4.43 Let us use superposition principle!

① Turn off v_2, v_3: circuit acts like an inverting amplifier, thus:

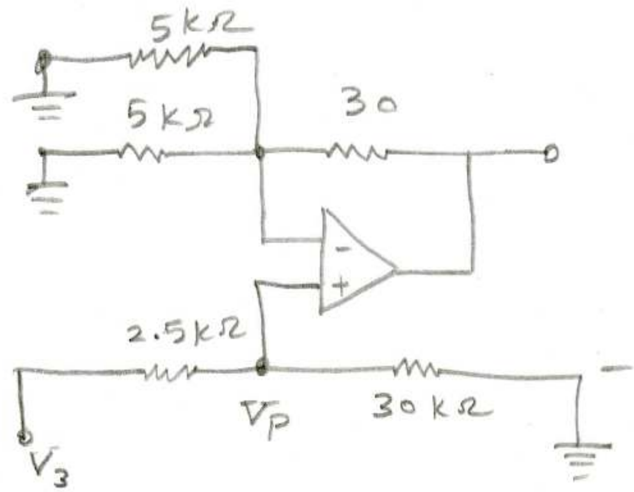
$$V_{o,1} = -\frac{R_f}{R_{in}} v_1 = -\frac{30}{5} v_1 = -6v_1$$

② Turn off v_1, v_3:

Circuits acts like inverting amp.

$$V_{o,2} = -\frac{R_f}{R_{in}} v_2 = -\frac{30}{5} v_2 = -6v_2$$

③ Turn off v_1, v_2: circuit acts like non-inverting amplifier:



by voltage division:

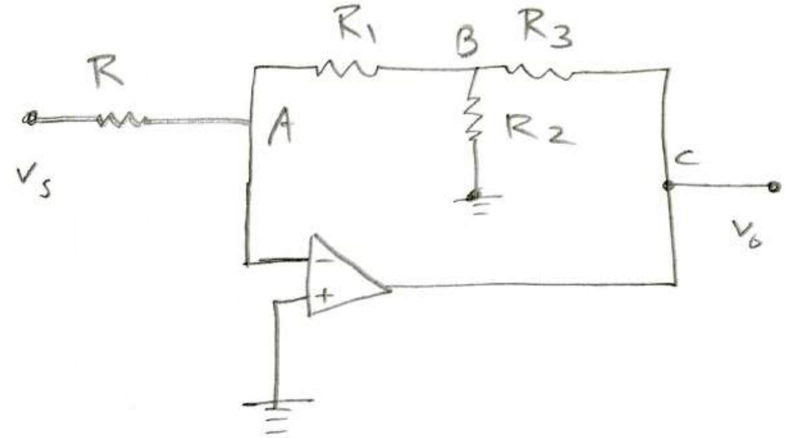
$$V_p = \frac{30}{30+2.5} v_3 = \frac{30}{32.5} v_3$$

Noninverting amplifier:

$$V_{o3} = \frac{2.5+30}{2.5} v_p = 12 v_3$$

$$v_o = v_{o1} + v_{o2} + v_{o3} = -6v_1 - 6v_2 + 12v_3$$

4.50



This is neither an inverting nor a non-inverting op-Amp

to use node voltage analysis to solve problem

KCL at A $\quad \dfrac{V_A - V_s}{R} + \dfrac{V_A - V_B}{R_1} = 0$

KCL at B $\quad \dfrac{V_B - V_A}{R_1} + \dfrac{V_B - V_c}{R_3} + \dfrac{V_B}{R_2} = 0$

equation of an ideal op-amp $\quad V_A = 0$

now 3-equations / 3 unknowns

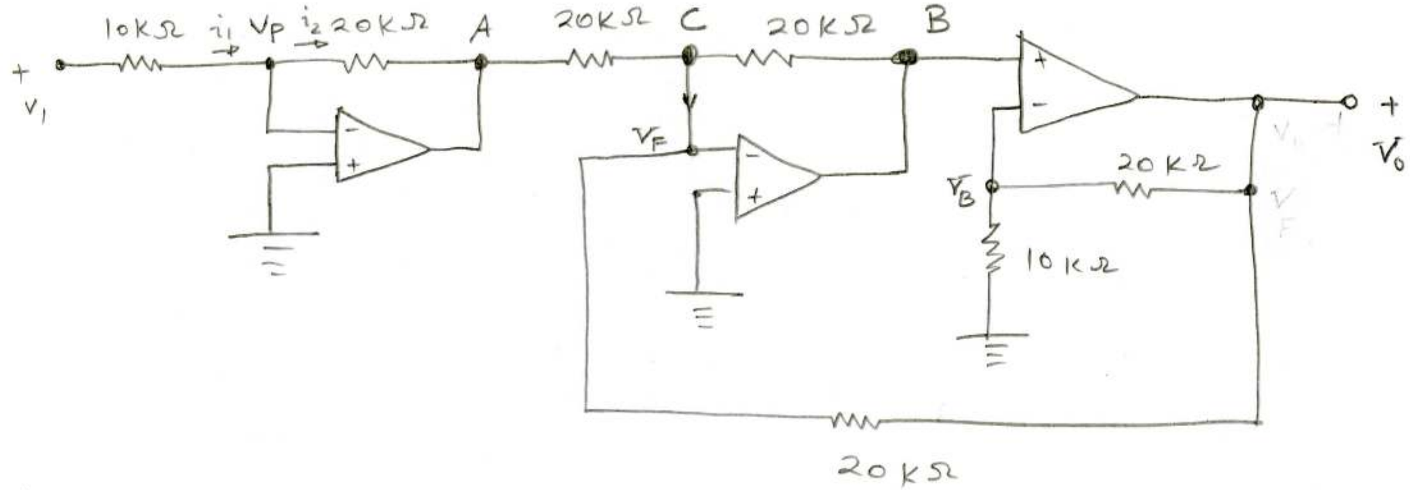
$V_A = 0 \longrightarrow V_B = V_s \cdot \dfrac{-R_1}{R} \qquad V_c = V_s \cdot \dfrac{-R_1R_2 - R_1R_3 - R_2R_3}{RR_2}$

$$K = \frac{-R_1R_2 - R_1R_3 - R_2R_3}{RR_2}$$

For $K = -10 \longrightarrow$ multiple ansewrs are possible!

4.61

Let us try to find v_A, v_B, v_C



$i_1 = i_2 \rightarrow \frac{V_1 - V_P}{10} = \frac{V_P - V_A}{20} \xrightarrow[V_P = 0]{\text{but}} \frac{V_1 - 0}{10} = \frac{0 - V_A}{20} \rightarrow \boxed{V_A = -2V_1}$

(noninverting amp) $\frac{V_o}{V_B} = \frac{20+10}{10} = 3 \rightarrow \boxed{V_o = 3V_B}$

writing KCL for C $\quad \frac{V_F - V_o}{20} = \frac{V_A - V_C}{20} + \frac{V_B - V_C}{20}$

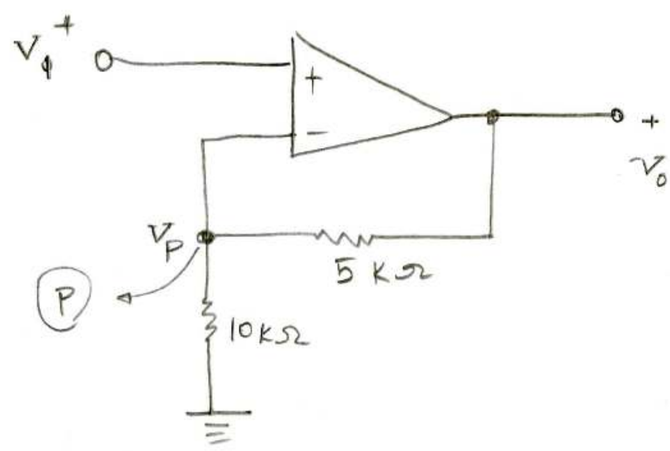
and we know $V_F = 0 \rightarrow$

$0 - V_o = V_A + V_B - 2V_C \rightarrow \boxed{2V_C = V_A + V_B + V_o}$ but $V_C = 0$

$\Longrightarrow (-2V_1) + \frac{1}{3}V_o + V_o = 0 \rightarrow 2V_1 = \frac{4}{3}V_o \rightarrow$

$$\boxed{\frac{V_o}{V_1} = \frac{3}{2}}$$

4.61



$v_1 = v_P$

at node (P)

$$\frac{v_P - 0}{10} = \frac{v_o - v_P}{5} \longrightarrow \frac{v_1}{10} = \frac{v_o - v_1}{5}$$

$$v_1 = 2v_o - 2v_1 \longrightarrow 3v_1 = 2v_o \longrightarrow \frac{v_o}{v_1} = \frac{3}{2}$$

$\boxed{4.70}$

$R_2 = 10\,R_F$ if put $\dfrac{R_3+R_4}{R_4} < 10^{+4}$

Let

$$1001 = \frac{R_3+R_4}{R_4} = \frac{R_3}{R_4}+1 \Rightarrow \rightarrow \frac{R_3}{R_4} = 1000 \longrightarrow R_3 = 1000\,\Omega$$
$$R_4 = 1\,\Omega$$

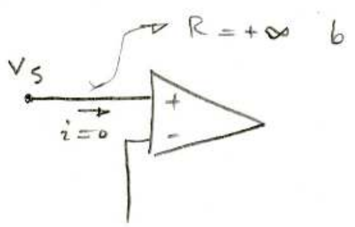
$$\frac{R_F}{R_1} = 3.496 \;10^{-9} \rightarrow R_F = 3.49\,\Omega \qquad R_1 = 10^{9}\,\Omega$$

$$\frac{R_F}{R_2} = \frac{1}{10} \longrightarrow R_2 = 34.9\,\Omega$$

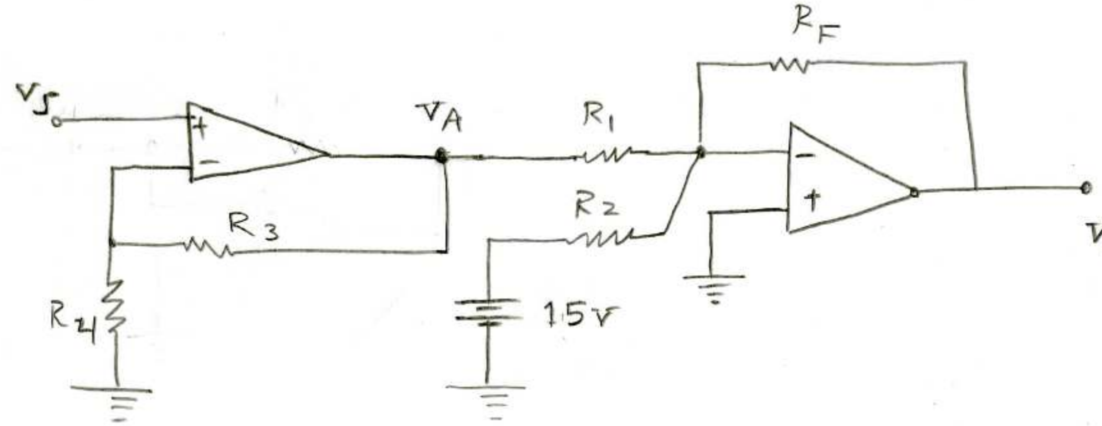
since input resistence to V_S is infinite

because no current, so it is greater than

$1\,k\Omega$



4.70



$$\frac{v_o}{v_A} = k_1 = -\frac{R_F}{R_1} \qquad K_2 = -\frac{R_F}{R_2} = \frac{v_o}{15}$$

$$\Longrightarrow \boxed{\frac{V_o}{15} = -\frac{R_F}{R_2}} \qquad \boxed{\frac{V_o}{V_A} = -\frac{R_F}{R_1}} \qquad \frac{R_F}{R_1} < 10^4$$

$$\boxed{\frac{V_A}{V_s} = \frac{R_3+R_4}{R_4}} < 10^4 \quad \text{and} \quad -\frac{R_F}{R_1}\cdot\frac{R_3+R_4}{R_4} = -3.5\times10^{-6}$$

but for summer we have $K_1 V_A + K_2 (15) = V_o$

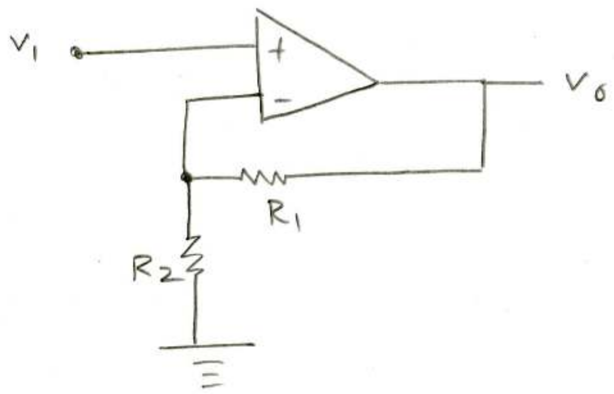
$$V_o = -3.5\times10^{-6} v_s + 1.5 = \left(-\frac{R_F}{R_1}\right) V_A + \left(-\frac{R_F}{R_2}\right) 15 \Longrightarrow$$

$$V_o = -3.5\times10^{-6} v_s - 1.5 = \left(-\frac{R_F}{R_1}\right)\left(\frac{R_3+R_4}{R_4}\right) v_s + \left(-\frac{R_F}{R_2}\right) 15$$

$$\Longrightarrow + \boxed{\frac{R_F}{R_2} = \frac{1}{10}} \qquad \boxed{\frac{R_F}{R_1}\cdot\frac{R_3+R_4}{R_4} = 3.5\times10^{-6}}$$

4.87

non-inverting amp.



So we know $\frac{V_o}{V_1} = \left(\frac{R_1 + R_2}{R_2} \right)$

but when PH = 4 , then $V_1 = 4 \times 50\ mV = 0.2\ V$

when PH = 7 then $V_1 = 7 \times 50\ mV = 0.35\ V$

and for $V_1 = 0.2\ V$ we have $V_o = 1\ V$ $\longrightarrow$

〜 $V_1 = 0.35\ V$ we have $V_o = 1.75$

So $K = \frac{1}{0.2} = \frac{1.75}{0.35} = 5$

$\frac{R_1 + R_2}{R_1} = 5 \longrightarrow R_1 = 2\,k\Omega ,\ R_2 = 8\,k\Omega$