ELECTRICAL ENGINEERING (SAMPLE RESPONSES)

You are testing a new hair dryer that will be sold in different countries. You know that wall outlets provide alternating current, or AC, which means the voltage changes in a repeating wave pattern instead of staying constant. Because AC voltage changes, engineers use **RMS voltage** to describe the effective voltage that powers a device.

The RMS voltage (in volts) can be found using the formula below, where **(MAX)** is the maximum voltage and **(RMS)** is the RMS voltage.

$$(RMS) = \frac{(MAX)}{\sqrt{2}}$$

1) During testing, the hair dryer reaches a maximum voltage of 324 volts. Find the RMS voltage and represent it as a simplified fraction with a rationalized denominator.

$(MAX) = 324$ volts

$$(RMS) = \frac{(MAX)}{\sqrt{2}} = \frac{(324)}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{324\sqrt{2}}{2} = 162\sqrt{2} \text{ volts}$$

2) Use your expression to calculate the approximate RMS voltage and round to the nearest whole number. Based on your answer, is the hair dryer compatible with outlets in the United States (120 volts), Europe (230 volts), or neither? Explain your reasoning.

$162\sqrt{2} \approx 229.103 \approx 230$, which means the hair dryer is designed for a European outlet, not a United States outlet because it is very close to 230 volts.

3) You want to design another model of the same hair dryer that is compatible with United States outlets. What maximum voltage should the new dryer use? Round your answer to the nearest tenth.

$(RMS) = 120$ volts

$$120 = \frac{(MAX)}{\sqrt{2}}$$

$$(\sqrt{2}) \cdot 120 = \frac{(MAX)}{\sqrt{2}} \cdot (\sqrt{2})$$

$$120\sqrt{2} = (MAX)$$

$$(MAX) \approx 169.706$$

The new hair dryer should be designed for a maximum voltage of about 169.7 volts.