

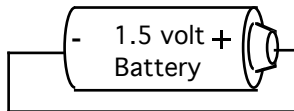
Current Electricity Basics Worksheet

Current Definition

1. 3.00 C of charge pass a point in a wire in 3.0 ms. How much current is this?
2. 3.00×10^{12} electrons pass a point in a wire in 0.0060 seconds. What is the current in the wire in amps?
3. How many electrons pass a point in a conductor in 1 second if the wire's current is 0.05 amps?

Ohm's Law

4. The fuse for a car radio is a thin wire. The wire is made to burn apart if the current is too high? What is the resistance of a fuse if it is to burn apart when 2.00 amps pass through it at 240 volts?
5. A light bulb is plugged into a wall outlet. It uses 0.68 A. What is the light bulb's resistance?
6. A flash light bulb is labeled to use 1.77 A. Its resistance is 1.60Ω . What voltage is the light bulb rated for?
7. A 1.5 volt battery is has a wire connecting its positive side to its negative side. The battery draws 0.10 amps of current. What is the resistance in the battery to create this current.



8. A flashlight light bulb is rated to take 2.83 Volts and use 0.300 amps. What is the resistance of the filament?
9. Another flash light bulb is rated to use 0.300 A and has a resistance of 4.0Ω . How much voltage does this bulb use?
10. A stereo speaker has a resistance of 8.00Ω . When it is operating at full power (exactly 100 watts) it uses 35 volts of electricity. What is the current drawn by the speaker?
11. A 100 watt light bulb draws 0.83333 amps from a wall outlet (120 volts). What is the resistance of the light bulb's filament?
12. A toaster plugged into the wall, (120 volts), uses 14 amps of electricity. What is the resistance of the toaster?
13. The thermostat in a house turns on and off the air conditioner and furnace using 24 volts. What is the current in the thermostat when it is turned on if it draws 0.100 amps?
14. A motor in a radio control car uses 7.2 volts and draws 14.4 amps of electricity. What is the resistance of the motor?
15. The volume knob on a radio varies the resistance on a line that goes to the speakers. At a low volume the resistance is $10,000 \Omega$. At a high volume the resistance is 10Ω . If the stereo maintains 35 volts into the speaker then, what are the two currents going into the speaker?

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- 16 When a battery “dies” the resistance inside the battery rises while the voltage it can produce almost always remains the same. A new 1.5 volt alkaline battery has a resistance of 0.15 ohms. an older battery may have a resistance of 15 Ω . how much current is drawn by a new and old battery?
- 17 The resistance of dry human skin is about 500,000 Ω and wet, sweaty, human skin is about 1000 Ω . How much current passes across someone’s fingers if they touch the leads of a 9 volt battery when their skin is wet or dry?
- 18 0.010 Amps causes involuntary muscle contractions. How much voltage is required to cause involuntary muscle contractions on wet and dry skin?

Power

- 19 A watch battery is produces a voltage of 1.5 volts. How much power is used by the watch if it draws 0.001 A?
- 20 A high tension power line carries 1,000,000 volts of electricity. If the line of to carry 200 A’s, then how power does the power line carry? What is the resistance of the power line?
- 21 A battery is rated at 1.5 volts. This battery can produce a maximum of 15 W of power.
- How much current can this battery produce?
 - What is the resistance of the wire attached to the battery ?
- 22 A stereo speaker is rated at 8 ohms and 40 watts. A fuse is going to be installed in the speaker. The fuse can only handle a certain amount of current at 240 volts. How much current does the fuse need to handle if it is to “blow” at 40 watts?
- 23 A radio control car uses 7.2 volts and 14 amps. How much power is used by the car?
- 24 What are the resistances of a 50, 100 and 150 watt light bulb that is plugged into a wall outlet , 120 volts?
- 25 A shorted out 12 V car battery can generate 4800 amps! (Never do this. a shorted out battery will explode.) What is the batteries resistance and how much power is generated by the battery before it explodes?
- 26 A hair dyer says it generates 1400 watts. It is plugged into a wall outlet, 120 volts. What is the current drawn by the hair dryer and what is its resistance?
- 27 On most home each circuit in a house can handle 15 amps at 120 volts. How much power is this? Will a 1400 watt hair dryer and four 75 watt light bulbs blow this circuit?
- 28 The heating element on a stove is connected to a 240 V outlet. The element draws 20 amps when it is turned on. What is the resistance and power of the element?
- 29 A motor on a band saw can generate $\frac{1}{2}$ horsepower on high. If the motor is plugged into a wall outlet, how much current will it require? (746 W = hp)

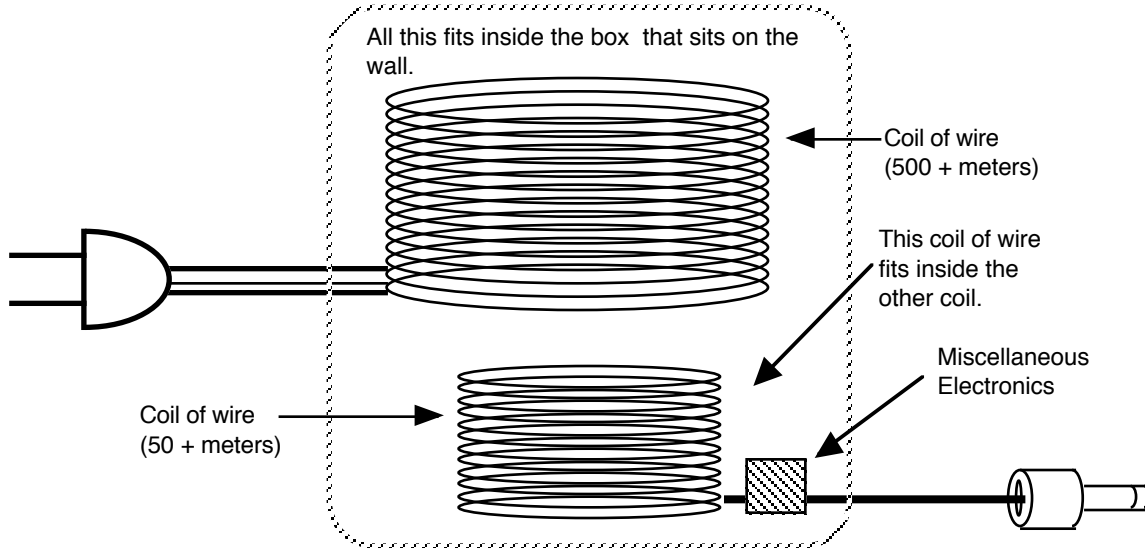
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- 30 The garbage disposal in a sink can generate $\frac{3}{4}$ horsepower. If the disposal is plugged into a wall outlet. How much current does it draw?
- 31 A small car can generate 95 hp. An equivalent electric vehicle is to be built such that it can generate the same power as its gasoline counter part. If the electric vehicle's motor uses 12 volts, then what is the resistance of the motor? What is the current drawn by the motor? How many charges are moved by the current if the car runs for 1 hour?
- 32 What is the current drawn by a household clock-radio using 12 watts?
- 33 A fan draws 0.184 amps while connected to a wall outlet. What is the power rating of this fan?
- 34 What is the current drawn by a hair dryer using 1500 watts?
35. What is the current drawn by car stereo that is connected to the car's 12.0 volt battery, if the car stereo draws 40 watts?
36. What is the battery voltage of a portable radio that draws 0.500 amps and is rated at 1.5 watts?
- 37 You've just invented a "Do-Hickie" that uses 3.0 volts and draws 3.0 amps. What is the power rating of your "Do-Hickie?"
- 38 What is the power rating of a household light bulb that draws 0.60 amps?
- 39 For the same fuse in problem #4, how much current would it take to burn apart the wire inside the fuse if it were connected to a 120 volt or a 12 volt source?
- 40 Stereo speaker is rated to take 100 watts. If the speaker's resistance is 8Ω , How much voltage is used by the speaker?
- 41 What is the power rating of a space heater that draws 9.6 amps while connected to a wall outlet?

Current Electricity Basics Worksheet

NOTES

The purpose of an adapter is to adapt the 120 volts from a wall to lower voltage that equals the batteries total voltage. This is done by two coils of wire wrapped around each other. One coil of wire has more turns than the other.



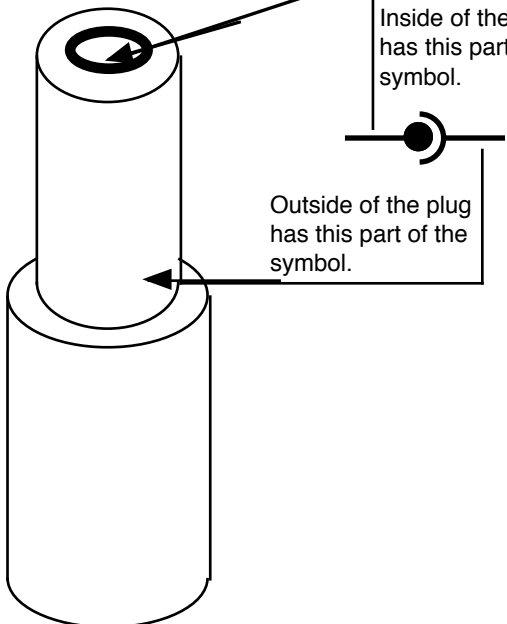
The voltage on the battery side of the adapter is determined by the sum of the voltages of all the batteries. For example; if a radio uses four 1.5 v batteries then the adapter would have to be rated at 6 volts AE ($1.5 \text{ v} + 1.5 \text{ v} + 1.5 \text{ v} + 1.5 \text{ v} = 6.0 \text{ v}$). If the adapter is less than 6 volts, then not enough energy will be supplied to run the radio. If the adapter is rated at more than 6 volts then electronics inside the radio can physically melt. The other variable to take into consideration when choosing an adapter is the current.

This is a question of supply and demand. The radio demands a specific amount of current. The adapter must be able to meet this demand. If the adapter cannot supply enough current then it overheats. This will cause it to do one of two things. (1) Get so hot the case melts -fire is a possibility. (2) The electronics inside the box melt. To summarize, the current rating on the adapter must meet or exceed the current needs of the device it is plugged into.

The plug and the appliance are polarized. the polarization of the device and the adapter must be identical. If they are backwards, its like putting the batteries in backwards. The device will not work.

At the top of the sheet are the symbols on various appliances. Which adapters below, if any, will run each device?

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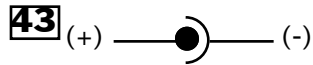
 <p>Inside of the plug has this part of the symbol.</p> <p>Outside of the plug has this part of the symbol.</p>	<p>This is the symbol you may see on the side of a device that can use an adapter.</p> <p>=====</p> <p>(-) —●— (+)</p> <p>The center of the adapter's tip is negative. The outside is positive.</p> <p>(+) —●— (-)</p> <p>The center of the adapter's tip is positive. The outside is negative.</p>
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Current Electricity Basics Worksheet

At the top of the sheet are the symbols on various appliances. Which adapters below, if any, will run each device?



Uses 5 batteries
(1.2 volts each)
0.4 A



Uses 2 batteries
(1.5 volts each)
0.8 A



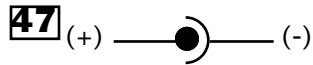
Uses 6 batteries
(1.5 volts each)
0.3 A



Uses 3 batteries
(1.5 volts each)
0.3 A



Uses 9 batteries
(1.5 volts each)
0.4 A



Uses 10 batteries
(1.2 volts each)
0.25 A



Uses 2 batteries
(1.5 volts each)
0.2 A



Uses 4 batteries
(1.5 volts each)
0.1 A

120 v AC
6 v DC/0.5 A
[center positive]
-A-

120 v AC
3 v DC/0.9 A
[center negative]
-B-

120 v AC
9 v DC/0.4 A
[center negative]
-C-

120 v AC
9 v DC/1.0 A
[center negative]
-D-

120 v AC
1.5 v DC/1.2 A
[center negative]
-D-

120 v AC
12 v DC/0.8 A
[center positive]
-E-

120 v AC
9 v DC/0.2 A
[center positive]
-F-

120 v AC
1.5 v DC/0.3 A
[center negative]
-G-

120 v AC
12 v DC/0.8 A
[center positive]
-H-

120 v AC
6 v DC/0.1 A
[center negative]
-I-

120 v AC
4.5 v DC/1.5 A
[center negative]
-J-

120 v AC
9 v DC/0.7 A
[center positive]
-K-

120 v AC
3 v DC/0.7 A
[center positive]
-M-

120 v AC
9 v DC/0.6 A
[center positive]
-N-

120 v AC
3 v DC/0.2 A
[center negative]
-O-

120 v AC
12 v DC/0.6 A
[center positive]
-P-

120 v AC
3 v DC/0.9 A
[center positive]
-Q-

120 v AC
9 v DC/1.2 A
[center positive]
-R-

120 v AC
3 v DC/0.1 A
[center negative]
-S-

120 v AC
9 v DC/0.3 A
[center negative]
-T-

120 v AC
9 v DC/0.3 A
[center negative]
-U-

120 v AC
9 v DC/0.4 A
[center positive]
-V-

120 v AC
6 v DC/0.5 A
[center negative]
-W-

120 v AC
3 v DC/0.5 A
[center negative]
-X-

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BATTERY NOTES

Battery Type	Voltage per Cell	Typical Charge in Amphrs	Recharge Notes	Maximum Current Output in amps	Notes
Zinc Carbon	1.5	4.00000000e-2	Can't Recharge	1	Only good for cheap flashlights
Alkaline	1.50000000e+0	4.00000000e-1	Can't Recharge (Except for a few special types)	10	Good for high current uses (walkmans, toys etc)
Ni-Cad	1.20000000e+0	1.20000000e+0	Recharge 100-500 times	10	Good for high current uses
Lithium	1.50000000e+0	1.20000000e+0	Can't Recharge	10	Longest shelf life (10 yrs)
Lead Acid	2	5-50	Recharge 100's to 1000's of times	2000	Super high current drains, Great rechartable

BATTERY CHARGING & BATTERY LIFE

50. A 12.6 Volt motorcycle battery can provide 5 Amp-hours of use. The headlight on a particular motorcycle is rated at 75 watts. The headlight on this motorcycle is left on while it is parked. How many hours will pass before the battery is "dead?"
51. The batteries in a radio control toy are rated at 1.2 Amp-hours (1200 mA•hr). The battery's voltage output is a constant 7.2 volts. If the car's motor draws 7.2 Amps from the battery, how many minutes will it take to completely discharge the batteries? How much power is the car's motor using?
52. A flashlight uses 5 Ni-Cad batteries. The Ni-Cad batteries are rated at 1.2 Amp-hours total. If the light bulb is rated at 6 watts and 6.0 volts, then how much current does the light bulb draw and how long will the batteries last?
53. A battery has a charge value of 1.2 A•hrs. If the battery is connected to a motor that draws 2.0 amps, then how many hours will the battery last?
54. A 12 volt motorcycle battery has a charge value of 5 A•hrs. If a light lasts for 25 hours when connected to this battery, then how much current is being drawn by the battery?
55. A 1.2 Volt rechargeable battery has a charge value of 1.5 A•hrs. If it is connected to a charging source that delivers 4 Amps, then how long will it take to recharge the batteries?
56. What is the value of the charge rating on a 3 volt battery that takes 1.2 hours to recharge if the charging device delivers 2 amps?
57. What is the charge value on a watch battery the lasts for 1 year if it draws 0.003 amps?
58. A car battery has a charge rating of 5 A•hrs. If the car takes 400 A's to turn the ignition motor on the car, then how many seconds of can the starter be on until the battery dies?
59. The resistance of dry human skin is 500,000 ohms. If a person with dry skin held on to the battery, how long would it take for the 1.5 Volt battery to completely discharge? The charge rating of the battery is 1.2 A•hrs.

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- 60 A flashlight is connected to a voltage source of 6 volts. The light bulb has a resistance of 8.5Ω . If a battery has a charge rating of 1.5 A•hrs, then how long will the battery last?
- 61 A motor in a radio controlled car can last for 8 minutes of a 7.2 volt battery pack. The battery pack has a charge rating of 1.2 A•hrs. What is the resistance of the car motor?
- 62 A cassette player draws 0.10 amps from the batteries. The combined voltage of the batteries is 6 volts. The cassette player lasts for 10 hours before the batteries go dead. What is the charge rating on the batteries?
- 63 If held between 2 fingers, a certain 1.5 Volt battery will last for 170 days before going dead. What is the resistance of this person's skin? (The battery has a charge of 1.2 A•hrs)
- 64 A package of good alkaline batteries is about \$0.55 per battery, on sale. If the charge rating of this 1.5 volt battery is 1.2 A•hrs, then what is the cost/kW•hr if it is connected to a light bulb with a resistance of 8.5Ω ? What is the cost/kW•hr if it is connected to a light bulb of resistance 17Ω ?
- 65 An "Indy" race car can generate 1000 hp. Death Wish Hershey is trying to make an electric race car. To make this car he is going to use regular 12 volt car batteries. These batteries can safely produce 14,400 W. How many batteries will it take to create an equivalent horsepower? A car battery has a charge rating of 30 Amp•hrs, how long will one battery last if it produces 14,400 w?
- 
- 66 A motor can lift a 10.204 kg mass 2 meters in 10 seconds. What is the horsepower of this motor? If the motor is connected to a 12 volt battery then how much current is drawn by the motor?

Electrical Work and Power

- 67 Below is a wire connected to the terminals of a battery. The wire poses no resistance, or friction, to the motion of the charges. The battery has a potential difference of 6.0 volts. 1,000,000 electrons travel from one terminal of the battery to the other in 0.001 seconds. How much electrical work is done on moving the charges between the battery poles?
- 68 A wire is connected to the terminals of a battery. The wire poses no resistance, or friction, to the motion of the charges. The battery has a potential difference of 1.5 volts. 1,000,000,000,000 electrons travel from one terminal of the battery to the other in 0.02 seconds. How much electrical work is done on moving the charges between the battery poles?
- 69 Suppose in problem number 3 that the length of wire that the electrons travel through is 10 centimeters long. What average force moves the electron through the circuit?
- 70 What supplies the force to move the electrons through the wire?
- 71 How much power is used in moving the electrons through the wire in both problem #1 and #2?
- 72 A battery bought from the store is rated at 9.0 volts on the side of the battery? What is the potential difference of the battery?
- 73 A 12 volt battery is connected to a motor that is connected to a motor that is used to lift a ball from rest. The ball's mass is 0.1 kg. When the motor is turned on it will draw 2.4 amps from the battery. The motor is on for 20 seconds.
- How much power is used by the motor?
 - How much power is used in raising the ball?

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- c. How much work is done by the motor?
d. How high is the ball raised?
- 74 A 6.0 volt battery is connected to a motor that is connected to a motor that drags a block from rest across the ACME friction less surface. (Patent pending by Wiley Coyote). The block's mass is 1.0 kg. When the motor is on it draws 4.5 amps from the battery. The motor is only on for 30 seconds at a time. In "real life" motors are not perfect convertors from electrical work to mechanical (lifting, sliding, spinning, etc.) work. In the case of this motor only 40 percent of the electrical work is converted into mechanical work.
- a. How much power is used by the motor?
b. How much work is done by the motor?
c. If the motor pulls with an average force of 2.5 newtons, then how far will the block be dragged?
d. What will be the block's final speed?
- 75 ACME has invented the "Bug's Bunny Buggy." It's an electric car. The car that uses 12 volts. The vehicle's motor draws 20 amps when the car is moving at a constant speed of 24.6 m/s (55 mph). The car has a 80 percent conversion efficiency from electrical work to mechanical work. Unfortunately the car only runs for 3 hours at this speed. (HINT: $P=Fv$)
- a. How much power is used by the motor?
b. How much work is done by the motor?
c. What average force is applied by the car for it to travel at 55 mph?
d. What distance is covered by the car in the 3 hours? (Calculate using work relationships).

Power Smart Tips for Appliance Use

Cooking

- Use your microwave oven whenever possible to reduce cooking time and costs.
- Cook by time and temperature, following cooking instructions. Avoid opening oven door or lifting pot lids, which release heat and wastes energy.
- When cooking on the range, lower the temperature setting once the food has heated. It will continue to steam or boil if you use tight-fitting lids.
- Don't preheat the oven or broiler, except when baked goods require a precise starting temperature.

Clothes dryer

- Dry full loads only. Don't use the dryer for just one or two items.
- Dry loads consecutively. This takes advantage of built-up heat.
- On nice days, consider using a clothesline to dry your clothes.

Clothes washer

- Wash full loads only.
- Use warm water instead of hot for washing whenever possible, and cold for rinsing.

Dishwasher

- Use only for full loads.

Current Electricity Basics Worksheet

- Turn off the dishwasher or use the "energy switch" if you have one, and let the dishes dry naturally.

Refrigerator

- Clean the coils in the back of the refrigerator, or near the floor at the front, at least once a year.
- Do not allow ice to build up more than 6 mm on manual defrost refrigerators.

Electrical Cost and Usage

A wall outlet has a potential difference of 120 volts for these problems.

Cost of Electricity and Electrical Work

\$0.16

For the following problems electricity costs $\frac{\$0.16}{\text{kWh}}$ (A high rate.)

76. The electric company charges for the electrical work they do in supplying your energy needs. If the electric company charges \$0.005 for every watt•second used then how much would it cost to run a 40 watt light bulb for 5 minutes?
77. In reality the unit of electrical work the electric company uses is called a KilloWatt•Hour, (abbreviated kWhr). Virginia Power charges \$0.16 for every kWhr used in the winter and early spring. How much does it cost to run a 40 watt light bulb for 5 minutes? ...for 5 hours? ...for 5 days?
78. You are in charge of analyzing the cost of installing security lighting on a house. The security lights consists of three 150 flood lights. Two options are available: (1) leave the lights on for an average of 12 hrs a night for 30 days. (2) Use a motion detector that runs the lights an average about 36 minutes a night. How much will each increase the household bill of electricity?
79. How much will it cost to run a 75 watt light bulb, that is plugged into a wall outlet for 12 hours?
80. A hair dryer uses 1250 watts. If electricity costs \$0.16 / (kW•hr), then how long can the hair dryer run before it uses up \$0.01.
81. A television uses 120 watts. If electricity costs \$0.16 / (kW•hr), then how long can the television run before it uses up \$0.01.
82. A toaster uses 1400 watts and takes 2 1/2 minutes to cook a piece of bread. If electricity costs \$0.16 / (kW•hr), then how many pieces of bread can be cooked for \$0.05.
83. A 75 watt light bulb is plugged into the wall outlet.
 - How much current does the light bulb draw?
 - How much electrical work is done in 1/2 hour?
84. How much power is used by small black and white TV that draws 0.35 amps at 120 volts AND how much electrical work is done in having the TV on for 3 hours?
85. A 40 watt curling iron is plugged into the wall.
 - How much current does the curling iron draw?
 - How much electrical work is done in 1/2 hour?
86. A "35 watt" stereo run at full volume may draw 195 watts from the wall outlet.
 - How efficient is this stereo at converting electrical power to "audio" power at full volume?
 - What current is the stereo drawing from the wall at full volume?
 - How much electrical work is done in running the stereo for 1 hour at full volume?

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87. If the stereo in problem #4 is run at "half-volume" it will use 136.5 watts from the wall outlet.

- How efficient is this stereo at converting electrical power to "audio" power at half-volume?
- What current is the stereo drawing from the wall at half-volume?
- How much electrical work is done in running the stereo for 1 hour at half-volume?

The electric company charges for the amount of electrical work they do in moving electrons through the appliances in a house. Instead of using the units of (watt)(second), [Ws], they use the unit of (kiloWatt)(hour), [kW].

For the problems above convert the power rating on the appliances to kilowatts.

For the problems above convert the electrical work rating on the appliances to kW·hr.

If the electric company were to charge (11 cents) per kW·hr used, then how much would is cost to run each appliance above?

88.

Fill in the missing information on the table below.

This table calculates the electrical work in kilowatt-hours.

It then estimates the cost for the time period expressed based on the rate of 12 cents per kilowatt-hour.

$$\text{COST} = (\text{power, in kW})(\text{time, in hrs})(\text{price}/(\text{kW-hr}))$$

--ITEM--	POWER in (watts)	TIME of use in a day (minutes)	ELECTRICAL WORK kilowatt- hours	COST for an hour's usage	COST for a day's usage	COST for a week's usage	COST for a month's usage	COST for a year's usage
Alarm clock	A	1440	.0020	\$.00024	\$.01	\$.04	B	\$2.11
Clock radio	5	1440	.0050	C	\$.01	\$.05	\$.22	D
BW TV (13")	160	180	E	\$.01920	E	\$.20	\$.87	\$10.53
Color TV (19")	360	180	.0450	\$.04320	\$.06	\$.45	G	\$23.70
"Star View" TV Bx	500	H	I	\$.06000	\$.09	\$.63	\$2.71	\$32.92
VCR (on)	21	210	.0031	J	\$.00	\$.03	\$.13	\$1.61
Stereo Receiver	K	240	.0317	\$.02280	\$.05	\$.32	L	\$16.68
Turntable	3	M	.0005	\$.00036	\$.00	\$.01	\$.02	\$.26
Cassette Deck	13	240	N	\$.00156	\$.00	\$.02	O	\$1.14
Equalizer	12	240	.0020	P	\$.00	\$.02	\$.09	\$1.05
CD Player	23	240	Q	\$.00276	\$.01	\$.04	\$.17	\$2.02
Light bulb 1000w	1000	210	.1458	\$.12000	\$.21	\$1.47	\$6.31	\$76.80
Light bulb 100w	100	210	.0146	\$.01200	\$.02	\$.15	\$.63	\$7.68
Light bulb 75w	R	210	.0109	\$.00900	\$.02	\$.11	\$.47	\$5.76
Toaster	1776	10	.0123	\$.21312	\$.02	S	\$.53	\$6.50
Microwave Oven	1000	T	.0069	\$.12000	\$.01	\$.07	\$.30	\$3.66
Refrigerator	1440	20	.0200	U	\$.03	\$.20	\$.87	\$10.53