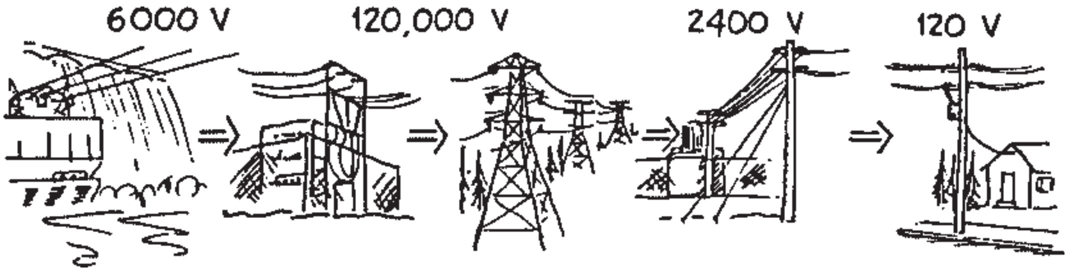
Name ______________________ Class ______________ Date ______________

Concept-Development Practice Page **37-2**

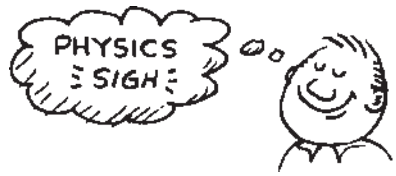
Power Transmission



Many power companies provide power to cities that are far from the generators. Consider a city of 100,000 persons who each continually use 120 W of power (equivalent to the operation of two 60-W light bulbs per person). The power constantly consumed is 100,000 persons × 120 W / 1 person = 12 million W (12 MW).

1. What current corresponds to this amount of power at the common 120 V used by consumers?

$$P = IV$$
$$12{,}000{,}000\ \text{W} = I \times 120\ \text{V}$$
$$I = \frac{\underline{\qquad\qquad}\ \text{W}}{\underline{\qquad\qquad}\ \text{V}} = \underline{\qquad\qquad}\ \text{A}$$



This is an enormous current, more than can be carried in the thickest of wires without overheating. More power would be dissipated in the form of heat than would reach the faraway city. Fortunately the important quantity is *IV* and not *I* alone. Power companies transmit power over long distances at very high voltages so that the current in the wires is low and heating of the power lines is minimized.

2. If the 12 MW of power is transmitted at 120,000 V, the current in the wires is

$$I = \frac{P}{V} = \frac{\underline{\qquad\qquad}\ \text{W}}{\underline{\qquad\qquad}\ \text{V}} = \underline{\qquad\qquad}\ \text{A}$$

This amount of current can be carried in long-distance power lines with only small power losses due to heating (normally less than 1%). But the corresponding high voltages wired to houses would be very dangerous. So step-down transformers are used in the city.

3. What ratio of primary turns to secondary turns should be on a transformer to step 120,000 V down to 2400 V? ______________

4. What ratio of primary turns to secondary turns should be on a transformer to step 2400 V down to 120 V used in household circuits? ______________

5. What is the main benefit of AC compared to DC power?

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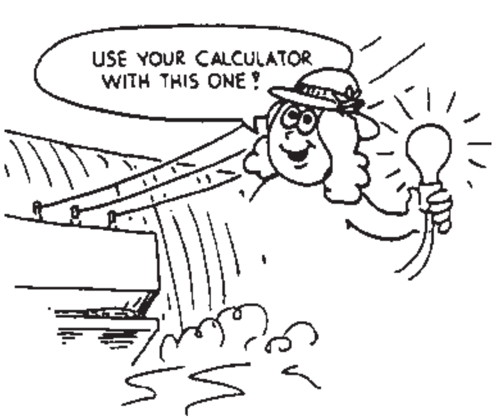
Power Production



Does it take a lot of water to light a light bulb? That depends on its wattage and how long it glows. In this practice page, you are to calculate the mass and volume of water that falls over a 10-m high dam to keep a 100-W light bulb glowing for 1 year.

1. First, calculate how many joules are required to keep the bulb lit for 1 year.

$$\text{Energy} = \text{power} \times \text{time} = 100\ \cancel{\text{W}} \times 1\ \cancel{\text{yr}} \times \frac{1\ \text{J}/\cancel{\text{s}}}{1\ \cancel{\text{W}}} \times \frac{365\ \cancel{\text{d}}}{1\ \cancel{\text{yr}}} \times \frac{24\ \cancel{\text{h}}}{1\ \cancel{\text{d}}} \times \frac{3600\ \cancel{\text{s}}}{1\ \cancel{\text{h}}}$$

$$= \underline{\hspace{3cm}}\ \text{J}$$

2. What mass of water elevated 10 m has this much PE? From Chapter 9, recall that gravitational PE = *mgh:*

$$\text{PE} = mgh$$

$$m = \frac{\text{PE}}{gh} = \frac{\underline{\hspace{3cm}}}{(9.8\ \text{m/s}^2)(10\ \text{m})} = \underline{\hspace{3cm}}\ \text{kg}$$

3. But this assumes 100% efficiency. A hydroelectric plant is typically 20% efficient. This means only 1 part in 5 of the PE of the falling water ends up as electricity. So the mass above must be multiplied by 5 to get the actual amount of water that must fall to keep the 100-W bulb lit.

$$5 \times \underline{\hspace{2.5cm}}\ \text{kg} = \underline{\hspace{2.5cm}}\ \text{kg}$$

4. This is an impressive number of kilograms! To visualize this amount of water, convert it to cubic meters. (Recall 1 kg of water occupies 1 liter, and there are 1000 liters in 1 cubic meter.)

$$\text{Volume} = \underline{\hspace{2.5cm}}\ \cancel{\text{kg}} \times 1\ \frac{\cancel{\text{L}}}{\cancel{\text{kg}}} \times \frac{1\ \text{m}^3}{1000\ \cancel{\text{L}}} = \underline{\hspace{2cm}}\ \text{m}^3$$

5. For comparison, an Olympic-size swimming pool holds about 4000 m^3 of water. How many such poolfuls of water are required to keep a 100-W bulb lit for one year?

$$\text{Number of poolfuls} = \frac{\underline{\hspace{3cm}}\ \cancel{\text{m}^3}}{\cancel{\text{m}^3}/\text{poolful}} \approx \underline{\hspace{1cm}}\ \text{poolfuls}$$

Does it take a lot of water to light a light bulb? To light a city full of light bulbs? Now you have a better idea!