Problem Set 12: Parallel and Series Circuits

12.1 Appliances are connected in a parallel arrangement in the home. This is done so that if one device fails, power isn't cut off from the rest of the appliances.

12.2 R = 30 ohms
R_T = 30 * 12 = 360 ohms

12.3 [a] V = 12 V
V_T = 2 * 12 = 24 V

[b] R = 60 ohms
I = 24/60 = 0.4 Amps

[c] R $= (+20^{-1})^{-1}$
= 6.67 Ω

[d] The bulbs in parallel will glow brighter as they have a larger overall current draw due to their lower total resistance. This leads in more power being supplied to the lights.

12.4 V = 32 – 12 = 20 V
I = 4 A
R = 20/4
= 5 Ω

12.5 [a] V = 18 V
R $= 3 + (2^{-1} + 2^{-1})^{-1}$
= 4 Ω

[b] V = IR
R = 18/4
= 4.5 A

[c] The most current will be drawn when both switches are closed. When both switches are closed, the total resistance is lower and hence more current is drawn.

[d] R = 5 ohms
t = 3 x 60
= 18/5
= 3.6 A
P $= I^2R$
$= (3.6)^2 \times 5$
= 64.8 W
W = Pt
= 64.8 x 60 x 3
$= 1.17 \times 10^4$ J

12.6 [a] $V = 12$ V
$R_{Rheostat} = 0$ to 150 ohms
$R_T = 300 + 0 + 2 = 302$ ohms
$V = IR$
$I = 12/302$
$= 3.97 \times 10^{-2}$ Amps

$R_T = 300 + 150 + 2 = 452$ ohms
$I = 12/452$
$= 2.65 \times 10^{-2}$ Amps

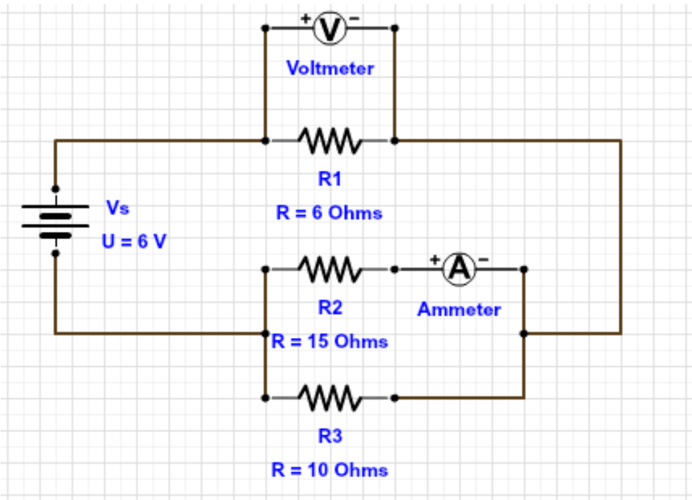
[b] Circuit B is the same as Circuit A – all elements are in series (no change from previous question)

[c] $R_T = 2 + 0$ (Rheostat = 0 creates a short circuit) = 2 ohms
$I = 12/2 = 6$ Amps

$R_T = 2 + (150^{-1} + 300^{-1})^{-1} = 102$ ohms
$I = 12/102 = 1.18 \times 10^{-1}$ Amps

[d] Circuit C [1.18×10^{-1} to 6 Amps]

12.7 [a]



[b] $V = 6$ V
$R_T = 6 + (15^{-1} + 10^{-1})^{-1}$
$= 12$ ohms
$I_S = 6/12$
$= 0.5$ Amps
$V_{Voltmeter} = 0.5 \times 6$
$= 3$v

[c] voltage over parallel branch
$V = 6 – 3 = 3$ V
$I = 3/15$
$= 0.2$ Amps

12.8 [a] $R_T = (4^{-1} + 8^{-1} + 40^{-1})^{-1}$
$= 2.5$ ohms

[b] $R = 4$ ohms
$I = 2$ A
$V = IR = 2 \times 4 = 8$ V

[c] $R = 8$ ohms
$V = IR$
$I = 8/8 = 1$ A

[d] $R = 40$ ohms
$V = IR$
$I = 8/40 = 0.2$ A

12.9 [a] Parallel (question 12.1)

[b] $R_T = (1440^{-1} + 960^{-1})^{-1}$
$= 576\ \Omega$

[c] V = 240 V (mains power)
V = IR
I = 240/576
$= 4.17 \times 10^{-1}$ A

12.10 [a] V = 240 V
$P_T = 450 + 600 + 1000 = 2050$ W
P = IV
I = 2050/240 = 8.54 A

[b] The amount of current will increase. Since the voltage isn't changing but more power is being used, more current must be drawn to meet the power requirements. P = IV

12.11 [a] $R_T = 100 + 100 = 200\ \Omega$

[b] $R_T = (100^{-1} + 100^{-1})^{-1}$
$= 500\ \Omega$

[c] Parallel – the combined resistance of the two heating elements is lower in this arrangement. The lower the resistance, the more current that is drawn. Larger current draw increases the amount of power dissipated which in turn heats the water faster. $P = I^2R$

12.12 [a] Circuit A will be double the resistance of Circuit B

[b] A1 = 2 x A = 12A
A1 = A2 + A3
A2 = A3
A1 = 2 *A2
A2 = 6A
A3 = 6A

[c] All the globes will have the same brightness as they all identical and have the same amount of current flowing through them.

12.13 [a] Set A won't have any glowing lights if a bulb blows
Set B will have one unlit globe while the rest will be glowing

[b] P = 4w
V = 240v
P = IV
I = 60/240 = 0.25 A
R = 240/0.25 = 960 Ω
R_{lamp} = 960/15 = 64 Ω

[c] P = 4w
I = 4/240 $= 1.67 \times 10^{-2}$A
R $= 240/1.67 \times 10^{-2}$ $= 1.44 \times 10^{4}\ \Omega$

[d] Set A: the globe from set B will drastically increase the total resistance in Set A resulting in the globes being very dim.

Set B: The globe from Set A has a very low resistance, causing it to effectively create a short circuit. This would cause a huge current to pass through the globe most likely causing it to blow.

12.14 [a] $P = 2 \times 60 + 2 \times 10 \quad = 140$ W

[b] $V = 12$v
$P = IV$
$I = 140/12 \quad = 11.67$ A
$P = I^2R$
$R = 140/(11.67)^2 \quad = 1.03\ \Omega$

[c] $P = 60$ W
$P = IV$
$I = 60/12 = 5$ A
$R = 12/5 \quad = 2.4\ \Omega$

[d] $P = 10$ W
$P = IV$
$I = 10/12 \quad = 0.833$ A
$R = 12/0.833 \quad = 14.4$ ohms

[e] $P_T = 140$w
$I = 140/12 \quad = 11.7$A

12.15 [a] The current is the same because the internal resistance and the load resistance are in series.

[b] $I = 80$A
$R = 0.05$ ohms
$V = IR \quad = 0.05 \times 80 \quad = 4$ V

[c] A lower resistance allows for greater currents to be produced. In applications such as a car battery where high currents are required, a large internal resistance can greatly affect the amount of current drawn.

[d] Starting the car with the headlights on will change the circuit resistance (lamp added in parallel), which will affect how much current goes through the motor.