calculation and controversy

The young Newton owed his greatest intellectual debt to the French mathematician and natural philosopher, René Descartes. He was influenced by both English and Continental commentators on Descartes' work. Problems derived from the writings of the Oxford mathematician, John Wallis, also featured strongly in Newton's development as a mathematician capable of handling infinite series and the complexities of calculations involving curved lines. The 'Waste Book' that Newton used for much of his mathematical working in the 1660s demonstrates how quickly his talents surpassed those of most of his contemporaries. Nevertheless, the evolution of Newton's thought was only possible through consideration of what his immediate predecessors had already achieved. Once Newton had become a public figure, however, he became increasingly concerned to ensure proper recognition for his own ideas. In the quarrels that resulted with mathematicians like Gottfried Wilhelm Leibniz (1646–1716) or Johann Bernoulli (1667–1748), Newton supervised his disciples in the reconstruction of the historical record of his discoveries. One of those followers was William Jones, tutor to the future Earl of Macclesfield, who acquired or copied many letters and papers relating to Newton's early career. These formed the heart of the Macclesfield Collection, which has recently been purchased by Cambridge University Library.

31 rené descartes, *Geometria* ed. and trans. frans van schooten
2 parts (Amsterdam, 1659–61)
4°: $\ast$-$2\ast^{4}$, a-$3t^{4}$, g-$3g^{4}$; π^{2}, $\ast$-$2\ast^{4}$, a-f^{4}
Trinity College, Cambridge, shelfmark nq 16/203

Newton acquired this book 'a little before Christmas' 1664, having read an earlier edition of Descartes' *Geometry* by van Schooten earlier in the year. His study of Descartes in the mid-1660s shaped his development as a mathematician and natural philosopher (see catalogue number 3 for further discussion of this book). For many years, he continued to believe that his work was compatible with Descartes' ideas. It seems likely that Newton's real break with Cartesianism took place only in the 1680s. The consideration of the nature of gravity and the successful creation of his own system of celestial mechanics in those years brought Newton firmly to different conclusions from Descartes.

Despite his early achievements as a mathematician, Newton seems to have had relatively little knowledge of classical geometry, other than Euclid's *Elements*, before the late 1670s. Then, he embarked on a close study of the writings of Pappus of Alexandria. He may have been prompted to do this by an increasing interest in classical authors and ancient wisdom, although that only reached its height a decade later. Equally, the publication of new studies of classical geometry, particularly Pierre Fermat's work on Apollonius, which appeared in 1679, may have caught Newton's attention. More probably, however, his curiosity was sparked by some remarks that he had found when reviewing the edition of Descartes' *Geometria* that he had used as a young man, with an eye to deploying it in the lectures on algebra that he was now delivering in Cambridge. Certainly, Newton marked a number of places in his copy of the *Geometria* with the words 'Error', 'non probo', 'Non Geom.', and 'Imperf.'. These annotations all seem to relate to Descartes' misrepresentation of Pappus' conics. Newton expanded on his criticism in a manuscript entitled 'Errores Cartesii Geometriae' (Ms. Add. 3961(4), f. 23r-4r), in which he considered Descartes' mistakes in detail.

D.T. Whiteside (ed.), *The Mathematical Papers of Isaac Newton*, 8 vols (Cambridge, 1967–81), vol. 4, 218–29, 336–45; John Harrison, *The Library of Isaac Newton* (Cambridge, 1978), pp. 14–15, 132.

Newton's signature appears on the stub of one of the flyleaves at the front of the book, which was later owned by John Smith. Bequeathed by his son, Robert Smith (1689–1768), who was Master of Trinity.

32 isaac barrow, *Lectiones XVIII*, ed. isaac newton

2 parts (London, 1669–70)
4°: a^4, a^2, b-r^4; a-t^2, v^4
17 × 11.5 cm
Trinity College, Cambridge, shelfmark nq 16/181

During his own lifetime, Isaac Barrow published two volumes of lectures that he had delivered as Lucasian Professor. His optical lectures appeared in November 1669 and those on geometry in summer 1670. Shortly after the publication of the second volume, Barrow presented a copy of both sets of lectures to Newton, who had assisted him in preparing them for the press. Newton dated the gift 'July 7th 1670' in the inscription that he wrote beside the titlepage, although he appears initially to have written the month as 'August'.

John Harrison, *The Library of Isaac Newton* (Cambridge, 1978), p. 94.

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 b1–20. Presented to Trinity College, Cambridge, on 30 October 1943 by the Pilgrim Trust.

33 cambridge university library, ms. add. 4004, ff. 32v–33r

(figure 21)

31 × 20.8 cm

Manuscript of 196 numbered folios, extracted from a larger volume. Modern binding.

The most cherished legacy that Newton received from his stepfather, Barnabas Smith (1582–1653), seems to have been a vast manuscript commonplace book. Smith was rector of North Witham, a wealthy clergyman who married Newton's mother on 27 January 1646. The immediate consequence of this union was that the three-year-old Isaac Newton had to be sent to live with his grandmother. On Smith's death, Newton appears to have inherited his library, most of which he gave away much later in life to a kinsman in Grantham. Smith himself had made extensive use of these books, in compiling a volume of theological commonplaces. This consisted of hundreds of folios bound in pasteboard, ruled at the top and in the margin of each folio to allow space for a heading and references to each entry. Newton was not interested by the very pedestrian efforts in divinity, largely the culling of quotations, with which Smith had begun to fill the book since its inception on 12 May 1612. He wanted its paper, as the title that he wrote on its original cover in February 1664 ('Waste Book') suggested.

By September 1664, Newton had started to use some of the pages for the optical and mathematical calculations, inspired by Descartes and van Schooten, that were beginning to occupy him (see catalogue numbers 2–3). Over the next two years, Newton broadened his reading only slightly. Nevertheless, through the study of Wallis' works and of

figure 21
En route to the calculus, entries in Newton's 'Waste Book' from 1665, University Library, Ms. Add. 4004, ff. 32v-33r.

the other authors (Johannes Hudde, Hendrick van Heuraet, and Jan de Witt) whose writings were presented by van Schooten in his edition of Descartes' *Geometria* (see catalogue number 31), Newton gradually mastered the analysis of curved lines, surfaces, and solids. He learned how to use the method of infinite series and extended it by discovering how to expand equations with fractional indices. Most significantly, he developed an approach to the measurement of curved lines that mapped the motion that produced them. This arose out of dissatisfaction with the method of infinitesimals and the advances towards describing curves through their tangents that Newton had so far made. By autumn 1665, Newton had worked out a method for replacing the use of infinitesimal increments of space in his calculations with instantaneous changes in the velocity of a moving point by which curved lines were described. Stimulated entirely by his reading, Newton had invented the method of fluxions, or calculus, through the working in his 'Waste Book'.

Newton was at this stage completely unknown. Others were groping for the solutions that he had found, and, encouraged by Barrow and

Collins, Newton both worked up his own methods and began to think of publishing them. By 1672, he began to have doubts about the wisdom of doing so. Later, the dated evidence of the work in the 'Waste Book' would provide Newton with many of the arguments that he used to assert his priority in discovering the calculus. In October 1676, Newton recorded in the 'Waste Book' the anagrams that concealed his methods for dealing with infinite series (see catalogue number 39). These had been used in letters that he sent to Leibniz about his discoveries. Judging from copies in the Macclesfield Collection, it seems likely that at least one of Newton's champions in the controversy that later broke out with Leibniz, William Jones, had the opportunity to check the chronology of the calculus against the manuscript itself. The 'Waste Book' was not retired by Newton after his initial mathematical labours. He continued to use it extensively for calculations and rough working on the topics that concerned him most. Thus, in the1680s or perhaps even the 1690s, he set down information about the motion of comets in this manuscript.

D.T. Whiteside (ed.), *The Mathematical Papers of Isaac Newton*, 8 vols (Cambridge, 1967–81), vol. 1, especially pp. 145–54; Richard S. Westfall, *Never at Rest. A Biography of Isaac Newton* (Cambridge, 1980), pp. 105–39; Cambridge University Library, Macclesfield Collection, Box 3/4/117–18.

Examined by Thomas Pellet on behalf of Newton's executors, 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. One leaf that had been removed from the 'Waste Book' (f. 87) is now in the Macclesfield Collection, Box 43.

34 *Philosophical Transactions*, number 224 (january 1697)

(figure 22)

4°: $3h^2$, $3i\text{-}m^4$, $3n^2$

16.6 × 10 cm

Cambridge University Library, shelfmark t.340.1 b.85.13.

Newton once told his successor as Lucasian Professor, William Whiston, that 'no old Men… love Mathematicks'. After his move to London in 1696, Newton did relax the hectic pace of his mathematical and philosophical activity. Since 1684, he had embarked on a period of concentrated study and calculation that almost rivalled the intensity and brilliance of his work from 1664 to 1675. In addition to the composition and publication of the first edition of the *Principia*, Newton had effectively completed a draft of the *Opticks*. He had taken substantial strides towards the writing of a highly ambitious history of religion and of the spread of idolatry in the Church, and had started to recast much of the *Principia* for a second edition. According to the plans of the early 1690s (see catalogue number 56), this would have made explicit the relationship between the correct understanding of natural philosophy and the true, primitive religion through the restoration of the geometry and wisdom of the ancients. Something certainly deflected Newton from the relentless course that he was following. Perhaps it was age, or a depressing realisation of the difficulty of some the tasks that he had set himself, in searching for solutions that had evaded him as a young man. More probably, changes in his personal circumstances and in public life as a whole forced Newton to lessen his scholarly commitment and withdraw to some extent from the full expression of his most controversial ideas. Newton and his closest allies were far more powerful by the mid-1690s than they had been in the 1680s, but they were also busier and had to bear greater burdens of responsibility. Newton in particular had increasingly more to lose than to gain, especially from any deeper public association with religious controversy at a time of widespread and vicious political and theological disagreement.

Nevertheless, Newton continued to relish the challenge of mathematics, particularly when it was allied to the opportunity to demonstrate his mastery of techniques that others were only beginning to understand. During the 1680s, Gottfried Wilhelm Leibniz, the philosopher to the court of Hanover, had published the first works to make use of new methods of analysis, the differential and integral calculus. By the 1690s, Johann Bernoulli, who became Professor of Mathematics at the University of Groningen in 1695, and several other Continental mathematicians had also mastered the skills necessary to work competently with infinite series and infinitesimals. These developments certainly perturbed Newton, who was later convinced that Leibniz must have taken his inspiration from some of his own, much earlier work. Newton's ideas had initially been communicated to Leibniz through Collins and Oldenburg in 1673. Newton sent Leibniz two detailed accounts in 1676 (see catalogue number 33), in which, despite the occasional use of code, he was remarkably frank about his mathematical knowledge and its development. This correspondence had been

figure 22
Newton's solution to Bernoulli's problem, University Library, T.340.1 b.85.13, pp. 388–9.

interrupted, partly as the result of the death of Oldenburg, in a manner that seemed, with hindsight, to show disrespect on Leibniz's part. Newton's command of infinitesimals was apparent to the few mathematicians who were equipped to recognise it in some of the reasoning of the *Principia*. During the early 1690s, references to Newton's methods also began to appear in some of Wallis' publications. Then, on New Year's Day 1697, Bernoulli issued a proclamation 'to the sharpest mathematicians in the whole world'.

Bernoulli's proclamation represented a challenge to solve two problems relating to curved lines. The first, and subsequently most famous, of these was to determine the shortest path between two given points in a vertical plane taken by a body moving under its own gravity and descending between them in the shortest time. Bernoulli had originally published this problem of the brachistochrone curve in the journal, *Acta eruditorum*, in June 1696. Only Leibniz had sent in a solution within the six-month period then specified for the competition by Bernoulli. The fresh proclamation extended the deadline, in addition adding a second problem to find a curve such that the sum of the segments of a line drawn at random from a fixed pole to cut it at two points is a constant, and threw a gauntlet firmly at Newton's feet. It was directed at 'the very mathematicians who pride themselves that, by the unparalleled methods that they recommend with so much effort, they have not only penetrated most intimately the hiding-places of a more secret Geometry, but have even extended its limits in a remarkable way by their golden theorems which, as they used to think, were known to no-one, but which others had already published a long time before.'

Although both Bernoulli and Leibniz believed that Newton had read the initial announcement of the brachistochrone problem in the *Acta eruditorum*, Newton steadfastly maintained that he was ignorant of its original formulation. According to the solution that he sent to his patron, Charles Montague, on 30 January 1697, the day before the expiry of the time limit for the extended task of Bernoulli's proclamation, Newton had known of the challenge for less than twenty-four hours. His friends later embroidered this fact by suggesting that Newton had received Bernoulli's paper at four in the afternoon, after his day's work at the Mint, and had solved it by four in the morning. Whatever the truth of Newton's acquaintance with Bernoulli's two problems, the character of his solutions left little doubt about the identity of their author when they were published anonymously in the *Philosophical Transactions* (pp. 388–9, on display). They proved conclusively that Newton had indeed penetrated more closely into the lair of the calculus than those who had appeared to mock him. In both of his answers to Bernoulli's examination, Newton had produced more lucid and wide-ranging proofs than those offered either by his tormentor or by any other contemporary mathematician. Bernoulli claimed that he knew immediately who had composed the solutions, remarking later that they gave away Newton's authorship in the same way that a lion was revealed by his claw (or, in a freer translation of Bernoulli's Latin, his footprint).

Newton later provided a simplified solution of the brachistochrone problem (Ms. Add. 3968(41), f. 2r) in response to a lengthy published description by Nicolas Fatio de Duillier. Fatio's essay, which appeared in 1699, kindled the dispute between Newton and Leibniz by suggesting that Newton's unpublished papers would make it clear that he alone had invented the calculus.

D.T. Whiteside (ed.), *The Mathematical Papers of Isaac Newton*, 8 vols (Cambridge, 1967–81), vol. 8, 72–91; H. W. Turnbull, J.F. Scott, A.R. Hall and Laura Tilling (eds), *The Correspondence of Isaac Newton*, 7 vols (Cambridge, 1959–77), vol. 4, 220–9

(where the translations are unfortunately inadequate); William Whiston, *Memoirs*, 2 vols (London, 1749), vol. 1, pp. 315–16; J.A. van Maanen (ed.), *Een complexe grootheid: leven en werk van Johann Bernoulli, 1667–1748* (Utrecht, 1995), pp. 69–92.

35 cambridge university library, ms. add. 3968, f. 126r

29.8 × 18.8 cm

The dispute about priority in the invention of the calculus smouldered throughout the first decade of the eighteenth century. It caught fire when one of Newton's supporters, the Oxford mathematician John Keill, hinted broadly that Leibniz had plagiarised Newton's work when he had described the calculus for the first time in print. In 1711, Leibniz complained about the accusations of Fatio and Keill in a letter to the secretary of the Royal Society, of which Newton was now President (see catalogue number 40). By then, Newton had begun to allow his disciples access to the manuscripts from his youth that would largely prove his claim to have invented the method (although not the form) of the calculus used by Leibniz. Displaying deviousness in controversy that presented a stark contrast to his relative openness in the 1670s, Newton searched his own records to select passages that seemed to support his case.

Superficially, one of the most telling examples of Newton's priority in the manipulation of infinite series was a tract, entitled 'De analysi per aequationes infinitas' (see catalogue number 36), that Barrow had communicated to Collins on 31 July 1669. Collins had copied the manuscript and then returned the work to Newton. The manuscript on display contains extracts that Newton himself made 'Out of Mr Newton's Treatise de Analysi per aequationes infinitas, ~~communicated~~ sent by Dr Barrow to Mr Collins [the] 31th of July 1669'. It was probably written in 1712, the year in which the Royal Society prepared its response to Leibniz's complaints about the conduct of Keill. Newton presented the initial selections from his papers to the Society on 24 April 1712, at a meeting that endorsed his claims. For much of the rest of the year, in between attempts to solve queries posed by the young editor of the long-awaited second edition of the *Principia* (see catalogue number 60), Newton completed the hunt for evidence and himself drafted the judgement of the Royal Society. This was published in January 1713 with the title *Commercium Epistolicum*; it was almost entirely the work of the man it claimed to vindicate.

D.T. Whiteside (ed.), *The Mathematical Papers of Isaac Newton*, 8 vols (Cambridge, 1967–81), vol. 8, 469–560.

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), pp. 6–8.

36 isaac newton, *Analysis per quantitatum series, fluxiones, ac differentias,* ed. william jones
(London, 1711)
4°: π^2, a-c^2, a-z^2, χ^4, 2a^2, 2b^4
19 × 12.5 cm
Trinity College, Cambridge, shelfmark nq 8/26

William Jones had already published an edition of the text of 'De analysi' by the time of Newton's work to prepare extracts for submission to the Royal Society (see catalogue number 10). He was also nominally one of the editors appointed by the Royal Society to supervise the compilation of the *Commercium Epistolicum*. In 1708, he had obtained the papers of John Collins, including the original correspondence in which Barrow had discussed Newton's mathematical work for the first time outside Cambridge. Also among Collins' manuscripts were copies that had been made of a number of unpublished papers. One of these was an anonymous version of 'De analysi'. From the correspondence now in his possession, Jones was quickly able to identify Newton as the author of this essay and he began to make preparations for its publication.

Jones was perhaps fortunate in the moment of his acquisition of Collins' archive. It is hard to imagine Newton wishing to collaborate on an edition of his juvenilia at any time before the middle of the first decade of the eighteenth century. Then, however, it started to become increasingly important to him to find clearly dated evidence of his work on infinitesimals during the 1660s. Only by doing this could he establish a significant interval between the moment of his own invention of the calculus and Leibniz's discoveries. The prospect of access to the letters in which he had first described his mathematical activities must have seemed like a godsend. In particular, the correspondence with Collins about Newton's planned additions to Mercator's translation of Kinckhuysen (see catalogue number 27) indicated that he had already reached beyond the mathematical competence of his Continental counterparts. Letters from Barrow and Collins testified to the extent of Newton's abilities even before he had read Mercator's *Logarithmotechnia* (1668), a book that had considerably extended contemporary knowledge of infinite series. It was true that Newton's youthful letters expressed modesty and reservations about the nature of his own discoveries at this point. But the slightly later tract, 'De analysi', which Newton had planned to revise for publication in the early 1670s, suggested a more confident claim to the originality of his thinking. Moreover, as Newton almost certainly realised, Collins had allowed Leibniz sight of his copy of the manuscript when the young German natural philosopher visited London in October 1676.

Newton communicated the autograph copy of 'De analysi' to Jones for use in the preparation of his edition. He also gave permission for Jones to include two other early mathematical papers, 'Enumeratio linearum tertii ordines' and 'Methodus differentialis' in his work. These dated in origin from the late 1660s and early 1670s, as notes in Newton's 'Waste Book' and elsewhere indicate. They bore signs, however, of much more recent revision. This was even more true of the fourth essay that Jones edited, 'De quadratura curvarum', in which Newton's full mastery of the dynamic nature of his calculus and of the peculiar notation that expressed it was made clear (see catalogue number 40). Newton composed this work in the early 1690s, not in the 1660s, as he had hinted when he had published it as an appendix to the *Opticks* in 1704. The pages on display (pp. 42–3), from Newton's copy of Jones' edition, indicate that he was still making changes to the wording of the text after its republication in 1711.

In his introduction to the edition, Jones quoted extensively from the correspondence that he had collected to prove Newton's priority in the invention of the calculus. In about 1712, he placed many of the originals at Newton's disposal. Some of these, together with both Collins' copy and the autograph of 'De analysi', Newton later deposited in the Royal Society. Most of the earliest letters, however, entered the Macclesfield Collection. As a result of his efforts, Jones was elected a Fellow of the Royal Society in 1712. His pride in the blow that he had struck for Newton's cause can be seen in the careful translation that he made of a letter from Charles Réné Reyneau, written in Paris on 23 November 1714: 'I have observ'd with a deal of pleasure, in this Collection, the first discoveries which the Author made, that serv'd to lead him into others, and how he carried them to the utmost perfection'.

D.T. Whiteside (ed.), *The Mathematical Papers of Isaac Newton*, 8 vols (Cambridge, 1967–81), vol. 2, 206–59; vol. 3, 3–19, vol. 7, 3–182; A. Rupert Hall, *Philosophers at War. The Quarrel between Newton and Leibniz* (Cambridge, 1980); Stephen Jordan Rigaud (ed.), *Correspondence of Scientific Men of the Seventeenth Century*, 2 vols (Oxford, 1841; reprinted Hildesheim, 1965); John Harrison, *The Library of Isaac Newton* (Cambridge, 1978), p. 200; Macclesfield Collection, Box 3/4/1.

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 E6–32. Presented to Trinity College, Cambridge, on 30 October 1943 by the Pilgrim Trust.

37 cambridge university library, macclesfield collection, box 3/3/91

20.7 × 16.1 cm

Jones' edition also won him praise nearer home. Roger Cotes (1682–1716), who at the time was helping Newton to prepare the second edition of the *Principia* (see catalogue number 60) for the press in Cambridge, wrote on 15 February 1711 to congratulate him on his work. Cotes was well aware of the significance of the 'papers of Sr Isaac's in your hands which were long ago communicated to Mr Collins'. Indeed, he had already advised another potential ally of Newton, Joseph Raphson, to ask Jones if he could make use of them in the history of the calculus on which he had been working.

By February 1711, Cotes had been assisting Newton with the editing of the second edition of the *Principia* for about two years. The initial flood of material that Newton had sent to Cotes had slowed to a trickle. As Cotes pointed out to Jones: 'We are now at a stand as to Sr Isaac's Principia; he designs to make some few Experiments before we proceed any further. The first Book & [the] six first sections of [the] second are printed off.' Cotes was being typically tactful in these remarks. The delay with Book II of the *Principia* was largely a product of revisions that Cotes had persuaded Newton to undertake in order to correct errors and obscurities that he had found in the text. These and other corrections and additions held up the delivery of the final copy for the second edition of the *Principia* for a further two years. Cotes himself composed the preface for the book, in which he controversially set out the importance of the Newtonian understanding of gravity for natural philosophy.

H. W. Turnbull, J.F. Scott, A.R. Hall and Laura Tilling (eds), *The Correspondence of Isaac Newton*, 7 vols (Cambridge, 1959–77), vol. 5, 94–5 (which prints this letter).

Purchased from the Earl of Macclesfield by Cambridge University Library, August 2000.

38 cambridge university library, ms. add. 3977(9), ff. 1v-2r
(figure 23)
23.1 × 17.9 cm

This letter, dated 5 July 1671, is one of many that John Collins (1625–83) exchanged with the young Isaac Newton. After a three-year apprenticeship to an Oxford bookseller, Collins had spent seven years as a sailor in the Mediterranean, mostly in Venetian service. Returning to London, he earned a living as a mathematical teacher in the 1650s, and published a number of practical works. By summer 1669, when Isaac Barrow prompted him to open a correspondence with Newton, Collins had been working as a clerk in the civil service for nearly ten years. The main passion of his life, however, was the exchange of mathematical information. His skill at letter writing and knowledge of the printing trade provided invaluable assistance to Oldenburg in sustaining the work of the Royal Society, of which Collins became a fellow in 1667. He was also instrumental in encouraging a number of younger mathematical authors, both English and foreign, to put their ideas into print.

Newton was one of the authors whom Collins encouraged (see catalogue number 36), circulating news of his ideas to the Scottish mathematician James Gregory and others, pressing the bookseller Moses Pitt to publish his work in the form of additions to Kinckhuysen's introduction to algebra, and generally providing him with a window on the wider world of British and European mathematics. In return, the young Newton trusted Collins with his mathematical discoveries, particularly with the text of 'De analysi' and his work on infinite series. As the draft of his reply to this letter indicates, Newton was almost embarrassed by Collins' generosity in sending him books. He was also candid about his progress. He marked with a cross two passages in Collins' letter. These asked him about Kinckhuysen's introduction and warned him not 'to overhasten the publication of your thoughts for being prevented by

figure 23
A letter from John Collins to Newton, with a draft of Newton's reply. Letters like this later helped Newton to establish the chronology of his discoveries and to claim priority in the invention of the calculus, University Library, Ms. Add. 3977(9), ff. 1v-2r.

others'. Newton's reply was full and displayed a relish for the prospect of appearing in print that he would soon regret: 'The last winter I reveiwed the introduction & made some few additions to it, & partly upon Dr Barrow['s] instigation, I began to new methodise [that] discourse of infinite series'.

This openness would later come to Newton's aid, once Collins' papers had passed into William Jones' hands. It was relatively unusual for Newton to preserve drafts of his letters. Collins, however, kept the correspondence that he received with the same care with which he collected or copied documents that related to the history of seventeenth-century mathematics. Thus, for example, the reply that Newton drafted here and sent on 20 July 1671 can now be found in the Macclesfield Collection.

H. W. Turnbull, J.F. Scott, A.R. Hall and Laura Tilling (eds), *The Correspondence of Isaac Newton*, 7 vols (Cambridge, 1959–77), vol. 1, 65–71 (printing both letter and reply).

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), pp. 32–3.

39 cambridge university library, macclesfield collection, box 3/4/56
29.8 × 18.5 cm

On 24 October 1676, Newton wrote to Henry Oldenburg, sending a reply to a letter from Leibniz whose contents Oldenburg had communicated to him. Leibniz had just left London, where he had visited Collins and other natural philosophers. The reply to Leibniz that Newton enclosed was more guarded than an earlier letter written in June 1676. It again praised Leibniz's work with infinite series and gave a detailed and comparatively modest account of the history and scope of Newton's own discoveries (see catalogue number 34). It was also generous in its recognition of the work of earlier mathematicians. Nevertheless, Newton was careful to conceal some of his more advanced discoveries, notably his own version of the calculus (the method of fluxions), by means of two insoluble anagrams (see catalogue number 33). Although Newton soon worried that he had been too severe, he also cautioned Oldenburg on 26 October: 'let none of my mathematical papers be printed [without] my special licence' and expressed reluctance about being drawn into any further mathematical communication. Misunderstandings of Leibniz's behaviour later convinced Newton that both he and his friends had been far too incautious in this correspondence.

H. W. Turnbull, J.F. Scott, A.R. Hall and Laura Tilling (eds), *The Correspondence of Isaac Newton*, 7 vols (Cambridge, 1959–77), vol. 2, 109–63 (which prints this letter and the enclosure for Leibniz).

Purchased from the Earl of Macclesfield by Cambridge University Library, August 2000.

40 cambridge university library, ms. add. 3968, f. 262r
32.8 × 20.9

Leibniz learned of John Keill's attack on his calculus early in 1711. On 4 March (21 February in England) 1711, he complained to Hans Sloane, the secretary of the Royal Society, in whose *Philosophical Transactions* Keill's work had appeared. Leibniz bemoaned 'this most impertinent accusation', which suggested that his calculus was merely Newton's method of fluxions in disguise. Although he did not accuse Keill directly of malice, he argued that he was nevertheless owed a public apology, which the Royal Society should secure. Sloane, who did not always see eye to eye with Newton, copied Leibniz's letter and dispatched it to the President of the Royal Society himself. There the matter rested for a month. Keill read parts of his reply to Leibniz at the Royal Society on 22 March, and subsequently sent Newton the reference to a review of 'De quadratura curvarum' (see catalogue number 36) that had been published anonymously in the *Acta eruditorum* in 1705. This seemed to suggest that Newton had depended on Leibniz's calculus when writing the *Principia*. Leibniz was clearly the review's author. He was no doubt responding to the suggestion that Fatio had made that Newton was the only inventor of the calculus, as well as to Newton's own attempts to pass off his mature work as juvenilia. But once the review was known in England, Newton set out mercilessly and deliberately to prove Leibniz wrong.

H. W. Turnbull, J.F. Scott, A.R. Hall and Laura Tilling (eds), *The Correspondence of Isaac Newton*, 7 vols (Cambridge, 1959–77), vol. 5, 96–8 (which prints this letter), 115–18, 132–52.

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), pp. 6–8.

41 cambridge university library, ms. add. 3968, f. 67r
30.2 × 18.5 cm

The publication of the *Commercium epistolicum* in 1713 did little to resolve the dispute between Newton and Leibniz. With the aid of Bernoulli, Leibniz replied mockingly to Newton's legalistic attempt to demonstrate mathematical priority through the dates of letters and the publication of manuscripts that contained only elements of the mature calculus. Newton set to work in turn on 'An Account of the Commercium Epistolicum', an anonymous review of the evidence that was published in the *Philosophical Transactions* in January/February 1715. Here, he rehearsed the testimony provided by 'ancient letters & Papers'.

By the time of his death in 1716, Leibniz was at war with Newton on a number of fronts. The controversy over the calculus showed no sign of resolution. Criticisms of Newton's natural philosophy had been given new life by the publication of the queries to the *Opticks* (see catalogue numbers 29 and 30) and by the General Scholium and Cotes' preface to the second edition of the *Principia* (see catalogue number 60). Leibniz raised doubts in particular about Newton's explanations for the role of gravity, suggesting that his arguments were both philosophically and theologically unsound. It seemed likely that he would convince his patron, Caroline of Ansbach, who had become Princess of Wales on the death of Queen Anne in 1714. Yet, despite the widespread success of Leibniz's supporters on the Continent, Newton and his allies won both the battle of ideas and the battle for patronage in England. They did so at a cost, however. The myth of Newton's youthful brilliance went hand in hand with resentment towards an often cantankerous and autocratic old man. Many of those who were cowed by the calculus, which they did not understand, nevertheless remained sceptical about Newton's metaphysical speculations that seemed to smack of a heretical theology.

D.T. Whiteside (ed.), *The Mathematical Papers of Isaac Newton*, 8 vols (Cambridge, 1967–81), vol. 8, 469–624.