its longitude was 3ˢ 4° 13′. its latitude 10° 20′ N
at 9ʰ 8′ at night.
The length of its tayle was about 11ᵈ being extended
towards Aldeboran or a little below it parallel
to ye Ecliptick. The tayle now perfectly manifested
it selfe on yt east side of ye * began to discover it selfe, ye cloude being now dissipated. It
moved northward against ye streame of ye Vortex cutting it at
an angle of about 45ᵈ or 46ᵈ. There was still
a very bright haire beard round about ye Comet & it
seemed to be nothing but Bird raying from ye center of it for I could not see ye limbe
of ye *.

Dec 28th ye comet was distant from ye bright *
in ye jaw of ye Whaile 2° 52′. from ye middle
star in ye Whailes mouth 3ᵈ 43′. Covering ye *
Aldeb. twixt ye 3ᵈ & 5ᵗʰ of ye figure
with its haire but being rather
above it as in ye
figure. Its tayle
extending to ye 3ᵈ
& 4th stars in ye
section of ye ball

Rigel

Dec: 29th when twas in ye meridian its altitude
was 44ᵈ 13′. Therfore its declinacon was 6ᵈ 31′
Northward. It passed a little below ye * ye
below ye whales eye.

Dec: 30th 15ᵐ past 7ʰ at night The right
ascen: of ye Comet was ye same with ye * below

learning and teaching

figure 2
Newton's first observations of a comet, Ms. Add. 3996, f. 115v.

Newton grew up at Woolsthorpe Manor, Lincolnshire. His family was prosperous, despite the death of Newton's father before his son's birth on Christmas Day 1642. The young Isaac, who showed little interest in tending his mother's flocks, did not have a happy childhood. In 1661, he entered Trinity College, Cambridge, but displayed few signs of exceptional promise until the year 1664, when he embarked on an intensive course of reading and note-taking in contemporary mathematics and natural philosophy. By the following year, when he retreated from Cambridge because of the spread of plague to the city, Newton's curiosity had begun to focus on the mathematical problem of describing curved lines and surfaces and the areas or volumes beneath them. He was also fascinated by philosophical questions associated with colour. At home in Lincolnshire, Newton started to develop answers to these problems. His reading also led him to consider other topics, such as the nature of gravity (with or without the assistance of the apple tree that has been given so much credit for his later discoveries). When he was elected a fellow of Trinity in 1667, Newton was already an accomplished, if unknown, natural philosopher. He soon acquired his first patrons, and, in 1669, he was appointed to succeed Isaac Barrow as Lucasian Professor of Mathematics. He held the post until 1701. Early in 1670, Newton delivered his first lectures. These described his experiments with prisms and set out his new theory of light.

1 king's college, cambridge, keynes ms. 112/4
(figure 1 – introduction)
15 × 18.5 cm

This small scrap of paper represents one of several attempts by Newton to establish his ancestry. He eventually decided that he descended from John Newton of Westby, Lincolnshire, whose son, also John Newton,

had purchased an estate at Woolsthorpe, near Grantham. Four generations of the family had resided there, before the birth of young Isaac in the manor house that had been bought in 1623 by his grandfather, Robert. They had mostly been buried in the parish church at neighbouring Colsterworth, where Newton himself had been baptised. Newton relied on the monuments and records of this church, together with deeds in his own possession, in drawing up this family tree. Newton's ancestors were solid Lincolnshire husbandmen and yeoman farmers, who had advanced the family's fortunes until they were able to aspire to gentility as lords of the manor. Such aspirations were also apparent in the marriage of Newton's father to Hannah Ayscough, a gentleman's daughter, whose dowry augmented the family's lands and finances. She was the first member of the family to have been educated: before 1642, none of Newton's immediate ancestors had been able to sign his own name and none of them had left any evidence of having owned any books. Newton embarked on a new path for the family in terms of learning, but the recognition that he won was nevertheless an extension of the search for wealth and status that had occupied his ancestors.

The genealogical items that survive among Newton's papers, including this one, mostly date from 1705. On 16 April 1705, Queen Anne knighted Newton in Trinity College, and, on 22 November, he filed his family tree with the College of Arms. Sensitive perhaps to the speed of the advance of his family's fortunes, Newton was keen to emphasise his relationship to Sir John Newton of Thorpe, who entered a submission at the College of Arms in support of his kinsman. Towards the end of his life, however, Newton altered his interpretation of his family's early history, suggesting that his grandfather or great-grandfather had come from East Lothian, arriving in England with James I.

C.W. Foster, 'Sir Isaac Newton's Family', *Reports and Papers of the Architectural Societies of the County of Lincoln, County of York, Archdeaconries of Northampton and Oakham, and County of Leicester*, 39 (1928–9), 1–62; William Stukeley, *Memoirs of Sir Isaac Newton's Life*, ed. A. Hastings White (London, 1936), pp. 27–36; David Brewster, *The Life of Isaac Newton* (London, 1831), pp. 347–58.

Sotheby sale, 14 July 1936, lot 177 (7); purchased by 'Ulysses', possibly the dealer Jacob Schwartz, for £6. The lot was subsequently split. J.M. Keynes eventually acquired parts 7 and 8. Other items from the lot may now be found in the Jewish National and University Library, Jerusalem; the Babson Collection (on deposit in the Dibner Library, Cambridge, Massachusetts), and the Harry Ransom Humanities Research Center, University of Texas, Austin.

2 cambridge university library, ms. add. 3996, ff. 115v–116r
(figures 2 and 9)
14.2 × 9.5 cm
Bound notebook of 140 leaves

Newton's youthful interest in learning was encouraged by his uncle, William Ayscough, and by the schoolmaster at Grantham, John Stokes. Despite opposition from his mother, who wanted him to stay at home and farm, Newton was admitted to Trinity College, Cambridge, on 5 June 1661, and matriculated on 8 July. His uncle had been educated at Trinity and one of the fellows of the College, Humphrey Babington, was related to a family with whom Newton had lodged while at school in Grantham. Perhaps because of some reluctance of his mother's to waste money on education, perhaps in order to assist Babington, Newton entered Trinity as a sub-sizar, that is a student who was to supplement his income by acting as a servant either for the fellows or for other wealthier students, and who was allowed to pay lower fees for attending lectures.

Although this is not the earliest of Newton's surviving notebooks, it may well be the one that he purchased, together with some ink, on his arrival in Cambridge. Undergraduate education at this time consisted largely of following courses of reading directed by a tutor, in Newton's case Benjamin Pulleyn. These initially focussed on the traditional skills of grammar, logic, and rhetoric. At Cambridge, it was also usual for undergraduates to study ethics, metaphysics, physics, and mathematics. Together with some books that he bought in the early 1660s, this notebook bears witness to Newton's first steps in the Aristotelian curriculum of the early modern university. It is dated on the flyleaf, 'Isaac Newton/ Trin: Coll Cant/ 1661', and contains notes and occasional exercises relating to Newton's reading, compiled in the manner of summarising and glossing recommended by most tutors. Many of these notes are written in the rather crude form of secretary hand that the young Newton practised. They cover his study of Aristotle's *Organon* and Porphyry's *Isagoge*; the scholastic compendium, *Physiologiae peripateticae*, by Joannes Magirus; Aristotle's *Ethics* and the *Ethica* of Eustachius of St Paul; the *Axiomata* of Daniel Stahl, which introduced him to Aristotelian metaphysics, and, finally, a text-book of rhetoric by the great humanist scholar, Gerardus Joannes Vossius.

By about the beginning of 1664, Newton's writing had matured into the neat, if slightly spindly, italic hand that he would continue to develop over the rest of his life. His reading and thinking had also taken a new course, albeit one that was promoted by many of the best tutors in contemporary Cambridge. Newton had begun to reflect for himself on the metaphysical and natural philosophical terms and concepts deployed by the scholastic authors that he had been studying. Prompted perhaps by the scholarship to which he was elected in April 1664, Newton had started to read for himself both in the classical sources and commentaries and in contemporary philosophical and scientific writing, notably the works of Walter Charleton and René Descartes. Within the confines of a traditional commonplace book, and deploying many of the categories of renaissance philosophy, Newton had thus embarked through reading on his career as a mechanical, and eventually experimental, philosopher. Quoting portentously from Charleton, he headed his remarks 'Amicus Plato amicus Aristoteles magis amica veritas' (Plato is my friend, Aristotle is my friend, but my greatest friend is truth).

Among the works of the new philosophy with which Newton became acquainted were several dealing with comets. The observation and study of comets was important for natural philosophers since their motion raised questions about the orderly structure of the heavens and the relationship between celestial and terrestrial matter. A list of books that Newton made at the back of this notebook included several of the works that had helped to make the study of comets controversial, notably the *Descriptio cometae* (Leiden, 1619) of the Dutch mathematician, Willebrord Snell, which had analysed the comet of winter 1618–19, as well as tracts by William, Landgrave of Hesse-Cassel, on the comet of 1585, and by the Copernican astronomer, Christopher Rothmann. Newton transcribed tables of the motion of the comets of 1585 and 1618 from Snell. He also noted the appearance of a comet in early December 1664, going on to describe his own observations 'On fryday before midnight Decembr. 23d 1664'.

The pages that are displayed show Newton's continued observations of the comet on 24, 27, 28, 29, and 30 December 1664 and between 1 and 23 January 1665. They include a diagram to illustrate the relative position of the comet with reference to the location of the stars, for which Newton based himself on Vincent Wing's publication (1651) of the catalogue of Tycho Brahe. Newton's descriptions of the comet were

not always clear, and his initial attempt to track its movements by comparison with those of the moon displayed his ignorance of the limits of contemporary astronomical knowledge. But the excitement of seeing for the first time 'a Comet whose rays were round her, yet her tayle extended it selfe a little towards [the] east' was clear. Newton had seen with his own eyes that the Aristotelian distinction between comets with rays and comets with tails could not be sustained. Through his reading of Descartes, Newton was also aware of contemporary ideas that the appearance of the comet's tail might simply be an optical phenomenon. He had realised the potential of comets as exemplars of celestial motion. Yet, although his observations proved to be reliable, there is little evidence that Newton's early interest in comets was sustained. He made a few further notes on a new comet in 1665 but seems not to have been concerned by the dispute between the French astronomer Adrien Auzout and his rival from Danzig, Johannes Hevelius, over their observation of the comets of 1664 and 1665.

J.E. McGuire and Martin Tamny (eds), *Certain Philosophical Questions: Newton's Trinity Notebook* (Cambridge, 1983), especially pp. 296–304; A. Rupert Hall, 'Sir Isaac Newton's Note-book, 1661–1665', *The Cambridge Historical Journal*, 9 (1948), 239–50; D.E. Smith, 'Two Unpublished Documents of Sir Isaac Newton', in W.J. Greenstreet (ed.), *Isaac Newton 1642–1727* (London, 1927), pp. 16–34; Richard S. Westfall, *Never at Rest. A Biography of Isaac Newton* (Cambridge, 1980), pp. 66–104; William T. Costello, SJ, *The Scholastic Curriculum at Early Seventeenth-Century Cambridge* (Cambridge, Mass., 1958); Tabitta van Nouhuys, *The Age of Two-Faced Janus* (Leiden, 1998); Gary W. Kronk, *Cometography*, volume 1 (Cambridge, 1999), pp. 350–7.

Assessed 'Not fit to be printed' on behalf of Newton's executors by Thomas Pellet (25 September 1727); presented to Cambridge University Library by the fifth Earl of Portsmouth. See *A Catalogue of the Portsmouth Collection of Books and Papers written by or belonging to Sir Isaac Newton* (Cambridge, 1888), p. 47. Exhibited in 1987: 'The Making of Newton's "Principia" (1664–1687)', case 1, items 1–3.

3 fitzwilliam museum, cambridge, ms. 1–1936, ff. 6v–7r

12.1 × 7.1 cm

Bound notebook of 118 leaves

Newton paid 8d. for this pocket-book and seems to have begun using it from what is now the back, entering the alphabet in Hebrew and the meanings of some words under the heading 'Nova cubi Haebraei Tabella'. This is among the earliest evidence that Newton attempted to learn the language of the Old Testament in a serious way. The testimony

of his later theological writings, however, suggests that, although he mastered the alphabet and some grammatical rudiments, he remained largely dependent on Latin translations for his knowledge of works written in Hebrew. Among Newton's contemporaries, especially those from godly backgrounds, it was not uncommon to try to add some knowledge of Hebrew to the Greek that was acquired as a second language at grammar school and the Latin that was ubiquitous in learned culture. Some indication of the nature of Newton's own upbringing and of his youthful piety may be gleaned from the shorthand notes that he entered in this pocket-book 'Before Whitsunday 1662'. They consisted of a numbered list of sins, such as the godly were supposed to draw up for self-examination, including transgressions such as 'Using the word "God" openly'; 'Squirting water on Thy day'; 'Putting a pin in John Keys hat on Thy day to pick him', or 'Caring for worldly things more than God'. They gave indications of the similarity of Newton's beliefs and behaviour to the attitudes of many provincial puritans. Already, the nineteen-year-old Newton suggested the obsession with the power and severity of God the Father that would later become a focus for his religious beliefs: 'Not loving Thee for Thy self'; 'Not fearing Thee so as not to offend Thee'. Yet he also displayed more conventional signs of godly anxiety about his failure to keep his 'covenant' with God through the pranks, quarrels, and petty thefts of a rural childhood or of undergraduate banter, as well as through absence from or inattentiveness at worship, or the reading of vulgar, best-selling chapbooks such as the neo-chivalric romance, *The Seven Champions of Christendom*.

Newton appears to have abandoned this pocket-book for a time after 1662, since, to judge both by handwriting and content, the rest of the entries in it were written from the summer of 1664 to the autumn of 1668. Most of these notes concern mathematical problems, for example methods of describing curves and of analysing their properties, and reveal Newton's growing familiarity with contemporary mathematics, in particular geometry. They draw on his reading of the *Clavis mathematicae* (third edition, 1652) of the early seventeenth-century English mathematician, William Oughtred, and more especially on his knowledge of the commentaries and exercises of Frans van Schooten (1615–60). Van Schooten, who was a professor of mathematics at Leiden University in the Netherlands, was also one of the most successful

popularisers of the *Geometria* of Descartes. Newton probably encountered this work for the first time through an editon of a Latin translation published by van Schooten in 1649. He soon owned the enlarged edition that van Schooten published between 1659 and 1661 (see catalogue number 31), in which Descartes' work was supported by the algebra of François Viète. This volume also contained the *Elementa curvarum* of the Dutch mathematician and statesman, Jan de Witt, who had been a pupil of Descartes' friend and collaborator, Isaac Beeckman. Newton's working in this pocket-book depends in places on constructions derived from de Witt. Many years later, in a paper sent to Richard Bentley explaining what mathematical reading was necessary in order to understand the *Principia*, Newton urged his disciple to begin by consulting de Witt and the other materials printed by van Schooten in his edition of Descartes.

At some point after he began using it for mathematical purposes, Newton also started to enter accounts in this pocket-book. These are written on the blank pages left over once Newton had marked up the bulk of the pocket-book for the calculation of sine tables. The first entry is dated 23 May 1665 and the accounts then continue until April 1669. They are of considerable interest since they cover the years in which Newton, who took his BA in 1665, ceased to be a student and became a natural philosopher in his own right. In particular, they reveal his expenditure on the tools and instruments necessary for serious work in optics and the widening scope of his reading in contemporary natural philosophy. They also illustrate the mundane expenditures of Newton's life at Cambridge and the more significant purchases associated with the taking of his MA degree (7 July 1668) and his election first to a minor fellowship (2 October 1667) and then to a major fellowship (7 July 1668) at Trinity. For much of the period described by the accounts, Newton was resident at Woolsthorpe, where he fled in summer 1665 in order to escape the plague in Cambridge. He seems to have remained there until late March 1666, returning between June 1666 and April 1667 and again between December 1667 and early February 1668. These accounts demonstrate Newton's continuing financial dependence on his mother, until he began receiving dividends as a fellow of Trinity in 1668. Finally, they provide information about Newton's first visit to London, between 5 August and 28 September 1668, and about the purchase in 1669 of books and equipment for his new interest in alchemical research.

Richard S. Westfall, 'Short-Writing and the State of Newton's Conscience, 1662', *Notes and Records of the Royal Society of London*, 17 (1962), 10–16; D.T. Whiteside (ed.), *The Mathematical Papers of Isaac Newton*, 8 vols (Cambridge, 1967–81), vol. 1, 15–45; H. W. Turnbull, J.F. Scott, A.R. Hall and Laura Tilling (eds), *The Correspondence of Isaac Newton*, 7 vols (Cambridge, 1959–77), vol. 3, 155–6; D. J. Struik, *Het land van Stevin en Huygens* (Nijmegen, 1979), pp. 90–5; [John Taylor], *Catalogue of the Newton Papers Sold by Order of Viscount Lymington* (London, 1936), pp. 52–3; Sir David Brewster, *Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton*, 2 vols (Edinburgh, 1855), vol. 1, 31–3.

Assessed 'Not fit to be printed' on behalf of Newton's executors by Thomas Pellet (25 September 1727). Collated against the text printed in Brewster's *Memoirs* by H.R. Luard (24 December 1873); entered in *A Catalogue of the Portsmouth Collection of Books and Papers written by or belonging to Sir Isaac Newton* (Cambridge, 1888), p. 48. Sotheby sale, 14 July 1936, lot 210; purchased by Maggs Brothers for £180. Presented to the Fitzwilliam by the Friends of the Museum (with the assistance of Sir Thomas Barlow), July 1936. Exhibited November 1973–January 1974: Michael Jaffe, *The European Fame of Isaac Newton* (Cambridge, 1974), p. 15.

4 isaac barrow (ed.), *Euclidis elementorum libri xv. breviter demonstrati* (Cambridge, 1655)
(figure 3)
12^{o}: a–$2g^{4}$
13.5 × 7.5 cm
Trinity College Library, Cambridge, nq 16/201

When Newton was a candidate for a scholarship at Trinity in April 1664, he was sent to be examined by the recently appointed Lucasian Professor of Mathematics, Isaac Barrow (1630–77). Barrow supposedly questioned him about Euclid, whose writings Newton had at that point neglected. Barrow was himself the editor of a pioneering edition of Euclid, prepared at first to assist him in teaching mathematics to Trinity undergraduates in the early 1650s. This edition deployed the system of mathematical symbols that William Oughtred had developed to clarify and simplify Euclid's text. Barrow's work displayed his reverence for the geometry of the ancients, as well as his skill in explanation, since it treated the whole of Euclid's *Elements* in a very brief book suitable for students. It was an immediate success when it appeared in February 1656 and it continued to be used very widely as a textbook throughout the later seventeenth century, although some readers felt that its brevity rendered it too obscure for those who were not already competent in geometry. Yet in the words of one student reader, Roger North (1651–1734), 'the forty-seventh proposition, which is that in all [right

angled] triangles the square of the greater [side] is equal to those of the two others… entered me alive, as I may say, and I digested it with great satisfaction, and having got Barrow, which is much the best, I launched farther and made myself master of so much as served to common practical geometry…'

In 1657, Barrow published a second work on Euclid, *Euclidis data succincte demonstrata*, which he had written in 1654. This is often found bound up with his earlier edition of the *Elements*, as is the case with Newton's copy, which is on display here. It seems slightly implausible that the young Newton really had so little acquaintance with Euclid as the story about his first meeting with Barrow implies. Nevertheless, the handwriting of Newton's annotations in this standard textbook suggests that he may well have turned to a closer study of Euclid in about 1664. The annotations themselves are not particularly profound. Many of them are fairly trivial corrections, additions, or supplementary proofs, some of which derive from Oughtred. Even the fullest notes, which seem to be the product of a second, more exhaustive reading of the text, are largely explanatory. The most remarkable of these is the one that occurs at proposition xviii of book X. After he had become Lucasian Professor in his own right, Newton also prepared exercises or lectures based on the second book of Barrow's edition of the *Elements*.

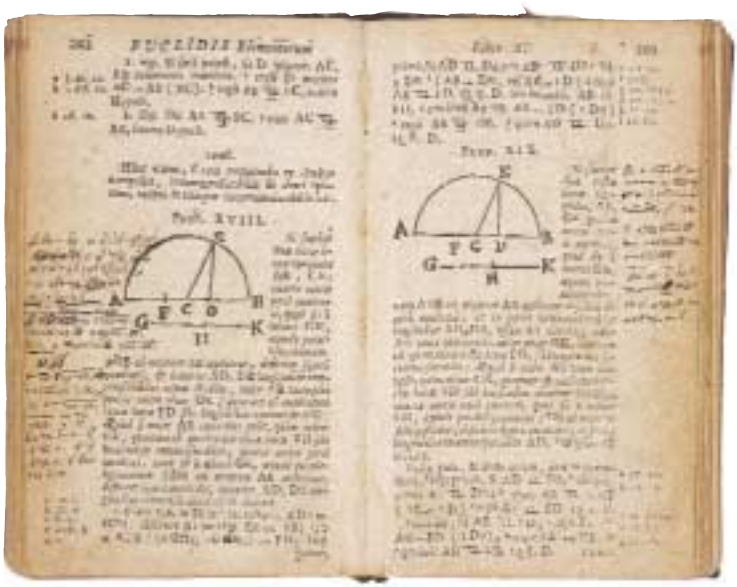

figure 3
Newton's annotations to Isaac Barrow's edition of Euclid, Trinity College, Cambridge, nq 16/201, pp. 202–3.

Whatever his first impressions, Barrow later formed a much more favourable view of Newton. He received aid from Newton in the preparation of his lectures for the press in 1669 and 1670, and presented Newton with a copy of the finished publication on 7 July 1670 (see catalogue number 32). He also began to publicise Newton's abilities during those years, especially in letters that he wrote to John Collins (see catalogue number 38), who was then helping to see Barrow's lectures through the press in London. With Barrow's encouragement, in 1669, Newton sent his tract 'De analysi' to Collins, revealing some of the work that he had been doing on infinite series during the previous couple of years.

John Harrison, *The Library of Isaac Newton* (Cambridge, 1978), pp. 51, 94–5, 139–40; D.T. Whiteside (ed.), *The Mathematical Papers of Isaac Newton*, 8 vols (Cambridge, 1967–81), vol. 1, p. 12; vol. 3, pp. 389, 402–7; Mordechai Feingold, 'Isaac Barrow: divine, scholar, mathematician', in Feingold (ed.), *Before Newton. The Life and Times of Isaac Barrow* (Cambridge, 1990), pp. 1–104, especially pp. 40–7; Augustus Jessopp (ed.), *The Autobiography of the Hon. Roger North* (London, 1887), p. 16; H. Zeitlinger, 'A Newton Bibliography', in W.J. Greenstreet (ed.), *Isaac Newton 1642–1727* (London, 1927), pp. 148–70, especially pp. 168–70.

Listed by the booksellers who appraised Newton's library for his executors; bought with the rest of the library by John Huggins in 1727. Bookplate of Charles Huggins. Bookplate of James Musgrave, with shelfmark E3–23. Presumed sold at Thame Park, 13–15 January 1920. Sold at Sotheby's, 20 April 1926, lot 597, purchased by Sotheran & Co. for 5s. Advertised in Sotheran's catalogues 804 (1927) and 828 (1931) at £500. Purchased for £500 by the Pilgrim Trust and presented to Trinity College, Cambridge, on 30 October 1943.

5 cambridge university archives, o.xiv.106

(figure 4)

43.5 × 66.5

In 1669, Isaac Barrow resigned the Lucasian Chair of Mathematics, perhaps in order to devote more time to his calling as a divine. Newton was appointed as his successor on 29 October 1669, almost certainly as a result of patronage from Barrow. The professorship had been endowed by the will of Henry Lucas, who died in 1663, and carried a stipend of around £100 per annum. The holder of the chair was allowed to retain the income from his College fellowship and to hold ecclesiastical appointments provided that they required no pastoral duties. He was not permitted to hold College office, however. The limits implied in these terms may also explain why Barrow, who subsequently became a royal chaplain and Master of Trinity, resigned his appointment. They

figure 4
Letters patent granting the Lucasian Professor of Mathematics dispensation from taking holy orders, University Archives, o.xiv.106.

were nevertheless acceptable to Newton. Unfortunately, by 1675, the requirement of Newton's College that he take holy orders, like all other fellows of seven years' standing, had become intolerable to him. In around 1673, Newton had begun to have doubts about orthodox teaching concerning the Holy Trinity, in particular believing that God the Father was different from and superior to Christ and the Holy Ghost. Consequently, he was no longer able to contemplate orders in the Church of England, whose Thirty-Nine Articles affirmed the doctrine of the Trinity.

There was, however, a way for Newton to avoid having to resign his fellowship. This was to receive a royal dispensation. Newton made several unsuccessful attempts to seek patronage to this end during 1674. It seems that, in the end, Barrow came to his rescue and bent the ear of the King. Newton was allowed to submit a draft for a patent that would allow the Lucasian Professor to hold a College fellowship without taking orders. He submitted his draft on 2 March 1675, and, on 27 April 1675, the letters patent displayed here were issued under the broad seal, according almost exactly to Newton's own wording.

Richard S. Westfall, *Never at Rest. A Biography of Isaac Newton* (Cambridge, 1980), pp. 206–8, 330–4; J. Edleston (ed.), *Correspondence of Sir Isaac Newton and Professor Cotes* (London, 1850), pp. xlix-l.

6 cambridge university library, ms. add. 4002, pp. 4–5
(figure 5)
23.1 × 17.3 cm
Bound quarto notebook of 182 leaves

Following his appointment as Lucasian Professor, Newton chose to use his first series of lectures as a vehicle to expound the new theory of light and colours that he had been developing since the mid-1660s. Rejecting the scholastic distinction between real and apparent colours, Newton had taken up the ideas of Descartes and of Robert Boyle in writing an essay 'Of Colours' (see catalogue number 11). He accepted the notion that colour was produced by the modification of light as it falls on a particular body and, by 1666, had begun to understand the phenomenon of refraction. This led him into further work on geometrical optics, a topic that was also being considered extensively by Barrow in his own Lucasian lectures that Newton would later help to prepare for publication.

As Lucasian Professor, Newton was required to deliver one lecture, lasting perhaps an hour, each week during term and to submit at least ten such lectures to the Vice-Chancellor annually for deposit in the University Library. Newton eventually presented a copy of his optical lectures to the University on 21 October 1674, by which time the *Optica* consisted of thirty-one lectures and was divided into two parts. These lectures had supposedly been delivered between January 1670 and the

figure 5
Experiments with a prism from Newton's first Lucasian lectures, Ms. Add. 4002, pp. 4–5.

end of Michaelmas Term 1672. By 1674, Newton had revealed many of his optical discoveries in letters sent to the secretary of the Royal Society, Henry Oldenburg, and published in his journal, the *Philosophical Transactions*. He had already suggested to others, including Barrow and Collins, that he was preparing the text of his lectures for publication. However, by the autumn of 1674, Newton had developed a deep distrust of printed communications as a means of securing credit and publicity for his scientific work. As a result, a manuscript copy of his lectures was deposited in Cambridge and, for more than a decade and a half, he abandoned his plans to publish them.

Newton nevertheless retained another manuscript of his lectures among his own papers. This was also a fair copy, preserved in the notebook on display here. It differed from the manuscript that he deposited in the University Library in a number of particulars and was also substantially shorter than it. It appears to have been completed in this form by about October 1671, after which Newton seems to have set it aside entirely and to have rearranged the order of presentation of his material. Nevertheless, this notebook contained almost all the major elements of Newton's optical lectures and represented the principal fruit of his research about the properties of light, conducted in the second half of the 1660s. Eighteen lectures were written out on 128 numbered pages and a different order of delivery was claimed from that in the later *Optica*. Both manuscripts, however, agree that the lectures began in January 1670.

The opening lecture, part of which is illustrated here, laid the foundations for all that would follow by showing that sunlight consists of rays that differ in their degree of refrangibility. In this lecture, Newton deployed experiments with a prism to demonstrate his ideas. Having found that a narrow beam of sunlight passed through a prism produces an elongated spectrum, he explained that it was indeed possible to achieve results that upheld the conventional view of refraction. Adherents of this theory argued that light rays should be refracted equally so that the sun's light would produce a circular image on passing through a prism. But Newton pointed out that this was a special case, whose properties he then investigated. He then went on in his second lecture to describe the shape of the spectrum created by his experiments and to observe that the same results could be achieved through considering the spectrum of Venus or of stars other than the sun.

These ideas were later taken up by Newton in his *Opticks* (1704). However, the difference between his treatment of them there and in these lectures was sufficient to prompt his executors to publish first an English translation (1728) and then a Latin edition edited by David Gregory (1729), both based on the manuscript of the *Optica*.

Alan E. Shapiro (ed.), *The Optical Papers of Isaac Newton*, vol. 1 (Cambridge, 1984), 1–81, especially pp. 52–7; D.T. Whiteside (ed.), *The Unpublished First Version of Isaac Newton's Cambridge Lectures on Optics 1670–1672* (Cambridge, 1973); Richard S. Westfall, 'Newton's Reply to Hooke and the Theory of Colours', *Isis*, 54 (1963), 82–96; J. A. Lohne, 'Isaac Newton: The Rise of a Scientist 1661–1671', *Notes and Records of the Royal Society of London*, 20 (1965), 125–39; Maurizio Mamiani, *Isaac Newton, filosofo della natura. Le lezioni giovanili di ottica e la genesi del metodo newtoniano* (Florence, 1976).

Assessed 'Not fit to be printed' on behalf of Newton's executors by Thomas Pellet (25 September 1727); presented to Cambridge University Library by the fifth Earl of Portsmouth. See *A Catalogue of the Portsmouth Collection of Books and Papers written by or belonging to Sir Isaac Newton* (Cambridge, 1888), p. 48.

7 cambridge university library, ms. dd. 4. 18, f. 1r

30.1 × 19.3 cm

26 folio leaves in a modern binding

The five lectures contained in this manuscript, under the title 'De motu Corporum Liber [secundus]', were supposedly delivered by Newton during Michaelmas Term 1687, beginning on 29 September, and then duly deposited in the University Library. They have been copied from a longer version of the text, which was probably written in the months before autumn 1685. Newton's heirs published the full text in 1728 as an addition to the *Principia*, under the title *De mundi systemate*.

The manuscript is not, however, the text of lectures actually delivered by Newton but rather a copy of part of a draft for Book III of the *Principia* that Newton later rejected. Passages that were later corrected by Newton are in places omitted entirely in this copy. It is thus principally interesting as an example of the manner in which Newton fulfilled the requirement that, as Lucasian Professor, he deliver suitable lectures and deposit copies of them in the University Library. It also provides an illustration of the collaboration between Newton and his amanuensis, Humphrey Newton. Newton had arranged for Humphrey, who was not related to him, to come up to Cambridge from the grammar school in Grantham either in 1683 or 1684. Humphrey Newton then served as

Isaac Newton's amanuensis for five years, during which he may also have been his sizar, although Humphrey appears not to have been admitted as a member of Trinity College. Many of Newton's compositions during this period survive in drafts written by Humphrey Newton, including both versions of 'De motu corporum liber secundus'. The most notable of these works is the manuscript from which the text of the *Principia* was printed. Humphrey Newton later returned to Grantham, where he practised as 'a physician and manmidwife' according to William Stukeley, and was still alive in 1728. The reminiscences of his master that he related to Stukeley and John Conduitt are the source for many of the stories of Newton's absent-mindedness as well as providing evidence for the pattern of Newton's life in College and his intellectual activity during the late 1680s.

I. Bernard Cohen, *Introduction to Newton's 'Principia'* (Cambridge, 1971), pp. 109–15, 299–309; Richard S. Westfall, *Never at Rest. A Biography of Isaac Newton* (Cambridge, 1980), pp. 343–4; Cambridge University Library, Ms. Add. 3990; William Stukeley, *Memoirs of Sir Isaac Newton's Life*, ed. A. Hastings White (London, 1936), p. 22; King's College, Cambridge, Keynes Ms. 135. Exhibited in 1987: 'The Making of Newton's "Principia" (1664–1687)', case 6, item 2.

8 cambridge university library, ms. add. 4005, ff. 14–15
29 × 18.2 cm

This brief document, headed 'Of educating Youth in the Universities', probably dates from the 1690s, when Newton was consulted on appointments and practices at both the universities of Oxford and Cambridge and at Christ's Hospital in London. It draws on Newton's own educational experience in places, and certainly reflects his interest in particular topics of natural philosophy. The programme of study that Newton recommends is fairly conservative: as a young man, he would certainly have recognised a mathematical education grounded on 'some easy & usefull practicall things, then Euclid, Sphericks, the projections of the Sphere, the construction of Mapps, Trigonometry, Astronomy, Opticks, Musick, Algebra…' The course that he suggested in philosophy concentrates on many of the topics that he had himself considered as a student and recorded in his commonplace book (see catalogue number 2): 'time, space, body, place, motion & its laws, force, mechanical powers, gravity & its laws, Hydrostaticks, Projectiles solid & fluid, circular motions & [the] forces relating to them'. Nevertheless, these

were precisely the areas of natural philosophy that had been revolutionised by Newton's own published work in the *Principia*. However, while it is tempting therefore to assume that Newton intended his own writings to become the basis of undergraduate instruction, one should perhaps remember that Newton was known in Cambridge as 'the man who has writt a book that neither he nor any one else understands'. Most of the relatively few people who could claim to understand the *Principia* during the 1690s were either distinguished natural philosophers in their own right or individuals close to its author who were able to ask him for advice. Yet Newton's insistence in this document that mathematical learning should underpin later investigations in natural philosophy is still remarkable.

The most unusual aspects of Newton's scheme, however, relate to the administration of learning. Not only did he suggest that Colleges should employ designated people to serve as lecturers in subjects like mathematics or philosophy, in addition to the role played by undergraduate tutors, but he also specified the terms under which they should serve. He was equally thorough concerning the duties of tutors and the fees that they might charge their students. Finally, Newton was explicit in condemning what he saw as a continuing legacy of Roman Catholic error. This was the practice of forcing College fellows to swear that they would take orders or uphold the established Church. He attacked the perjury that he believed to be the inevitable result of this behaviour and insisted that others should be allowed the religious toleration that he had himself enjoyed: 'No oaths of office to be imposed on [the] Lecturers'.

A. Rupert Hall and Marie Boas Hall (eds), *Unpublished Scientific Papers of Isaac Newton* (Cambridge, 1962), pp. 369–73; James L. Axtell, 'Locke, Newton and the Two Cultures' in John W. Yolton (ed.), *John Locke: Problems and Perspectives* (Cambridge, 1969), pp. 165–82; King's College, Cambridge, Keynes Ms. 130.5, number 2.

Presented to Cambridge University Library by the fifth Earl of Portsmouth. See *A Catalogue of the Portsmouth Collection of Books and Papers written by or belonging to Sir Isaac Newton* (Cambridge, 1888), p. 49.

[Dating to the 1690s confirmed from the watermark (fleur de lys/HD)]