Problem sheet 2, January 2005

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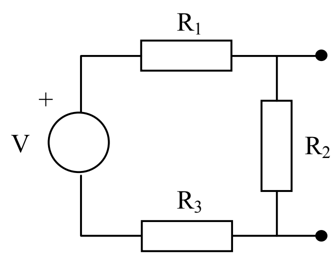
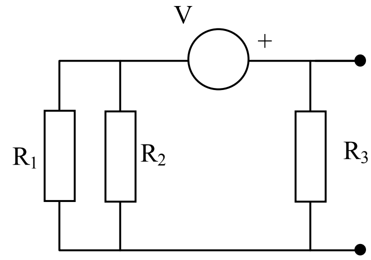
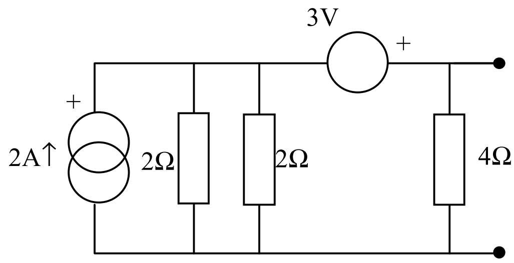
1. A single 100 Ω resistor has a voltage of 10 V applied to one end and 4 V to the other. How much current flows through the resistor as a result and how much power is dissipated? If the voltages on either side of the resistor are ***both*** increased by 20V at the same time how do your answers change?
2. Find Thévenin and Norton equivalent circuits for the following networks.



(a)

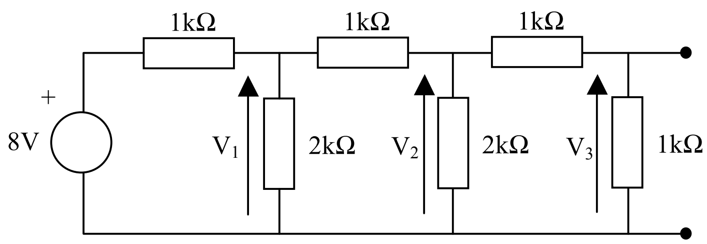


(b)

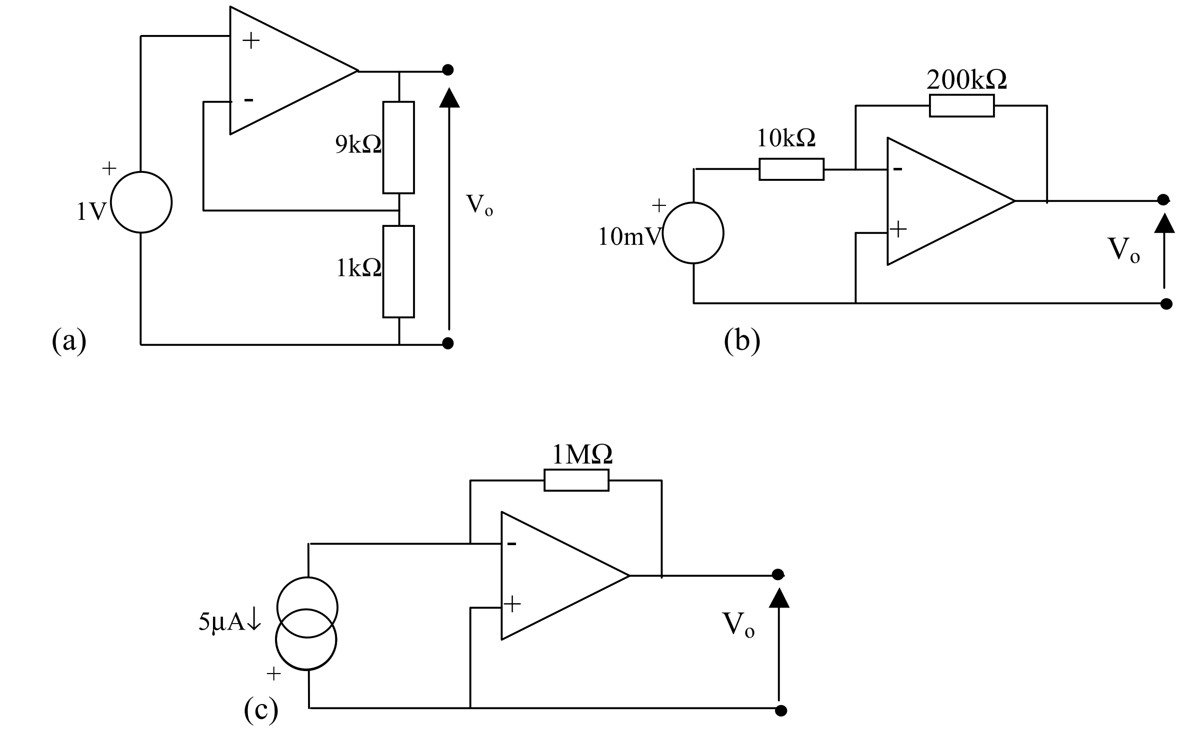


(c)

3. How do the principles of conservation of charge and conservation of energy in an electrical circuit lead to Kirchhoff's laws. State Kirchhoff's laws in as concise a form as possible.
4. Write down the node voltage equations for the circuit in 2(c) and hence find the voltage at each node in the circuit.
5. Write down the mesh current equations for the circuit in 2(c) and hence determine the current in each resistor in the circuit.
6. For the following network of resistors calculate the voltages V_1, V_2 and V_3. [Hint think about simplifying the circuit in blocks and work out the relationship between the various voltages as potential dividers eg V_3/V_2].



7. Calculate the output voltage for each of the following op-amp circuits



8. Resistor ladder networks like that in question 6 can used to construct digital to analog converters (circuits that turn a binary digital number into an analog voltage). For the circuit shown below determine what range of output voltages can be achieved by switching the switches S_0 to S_2 between ground and $-V_{ref}$. [Hint: use superposition to work out the Thevenin equivalent of the network connected to the op-amp input when each of the S_n is independently switched to $-V_{ref}$ in turn while the others are switch to ground].