Multiple Choice & Short Answer

(5 points each)

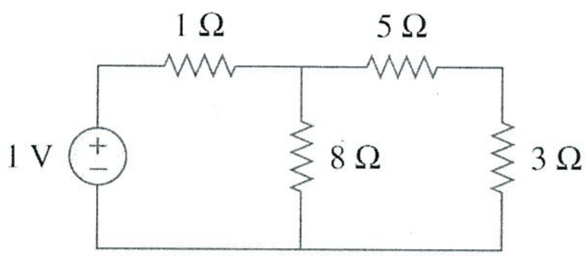
1) For the circuit below, if the 3Ω resistor is removed (and there is an open circuit where it previously was) then the current supplied by the source:

a) is doubled
b) increases
c) decreases ◯
d) is unchanged

Ckt as given

$R_{eq} = 1 + 8 \| (5+3) = 5\Omega$

$I = \frac{1V}{5\Omega} = 0.2\,A$



Ckt w/3Ω removed

$R_{eq} = 1 + 8 = 9\Omega$

$I = \frac{1V}{9\Omega} < \frac{1V}{5\Omega}$

2) For the same circuit as in question (1) above, if the 1Ω resistor is shorted out then the current supplied by the source:

a) is doubled
b) increases ◯
c) decreases
d) is unchanged

Ckt w/1Ω shorted

$R_{eq} = 8 \| (5+3) = 4\Omega$

$I = \frac{1V}{4\Omega} > \frac{1V}{5\Omega}$

3) Kirchoff's current law represents the conservation of ___CHARGE___.

4) Kirchoff's voltage law represents the conservation of ___ENERGY___.

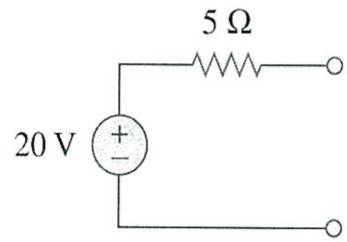
(conservation of momentum is also ok)

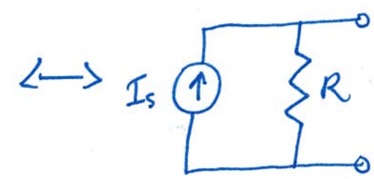
5) For the circuit below, an equivalent circuit would consist of:

a) A 20 V source in series with a 100Ω resistor
b) A 20 A source in parallel with a 5Ω resistor
c) A 4 A source in parallel with a 5Ω resistor
d) A 4 V source in series with a 100Ω resistor
e) None of the above

$I_S = \frac{20V}{5\Omega} = 4A$

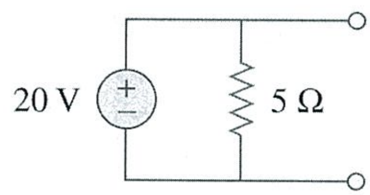
$R = 5\Omega$





6) For the circuit below, an equivalent circuit would consist of:

a) A 20 V source in series with a 100Ω resistor
b) A 20 A source in parallel with a 5Ω resistor
c) A 4 A source in parallel with a 5Ω resistor
d) A 4 V source in series with a 100Ω resistor
e) None of the above



7) For 3 parallel resistors of different resistance, $R_1 > R_2 > R_3$, the equivalent resistance is

a) Greater than the value of R_3
b) Less than the value of R_1
c) Less than the value of R_3
d) Greater than the value of R_1
e) None of the above

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

R_{eq} will always be of lesser value than the smallest R_i

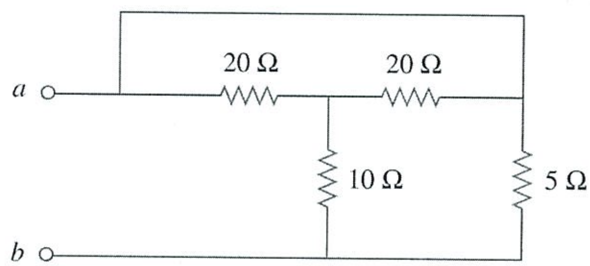
8) For 3 parallel resistors of different resistance, $R_1 > R_2 > R_3$, powered by a current course, I_s, the following is true about the circuit:

a) The current through R_3 is the greatest
b) The current through R_1 is the greatest
c) The current is equal through all three resistors
d) The voltage across R_1 is the greatest
e) None of the above

The current will divide so that the greatest portion flows through the least resistance

9) The equivalent resistance for the circuit below is

a) $R_{eq} = 33\ \Omega$
b) $R_{eq} = 10\ \Omega$
c) $R_{eq} = 5\ \Omega$
d) None of the above



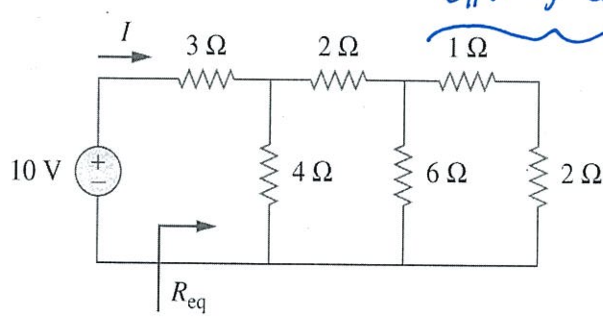
10) The current supplied by the source for the circuit below is

a) $I = 1.25$ A
b) $I = 2$ A
c) $I = 3.3$ A
d) None of the above

$R_{eq} = 3 + 2 = 5\Omega \therefore 10V/5\Omega = 2A$

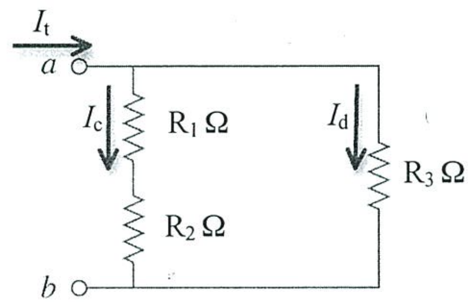
$4 \| (2+2) = 2\Omega$

$6 \| (1+2) = 2\Omega$



11) **DERIVE** the expression for the equivalent resistance for the circuit below. (20 points)

- Start with Ohm's Law, Kirchhoff's Current Law (KCL), and Kirchhoff's Voltage Law (KVL)
    - You may use the current as labeled: I_t for the 'total' current into the circuit at node *a*, I_c for the current through the branch with R_1 and R_2, and I_d for the current through the branch with R_3
    - You may not use expressions for series or parallel equivalent resistance without first deriving them.
- End with an expression for $R_{eq} = f(R_1, R_2, R_3)$ (*i.e.*, R_{eq} is equal to an expression containing only R_1, R_2, R_3)



First find Req for branch "c" ≡ Rc → series combo of $R_1 + R_2$

Ohm: $V = IR$

KCL: all current equal: $I_c = I_{R1} = I_{R2}$

KVL: $V_{ab} \equiv V_c = V_{R1} + V_{R2}$

subs in ohm's Law: $I_c R_c = I_{R1} R_1 + I_{R2} R_2$ ⇒ KVL w/ Ohm subs. in

cancel all current since are all equal, thus $R_c = R_1 + R_2$

Now parallel combination of branch "c" ∥ branch "d"

KCL: $I_t = I_c + I_d$

KVL: $V_{ab} = V_c = V_d$ → $V_{ab} = (V_{R1} + V_{R2}) = V_{R3}$

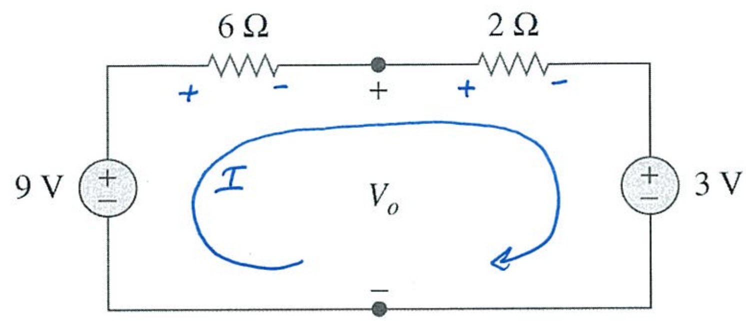
using Ohm's Law as $I = V/R$

Subs. Ohm's Law into KCL $\frac{V_{ab}}{R_{eq}} = \frac{V_c}{R_c} + \frac{V_d}{R_d}$; $R_c = R_1 + R_2$ (above), $R_d \equiv R_3$

cancel voltages since all are equal, via KVL

thus $\frac{1}{R_{eq}} = \frac{1}{R_1 + R_2} + \frac{1}{R_3}$ ∴ $R_{eq} = \frac{(R_1 + R_2) R_3}{R_1 + R_2 + R_3}$ Ω

12) Find V_0 in the circuit below. (15 points)

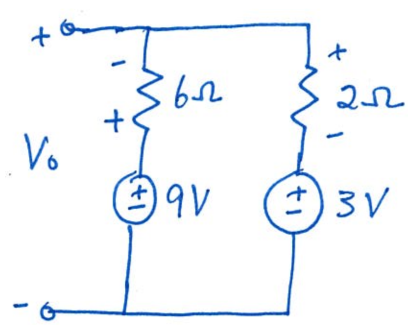


Use mesh analysis $\sum V_{loop} = 0$

$$-9 + 6I + 2I + 3 = 0$$

$$8I = 6 \quad \text{or} \quad I = \frac{6}{8} = \frac{3}{4}\ A$$

Next observe ckt can be drawn as



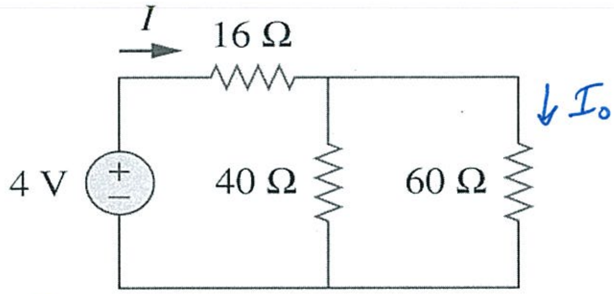
using left branch

$$V_o = 9 - 6I = 9 - 4.5 = 4.5\ V$$

using right branch

$$V_o = 3 + 2I = 3 + 1.5 = 4.5\ V$$

13) Find the current through the 60 Ω resistor. (15 points)



Strategy: • find I
• use current divider to find I_o

$I = \frac{4V}{R_{eq}}$ so find R_{eq}: $40 \| 60 = \frac{2400}{100} = 24\Omega$

so $R_{eq} = 16 + 24 = 40\Omega$

thus $I = \frac{4V}{40\Omega} = 0.1\,A$

Applying current divider to original circuit

$I_o = I\left(\frac{40}{60+40}\right) = 0.04A$