



Heat Transfer Service Unit H112



H112 Unit Shown with Optional H112A Linear Heat Conduction fitted

- *Up to Fifteen Fundamental Heat Transfer Experiments may be Used Individually on the Common Service Unit.*
- *Investigation of Convection, Conduction, Radiation, Steady State and Transient Heat Transfer.*
- *Investigation of Gas Laws and Pressure-Temperature Relationship for Water*
- *Safe and Suitable For Unsupervised Student Operation.*
- *Responds Rapidly to Control Changes.*
- *Negligible Operating and Maintenance Costs.*
- *Two year Warranty.*



Introduction

It is essential that the three basic modes of heat transfer; **Conduction, Convection and Radiation** are understood by students as a foundation for further studies involving heat transfer and temperature measurement. The Hilton Heat Transfer Service Unit H112 may be connected to any of fifteen optional experimental units each demonstrating a fundamental mode of heat transfer or a combination of modes of heat transfer and a range of other experiments to reinforce the learning process.

The Hilton Heat Transfer Service Unit H112 is bench mounted, operates from a conventional single-phase electrical power supply and provides both control and instrumentation for each of the fifteen optional experimental units.

The fifteen optional units are: -

Linear Heat Conduction	H112A
Radial Heat Conduction	H112B
Laws of Radiant Heat Transfer & Radiant Heat Exchange	H112C
Combined Convection and Radiation	H112D
Extended Surface Heat Transfer	H112E
Radiation Errors in Temperature Measurement	H112F
Unsteady State Heat Transfer	H112G
Thermal Conductivity of Liquids and Gases Unit	H112H
Perfect Gas Law Demonstration	H112J
Marcet Boiler (Saturation Pressure)	H112M
Thermal Conductivity of Building Materials	H112N
Free and Forced Convection from Flat, Pinned and Finned Plates	H112P
Thermoelectric Heat Pump	H112Q
Closed Cycle Hot Air Engine	H112R
Boiling Heat Transfer	H112S

Addition of the optional Heat Transfer Service Unit Computer Upgrade HC113A enables students to record, display and process data using a computer. The dedicated software enhances student interest and speeds comprehension of the principles being demonstrated.

The unit will be of particular interest to those studying:

- Mechanical Engineering
- Nuclear Engineering
- Chemical Engineering
- Control and Instrumentation
- Plant and Process Engineering
- Building Services
- Engineering Physics
- Refrigeration
- Marine Engineering

Experimental Capabilities

For detailed descriptions and experimental capabilities refer to individual data sheets for each optional unit.

Description

Heat Transfer Service Unit H112

The bench mounted Hilton Heat Transfer Service Unit H112 contains a variable power supply with all associated electrical circuits protected by a residual current circuit breaker and overload cut outs. The rear panel contains a power socket for the optional units and access for the optional data acquisition system.

Miniature type K thermocouple sockets allow the connection of up to 12 temperature sensors from the range of optional experimental units available.

The unit has three digital displays on the front panel including a push button digital temperature indicator allowing all relevant parameters to be displayed. Parameters displayed on the Heat Transfer Service Unit H112 are Temperature, Voltage range 0-240Vac and Current range 0-2Aac.

Additional parameters, as required, are displayed by reference to instruments on the optional demonstration units.

Built in transducers allow all parameters from each of the optional demonstration units to be recorded, processed and displayed on the addition of the optional Heat Transfer Service Unit Computer Upgrade HC113A.



Specification

Heat Transfer Service Unit H112

General

A fully instrumented bench top heat transfer service unit providing regulated and adjustable ac power and instrumentation for twelve optional heat transfer experiments into conduction, convection, radiation, steady state and transient heat transfer.

Detailed

A metal cased bench mounted heat transfer service unit containing a regulated and variable ac power supply and signal conditioning with three digital displays and selector switch for up to 12 type K thermocouples, ac voltage and current. Internal electric and mechanical safety devices to allow for unsupervised operation by students.

Optional demonstration units include:

Linear Heat Conduction	H112A
Radial Heat Conduction	H112B
Laws of Radiant Heat Transfer & Radiant Heat Exchange	H112C
Combined Convection and Radiation	H112D
Extended Surface Heat Transfer	H112E
Radiation Errors in Temperature Measurement	H112F
Unsteady State Heat Transfer	H112G
Thermal Conductivity of Liquids and Gases	H112H
Perfect Gas Laws Demonstration	H112J
Marcet Boiler (Saturation Pressure)	H112M
Thermal Conductivity of Building Materials	H112N
Free and Forced Convection from Flat, Pinned and Finned Plates	H112P
Thermoelectric Heat Pump	H112Q
Closed Cycle Hot Air Engine	H112R
Boiling Heat Transfer	H112S
Heat Transfer Service Unit Data Acquisition Upgrade	HC113A

Supplied with a detailed experimental operating and maintenance manual giving example experimental results and sample calculations.

Accessories and spares for two years normal operation together with a full two-year warranty.

Dimensions

Height: 240mm Depth: 280mm
Width: 430mm Weight: 7kg.

Services Required

Electrical:

A: 220-240 Volts, Single Phase, 50Hz
(With earth/ground). Line current up to 6A at 230v.

Or

B: 110-120 Volts, Single Phase, 60Hz
(With earth/ground). Line current up to 10A at 110v

Ordering Information

Order as: Heat Transfer Service Unit H112

Electrical Specification

Either: **A:** 220-240 Volts, Single Phase, 50Hz (With earth/ground).

B: 110-120 Volts, Single Phase, 60Hz (With earth/ground).

Language

Either: English, Spanish, French.

Shipping Specification

Service Unit Net Weight: 12.3 kg.

Packing Case Volume: 0.22m³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.

Additional copies of instruction manual.

Recommended list of spares for 5 years operation.



Optional Extra H112A **Linear Heat Conduction**



Specification

A small-scale accessory that allows experimental investigation of linear heat conduction and the measurement of the thermal conductivity of various solid conductors and insulators.

An insulated, 25mm diameter brass heated section and cooling section that may be either clamped together, or assembled with one of four insulated intermediate sections or test specimens between the interfaces.

The hot end uses a nominal 65W heater (operating at 240v maximum), which is fitted with a high temperature limit switch. The power supplied to the heater is controlled and measured by the Heat Transfer Service Unit H112.

The cold section is of identical dimensions to the hot end and is water-cooled. Both the heated and cooled ends are each fitted with three thermocouples at 15mm intervals to measure the temperature gradients along the bars.

Four intermediate insulated sections are supplied as follows: -
30mm long x 25mm diameter brass with two thermocouples at the same interval as the hot and cold sections.

When clamped together the hot and cold sections form a uniform bar with eight equally spaced temperature-measuring points.
30mm long x 25mm diameter stainless steel section.
30mm long x 25mm diameter aluminium section.
30mm long x 13mm diameter brass section.

All eight thermocouples plug directly into the Heat Transfer Service Unit H112 and temperatures are displayed on its digital panel meter.

Experimental Capabilities:

- Understanding the Fourier rate equation in determining the rate of heat flow through solid materials.
- Measuring the temperature distribution for steady state conduction of energy through a uniform plane solid and a composite plane solid.
- Determine the constant of proportionality (Thermal conductivity) of different materials (conductors and insulators).
- Measuring the temperature drop at the contact face between adjacent layers in a composite plane solid.
- Measuring the temperature distribution for steady state conduction of energy through a plane solid of reduced cross sectional area.
- Understanding the application of poor conductors (insulators).
- Observing unsteady state conduction (qualitative only)

Dimensions

Height:	305mm	Depth:	240mm
Width:	240mm	Weight:	4.0kg.

Ordering Information

Order as: Linear Heat Conduction H112A

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Linear Heat Conduction H112A accessory.

Water: - 1.5 Litres/ minute at a minimum 10m head.

Shipping Specification

Net Weight	6.45kg
Packing Case Volume	0.18m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.
Additional copies of instruction manual.
Recommended list of spares for 5 years operation.



Optional Extra H112B **Radial Heat Conduction**



Specification

A small-scale accessory designed to experimentally investigate the basic principles of radial heat conduction and to allow the thermal conductivity of the solid metal disc to be determined.

An insulated, 110mm diameter brass disc 3.2mm thick is heated in its centre by a nominal 100W heater (operating at 240v ac maximum) which is fitted with a high temperature limit switch. The power supplied to the heater is controlled and measured by the Heat Transfer Service Unit H112.

The periphery of the disc is cooled by water passing through a copper tube bonded to the disc.

Six type K thermocouples are positioned at 10mm radial increments from the heated centre to the periphery. All six thermocouples plug directly into the Heat Transfer Service Unit H112 and temperatures are displayed on its digital panel meter.

Dimensions

Height: 155mm Depth: 190mm
Width: 190mm Weight: 2.7kg.

Experimental Capabilities:

- Understanding the Fourier rate equation in determining the rate of heat flow through solid materials.
- Measuring the temperature distribution for steady state conduction of energy through the wall of a cylinder (radial energy flow).
- Determine the constant of proportionality (Thermal conductivity) of the disc material.

Ordering Information

Order as: Radial Heat Conduction H112B

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Radial Heat Conduction H112B accessory.

Water: - 1.5 Litres/ minute at a minimum 10m head.

Shipping Specification

Net Weight	4.55kg
Packing Case Volume (Estimated)	0.16m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.
Additional copies of instruction manual.
Recommended list of spares for 5 years operation.



Optional Extra H112C

Laws of Radiant Heat Transfer and Radiant Heat Exchange



Specification

An accessory designed to experimentally investigate the laws of radiant heat transfer and radiant heat exchange. The application of the laws to both heat and light radiation are demonstrated using a radiant heat source and light source. Two appropriate detectors, light filters, target plates of different Emissivity and aperture plates each mounted on suitable carriages on a parallel graduated track, and allow simple and rapid experimental procedures.

The electrically heated matt black radiant heat source has an effective diameter of 100mm. and is fitted with an integral thermocouple to record its surface temperature. Heat input to the radiant source is controlled and recorded by the Heat Transfer Service Unit H112.

A radiometer detects the heat flux directly in W/m^2 from either the source, a combination of four plates of different Emissivity (two matt black, one grey and one polished) or between a slot formed by two moveable cork faced plates. Each plate of different Emissivity incorporates a surface thermocouple for temperature measurement.

The diffuse light source comprises a low voltage filament lamp within a rotatable enclosure (180°) that can be located on the parallel track in place of the heat source.

A lightmeter recording directly in lux may be located in place of the radiometer in order to measure incident intensity.

Supplied filter plates of varying opacity and thickness can also be mounted on the track to demonstrate the laws of light absorption.

All six thermocouples plug directly into the Heat Transfer Service Unit H112. The radiometer and light meter plug into an auxiliary console that is integral with the H112C demonstrator.

Both the heat source and light source intensity are controlled through the variable 240v ac supply from the Heat Transfer Service Unit H112.

Dimensions

Height: 440mm Depth: 300mm
Width: 1230mm Weight: 12.4kg.

Experimental Capabilities:

- Inverse square law using the heat source and radiometer or light source and light meter.
- Stefan Boltzman Law using the heat source and radiometer.
- Relating the radiation intensity received at the radiometer to that emitted by the source.
- Emissivity using heat source, metal plates and radiometer.
- Kirchoff Law using the heat source, metal plates and radiometer.
- Area factors using the heat source, aperture and radiometer.
- Lamberts Cosine Law using the light source (rotated) and lightmeter.
- Lamberts Law of Absorption using the light source, filter plates and lightmeter.

Ordering Information

Order as: Laws of Radiant Heat Transfer and Radiant Heat Exchange H112C

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Laws of Radiant Heat Transfer and Heat Exchange H112C accessory.

Shipping Specification

Net Weight	12.4kg
Packing Case Volume	0.32m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.
Additional copies of instruction manual.
Recommended list of spares for 5 years operation.



Optional Extra H112D **Combined Convection and Radiation**



Specification

A small scale accessory that allows experimental investigation of both natural and forced convection from a heated cylinder in a cross-flow configuration. The surface temperature of a duct mounted, 10mm diameter matt black cylinder may be varied over a wide range; thereby allowing the increasing effects of radiant heat transfer to be investigated as the temperature is increased.

A variable velocity airflow within the small diameter circular duct allow the effects on convective heat transfer from the cylinder to be investigated over the range of 0 to approximately 8m/s.

An integral thermocouple on the surface of the electrically heated cylinder allows surface temperature to be measured at all operating conditions. This combined with a duct-mounted thermocouple, heater input power measurement and in duct air velocity measurement allows all of the relevant parameters to be recorded.

The heater power supply and temperature sensors connect to the Heat transfer service unit H112 while velocity is recorded on auxiliary instrumentation supplied as part of the H112D demonstration unit.

The cylinder heater input power is controlled through the variable 240v ac supply from the Heat Transfer Service Unit H112 and is designed to operate at up to 100 Watts.

The variable velocity airflow is provided by an integral centrifugal fan. All relevant components are secured to a bench mounted plate that is designed to be situated alongside the Heat Transfer Service Unit H112.

Dimensions

Height: 1200mm Depth: 300mm
Width: 350mm Weight: 17.2kg.

Experimental Capabilities:

- Determination of the combined heat transfer ($Q_{\text{Radiation}} + Q_{\text{Convection}}$) from a horizontal matt black cylinder in natural convection over a wide range of power inputs and corresponding surface temperatures.
- Measuring the domination of the convective heat transfer coefficient (H_c) at low surface temperatures and the domination of the radiation heat transfer (H_r) at high surface temperatures.
- Determination of the effect of forced convection on the heat transfer from the cylinder at varying air velocities.
- Investigation of the local heat transfer coefficient around the cylinder at varying air velocities.

Ordering Information

Order as: Combined Convection and Radiation H112D

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Combined Convection and Radiation H112D accessory.

Shipping Specification

Net Weight	17.2kg
Packing Case Volume	0.28m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.

Additional copies of instruction manual.

Recommended list of spares for 5 years operation.



Optional Extra H112E **Extended Surface Heat Transfer**



Specification

A small scale bench top accessory designed to measure the temperature profile and heat transfer along a horizontal extended surface (cylindrical pin).

A small diameter uniform rod is heated at one end and heat flowing along the rod by conduction is lost to the surroundings by a combination of natural convection and radiation. The resulting heat transfer gives a temperature profile that may be investigated and predicted by conventional analysis.

The apparatus consists of a solid cylindrical matt black brass bar of 10mm diameter and effective length of 350mm supported in a frame and heated at one end. At intervals of 50mm from the heated end are eight thermocouples recording the surface temperature so that a temperature profile along the bar may be developed. An additional thermocouple records the ambient temperature.

The heater is located inside an insulated cylinder at one end of the apparatus. The heater input power is controlled through the variable 240v ac supply from the Heat Transfer Service Unit H112 and is designed to operate at up to 20 Watts

All instrumentation and power supplies plug directly into the Heat Transfer Service Unit H112 and readings are displayed on digital panel meters.

All relevant components are secured to a bench mounted plate that is designed to be situated alongside the Heat Transfer Service Unit H112.

Dimensions

Height: 150mm	Depth: 150mm
Width: 500mm	Weight: 3.85 kg

Experimental Capabilities:

- Measuring the temperature distribution along an extended surface and comparing the result with a theoretical analysis.
- Calculating the heat transfer from an extended surface resulting from the combined modes of free convection and radiation heat transfer and comparing the result with a theoretical analysis.
- Determining the constant of proportionality / thermal conductivity of the rod material.

Ordering Information

Order as: Extended Surface Heat Transfer H112E

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Extended Surface Heat Transfer H112E accessory.

Shipping Specification

Net Weight	3.85kg5
Packing Case Volume	0.14m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.
Additional copies of instruction manual.
Recommended list of spares for 5 years operation.



Optional Extra H112F
Radiation Errors in Temperature Measurement



Specification

A small scale bench top accessory designed to experimentally investigate how measured temperatures can be influenced by the effects of radiation, temperature sensor design and surface finish.

Three temperature sensors of different form and surface finish are mounted centrally in a circular stainless steel duct that is surrounded locally by an electrical heater. An additional temperature sensor records the temperature of the inside of the heated duct adjacent to the centrally mounted thermocouples.

A radiation shield may be raised or lowered over the centrally mounted thermocouples to investigate the effects of shielding

The circular duct is mounted on the discharge from a centrifugal fan. Air from the fan is blown through the duct past the temperature sensors at a controlled velocity of between 0 and 8m/s. The air velocity is measured by an in duct anemometer.

The duct heater is controlled using the variable 240v ac supply from the Heat Transfer Service Unit H112. The heater power supply and temperature sensors connect to the Heat Transfer Service Unit H112 while velocity is recorded on auxiliary instrumentation supplied as part of the H112F unit. All relevant components are secured to a bench mounted plate that is designed to be situated alongside the Heat Transfer Service Unit H112.

Dimensions

Height: 1220mm Depth: 350mm
 Width: 300mm Weight: 19.1 kg

Experimental Capabilities:

- Demonstration of how temperature measurements can be affected by radiant heat transfer to a sensor from its surroundings and to show:
- Effect of temperature difference between the sensor and its surroundings
- Effect of air velocity.
- Effect of sensor size.
- Effect of sensor Emissivity.
- Demonstration of methods of reducing the errors in temperature measurement, which are due to radiation from a source that is visible to the sensor. Including:
- Use of a radiation shield between the sensor and the source of radiation.
- Design of a radiation resistant sensor.

Ordering Information

Order as: Radiation Errors in Temperature Measurement H112F

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Radiation Errors in Temperature Measurement H112F accessory.

Shipping Specification

Net Weight 19.1kg.
 Packing Case Volume 0.34m³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.
 Additional copies of instruction manual.
 Recommended list of spares for 5 years operation.



Optional Extra H112G **Unsteady State Heat Transfer**



Specification

A small scale bench top accessory designed to allow experimental investigation of unsteady state heat transfer by conduction and convection.

Instrumented solid shapes of different materials are plunged into a controlled temperature water bath and the temperature changes at the geometric centre of the shapes are recorded at regular intervals.

As the shapes are of regular geometric form standard empirical methods may be used to predict the temperature variation with time and determine factors about the material properties.

The accessory also allows investigation of the lumped thermal capacitance method of thermal analysis.

The seven shapes supplied comprise rectangular slabs (2), spheres (2), small diameter cylinders (2), large diameter cylinder (1). Where two identical shapes are supplied the materials are plated brass and stainless steel. The large diameter cylinder is plated brass. Each shape has a thermocouple at its geometric centre and is fitted into a shape holder, which allows it to be safely immersed in the controlled temperature water bath.

The controlled temperature water bath has a variable speed circulating pump and central cylindrical flow channel to establish stable forced convection conditions to be maintained around the immersed shapes.

Bath temperature, shape temperature and convective stream temperature are recorded. All the thermocouples and the variable speed circulating pump power supply plug directly into the Heat Transfer Service Unit H112 and readings are displayed on digital panel meters. The water bath heater operates directly from the local mains supply.

All major components are secured to a bench mounted plate that is designed to be situated alongside the Heat Transfer Service Unit H112.

Dimensions

Height: 670mm Depth: 400mm
Width: 600mm Weight: 23.2 kg

Experimental Capabilities:

- Observation of unsteady state conduction of heat to the centre of a solid shape (Qualitative, using a chart recorder, manual recording or the optional Computer Upgrade HC113A accessory) when a step change is applied to the temperature at the surface of the shape.
- Using analytical transient-temperature/heat flow charts to determine the thermal conductivity of solid shapes from measurements taken on similar shapes of different thermal conductivity.
- Investigation of the effect of shape, size and material properties on unsteady heat flow.
- Investigating the Lumped Thermal Capacitance method of transient temperature analysis.

Ordering Information

Order as: Unsteady State Heat Transfer H112G

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Unsteady State Heat Transfer H112G accessory.

The Water Bath requires either:

- A: 220-240 Volts, Single Phase, 50Hz
(With earth/ground), 13 Amps
- B: 110-120 Volts, Single Phase, 60Hz
(With earth/ground), 26 Amps

Shipping Specification

Net Weight 23.2kg
Packing Case Volume 0.53m³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.

Additional copies of instruction manual.

Recommended list of spares for 5 years operation.



Optional Extra H112H **Thermal Conductivity of Liquids and Gases**



Specification

A small scale bench top accessory designed to allow experimental investigation of the thermal conductivity of liquids and gases. The unit is designed specifically for teaching purposes.

The unit comprises a heated plug and water cooled jacket with a small radial clearance in which gas or liquid samples may be tested. The thin laminar film prevents natural convection in the fluid under test. The temperatures either side of the sample under test are recorded by integral thermocouple sensors.

The unit is calibrated using air, in order to account for incidental heat losses and is suitable for determining the thermal conductivity of viscous non-corrosive liquids such as oils, glycerine etc. and non-flammable gases.

The unit may be readily dismantled for cleaning and is re-assembled with a single bolt and replaceable O ring seals.

Heat input is both measured and controlled by the Heat Transfer Service Unit H112 which also provides instrumentation for measurement of the temperatures on either side of the sample under test.

Thermocouples allow use of the accessory with the optional Heat Transfer Service Unit Computer linked Upgrade HC113A.

Dimensions

Height:	80mm	Depth:	100mm
Width:	180mm	Weight:	1.0 kg

Experimental Capabilities:

- Calibration of the unit to establish the effect of incidental heat transfers.
- Determination of the thermal conductivity of any suitable gas or liquid compatible with the materials of construction.

Ordering Information

Order as: Thermal Conductivity of Liquids and Gases Accessory H112H

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Thermal Conductivity of Liquids and Gases Accessory H112H.

Shipping Specification

Net Weight	10kg
Packing Case Volume	0.028m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.

Additional copies of instruction manual.

Recommended list of spares for 5 years operation



Optional Extra H112J **Perfect Gas Law Demonstration**



Specification

A small scale bench top accessory designed to allow experimental investigation of the first law of thermodynamics using the perfect gas law and the expansion of air.

The unit consists of two vessels connected by a large bore pipe and valve together with an integral air pump. The pump can be used to both pressurise one vessel and evacuate the other.

Additional valves allow the vessels to be used in isolation; venting to or from atmosphere and in a combined arrangement where the pressurised vessel can vent into the evacuated vessel.

Low inertia thermocouple sensors located in each vessel record the air temperatures and individual pressure transducers record the chamber pressures.

The vessels and interconnecting pipe work are constructed from impact resistant plastic and for operator safety pressure switches limit the operating pressures to safe levels.

The unit is provided with its electrical services and temperature instrumentation by the Heat Transfer Service Unit H112. This also provides digital display of the air temperatures in the vessels while an auxiliary display provided with the H112J allows display of the chamber pressures.

Though digital display of parameters is possible using the instrumentation provided the processes involved are transient (vary rapidly with time) and use of the Heat Transfer Service Unit Upgrade HC113A is essential. However the same upgrade is useable with all of the optional devices (H112A through to H112J) in the Hilton H112 range.

The larger vessel has an approximate volume of 25 litres and the smaller approximately 15 litres.

Dimensions

Height:	700mm	Depth:	350mm
Width:	700mm	Weight:	15 kg

Experimental Capabilities:

- Investigation of the First law of Thermodynamics.
- The second Law of Thermodynamics and its Corollaries
- Observation of the Pressure, Volume, Temperature Relationship for Air.
- Observation of the transient responses to different rates of change in a process.

Ordering Information

Order as: Perfect Gas Law Demonstration H112J

Services Required

Electrical and instrumentation services are provided by the **Heat Transfer Service Unit H112**, which is an essential item of equipment for operation of the optional Perfect gas Law Demonstration Accessory H112J.

Shipping Specification

Net Weight	15kg
Packing Case Volume	0.22m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.

Additional copies of instruction manual.

Recommended list of spares for 5 years operation.`



Optional Extra H112M
Marcet Boiler (Saturation Pressure)



Dimensions

Height: 450mm Depth: 450mm
 Width: 500mm Weight: 20 kg

Experimental Capabilities:

- Measurement of the pressure and temperature of saturated steam between ambient temperature and 10 bar absolute pressure.
- Comparison of the test results with steam tables

Ordering Information

Order as: Marcet Boiler H112M

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Marcet Boiler accessory H112M

Shipping Specification

Net Weight 30kg
 Packing Case Volume 0.21m³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification
 Additional copies of instruction manual
 Recommended list of spares for 5 years operation

Specification

A small scale bench top accessory designed to allow experimental investigation of the pressure and temperature relationship of saturated steam in equilibrium with pure water.

The unit allows investigation of the saturation pressure-temperature relationship of water between ambient temperature and up to 10 bar absolute pressure (179.9 °C Saturation temperature).

The unit incorporates an electrical heater that is controlled by the H112 Service unit together with an integral high pressure cut out for safe operation. The unit is also fitted with a certified pressure relief valve.

Saturation temperature of the steam/water is measured and displayed using the H112 Heat Transfer service unit. The saturation pressure inside the vessel is displayed using a high accuracy dial pressure gauge.

Thermocouples and an integral connection point for a pressure transducer allow use of the accessory with the optional Heat Transfer Service Unit Computer linked Upgrade HC113A.



Optional Extra H112N **Thermal Conductivity of Building Materials**



Specification

A bench top accessory designed to allow students to easily investigate the relative thermal conductivities of typical building materials.

The H112N utilises a relative method of thermal conductivity measurement base upon an international standard ISO 8301. However due to its design, the H112N allows simple investigation at low cost.

The H112N uses a PID controlled flat plate electrical heater and a water cooled flat plate with an integral and highly sensitive heat flowmeter. The 300mm x 300mm specimen under test is sandwiched between the heated and cooled plates. Maximum specimen thickness is 75mm, maximum hot plate temperature 70°C.

The assembly is contained in a thermally insulated enclosure to minimise heat losses.

The loading system supplied ensures that the same clamping force is applied to all specimens.

The heat flowmeter gives an output to a digital panel meter on the special control and instrumentation console. Special thermocouples are arranged to measure mean temperatures either side of the test specimen, allowing the temperature gradient across the sample and hence the thermal conductivity to be determined.

The thickness of the test sample may be measured in situ using the dial indicator on the clamping mechanism. The unit allows the thermal resistance of samples to be determined and the measurement of samples connected in series (stacked). This allows the formula relating individual thermal resistances and the overall thermal resistance of a stacked sample to be investigated.

The H112N accessory will allow comparative investigation of the thermal conductivity of building material samples and is designed specifically for teaching purposes.

Dimensions

Height: 450mm Depth: 450mm
Width: 500mm Weight: 20 kg

Experimental Capabilities:

- Rapid measurement of Thermal Conductivity for materials with Thermal Resistance in the range 0.1 to 1.4 m² K/W.
(Resistance=Thickness/Conductivity)
- Measurement of the Thermal Resistance of typical building materials.
- Measurement of the Thermal Resistance of thin stacked samples of building materials.

Ordering Information

Order as: Thermal Conductivity of Building Materials H112N

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Thermal Conductivity of Building Materials accessory H112N.

Water cooling:- Either locally sourced temperature controlled, or local water supply and drain.

Shipping Specification,

Net Weight 30kg
Packing Case Volume 0.21m³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification
Additional copies of instruction manual
Recommended list of spares for 5 years operation



Optional Extra H112Q Thermoelectric Heat Pump



Specification

A bench top accessory designed to allow students to experimentally investigate the performance of a thermoelectric cooler module.

A thermoelectric device has no moving parts and uses a direct electrical current to transfer heat from one face of the device to the other.

Thermoelectric devices have been used for many years for cooling electronic devices and vaccines. More recently due to reduced production costs they have found application in mobile coolers for domestic and recreational use.

In the H112Q, the thermoelectric module is held between a heated block and a water cooled plate. The module extracts heat from the block and transfers this, and the input power, to the water cooled plate. An insulated hinged enclosure allows student examination and minimises heat gains/losses from the system.

The module will also act in reverse and generate a small amount of electrical power if one face is maintained at a higher temperature than the other. This can also be demonstrated.

Controllable power for the module and heater is supplied by the H112 Heat Transfer Service Unit.

Instrumentation is provided with the unit that allows measurement of the DC power supplied to the module, the temperatures either side of the module, the cooling water flow rate and the cooling water temperature rise. The heater power is measured by the H112 Heat Transfer Service unit.

Dimensions

Height: 305mm Depth: 240mm
Width: 240mm Weight: 20.0kg.

Experimental Capabilities:

- Investigation of the effects upon the surface temperature of either face of the module with increasing power. (Peltier Effect)
- Investigation of the effect upon heat transfer direction of reversing the polarity of the power supply to the module. (Thomson or Lenz Effect).
- Investigation of the variation in open circuit voltage across the module due to the variation in surface temperature difference. (Seebeck Effect).
- Investigation of the power generating performance of the module with a steady load and increasing temperature difference.
- Estimation of the coefficient of performance of the module when acting as a refrigerator.
- Conducting a full energy balance for the module.

Ordering Information

Order as: Thermoelectric Heat Pump Module H112Q

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Thermoelectric Heat Pump H112Q.

Water: - 1.5 Litres/ minute at a minimum 10m head.

Shipping Specification, Nominal

Net Weight	30kg
Packing Case Volume	0.28m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification
Additional copies of instruction manual
Recommended list of spares for 5 years operation



Optional Extra H112R **Closed Cycle Hot Air Engine**



Dimensions

Height: 230mm Depth: 300mm
Width: 350mm Weight: 20kg.

Experimental Capabilities:

- Demonstration of a direct conversion of heat energy into shaft power.
- Investigation of the cycle efficiency.
- Investigation of the parameters affecting the cycle performance.

Specification

A bench top accessory designed to allow students to experimentally investigate one of the methods available to convert heat energy directly into work.

The engine consists of a water cooled power cylinder and a transfer cylinder connected via a common duct. A single acting power piston and double acting displacer piston are connected to a flywheel.

The cycle of the engine consists of two isothermal processes and two constant volume processes

Heat to expand the captive gas charge and drive the power piston is provided by an electrical element controlled from the standard instrumentation console.

As the unit is water cooled, unlike competing models, the Hilton H112R can operate continuously.

A belt brake dynamometer allows the mechanical output of the engine to be measured. Control and measurement of the heater input power and shaft output torque and speed allows system overall performance to be measured at a range of speeds and heater temperatures.

The standard instrumentation console allows heater input and system temperatures to be recorded

Ordering Information

Order as: Stirling Cycle Hot Air Engine H112R

Services Required

Electrical and instrumentation services are provided by the **Heat Transfer Service Unit H112**, which is an essential item of equipment for operation of the optional Stirling Cycle Hot Air Engine H112R.

Water: - 1.5 Litres/ minute at a minimum 10m head.

Shipping Specification, Nominal

Net Weight	30kg
Packing Case Volume	0.28m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification
Additional copies of instruction manual
Recommended list of spares for 5 years operation



Optional Extra H112S **Boiling Heat Transfer**



Specification

A bench top accessory designed to allow students to experimentally investigate convective, nucleate and film boiling.

The unit consists of a high strength clear glass cylinder with instrumented electric heater element immersed in a volatile solvent that boils at low pressure.

An integral water cooled condenser coil allows the chamber pressure to be controlled over a wide range of negative and positive pressures depending upon the local water supply.

A digital wattmeter allows students to determine the heat transfer from the heated element and this together with instrumentation on the H112 enables all relevant parameters to be recorded.

An integral control console provides heater power control and high temperature/pressure safety cut outs. The chamber is also fitted with a safety valve.

Dimensions

Height: 700mm Depth: 300mm
Width: 350mm Weight: 25kg.

Experimental Capabilities:

- Visual demonstration of convective, nucleate and film boiling.
- Study of the heat flux and surface heat transfer coefficient at constant temperature.
- Investigation of the effect of pressure on critical heat flux.
- Study of filmwise condensation and condenser overall heat transfer coefficient.
- Investigation of the pressure- temperature relationship of a pure substance, and the effect of air in a condenser.
- Demonstration of:
 - Liquid carry over or priming in boilers.
 - Law of partial pressures

Ordering Information

Order as: Boiling Heat Transfer H112S

Services Required

Electrical and instrumentation services are provided by the *Heat Transfer Service Unit H112*, which is an essential item of equipment for operation of the optional Boiling Heat Transfer option H112S.

Water: - 1.8 Litres/ minute at a minimum 10m head.

Shipping Specification, Nominal

Net Weight	40kg
Packing Case Volume	0.28m ³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification
Additional copies of instruction manual
Recommended list of spares for 5 years operation



Optional Extra HC113A **Data Acquisition Upgrade**

Hardware details

The Optional Computerised Data Acquisition Upgrade HC113A consists of a 21 channel Hilton Data logger (D103), together with pre-configured, ready to use, Windows™ compatible educational software.

Factory fitted coupling points on the H112 Options allow installation of the upgrade to the unit at any time in the machine's extensive life.

The Hilton Data logger (D103) connects using the cable supplied to a standard USB port on the user supplied PC. If more than one logger is required connection is via a second USB port or standard USB hub.

The combined educational software and hardware package allows immediate computer monitoring and display of all relevant parameters on the H112 Series Options.

Software Details

The pre-configured menu driven Software supplied with the Computer Upgrade HC113A allows all recommended experiments involving the electronic transducers and instruments on the H112 options to be carried out with the aid of computerised data acquisition, data storage and on-screen data presentation. This enhances student interest and speeds comprehension of the principles being demonstrated.

Students are presented with either raw data for later hand calculation or alternatively data may be transferred to most spreadsheets for computerised calculation and graphical presentation.

Data may be stored on disc and displayed at any time using the software supplied. Alternatively data may be transferred to any compatible spreadsheet together with individual time and date stamp on each reading for complex analysis.

Additional Data Logging Facility Supplied As Standard

The D103 is the third generation of Hilton Data Logger. It comprises an industrially proven 21 channel interface with 8 thermocouples (type T and K as standard) / differential voltage inputs ($\pm 100\text{mv DC}$), 8 single ended DC voltage inputs ($\pm 8\text{v}$), 4 logic or frequency inputs and one mains voltage input. In addition there are on board 12v DC, $\pm 5\text{V DC}$ and $\pm 15\text{v DC}$ power supplies for most commercially available transducers.

The Hilton Data Logging software supplied as standard with the HC113A package allows the D102 to be disconnected from the H112 options and used together with most standard transducers as a stand-alone computer data logger for the instrumentation and monitoring of existing laboratory equipment using locally sourced industrial transducers. The software is also backwards compatible with our many second generation D102 data loggers that are already in use worldwide.

Full data logger command protocol and communications details are provided in an extensive user manual that allows other software applications to communicate with the logger via the USB interface. Users can write their own software, typically in LabView, Matlab, C, C++, Visual Basic etc. This further expands the student project capabilities of the HC113A package from teaching and demonstration into the field of research and postgraduate study.

Computer Hardware Requirements

The menu driven Software supplied with the Computer Upgrade HC113A will operate on a PC which has at least 0.5Gb Mb ram, VGA graphics, 1Gb hard drive, CD drive and an available USB port. The software is Windows 2000, XP and 7 compatible.

Ordering Information

Order as: Data Acquisition Upgrade HC113A

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