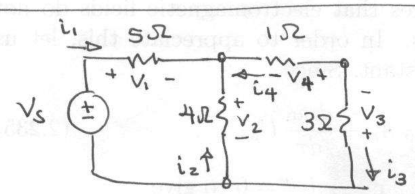
M 08-OCT-2007

PHYSICS 116A HW # 1

CH1: 8, 12, 18 ; CH2: 6, 8, 30, 47, 48, 59

1-8



~~GIVEN: V_1 = 30V~~

a) Given $V_1 = 30\text{ V}$; find i_1

$$V_1 = i_1 R_1 \Rightarrow 30\text{V} = i_1 (5\,\Omega) \Rightarrow \boxed{i_1 = 6\text{A}}$$

b) Given $V_2 = 12\text{V}$; find i_2

$$i_2 = -V_2 / R_2 = -12\text{V}/4\,\Omega \Rightarrow \boxed{i_2 = -3\text{A}}$$

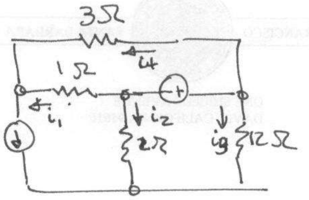
c) Given $V_2 = -9\text{V}$; find i_3

$$i_3 = -V_3 / 3\,\Omega = -(-9\text{V})/3\,\Omega \Rightarrow \boxed{i_3 = +3\text{A}}$$

d) Given $V_4 = -3\text{V}$; find i_4

$$i_4 = V_4 / R_4 = -3\text{V}/1\,\Omega \Rightarrow \boxed{i_4 = -3\text{A}}$$

1.12



a) Given $i_1 = -4A$; find v_1

$$v_1 = -i_1 R_1 = -(-4A)(1\Omega) \Rightarrow \boxed{v_1 = +4V}$$

b) Given $i_2 = 1A$; find v_2

$$v_2 = i_2 R_2 = (1A)(2\Omega) \Rightarrow \boxed{v_2 = 2V}$$

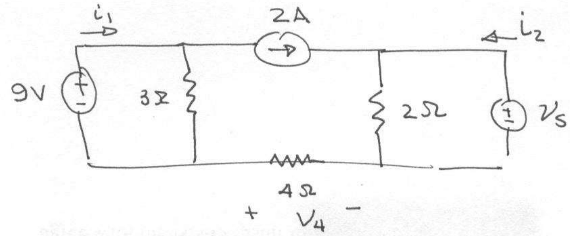
c) Given $i_3 = 1A$; find V_3

$$v_3 = -i_3 R_3 = -(1A)(12\Omega) \Rightarrow \boxed{V_3 = -12V}$$

d) Given $i_4 = 2A$; find V_4

$$V_4 = i_4 R_4 = (2A)(3\Omega) \Rightarrow \boxed{V_4 = +6V}$$

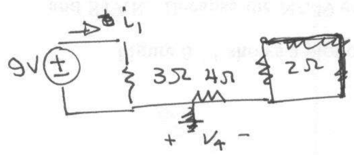
1.18



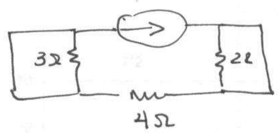
Find V_4 for $V_s = 2, 4, 6\,V$

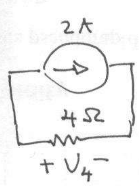
This is a perfect superposition problem:

lets consider ~~one~~ each source independently:

- 

V_4 from the 9V = 0

- 

⇒ 

$V_4 = -8V$

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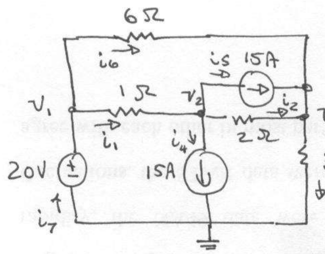
⇒ V_s only effects the current through the 2Ω.

⇒ for all values of V_s, $\boxed{V_4 = -8V}$

2.6



Find v_1, v_2, v_3

$$\boxed{v_1 = 20V}$$

by KCL @ node v_2 $\quad \frac{v_2 - 20}{1\Omega} + 15 + 15 + \frac{v_2 - v_3}{2\Omega} = 0$

$$2v_2 - 40 + 60 + v_2 - v_3 = 0$$

$$3v_2 - v_3 = -20 \qquad \text{eq 1}$$

KCL @ node v_3

$$15 = \frac{v_3 - 20}{6} + \frac{v_3 - v_2}{2} + \frac{v_3}{3}$$

$$90 = v_3 - 20 + 3v_3 - 3v_2 + 2v_3$$

$$-3v_2 + 6v_3 = 110 \qquad \text{eq2}$$

2 Eqns
2 unknowns

Add eq1 + eq2

$$5v_3 = 90 \Rightarrow \boxed{v_3 = 18V}$$

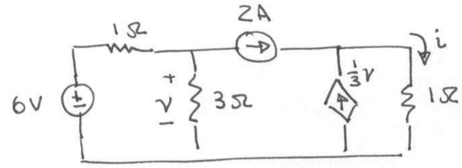
USE EQ1:

$$3v_2 - 18 = -20$$

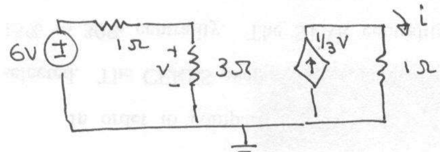
$$3v_2 = -2$$

$$\boxed{v_2 = -2/3}$$

2.59



a) Find i and v due to 6V source



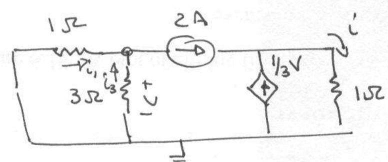
current source becomes open

$\cancel{v = \frac{6V}{3\Omega} = 2A}$

Voltage divider: $v = \frac{3}{4}(6V) = \boxed{4.5V}$

$i = \frac{1}{3}v = \boxed{1.5A}$

b) Find i and v due to 2A source



Voltage source becomes short

i_1 and i_3 are a current divider of 2A

$i_3 = \frac{R_1}{R_1+R_3} I = \frac{1}{4}(2A) = 0.5A$

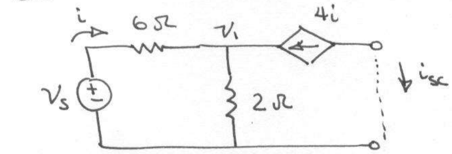
$v = (-0.5A)(3\Omega) = \boxed{-1.5V}$

$i = 2A + \frac{1}{3}(-1.5V) = 2A - 0.5A = \boxed{1.5A}$

c) $v_{TOT} = 4.5 - 1.5 = \boxed{3.0V}$

$i_{TOT} = 1.5 + 1.5 = \boxed{3.0A}$

2.47 Demonstrate that the Norton Equivilent



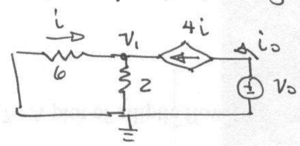
First find the I_{eq}, which is the short circuit current

KCL @ v_1, $i + 4i = \frac{v_1}{2} \Rightarrow 5i = \frac{v_1}{2} \Rightarrow 5\left(\frac{v_s - v_1}{6\Omega}\right) = \frac{v_1}{2}$

$5v_s - 5v_1 = 3v_1 \Rightarrow 5v_s = 8v_1 \Rightarrow v_1 = \frac{5}{8} v_s$

$i_{sc} = -4i = -4\left(\frac{v_s - v_1}{6}\right) = -4\left(\frac{v_s - \frac{5}{8}v_s}{6}\right) = -4\left(\frac{3}{48}v_s\right) = \boxed{\frac{-v_s}{4}}$

Next, find Req by putting v_o across the load



KCL @ v_1: $i + 4i = \frac{v_1}{2} \Rightarrow 5i = \frac{v_1}{2} \Rightarrow 5\left(\frac{-v_1}{6}\right) = \frac{v_1}{2}$

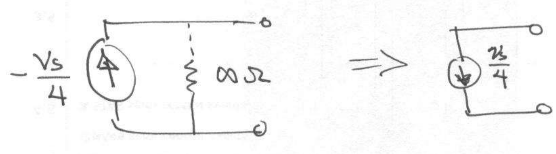
$-5v_1 - 3v_1 = 0 \Rightarrow v_1 = 0$

$\Rightarrow i = 0$

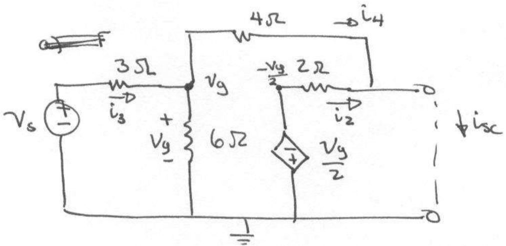
$\Rightarrow i_o = 0$

$R_{eq} = \frac{v_o}{i_o} = \frac{v_o}{0} = \infty$

Norton Equivilent:



2.48

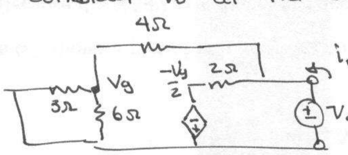


a) Find the Norton Equivilent

First find i_{sc} : $i_{sc} = i_2 + i_4$

$$i_{sc} = \frac{(-V_g/2)}{2} + \frac{V_g}{4} = -\frac{V_g}{4} + \frac{V_g}{4} = \boxed{0}$$

Next, consider V_o at the load to determine R_{eq}



consider 3Ω ∥ 6Ω ⇒ $R_{11} = \frac{(3)(6)}{3+6} = 2\,\Omega$

get V_g from voltage division ⇒ $V_g = \frac{2}{2+4} V_o = \frac{1}{3} V_o$

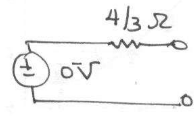
get i_o from KCL @ V_o

$$i_o = \cancel{\frac{V_g - V_o}{4}} - (i_4 + i_2) = -\left(\frac{V_g - V_o}{4} + \frac{\left(-\frac{V_g}{2} - V_o\right)}{2}\right)$$

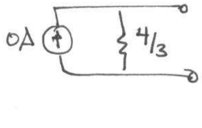
$$i_o = -\left(\cancel{\frac{V_g}{4}} - \frac{V_o}{4} - \cancel{\frac{V_g}{4}} - \frac{V_o}{2}\right) = +\frac{3V_o}{4}$$

$$R_{eq} = \frac{V_o}{i_o} = \frac{V_o}{\frac{3}{4}V_o} = \boxed{\frac{4}{3}\,\Omega}$$

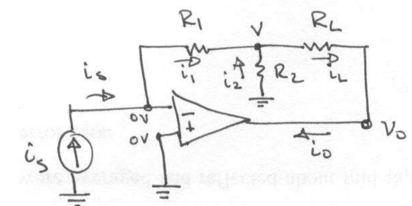
b)



a)



2.28



Find a) v_o

b) i_o

KCL @ node v : $i_1 + i_2 = i_L = i_o$

$$\frac{-v}{R_1} - \frac{v}{R_2} = \frac{v - v_o}{R_L} = i_o$$

$$i_1 = i_s = \frac{-v}{R_1} \Rightarrow v = -i_s R_1$$

$$i_s + i_s \frac{R_1}{R_2} = i_o \Rightarrow \boxed{i_o = \left(\frac{R_2 + R_1}{R_2}\right) i_s}$$ b)

$$\frac{v - v_o}{R_L} = i_o \Rightarrow \frac{-i_s R_1 - v_o}{R_L} = i_o$$

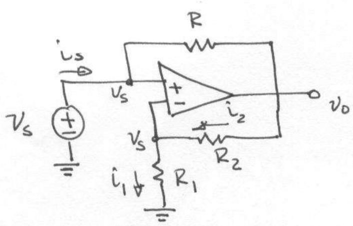
$$-i_s R_1 - v_o = i_o R_L$$

$$v_o = -i_s R_1 - i_o R_L$$

$$v_o = -i_s R_1 - \left(\frac{R_2 + R_1}{R_2}\right) R_L \, i_s$$

a) $$\boxed{v_o = -\left(R_1 + R_L + \frac{R_1 R_L}{R_2}\right) i_s}$$

2.30



find a) v_o

b) resistance v_s / i_s

$$i_2 = i_1 \Rightarrow \frac{v_o - v_s}{R_2} = \frac{v_s}{R_1}$$

$$v_o - v_s = \frac{R_2}{R_1} v_s$$

$$v_o = \frac{R_2}{R_1} v_s + v_s = \boxed{\left(\frac{R_2 + R_1}{R_1}\right) v_s}$$

b) $$i_s = \frac{v_s - v_o}{R} = \frac{v_s}{R} - \frac{1}{R}\left(\frac{R_2 + R_1}{R_1}\right) v_s$$

$$= \cancel{\frac{v_s}{R}} - \frac{R_2}{R R_1} v_s - \cancel{\frac{v_s}{R}} = -\frac{R_2}{R R_1} v_s$$

$$\boxed{\frac{v_s}{i_s} = -\frac{R R_1}{R_2}}$$