Electric Circuits Review

① The rate at which charge flows through a conductor.

② $I = \frac{Q}{t} = \frac{180\ C}{7200\ s} = \boxed{0.025\ A}$

③ $Q = It = (0.27)(60) = 16.2\ C$

$Q = Ne$

$16.2 = N(1.6 \times 10^{-19})$

$N = \boxed{1.01 \times 10^{20}}$ electrons

④ $V = IR$

$120 = I(14)$

$I = \boxed{8.57\ A}$

⑤ $Q = It = (6)(18\,000\ s) = 108\,000\ C$

$V = \frac{E}{Q}$

$12 = \frac{E}{108\,000}$

$E = \boxed{1\,296\,000\ J}$

⑥ $V = IR$

$120 = I(14)$

$I = 8.57\ A$

$Q = It$

$= (8.57)(60)$

$Q = 514.3\ C$

$V = \frac{E}{Q}$

$120 = \frac{E}{514.3}$

$E = \boxed{61\ 714\ J}$

⑦ Conventional current flows from the positive terminal of the battery, around the circuit to the negative terminal. (This current is based on the direction positive charges would move.)

Electrons would flow in the opposite direction.

⑧
- length of wire
- cross sectional area of wire
- material of wire
- temperature

⑨ $R = \rho \frac{L}{A}$

$= \frac{(2.65 \times 10^{-8})(10\ 000)}{4.9 \times 10^{-4}}$

$R = \boxed{0.54\ \Omega}$

(10) $V = IR$

$120 = 1.24\, R$

$R = 96.774\ \Omega$ ← desired resistance

$A = \pi r^2 = \pi (0.045 \times 10^{-3})^2 = 6.362 \times 10^{-9}\ m^2$

$R = \rho \frac{L}{A}$

$96.774 = 5.65 \times 10^{-8} \frac{L}{6.362 \times 10^{-9}}$

$L = \boxed{10.9\ m}$

(11) $R = \rho \frac{L_1}{A_1}$ $\qquad R = \rho \frac{L_2}{A_2}$

$\frac{R}{R} = \frac{\rho \frac{L_1}{A_1}}{\rho \frac{L_2}{A_2}}$

$1 = \frac{\frac{L_1}{A_1}}{\frac{L_2}{A_2}}$

$\frac{L_1}{A_1} = \frac{L_2}{A_2}$ →

$\frac{20}{\pi (0.4 \times 10^{-3})^2} = \frac{L_2}{\pi (0.3 \times 10^{-3})^2}$

$L_2 = \boxed{11.25\ m}$

(12) The two bars are in series. $\therefore$ $R_{Total} = R_1 + R_2$

$$R_1 = \rho_1 \frac{L_1}{A_1}$$

$$= \frac{(1.72 \times 10^{-8})(0.47)}{\pi \left(\frac{0.023}{2}\right)^2}$$

$$R_1 = 1.946 \times 10^{-5}\ \Omega$$

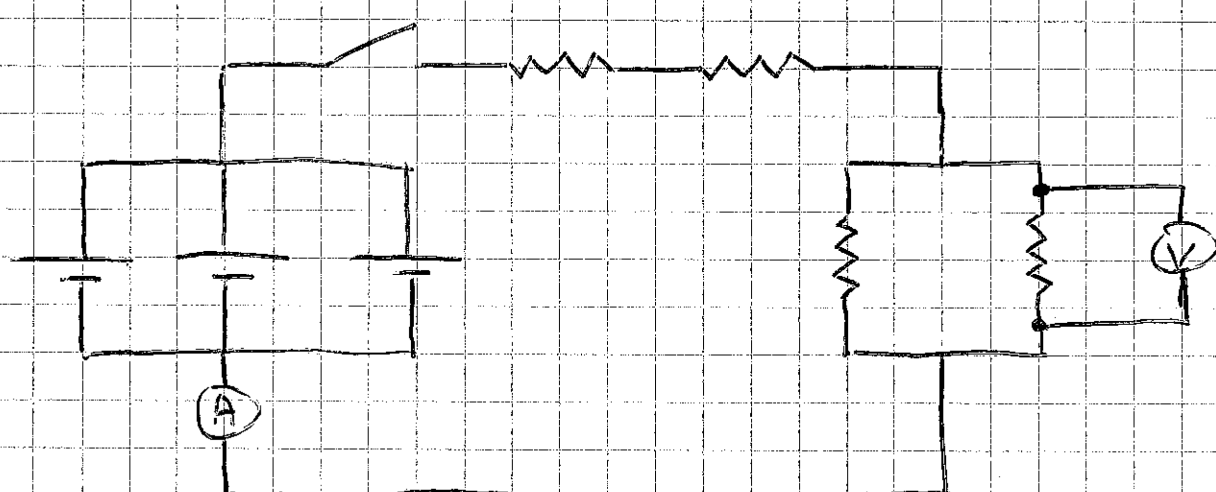
$$R_2 = \rho_2 \frac{L_2}{A_2}$$

$$= \frac{(9.71 \times 10^{-8})(0.125)}{\pi \left(\frac{0.023}{2}\right)^2}$$

$$R_2 = 2.921 \times 10^{-5}\ \Omega$$

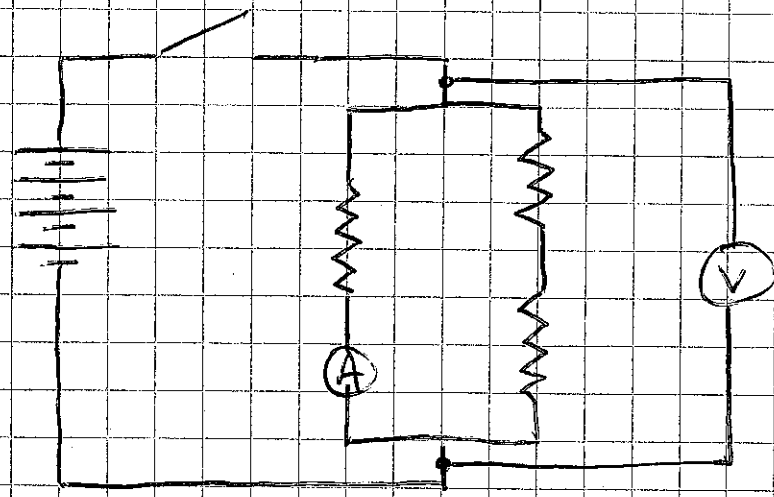
$$\boxed{R_{Total} = 4.87 \times 10^{-5}\ \Omega}$$

(13)



note: other answers are possible.

(14)



note: other answers are possible

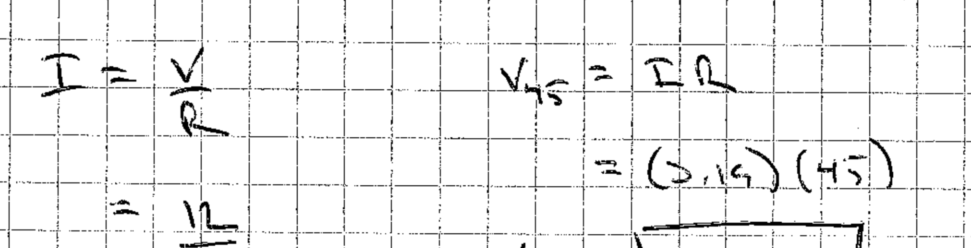
(15) a) $R = 50 + 90 + 150 = \boxed{290\ \Omega}$

b) $V = IR$

$= (1.02)(290)$

$V = \boxed{295.8\ V}$

(16)



$I = \frac{V}{R}$

$= \frac{12}{63}$

$I = 0.19\ A$

$V_{45} = IR$

$= (0.19)(45)$

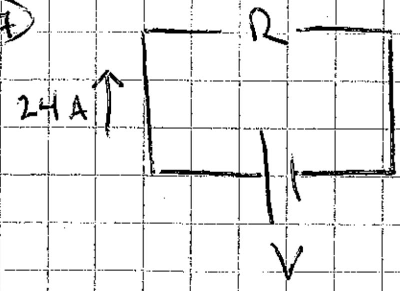
$V_{45} = \boxed{8.57\ V}$

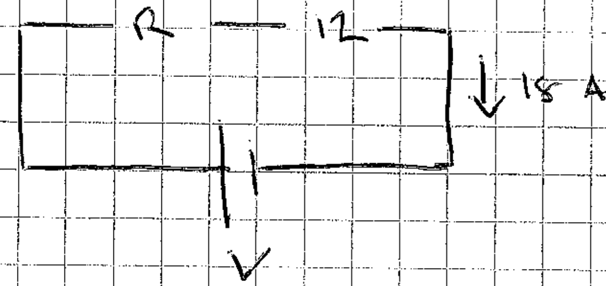
$V_{18} = IR$

$= (0.19)(18)$

$V_{18} = \boxed{3.43\ V}$

(17)





$$V = IR \qquad\qquad V = I(R+12)$$

$$V = 24R \qquad\qquad V = 18(R+12)$$

$$24R = 18(R+12)$$

$$24R = 18R + 216$$

$$6R = 216$$

$$R = \boxed{36\ \Omega}$$

(18)

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{8}$$

$$\frac{1}{R} = \frac{2}{8} + \frac{1}{8}$$

$$\frac{1}{R} = \frac{3}{8}$$

$$R = \frac{8}{3} = \boxed{2.\bar{6}\ \Omega}$$

(19) a) $V_{64} = IR$

$= (3)(64)$

$V_{64} = 192\ V$

$V_{42} = V_{64} = 192\ V$ (b/c in parallel)

$I_{42} = \frac{V}{R} = \frac{192}{42} = \boxed{4.57\ A}$

b) $P_1 = \frac{V^2}{R}$

$= \frac{192^2}{64}$

$P_1 = 576\ W$

$P_2 = \frac{V^2}{R}$

$= \frac{192^2}{42}$

$P_2 = 877.7\ W$

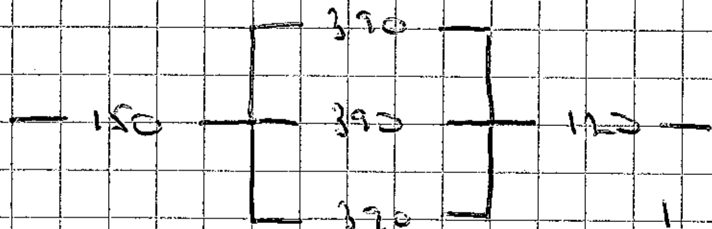
$\text{Total} = \boxed{1453.7\ W}$

(20) $\frac{1}{R} = \frac{1}{100} + \frac{1}{47} + \frac{1}{33}$

$\frac{1}{R} = 0.0616$

$R = \boxed{16.2\ \Omega}$

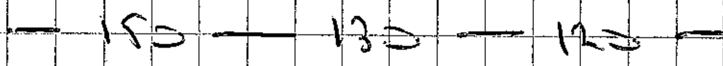
(21)



$$\frac{1}{R} = \frac{1}{390} + \frac{1}{390} + \frac{1}{390}$$

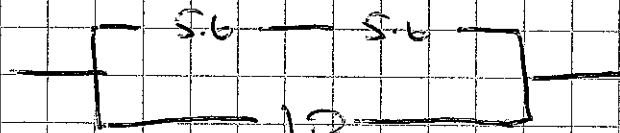
$$\frac{1}{R} = \frac{3}{390}$$

$$R = 130\ \Omega$$

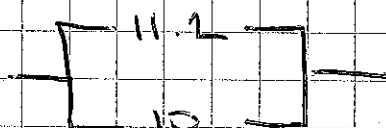


$$R = 150 + 130 + 120 = \boxed{400\ \Omega}$$

(22)



$$R = 5.6 + 5.6 = 11.2\ \Omega$$

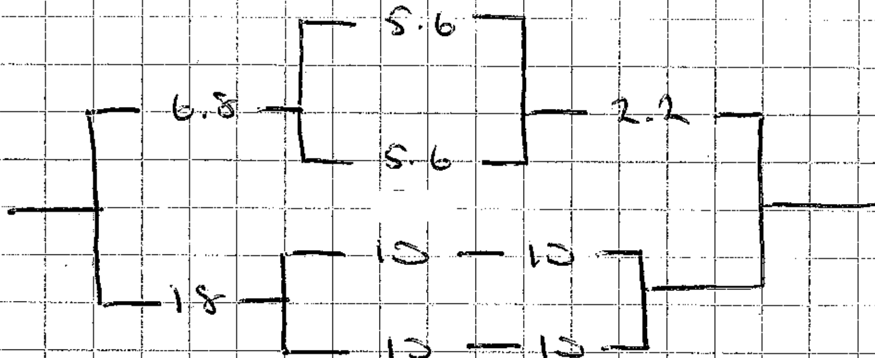


$$\frac{1}{R} = \frac{1}{11.2} + \frac{1}{10}$$

$$\frac{1}{R} = 0.189$$

$$R = \boxed{5.28\ \Omega}$$

(23)

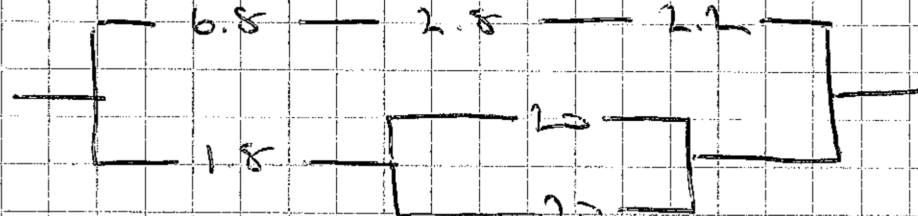


$$\frac{1}{R} = \frac{1}{5.6} + \frac{1}{5.6}$$

$$R = 10 + 10 = 20$$

$$\frac{1}{R} = 0.357$$

$$R = 2.8\ \Omega$$

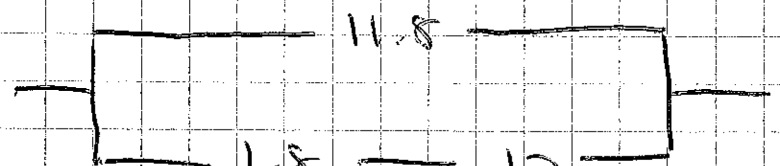


$$\frac{1}{R} = \frac{1}{20} + \frac{1}{20}$$

$$R = 6.8 + 2.8 + 2.2 = 11.8$$

$$\frac{1}{R} = \frac{2}{20}$$

$$R = 10\ \Omega$$



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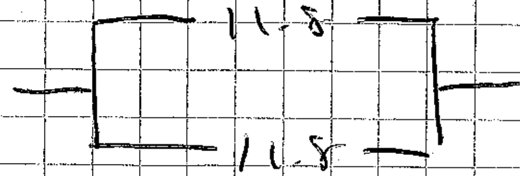
(23) $R = 1.8 + 10 = 11.8$



$$\frac{1}{R} = \frac{1}{11.8} + \frac{1}{11.8}$$

$$\frac{1}{R} = 0.169$$

$$R = \boxed{5.9\ \Omega}$$

(24) $W = F \cdot d$

$= (7200)(50)$

$W = 360\ 000\ J$

Since the elevator is only 50% efficient, we must spend 2x this.

So $W = 2(360\ 000) = 720\ 000\ J$

$$720\ 000\ J \times \frac{1\ kWh}{3.6 \times 10^6\ J} = 0.2\ kWh$$

Cost = 0.2 kWh × \$0.078 / kWh = \$0.016

or

1.6 cents

(25) a) $P = \frac{V^2}{R}$

$2 = \frac{V^2}{1500}$

$V^2 = 3000$

$V = \boxed{54.8\ V}$

b) $P = I^2 R$

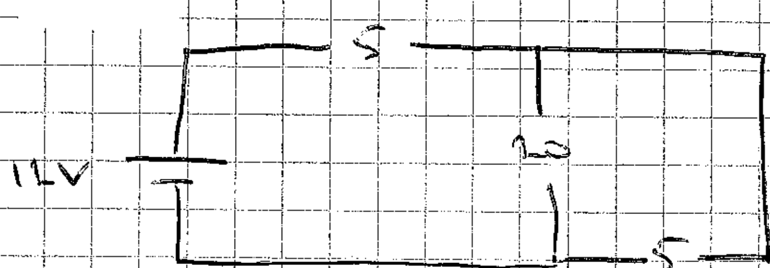
$2 = I^2 (1500)$

$I = \sqrt{\frac{2}{1500}}$

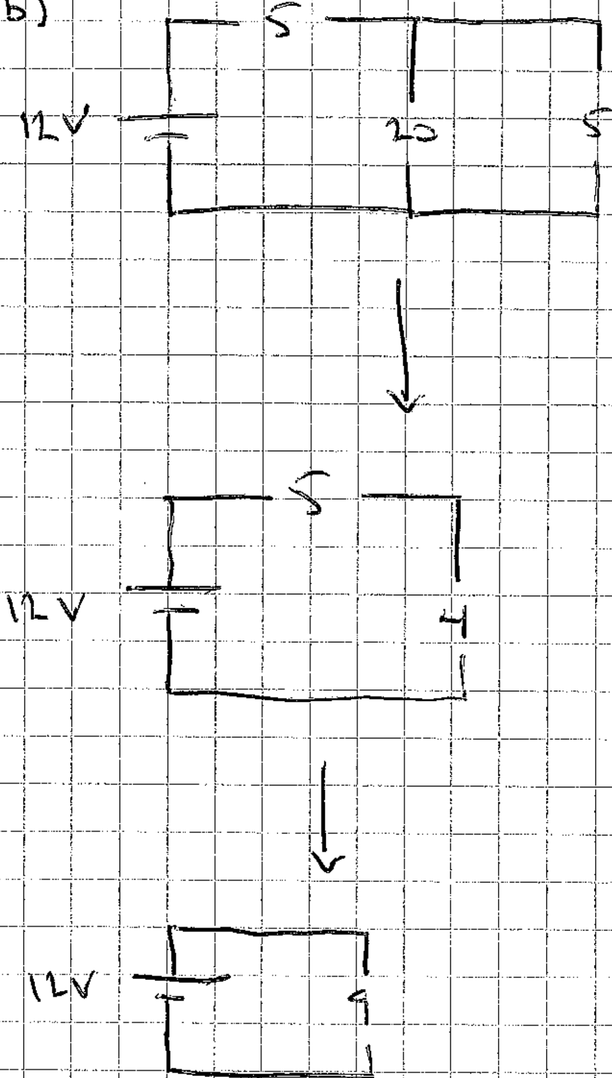
$I = \boxed{0.037\ A}$

(26) a) $I_{10} = 0$

The wire with no resistor on it will act as a short circuit. This will result in no current going through the $10\,\Omega$ resistor. (The $10\,\Omega$ resistor might as well not be there - see circuit below.)



(26) b)



$$\frac{1}{R} = \frac{1}{20} + \frac{1}{5}$$

$$\frac{1}{R} = \frac{5}{20}$$

$$R = 4\,\Omega$$

$$R = 5 + 4 = 9\,\Omega$$

$$I_{Total} = \frac{V}{R} = \frac{12}{9} = 1.\bar{3}\text{ A}$$

$$V_4 = IR$$

$$= (1.\bar{3})(4)$$

$$V_4 = 5.\bar{3}\text{ V}$$

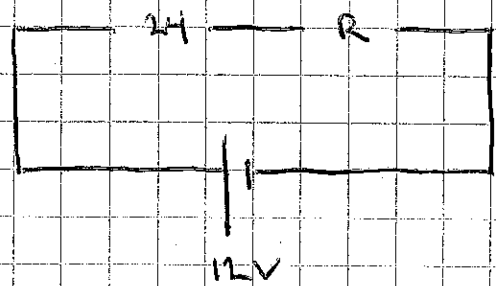
$$V_{20} = V_4 = 5.\bar{3}\text{ V}$$

$$I_{20} = \frac{V}{R}$$

$$= \frac{5.\bar{3}}{20}$$

$$I_{20} = \boxed{0.2\bar{6}\text{ A}}$$

(27)



a) $V_{battery} = V_{24} + V_R$

$12 = V_{24} + 3.60$

$V_{24} = \boxed{8.40\ V}$

b) $I_{24} = \frac{V}{R} = \frac{8.40}{24} = \boxed{0.35\ A}$

c) $R = \frac{V}{I} = \frac{3.60}{0.35} = \boxed{10.3\ \Omega}$

d) $P_{24} = I^2R = (0.35)^2(24) = 2.94\ W$

$P_{10} = I^2R = (0.35)^2(10.3) = 1.26\ W$

$P_{total} = 2.94 + 1.26 = \boxed{4.2\ W}$

(28) a) Since the voltage drop across R_1 is 8 V, the drop across the parallel part of the circuit must be:

$$V_2 = V_3 = 24 - 8 = 16\ V$$

$$R_2 = \frac{V_2}{I_2} = \frac{16}{0.2} = \boxed{80\ \Omega}$$

$$P_3 = \frac{V_3^2}{R_3}$$

$$R_3 = \frac{V_3^2}{P_3} = \frac{(16)^2}{2.56} = \boxed{100\ \Omega}$$

$$I_3 = \frac{V_3}{R_3} = \frac{16}{100} = 0.16\ A$$

$$I_1 = I_2 + I_3$$

$$= 0.2 + 0.16$$

$$I_1 = 0.36\ A$$

$$R_1 = \frac{V_1}{I_1} = \frac{8}{0.36} = \boxed{22.\bar{2}\ \Omega}$$

b)

$$\boxed{\begin{aligned} I_1 &= 0.36\ A \\ I_2 &= 0.2\ A \\ I_3 &= 0.16\ A \end{aligned}}$$

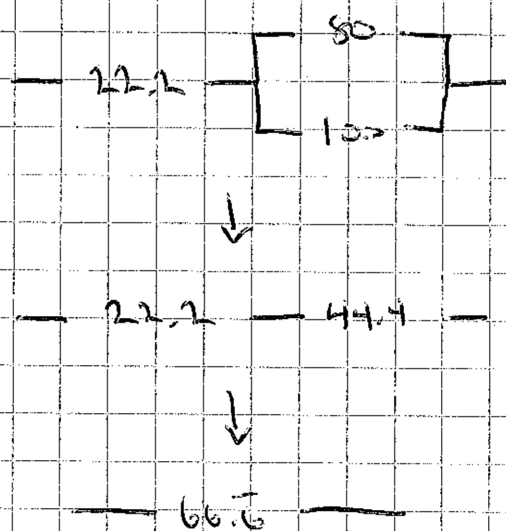
see question (a) for the work.

(28) c) $P_1 = I_1^2 R_1 = (0.36)^2 (22.\bar{2}) = \boxed{2.88 \text{ W}}$

$P_2 = I_2^2 R_2 = (0.2)^2 (80) = \boxed{3.2 \text{ W}}$

$P_3 = I_3^2 R_3 = (0.16)^2 (100) = \boxed{2.56 \text{ W}}$

d)



$\frac{1}{R} = \frac{1}{80} + \frac{1}{100}$

$\frac{1}{R} = 0.0225$

$R = 44.\bar{4}\ \Omega$

$R = 22.\bar{2} + 44.\bar{4}$

$R = \boxed{66.\bar{6}\ \Omega}$

e) $I = \frac{V}{R}$

$= \frac{(24)}{66.\bar{6}}$

$I = \boxed{0.36 \text{ A}}$

f) $P = IV$

$= (0.36)(24)$

$P = \boxed{8.64 \text{ W}}$