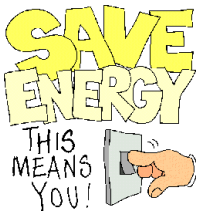
Electrical Energy Consumption



Calculating Power

Power can be calculated using the equation:

Where P= Power
V= voltage
I = current

$P = I \times V$

OR

Power is the amount of energy per unit time.

If P= power
E= energy
t= time

...another equation to calculate power would be:

$P = \frac{E}{t}$

We can also derive this second equation from the first one using the formulas for voltage and current from our previous note:

$R = \frac{V}{I} = \frac{10V}{2A} = 5V/A$

5Ω

note- the units on power (J/s) is often expressed as a watt since 1 J/s = 1 W

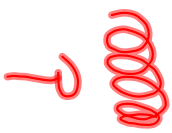
Power Ratings

- A power rating indicates how much electrical energy an appliance consumes.

- Power is measured in Watts, symbol W (1000 W= 1kW)

- Eg. A 60W bulb uses 60J of energy every second

- To find out how much energy an appliance has used we must consider the time it has been used for.



Calculating Power Consumption

Use the following formula to find the energy used: $E = P \times t$

Where E= Energy used (in kW·h)
P= Power (in kW)
t= time (in hours)

pay attention to the units

$t \times P = \frac{E}{t}(t)$

Sample Problem 1- Calculating Energy Consumption

A refrigerator has a power rating of 350 W. How much energy does the fridge use in a) one day and b) one year? Show all of your work using GRASP.

*Hint: to convert W into kW divide by 1000

a)

G: $P = 350\,W = .35\,kW$
$t = 1\,day = 24\,hours$

R: E

A: $E = P \times t$

S: $E = .35\,kW \times 24\,hrs = 8.40\,kW/h$

P: The refrigerator uses 8.4 kw/h of energy per day

Calculating Cost

The power company charges users based on the number of kW·h's used

The current rate in Ontario is about 9.5 cents for every kW·h used. (i.e. 9.5 ¢ per kW·h)

To calculate cost used the following formula

$$\text{Cost (in cents)} = \text{Energy Used (E) (in kW·h)} \times \text{cost per kW·h (in ¢ per kW·h)}$$

b)

G: $P = 350\,W \Rightarrow .35\,KW$
$t = 1\,year \Rightarrow 365\,days \times 24\,h = 8760\,h$

R: E

A: $E = P \times t$

S: $E = .35\,kW \times 8760\,h$
$= 3066\,kw/h$

P: The refrigerator uses 3066 kw/h of energy each year.

Sample Problem 2- Calculating Cost

If the power rating of a video game console is 0.10 kW, answer the following questions:

1) Calculate the energy consumption of the appliance if it is used for two hours. Use GRASP

G: P = 0.10 kW, t = 2 h
R: E
A: E = P × t
S: E = 0.10 kW × 2 h = 0.20 kW/h
P: Using the video game for 2 h would use .20 kW/h of energy

2) If the electricity rate is 8.8 ¢ per kW·h, how much would it cost (in cents) to run for two hours. ~~Use GRASP~~.

G: 8.8¢ cost per kW·h; .20 kw/h = E
Cost (in cents) = energy (kW·h) × cost (¢/kW·h)
R: cost
A: cost = energy × cost (¢/kw/h)
S: cost = .20 kw/h × 8.8 ¢ = $1.76
P: It costs $1.76 to play videos for 2 hrs.

Percent Efficiency

Most electrical devices convert electrical energy to some other form (light, heat, sound, movement of a motor…)

The energy conversion is never 100%, much energy is lost

The ability of a device to convert electrical energy (input) into useful energy (output) is called its "Percent Efficiency"

The formula for calculating percent efficiency is:

$$\% \text{ Efficiency} = \frac{\text{useful energy output (in J)}}{\text{total energy input (in J)}} \times 100$$

E: Cost = E × C(s ...
= .20 kw/h × 8.8
=

Sample Problem 3

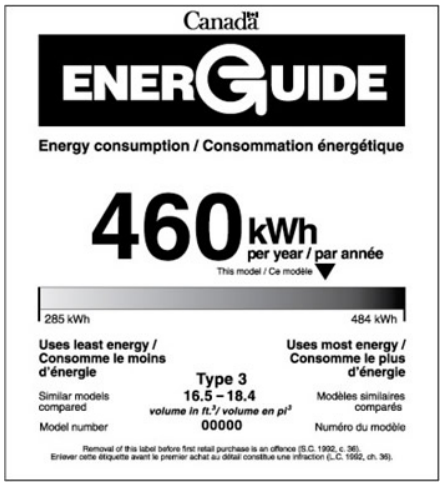
An electric kettle has a power rating of 1000 W. It takes the kettle 4 minutes to heat up a pot of water until it boils. If it takes 196 000 J of energy to heat the water, what is the efficiency of the kettle?

Part A- find energy used by kettle

Part B- find percent efficiency

*convert minutes into seconds

EnerGuide and Energy Star Labels



When buying an electrical device, it is important to consider both the price of the device and the cost of operating the device over time.

All household appliances are sold with the EnerGuide label (see image on the right) to help consumers make good choices about what appliances to buy.

Buying energy-efficient appliances can not only end up being more cost effective, but it can also be better for the environment since a large amount of our electrical energy generation is powered by burning fossil fuels. When we burn fossil fuels to generate electricity, harmful gases are released into the atmosphere which contribute significantly to global warming.

Homework- Complete the Energy Consumption Worksheet