Physics 08-07 Electricity and the Human Body *Name:* _____

Electric Hazards

Thermal Hazards

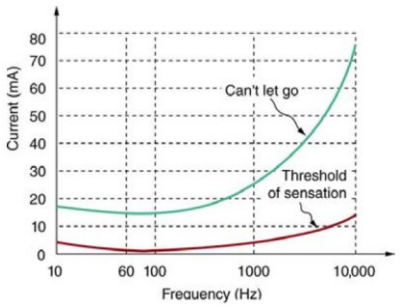
- _____ energy converted to _____ energy _____ than can be _____
- Happens in _____ circuits where electricity _____ between two parts of _____ bypassing the _____ load
  - $P = \frac{V^2}{R}$
  - Low _____ so high _____
  - Can start _____
  - _____ _____ or _____ try to stop
- Or _____ wires that have
  - _____ resistance (_____)
  - Or are _____ so _____ can't _____

Shock Hazards

- Factors
  - _____ of _____
  - _____ of current
  - _____ of shock
  - _____ of current
- Human body mainly _____, so decent _____
- _____ are controlled by _____ impulses in nerves
  - A shock can cause _____ to _____
  - Cause _____ to close around _____ (muscles to close, stronger than to open)
  - Can cause _____ to _____
- Body most sensitive to _____Hz

Table 20.3 Effects of Electrical Shock as a Function of Current[3]

Current (mA)	Effect
1	Threshold of sensation
5	Maximum harmless current
10–20	Onset of sustained muscular contraction; cannot let go for duration of shock; contraction of chest muscles may stop breathing during shock
50	Onset of pain
100–300+	Ventricular fibrillation possible; often fatal
300	Onset of burns depending on concentration of current
6000 (6 A)	Onset of sustained ventricular contraction and respiratory paralysis; both cease when shock ends; heartbeat may return to normal; used to defibrillate the heart



Practice Work

1. What are the two major hazards of electricity?
2. Why isn't a short circuit a shock hazard?
3. What determines the severity of a shock? Can you say that a certain voltage is hazardous without further information?
4. Some devices often used in bathrooms, such as hairdryers, often have safety messages saying "Do not use when the bathtub or basin is full of water." Why is this so?
5. We are often advised to not flick electric switches with wet hands, dry your hand first. We are also advised to never throw water on an electric fire. Why is this so?
6. Before working on a power transmission line, linemen will touch the line with the back of the hand as a final check that the voltage is zero. Why the back of the hand?
7. (a) How much power is dissipated in a short circuit of 240-V AC through a resistance of 0.250 Ω? (b) What current flows? (OpenStax 20.85) **230 kW, 960 A**

8. What voltage is involved in a 1.44-kW short circuit through a 0.100-Ω resistance? (OpenStax 20.86) **12 V**

9. Find the current through a person and identify the likely effect on her if she touches a 120-V AC source: (a) if she is standing on a rubber mat and offers a total resistance of 300 kΩ; (b) if she is standing barefoot on wet grass and has a resistance of only 4500 Ω. (OpenStax 20.87) **0.400 mA (no effect), 26.7 mA (muscular contraction)**

10. While taking a bath, a person touches the metal case of a radio. The path through the person to the drainpipe and ground has a resistance of 4000 Ω. What is the smallest voltage on the case of the radio that could cause ventricular fibrillation? (OpenStax 20.88) **400 V**

11. Foolishly trying to fish a burning piece of bread from a toaster with a metal butter knife, a man comes into contact with 120-V AC. He does not even feel it since, luckily, he is wearing rubber-soled shoes. What is the minimum resistance of the path the current follows through the person? (OpenStax 20.89) $\mathbf{1.20 \times 10^5\ \Omega}$

12. (a) During surgery, a current as small as 20.0 μA applied directly to the heart may cause ventricular fibrillation. If the resistance of the exposed heart is 300 Ω, what is the smallest voltage that poses this danger? (b) Does your answer imply that special electrical safety precautions are needed? (OpenStax 20.90) **6.00 mV**

13. (a) What is the resistance of a 220-V AC short circuit that generates a peak power of 96.8 kW? (b) What would the average power be if the voltage was 120 V AC? (OpenStax 20.91) **1.00 Ω, 14.4 kW**

14. A heart defibrillator passes 10.0 A through a patient's torso for 5.00 ms in an attempt to restore normal beating. (a) How much charge passed? (b) What voltage was applied if 500 J of energy was dissipated? (c) What was the path's resistance? (OpenStax 20.92) $\mathbf{5.00 \times 10^{-2}\ C}$**, 10.0 kV, 1.00 kΩ**