Lesson 2 Joule's Law Homework Solutions

Exercises
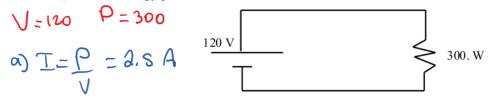
1. A 120 V source is connected to a 300. W resistor. Find
   a) the current
   b) the resistance
   c) the heat energy produced in 20. minutes

$P = VI$

$V = IR$

$V = 120$ $P = 300$

120 V   300. W

a) $I = \dfrac{P}{V} = 2.5\ A$

b) $R = \dfrac{V}{I} = \dfrac{120}{2.5} = 48\ \Omega$ (2.5A; 48 Ω; 3.6×10⁵J or 0.10 kWhr)

c) $P = \dfrac{E}{t} \rightarrow E = Pt = (300)(20 \times 60) = 3.6 \times 10^5\ J$

2. A 120. V source is connected to a 1500. W kettle. Find
   a) the current
   b) the resistance
   c) the energy (in kWhr) used in a day
   d) if energy costs 5.20 cents per kWhr, how much would it cost to run the kettle for a day
   (12.5 A; 9.60Ω; 36.0 kWhr; $1.87)

$P = 1500$

$V = 120$

a) $I = \dfrac{P}{V} = \dfrac{1500}{120} = 12.5\ A$

b) $R = \dfrac{V}{I} = \dfrac{120}{12.5} = 9.6\ \Omega$

c) $P = \dfrac{W}{t} \rightarrow E = Pt = (1500)(24 \times 60 \times 60) = 1.296 \times 10^8\ J$

$= \dfrac{1.296 \times 10^8}{3.6 \times 10^6} = 36\ kwh$

d) $price = (36)(.052) = \$1.87$

3. A 220. Watt computer is connected to 110. volts of alternating current and left on all month. Find
a) the resistance   b) current c) energy used per 30 day month
d) cost of electricity (5.50 cents/ kWhr) (55.0Ω;2.00A; 158 kWhr; $8.71)

a) $P = \dfrac{V^2}{R} \rightarrow R = \dfrac{V^2}{P} = \dfrac{110^2}{220} = 55.0\ \Omega$

b) $I = P$ $\dfrac{220}{?} \approx ? \cap A$

$\dfrac{}{V} = \dfrac{}{110} = 2.0 \text{ A}$

c) $E = Pt = \dfrac{(220)(30)(24)(60)(60)}{3.6 \times 10^6} = 158.4 \text{ kWh}$

d) price $= (158.4)(.055) = \$8.71$

4. It takes 10.0 kJ of energy to cook a hot dog. If a 30.0 ohm hot dog is connected to 120. volts, how long will it take until it is cooked?　　　(20.8 sec)

$t = ?$　　$E = 10,000 \text{ J}$　　$R = 30$　　$V = 120$

$P = \dfrac{E}{t} \rightarrow t = \dfrac{E}{P} = \dfrac{E}{\left(\dfrac{V^2}{R}\right)} = \dfrac{10000}{\left(\dfrac{120^2}{30}\right)} \boxed{= 20.8 \text{ s}}$

By the way: a really cool website to look at . . . Do a google search for "Unwise Microwave Oven Experiments". <u>DON'T TRY THE EXPERIMENTS YOURSELF AT HOME</u>

5. Which of the following is the best definition of current?

A. the number of charges stored in a cell.
B. the amount of energy given to a charged object.
C. the charge passing a point in a circuit in a given time.
D. the resistance to the flow of charged particles in a circuit.

$I = \dfrac{Q}{t}$

6. A 12 V battery transfers 45 C of charge through a light bulb in 5.0 seconds. (a) What current flows through the circuit? (b) What is the resistance of the light bulb? (c) What is the power used by the light bulb?

Ans: (a) 9.0 A　　(b) 1.33 Ω　　(c) 108 W

a) $I = \dfrac{Q}{t} = \dfrac{45}{5} = 9.0 \text{ A}$　　b) $R = \dfrac{V}{I} = \dfrac{12}{9} = 1.33 \, \Omega$

c) $P = VI = (12)(9) = 108 \text{ W}$

7. A 6 V battery transfers 24 C of charge through a light bulb in 16 seconds. (a) What current flows through the circuit? (b) What is the resistance of the light bulb? (c) What is the power used by the light bulb?

Ans: (a) 1.5 A　　(b) 4.0 Ω　　(c) 9.0 W

a) $I = \dfrac{Q}{t} = \dfrac{24}{16} = 1.5 \text{ A}$

a) $I = \dfrac{Q}{t} = \dfrac{24}{16} = 1.5 \, A$

b) $R = \dfrac{V}{I} = \dfrac{6}{1.5} = 4.0 \, \Omega$

c) $P = VI = 6(1.5) = 9.0 \, W$

8. A electric motor with a constant resistance draws 0.60 A when connected to a 4.8 V power source. The motor is now connected to a 9.0 V power source. What is the new current and the power use for the motor?

Ans: I = 1.13 A, P = 10.1 W

$\underline{4.8 \, V}$

$R = \dfrac{V}{I} = \dfrac{4.8}{.6} = 8.0 \, \Omega$

$\underline{9.0 \, V}$

$R = \underline{8.0 \, \Omega} \quad V = 9.0 \, V$

$I = \dfrac{V}{R} = \dfrac{9}{8} = \boxed{1.125 \, A}$

$P = VI = 9(1.125)$

$\boxed{P = 10.1 \, W}$

9. A 120 V supply is connected to a heater of resistance 25 Ω. (a) How much power will it use? (b) What must be the resistance of another heater to produce the same power output when connected to a 240 V supply?

Ans: (a) 576 W (b)

a) $P = \dfrac{V^2}{R} = \dfrac{120^2}{25} = 576 \, W$

b) $R = \dfrac{V^2}{P} = \dfrac{240^2}{576} = 100 \, \Omega$

10. A 24 V supply is connected to a 15 Ω for 3 minutes. How many coulombs of charge pass through the resistor?

Ans: 288 C

$I = \dfrac{Q}{t} \rightarrow Q = I \, t$

$Q = \left(\dfrac{V}{R}\right) t = \left(\dfrac{24}{15}\right)(180) = 288 \, C$

11. Which of the following electric devices has the greatest rate of energy consumption?

ITEM	VOLTAGE		CURRENT
Video Camera	6.0 V	1.2 W	0.20 A
Radio	4.5 V	2.25 W	0.50 A
Smartphone	3.0 V	1.8 W	0.60 A
Fan	120 V	3 W	0.025 A

Fan	120 V 3 W	0.025 A

$P = V I$

(Answer: Fan with 3.0 W)