Physics - Current Electricity
Problem Set 2 - Power (P=IV)

Key

Name:
Date:

1. Determine the amount of electrical energy (in J) used by the following devices when operated for the indicated times.

$P = E/\Delta t$

$1W = 1J/1s$

a. Hair dryer (1500 W) - operated for 5 minutes

a) $P \times t = E$
1500×300
$4.5 \times 10^5 J$

b. Electric space heater (950 W) - operated for 4 hours

b) $P \times t = E$
$950 \times 14400 =$
$1.4 \times 10^7 J$

4 hrs $\frac{60}{1hr}$ $\frac{60s}{1m}$

c. X-Box video game player (180 W) - operated for 2 hours

c) $P = 180W$
$t = 2hr$
$= 7700s$
$= 1.3 \times 10^6 J$

d. 42-inch LCD television (210 W) - operated for 3 hours

d) $P = 210W$
$t = 10800s$
210×10800
$= 2.3 \times 10^6 J$

2. Having recently lost her job, Penny Penching is looking for every possible means of cutting costs. She decides that her 4.0-Watt clock radio alarm does not need to be on for 24 hours every day since she only needs it for waking up after her average 8-hour sleep. So she decides to plug it in before going to sleep and to unplug it when waking. Penny pays 12 cents per kiloWatt•hour for her electricity. How much money is Penny able to save over the course of a month (31 days) with her new alarm clock usage pattern?

Old usage

$P = 4W = .0004 kW$
$t = 24hr$
$= .096 kW \cdot hr$

rate = $0.12/kWhr
$= \$0.012$
$\times 31 = \$.36$

New
$\$.00384 \times 31 = \$0.12$

$.36 - .12 = \$.24$ Savings

3. The power of a 1.5-volt alkaline cell varies with the number of hours of operation. A brand new D-cell can deliver as much as 13 A through a copper wire connected between terminals. Determine the power of a brand new D-cell.

$P = ?$
$V = 1.5V$
$I = 13A$

$P = IV = 19.5W$

4. A central air conditioner in a typical American home operates on a 220-V circuit and draws about 15 A of current.

a. Determine the power rating of such an air conditioner.

a) $V = 220V$
$I = 15A$
$P = ?$
$P = IV$
3300W

b. Determine the energy consumed (in kW•hr) if operated for 8 hours per day.

b) $P = 3300W$
$= 3.3kW$
$t = 8 hrs$
$e = 26.4 kWhr$

c. Determine the monthly cost (31 days) if the utility company charges 13 cents per kW•hr.

c) $.13/kWhr
$t = 31 days$
$P = 26.4 kWhr$
$(\$ = .13)(26.4)(31)$
$= \$106$

5. During the Christmas season, Sel Erbate uses the equivalent of 45 strings of 100 mini-bulbs to light the inside and outside of his home. Each 100-bulb string of lights is rated at 40 Watts. The average daily usage of the strings is 7 hours. The lights are used for approximately 40 days during the holiday season.

a. Determine the resistance of each string of lights. Each is powered by 110-volt outlet.

b. Determine the energy consumed (in kW•hr) by the lights over the course of 40 days.

c. If Sel pays 12 cents/kW•hr for electrical energy, then what is the total cost of Christmas lighting for a single season?

a) $P = 45 \times 40 = 1800\,W$

$P = IV \quad I = 16.4\,A$

$V = IR \quad R = 6.7\,\Omega$

$\div 45 = 0.15\,\Omega$ each

b) $P = 1800\,W = 1.8\,kW$

$t = 7\,hrs \times 40\,days$

$= 500\,kWh$

c) $500\,kWhr \cdot \$.12$

$= \$60$

6. Alfredo deDarke sleeps with a 7.5-Watt night light bulb on. He turns it on before getting in bed and turns it off 8 hours later.

a. Determine the amount of energy used during one evening in units of kiloWatt•hours.

b. Electrical energy costs 13 cents/kW•hr where Alfredo lives. Determine the annual (365 days) cost of this practice of using a 7.5-Watt night light.

c. Determine the annual savings if Alfredo replaced his 7.5-Watt incandescent night light by a 0.5-Watt LED night light.

a) $P = 7.5\,W = .0075\,kW$

$t = 8\,hr$

$= .06\,kWhr$

b) $0.06 \times 365\,d$

$= 21.9\,kWhr \times .13$

$= \$2.85$

c) $\frac{.5}{7.5} = .067\%$

6.7%

$2.85 \times 6.7\%$

$\$.19$

$\$2.65$ savings

Answers:

1. a. 4.5x105 J
   b. 1.4x107 J
   c. 1.3x106 J
   d. 2.3x106 J
2. 24cents
3. 20 W
4. a. 3300 W
   b. 26 kW•hr
   c. $110 per month (rounded from $106)

5 a. $3 \times 10^2\ \Omega$ (rounded from 302.5 Ω)

b. 5×10^2 kW•hr (rounded from 504 kW•hr)

c. $60 (rounded from $60.48).

6. a. 0.060 kW•hr for one evening
   b. $2.8 for one year
   c. $2.7 savings for one year