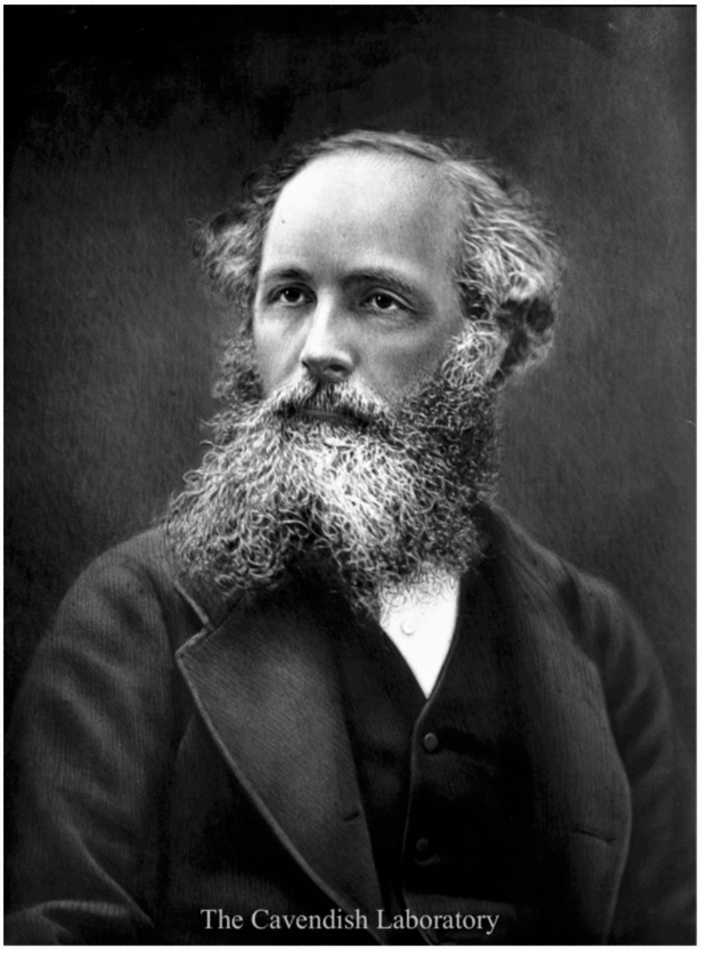
James Clerk Maxwell



James Clerk Maxwell (1831- 1879) was born in Edinburgh and studied mathematics at Cambridge as an undergraduate. He graduated in 1854, and shortly afterwards presented a paper to the Cambridge Philosophical Society *On the transformation of surfaces by bending*. His career took him to Aberdeen, King's College London and the family estates at Glenlair before returning to Cambridge in 1871 to become the first Cavendish Professor of Experimental Physics. He died in Cambridge at the age of 48.

In the millennium poll, Maxwell was voted the third greatest physicist of all time – behind Newton and Einstein. He is best known for his equations of electromagnetism and thermodynamic relations, but his interests and achievements extended far beyond these fields. His profound insights across many extraordinarily diverse areas have laid the foundations for much of contemporary physical science.

Quarter length studio portrait (1870s)
Cavendish PhotoArchive reference P422

Maxwell and his wife with Toby

Maxwell and his wife, Katherine Mary Dewar, with their dog Toby. Maxwell had many dogs and a whole series of them were called Toby. This photograph was taken in Scotland around 1875. Katherine was the daughter of the Principal of Marischal College in Aberdeen.

When Marischal College and King's College were amalgamated in 1860 to form the University of Aberdeen, only one professor of natural philosophy was needed. Maxwell, as the junior professor, was made redundant. He soon moved to King's College, London.

Cavendish PhotoArchive reference: P1180

Maxwell's determination of the inverse square law of electrostatics

This apparatus was used in Maxwell's determination of the inverse square law of electrostatics in 1877-78. The experiments were carried out with Donald MacAlister and resulted in an improvement by a factor of 1000 in the accuracy with which the inverse square law of electrostatics was known to hold good. This technique used the absence of an electric field inside a conducting spherical shell and was proposed by Henry Cavendish.

Dimensions: Width 80 cm, Depth 40 cm, Height 60 cm
Cavendish PhotoArchive reference P2025
Museum Catalogue Number CAV 131

Maxwell with his Colour Wheel in 1855

This famous image of Maxwell, aged 24, with his colour wheel was taken in 1855, around the time he was elected a junior Fellow of Trinity College, Cambridge. He is holding the colour wheel with which he carried out experiments on the three-colour theory, testing the colour vision of his friends and colleagues. These experiments led to the need for more precise three-colour experiments with his colour box.

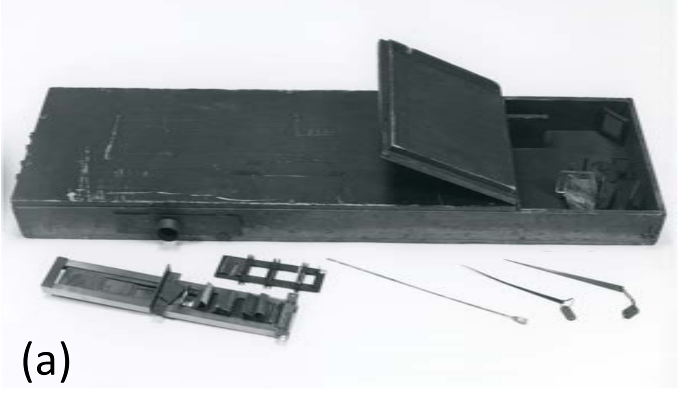
Cavendish PhotoArchive reference: P421

Maxwell's colour wheel (1855)

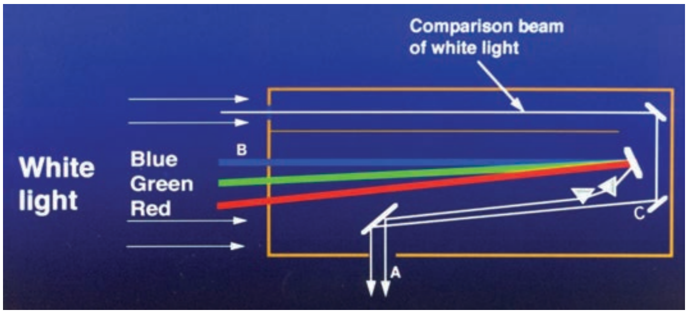
Maxwell did most of his work on the quantitative theory of colour in the time between finishing his BA early in 1854 and starting his research Fellowship at Trinity College in late 1855. The mixing of different amounts of the primary red, green and blue lights could be used to synthesize any colour. The merging of these primary lights was achieved by rotating the disc rapidly. The central black and white sectors enabled a grey comparison light to be synthesized.

Dimensions: *Width 34 cm, Depth 22 cm, Height 3 cm*
Cavendish PhotoArchive reference P7, P2000 (colour)
Museum Catalogue Number CAV118

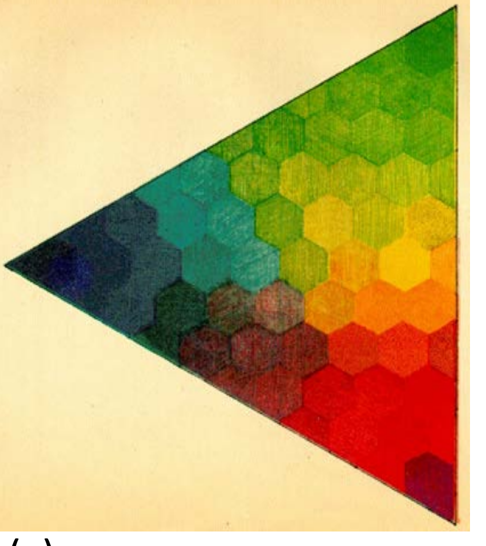
Maxwell’s colour box



(a)



(b)



(c)

(a) Photograph of Maxwell's light box showing the overall layout of the prism arrangement to disperse white light. The amounts of red, green and blue light were measured by the widths of the apertures at the left end of the box, which have been placed in the foreground of the photograph.
(b) Showing the light paths of the blue, green and red components of sunlight which are combined at the eyepiece A.
(c) These measurements enabled Maxwell to create his ‘colour triangle’. The distance from each of the red, green and blue corners indicates how much of each of these lights has to be combined to produce the colour shown.

Colour box dimensions: Width 112 cm, Depth 30 cm, Height 12 cm

Cavendish PhotoArchive reference P908, P2170

Museum Catalogue Number CAV 464

Colour triangle: Cavendish PhotoArchive reference: P2078, P2079

Maxwell and the First Coloured 'Photograph' (1861)



With Maxwell's determination of the three primary coloured lights needed to synthesise any colour, he photographed a tartan ribbon on three plates through red, green and blue-violet filters. The three negative slides are shown above. Three positive plates were produced and the projected images were superimposed through the same filters in a demonstration at the Royal Institution in 1861 When these images were combined, a fully-coloured image was produced.

Maxwell was lucky. His emulsions had essentially zero response in the red filter, but there was an ultraviolet leak in the red filter which transmitted light in the 320-400 nm waveband. The red dye in the ribbon reflected UV light and so the UV light produced the red negative. When projected, a more or less correct colour balance was obtained.

Slide dimensions: Width 18 cm, Depth 1 cm Height 12 cm
Cavendish PhotoArchive reference P1217 a,b,c
Museum Catalogue Number CAV 83
Lower photograph: Cavendish PhotoArchive reference: P1217

Maxwell's direct image stereoscope

Maxwell had this direct image stereograph constructed to enable him to view in three dimensions the various mathematical objects which were of interest to him throughout his career. A collection of 57 cardboard stereoscopic pairs of diagrams accompanies this instrument. By viewing through the large lens, a three-dimensional image is observed, without the need to view the diagrams through separate lenses for each eye.

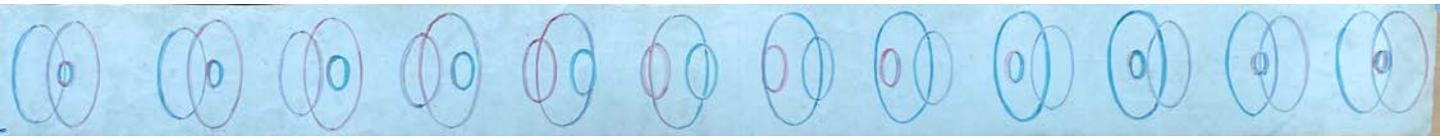
Dimensions: Width 60 cm, Depth 20 cm, Height 19 cm
Cavendish PhotoArchive reference P13
Museum Catalogue Number CAV77

Maxwell's experiments on polarization observed in strained glasses

Five pieces of strained glass (from left to right: triangle, square, rectangle with side arcs, cross and circle) observed by Maxwell through a polarizing filter. Maxwell had a lifelong interest in the optical effects observable in strained glasses. The birefringence resulted from the strains within the glasses, producing brightly coloured images showing the strain patterns in the samples. The top image shows the wooden holder for the five examples of strained glasses. The lower image shows the colours observed through a polarizing filter.

Dimensions: Width 31 cm, Depth 7 cm, Height 2 cm
Cavendish PhotoArchive reference P103, P1974
Museum Catalogue Number CAV126, 631

Maxwell’s Improved Zoetrope (1861)



Zoetropes, animation devices producing the illusion of motion by displaying a sequence of images on a rotating cylinder, became popular in the mid-19th century. Maxwell’s device of 1861 replaced the slits of the simple zoetrope by convex lenses, focussing the images on the axis of the zoetrope. This arrangement resulted in a wider field of view of the moving images.

He drew several zoetrope strips for scientific illustration. This strip, drawn by Maxwell himself, shows a model of a triatomic molecule consisting of three interacting frictionless vortices in the aether. This was an accepted construct at that time for the nature of atoms and molecules.

Dimensions: Width 60 cm, Depth 60 cm, Height 80 cm
Cavendish PhotoArchive reference P6, P2001 (colour)
Museum Catalogue Number CAV 116

Maxwell's model of Saturn’s rings (1857)

Maxwell won the 1857 Adams prize for a mathematical analysis of the dynamical stability of the rings of Saturn. He showed that the rings could not consist of a solid, liquid or gas, but had to be made up of huge numbers of small particles. He showed that there are stable prograde and retrograde motions under gravity of the small particles which make up the rings. Ramage of Aberdeen built the model, working to Maxwell's design. It shows the epicyclic motion of the particles of Saturn's rings about the mean circular orbit for both prograde and retrograde motions. In fact, the motions of the particles are ellipses, rather than circles, about the mean circular orbit. The theory is the fore-runner of the modern theory of planetary disc formation.

Dimensions: Width 20 cm, Depth 16 cm, Height 25 cm
Cavendish PhotoArchive reference P2041
Museum Catalogue Number CAV123

Maxwell's Critical Surface for Water

Maxwell's plaster model of Gibbs's thermodynamic surface of water of 1876. The three-dimensional coordinates are volume, entropy and energy. According to classical thermodynamics, the pressure is the tangential slope of energy against volume; the temperature is the tangential slope of energy against entropy. The three-dimensional model also shows the transition points between the solid, liquid and gaseous phases of water.

Dimensions: Width 20 cm, Depth 20 cm, Height 18 cm
Cavendish PhotoArchive reference P16, P2019 (colour) and P2070 (colour)
Museum Catalogue Number CAV 122, CAV326

Maxwell's apparatus to detect the inertia of an electric current

Maxwell's apparatus to measure the inertia of an electric current as it flowed round a current loop. This was one of three experiments Maxwell performed to detect the inertia associated with the flow of current, or the rotational inertia of a magnetic field, none of which showed any evidence for such a phenomenon. These experiments were carried out long before it was understood that electric currents are associated with the flow of electrons.

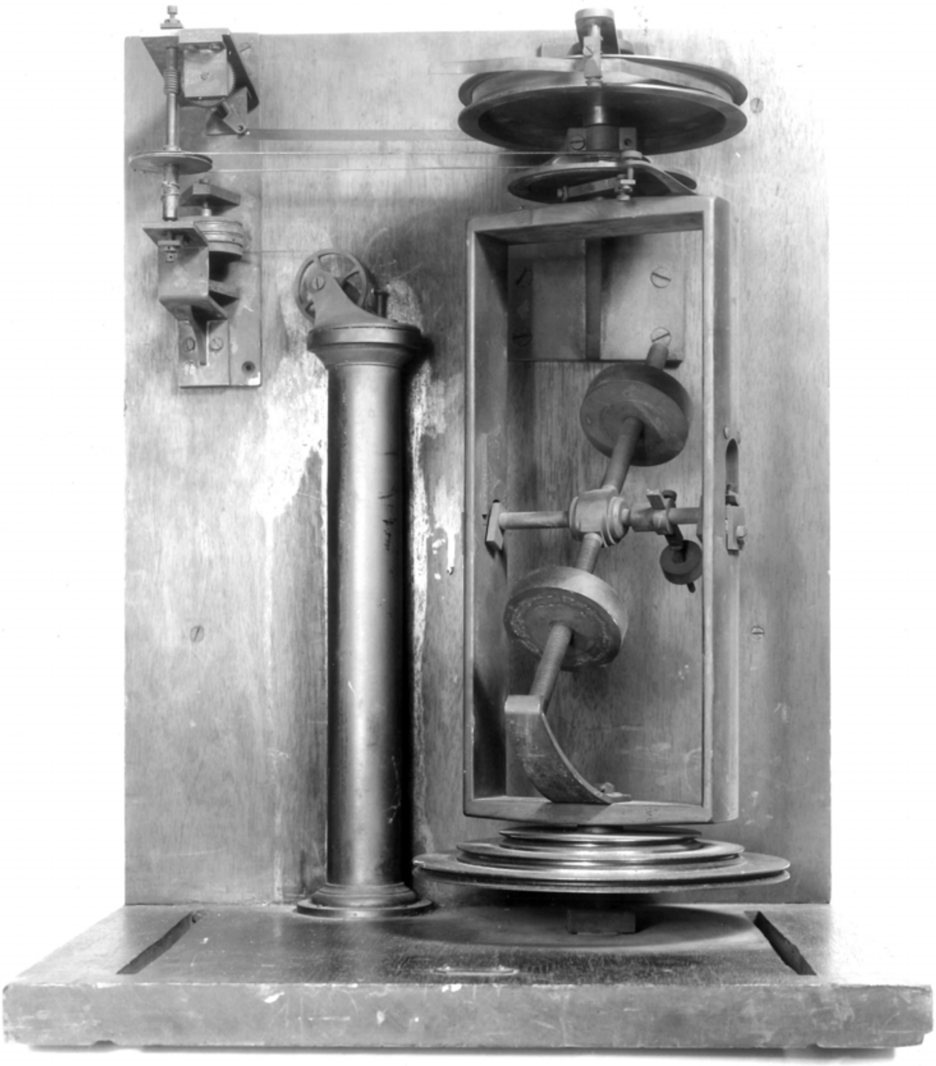
Dimensions: Width 36 cm, Depth 20 cm, Height 30 cm
Cavendish PhotoArchive reference P14
Museum Catalogue Number CAV 124

Maxwell's mechanical model of electromagnetic induction

Maxwell's mechanical model of electromagnetic induction. The flywheel is acted upon by two forces at different locations on the axis of the flywheel: these forces are the analogues of electric fields. When one of the forces is changed, this change is communicated to the other force. The equations describing the net changes in force acting upon the flywheel are of exactly the same mathematical form as electromagnetic induction.

Whipple Museum Accession no. 2455
Designed by Maxwell, made by Elliott Brothers, London, 1876

Fleeming Jenkin’s centrifugal governor



Maxwell's paper of 1868 'On Governors' sets out the theory of control systems and feedback and is regarded as the foundation paper of the field of cybernetics. This governor was needed to control the spinning of the coil in the determination of the ohm. Fleeming Jenkin was one of the leading members of the British Association Committee on electric standards and carried out the first spinning coil experiments with Maxwell.

Dimensions: Width 36 cm, Depth 20 cm, Height 30 cm
Cavendish PhotoArchive reference P1519
Museum Catalogue Number CAV 124