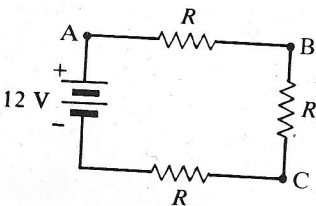


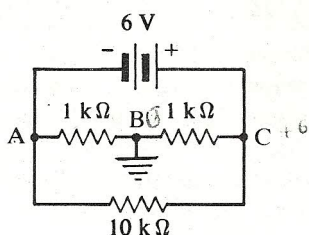
Thus if $R_3 > R_{3B}$, $I_M > 0$, and if $R_3 < R_{3B}$, $I_M < 0$, as we have stated. This feature of the bridge is particularly useful because the *sign* of I_M (or, equivalently, the sign of $V_C - V_D = I_M R_M$) can be used as an indicator of whether R_3 is greater than or less than a certain value R_{3B} . For example, R_3 could be a thermistor whose resistance changes rapidly with temperature. Then R_1 , R_2 , and R_4 could be chosen to balance the bridge at a certain temperature, say, 37.4°C . Then if the temperature of R_3 changed from 37.4°C , the bridge unbalance current *magnitude* (I_M) would approximately indicate the *magnitude* of the temperature change, and the *sign* would indicate whether the temperature was above or below 37.4°C . Thus, the bridge unbalance current (or voltage) could be used to control a heater (or cooler) element to regulate the temperature at 37.4°C .

PROBLEMS

1. What is the electric charge on (a) one electron, (b) a He^+ ion, (c) a He^{2+} ion, (d) an As^+ ion? State why the quantization of charge can be neglected in most electrical circuit problems.
2. Doubly ionized helium ions at a concentration of 10^{13} ions/cm³ move with a velocity of 10^5 cm/s. Calculate the current density in A/cm².
3. Define current.
4. Calculate how many electrons flow per second past a fixed point in a wire carrying 10 mA of current. If the current moves from left to right, which way do the electrons move? ✓
5. Define electric potential or voltage. What are the mks units of voltage? What does "ground" mean?
6. Calculate the gain in kinetic energy for an electron moving from a point of voltage 3 V to a point of voltage 5 V. Express your answer in joules and in electronvolts.
7. Define resistance.
8. State Ohm's law, including the units of all the terms.
9. Calculate the resistance of a silver wire 2.0 m long of radius 1 mm. Repeat for an aluminum wire of the same dimensions.
10. If a wire has a resistance of $10\ \Omega$, what would be the resistance of a wire with twice the length (made from the same material) and twice the diameter? Assume the temperatures of both wires are the same.
1. Calculate the voltage at points A, B, and C if (a) A is grounded, (b) B is grounded, (c) C is grounded.

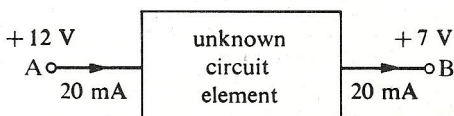


12. Calculate the voltage at points A, B, and C in the following circuit.

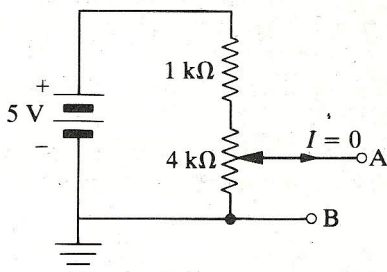


What is the current through the 10-k Ω resistor?

13. Calculate the resistance between terminals A and B.



14. A fixed 1.0-k Ω resistor and a 4.0-k Ω potentiometer are connected in series across a 5-V battery of negligible internal resistance. Calculate the maximum and minimum values of V_{AB} as the potentiometer shaft is rotated.



15. A gas discharge tube draws a current of 20 mA when a voltage difference of 800 V is maintained between its ends. Calculate the effective dc resistance in ohms between the ends of the tube.
16. Estimate quantitatively the static (dc) and the dynamic (ac) resistances at points A, B, and C of the device whose current-voltage curve is shown.

