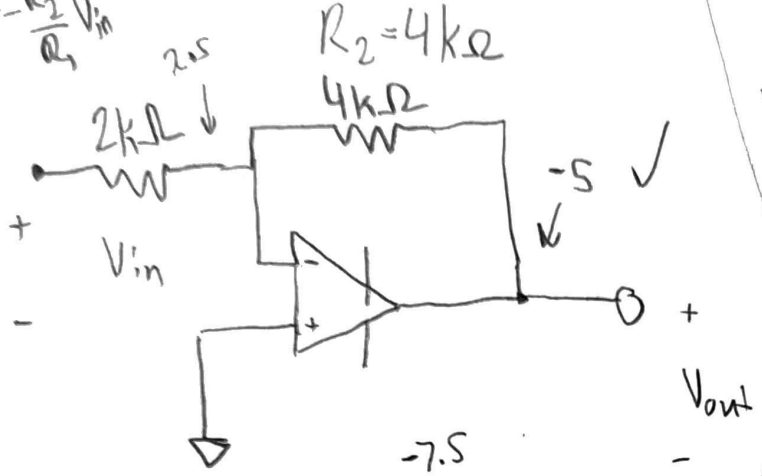
6.4.1

$R_1 = 2k\Omega$ gain $= 2 = \frac{R_2}{2k\Omega}$

$V_{out} = -\frac{R_2}{R_1} V_{in}$



Input	Output
2	-4.001
2.49	-4.978
2.99	-5.97
3.5	-6.993
4.01	-7.999
4.50	-8.97
5	-9.96

The circuit worked flawlessly.

6.4.2

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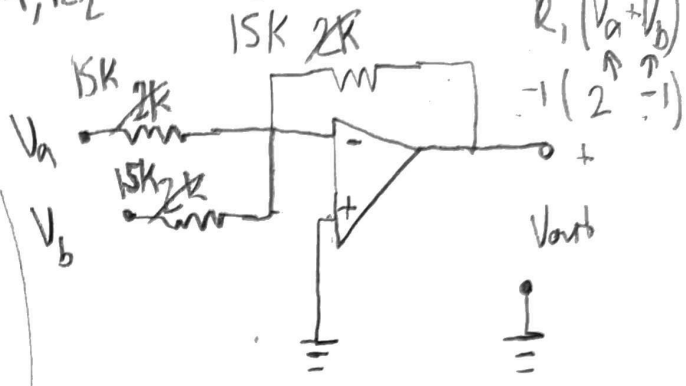
R_1, R_2 will be 2KΩ

$V_{out} = -\frac{R_3}{R_1}(V_a + V_b)$

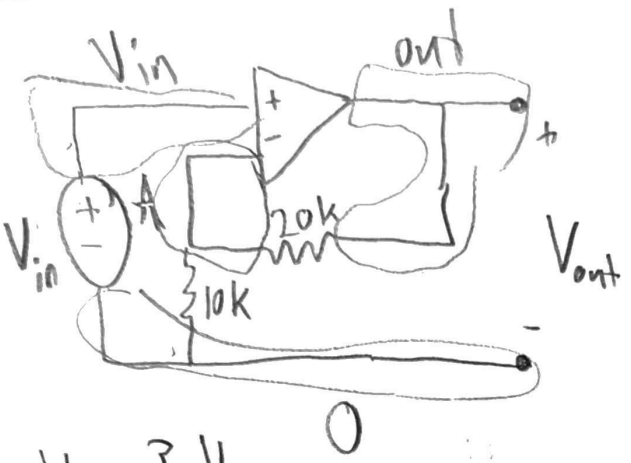
$-1(2 \cdot -1)$



V_b Input / V_a Input	Output
-1, 0	0.977
-1, 0.5	0.483
-1, 0.97	-0.0018
-1, 1.50	-0.527
-1, 1.98	-1.006
-1, 5	-4.0058

Using 15k instead on 2k resistors helped prevent V_{in} from shorting through the ground connection through V_B.

6.4.3



$V_{out} = ? \cdot V_{in}$

$$\frac{V_{in} - 0}{10} + \frac{V_{in} - out}{20} = 0$$

$$\frac{3}{20} V_{in} = \frac{V_{out}}{20}$$

$$V_{out} = 3V_{in}$$

V_{in}	V_{out}
0	0
1.00	3.643
1.99	7.186
2.99	10.815
4	14.103
5.00	14.102

← Saturation at about 4V input

$$V_{out} = \left(\frac{10.815}{2.99}\right) V_{in}$$

$$\boxed{V_{out} = 3.617\ V_{in}}$$

this was the relationship we observed.

opp amp is likely a source of error because 3.617 was a very reliable approximation.