Problem Set 13: Circuits and Safety

13.1 Active/Live: Carries the high voltage
Neutral: Completes the circuit
Earth: A safety wire to stop the appliance becoming live

13.2 It is impossible to say what voltage is dangerous because the resistance of each person is different. This means that a voltage of 240v might be fatal to one person, but not to the next.
$V = IR$

13.3 $P = 40$ W
$V = 240$ V
$I_{Limit} = 15$ A
$P = IV$
$I = 40/240$
$= 0.167$ A
Gloves $= 15/0.167$
$= 90$ globes

13.4 $V = 12$v
$R = 2.4\ \Omega$
$V = IR$
$I = 12/2.4$
$= 5$ Amps

13.5 [a] In a short circuit, the resistance of the circuit becomes negligible. As a result huge currents are drawn which dissipate lots of thermal energy.

[b]AC's alternating nature has a greater tendency to throw the heart's pacemaker neurons into fibrillation whereas DC tends to just make the heart stand still. Once the current is halted, a stopped heart has a better chance of regaining a normal beat pattern than a fibrillating heart.

[c]By doubly insulating a device, if there is a fault within the inside of the device allowing the case to have a potential difference, there is nowhere for the circuit to be finished. This is because the second insulating layer prevents the circuit from being completed.

13.6 [a] $P = 1200$ W
$V = 240$ V
$P = IV$
$I = 1200/240 = 5$ A

[b] $I_T = 2 \times 4.17 = 8.34$ A
$8.34 < 15$
Yes you could, there isn't enough current being drawn to trip the circuit breaker.

13.7 $V = 240$v
$I_{Max} = 15$ A
$P = 1000 + 2400 + 2000 = 5400$ W
$I = 5400/240$
$= 22.5$ A
$22.5 > 15$
No you shouldn't, the drawn power will be greater than the circuit breakers tolerable level.

13.13 [a] P = 1500 W
V = 240 V
P = IV
I = 1500/240 = 6.25 A

[b] I = 10A
V = IR
R = 240/10 = 24 ohms

[c] If the fridge is turned on on its own, the circuit breaker won't be tripped. However, if both are turned on at the same time, the circuit breaker will trip.

13.14 [a] V = 3000 V
$R = 5.00 \times 10^7\ \Omega$
V = IR
$I = 3000/(5.00 \times 10^7) = 6.00 \times 10^{-5}$ A

[b] $R \approx 3/0.5 \approx 6$ ohms
$R_T = 50M + 6$
$I = 3000/(50M + 6) = 6.00 \times 10^{-5}$ A
V = IR
$= 6.00 \times 10^{-5} \times 6$
$= 3.60 \times 10^{-4}$ V

[c] The 50 M resistor acts as a current limiter. With such a large resistance and a fixed potential, a lethal current cannot be produced.

13.15 [a] V = 240 V
R= 4400 Ω
V = IR
$I = 240/4400 = 5.45 \times 10^{-2}$ A

[b] Increase – when Carmen grabs hold of John, the current no longer travels to the ground through John's right side around his heart, but to the ground and to Carmen through his heart.

[c] V = 240 V
R = 8400
V = IR
$I = 240/8400 = 2.86 \times 10^{-2}$ A

[d] She should have turned the power off at the power point or at the main switchboard (preferably) before interfering.

[e] A fuse will only turn off the power once it reaches a certain current draw. Electrocution might happen under the fuse's amperage rating. If the current is too high for the fuse, the fuse takes time to blow.