

The Armfield Linear Heat Conduction accessory has been designed to demonstrate the application of the Fourier rate equation to simple steady-state conduction in one dimension.

**Linear Heat Conduction - HT11X**

HT11X Change heat conductor



**Hardware description**

The accessory comprises a heating section and a cooling section, which is clamped together or clamped with interchangeable intermediate sections between them, as required. The temperature difference created by the application of heat to one end of the resulting wall and cooling at the other end results in the flow of heat linearly through the wall by conduction.

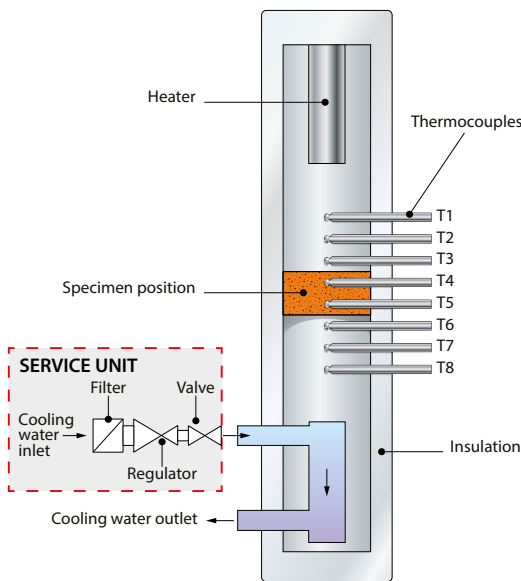
- ▶ Thermocouples are positioned along both the heated section and cooled section at uniform intervals of 15mm to measure the temperature gradient along the sections
- ▶ Heater is voltage or PID controlled allowing for the temperature set-point to be achieved rapidly and maintained within 0.1°C
- ▶ The HT10X service unit provides the accessory with the cooling water system
- ▶ A pressure regulator is incorporated to minimise the effect of fluctuations in the supply pressure
- ▶ The cooling water flow rate is measured by a turbine type flow sensor
- ▶ A control valve on the HT10X service unit allows the flow of cooling water to be varied, if required, over the operating range of 0-1.5 L/min. The valve can be PID controlled for improved supply pressure disturbance reduction

**Four intermediate sections are supplied as follows:**

- ▶ 30mm-long brass section of the same diameter as the heating and cooling sections are fitted with two thermocouples at the same intervals. When this section is clamped between the heating and cooling sections, a long plane wall of uniform material and cross-section is created with temperatures measured at eight positions
- ▶ A stainless-steel section of the same dimensions as the brass section demonstrates the effect of change in thermal conductivity
- ▶ Aluminium section of the same dimensions as the brass section to demonstrate the effect of change in thermal conductivity
- ▶ 30mm-long brass section reduced in diameter to 13mm to demonstrate the effect of change in cross-sectional area
- ▶ The heat-conducting properties of insulators may be found by simply inserting the paper or cork specimens supplied between the heating and cooling sections
- ▶ A tube of thermal paste is provided to demonstrate the difference between good and poor thermal contact between the sections

## Experimental capabilities

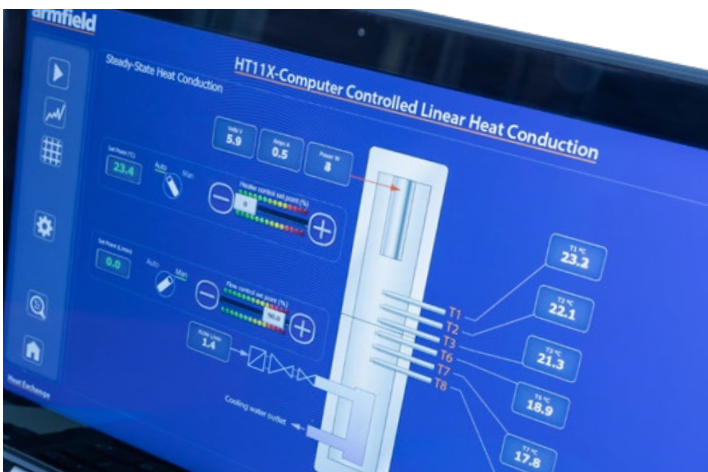
- ▶ Understanding the use of the Fourier rate equation in determining rate of heat flow through solid materials
- ▶ Measuring the temperature distribution for steady-state conduction of energy through a uniform plane wall and a composite plane wall
- ▶ Overall heat transfer coefficient for differing materials in series
- ▶ Determining the constant of proportionality (thermal conductivity  $k$ ) of different materials (conductors and insulators)
- ▶ Relationship of temperature gradient to cross-sectional area
- ▶ Effect of contact resistance on thermal conduction
- ▶ Understanding the application of poor conductors (insulators)
- ▶ Observing unsteady-state conduction (qualitative only)



Schematic diagram showing construction of HT11X



Thermocouples



HT11X mimic and control screen

## Requirements

## Scale

HT  
10X

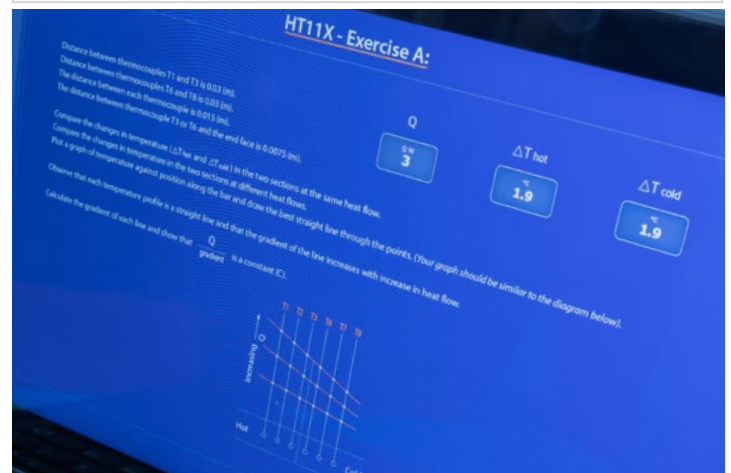


All electrical requirements and cold water supply are obtained from the HT10X service unit

## Ordering specification

A small-scale accessory designed to introduce students to the principles of linear heat conduction, and to enable the conductivity of various solid conductors and insulators to be measured.

- ▶ Comprises a PID controlled heating section and cooling section, plus four intermediate section conductor samples and two insulator samples
- ▶ The heating section, cooling section and one of the intermediate sections are fitted with thermocouples (eight in total) evenly spread along the length of the assembled conduction path
- ▶ All sections are thermally insulated to minimise errors due to heat loss
- ▶ Heater power variable up to 60W
- ▶ Water flow rate variable up to 1.5 L/min
- ▶ Heating and cooling sections, 25mm diameter
- ▶ A comprehensive instruction manual is included



HT11X armBUS exercise and calculation screen

## Essential accessories

HT10X Computer-Controlled Heat Transfer Service Unit

## Overall dimensions

Length	0.43m
Width	0.21m
Height	0.29m

## Packed and crated shipping specifications

Volume	0.05m <sup>3</sup>
Gross weight	10kg

## Ordering codes

HT11X

Issue: 1

URL: <http://www.armfield.co.uk/ht10x>

Applications

Me ChE CE IP

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