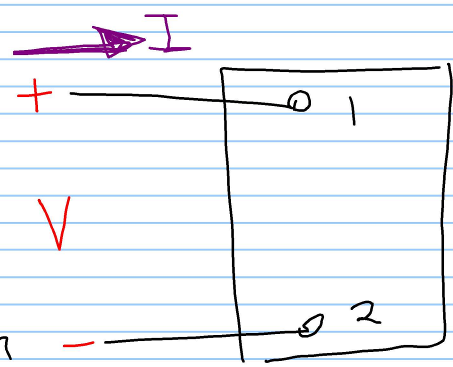
chapter 1

Voltage, current
power, Energy

→ Passive Sign Convention :-

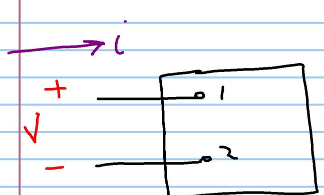
uses a +ve sign in the expression that relates the voltage & current at the terminals of an element when the reference direction for the current through the element is in the direction of the reference voltage drop across the element



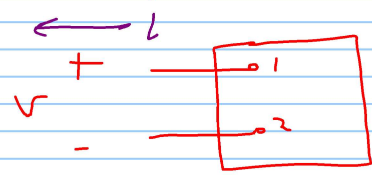
$$\boxed{P = VI} \quad \text{OR} \quad \boxed{P = -VI} \quad \text{Watts}$$

→ if $P > 0$, Power is being delivered to the circuit or circuit component. (element is absorbing power)

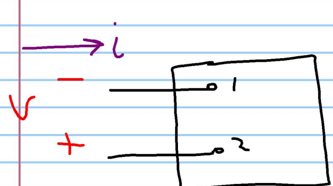
→ if $P < 0$, Power is being extracted from the circuit or circuit component. (element is delivering Power)



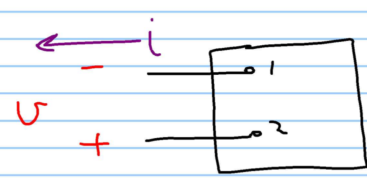
$P = VI$



$P = -VI$



$P = -VI$



$P = VI$

chapter 2

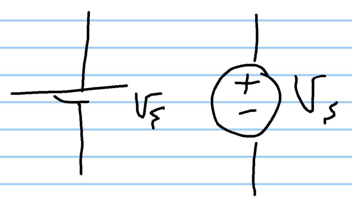
2.1 Voltage & current sources

voltage source } → dependent
current // } → independent

→ **Independent** → it's value is not influenced by any other current or voltage in the circuit
Ideal sources

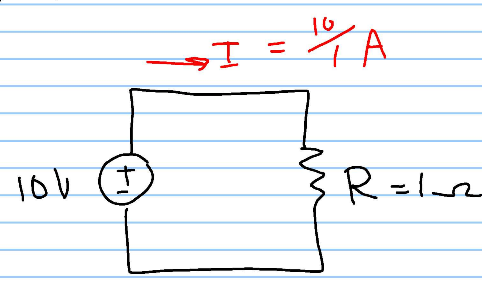
→ **dependent** → it's value is determined by some other current or voltage in the circuit

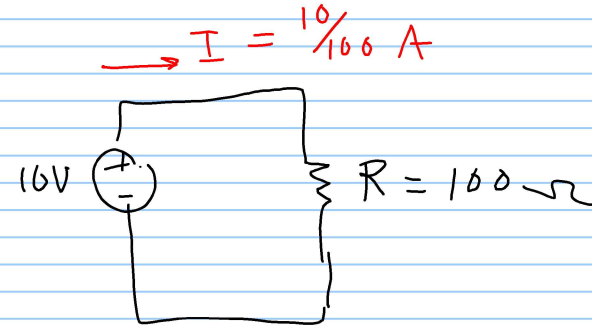
Ideal voltage source: maintain a prescribed voltage. regardless of the current in the device

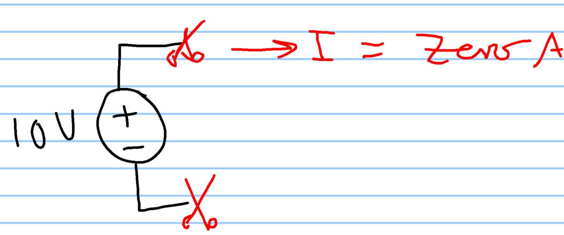


Ideal indep. voltage source

Ex)

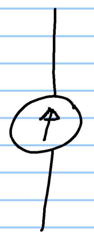






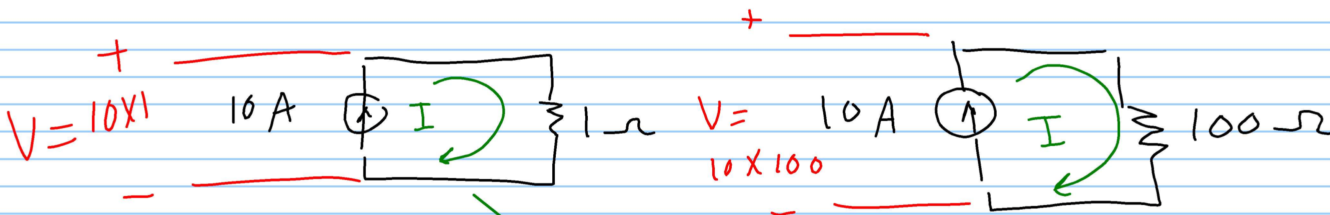
Ideal current source

maintain a prescribed current, regardless of the voltage in the device



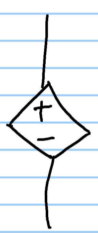
i_s Ideal Indep. current source

EX)

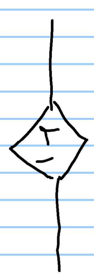


$I = 10A$

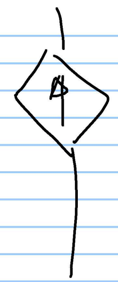
dependent sources — controlled sources



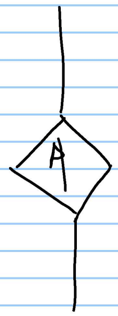
$v_s = \mu v_x$ — Ideal dep. voltage-controlled voltage source



$v_s = \rho i_x$ — Ideal dep. current-controlled voltage source



$i_s = \alpha\, v_x$ Ideal dep. voltage-controlled current source

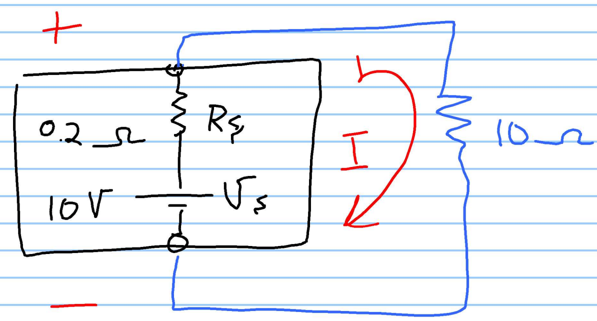


$i_s = \beta\, i_x$ Ideal dep. current-controlled current source

---

Ex:-

non-Ideal V

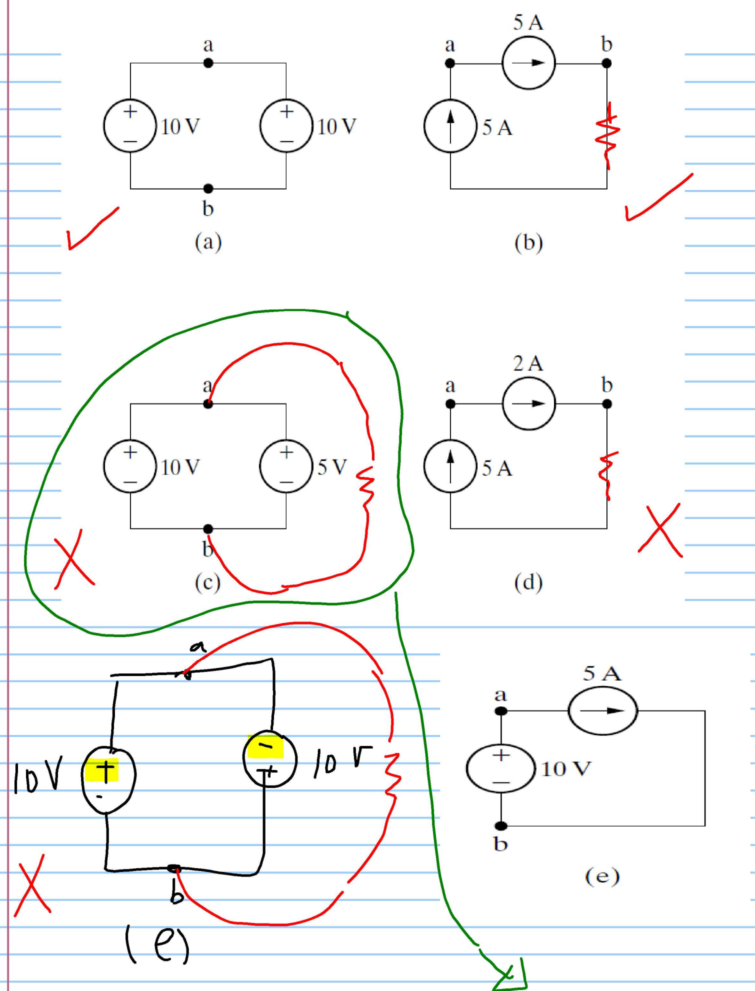


$$I = \frac{V_s}{10+0.2} = \frac{10}{10.2} = 0.98\ A$$

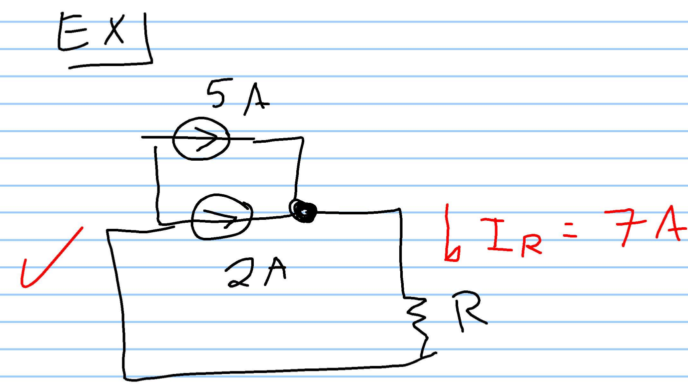
$$\therefore V = V_s - 0.2 \times 0.98$$
$$= 10 - 0.196 \simeq +9.804\ \text{Volt.}$$

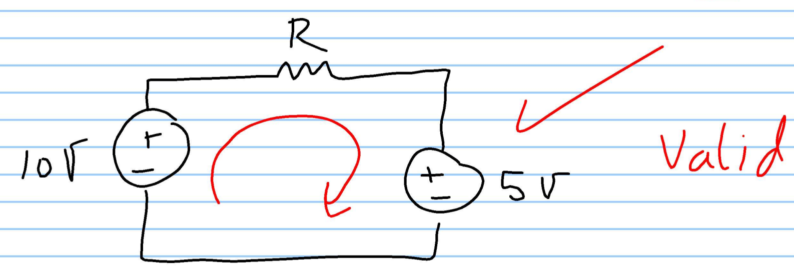
Example 2.1 Testing Interconnections of Ideal Sources

Using the definitions of the ideal independent voltage and current sources, state which interconnections in Fig. 2.3 are permissible and which violate the constraints imposed by the ideal sources.



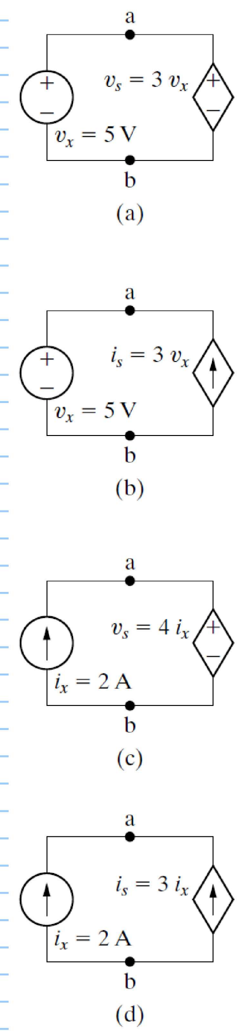
Ex1



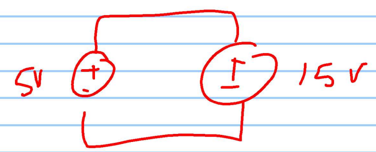


Example 2.2 **Testing Interconnections of Ideal Independent and Dependent Sources**

Using the definitions of the ideal independent and dependent sources, state which interconnections in Fig. 2.4 are valid and which violate the constraints imposed by the ideal sources.



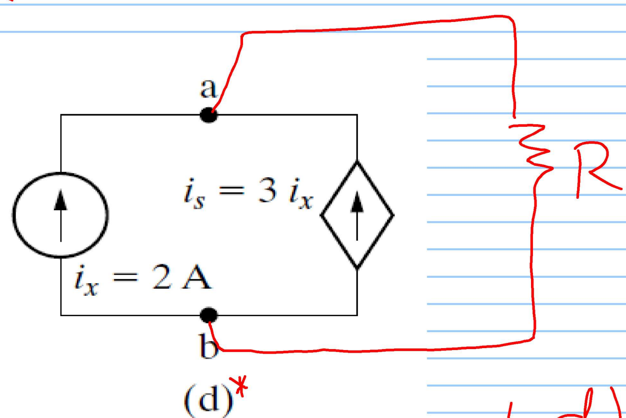
(a) X



(b) ✓

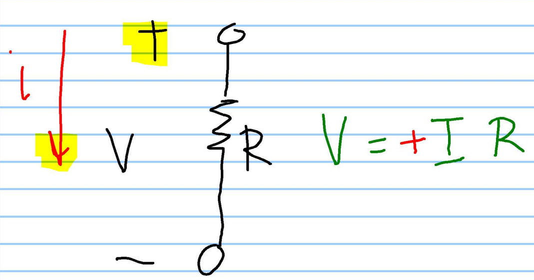
(c) ✓

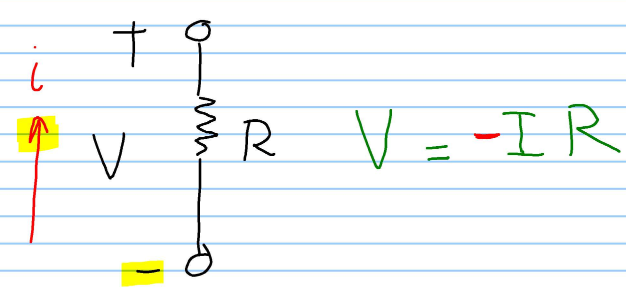
(d) X



(d)* ✓

2.2. Electrical Resistance (ohm's law)





→ Conductance G :-   ~~$R = \frac{\rho l}{A}$~~

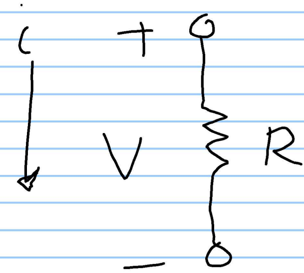
$$G = \frac{1}{R} \quad , \quad \mho \ \text{OR} \ S \ \text{siemens}$$

→ $P = v i$

$= (i R) i$

$\boxed{P = i^2 R}$, W

(+ve)



$P = v i$

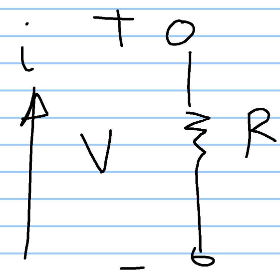
$= v \left(\frac{v}{R} \right)$

$\boxed{P = \frac{V^2}{R}}$

→ $P = - V i$

$= -(-i R) i$

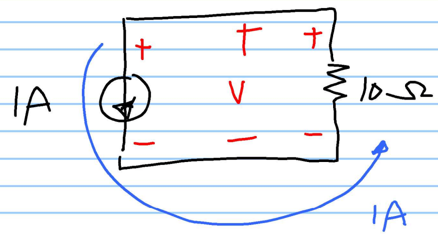
$= i^2 R$ (+ve)!



$\boxed{P = \frac{V^2}{R}}$

∴ The resistors (ONLY) absorbs power from the circuit !!

Ex1



find v

sol

* $v = -(1A)(10\Omega)$

$= -10\,V$

$P_R = i^2 R = 10 W = \frac{V^2}{R}$

OR * $P_R = -V I = -(-10)(1) = 10 W$ (absorbed)

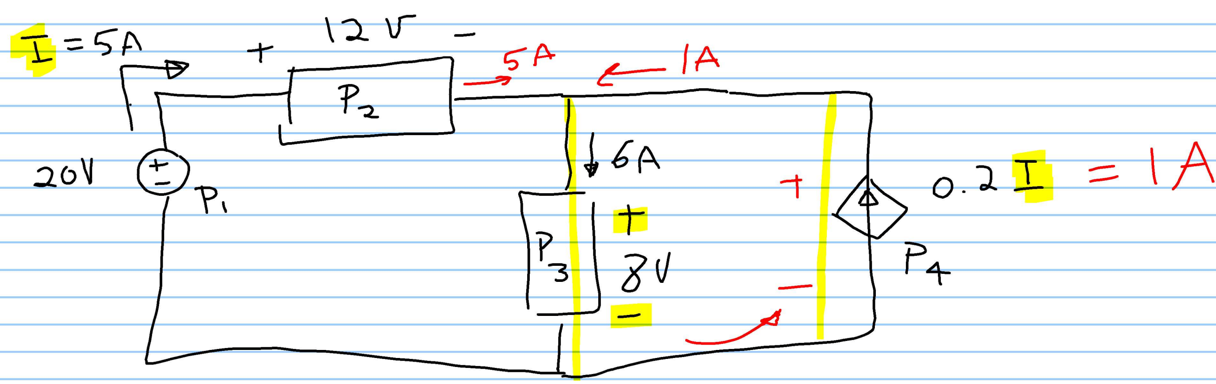
* $P_{1A} = VI = (-10)(1) = -10\,W$ (delivered)

∴ The algebraic sum of power in a circuit at any time must be zero

$$\sum p(t) = \text{Zero}$$

OR → $\sum P_{absorbed} = \sum P_{delivered}$

EX) $I = 5A$



Calculate the power supplied or absorbed by each element

sol

$P_1 = -(20)(5) = -100\,W$ (supplied (delivered))

$P_2 = +(12)(5) = 60\,W$ (absorbed)

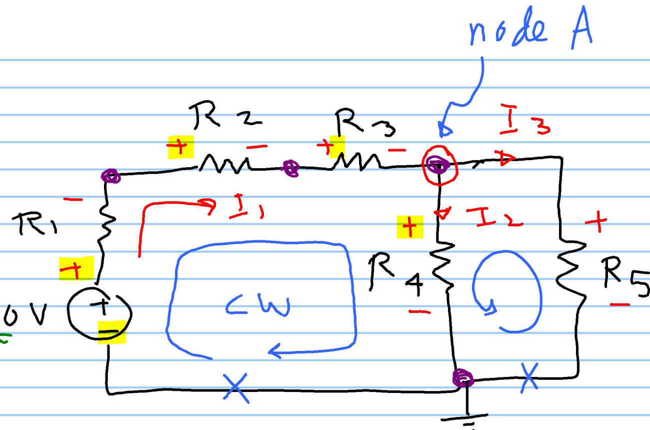
$P_3 = +(8)(6) = 48\,W$ (//)

$P_4 = -(8)(0.2 \times 5) = -8\,W$ (supplied)

$$\sum P_{abs.} = \sum P_{supp.}$$

$$60 + 48 = 100 + 8$$

2.4 Kirchhoff's laws:-



KCL Kirchhoff's current law

The algebraic sum of all currents at any node in a circuit equals zero. $\sum I_{in} = \sum I_{out}$

@node A) $I_1 = I_2 + I_3$ OR $I_1 - I_2 - I_3 = 0$

KVL Kirchhoff's voltage law

The algebraic sum of all voltages arround any closed path in a circuit equals zero.

closed path → CW, CCW

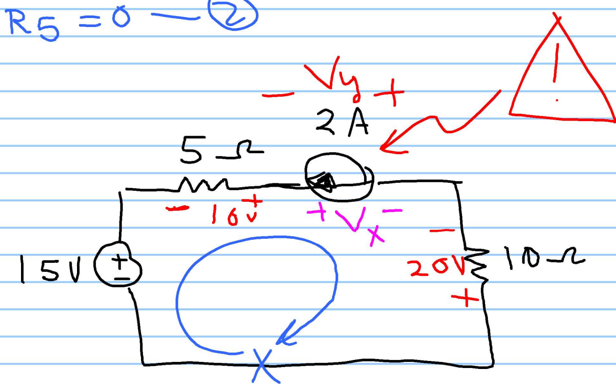
$-10V + V_{R_1} + V_{R_2} + V_{R_3} + V_{R_4} = 0$

$-10 + I_1 R_1 + I_1 R_2 + I_1 R_3 + I_2 R_4 = 0$ — ①

$-10 + I_1 R_1 + I_1 R_2 + I_1 R_3 + I_3 R_5 = 0$ — ②

$-I_3 R_5 + I_2 R_4 = 0$ — ③

EX) write the KVL equation



$-15 + 10 + 20$ X ✗

$-15 - 10 - 20 = 0$ ✗

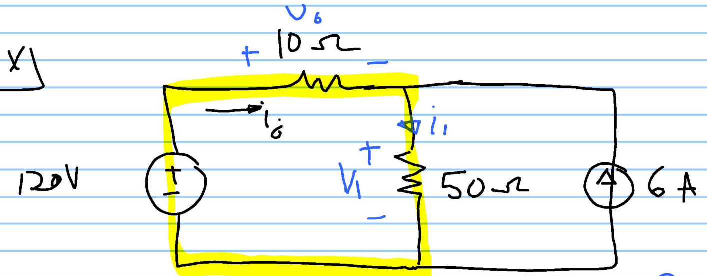
$\therefore -15 - 5 \times 2 + V_x - 10 \times 2 = 0$

$V_x = 45\ Volt$

$V_x = -V_y$

OR $-15 - 10 - V_y - 20 = 0 \Rightarrow V_y = -45\ Volt$

EX)



use KVL, KCL, ohm's law to find i_0.

KCL $i_0 + 6 = i_1$ — ①

KVL $-120 + 10 i_0 + 50 i_1 = 0$ — ②

} → $i_0 = -3A$, $i_1 = 3A$

$P_{50\Omega} = (3)^2 \times 50 = 450\,W$ (absorbed / dissipated)

$P_{10\Omega} = (-3)^2 \times 10 = 90\,W$ (" / ")

$V_o = -30V$, + 10 −, $i_o = -3A$ → $P_{10\Omega} = V_o i_o = (-30)(-3) = 90W$

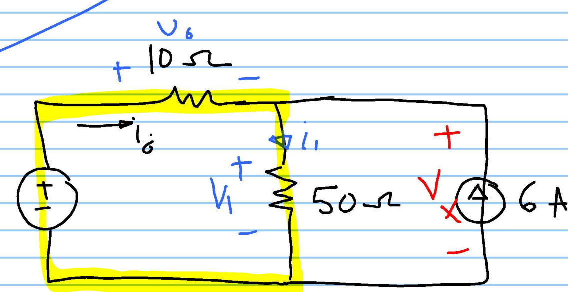
OR $V_o = -i_o \times 10 = -30V$, + 10Ω −, $i_o^* = 3A$

$P_{10\Omega} = -i_o^* V_o$
$= -(3)(-30) = 90W$

$P_{120V} = -(120V)(i_o)$
$= -(120)(-3) = 360W$ (absorbed)

$P_{6A} = ?$ $P_{6A} = -(360 + 90 + 450) = -900W$ (delivered)

OR $P_{6A} = -(6A)(V_x)$



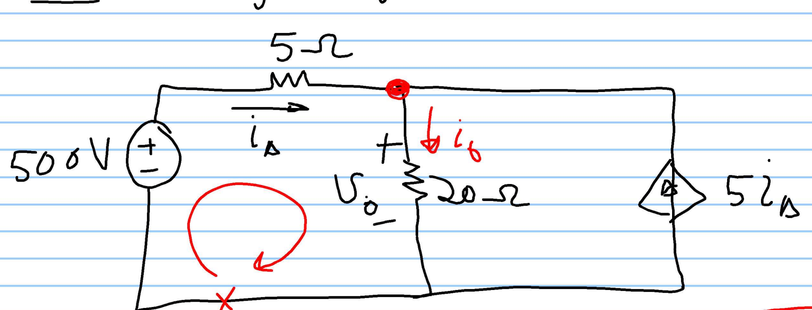
$V_x = V_1$ (KVL)

$-V_x + V_1 = 0$

$\therefore V_x = i_1 \times 50 = 150V$

$\therefore P_{6A} = -(6)(150)$
$= -900W$

2.5 Analysis of a circuit containing Dependent sources.



Find V_o

KCL $i_\Delta + 5 i_\Delta = i_o \Rightarrow$ $i_o = 6 i_\Delta$ —— (1)

KVL $\quad -500 + 5 i_\Delta + \overbrace{20 i_o}^{v_o} = 0$

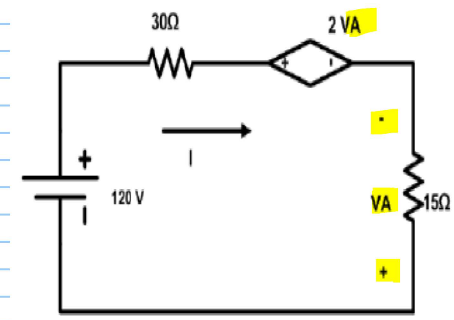
$$-500 + 5 i_\Delta + 20(6 i_\Delta) = 0$$

$$i_\Delta = \frac{500}{125} = 4\,A$$

$$\therefore\ i_o = 6 i_\Delta = 6 \times 4 = 24\,A$$

$$\therefore\ v_o = 20 \times i_o = 480\ \text{Volt.}$$

- Find I?



KVL

$$-120 + 30I + 2VA - VA = 0$$

$$30I + VA = 120 \quad —(1)$$

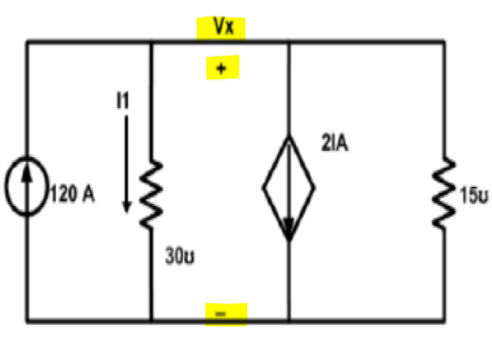
$\to$ $VA = -I \times 15$ sub in (1)

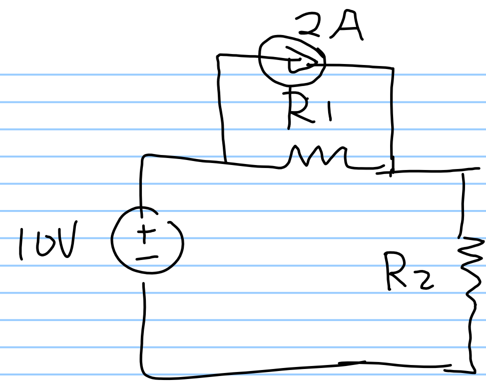
$$\therefore\ 30I - 15I = 120$$

$$I = \frac{120}{15} = 8\,A$$

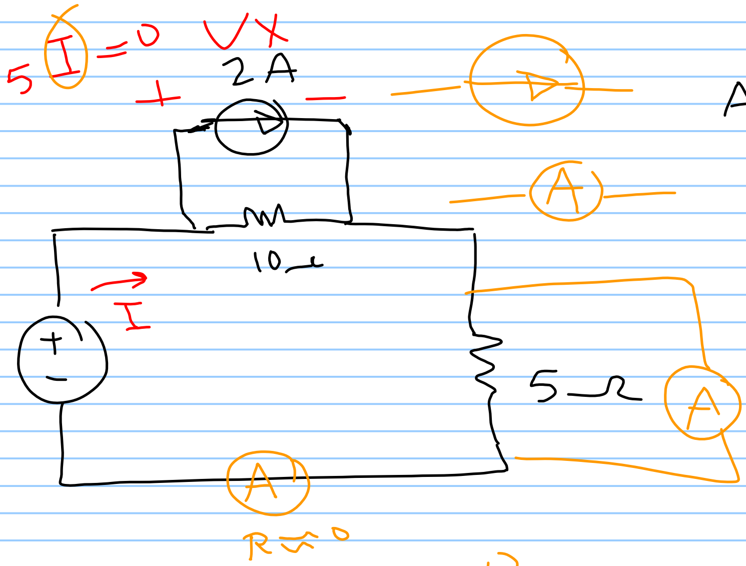
$$VA = -I \times 15 = -120\,V.$$

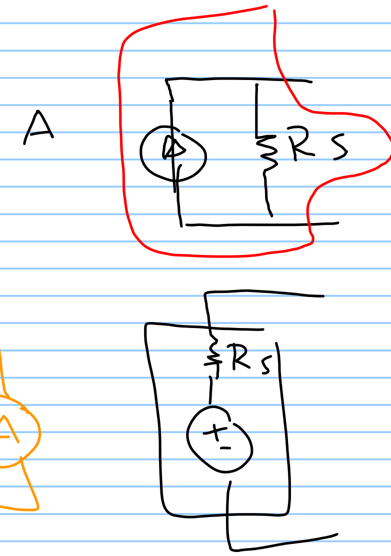
- Find Vx

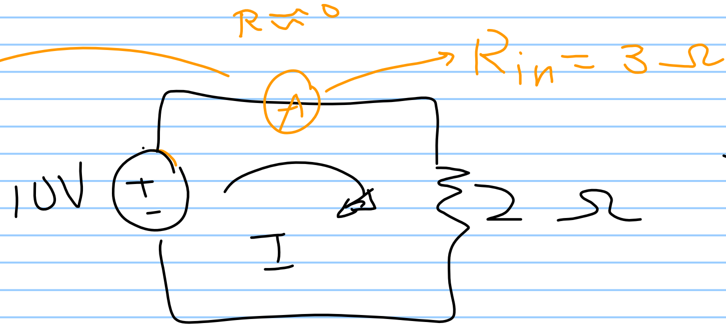




$-10 + 2A \; V_x + 5I = 0$







$\frac{10}{5} = 2A$

$I = \frac{10}{2} = 5A$