HW1 Solution

1.8 By definition:

$$I = \frac{dq}{dt}$$

w/ $q(t) = 20 + 4t$ mC

$$I = \frac{d}{dt} q(t) = \frac{d}{dt}(20 + 4t) = \boxed{4\text{ mA}}$$

1.16 Power of 100 LED lights:

$$P_{100\text{-LED}} = 100 \cdot P_{LED} = 3\text{ W}$$

Voltage difference for each string: (from $P = IV$)

$$V_s = \frac{P_s}{I_s} = \frac{3\text{ W}}{0.5\text{ A}} = 6\text{ V}.$$

Max # of string:

$$n = \frac{V_{total}}{V_{string}} = \frac{120\text{ V}}{6\text{ V}} = \boxed{20.}$$

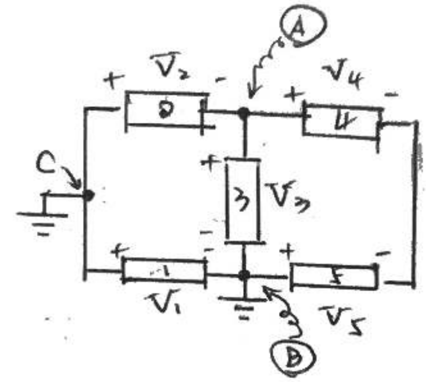
1.18 Assume battery voltage is constant:

Power of battery: $P_b = I_b V_b = (20 \times 10^{-3}\text{ A})(6\text{ V})$

$$= 1.2 \times 10^{-1}\text{ W} = 0.12\text{ W}$$

$$t = \frac{\text{Energy}}{\text{Power}} = \frac{237.5 \times 10^3\text{ J}}{0.12\text{ W}} \boxed{\begin{aligned} &= 1.9792 \times 10^6\text{ s} \\ &= 3.2986 \times 10^4\text{ min} \\ &= 549.7685\text{ hrs.} \end{aligned}}$$

1-24.



For electronic element, voltage at positive is higher.

$\underline{C}$ is connected to ground $V_C = 0$.

Across element 2. $V_2 = 10\,V = V_C - V_A$

$\Rightarrow \quad V_A = V_C - V_2 = 0 - 10\,V = -10\,V$

$V_B = 0$, grounded. Similarly, $V_3 = V_A - V_B = -10V - 0 = \boxed{-10V}$

$V_1 = V_C - V_B = 0 - 0 = 0$.

$V_A - V_4 + V_5 = V_B \Rightarrow V_5 = V_B - V_A + V_4 = 0 - (-10V) + 5V$

$= 15\,V$.

$$\therefore \boxed{\begin{aligned} V_1 &= 0 \\ V_3 &= -10\,V \\ V_5 &= 15\,V \end{aligned}}$$

2.4.

~~No It won't work because of open-loop connection~~

Yes, it will work. In the left location, you could control the circuits. (on and off) by only use the left switch, no matter which position the right switch at. Similarly for right switch.

2-9. According to 4-band color code resistor.

1^{st} strip : orange = 3

2^{nd} strip : orange = 3

3^{rd} strip : orange = $1K\Omega$

$\Rightarrow 33 \times 1K\Omega = 33K\Omega$

Gold : $\pm 5\% \Rightarrow 33K\Omega \pm 5\% = 33K\Omega \pm 1.65\,K\Omega$

Max $= 34.65\,K\Omega < 34.9\,K\Omega$. $\boxed{\therefore \text{ not proper}}$

2.19 By definition of parallel & series connection. $\boxed{\text{(pp. 26)}}$:

Parallel: "elements are said to be in parallel when they form a loop containing no other elements"

Series: "Two elements are said to be connected in series when they have one common node to which no other element with current flowing through it is connected".

a). Nodes: A, B, C, D

Loops: $1 \to 3 \to 2$, $3 \to 6 \to 4$

$2 \to 4 \to 5$, $2 \to 3 \to 6 \to 5$, $1 \to 6 \to 5$

b) According to the definition above, no elements are in series or parallel.

c) KCL: $-i_2 - i_3 - i_4 = 0$ Ⓐ $\quad i_5 + i_2 + i_1 = 0$ Ⓒ

$-i_1 + i_3 - i_6 = 0$ Ⓑ $\quad i_4 + i_6 - i_5 = 0$ Ⓓ

KVL: $1 \to 3 \to 2$: $-V_1 + V_2 + (-V_3) = 0$

$3 \to 6 \to 4$: $-V_3 - V_6 + V_4 = 0$

$2 \to 4 \to 5$: $+V_2 - V_4 - V_5 = 0$

$2 \to 3 \to 6 \to 5$: $+V_2 - V_3 - V_6 - V_5 = 0$

$1 \to 6 \to 5$: $-V_1 + V_5 + V_6 = 0$

2.20 $V_2 = 20\ V,\ V_3 = -20\ V,\ V_4 = 6\ V$

loop $1 \to 3 \to 2 \Rightarrow -V_1 + V_2 - V_3 = 0$

$$\boxed{V_1 = V_2 - V_3 = 40\ V}$$

loop $2 \to 4 \to 5 \Rightarrow V_2 - V_4 - V_5 = 0$

$$\boxed{V_5 = V_2 - V_4 = 14\ V}$$

loop $3 \to 6 \to 4 \Rightarrow -V_3 - V_6 + V_4 = 0$

$$\boxed{V_6 = V_4 - V_3 = 6\ V - (-20\ V) = 26\ V}$$

2.23. By definition (Problem 2.19) and observation:

no elements in series or parallel

loop $1 \to 2 \to 4 \to 5$: $V_1 - V_2 - V_4 - V_5 = 0$

$V_1 = V_2 + V_4 + V_5$

$= \boxed{25\ V}$

loop $2 \to 4 \to 6$: $-V_2 - V_4 + V_6 = 0$

$V_6 = V_2 + V_4$

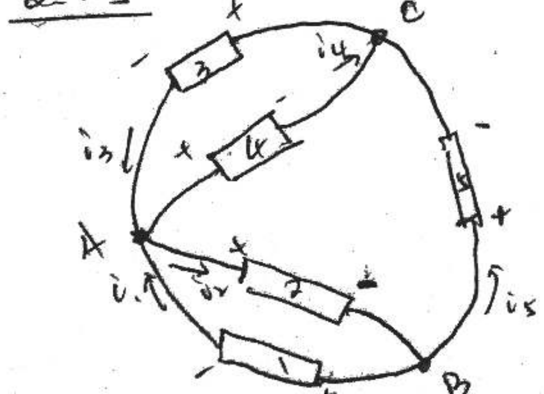
$= \boxed{20\ V}$

loop $3 \to 4 \to 5$: $+V_3 - V_4 - V_5 = 0$

$V_3 = V_4 + V_5$

$= \boxed{15\ V}$

2.25



$3 \to 4$: $V_3 + V_4 = 0$

$2 \to 4 \to 5$: $V_2 - V_4 + V_5 = 0$

$1 \to 2$: $V_1 + V_2 = 0$

b) $V_4 = 0 \Rightarrow V_3 = 0 \quad V_1 = V_5 = -V_2$