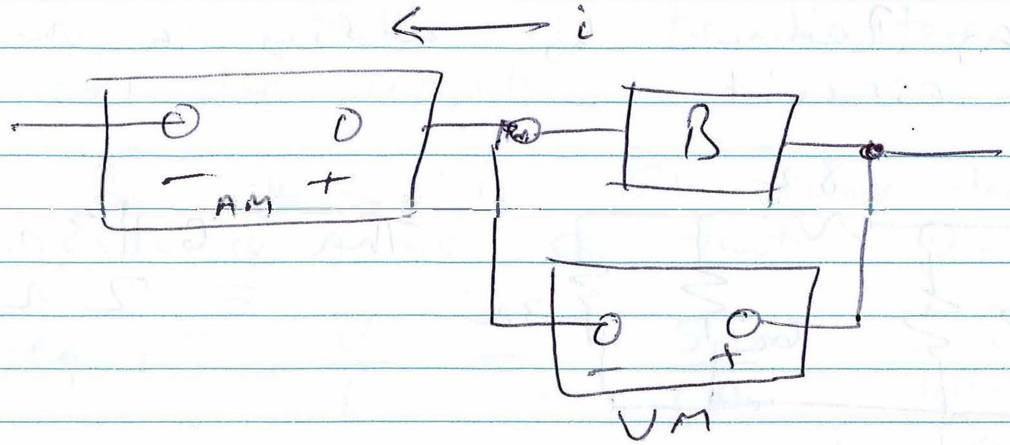
MID TEST SOLUTIONS

(1)



(a) Reference current enters the (+) node of the ammeter. This is also the (+) node of the voltmeter. Hence passive sign convention applies.

MUST BE FULLY CORRECT 3

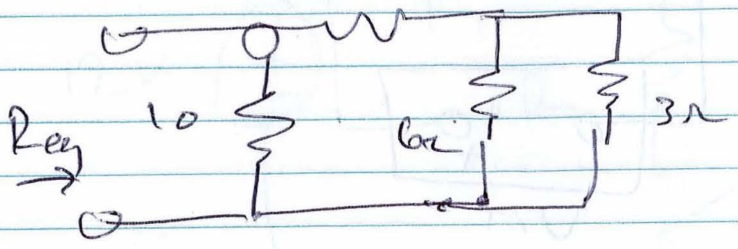
(b) Since PSC applies, we have

$$P = v i$$
$$= (-10\ V)(3A)$$
$$= -30\ W$$
$$< 0.$$

Since power is negative, device B generating energy.

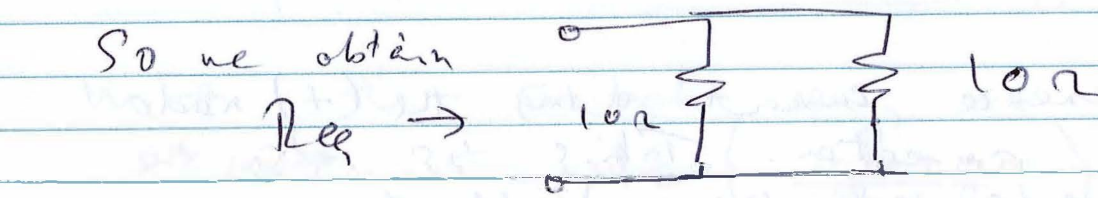
MUST BE FULLY CORRECT 2

(2) (a) Reduce by adding a short circuit



Then $6 \parallel 3\Omega = 2\Omega$ (2)

So we obtain

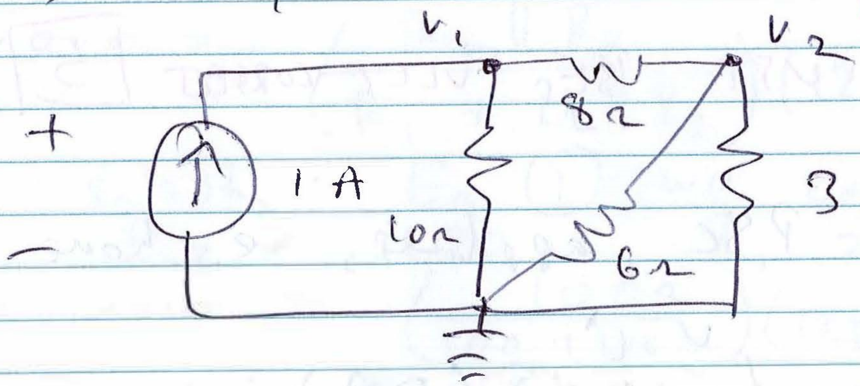


(2)

Thus $R_{eq} = 5\ \Omega$.

TOTAL (a) $\boxed{4}$

(b)



Label Diagram (1)

KCL node (1) : $1A = \frac{v_1}{10\Omega} + \frac{v_1 - v_2}{8\Omega}$ (2) — (1)

KCL node (2) : $0 = \frac{v_2 - v_1}{8\Omega} + \frac{v_2}{6\Omega} + \frac{v_2}{3\Omega}$ (2) — (2)

Rewrite (1) : $1A = \frac{4v_1 + 5v_1 - 5v_2}{40}$

$\Rightarrow 40 = 9v_1 - 5v_2$

Rewrite (2) $0 = \frac{(3v_2 - 3v_1) + 4v_2 + 8v_2}{24}$

$\Rightarrow 0 = 15v_2 - 3v_1$ (1)

$= 45v_2 - 9v_1$

$\Rightarrow 40 = 40v_2 \Rightarrow v_2 = 1$ ✓

$\Rightarrow 9v_1 = 40 + 5 = 45$

$\Rightarrow v_1 = 5\ V$ (1) TOTAL $\boxed{7}$

(2) So $v_1 = 5V$, is the voltage across the inputs.

(c) Since there is 5V across the 1 A source, we see that

$$R_{eq} = \frac{V}{I} = \frac{5V}{1A}$$

must have correct V and I from (b)

$$= 5\,\Omega$$

(c) $\boxed{1}$

which confirms our answer to part (a).

TOTAL (2) $\boxed{12}$

(3) (a) Brown | Black | Black | Brown | Red

= 1 | 0 | 0 | 1 | 2

= $100 \times 10^1 \pm 2\%$

= $1\,k\Omega \pm 2\%$ $\boxed{2}$

MUST BE FULLY CORRECT

(b) $6.8\,mH = 6\,800\,\mu H \pm 2\%$

$= 68 \times 10^2\,\mu H \pm 2\%$

= Blue | Grey | Red | Red $\boxed{2}$

MUST BE FULLY CORRECT

(c) $3.3\,nF = 3\,300\,pF \pm 5\%$

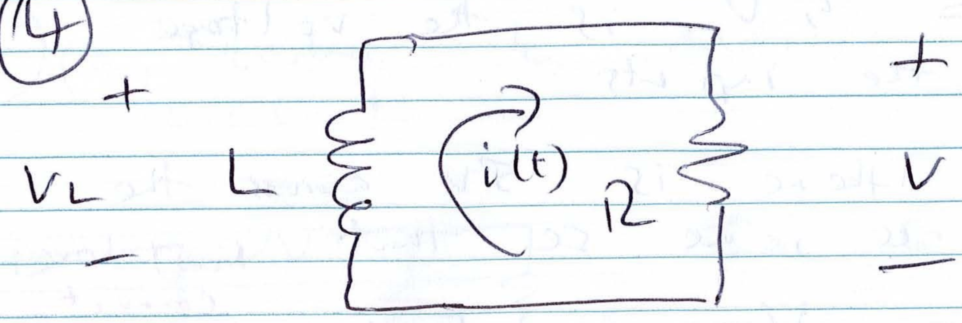
$= 33 \times 10^2\,pF \pm 5\%$

= 332 J $\boxed{2}$

MUST BE FULLY CORRECT.

TOTAL (3) $\boxed{6}$

(4)



Draw and label (1)

KVL loop : $V_L = V$ (1)

OHM'S LAW: $V = R\,i(t)$ (1)

Inductor Equation: $V_L = -L\dfrac{di}{dt}$ (1)

as ASL applies to inductor. (1)

Obtain
$$\left.\begin{aligned} 0 &= L\frac{di}{dt} + R\,i(t) \\ i(0) &= I_0. \end{aligned}\right\} \quad (1)$$

Solution is $i(t) = K_1 + K_2 e^{st}$ (1)

$$\frac{di}{dt} = sK_2 e^{st}$$

So $0 = sLK_2 e^{st} + RK_1 + RK_2 e^{st}$

$= RK_1 + K_2(sL+R)e^{st}$

$\Rightarrow \quad 0 = K_1$ (1)

$0 = sL + R$

$\Rightarrow \quad s = -\dfrac{R}{L}$ (1)

$\Rightarrow \quad i(t) = K_2 e^{-\frac{tR}{L}}$ (1)

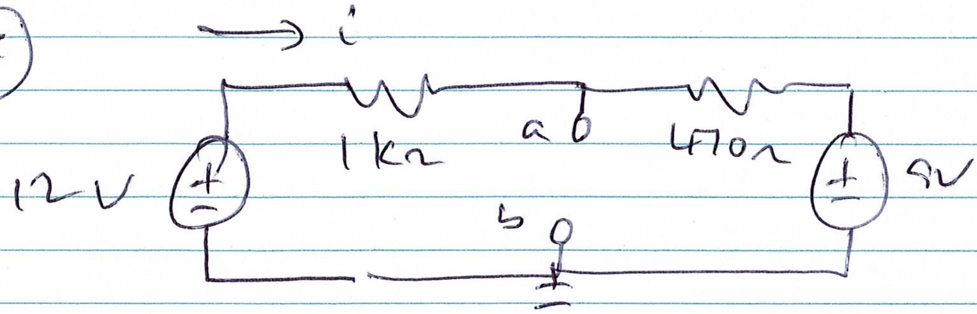
$i(0) = K_2 = I_0$ (1)

$\Rightarrow \quad i(t) = I_0 e^{-\frac{Rt}{L}}$ (1)

$\Rightarrow \quad V(t) = R\,i(t) = RI_0 e^{-Rt/L}.$ (1)

TOTAL (4): $\boxed{13}$

(5)



(a) KVL loop: $0 = -12V + 1.47i + 9V$

$\Rightarrow 3V = 1.47\, i$ (in mA)

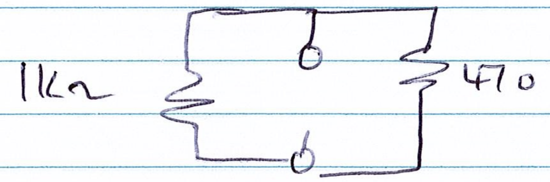
$\Rightarrow i = 2.048$ mA.

Hence $V_a = 12V - (1\,k\Omega)(2.048\,mA)$

$= 9.96\ V.$ (2)

$= V_{oc}$

To find R_T, we can 'switch off' the independent voltage sources.

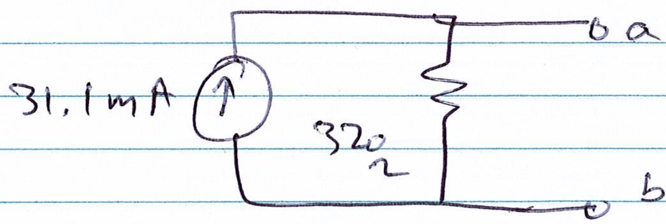


$R_T = 1\,k\Omega \parallel 470\,\Omega$

$= 320\ \Omega.$ (2)

$\Rightarrow I_{SC} = \dfrac{V_{OC}}{R_T} = 31.1\ mA.$ (1)

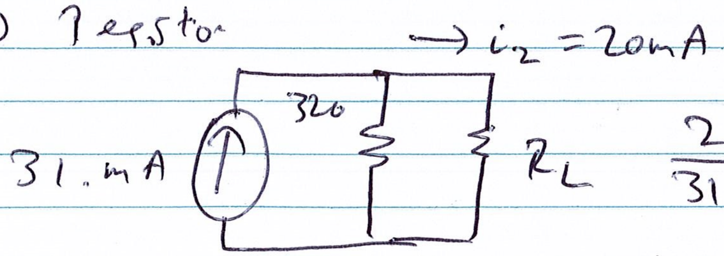
NORTON CIRCUIT:



(1)

TOTAL (a) 6

(b) Attach Load Resistor



By Current Division

$\dfrac{20mA}{31.1mA} = \dfrac{320}{320+R_L}$. (2)

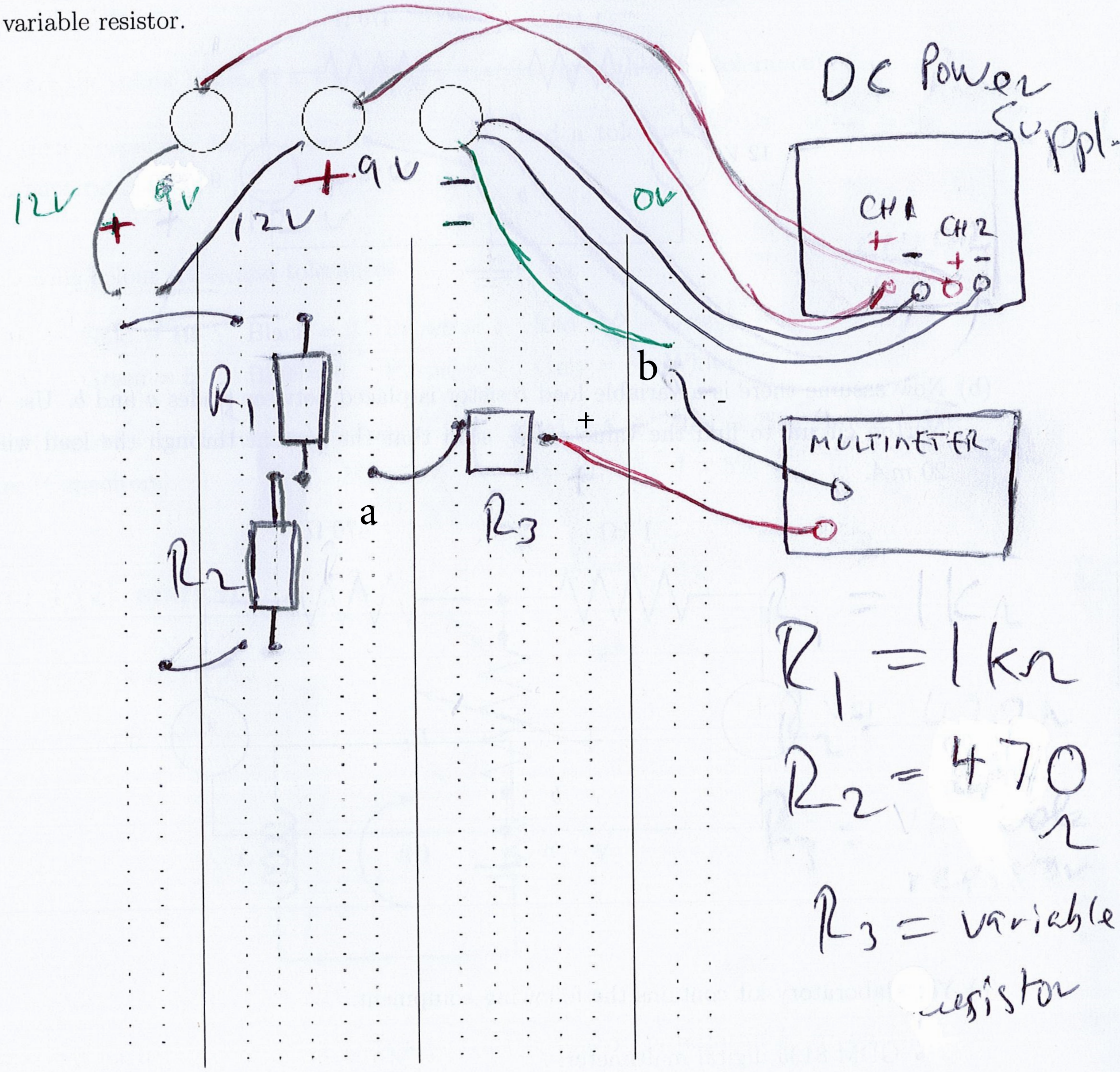
$\Rightarrow 320 + R_L = 497.6$

$\Rightarrow R_L = 177.6\ \Omega$ (2)

yields 20 mA of current in the load resistor.

Total (b) 4

Use the Breadboard diagram below to show how you would build and measure the circuit in Question (b) on your breadboard. Draw and label the input voltage terminals, the resistors (these may be drawn as rectangular boxes) and the connecting wires. Show where you would place the multimeter probes in order to measure the current through the variable resistor.



TOTAL (c) 4

TOTAL 6 14