

➤ **World leading  
supplier of  
engineering  
teaching  
equipment**

## Mechanical Science

The P.A.Hilton range of mechanical science products allow students to study, understand and form opinions around the principles of mechanisms.

Mechanisms generally consist of devices that utilise input forces to generate a set of output forces resulting in movement.

Our range of study units include gears and gear trains, belt and chain drives, linkages, friction devices frames, springs and bearings.

Theory of  
Machines (HTM)



Friction  
(HFN)



Vibration  
(HVT)



Forces  
(HFC)



## FORCES



### HFC1 Reactions of Beams Apparatus

- Experimental determination of the reaction forces in the supports of a simply supported beam under various loadings. Validation of the principal of equilibrium



### HFC4 Shearing Force Apparatus including set of weights

- A desk top unit which allows for the study of shear force



### HFC12 Three Wire Suspension Apparatus including set of weights

- To investigate the possibility of redundancy in the vertical tie. To compare the sum of the vertical components of the forces in the three wires with the vertical load they support.



### HFC1A Forces on a Beam Apparatus

- Measurement of loads and moments on a lever.



### HFC5 Bending Moment Apparatus

- A desk top unit for the study of bending moment



### HFC13 Rolling disc on an inclined plane

- Bench mounted self contained apparatus to enable the moment of inertia of two discs to be determined



### HFC2 Triangle of Forces Apparatus including set of weights

- Allows for the study of three or more coplanar forces acting at a point, on a circular disc, or on a rectangular shape.



### HFC8 Centre of Gravity Apparatus

- The centre of gravity of a shape of uniform thickness can easily be found by this apparatus. It provides a simple technique for complicated shapes, far quicker than using calculus for example.



### HFC14 Wall Jib Crane

- Determination of forces in crane members allows for the confirmation by theory and polygon of forces



### HFC3 Funicular Polygon and Forces Apparatus including set of weights

- A desk top unit which allows for the study of shear force



### HFC9 Bell Crank Lever including set of weights

- To experimentally determine the reaction force of a bell-crank lever to an applied load, confirm leverage ratio effect and take moments about a pivot



### HFC15 Derrick Crane

- Determination of forces in the crane members; confirmation of theory, and polygon of forces



**HFC16 Tension Coefficients Apparatus including set of weights**

- To determine experimentally forces induced in individual frame members



**HFC17 Basic Roof Truss including set of weights**

- Bench top apparatus for evaluating coplaner forces within a basic roof truss.



**HFC19 Toggle Joint Apparatus**

- Determines the horizontal reaction due to loading a toggle joint mechanism; assesses the effect of the toggle angle.



**HFC21 Centrifugal Force Apparatus**

- To verify that the centrifugal force on a rotating mass is proportional to the square of the speed, mass, radius of gyration



**HFC25 Conservation of Angular Momentum**

- For the study of conservation of angular momentum and rotational motion



**HFC29 Coriolis Force Apparatus**

- To observe the Coriolis Force on a jet of water being rotated in a horizontal plane  
Effect of jet deflection as a function of boom rotational speed and the direction of boom rotation



**HFC31 Combined Shear Force and Bending Moment Apparatus**

- Allows for the study of both shear force and bending moment in a single compact unit.



**HFC33 Conservation of Linear Momentum**

- Experiment for the study of the Conservation of linear momentum



**HFC38 Work Done by a Variable Force (Combined Vertical and Tangential)**

- A single unit for experiments on mechanical work and potential energy. Lifting a weight using a lever and a dynamometer (spring balance) in both the vertical and tangential plane. The vertical back board contains ONE EXPERIMENT ON EACH SIDE, thus allowing student groups to work on a separate experiment.



**When one body exerts a force on a second body, the second, simultaneously exerts a force equal in magnitude and opposite in direction on the first body.**



Isaac Newton 1643–1727

## FRICTION



### HFN1 Friction on an Inclined Plane

- A compact, bench mounted apparatus to measure the force required to move a body up an inclined plane and measure the friction coefficient for various materials in contact with that plane.



### HFN3 Clutch Plate Friction Apparatus

- A self contained, wall mounted unit, to demonstrate and determine the coefficient of friction of brake lining material and minimum torque to maintain rotation.



### HFN4 Pivot Friction Apparatus (including set of weights)

- A wall mounted apparatus that demonstrates the relationship between friction torque and axial thrust; determines the influence of bearing cone angle



### HFN5 Journal Friction Apparatus

- Self-contained, free-standing, floor mounted unit driven by a speed controlled motor. Determines the friction torque under variable load, speed and lubrication.



### HFN6 Bearing Friction Apparatus

- Wall mounted unit to compare the frictional losses of bearings by measuring the coefficient of sliding friction between pairs of materials.



### HFN8 Rope Belt Friction Apparatus

- A self contained, wall mounted unit for the effective determination of the coefficient of friction between a steel pulley and cotton rope. To also investigate belt tensions; evaluate effects of different 'V' angles in a pulley, and of different lap angles.



### HFN9 Friction of Belts Apparatus

- A self-contained, wall mounted apparatus for determining relationship of friction in varying belts.



### HFN11 Brake Drum Friction Apparatus (including set of weights)

- A self contained, bench mounted apparatus, with a single leading and trailing shoe, for the study of coefficient of friction and determine experimentally the variation of tangential force with braking load. Simulates a real braking system.

## VIBRATIONS



### HVT3 Compound Pendulum

- A wall mounted apparatus to determine the radius of gyration and centre of gravity of a compound pendulum. Investigations also include the effect of fulcrum position, finding gravitational acceleration 'g', and comparison with a simple pendulum.



### HVT5 Seismic Table

- A bench mounted uniaxial motion simulator allowing some of the fundamental concepts of structure design and designing principles to be investigated. Topics as resonance, dampening, torsion, material properties and end condition fixings.



### HVT8 Bifilar / Trifilar Suspension

- Both Bifilar and Trifilar setup apparatus to determine experimentally the moment of inertia and radius of gyration of a rectangular bar, ring and cylinder.



### HVT12K Data Acquisition System

- Two channel digital oscilloscope and software allows the capture, display, storage and retrieval of the excitation frequency and beam response from the HVT12 apparatus.



#### HAC190 Tachometer

- Displays the excitation force frequency as part of the HVT12G free and forced vibrations experiment
- Unit to control the rotational speed of the motor exciters used on the HVT12C and HVT12G. The unit connects directly to the HAC90 tachometer.



#### HAC120 Motor Exciter

- Its primary function is to transmit rotational motion into linear displacement of a beam, and hence force the beam to vibrate at varying amplitudes and frequencies



#### HVT12A Pendulum Module Note: Requires the HVT12F for operation

- Test set allowing the study of: simple and compound pendulums, radius of gyration, acceleration due to gravity and moment of inertia.



#### HVT12B Torsional Oscillation Module (Free and Damped) Note: Requires the HVT12F for operation.

- Accessory to verify the dependence of the periodic time of oscillation of a "shaft" mounted flywheel on the moment of inertia, length of shaft, and shaft diameter. Allows the study of the modulus of rigidity and effect of damping.



#### HVT12C Beam Bending (Transverse) Vibration Module Note: Requires the HVT12F, HAC90, HAC190 and HVT12K for operation

- A flexible beam supported between two end brackets which create simply supported end conditions. Allowing the study of free and forced vibrations, resonance, amplitude and phase lag.



#### HVT12D Vibration Absorber

- Mounted on the HVT12G beam, the cantilevers and mass system can be tuned to the same natural frequency as the surround test beam and motor exciter. This gives a visual demonstration of how a vibration absorber operates.



#### HVT12F Vibration Frame

- HVT12 Universal Vibrations Apparatus Modules are all mounted within the HVT12f Vibration frame.



#### HVT12G Free and Forced Vibrations Note: Requires the HVT12F, HAC190, HAC120 and HVT12K for operation

- A range of experiments designed to illustrate the vibrational characteristics and controlling properties of a simple mechanical system.



#### HVT12 Universal Vibration System

- A complete kit to allow the study of free and forced vibration, resonance and damping
- Kit includes HVT12F, HVT12G, HVT190, HAC120, HVT12D, HVT12K



#### HVT13 Torsional Vibration Apparatus

- A bench top unit for investigating torsional vibration and stiffness and demonstration of the effect of frictional damping.



#### HVT14D Digital Spring Mass Vibration System

- A sturdy, floor mounted, unit to analyse the oscillations of a helical spring mass system.



#### HVT14B Optional Interchangeable Spring Kit

- To investigate different aspects of the experiment. Each of the 3 additional springs has one main variable different from the standard spring supplied as part of one of the main units.



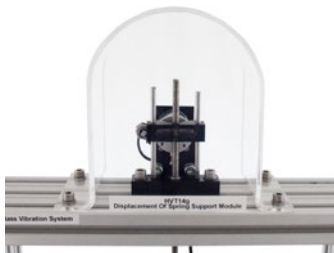
**HVT14C Optional Motor Control Unit**

- Essential to run either the HVT14e, forced vibration, or the HTV14g, forced displacement of spring support, modules.



**HVT14E Optional Forced Vibration Module**  
Note : Requires the HVT14c for operation

- Used in conjunction with the HVT14c Motor Controller it produces vertical periodic vibration of the spring.



**HVT14G Optional Forced Displacement of Spring Support Module**  
Note: Requires the HVT14c for operation.

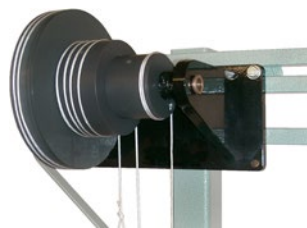
- Used in conjunction with the HVT14c Motor Control Unit to generate a harmonic amplitude displacement of the top of the spring.

**THEORY OF MACHINES**



**HTM1 Wheel and Axle**

- Wall mounted apparatus for investigation of the mechanics of a simple wheel and axle machine. Experiments to determine the velocity ratio and variation with load of effort and efficiency.



**HTM2 Wheel and Differential Axle Apparatus**

- Wall mounted apparatus for investigation of the mechanics of simple wheel and differential axle.



**HTM6 Efficiency of Screw Threads**

- Compact wall mounted apparatus to conduct experiments on the efficiencies of carrying screw thread forms



**HTM7 Gear Tooth Form Apparatus**

- Wall, or bench, mounted apparatus designed to show and describe how gear teeth are defined and how basic gears work. It also explains the form of an involute curve and how this is used to create a gear tooth profile



**HTM8 Cam and Follower Apparatus**

- Self-contained, bench mounted apparatus for viewing the rise and fall of profiled cams



**HTM9 Simple Flywheel (250Mm Diameter Flywheel)**

- Self-contained wall mounted apparatus to demonstrate second Law of Motion and Energy storage



**HTM13 Epicyclical Gear Train**

- Wall or frame mounted Double Epicyclical Gear Train Unit consisting of two standard Epicyclical gear trains for laboratory demonstration of gear systems similar to those used in automotive applications.



**HTM17 Crank and Connecting Rod Apparatus**

- Bench mounted unit to determine the relationship between crank angle and stroke, and the effect of changing crank radius and connecting rod length


**HTM19 Hooke's Coupling**

- A bench mounted unit to Investigate the relative angular displacement of shafts at opposite ends of a single and double Hooke's joint; observes effect of changing the angles between the axes of the coupling and the interconnecting rod.


**HTM21 Castor, Camber and King Pin Inclination**

- Bench mounted apparatus designed around the front steering arrangement of a vehicle. Shows precisely the set up of castor, camber and king pin inclination.


**HTM22 Relation Between Angular and Linear Speeds**

- Bench mounted unit comparing the angular rotation of a shaft and the tangential speed at the circumference to find the relationship between angular rotation and the peripheral movement of a stepped shaft.


**HTM25 Gear Train Apparatus**

- Compact apparatus for investigating transmission ratios on single stage, two stage and planetary spur gear drives.


**HTM38 Disc Brake Apparatus**

- Frame or wall mounted apparatus to investigate the relationship between the normal force acting on the brake pads, the effective radius of the brake pads and the braking torque


**HTM66 Static & Dynamic Balancing Apparatus**

- A bench top unit to demonstrate the fundamentals of static and dynamic balancing. Allows independent analysis of static and dynamic balancing.


**HTM71 Governor Apparatus**

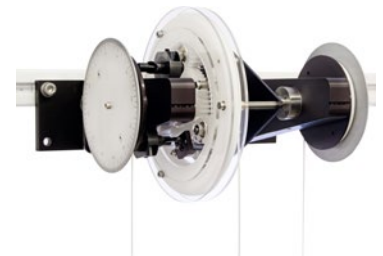
- Bench top unit to demonstrate the principle of operation of Porter, Propel and Hartwell centrifugal force governors


**HTM73 Gear Assembly Unit Combined Drives**

- Frame mounted apparatus to introduce basic engineering principles of gearing and drives


**HTM78 Four Bar Chain**

- Bench top apparatus for investigating the conversion of rotary motion into linear oscillatory motion.


**HTM98 Single Epicyclical Gear Train**

- wall mounted Single Epicyclical Gear Train for laboratory demonstration of a gear system similar to those used in automotive applications.



**Franz Reuleaux**  
 pioneered the study  
 of so called spherical  
 triangles for translating  
 one type of motion into  
 another examples being  
 guitar picks, pencils,  
 and drill bits for drilling  
 square holes and the  
 Wankel engine.



**Franz Reuleaux 1829–1905**



Maximise students per session, so **more efficient use of lab and student time.**

### HTM90 Machinery Diagnostic Base Unit & Instrumentation

- The HTM90 base unit permits initial and general vibration measurement exercises when paired with the appropriate accessories



### HTM90A Enhanced Instrumentation Module

- This sensor box incorporates a two channel digital oscilloscope, with USB connection to a host computer (Not supplied).



### HTM90B Roller Bearing Module

- This bearing fault module comprises of four faulty ball bearings. Induced faults are faulty inner race, outer race, ball and all faults.



### HTM90C Couplings Module

- Allows the user to test four different coupling types (five including the standard unit coupling) and to see how the transfer of torque may differ and how this can affect the vibrations in the system.



### HTM90D Load and Brake Module

- Unit allows the simulation of a system under load. This enables the students to observe the vibrational affects produced at different speeds and load forces.



### HTM90E Elastic Shaft module

- Allows students to investigate flexural vibrations of an elastic shaft



### HTM90F Fan Vibration module

- Introduction to vibration measurement methods on rotating machinery systems.



### HTM90G Belt, Brake and Crank Module

- The module consists of a combined system of a belt drive (attached to base unit output shaft), a magnetic brake module with adjustable strength setting and crank mechanism with adjustable stroke and spring stiffness.



### HTM90H Gear Damage Module

- The unit simulates a system under load which enables students to observe the vibrational affects produced at different speeds and load forces.

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