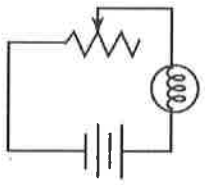
**Variable Resistor:** A resistor whose resistance can be deliberately changed.

Also called: potentiometer

7. What are some common uses for a variable resistor?

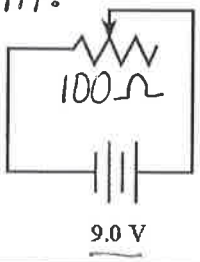
volume knobs, dimmer switches

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



$I = \frac{V}{R}$ If R is increased, then "I" or the current will decrease + light will dim.

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




$I = \frac{V}{R} = \frac{9.0V}{100\Omega} = \boxed{0.09A}$

## Electrical Power and Energy

**Power:** rate at which energy is used

**Mechanical Power**

$P = \frac{W}{t} = \frac{\vec{F} \cdot \vec{d}}{t} = \vec{F} \cdot \vec{v}$

$P = \frac{E}{t}$

Units: $\left[\frac{J}{s}\right]$ watt $[W]$

**Electrical**

$\frac{PE_e}{t} = P = IV$

$\left[\frac{q}{t}\right]\left[\frac{PE_e}{q}\right]$

Units: $\left[\frac{J}{s}\right] = [W]$ watt

$\left[\frac{C}{s}\right]\left[\frac{J}{C}\right]$

**Electrical Power** $P = IV$ & $V = IR$

$P = I(IR) = I^2R$ units = watts [W]

$P = \left(\frac{V}{R}\right)V = \frac{V^2}{R}$

**Electrical Energy**

$PE_e = P \cdot t$ $W = P \cdot t$ (work)

Units: Joules [J]

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? $P = IV = (0.028A)(1.5V) = \boxed{0.042W}$

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

$PE_e = P \cdot t = \left(0.042\frac{J}{s}\right)\left(\frac{60s}{min}\right) = \boxed{\frac{2.5J}{min}}$

Use "g" = $10\frac{m}{s^2}$

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

$P = IV$

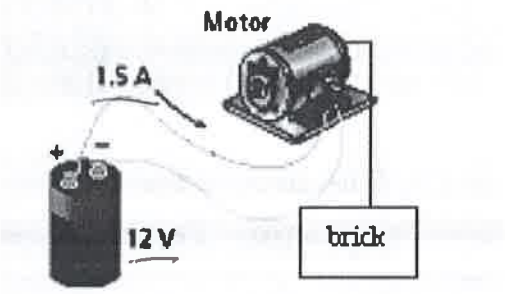
a) How fast can the motor raise a 2.0 kg brick?

$P = F \cdot \vec{v}$ $\quad \vec{v} = \frac{IV}{F} = \frac{(1.5A)(12V)}{20N} =$ **0.90 m/s**

$IV = F \cdot \vec{v}$ $\quad F = ma$

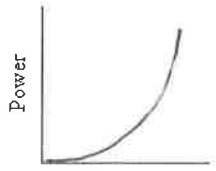
b) How much energy will the motor use in 10.0 seconds?

$PE_e = P \cdot t = (IV) \cdot t \quad (1.5A)(12V)10.0s) = 180J$



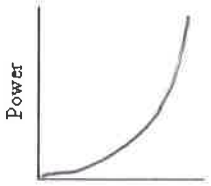
A battery runs a motor that lifts a brick.

3. Sketch each of the following relationships:



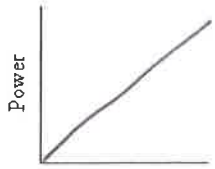
$P = I^2R$

Control: R

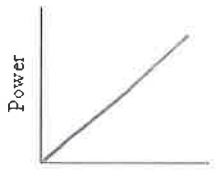


$P = \frac{V^2}{R}$

Control: R

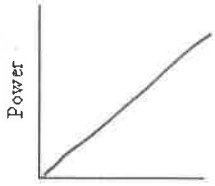


Control: I $\quad P = I^2R$



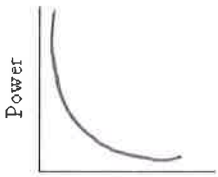
$P = IV$

Control: V



$P = IV$

Control: I



$P \propto \frac{1}{R}$ $\quad P = \frac{V^2}{R}$

Control: V

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

$P = \frac{V^2}{R}$ $\quad \frac{V^2}{(2)R} = \left(\frac{1}{2}\right)P$ $\quad 2R = \frac{1}{2}$ Power

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? **Energy**

(1000 watts)(1hr) = P·t = measure of energy

$PE_e = P \cdot t$

ENERGY! **Kilowatt-hour (kWhr):** The amount of energy used running 1000 watts for one hour.

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

$1000W = 1000\frac{J}{s}$ $\quad 1000\frac{J}{s} \cdot 3600s = 3.6 \times 10^6 J$ $\quad 1hr = 3600s$

**KWhr = $3.6 \times 10^6$ J**

7. Determine the energy cost for the consumer whose bill is shown above.

$\frac{\$0.0355}{Kwhr} \cdot 471 Kwhr = \$16.72$ $\quad$ conversion factor → $\frac{1 Kwhr}{3.6 \times 10^6 J}$ 10