outlet. How much power is dissipated by this bulb?
9. A gasoline-powered generator consumes 15 000 J of energy in 5.0 min. How much power did it produce in this time?
10. A toaster connected to a 110 V power source has 6.0 A of current flowing through it. How much power is dissipated as heat?

**Answers:**

1)***1800 J*** 2)***120000 J*** 3)***1.33 x 109 J*** 4)***200 W*** 5)***13750 W*** 6)***80 sec*** 7)***110 W*** 8)***55 W*** 9)***50 W*** 10)***660 W***