$P = \frac{E}{t} = IV \quad [J/s] = [W]$

$I = q/t \quad [A] = [C/s]$

$V = E/q \quad [V] = [J/C]$

$V = IR$

Electrical Power and Energy

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

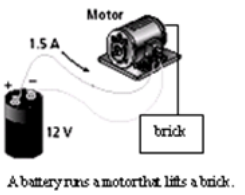
Mechanical	Electrical
$P = \frac{W}{t} = \frac{Energy}{t} = F \cdot \bar{v}$	$P = I \cdot V$
$[J/s] = [W]$	$[C/s][J/C] = [W]$

$V = IR$

$P = IV$
$V = IR$

Electrical Power

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



A battery runs a motor that lifts a brick.

Electrical Energy

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

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?

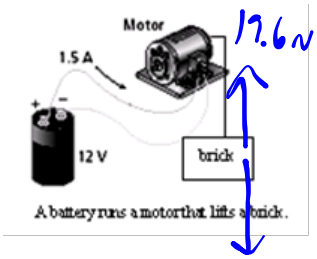
$P = IV = .028A \cdot 1.5V = .042W$

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

$E = P \cdot t = .042W \cdot 60s = 2.5J$

Electrical Power and Energy

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



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

$P = IV = F \cdot \bar{v}$

$1.5A \cdot 12V = 19.6N \cdot \bar{v}$

$\bar{v} = .9 m/s$

$18W$

$19.6N$

$mg = 19.6N$

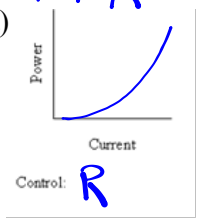
b) How much energy will the motor use in 10.0 seconds?

$E = Pt = 18W \cdot 10s = 180J$

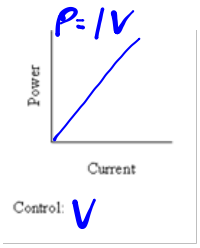
Electrical Power and Energy

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

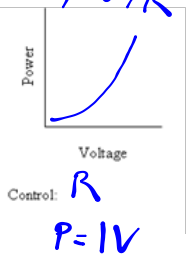
a) $P = I^2R$



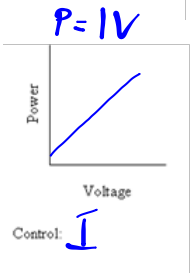
$P = IV$



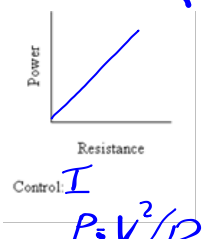
b) $P = V^2/R$



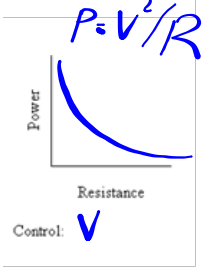
$P = IV$



c) $P = I^2R$



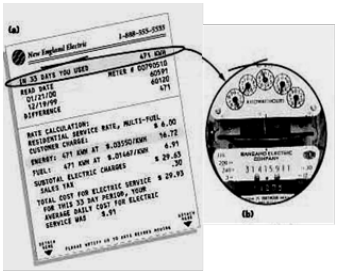
$P = V^2/R$



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):



Electrical Power and Energy

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

1 kWh

$1000\frac{J}{s} \cdot 3600 s$

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

$471\ kWh \times \$.0355/kWh = \$16$

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

$3.6 \times 10^6 J = 1\ kWh$

$E = P \cdot t = 60\frac{J}{s} \cdot 4.5 \cdot 3600 s = 9.7 \times 10^5 J$

$.06\ kW \times 4.5\ hr = .27\ kWh$

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 3.5~~VA~~W."

a) What quantity if being measured as 3.5 VA?

POWER

b) How much current does the charger use?

$P = IV \qquad I = P/V = \frac{3.5VA}{5V} = .7A$

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?

$P = I^2R$

$I = \sqrt{P/R} = \sqrt{\frac{.5W}{270\Omega}} = .043A$

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

overheat, non-ohmic after this

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

a) what quantity is being measured as 90 mAh?

12 J/C

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

Capacity:

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.

$V = \frac{E}{q}$

$12 J/C \times 324 C = 3888 J$

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