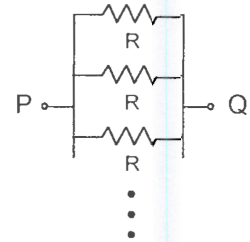
Short Answer Questions (15 pts):

1. As more identical resistors R are added to the parallel circuit shown here, what happens to value of the equivalent resistance, R_{eq}, between terminals P and Q? (4 pts)



   a. R_{eq} increases
   b. R_{eq} remains the same
   (c.) R_{eq} decreases

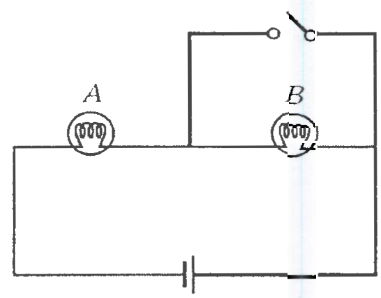
$\frac{1}{R_{eq}} = \sum_{1}^{n} \left(\frac{1}{R_i}\right)$

← IF THIS GETS BIGGER AS n ↑, R_{eq} ↓

2. Circle T (true) or F (false) for the following statements (3 pts):

(T)	F	Decreasing the diameter of a conductor increases its resistance. $R = \rho L / A$
(T)	F	kWh and Joules are both measures of energy.
T	(F)	Voltmeters are connected in ~~series~~ parallel to measure the voltage across an element.

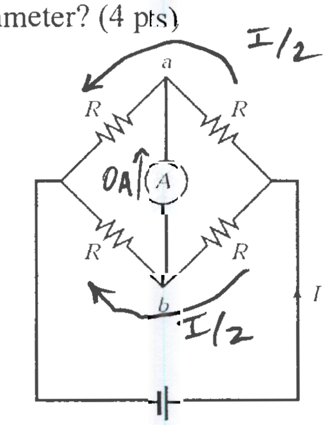
3. The circuit below consists of two identical light bulbs and a single 12 V battery. The light bulbs can be modeled as resistors each with equal resistance. When the switch is closed, what happens at bulb A? (4 pts)



R ↓ so I ↑

(a.) current through bulb A increases and it glows more brightly
b. current through bulb A remains unchanged and its brightness remains unchanged
c. current through bulb A decreases and it glows more dimly

4. An ideal ammeter A is connected between points a and b in the bridge circuit below, in which the four resistors are identical. The value of the total current supplied by the battery is *I*. What value of current will be measured through the ammeter? (4 pts)



   a. I/2
   b. I/4
   (c.) zero
   d. need more information to answer the question

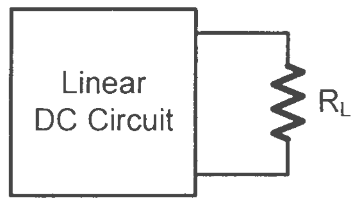
2R IN EACH BRANCH, CURRENT SPLITS EVENLY

Short Answer Problems (20 pts):

1. In the linear DC circuit below, the output voltage across a 500 Ω load is 2.0V. Using the same circuit, maximum power is delivered to the load when R_L = 1500Ω. What is the value of the maximum power that is delivered to a load resistor of R_L = 1500 Ω? (10 pts)

$R_{TH} = 1500\Omega$

a. 0.5 mW
b. 0.67 mW
c. 2 mW
d. 10.67 mW
e. Cannot be determined



THEV EQ

R_{TH} 1500Ω, + x −, V_{TH}, 2V, 500Ω

V-DIV

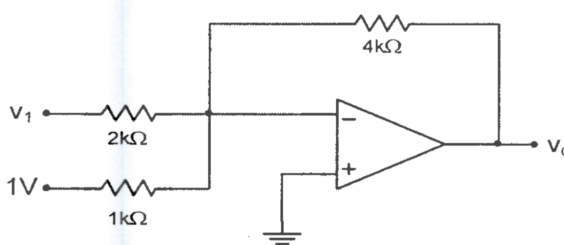
$$\frac{x}{1500} = \frac{2V}{500}$$

$$x = 6V$$

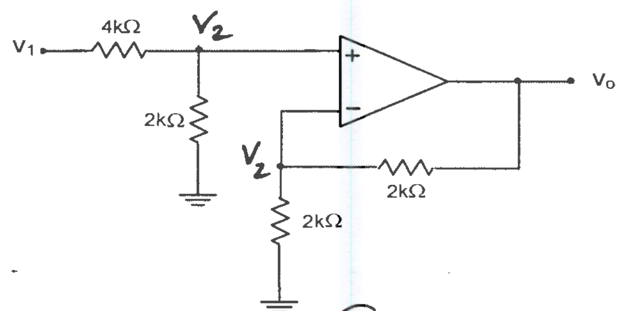
$$V_{TH} = 6 + 2 = 8V$$

$$P_{max} = \frac{V_{TH}^2}{4R_{TH}} = \frac{(8)^2}{4(1500)} = 10.67\,mW$$

2. Answer the following for the two circuits below. (10 pts)



OR



a) (Fill in the blanks with the best answer.) Circuits A and B are configured as ______ and ______ amplifiers, respectively. (4 pts)

I.	inverting, non-inverting	IV.	non-inverting, summing
II.	inverting, summing	V.	summing, inverting
III.	non-inverting, inverting	VI.	summing, non-inverting

b) If v_o = 6V in each of the circuits, solve for v_1 in only ONE of the circuits A or B above. **Clearly indicate which circuit was chosen by circling either letter A or letter B for that circuit.** (6 pts)

CKT A

$$V_o = 6 = V_1\left(\frac{-4k}{2k}\right) + 1\left(\frac{-4k}{1k}\right)$$

$$= -2V_1 - 4$$

$$10 = -2V_1$$

$$V_1 = -5V$$

CKT B

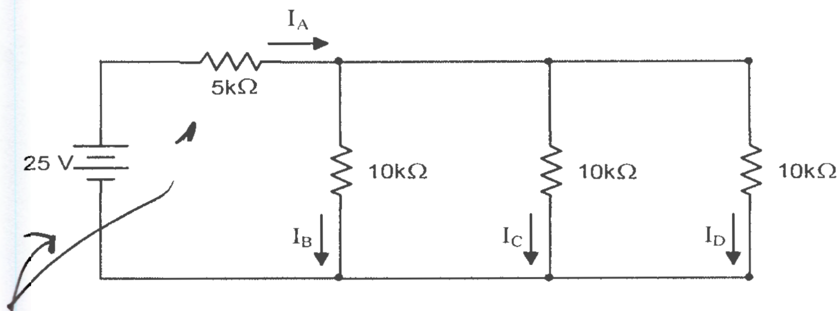
$$V_2 = V_o \cdot \frac{2k}{4k} = \frac{1}{2}V_o = \frac{1}{2}6 = 3V$$

ALSO $V_2 = V_1 \cdot \frac{2k}{6k} = 3$ so $V_1 = 3 \cdot 3$

OR $V_1 = 9V$

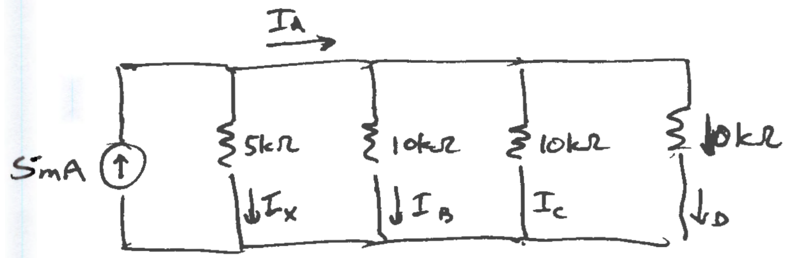
Problems (65 pts):

1. In the circuit shown below, use **source transformation** and **current dividers** to determine the currents I_A, I_B, I_C and I_D. (20 pts)



$\frac{25V}{5k\Omega} = 5mA$

NOTE: $I_A = I_B + I_C + I_D$



I-DIV

$I_B = I_C = I_D$ AND $I_x = 2 I_B$

SINCE $5mA = I_x + I_B + I_C + I_D$

$I_B = I_C = I_D = 1mA \rightarrow I_A = I_B + I_C + I_D = 3mA$

$I_x = 2mA$

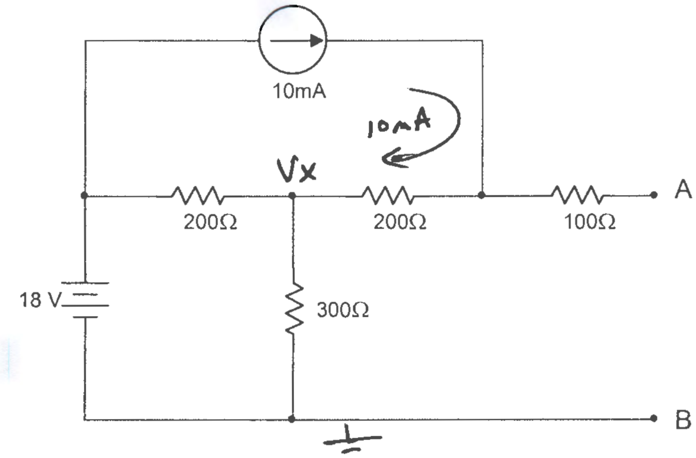
$I_A =$ 3 mA

$I_B =$ 1 mA

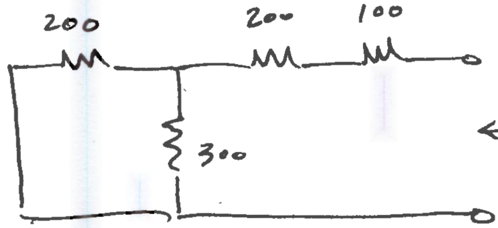
$I_C =$ 1 mA

$I_D =$ 1 mA

2. For the circuit shown below, **determine and draw** the Thevenin equivalent circuit between terminals A and B. (Hint: Use superposition or nodal analysis to solve for V_{TH}.) (20 pts)



R_{TH}



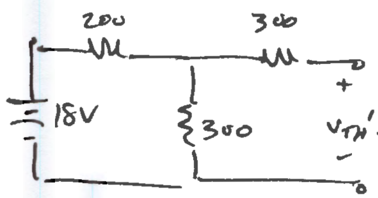
$\frac{200(300)}{500} = 120\Omega$

$R_{TH} = 200 \| 300 + 200 + 100$

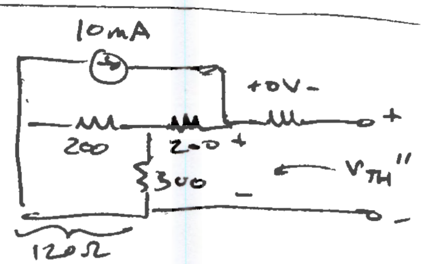
$= 120 + 300 = 420\Omega$

V_{TH}

SUPERPOSITION



$V_{TH}' = 18 \cdot \frac{300}{500} = 10.8V$



V_{TH}''

$V_{TH}'' = (10m)(120 + 200) = 3.2V$

$V_{TH} = V_{TH}' + V_{TH}'' = 10.8 + 3.2 = 14V$

OR

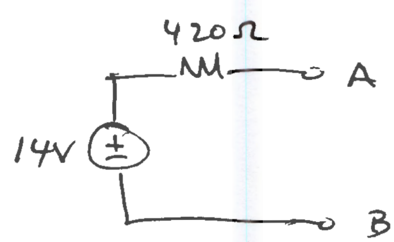
NODAL – SEE LABELS ON ORIGINAL CKT

$\left(\frac{18 - V_x}{200} + 10mA = \frac{V_x}{300}\right) 600$

$54 - 3V_x + 6 = 2V_x$

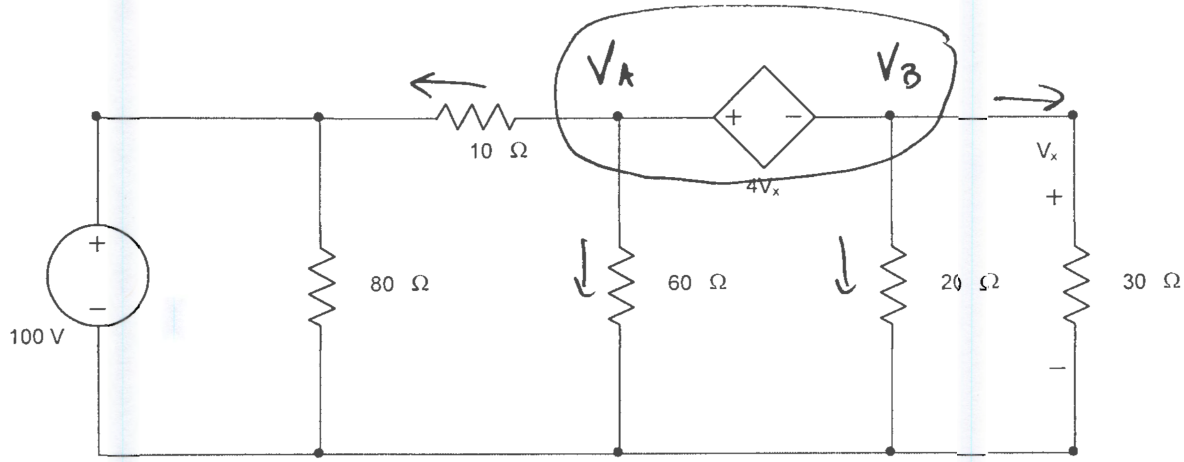
$60 = 5V_x \qquad V_x = 12V$

$V_{TH} = 12 + 0.01(200) = 14V$



V_{TH} = 14V $\qquad R_{TH}$ = 420Ω

3. Use the **node-voltage** method (aka "nodal analysis") to **determine the value of V_x** in the following circuit. (25 pts)



$V_B = V_x$

$V_A - V_B = 4V_x$

$V_A = 5V_x$

so

$$\frac{V_A - 100}{10} + \frac{V_A}{60} + \frac{V_B}{20} + \frac{V_B}{30} = 0$$

$$\left(\frac{5V_x - 100}{10} + \frac{5V_x}{60} + \frac{V_x}{20} + \frac{V_x}{30} = 0\right) 60$$

$$30V_x - 600 + 5V_x + 3V_x + 2V_x = 0$$

$$40V_x = 600$$

$$V_x = \frac{600}{40} = 15V$$

V_x = 15 V