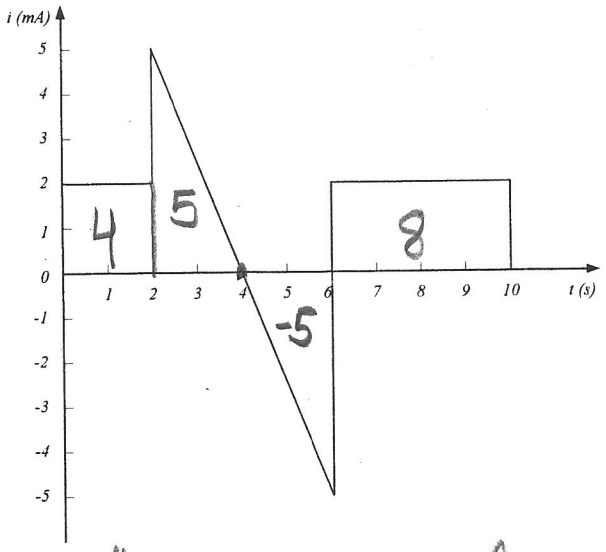
Question 1(i) (10 marks):

The current flowing through an element is as shown in the figure below. Determine the total charge that passed through the element from t=0 s to:

(a) t=2 s (b) t=4 s (c) t=6 s (d) t= 10 s



a) $i = \frac{dq}{dt}$

$dq = i\,dt$

$q = \int_0^2 i\,dt$

$q = 2 \times 2$

$q = 4C$

b) $q = \int_0^4 i\,dt$

$q = 4 + 5$

$= 9C$

c) $q = \int_0^8 i\,dt$

$= 4 + 5 - 5$

$= 4C$

$dt \quad q = \int_0^{10} i\,dt$

$= 4 + 5 - 5 + 8$

$= 12C$

Q_{2s}	$Q = 4C$
Q_{4s}	$Q = 9C$
Q_{6s}	$Q = 4C$
Q_{10s}	$Q = 10C$

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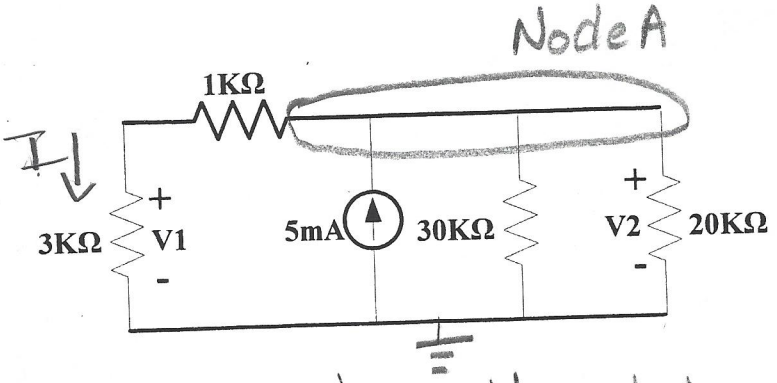
Question 1(ii) (15 marks):

For the circuit shown in the figure below, find: (a) v1, (b) v2, (c) the power dissipated in 3 kΩ (d) the power dissipated in 20 kΩ, and (e) the power supplied by the current source?



a) Using Result in part b)

$V_a = 15^V$

$I = \frac{V_a}{4} = \frac{15}{4}$ mA

$R = 3$ KΩ

$V_1 = IxR$

$= (\frac{15}{4}) \times (3)$

$V_1 = 11.25^V$

b) Using nodal analysis

Node A: (Assuming all current in mA and resistance in KΩ)

$\frac{V_a}{20} + \frac{V_a}{30} - 5 + \frac{V_a}{4} = 0$

$\frac{3V_a + 2V_a - 300 + 15V_a}{60} = 0$

$20V_a = 300$

$V_a = 15^V$

Since $V_a = V_2$

$V_2 = 15^V$

c) $P = iV$

$= \frac{15}{4} \times 11.25$

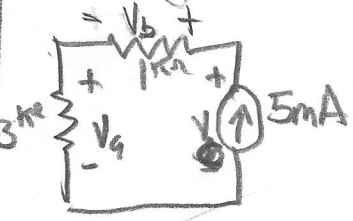
$= 42.19$mW

d) $P = iV$

$= \frac{15}{20} \times 15$

$= 11.25$mW

e) using KVL



$V_a + V_b + V_c = 0$

$V_a = 11.25$V

$V_b = +15$V

$V_c = ?$

$11.25 + 15 + V_c = 0$

$V_c = -23.25$V

$P = i \times V$

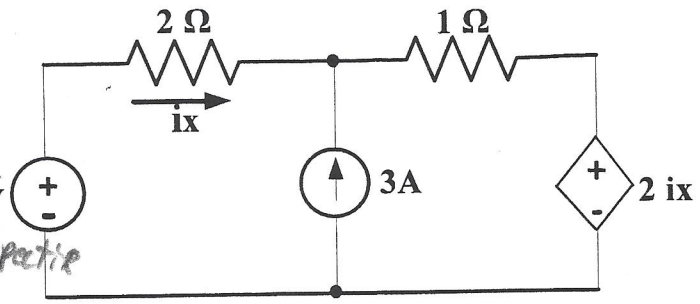
$= 0.005 \times -23.25$

$P = -116.25$ mW

(a)	$V_1 = 11.25^V$
(b)	$V_2 = 15V$
(c)	$P_{3K\Omega} = 42.19$ mW
(d)	$P_{20K\Omega} = 11.25$ mW
(e)	$P_{source} = -116$ mW

Question 2 (25 marks):

For the circuit shown in the figure below, use the superposition theorem to find i_x.



$I_x = I_1 + I_2$

where I_1 and I_2 are currents from each respective independant source

Find I_1

eliminating 10V source

(2.5)

Node A equation

$$-3 + \frac{V_a - 2i_1}{1} + \frac{V_a}{2} = 0$$ (5)

$$I_1 = -\frac{V_a}{2}$$

$$\frac{-6 + 2V_a - 4i_1 + V_a}{2} = 0$$

$$-6 + 2V_a + 4\left(\frac{V_a}{2}\right) + V_a = 0$$

$$5V_a = 6$$

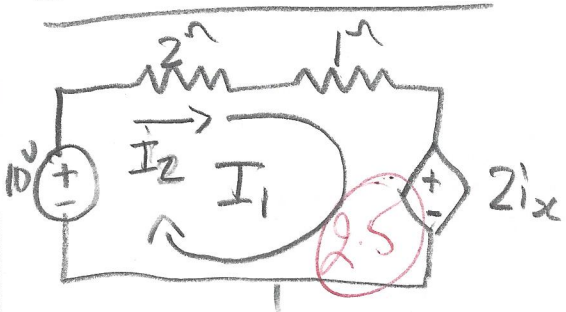
$$V_a = \frac{6}{5}\ V$$

$$I_1 = -\frac{V_a}{2}$$

$$= -\frac{6}{10} = -0.6\ A$$ (5)

Find I_2

Eliminate 3A source



(2.5)

KVL Equation

$$2I_2 - 10 + 2I_1 + I_1 = 0 \quad (1)$$

$$I_2 = I_1 \quad (2)$$

Sub (1) into (2)

$$2I_1 - 10 + 2I_1 + I_1 = 0$$ (5)

$$5I_1 = 10$$

$$I_1 = 2A$$

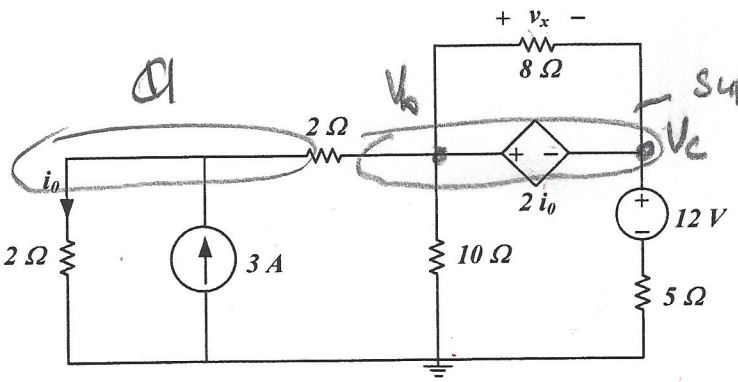
Since $I_x = I_1 + I_2$

$I_x = -0.6 + 2$

$I_x = 1.4A$ (5)

i_x	$I_x = 1.4A$

Question 3 (25 marks):
Apply nodal analysis to find the current i_o and the voltage v_x in the circuit shown below



supernode b

$i_o = \frac{V_a}{2}$

Node Equation at node A

$$-3 + \frac{V_a - V_b}{2} + \frac{V_a}{2} = 0$$

$$-6 + 2V_a - V_b = 0$$

Super node Equation $2V_a - V_b = 6$ (1)

$$2i_o = V_b - V_c$$

$$V_c = V_b - 2i_o$$

$$\frac{V_b}{10} + \frac{V_b - 2i_o - 12}{5} + \frac{V_b - V_b + 2i_o}{8} = 0$$

$$\frac{3V_b + 4i_o - 24}{10} + \frac{i_o}{4} = 0$$

$$\frac{6V_b - 8i_o - 48 + 5i_o}{20} = 0$$

$$6V_b - 3i_o = 48$$

$$6V_b - \frac{3V_a}{2} = 48$$

$$12V_b - 3V_a = 96 \quad (2)$$

$V_a = 8^V$

$V_b = 10^V$

Find i_o

$$i_o = \frac{V_a}{2} = \frac{8}{2} = 4^A$$

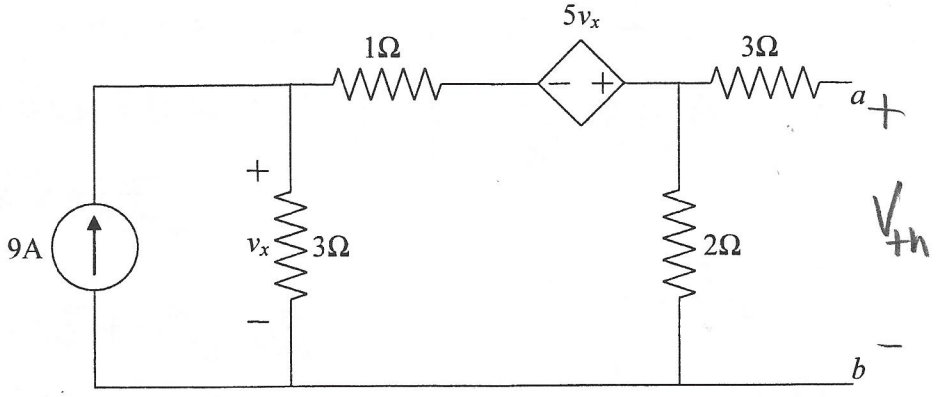
Find V_x

$$V_x = \frac{i_o}{4} \times 8 = \frac{4}{4} \times 8 = 8^V$$

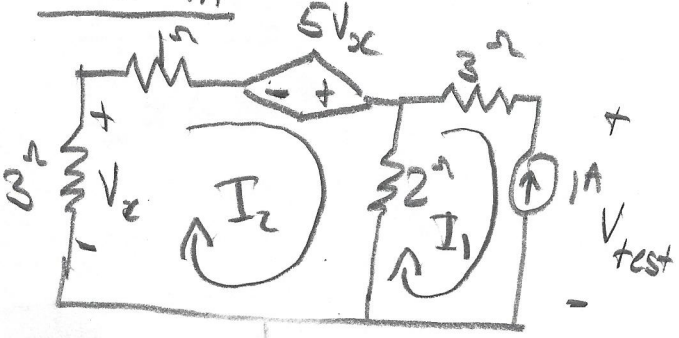
$i_o(A) =$	4A
$v_x(V) =$	8V

Question 4 (25 marks):

Find the Thevenin equivalent between terminals *a*-*b* of the following circuit:



Find R_{th}



$I_1 = -1\,A$

I_2: $-5V_x + 2(I_2 - (-1)) + 3I_2 + I_2 = 0$

$V_x = -3I_2$

$15I_2 + 2I_2 + 2 + 3I_2 + I_2 = 0$

$21I_2 = -2$

$I_2 = -\frac{2}{21}$

Find V_{test}

$V_{test} + 2(I_1 - I_2) + 3I_1 = 0$

$V_{test} + 2(-1 + \frac{2}{21}) - 3 = 0$

$V_{test} = -4.81\,V$

Find V_{th}

$I_3 = 9\,A$

I_2: $3(I_2 - 9) + I_2 - 5V_x + 2(I_2 - I_1) = 0$

I_1: $2(I_1 - I_2) + 3I_1 = 0$

$5I_1 - 2I_2 = 0$ (1) ✗ no I_1 no current passing

$3I_2 - 27 + I_2 - 5V_x + 2I_2 - 2I_1 = 0$

$6I_2 - 5V_x - 2I_1 = 27$ (2)

$V_{th} = -12.84\,V$ ✗

$V_x = 3(I_3 - I_2)$

$V_x = 27 - 3I_2$ (3)

$R_{th} = +4.81$ Ohms. ✓

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Find R_{th}

$R_{th} = \frac{+4.81}{1}$

$= 4.81\,\Omega$

Resistance has no negative

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$5I_1 - 2I_2 = 0$ (1)

$-2I_1 - 5V_{2c} + 6I_2 = 0$ (2)

$V_{2c} = 27 - 3I_2$

$-2I_1 - 135 + 15I_2 + 6I_2 = 0$

$-2I_1 + 21I_2 = 135$ (3)

$I_1 = 2.67^A$

$I_2 = 6.68^A$

$I_1 = I_N$

$I_N = 2.67^A$

$V_{TH} = I_N \times R_{th}$

$= 2.67 \times -4.81$

$= 12.84^V$