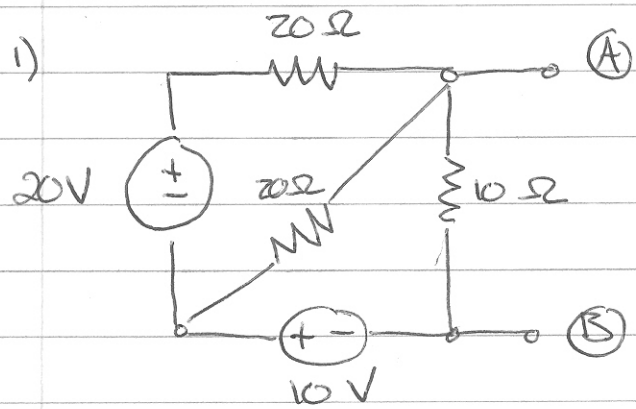
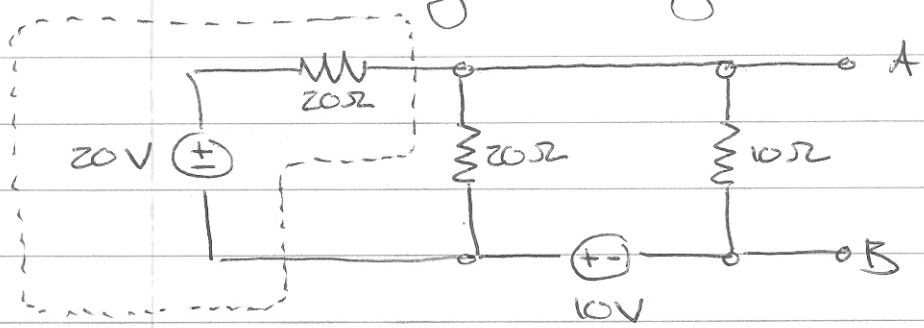
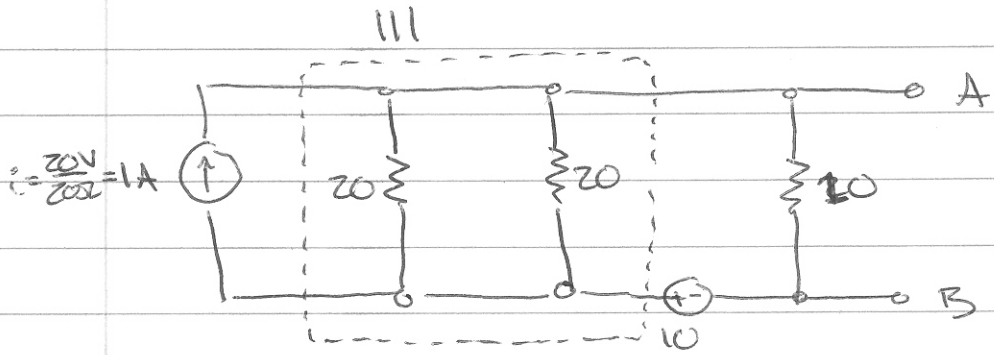
1)



+1 point per step, no need to explicitly show each w/ proper results!

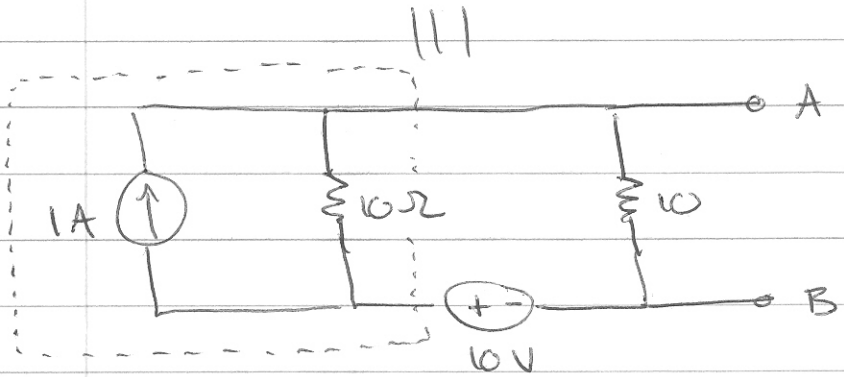
(i) Redrawing the original circuit:





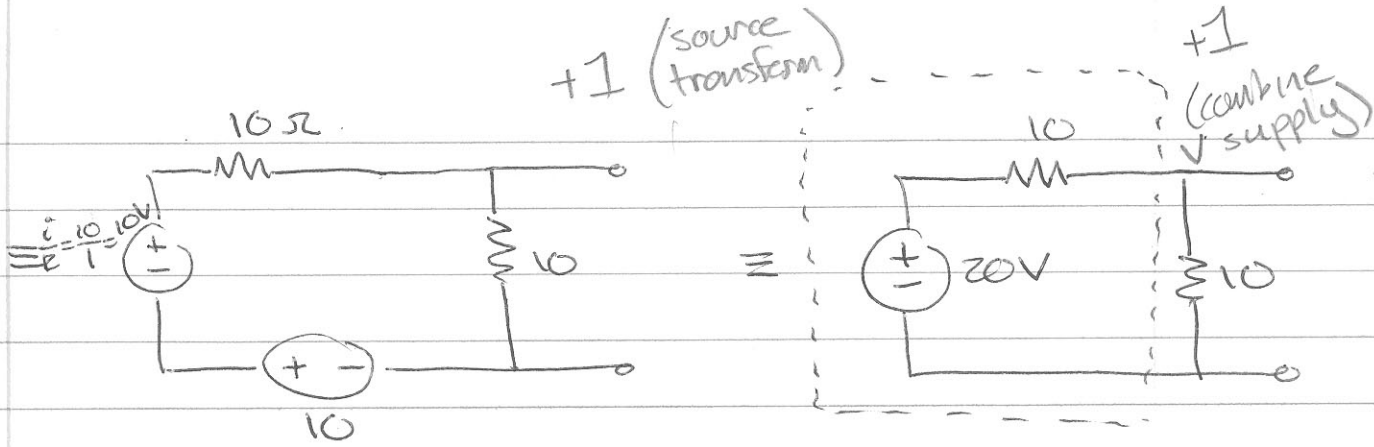
+1 (source transform)

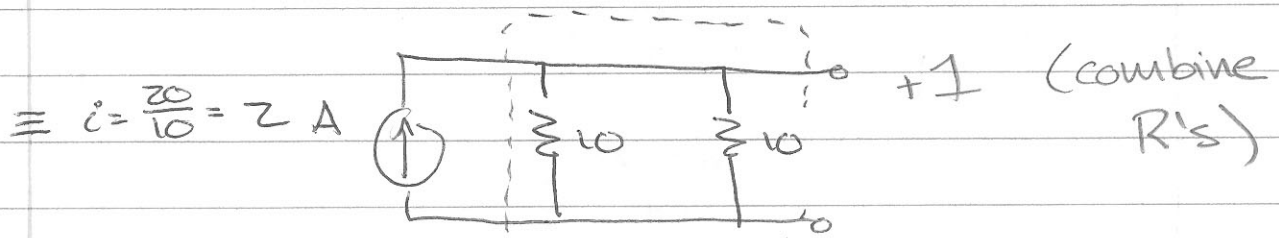
$$20\Omega \| 20\Omega = \frac{(20)(20)}{20+20} = \frac{400}{40} = 10\Omega$$



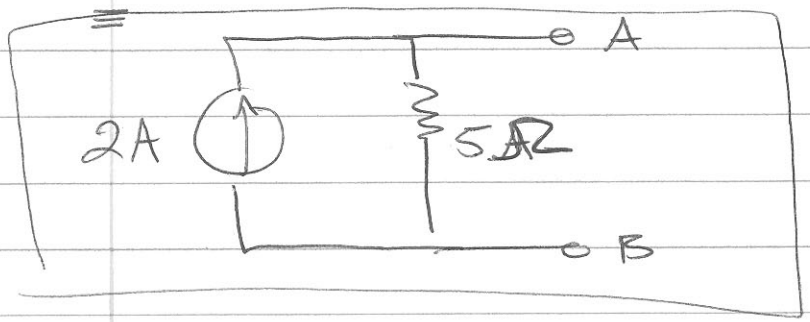
+1 (combining R's)

1 cont.)



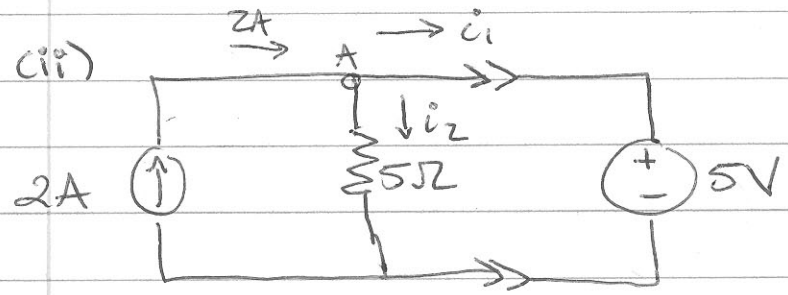


$10 \| 10 = \frac{10+10}{(10)(10)} = \frac{20}{100} = \frac{(10)(10)}{(10)+(10)} = \frac{100}{20} = 5$



+1 (show N-equivalent circuit)

(ii)



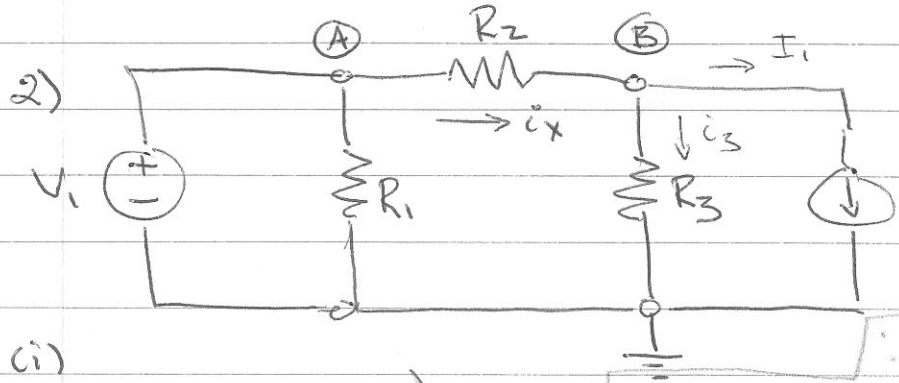
KCL @ A: $2A = i_1 + i_2$

$i_2 = \frac{5}{5} = 1A \Rightarrow 2A = 1A + i_2 \Rightarrow i_2 = 1A$

$P = iV \Rightarrow P = (1A)(5V) = \boxed{5\,W}$ +1

P is (+) $\Rightarrow$ the voltage supply absorbs power +1

2)



Need to give each equation for the nodes (+1) then supply an explanation (+2) (not necessarily an eq.) to get V_B.

(i)

$V_A - 0 = V_1 \Rightarrow \underline{V_A = V_1}$ +1

$i_x - i_3 - I_1 = 0, \quad i_x = \frac{V_A - V_B}{R_2} \quad i_3 = \frac{0 - V_B}{R_3}$

$\Rightarrow \frac{V_A - V_B}{R_2} - \frac{V_B}{R_3} - I_1 = 0$ +1

(subbing in $V_A = V_1$)

×2

$\Rightarrow \boxed{\frac{V_1 - V_B}{R_2} - \frac{V_B}{R_3} - I_1 = 0}$ and we solve this for V_B

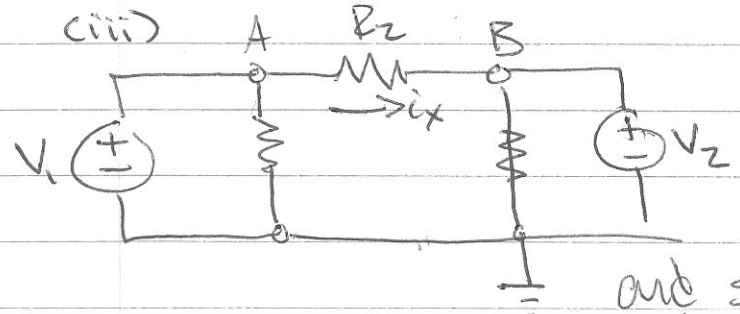
(ii) as noted $\boxed{i_x = \frac{V_A - V_B}{R_2}} \Rightarrow \boxed{i_x = \frac{V_1 - V_B}{R_2}}$

$\therefore \frac{V_1 - V_B}{R_2} - \frac{V_B}{R_3} - I_1 = 0 \Rightarrow i_x - \frac{V_B}{R_3} - I_1 = 0$

$\Rightarrow \boxed{i_x = I_1 + \frac{V_B}{R_3}}$ & V_B found above!

Any approp. eq. for i_x w/ respect to work in (i) +2

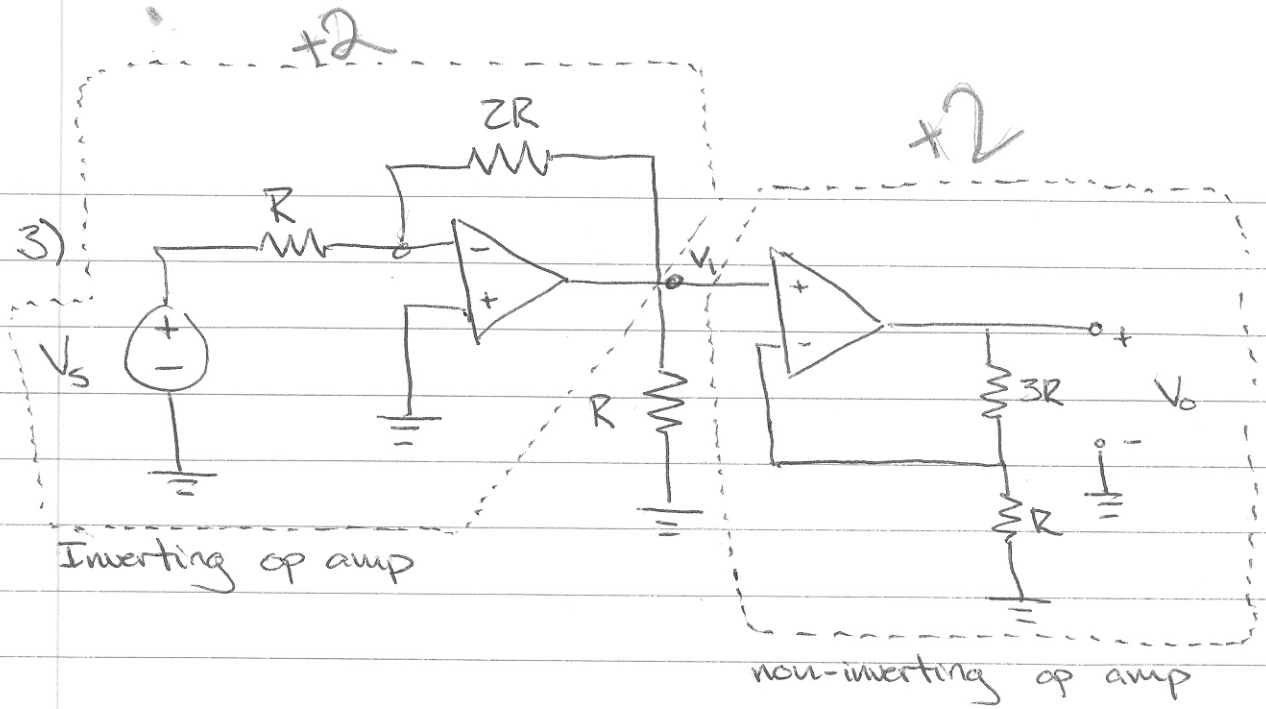
(iii)



$\underline{V_B = V_2}$! +1

$\Rightarrow$ we no longer need (i) and simply solve Ohm's law

$\frac{V_A - V_B}{R_2} = \boxed{i_x = \frac{V_1 - V_2}{R_2}}$ +1



(ii) inverting op amp: +2

$$\frac{V_1}{V_s} = -\left(\frac{2R}{R}\right) \Rightarrow \cancel{V_1 = -RV_s}$$

$$V_1 = -2V_s$$

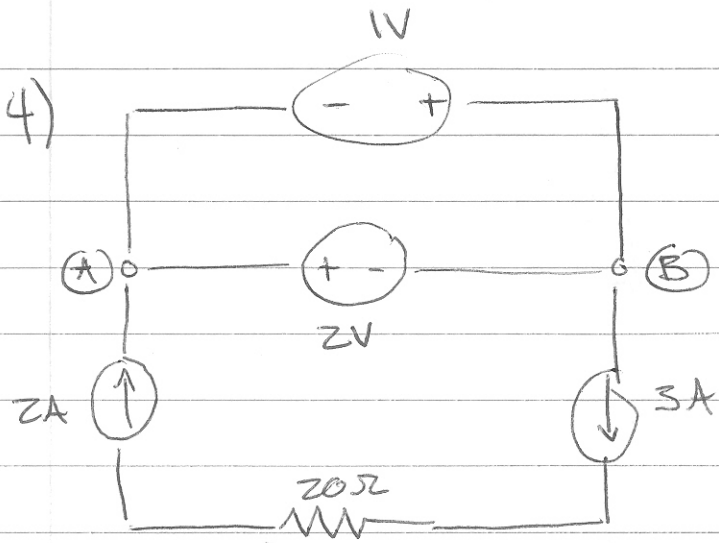
(this is the input voltage to the next block!)

non-inverting op amp: +2

$$\frac{V_o}{V_1} = \frac{(3R+R)}{R} \Rightarrow V_o = 4V_1$$

$$\therefore \quad V_o = 4(-2)V_s = \boxed{-8V_s = V_o}$$

4)



(Nodes (A) & (B) are both at 2V and 1V simultaneously!
∴ KVL is violated! +1/+2) +2

(if note this only +1)

(The resistor loop connecting (A) & (B) is at 3A and 2A at the same time.
∴ KCL is violated! +1/+2) +1

(if this only +2)

if this only +1