Practice problems for Lesson 1

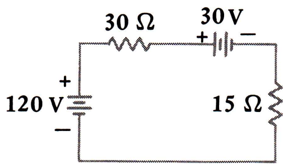
Numerical problems in DC using **e** and **r**

The following are practice problems taken from several textbooks. They were chosen because they apply only the concepts that you have learned so far in Lesson 1. This will allow you to practice these concepts and reinforce them before moving to Lesson 2.

The problem below comes from Figure 1-26 (a) in Hyatt and Kemmerly's *Engineering Circuit Analysis* (5ed). Moving forward, we will refer to that textbook as **HK5.**

HK5's Figure 1-26

We are asked to determine the current, voltage drop and power consumed in each resistor, as well as the power *delivered* by each voltage source. We are also asked to check that the powers in the circuit add up to zero. Here is my solution.



I named the nodes thus: the bottom node is named **0**, the top nodes, from left to right, are named **1**, **2** and **3**. My description of the circuit is given below, followed after a colon by the DC simulation command.

```
s\dc("e1,1,0,120:r1,1,2,30:e2,2,3,30:r2,3,0,15")
```

When the simulation is done, you can ask the calculator for the answers you need:

- Evaluating `ir1` or `ir2` gets the current in the resistors: **2** A
- Evaluating `vr1` gets the voltage drop in the 30Ω resistor: **60** V
- Evaluating `vr2` gets the voltage drop in the 15Ω resistor: **30** V
- Evaluating `pr1` gets the power consumed in the 30Ω resistor: **120** W
- Evaluating `pr2` gets the power consumed in the 15Ω resistor: **60** W
- Evaluating `-pe1` gets the power delivered by the 120V source: **240** W
- Evaluating `-pe2` gets the power delivered by the 30V source: **-60** W. This means this source is actually consuming 60W.
- Evaluating `pr1+pr2+pe1+pe2` gets the sum of powers: **0** W. As expected.

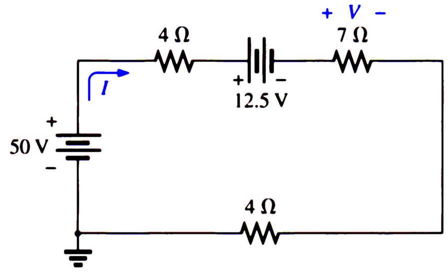
Wasn't that easy? We could also have asked for all the answers with one array:

```
{ir1,vr1,vr2,pr1,pr2,-pe1,-pe2,pr1+pr2+pe1+pe2}
```

B11's Example 5.20

The practice problems will get progressively more complicated as we move on. This will allow you to build up your *'symbulating'* skills with confidence.

Determine *I* and the voltage across the 7 Ω resistor



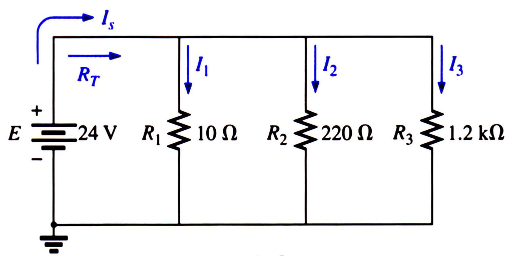
I named the nodes clockwise starting from the ground: **0**, **1**, **2**, **3** and **4**. Below is my circuit description, given as an argument of the command to do the DC simulation:

```
s\dc("e1,1,0,50:r1,1,2,4:e2,2,3,12.5:r2,3,4,7:r3,4,0,4")
```

When it's done, ask for the answers we need. Evaluating `ir1` gets the current I: **2.5** A. Evaluating `vr2` gets the voltage drop in the 7Ω resistor: **17.5** W

B11's Example 6.13

a. **Find the total resistance.**
b. **Calculate the source current.**
c. **Determine the current through each branch.**



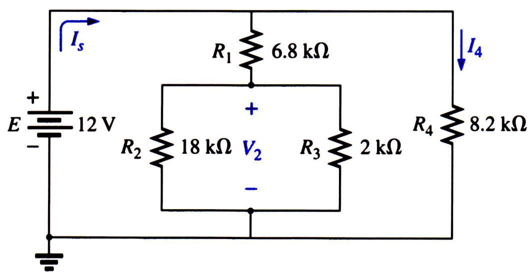
Since the ground is the bottom node, I named it **0**. I named the top node **1**.

```
s\dc("e,1,0,24:r1,1,0,10:r2,1,0,220:r3,1,0,1.2'k")
```

a) Evaluating `re` gets the total resistance: **9.49** Ω
b) Evaluating `-ie` gets us the source current: **2.53** A
c) Evaluating `ir1` gets I_1: **2.4** A, `ir2` gets I_2: **0.11** A, and `ir3` gets I_3: **0.02** A.

B11's Example 7.2

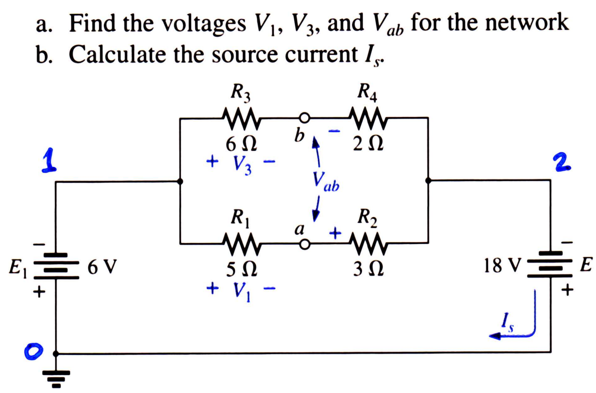
Determine I_4, I_S and V_2. My solution below. I named the top node **1**, and the other **2**:




```
s\dc("e,1,0,12:r1,1,2,6.8'k:r2,2,0,18'k:r3,2,0,2'k:r4,1,0,8.2'k")
```

Answers: `v2` is **2.51** V, `-ie` (e.g. I_S) is **2.86** mA and `ir4` is **1.46** mA.

B11's Example 7.7



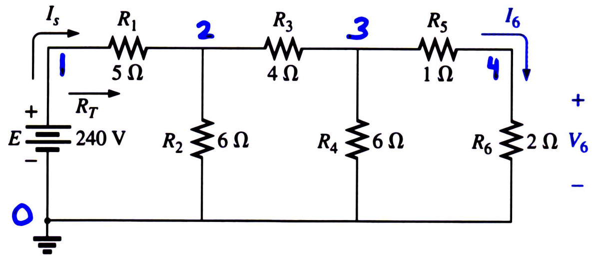
For your benefit, I have labeled the node names I used. My solution:

```
s\dc("e1,0,1,6:e2,0,2,18:r1,1,a,5:r2,a,2,3:r3,1,b,6:r4,b,2,2")
```

Answers: `vr1` is **7.5** V, `vr3` is **9** V. For V_{ba}, `vb-va` is **-1.5** V. For I_S, `-ie2` is **3** A.

B11's Figure 7.32

Determine I_6 and V_6.



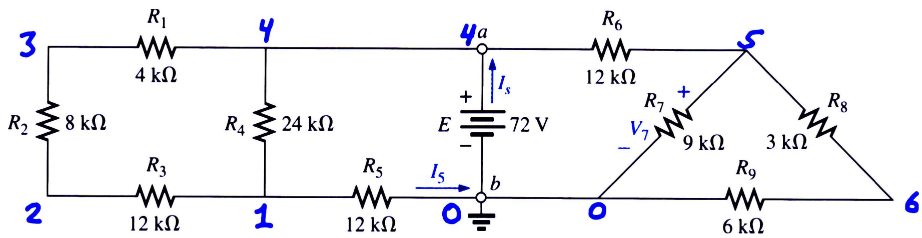
My solution below:

```
s\dc("e,1,0,240:r1,1,2,5:r2,2,0,6:r3,2,3,4:r4,3,0,6:r5,3,4,1:r6,4,0,2")
```

Answers: ir6 is **10** A, and vr6 is **20** V.

B11's Example 7.10

Calculate the indicated currents and voltages.



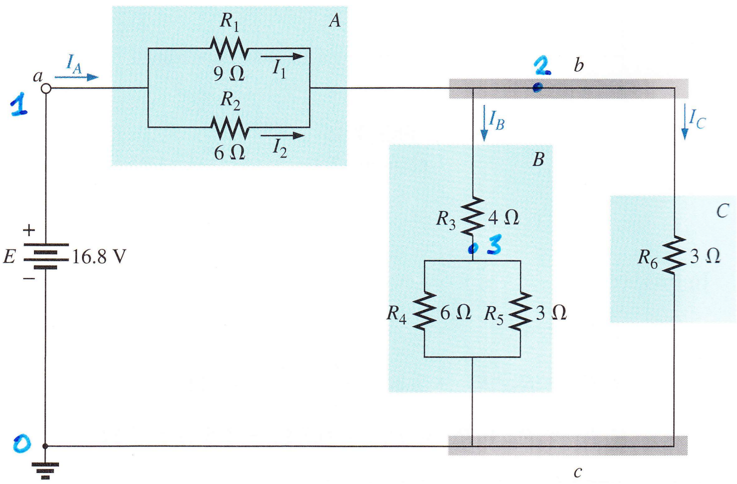
My solution below:

```
s\dc("r2,2,3,8'k:r1,3,4,4'k:r3,1,2,12'k:r4,1,4,24'k:
r5,1,0,12'k:e,4,0,72:r6,4,5,12'k:r7,5,0,9'k:r8,5,6,3'k:r9,0,6,6'k")
```

Answers: ir5 is **3** mA, -ie (e.g. I_S) is **7.36** mA, and vr7 is **19.6** V.

B11's Example 7.4

Determine the currents I_1, I_2, I_A, I_B and I_C, and the voltage drop areas A, B and C.



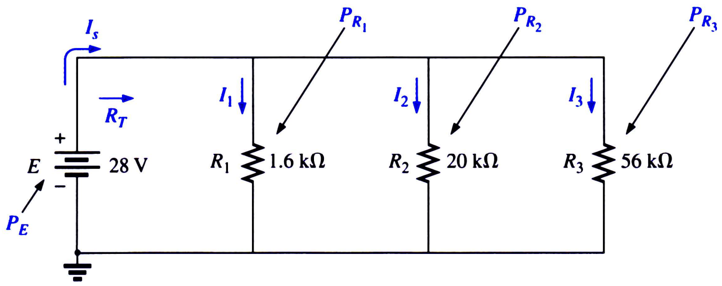
My solution below:

```
s\dc("e,1,0,16.8:r1,1,2,9:r2,1,2,6:r3,2,3,4:r4,3,0,6:r5,3,0,3:r6,2,0,3")
```

Current I_1 is found via ir1 = **1.2** A, I_2 via ir2 = **1.8** A, I_A, via -ie = **3** A, I_B via ir3 = **1** A and I_C via ir6 = **2** A. The voltage drop in area A is vr1 = **10.8** V; in both B and C it is v2 = **6** V.

B11's Example 6.15

a. Determine the total resistance R_T.
b. Find the source current and the current through each resistor.
c. Calculate the power delivered by the source.



My solution below:

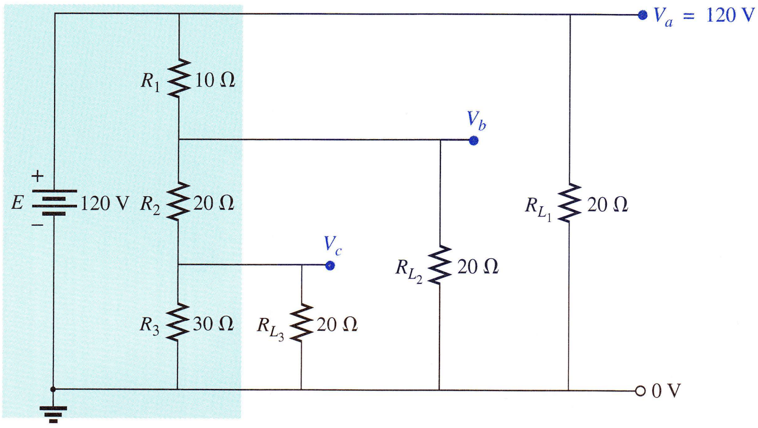
```
s\dc("e,1,0,28:r1,1,0,1.6'k:r2,1,0,20'k:r3,1,0,56'k")
```

a) Evaluating re gets the total resistance: **1.44** kΩ
b) Evaluating ir1 gets **17.5** mA, ir2 gets **1.4** mA, and ir3 gets **0.5** mA
c) Evaluating -pe gets the power: **543** mW

These are the correct answers.

B11's Figure 7.40

Determine V_b and V_c.



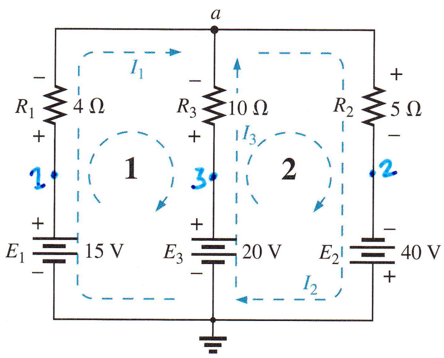
My solution below:

```
s\dc("e,a,0,120:r1,a,b,10:r2,b,c,20:r3,c,0,30:
rl1,a,0,20:rl2,b,0,20:rl3,c,0,20")
```

Answers: `vb` is **66.21** V, and `vc` is **24.83** V.

B11's Example 8.10

Determine the current through each resistor.



My solution below:

```
s\dc("e1,1,0,15:r1,1,a,4:e3,3,0,20:r3,3,a,10:e2,0,2,40:r2,a,2,5")
```

Through an array, and using the `approx` command, we ask for all the three answers:

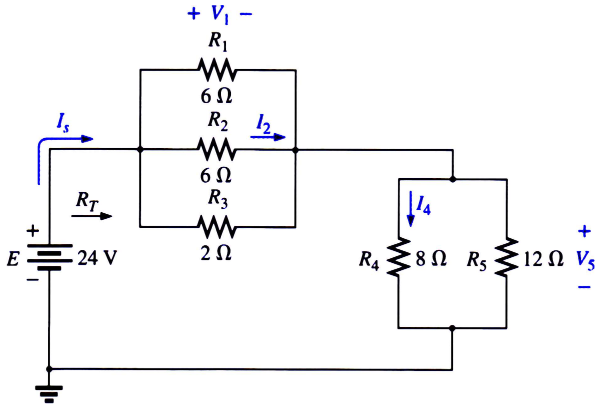
```
approx({ir1,ir2,ir3})
```

The calculator returns **{4.77,7.18,2.41}** meaning I_{R1} =4.77A, I_{R2} =7.18A and I_{R3} =2.41A. These are the correct answers. We could get this answer in a single-line command:

```
s\dc("e1,1,0,15:r1,1,a,4:e3,3,0,20:r3,3,a,10:e2,0,2,40:r2,a,2,5"):
approx({ir1,ir2,ir3})
```

Moving forward, we will often use this single-line approach for getting our answers.

B11's Example 7.6



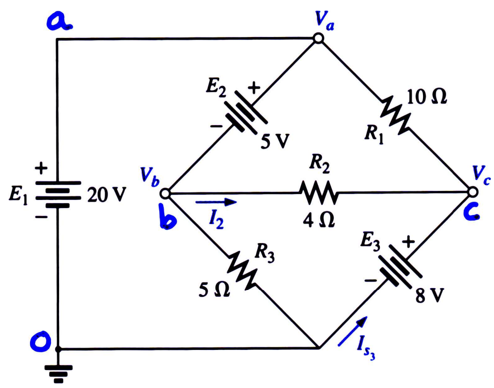
My solution below:

```
s\dc("e,1,0,24:r1,1,2,6:r2,1,2,6:r3,1,2,2:r4,2,0,8:r5,2,0,12")
```

Answer: `-ie` is I_S=**4** A, `ir2` is I_2=**.8** A, `ir4` is I_4=**2.4** A, `vr1` is V_1=**4.8** V, `vr5` is V_5=**19.2** V.

B11's Example 7.11

a. Determine voltages V_a, V_b, and V_c.
b. Find voltages V_{ac} and V_{bc}.
c. Find current I_2.
d. Find the source current I_{s_3}.



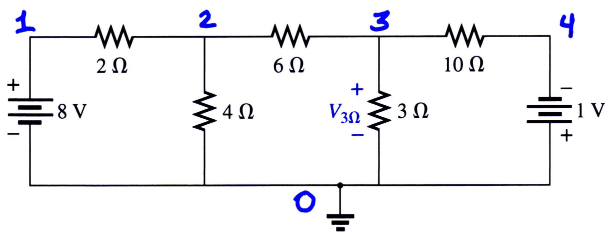
My solution below:

```
s\dc("e1,a,0,20:e2,a,b,5:e3,c,0,8:r1,a,c,10:r2,b,c,4:r3,b,0,5")
```

Answers: `va`=**20**, `vb`=**15**, `vc`=**8**, `va-vc`= **12**, `vb-vc`=**7**, `ir2`=**1.75**, I_S via `-ie3`=**-2.95**

B11's Example 8.24

Find the voltage drop in the 3Ω resistor.



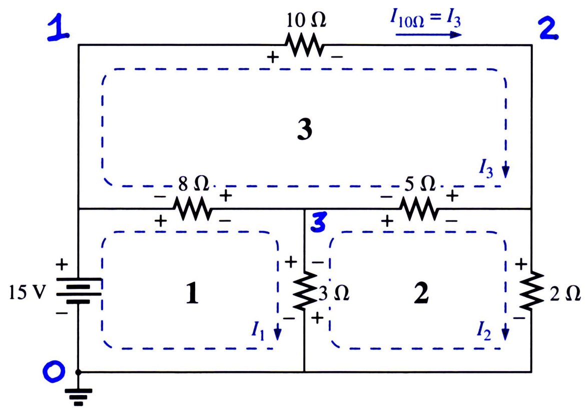
My solution below:

```
s\dc("e8,1,0,8:r2,1,2,2:r4,2,0,4:r6,2,3,6:r3,3,0,3:r10,3,4,10:e1,0,4,1")
```

Now, evaluating **vr3** via `approx(vr3)` finds that $V_{3\Omega}$ is **1.1** V. This is correct.

B11's Example 8.18

Find the current through the 10Ω resistor in the network shown below.



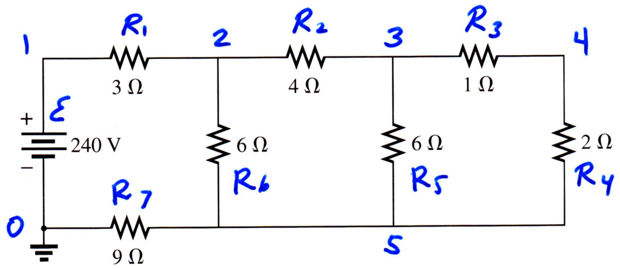
My solution below:

```
s\dc("e15,1,0,15:r10,1,2,10:r8,1,3,8:r5,3,2,5:r3,3,0,3:r2,2,0,2"):
approx(ir10)
```

We find that `ir10` = **1.22** A.

B11's Example 8.26

Find the voltage drop in the 2Ω resistor.



My solution is below:

```
s\dc("e,1,0,240:r1,1,2,3:r2,2,3,4:r3,3,4,1:
r4,4,5,2:r5,3,5,6:r6,2,5,6:r7,5,0,9")
```

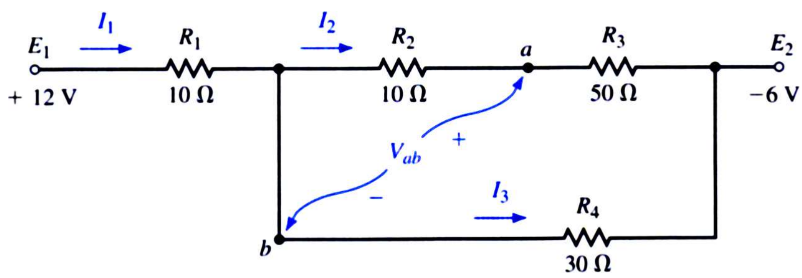
Evaluating `approx(vr4)`, we find the voltage drop in R_4 (the 2Ω resistor): it is **10.67** V

Circuits with 'hidden source'

Sometimes the schematics of circuits are presented in such a way that sources of voltage are not shown explicitly, yet their voltage is provided. These are what I call 'hidden source' problems. Below I offer two examples of these types of problems. Both are taken from the textbook *Circuit Analysis: Theory and Practice* (3ed) by Allan H. Robbins and Wilhelm C. Miller, to which from this point on we will refer as ***RM3***.

RM3's Example 7-5 (Hidden source)

Find the indicated currents and voltages.



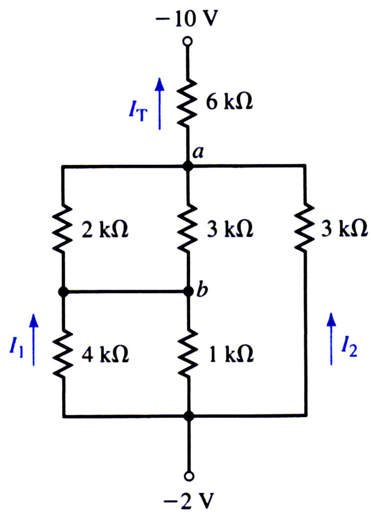
In my solution below, notice I introduced two sources, one for 12V and one for -6V:

```
s\dc("e1,1,0,12.:r1,1,b,10:r2,b,a,10:r3,a,2,50:
r4,b,2,30:e2,2,0,-6"):approx({ir1,ir2,ir4,va-vb})
```

The answer, **{.6,.2,.4,-2.}**, indicates I_1=.6, I_2=.2, I_3=.4 and V_{ab}=-2. This is correct.

RM3's Figure 7-16 (Hidden source)

Find the total circuit resistance, and the indicated currents and voltages.



My solution below:

This is how I named the nodes: the top, **1**; the bottom, **2**, and **a** and **b** as in the figure. In my solution below, notice I introduced two sources, one for -10V and one for -6V:

```
s\dc("r1,1,b,4'k:r2,1,a,3'k:r3,b,a,2'k:r4,b,a,3'k:r5,1,b,1'k:
rt,a,2,6'k:e1,1,0,-2:e2,2,0,-10"): approx({(v1-v2)/irt,irt,ir1,ir2,va-vb})
```

The answer we get indicates that the equivalent resistance, given by $(v_1-v_2)/I_T$, is **7.2** KΩ, and that I_T=**1.11 m**A, I_1=**.133 m**A, I_2=**.444 m**A and V_{ab}=**-0.8** V. This is correct.