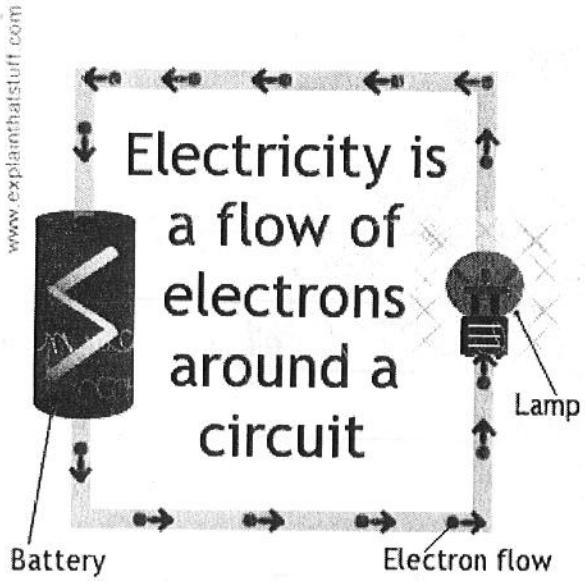
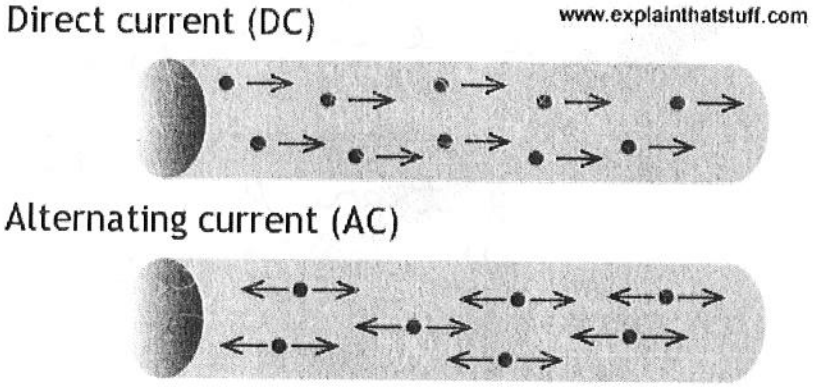
Direct current and alternating current

Answer Key



Electricity can move around a circuit in two different ways. In the big picture up above, you can see electrons racing around a loop like race cars on a track, always going in the same direction. This type of electricity is called **direct current** (DC) and most toys and small gadgets have circuits that work this way.



Artwork: Top: In a direct current (DC) circuit, electrons always flow in the same direction. Bottom: In an alternating current (AC) circuit, the electrons reverse direction many times each second.

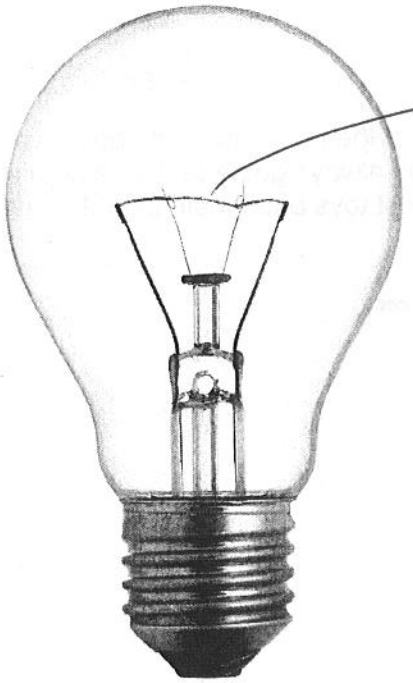
The bigger appliances in your home use a different kind of electricity called **alternating current** (AC). Instead of always flowing the same way, the electrons constantly reverse direction—about 50–60 times every second (this is known as the frequency). Although you might think that makes it impossible for energy to be carried round a circuit, it doesn't! Take the flashlight bulb in the circuit above. With direct current, new electrons keep streaming through the filament (a thin piece of wire inside the bulb), making it heat up and give off light. With alternating current, the same old electrons whiz back and forth in the filament. You can think of them running on the spot, heating up the filament so it still makes bright light we can see. So both types of current can make the lamp work even though they flow in different ways. Most other electric appliances can also work using either direct or alternating current, though some circuits do need AC to be changed to DC (or vice versa) to work correctly.

PoWer

→ really a heat bulb!

What does a LB do? Think EasyBake Oven!!!

- it transforms electrical energy into HE + light E
- very inefficient = only 5% of consumed elec E becomes light E



skinny, long tungsten metal filament = low conductivity = ∴ e⁻ running along surface of wire encounter resistance ∴ friction ∴ glows red hot and then white hot

Think "Short Fat Cu Cold"

What does a 100 W LB do compared to a 60 W LB?

- a 100 W LB uses 100 J of elec E every 5 it is on
- the 60 W LB uses 60 J of elec E / 1 second

∴ the 100 W LB is brighter

The rate at which energy is converted from one form to another is power.

Power is how fast energy is generated or used.

Power is how much energy is used in a given time period.

Do not confuse power and energy!!

Power is:

1) $P = \frac{E}{t}$ = the amt of E produced per unit time

2) $P = \frac{E}{t}$ = the amt of E consumed every second the appliance is on.

Equations: $P = \frac{E}{t}$ $\quad P = IV$

$W = \frac{J}{S}$ $\quad W = \frac{J}{S}$??

PoWer Energy = J time = S

How can PoWer exist as 2 very different equations?

$\boxed{P = IV}$ $\quad I\,(A)$ $\quad 1A = \frac{1C}{1S}$ $\quad V(V)$ $\quad 1V = \frac{1J}{1C}$

$P = IV$

$W = AV$

$= \frac{C}{S} \cdot \frac{J}{C}$

$W = \frac{J}{S}$

A 100 watt light burns just as brightly in both Europe and in Canada and uses the same amount of power in each case.

In Europe it uses a higher voltage (220V) and lower current; in North America, there's a lower voltage (120V) and higher current.

Together, voltage and current give you electrical **power**. The bigger the voltage and the bigger the current, the more electrical power you have.

oven = 5000 W

Problems: Show your work and include formulae, rearranged formulae and units. Because I said so and it is my class and I know what is best for you!!

focus on key words & circle

Units of Electricity:

1 Which of the following correctly describes the units of Current and of Potential Difference? $= V = \frac{J}{C}$

A) 1 A = 1 C•s and 1 V = 1 J•C

B) 1 A = 1 C/s and 1 V = 1 J/C

C) 1 A = 1 C/s and 1 V = 1 J•C

D) 1 A = 1 C•s and 1 V = 1 J/C

$\frac{C}{S}$ ✓ memorize!

go through every multiple choice answer & eliminate

2 Electrical potential difference is expressed in joules per coulomb (J/C) and electric current in coulombs per second (C/s). Using this information and knowing that 1 W = 1 J/1 s, which of the following units could apply to electrical energy?

A) V•A•s $= \frac{J}{C} \cdot \frac{C}{S} \cdot S = J$

B) W•s $= \frac{J}{S} \cdot S = J$

C) J•s

D) kWh $1\,kWh \times \frac{1000W}{1kW} \times \frac{1\frac{J}{S}}{1W} \times \frac{3600s}{1h} = 3.6 \times 10^6\,J$

E) W = Power Not Energy!

F) V•A

Jare really small ∴ Hydro QC bills your parents for electrical energy in kW•h!

3 Which of the following is a unit of electrical energy?

A) V•A $= VI = \frac{J}{C} \cdot \frac{C}{S} = \frac{J}{S} = W = P$

B) $\Omega \cdot A^2 = R \times I^2 = \frac{V}{I} \cdot I^2 = VI = P$

C) W•s $= \frac{J}{S} \cdot S = J$

D) kW/h ✗ not a unit!

Hydro ≠ Power

E = Pt or **P = IV** & next $E = VIt$

1. A 750 Watt hairdryer is used for 15 minutes. $E = Pt = 750\,W \times 15\,\cancel{min} \times \frac{60\,s}{1\,\cancel{min}} = 6.75 \times 10^3$

   a) Calculate the amount of energy in Joules used by the hairdryer for this period of time.

   b) Calculate the amount of energy in kWh used by the hairdryer for this period of time.

   If Hydro QC charges your parents approx. 6.5 ¢ per kWh of electrical energy, how much does blow drying your hair cost?

$$E = Pt = 750\,W \cdot 15\,min \times \frac{1\,kW}{1000\,W} \cdot \frac{1\,h}{60\,min} \cdot \frac{6.5\,¢}{1\,kWh} = 1.22\,¢$$

2. A room has a 60 W, a 100 W and a 150 W LB.

   How much would it cost to use all of the light bulbs for 2.5 h?

$$E = Pt = (60\,W + 100\,W + 150\,W) \cdot 2.5\,h \times \frac{1\,kW}{1000\,W} \cdot \frac{6.5\,¢}{1\,kWh} = 5.04\,¢$$

3. A microwave has a power rating of 1400 W. A convection oven has a power rating of 5000 W and takes 45 minutes to cook a baked potato.

   At 6.5 ¢ per kWh how much does it cost to bake a potato in the convection oven?

   A microwave oven takes 6 min to bake the same potato. How much?

$$E = Pt = 1400\,W \cdot 6\,min \times \frac{1\,h}{60\,min} \times \frac{1\,kW}{1000\,W} \times \frac{6.5\,¢}{kWh} = 0.91\,¢$$

$$E = Pt = 5000\,W \cdot 45\,min \times \frac{1\,h}{60\,min} \times \frac{6.5\,¢}{kWh} \cdot \frac{1\,kW}{1000\,W} = 24.4\,¢$$

4. How much does it cost to run a 615 W refrigerator for a year?

$$E = Pt = 615\,W \times \frac{1\,kW}{1000\,W} \times \frac{24\,h}{1\,d} \times \frac{365\,d}{yR} \times \frac{6.5\,¢}{kWh} \cdot \frac{1\,\$}{100\,¢} = \$350.18$$

5. How long was a 15 W radio on for if it used 2.35×10^8 J of energy?

$$t \cdot \frac{P}{\cancel{P}} = \frac{E}{\cancel{t}} \cdot \frac{\cancel{t}}{P} = \left(\frac{2.35 \times 10^8\,J}{15\,W}\right) \cdot \frac{1\,h}{3600\,s} \cdot \frac{1\,d}{24\,h} = 181\,d$$

6. What is the power rating in kW of an appliance that runs for 4.5 s and uses 6.2×10^2 J of energy?

$$P = \frac{E}{t} = \left(\frac{6.2 \times 10^2\,J}{4.5\,s}\right) \cdot \frac{1\,kW}{1000\,W} = 0.14\,kW$$

P = IV

W

$$P = IV = (2A)(120V)$$

1. What is the power when a voltage of 120 V drives a 2 A current through a device? = 240 W

2. What is the current reading on an ammeter when a 60 W light bulb is connected to a 120 V source?

$$\frac{P}{\cancel{V}} = \frac{I\cancel{V}}{\cancel{V}} \quad \frac{60\,W}{120\,V} = 0.5\,A$$

3. A bulb with a resistance of 330 Ω is plugged into a 240 V source in Paris. What is the current flowing through the bulb?

$$\frac{V}{R} = \frac{IR}{R} \quad \frac{240\,V}{330\,\Omega} = 0.73\,A$$

4. If part of an electric circuit dissipates energy at 6 W when it draws a current of 3 A, what voltage is impressed upon it? $P=IV$ $\frac{P}{I}=\frac{IV}{I}=\frac{6W}{3A}=2V=V$

5. An appliance runs for 5 h and uses 3.4×10^{25} J of electrical energy. If it is connected to a conventional 120 V source, how much current does it use? $P=\frac{E}{t}=\frac{3.4\times10^{25}J}{5h\cdot360}=1.58\times10^{19}A$ stupid #1

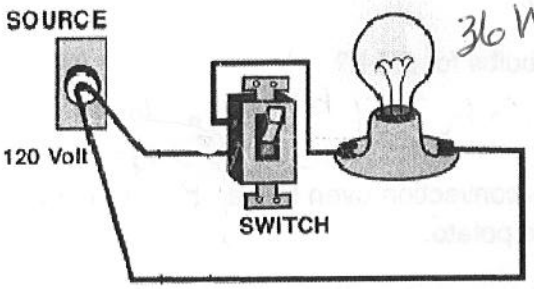
$P=IV$, $\frac{P}{V}=\frac{IV}{V}$, $\frac{1.89\times10^{21}W}{120V}=$ $1.89\times10^{5}W$

6. How much does it cost to run an appliance that is connected to a 120 V source and has a resistance of 500 Ω for 2 weeks? $V=IR$, $\frac{V}{R}=\frac{IR}{R}$, $\frac{120V}{500\Omega}=0.24A$ in

7. What is the power rating of the LB in the following circuit if an ammeter reads 300 mA?

$P=IV=(0.24A)(120V)=28.8W$ $E=Pt=28.8W\cdot\frac{1kW}{1000W}\cdot 2wks\cdot$

$\frac{7d}{1wk}\cdot\frac{24h}{1d}\cdot\frac{6.5¢}{kWh}=$ 62.90¢



36 W

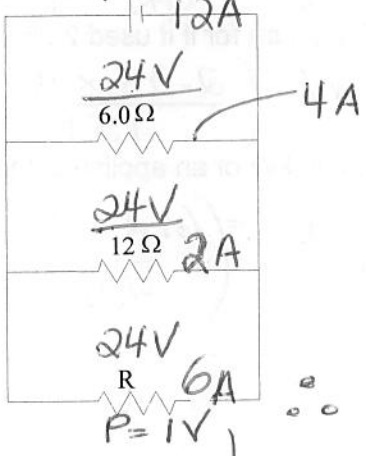
$P=IV=300mA\cdot\frac{1A}{1000mA}\cdot 120V=36W$

8 Three resistors are connected in parallel in the electrical circuit shown below. The value of resistance R is unknown.

The potential difference at the terminals of the battery is 24 V. The current furnished by the battery is 12 A.

V_T I_T P $V_T=V_1=V_2=V_3$

identify the circuit as series or P first!



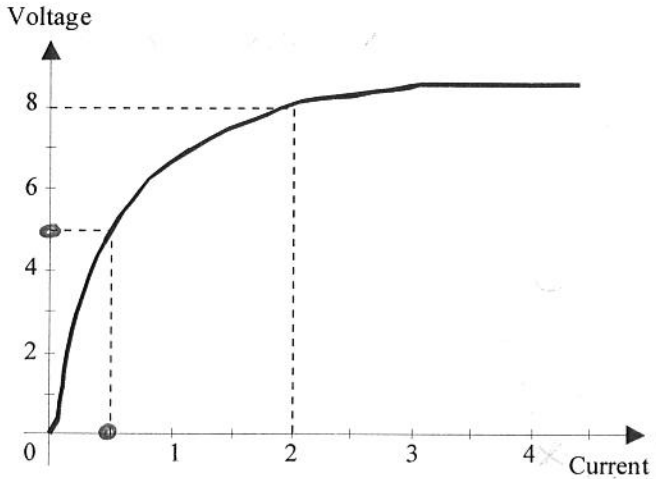
$\therefore I_3=12A-4A-2A=6A$

How much power is used by the unknown resistor?

$P=6A\cdot24V=144W$

A) 27 W
B) 36 W
C) 108 W
D) 144 W

9 The following graph shows the variation of the voltage across the terminals of a ceramic element as a function of the intensity of the current passing through it.



lost

What power is dissipated when this ceramic element is connected to a voltage of 5.0 V?

$P = IV$

$= (0.5A)(5.0V)$

$P = 2.5\ W$

A) 20 W

B) 10.0 W

C) 5.0 W

D) 2.5 W