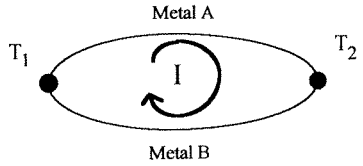
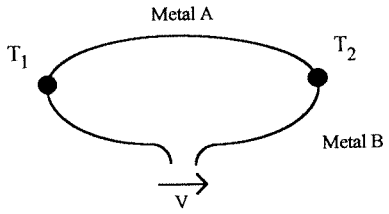
The Thermocouple

Introduction

If a simple closed circuit is made with two dissimilar metals, and the junctions between those metals are held at different temperatures, T_1 and T_2, then a small current flows due to the *Seebeck effect.*

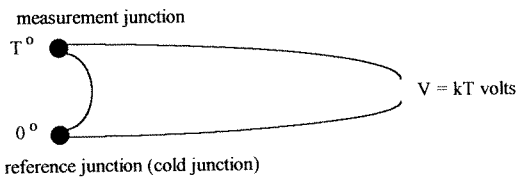


If the circuit is opened, below left, a voltage can be measured across the terminals.



The measured voltage is found to be proportional to temperature difference $(T_1 - T_2)$, ie $V = k(T_1 - T_2)$, where k is dependent on the metal combination. The circuit so formed is called a *thermocouple.* A number of standard material combinations exist for thermocouples, optimised for different temperature ranges. A popular one, the "K-type" thermocouple, is made from nickel/chromium, nickel/aluminium. For this material combination, k is approximately $40\mu V/^oC$.

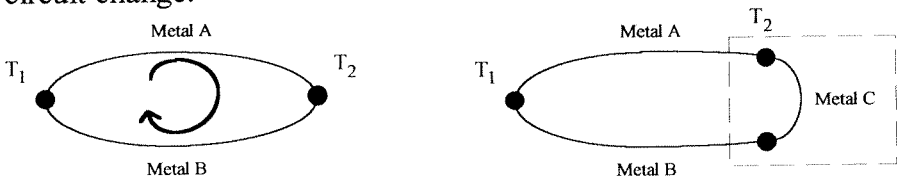
The thermocouple is essentially a *difference* measurement (ie it can only measure temperature difference between two junctions). For measurements of absolute temperature one junction is defined as a reference junction, and held at a known temperature. Conventionally this was done with an ice/water mix, and called the *cold junction.* These days the cold junction is almost always simulated electronically.



OVER

The Law of Intermediate Metals

The Law of Intermediate Metals states that, if a junction in a thermocouple is opened and other metals connected into the circuit (eg amplifier or voltmeter terminals), there will be no change in the thermo-electric emf induced as long as any new junctions so created are all at the same temperature as the original junction. The diagram below illustrates an acceptable circuit change.



Thermocouple use in the IDP

The thermocouple used on the IDP is a "K-type" thermocouple, made from nickel/chromium, nickel/aluminium. It is intended that the thermocouples should be made by the workshop to lengths specified, up to a max length of 500mm, by IDP team members.
The thermocouple should be used for differential measurement. One junction can be held at ambient, eg by attaching it to a thermally conductive surface of the AGV, while the other can be used for measurement. The LTC1152, a low drift op amp, is supplied as a suitable amplifier, and may be used in any standard op amp configuration.