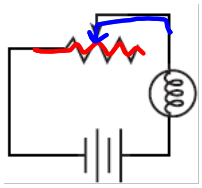
Simple Circuits and Schematics

Variable Resistor : a resistor whose resistance can be deliberately controlled/changed (rheostat). If there are 3 terminals, it is called a potentiometer (pot).

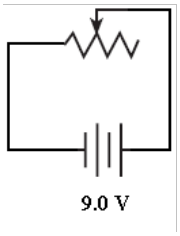
Also called: potentiometer – rheostat

7. What are some common uses for a variable resistor?
volume knob, dimmer switch

8. If the resistance in the circuit is increased, what will happen to the brightness of the lamp? Why?



9. If the resistor is set to 100 ohms, what is the current in the circuit?



Electrical Power and Energy

Power: rate at which work is done – rate at which energy is used/dissipated

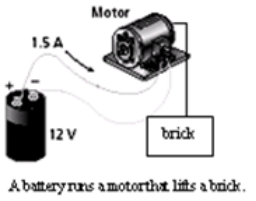
Mechanical	Electrical
$P = W/t = F \cdot d/t$ [J/s]	$V = E/q$ [J/C]
$P = F \cdot v_{avg}$ [W]	$I = q/t$ [C/s]
	$V = IR$
	$P = IV$ [W] [J/s] [V·A]

Electrical Power

P = $IV = I^2R = V^2/R$ Units: [W]

Electrical Energy

W = $Pt = IV \cdot t = I^2R \cdot t = V^2/R \cdot t$ Units: [J]



A battery runs a motor that lifts a brick.

Electrical Power and Energy

1. A mini light bulb is connected to a 1.5 volt battery and draws a current of 28 mA.

a) How much power does it dissipate?

$P = IV = .028A \cdot 1.5V$

$= 42mW$

b) How much energy does the light bulb use in 1.0 minute?

$P \cdot t = 42 \times 10^{-3} J/s \cdot 60s$

$\sim 2.5J$

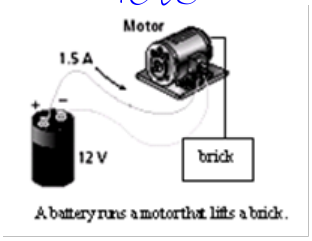
Electrical Power and Energy

2. Refer to the drawing above of a motor lifting a brick. 18w

a) How fast can the motor raise a 2.0 kg brick? 20N

$P = F \cdot v = IV$

$v = IV/F = \frac{18w}{20N} = .9 m/s$



A battery runs a motor that lifts a brick.

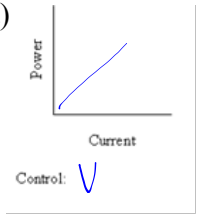
b) How much energy will the motor use in 10.0 seconds?

$E = P \cdot t = 18w \cdot 10s = 180J$

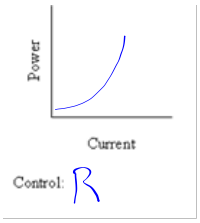
Electrical Power and Energy

3. Sketch each of the following relationships. Determine the type of relationship and the significance of the slope.

a)

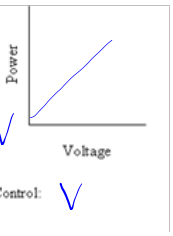


$P = IV$

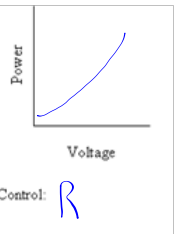


$P = I^2R$

b)



$P = IV$



$P = \frac{V^2}{R}$

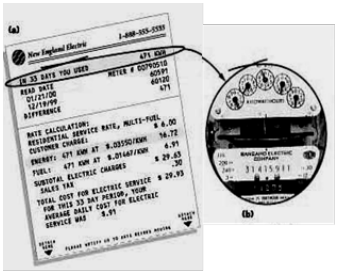
c)

$P = V^2/R$

$P = I^2R$

4. If the resistance of an appliance attached to a constant source of voltage is doubled, how much power does it now dissipate?

5. The electric meter connected to a house is marked "kilowatthours." The electric bill lists a charge to the homeowner for using 471 KWH (kWh) for the month. What is being measured in kilowatthours?



Kilowatt-hour (kWhr):

$1000\ W$

$1000\ J/s \cdot 3600\ s = 3.6 \times 10^6\ J$

Electrical Power and Energy

6. How many joules of energy are equivalent to one kilowatt-hour?

7. Determine the energy cost for the consumer whose bill is shown above. (471 kWh)

8. a) How much energy is used lighting a 60. W bulb for 4.5 hours? Answer in joules and kilowatt-hours.

60 J/s · 4.5 · 3600 s = 9.4×10^5 J

.06 kW x 4.5 hr = .27 kWhr

b) How much will this cost if the energy is billed at $0.03550 per kWh?

9. A DC power charger is marked as "5.0 V 3.5VA."

a) What quantity if being measured as 3.5 VA?

power

b) How much current does the charger use?

$P = IV$

$(3.5VA) = I \cdot (5V)$

$I = .7A$

10. A resistor is marked as 270Ω with a power rating of 0.50 W.

a) What is the maximum current this resistor can safely handle?

$P = I^2R$

$I_{max} = \sqrt{P/R} = \sqrt{.5w/270\Omega} = .043A$

b) What will happen if there is more current than this maximum amount in the resistor?

11. A cell phone battery is marked as "90 mA h 12V 1.08 Wh."

a) what quantity is being measured as 90 mAh?

$I = q/t$ $\quad (I)(t)$

$90 \times 10^{-3}\ C/s \times 3600\ s = 324\ C$

Capacity: charge stored in a battery

A battery whose capacity is 90 mA h means that before it "dies" and needs recharging you can run it:

at 90 mA for 1 hour or

at 45 mA for 2 hours or

at 9 mA for 10 hours, etc.

b) Determine how much energy is stored in the battery.

$V = E/q \rightarrow E = q \cdot V$

$(324\ C)(12\ J/C) = 3888\ J$

$1.08\ whr$

$.00108\ Kwhr$

12. A cell has a capacity of 1400 mA h. Calculate the number of hours for which it can supply 1.8 mA.