Acdc

This article is about the band. For other uses, see Acdc (disambiguation).

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AC/DC	
 AC/DC, from left to right: Brian Johnson, Malcolm Young, Phil Rudd, Angus Young, Cliff Williams, performing at the Tacoma Dome in Tacoma on 31 August 2009.	
Background information	
Origin	Sydney, New South Wales, Australia
Genres	• Hard rock • blues rock • rock and roll
Years active	1973–present
Labels	• Albert • EMI • Columbia • Epic • Atlantic • Atco • Elektra • East West
Associated acts	• Geordie • The Easybeats • Fraternity • Dio • The Valentines • Marcus Hook Roll Band • Wolfmother • Guns N' Roses
Website	acdc<wbr/>.com [1]
Members	Angus Young Cliff Williams Stevie Young Chris Slade

Past members	Bon Scott Malcolm Young Phil Rudd Brian Johnson Dave Evans Larry Van Kriedt Colin Burgess Neil Smith Ron Carpenter Russell Coleman Noel Taylor Peter Clack Rob Bailey Mark Evans Simon Wright

AC/DC are an Australian rock band, formed in 1973 by brothers Malcolm and Angus Young. A hard rock/blues rock band, they have also been considered a heavy metal band,[2][3] although they have always dubbed their music simply "rock and roll".

AC/DC underwent several line-up changes before releasing their first album, *High Voltage*, in 1975; Malcolm and Angus were the only original members left in the band. Membership subsequently stabilised until bassist Mark Evans was replaced by Cliff Williams in 1977 for the album *Powerage*. Within months of recording the album *Highway to Hell*, lead singer and co-songwriter Bon Scott died on 19 February 1980 after a night of heavy alcohol consumption. The group considered disbanding, but buoyed by support from Scott's parents, decided to continue and set about finding a new vocalist. Ex-Geordie singer Brian Johnson was auditioned and selected to replace Scott. Later that year, the band released the new album, *Back in Black*, which was made as a tribute to Bon Scott. The album launched them to new heights of success and became their all-time best-seller.

The band's next album, *For Those About to Rock We Salute You*, was their first album to reach number one in the United States. Drummer Phil Rudd was fired in 1983 and replaced by ex-A II Z drummer Simon Wright, who left to join Dio in 1989. The band experienced a resurgence in the early 1990s with the release of *The Razors Edge*. Phil Rudd returned in 1994 after Chris Slade, who was with the band from 1989 to 1994, was asked to leave in favour of him, and contributed to the band's 1995 album *Ballbreaker*. *Stiff Upper Lip*, released in 2000, was well received by critics. The band's studio album, *Black Ice*, released in 2008, was the second-highest-selling album of that year, and their biggest chart hit since *For Those About to Rock*, eventually reaching No.1 on all charts worldwide. The band's line-up remained the same until 2014 with Malcolm Young's retirement and Rudd's legal troubles. In 2016, Johnson was advised to stop touring on account of worsening hearing loss and Guns N' Roses frontman Axl Rose stepped in as the band's vocalist for the remainder of that year's dates.

AC/DC have sold more than 200 million records worldwide, including 71.5 million albums in the United States alone, adding them to the List of highest-certified music artists in the United States and the List of best-selling music artists. *Back in Black* has sold an estimated 50 million units worldwide, making it the fifth-highest-selling album by any artist – and the third-highest-selling album by any band. The album has sold 22 million units in the US alone, where it is the sixth-highest-selling album of all time. AC/DC ranked fourth on VH1's list of the "100 Greatest Artists of Hard Rock"[4] and were named the seventh "Greatest Heavy Metal Band of All Time" by MTV. In 2004, AC/DC ranked No. 72 on the *Rolling Stone* list of the "100 Greatest Artists of All Time". Producer Rick Rubin, who wrote an essay on the band for the Rolling Stone list, referred to AC/DC as "the greatest rock and roll band of all time." In 2010, AC/DC were ranked number 23 in the *VH1* list of the "100 Greatest Artists of All Time".

History

Background and name

Brothers Malcolm, Angus, and George Young were born in Glasgow, Scotland, and moved to Sydney with most of their family in 1963. George was the first to learn to play the guitar. He became a member of The Easybeats, one of Australia's most successful bands of the 1960s. In 1966, they became the first local rock act to have an international hit, with the song "Friday on My Mind". Malcolm followed in George's footsteps by playing with a Newcastle, New South Wales, band called the Velvet Underground (not to be confused with the New York-based Velvet Underground). Their oldest brother Alex Young chose to remain in Britain to pursue musical interests. In 1967, Alexander formed and played bass in the London-based band Grapefruit—initially called "The Grapefruit"—with three former members of Tony Rivers and the Castaways, John Perry, Geoff Swettenham, and Pete Swettenham.

Malcolm and Angus Young developed the idea for the band's name after their sister, Margaret Young, saw the initials "AC/DC" on a sewing machine. "AC/DC" is an abbreviation meaning "alternating current/direct current" electricity. The brothers felt that this name symbolised the band's raw energy, power-driven performances of their music. "AC/DC" is pronounced one letter at a time, though the band are colloquially known as "Acca Dacca" in Australia. The AC/DC band name is stylised with a high voltage sign separating the "AC" and "DC" and has been used on all studio albums, with the exception of the international version of *Dirty Deeds Done Dirt Cheap*.

The band's logo was designed in 1977 by Gerard Huerta. It first appeared on the international version of *Let There Be Rock*.

Early years

In November 1973, Malcolm and Angus Young formed AC/DC and recruited bassist Larry Van Kriedt, vocalist Dave Evans, and Colin Burgess, ex-Masters Apprentices drummer. Pushing hard for the band's success were Australia's legendary roadie Ray Arnold and his partner Alan Kissack. Gene Pierson booked the band to play at Bondi Lifesaver on New Year's Eve, 1973.

By this time, Angus Young had adopted his characteristic school-uniform stage outfit. The idea was his sister Margaret's. Angus had tried other costumes: Spider-Man, Zorro, a gorilla, and a parody of Superman, named Super-Ang. In its early days, most members of the band dressed in some form of glam or satin outfit but this approach was abandoned seeing as Melbourne band Skyhooks had already adopted this approach to their stage presentation.

The Young brothers decided that Evans was not a suitable frontman for the group because they felt he was more of a glam rocker like Gary Glitter. On stage, Evans was occasionally replaced by the band's first manager, Dennis Laughlin, who was the original lead singer with Sherbet prior to Daryl Braithwaite. Evans did not get along with Laughlin, which also contributed to the band's ill feeling toward Evans.

The Bon Scott era (1974–80)

The journey begins (1974–77)

In September 1974, Ronald Belford "Bon" Scott, an experienced vocalist and friend of George Young, replaced Dave Evans after friend Vince Lovegrove recommended him to George Young. Like the Young brothers, Scott had been born in Scotland before emigrating to Australia in his childhood. The band had recorded only one single with Evans, "Can I Sit Next To You, Girl" / "Rockin' in the Parlour"; eventually, the song was re-written and re-recorded with Bon Scott as "Can I Sit Next to You Girl" [Track 7 on the Australian album *TNT* (1975), and Track 6 on the international release of *High Voltage* (1976)].

"It's a Long Way to the Top" (1975)

The second single of *High Voltage* demonstrates a combination of bagpipes with more traditional rock instruments while the lyrics discuss the perils of being in a rock band.

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By October 1974, the Australia-only album *High Voltage* had been recorded. It took only ten days and was based on instrumental songs written by the Young brothers, with lyrics added by Scott. Within a few months, the band's line-up had stabilised, featuring Scott, the Young brothers, bassist Mark Evans and drummer Phil Rudd. Later that year they released the single "It's a Long Way to the Top", which became their perennial rock anthem. It was included on their second album, *TNT* (1975), which was also released only in Australia and New Zealand. *T.N.T.* featured the song "High Voltage", which was the first song written and recorded for the album. Because "High Voltage" was released as a single before *T.N.T.* was released, some people thought it was the title track to AC/DC's debut album.

Between 1974 and 1977, aided by regular appearances on Molly Meldrum's *Countdown*, the ABC's nationally broadcast pop-music television show, AC/DC became one of the most popular and successful acts in Australia. Their performance on 3 April 1977 was their last live TV appearance for more than 20 years.

International success (1976–80)

In 1976, the band signed an international deal with Atlantic Records and toured extensively throughout Europe, including their first UK tour sponsored by *Sounds* magazine, called the 'Lock Up Your Daughters Summer Tour'. They gained invaluable experience of the stadium circuit, supporting leading rock acts such as Black Sabbath, Aerosmith, Kiss, Styx, UFO, and Blue Öyster Cult, and co-headlined with Cheap Trick.

Former vocalist Bon Scott (centre) pictured with guitarist Angus Young (left) and bassist Cliff Williams (back), performing at the Ulster Hall in August 1979

The first AC/DC album to gain worldwide distribution was a 1976 compilation of tracks taken from the *High Voltage* and *T.N.T.* LPs. Also titled *High Voltage*, and released on the Atlantic Records label, the album, which has to date sold three million copies worldwide, gained the band a following among the then-substantial British punk audience. The track selection was heavily weighted toward the more recent *T.N.T.*, and included only two songs from their first LP. The band's next album, *Dirty Deeds Done Dirt Cheap*, was released in the same year in both Australian and international versions, like its predecessor. Track listings varied worldwide, and the international version of the album also featured the *T.N.T.* track "Rocker", which had previously never been released internationally. The original Australian version included "Jailbreak" (now more readily available on the 1984 compilation EP *'74 Jailbreak* or as a live version on the 1992 *Live* album). *Dirty Deeds* was not released in the US until 1981, by which time the band were at the peak of their popularity.

Following the 1977 recording *Let There Be Rock*, bassist Mark Evans was fired; purportedly to find someone who could sing backup vocals. Evans described disagreement with Angus and Malcolm as a contributing factor. He was replaced by Cliff Williams. Neither of the Young brothers has elaborated on the departure of Evans, though Richard Griffiths, the CEO of Epic Records and a booking agent for AC/DC in the mid-1970s, later commented, "You knew Mark wasn't going to last, he was just too much of a nice guy." Mark Evans' autobiography, *DIRTY DEEDS: My Life Inside/Outside of AC/DC*, released in 2011, predominantly dealt with his time in AC/DC, including being fired.

Bronze statue of Bon Scott, unveiled in Fremantle, Western Australia, in October 2008

AC/DC were a somewhat formative influence on new wave of British heavy metal bands who emerged in the late 1970s, such as Saxon and Iron Maiden, in part as a reaction to the decline of traditional early 1970s hard rock bands. In 2007, critics noted that AC/DC, along with Thin Lizzy, UFO, Scorpions and Judas Priest, were among "the second generation of rising stars ready to step into the breach as the old guard waned."[5]

AC/DC's first American exposure was through the Michigan radio station AM 600 WTAC in 1977. The station's manager, Peter C. Cavanaugh, booked the band to play at Flint's Capitol Theater. The supporting act was MC5, who had just briefly reunited and agreed to play at the event. The band opened with their popular song "Live Wire" and closed with "It's a Long Way to the Top (If You Wanna Rock 'n' Roll)".

AC/DC came to be identified with the punk rock movement by the British press. Their reputation, however, managed to survive the punk upheavals of the late 1970s, and they maintained a cult following in the UK throughout this time. Angus Young gained notoriety for mooning the audience during live performances.

The 1978 release of *Powerage* marked the debut of bassist Cliff Williams, and with its harder riffs, followed the blueprint set by *Let There Be Rock*. Only one single was released from *Powerage*, "Rock 'n' Roll Damnation/Sin City". An appearance at the Apollo Theatre, Glasgow during the *Powerage* tour was recorded and released as *If You Want Blood You've Got It*, featuring such songs as "Whole Lotta Rosie", "Problem Child", and "Let There Be Rock", as well as lesser-known album tracks like "Riff Raff". *Powerage* was the last album produced by Harry Vanda and George Young that had lead vocals by Bon Scott, and is claimed to be AC/DC's most under-rated album.

The major breakthrough in the band's career came in their collaboration with producer "Mutt" Lange on the album *Highway to Hell*, released in 1979. Eddie Van Halen notes this to be his favourite AC/DC record, along with *Powerage*. It became the first AC/DC LP to break into the US top 100, eventually reaching No. 17, and it propelled AC/DC into the top ranks of hard rock acts. *Highway to Hell* had lyrics that shifted away from flippant and comical toward more central rock themes, putting increased emphasis on backing vocals but still featured AC/DC's signature sound: loud, simple, pounding riffs and grooving backbeats. The final track, "Night Prowler", has two breaths in quick succession at the start of the song, intended to create a tone of fear and loathing.

Scott's death (1980)

As 1980 began, the band began work on a new album that would eventually become *Back in Black*, but Bon Scott would not live to see it finished. On 19 February 1980, Scott passed out in the car on the way back to friend Alistair Kinnear's house after a night of heavy drinking at the Music Machine club in London. Upon arrival at his home, Kinnear was unable to move Scott from the car into his home for the night, so he left him in the car overnight to sleep off the effects of the alcohol. Unable to wake Scott late the next morning, Kinnear rushed him to King's College Hospital in Camberwell, where Scott was pronounced dead on arrival. Pulmonary aspiration of vomit was the cause of Scott's death,[6] and the official cause was listed as "acute alcohol poisoning". Scott's family buried him in Fremantle, Western Australia, the area they emigrated to when he was a boy.

Inconsistencies in the official accounts of Scott's death have been cited in conspiracy theories, which suggest that Scott died of a heroin overdose, or was killed by exhaust fumes redirected into the car, or that Kinnear did not exist. Additionally, Scott was asthmatic, and the temperature was below freezing on the morning of his death.

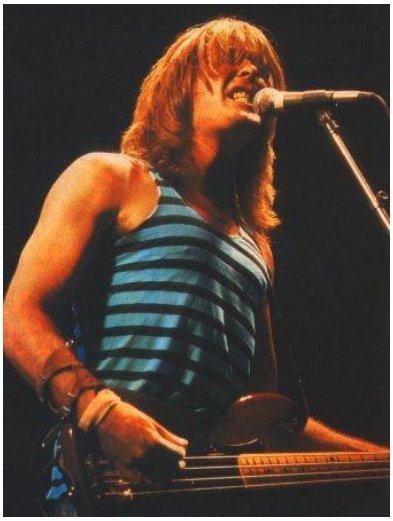
The Brian Johnson era (1980–2016)

Rebirth (1980–83)

Brian Johnson Live with AC/DC in 2008

Following Scott's death the band briefly considered quitting, but encouraged by the insistence from Scott's parents that he would have wanted them to go on, they eventually decided to continue and went about finding a new frontman. Various candidates were considered for his replacement, including: Buzz Shearman, ex-Moxy member, who was not able to join because of voice problems, ex-Back Street Crawler vocalist Terry Slesser and then Slade vocalist, Noddy Holder. The remaining AC/DC members finally decided on ex-Geordie singer Brian Johnson.

Angus Young later recalled, "I remember the first time I had ever heard Brian's (Johnson) name was from Bon. Bon had mentioned that he had been in England once touring with a band and he had mentioned that Brian had been in a band called Geordie and Bon had said 'Brian Johnson, he was a great rock and roll singer in the style of Little Richard.' And that was Bon's big idol, Little Richard. I think when he saw Brian at that time, to Bon it was 'Well he's a guy that knows what rock and roll is all about.' He mentioned that to us in Australia. I suppose when we decided to continue, Brian was the first name that Malcolm and myself came up with, so we said we should see if we can find him."



Cliff Williams in 1981 during the For Those About to Rock Tour

For the audition, Johnson sang "Whole Lotta Rosie" from *Let There Be Rock* and Ike & Tina Turner's "Nutbush City Limits". He was hired a few days after the audition. With Johnson the band completed the songwriting that they had begun with Scott for the album *Back in Black*. Recording took place at Compass Point Studios in The Bahamas a few months after Scott's death. *Back in Black*, produced by Mutt Lange and recorded by Tony Platt, became their biggest-selling album and a hard-rock landmark; hits include "Hells Bells", "You Shook Me All Night Long", "Rock and Roll Ain't Noise Pollution" and the title track. The album reached No.1 in the UK and No.4 in the US, where it spent 131 weeks on the *Billboard* 200 album chart.

The follow-up album, 1981's *For Those About to Rock We Salute You*, also sold well and was positively received by critics. The album featured two of the band's most popular singles: "Let's Get It Up" and the title track, "For Those About to Rock", which reached No.13 and No.15 in the UK, respectively. The band split with Lange for their self-produced 1983 album, *Flick of the Switch*, in an effort to recover the rawness and simplicity of their early albums.

Departure of Rudd and commercial decline (1983–87)

"Back in Black" (1980)

"Back in Black"'s riff is one of the most recognised in hard rock history. The song ranked No.187 on *Rolling Stone* 's list of The 500 Greatest Songs of All Time and reached No.37 in the US.

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After having problems with drugs and alcohol, drummer Phil Rudd's friendship with Malcolm Young deteriorated and eventually escalated to a physical confrontation after which Rudd was fired. Session drummer B.J. Wilson was drafted in to help complete the recordings, but his drum parts were eventually not used, as Rudd had already completed his drum parts. Rudd was replaced by Simon Wright in the summer of 1983 after the band held over 700 auditions in the US and UK. Simon Kirke of Free and Bad Company fame, and Paul Thompson of Roxy Music were two of the drummers auditioned.

Later in the year, AC/DC released the self-produced album *Flick of the Switch*, which was less successful than their previous albums, and was considered underdeveloped and unmemorable. One critic stated that the band "had made the same album nine times". AC/DC were voted the eighth-biggest disappointment of the year in the 1984 *Kerrang!* readers' poll. However, *Flick of the Switch* eventually reached No.4 on the UK charts, and AC/DC had minor success with the singles "Nervous Shakedown" and "Flick of the Switch". *Fly on the Wall*, produced by the Young brothers in 1985, was also regarded as uninspired and directionless. A music concept video of the same name featured the band at a bar, playing five of the album's ten songs.

In 1986, the group returned to the charts with the made-for-radio "Who Made Who". The album *Who Made Who* was the soundtrack to Stephen King's film *Maximum Overdrive*; it brought together older hits, such as "You Shook Me All Night Long" and "Ride On", with newer songs such as title track "Who Made Who", and two new instrumentals, "D.T." and "Chase the Ace".

In February 1988, AC/DC were inducted into the Australian Recording Industry Association's Hall of Fame.

Back to commercial success (1987–90)

AC/DC's 1988 album, *Blow Up Your Video*, was recorded at Studio Miraval in Le Val (Occitania), France, and reunited the band with their original producers, Harry Vanda and George Young. The group recorded nineteen songs, choosing ten for the final release; though the album was later criticised for containing excessive "filler", it was a commercial success. *Blow Up Your Video* sold more copies than the previous two studio releases combined, reaching No.2 on the UK charts—AC/DC's highest position since "Back in Black" in 1980. The album featured the UK top-twenty single "Heatseeker" and popular songs such as "That's the Way I Wanna Rock 'n' Roll". The *Blow Up Your Video* World Tour began in February 1988, in Perth, Australia. That April, following live appearances across Europe, Malcolm Young announced that he was taking time off from touring, principally to begin recovery from his alcoholism. Another member of the Young family, Stevie Young, temporarily took Malcolm's place.

Following the tour, Wright left the group to work on the upcoming Dio album *Lock Up the Wolves*, and was replaced by session veteran Chris Slade. Johnson was unavailable for several months while finalising his divorce, so the Young brothers wrote all the songs for the next album, a practice they continued for all subsequent releases through *Rock or Bust* in 2014.

Popularity regained (1990–1994)

Phil Rudd performs at the KeyArena in Seattle on 12 August 1996 during the Ballbreaker World Tour

The next album, *The Razors Edge*, was recorded in Vancouver, British Columbia, Canada, and was mixed and engineered by Mike Fraser and produced by Bruce Fairbairn, who had previously worked with Aerosmith and Bon Jovi. Released in 1990, it was a major comeback for the band, and included the hits "Thunderstruck" and "Are You Ready", which reached No.5 and No.16 respectively on *Billboards Mainstream Rock Tracks Chart, and Moneytalks*, which peaked at No.23 on the *Billboard* Hot 100. The album went multi-platinum and reached the US top ten. Several shows on the Razors Edge tour were recorded for the 1992 live album, titled *Live*. *Live* was produced by Fairbairn, and is considered one of the best live albums of the 1990s. AC/DC headlined the Monsters of Rock show during this tour, which was released on DVD as *Live at Donington*. During *The Razors Edge* tour three fans were killed at a concert at the Salt Palace in Salt Lake City, Utah in January 1991. When the concert began fans rushed the stage crushing the three and injuring others. It took 20 minutes before venue security and the group understood the severity of the situation and stopped the concert. AC/DC settled with the victims' families out of court. As a result of this incident, the Salt Palace eliminated festival seating from future events. A year later, AC/DC recorded "Big Gun" for the soundtrack of the Arnold Schwarzenegger movie *Last Action Hero*, and was released as a single, reaching No.1 on the US Mainstream Rock chart, the band's first No.1 single on that chart.

Popularity confirmed (1994–2008)

In 1994, Angus and Malcolm invited Rudd to several jam sessions. He was eventually rehired to replace Slade, whose amicable departure arose in part because of the band's strong desire to again work with Rudd. Recorded at the Ocean Way Studios in Los Angeles by the reunited 1980–83 line-up and produced by Rick Rubin, *Ballbreaker* was released in 1995. The first single from the album was "Hard as a Rock". Two more singles were released from the album: "Hail Caesar" and "Cover You in Oil".

In 1997, a box set named *Bonfire* was released. It contained four albums; a remastered version of *Back in Black*; *Volts* (a disc with alternate takes, outtakes, and stray live cuts) and two live albums, *Live from the Atlantic Studios* and *Let There Be Rock: The Movie*. *Live from the Atlantic Studios* was recorded on 7 December 1977 at the Atlantic Studios in New York. *Let There Be Rock: The Movie* was a double album recorded in 1979 at the Pavillon de Paris and was the soundtrack of a motion picture, *AC/DC: Let There Be Rock*. The US version of the box set included a colour booklet, a two-sided poster, a sticker, a temporary tattoo, a keychain bottle opener, and a guitar pick.

Angus Young performs in Cologne, Germany in 2001 during the Stiff Upper Lip Tour

In 2000, the band released *Stiff Upper Lip*, produced by brother George Young at the Warehouse Studio, again in Vancouver. The album was better received by critics than *Ballbreaker* but was considered lacking in new ideas. The Australian release included a bonus disc with three promotional videos and several live performances recorded in Madrid, Spain in 1996. *Stiff Upper Lip* reached No.1 in five countries, including Argentina and Germany; No.2 in three countries, Spain, France and Switzerland; No.3 in Australia; No.5 in Canada and Portugal; and No.7 in Norway, the US and Hungary. The first single, "Stiff Upper Lip", remained at No.1 on the US Mainstream Rock

charts for four weeks. The other singles released also did very well; "Satellite Blues" and "Safe in New York City" reached No.7 and No.31 on Billboard's Mainstream Rock Tracks, respectively.

In 2002, AC/DC signed a long-term, multi-album deal with Sony Music, who went on to release a series of remastered albums as part of their AC/DC remasters series. Each release contained an expanded booklet featuring rare photographs, memorabilia, and notes. In 2003, the entire back-catalogue (except *Ballbreaker* and *Stiff Upper Lip*) was remastered and re-released. *Ballbreaker* was eventually re-released in October 2005; *Stiff Upper Lip* was later re-released in April 2007. Also in 2003, the band was inducted into the Rock and Roll Hall of Fame.

On 30 July 2003, the band performed with the Rolling Stones and Rush at Molson Canadian Rocks for Toronto. The concert, held before an audience of half a million, was intended to help the city overcome the negative publicity stemming from the effects of a 2003 SARS epidemic. The concert holds the record for the largest paid music event in North American history. The band came second in a list of Australia's highest-earning entertainers for 2005, and sixth for 2006, despite having neither toured since 2003 nor released an album since 2000. Verizon Wireless has gained the rights to release AC/DC's full albums and the entire *Live at Donington* concert to download in 2008.

On 16 October 2007, Columbia Records released a double and triple DVD titled *Plug Me In*. The set consists of five and seven hours of rare footage, and even a recording of AC/DC at a high school performing "School Days", "TNT", "She's Got Balls", and "It's a Long Way to the Top". As with *Family Jewels*, disc one contains rare shows of the band with Bon Scott, and disc two is about the Brian Johnson era. The collector's edition contains an extra DVD with 21 more rare performances of both Scott and Johnson and more interviews.

AC/DC made their video game debut on *Rock Band 2*, with "Let There Be Rock" included as a playable track. The setlist from their *Live at Donington* live album was released as playable songs for the *Rock Band* series by means of a Wal-Mart-exclusive retail disc titled *AC/DC Live: Rock Band Track Pack*.

No Bull: The Directors Cut, a newly edited, comprehensive Blu-ray and DVD of the band's July 1996 Plaza De Toros de las Ventas concert in Madrid, Spain, was released on 9 September 2008.

Black Ice (2008–11)

"Rock 'n' Roll Train"

Sample of *Black Ice*'s lead single "Rock 'n' Roll Train". The song is built on guitar riffs and elemental drum beats, and features harmonic backing vocals during the chorus.

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On 18 August 2008, Columbia Records announced 18 October Australian release, and 20 October worldwide release, of the studio album *Black Ice*. The 15-track album was the band's first studio release in eight years, was produced by Brendan O'Brien and was mixed and engineered by Mike Fraser. Like *Stiff Upper Lip*, it was recorded at The Warehouse Studio in Vancouver, British Columbia. *Black Ice* was sold in the US exclusively at Walmart and Sam's Club and the band's official website.

AC/DC performs at Rogers Centre in Toronto on 7 November 2008 during their Black Ice World Tour

"Rock 'n' Roll Train", the album's first single, was released to radio on 28 August. On 15 August, AC/DC recorded a video for a song from the new album in London with a special selection of fans getting the chance to be in the video. Black Ice debuted at No.1 on album charts in 29 countries and also was Columbia Records' biggest debut album (since Nielsen SoundScan began tracking sales data for Billboard in March 1991). Black Ice has been certified Multi Platinum in eight countries, including the US, Australia, Canada, Switzerland, Sweden, Norway, Germany and the Czech Republic. Additionally Black Ice has achieved Platinum status in twelve countries (Austria, Belgium, Denmark, Finland, France, Hungary, Ireland, Italy, UK, Argentina, Singapore and New Zealand) and Gold status in four countries (The Netherlands, Spain, Poland and Brazil). The 18-month Black Ice World Tour supporting the new album was announced on 11 September and began on 28 October in Wilkes-Barre, Pennsylvania.

On 15 September 2008, AC/DC Radio debuted on Sirius Channel 19 and XM channel 53. The channel plays AC/DC music along with interviews with the band members.


Angus Young on 18 June 2010 at the Stade de France (Paris).

With the North American release of *Black Ice* on 20 October 2008, Columbia Records and Walmart created "Rock Again AC/DC Stores" to promote the album. In October 2008, MTV, Walmart, and Columbia created "AC/DC Rock Band Stores" in New York City, at Times Square, and in Los Angeles. "Black Ice" trucks were also dispatched on the streets of these two cities after the release, playing AC/DC music aloud and making various stops each day to sell merchandise.

In late September 2009, the band rescheduled six shows when Brian Johnson underwent an operation for ulcers.[7] On 29 September, the band announced a collection of studio and live rarities, *Backtracks*, which was released on 10 November 2009 as a 3-CD/2-DVD/1-LP box-set.

On 4 November AC/DC were announced as the Business Review Weekly top Australian earner (entertainment) for 2009 with earnings of $105 million. This displaced The Wiggles from the number one spot for the first time in four years.

On 19 April 2010, AC/DC released *Iron Man 2*, the soundtrack for the eponymous film. One month later, the band headlined Download Festival at Donington Park,[8] and closed the Black Ice World Tour in Bilbao, Spain on 28 June 2010, after 20 months in which AC/DC went to 108 cities in over 28 countries, with an estimated audience of over five million people. Three concerts in December 2009 at the River Plate Stadium in Argentina were released as the DVD *Live at River Plate* on 10 May 2011. An exclusive single from the DVD, featuring the songs "Shoot to Thrill" and "War Machine", was issued on Record Store Day. In 2011, the band also issued on DVD and Blu-ray the concert movie *AC/DC: Let There Be Rock*, which had its theatrical release in 1980.

Multiple lineup changes (2011–present)

Angus stated in an interview in early May 2011 that the band was beginning to plan another world tour, saying, "Now we're thinking, 'How can we ever better the 'Black Ice' world tour?' But we will." At the band's *Live at River Plate* DVD premiere on 6 May 2011 at the Hammersmith Apollo in London, England, Angus said that there were plans for the group to release a new studio album "within the next couple of years", which the tour would support.

In May 2012, Malcolm Young confirmed that the band are working on a potential follow-up to 2008's *Black Ice*. But he warned that fans were in for a longer wait than expected, after lead singer Brian Johnson suggested there would be new material next year. Malcolm stated, "You know what Brian's like. He just says things and then walks away. It'll be a little while – a year or two anyway. I've been doing some jamming on some song ideas but I do that all the time, as do the rest of the band. We are still working. But we had a long rest between *Stiff Upper Lip* and *Black Ice*, so I think we need a couple of years to recuperate and work on it a bit more."

On 19 November 2012, AC/DC released *Live at River Plate*, their first live album in 20 years.

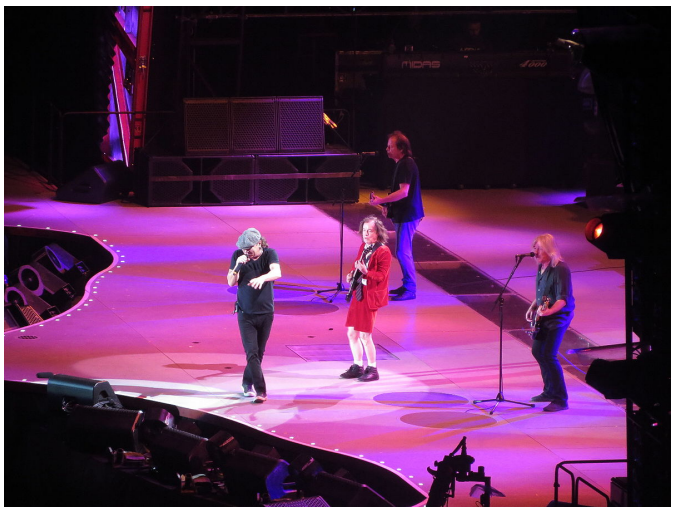
Malcolm Young's retirement

On 16 April 2014, in response to earlier reports that the band may be retiring due to Malcolm Young being seriously ill and unable to perform, Brian Johnson commented that AC/DC are not retiring, stating "We are definitely getting together in May in Vancouver. We're going to pick up guitars, have a plonk and see if anybody has got any tunes or ideas. If anything happens we'll record it." AC/DC subsequently announced in an official statement on their Facebook page that Malcolm Young would be taking a break from the band due to his ill health. It ended: "The band will continue to make music." In June, Johnson announced that AC/DC are "very likely" to be on the road again before the end of 2014. In July 2014, AC/DC confirmed that they have finished recording their next album and that Malcolm's nephew, Stevie Young replaced Malcolm in the studio.

Drummer Phil Rudd released his first solo album, *Head Job*, on 29 August 2014. He confirmed that there would be another AC/DC tour, and stated that the band had no intention of retiring, adding, "We'll all have to be dead before it stops."

"Rock or Bust"

On 23 September 2014, Alberts management confirmed that founding member Malcolm Young had officially departed from the band and revealed that their new record entitled *Rock or Bust* featuring eleven new tracks would be released on 28 November 2014 as the first AC/DC album in the band's history without Malcolm Young on the recordings. The band also announced plans for a world tour to promote the new album with Malcolm and Angus' nephew Stevie Young as Malcolm's replacement.



AC/DC performs at Estadi Olímpic Lluís Companys in Barcelona on 29 May 2015 during their Rock or Bust Tour

Phil Rudd's replacement

On 6 November 2014 Rudd was charged with attempting to procure a murder, threatening to kill, possession of methamphetamine and possession of cannabis, following a police raid on his home. The charge of attempting to procure a murder was

withdrawn the following day, but the other charges remained. AC/DC released a statement clarifying that the tour promoting *Rock or Bust* would continue, but did not say whether or not Rudd would participate, or if he was still a member of the band.

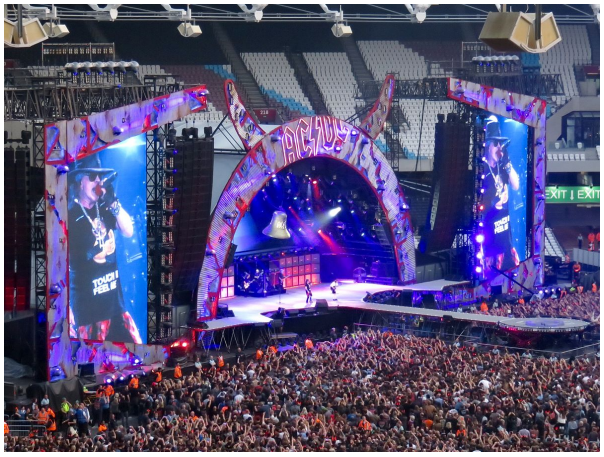
In an interview on 13 November, Angus Young stated that the band had experienced problems with Rudd earlier in the year when recording *Rock or Bust*, and that his situation had taken the band by surprise. Rudd had also missed video and photo shoots, and with reference to Rudd's future in the band, Young added, "So, at this stage, it's a pretty tough call for us." He also said the band would continue: "He's got to sort himself out I think ... At this point it's kind of a question mark. But if we're touring, there will be a drummer in place, put it that way."

At the charity signing before the Grammy awards, the band was photographed together with former drummer Chris Slade. It was later confirmed that he had rejoined the band for the Grammys and upcoming tour. In April 2015, Rudd pleaded guilty to drug charges and threatening to kill a former assistant. Shortly thereafter, the band's web site removed Rudd as the band's drummer and replaced him with Slade. On 9 July 2015 Rudd was sentenced to eight month's home detention despite seeking to be discharged without conviction.

Brian Johnson's hearing loss and departure

On 7 March 2016, the band announced that the final ten dates of the Rock or Bust World Tour would be rescheduled as Johnson's doctors had ordered him to stop touring immediately, as his hearing loss had accelerated and he risked complete deafness if he persisted on the road. The ten cancelled dates would be performed "likely with a guest vocalist" later in the year, leaving Johnson's future in touring with the group uncertain. Johnson himself later stated on *The Howard Stern Show* that his hearing loss didn't come from having performed for 36 years with AC/DC, but rather his love of auto racing and having forgotten to put ear plugs in during one race left him with a busted ear drum in his left ear.

However, on 15 March 2016, American comedian Jim Breuer (a friend of Johnson) revealed on his podcast that Johnson had received a second opinion on his hearing and it was not as bad as initially thought. Nonetheless, Breuer mentioned that Johnson told him that he was essentially fired from AC/DC and that he hadn't heard from the band since the announcement of the tour being postponed, adding that Angus Young wants to continue the band for at least another ten years and do at least one more studio album and world tour. Breuer later clarified his comments on Facebook that did not end speculation on Johnson's future with the band.



Axl Rose performing with AC/DC at the Olympic Stadium, London, June 2016.

On 19 April 2016, Johnson made an official statement regarding his health problems and inability to tour. In the statement, he acknowledged his ongoing hearing difficulties but stated his intentions to continue recording and potentially resume touring if his health improves sufficiently. He also specifically thanked Angus Young and Cliff Williams for their support during his AC/DC tenure.

Guest vocalist Axl Rose

On 16 April 2016, AC/DC released a statement announcing the addition of Guns N' Roses frontman Axl Rose as the band's lead vocalist for the remainder of their 2016 tour dates, and apparently confirming Johnson's departure. The statement reads: "AC/DC band members would like to thank Brian Johnson for his contributions and dedication to the band throughout the years. We wish him all the best with his hearing issues and future ventures. As much as we want this tour to end as it started, we understand, respect and support Brian's decision to stop touring and save his hearing. We are dedicated to fulfilling the remainder of our touring commitments to everyone that has supported us over the years, and are fortunate that Axl Rose has kindly offered his support to help us fulfill this commitment. AC/DC will resume their Rock or Bust World Tour with Axl Rose joining on vocals."

Planned departure of Cliff Williams

On 8 July 2016, Cliff Williams announced he would leave the group at the end of its 2016 touring commitments; he cited the departures of Malcolm Young, Phil Rudd and Brian Johnson as a contributing factor in his decision.

Legacy

The street sign for ACDC Lane, Melbourne

AC/DC were inducted into the Rock and Roll Hall of Fame on 10 March 2003. During the ceremony the band performed "Highway to Hell" and "You Shook Me All Night Long", with guest vocals provided by host Steven Tyler of Aerosmith. He described the band's power chords as "the thunder from down under that gives you the second most powerful surge that can flow through your body." During the acceptance speech, Brian Johnson quoted their 1977 song "Let There Be Rock".

On 22 March 2000, the municipality of Leganés (near Madrid) named a street in honour of the band as "Calle de AC/DC" ("AC/DC Street"). Malcolm and Angus attended the inauguration with many fans. Later that day, the plaque with the name of the group was stolen, perhaps by an enthusiast or collector. The plaque was replaced two hours later, and stolen once again a mere three days after the fact. The plaque had since been stolen numerous times, forcing the municipality of Leganés to begin selling replicas of the official street plaque.

In May 2003, the Young brothers accepted a Ted Albert Award for Outstanding Service to Australian Music at the 2003 Music Winners Awards, during which Malcolm paid special tribute to Bon Scott, who was also a recipient of the award.

On 1 October 2004, a central Melbourne thoroughfare, Corporation Lane, was renamed ACDC Lane in honour of the band. However, the City of Melbourne forbade the use of the slash character in street names, so the four letters were combined. The lane is near Swanston Street where, on the back of a truck, the band recorded their video for the 1975 hit "It's a Long Way to the Top".

They sold over 1.3 million CDs in the US during 2007 despite not having released a new album since 2000 at that point. Additionally, the group's commercial success continues to flourish despite their choice to refrain from selling albums in digital online formats for many years. However, in November 2012, the entire catalogue (excluding the *TNT* album and the Australian versions of the *High Voltage*, *Dirty Deeds Done Dirt Cheap* and *Let There Be Rock* albums) became available on the iTunes Store.

In 2009 the Recording Industry Association of America upgraded the group's US sales figures from 69 million to 71 million, making AC/DC the fifth-best-selling band in US history and the tenth-best-selling artist, selling more

albums than Madonna and Mariah Carey. The RIAA also certified *Back in Black* as double Diamond (20 million) in US sales, and by 2007 the album had sold 22 million copies, which made it the fifth-best-selling album of all-time in the US. It is currently the second-best-selling album worldwide.

Band members

Main article: List of AC/DC band members

Current members

- Angus Young – lead guitar (1973–present)
- Cliff Williams – bass guitar, backing vocals (1977–present)
- Stevie Young – rhythm guitar, backing vocals (1988 [touring member], 2014–present)
- Chris Slade – drums (1989–1994, 2015–present)

Current touring member

- Axl Rose – lead vocals (2016)

Former members

- Malcolm Young – rhythm guitar, backing vocals (1973–2014)
- Dave Evans – lead vocals (1973–1974)
- Bon Scott – lead vocals (1974–1980)
- Mark Evans – bass guitar (1975–1977)
- Phil Rudd – drums (1975–1983, 1994–2015)
- Brian Johnson – lead and backing vocals (1980–2016 [Indefinite Hiatus])
- Simon Wright – drums (1983–1989)

Note: Before their debut album, *High Voltage* (1975), AC/DC had several line up changes. For a more comprehensive list of members that were part of the band before 1975, see List of AC/DC band members.

Tours

Date	Tour
1973–75	Australian Clubs Tour
1975	High Voltage Australian Clubs Tour
1975–76	TNT/Lock Up Your Daughters Summer Vacation Tour
1976	Lock Up Your Daughters
1976–77	Dirty Deeds Done Dirt Cheap/A Giant Dose of Rock and Roll
1977	Let There Be Rock Tour
1978	Powerage Tour
1978–79	If You Want Blood Tour
1979–80	Highway to Hell Tour
1980–81	Back in Black Tour
1981–82	For Those About to Rock Tour
1983–84	Flick of the Switch Tour/Monsters of Rock Tour
1985–86	Fly on the Wall Tour
1986	Who Made Who Tour
1988	Blow Up Your Video World Tour

1990–91	The Razors Edge World Tour
1996	Ballbreaker World Tour
2000–01	Stiff Upper Lip World Tour
2003	Club Dates/Rolling Stones Tour
2008–10	Black Ice World Tour
2015–16	Rock or Bust World Tour

Discography

Main articles: AC/DC discography and List of songs recorded by AC/DC

Studio albums

- *High Voltage* (1975) (Australia only)
- *T.N.T.* (1975) (Australia only)
- *High Voltage* (1976) (International version)
- *Dirty Deeds Done Dirt Cheap* (1976)
- *Let There Be Rock* (1977)
- *Powerage* (1978)
- *Highway to Hell* (1979)
- *Back in Black* (1980)
- *For Those About to Rock We Salute You* (1981)
- *Flick of the Switch* (1983)
- *Fly on the Wall* (1985)
- *Blow Up Your Video* (1988)
- *The Razors Edge* (1990)
- *Ballbreaker* (1995)
- *Stiff Upper Lip* (2000)
- *Black Ice* (2008)
- *Rock or Bust* (2014)

Awards and nominations

Main article: List of awards and nominations received by AC/DC

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External links

- **No URL found. Please specify a URL here or add one to Wikidata.**
- AC/DC (https://www.dmoz.org//Arts/Music/Bands_and_Artists/A/AC-DC) at DMOZ
- AC/DC (http://musicbrainz.org/artist/66c662b6-6e2f-4930-8610-912e24c63ed1) discography at MusicBrainz

Number

For other uses, see Number (disambiguation).

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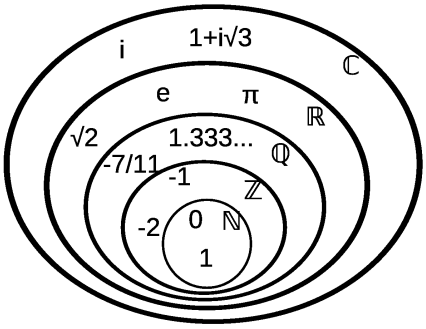


Subsets of the complex numbers.

A **number** is a mathematical object used to count, measure, and label.Wikipedia:Citation needed The original examples are the natural numbers 1, 2, 3, and so forth. A notational symbol that represents a number is called a numeral. In addition to their use in counting and measuring, numerals are often used for labels (as with telephone numbers), for ordering (as with serial numbers), and for codes (as with ISBNs). In common usage, *number* may refer to a symbol, a word, or a mathematical abstraction.

In mathematics, the notion of number has been extended over the centuries to include 0, negative numbers, rational numbers such as and , real numbers such as and , complex numbers, which extend the real numbers by including , and sometimes additional objects. Calculations with numbers are done with arithmetical operations, the most familiar being addition, subtraction, multiplication, division, and exponentiation. Their study or usage is called arithmetic. The same term may also refer to number theory, the study of the properties of the natural numbers.

Besides their practical uses, numbers have cultural significance throughout the world.[1][2] For example, in Western society the number 13 is regarded as unlucky, and "a million" may signify "a lot." Though it is now regarded as pseudoscience, numerology, the belief in a mystical significance of numbers permeated ancient and medieval thought.[3] Numerology heavily influenced the development of Greek mathematics, stimulating the investigation of many problems in number theory which are still of interest today.

During the 19th century, mathematicians began to develop many different abstractions which share certain properties of numbers and may be seen as extending the concept. Among the first were the hypercomplex numbers, which consist of various extensions or modifications of the complex number system. Today, number systems are considered important special examples of much more general categories such as rings and fields, and the application of the term "number" is a matter of convention, without fundamental significance.[4]

Numerals

Main article: Numeral system

Numbers should be distinguished from **numerals**, the symbols used to represent numbers. Boyer showed that Egyptians created the first ciphered numeral system.Wikipedia:Citation needed Greeks followed by mapping their counting numbers onto Ionian and Doric alphabets. The number five can be represented by digit "5" or by the Roman numeral "Ⅴ". Notations used to represent numbers are discussed in the article numeral systems. An important development in the history of numerals was the development of a positional system, like modern decimals, which have many advantages, such as representing large numbers with only a few symbols. The Roman numerals require extra symbols for larger numbers.

Main classification

"Number system" redirects here. For systems for expressing numbers, see Numeral system.

See also: List of types of numbers

Different types of numbers have many different uses. Numbers can be classified into sets, called **number systems**, such as the natural numbers and the real numbers. The same number can be written in many different ways. For different methods of expressing numbers with symbols, such as the Roman numerals, see numeral systems.

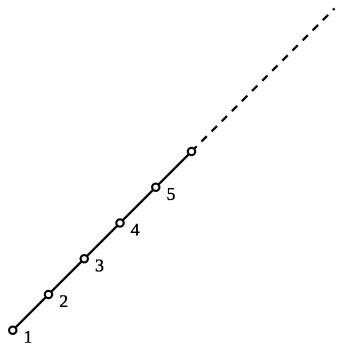
Main number systems

Natural	0, 1, 2, 3, 4, ... **or** 1, 2, 3, 4, ... or are sometimes used.
Integer	..., −5, −4, −3, −2, −1, 0, 1, 2, 3, 4, 5, ...
Rational	a/b where a and b are integers and b is not 0
Real	The limit of a convergent sequence of rational numbers
Complex	$a + bi$ where a and b are real numbers and i is the square root of −1

Natural numbers

Main article: Natural number

The most familiar numbers are the natural numbers (sometimes called whole numbers or counting numbers): 1, 2, 3, and so on. Traditionally, the sequence of natural numbers started with 1 (0 was not even considered a number for the Ancient Greeks.) However, in the 19th century, set theorists and other mathematicians started including 0 (cardinality of the empty set, i.e. 0 elements, where 0 is thus the smallest cardinal number) in the set of natural numbers. Today, different mathematicians use the term to describe both sets, including 0 or not. The mathematical symbol for the set of all natural numbers is **N**, also written , and sometimes or when it is necessary to indicate whether the set should start with 0 or 1, respectively.



The natural numbers, starting with 1

In the base 10 numeral system, in almost universal use today for mathematical operations, the symbols for natural numbers are written using ten digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. In this base 10 system, the rightmost digit of a natural number has a place value of 1, and every other digit has a place value ten times that of the place value of the digit to its right.

In set theory, which is capable of acting as an axiomatic foundation for modern mathematics, natural numbers can be represented by classes of equivalent sets. For instance, the number 3 can be represented as the class of all sets that have exactly three elements. Alternatively, in Peano Arithmetic, the number 3 is represented as sss0, where s is the "successor" function (i.e., 3 is the third successor of 0). Many different representations are possible; all that is needed to formally represent 3 is to inscribe a certain symbol or pattern of symbols three times.

Integers

Main article: Integer

The negative of a positive integer is defined as a number that produces 0 when it is added to the corresponding positive integer. Negative numbers are usually written with a negative sign (a minus sign). As an example, the negative of 7 is written −7, and 7 + (−7) = 0. When the set of negative numbers is combined with the set of natural numbers (including 0), the result is defined as the set of integers, **Z** also written . Here the letter Z comes from German *Zahl*, meaning "number". The set of integers forms a ring with the operations addition and multiplication.

The natural numbers form a subset of the integers. As there is no common standard for the inclusion or not of zero in the natural numbers, the natural numbers without zero are commonly referred to as **positive integers**, and the natural numbers with zero are referred to as **non-negative integers**.

Rational numbers

Main article: Rational number

A rational number is a number that can be expressed as a fraction with an integer numerator and a positive integer denominator. Negative denominators are allowed, but are commonly avoided, as every rational number is equal to a fraction with positive denominator. Fractions are written as two integers, the numerator and the denominator, with a dividing bar between them. The fraction *m*/*n* represents *m* parts of a whole divided into *n* equal parts. Two different fractions may correspond to the same rational number; for example 1/2 and 2/4 are equal, that is:

If the absolute value of *m* is greater than *n* (supposed to be positive), then the absolute value of the fraction is greater than 1. Fractions can be greater than, less than, or equal to 1 and can also be positive, negative, or 0. The set of all rational numbers includes the integers, since every integer can be written as a fraction with denominator 1. For example −7 can be written −7/1. The symbol for the rational numbers is **Q** (for *quotient*), also written .

Real numbers

Main article: Real number

The real numbers include all the measuring numbers. The symbol for the real numbers is **R**, also written as . Real numbers are usually represented by using decimal numerals, in which a decimal point is placed to the right of the digit with place value 1. Each digit to the right of the decimal point has a place value one-tenth of the place value of the digit to its left. For example, 123.456 represents 123456/1000, or, in words, one hundred, two tens, three ones, four tenths, five hundredths, and six thousandths. A finite decimal representation allows us to represent exactly only the integers and those rational numbers whose denominators have only prime factors which are factors of ten. Thus one half is 0.5, one fifth is 0.2, one tenth is 0.1, and one fiftieth is 0.02. To represent the rest of the real numbers requires an infinite sequence of digits after the decimal point. Since it is impossible to write infinitely many digits, real numbers are commonly represented by rounding or truncating this sequence, or by establishing a pattern, such as 0.333..., with an ellipsis to indicate that the pattern continues. Thus 123.456 is an approximation of any real number between 1234555/10000 and 1234565/10000 (rounding) or any real number between 123456/1000 and 123457/1000 (truncation). Negative real numbers are written with a preceding minus sign: -123.456.

Every rational number is also a real number. It is not the case, however, that every real number is rational. A real number, which is not rational, is called irrational. A decimal represents a rational number if and only if has a finite

number of digits or eventually repeats for ever, after any initial finite string digits. For example, 1/2 = 0.5 and 1/3 = 0.333... (forever repeating 3s, otherwise written 0.3). On the other hand, the real number π, the ratio of the circumference of any circle to its diameter, is

Since the decimal neither ends nor eventually repeats forever (see: proof that pi is irrational) it cannot be written as a fraction, and is an example of an irrational number. Other irrational numbers include

(the square root of 2, that is, the positive number whose square is 2).

Just as the same fraction can be written in more than one way, the same decimal may have more than one representation. 1.0 and 0.999... are two different decimal numerals representing the natural number 1. There are infinitely many other ways of representing the number 1, for example 1.00, 1.000, and so on.

Every real number is either rational or irrational. Every real number corresponds to a point on the number line. The real numbers also have an important but highly technical property called the least upper bound property.

When a real number represents a measurement, there is always a margin of error. This is often indicated by rounding or truncating a decimal, so that digits that suggest a greater accuracy than the measurement itself are removed. The remaining digits are called significant digits. For example, measurements with a ruler can seldom be made without a margin of error of at least 0.001 meters. If the sides of a rectangle are measured as 1.23 meters and 4.56 meters, then multiplication gives an area for the rectangle of 5.6088 square meters. Since only the first two digits after the decimal place are significant, this is usually rounded to 5.61.

In abstract algebra, it can be shown that any complete ordered field is isomorphic to the real numbers. The real numbers are not, however, an algebraically closed field, because they do not include the square root of minus one.

Complex numbers

Main article: Complex number

Moving to a greater level of abstraction, the real numbers can be extended to the complex numbers. This set of numbers arose historically from trying to find closed formulas for the roots of cubic and quartic polynomials. This led to expressions involving the square roots of negative numbers, and eventually to the definition of a new number: a square root of −1, denoted by i, a symbol assigned by Leonhard Euler, and called the imaginary unit. The complex numbers consist of all numbers of the form

where a and b are real numbers. Because of this, complex numbers correspond to points on the complex plane, a vector space of two real dimensions. In the expression $a + bi$, the real number a is called the real part and b is called the imaginary part. If the real part of a complex number is 0, then the number is called an imaginary number or is referred to as *purely imaginary*; if the imaginary part is 0, then the number is a real number. Thus the real numbers are a subset of the complex numbers. If the real and imaginary parts of a complex number are both integers, then the number is called a Gaussian integer. The symbol for the complex numbers is **C** or .

In abstract algebra, the complex numbers are an example of an algebraically closed field, meaning that every polynomial with complex coefficients can be factored into linear factors. Like the real number system, the complex number system is a field and is complete, but unlike the real numbers, it is not ordered. That is, there is no meaning in saying that i is greater than 1, nor is there any meaning in saying that i is less than 1. In technical terms, the complex numbers lack the trichotomy property.

Each of the number systems mentioned above is a proper subset of the next number system. Symbolically, .

Subclasses of the integers

Even and odd numbers

Main article: Even and odd numbers

An **even number** is an integer that is "evenly divisible" by two, that is divisible by two without remainder; an **odd number** is an integer that is not even. (The old-fashioned term "evenly divisible" is now almost always shortened to "divisible".) Equivalently, another way of defining an odd number is that it is an integer of the form $n = 2k + 1$, where k is an integer, and an even number has the form $n = 2k$ where k is an integer.

Prime numbers

Main article: Prime number

A **prime number** is an integer greater than 1 that is not the product of two smaller positive integers. The first few prime numbers are 2, 3, 5, 7, and 11. The prime numbers have been widely studied for more than 2000 years and have led to many questions, only some of which have been answered. The study of these questions is called number theory. An example of a question that is still unanswered is whether every even number is the sum of two primes. This is called Goldbach's conjecture.

A question that has been answered is whether every integer greater than one is a product of primes in only one way, except for a rearrangement of the primes. This is called fundamental theorem of arithmetic. A proof appears in Euclid's Elements.

Other classes of integers

Many subsets of the natural numbers have been the subject of specific studies and have been named, often after the first mathematician that has studied them. Example of such sets of integers are Fibonacci numbers and perfect numbers. For more examples, see Integer sequence.

Subclasses of the complex numbers

Algebraic, irrational and transcendental numbers

Algebraic numbers are those that are a solution to a polynomial equation with integer coefficients. Real numbers that are not rational numbers are called irrational numbers. Complex numbers which are not algebraic are called transcendental numbers. The algebraic numbers that are solutions of a monic polynomial equation with integer coefficients are called algebraic integers.

Computable numbers

Main article: Computable number

A **computable number**, also known as *recursive number*, is a real number such that there exists an algorithm which, given a positive number n as input, produces the first n digits of the computable number's decimal representation. Equivalent definitions can be given using μ-recursive functions, Turing machines or λ-calculus. The computable numbers are stable for all usual arithmetic operations, including the computation of the roots of a polynomial, and thus form a real closed field that contains the real algebraic numbers.

The computable numbers may be viewed as the real numbers that may be exactly represented in a computer: a computable number is exactly represented by its first digits and a program for computing further digits. However, the computable numbers are rarely used in practice. One reason is that there is no algorithm for testing the equality of two computable numbers. More precisely, there cannot exist any algorithm which takes any computable number as an input, and decides in every case if this number is equal to zero or not.

The set of computable numbers has the same cardinality as the natural numbers. Therefore, almost all real numbers are non-computable. However, it is very difficult to produce explicitly a real number that is not computable.

Extensions of the concept

p-adic numbers

Main article: *p*-adic number

The *p*-adic numbers may have infinitely long expansions to the left of the decimal point, in the same way that real numbers may have infinitely long expansions to the right. The number system that results depends on what base is used for the digits: any base is possible, but a prime number base provides the best mathematical properties. The set of the *p*-adic numbers contains the rational numbers, but is not contained in the complex numbers.

The elements of an algebraic function field over a finite field and algebraic numbers have many similar properties (see Function field analogy). Therefore, they are often regarded as numbers by number theorists. The *p*-adic numbers play an important role in this analogy.

Hypercomplex numbers

Main article: hypercomplex number

Some number systems that are not included in the complex numbers may be constructed from the real numbers in a way that generalize the construction of the complex numbers. They are sometimes called hypercomplex numbers. They include the quaternions **H**, introduced by Sir William Rowan Hamilton, in which multiplication is not commutative, and the octonions, in which multiplication is not associative.

Transfinite numbers

Main article: transfinite number

For dealing with infinite sets, the natural numbers have been generalized to the ordinal numbers and to the cardinal numbers. The former gives the ordering of the set, while the latter gives its size. For finite sets, both ordinal and cardinal numbers are identified with the natural numbers. In the infinite case, many ordinal numbers correspond to the same cardinal number.

Nonstandard numbers

Hyperreal numbers are used in non-standard analysis. The hyperreals, or nonstandard reals (usually denoted as $^*\mathbf{R}$), denote an ordered field that is a proper extension of the ordered field of real numbers **R** and satisfies the transfer principle. This principle allows true first-order statements about **R** to be reinterpreted as true first-order statements about $^*\mathbf{R}$.

Superreal and surreal numbers extend the real numbers by adding infinitesimally small numbers and infinitely large numbers, but still form fields.

A relation number is defined as the class of relations consisting of all those relations that are similar to one member of the class.Wikipedia:Please clarify

History

First use of numbers

Main articles: History of numbers and History of writing ancient numbers

Bones and other artifacts have been discovered with marks cut into them that many believe are tally marks.[5] These tally marks may have been used for counting elapsed time, such as numbers of days, lunar cycles or keeping records of quantities, such as of animals.

A tallying system has no concept of place value (as in modern decimal notation), which limits its representation of large numbers. Nonetheless tallying systems are considered the first kind of abstract numeral system.

The first known system with place value was the Mesopotamian base 60 system (ca. 3400 BC) and the earliest known base 10 system dates to 3100 BC in Egypt.

Zero

Further information: History of zero

The use of 0 as a number should be distinguished from its use as a placeholder numeral in place-value systems. Many ancient texts used 0. Babylonian (Modern Iraq) and Egyptian texts used it. Egyptians used the word *nfr* to denote zero balance in double entry accounting entries. Indian texts used a Sanskrit word *Shunye* or *shunya* to refer to the concept of *void*. In mathematics texts this word often refers to the number zero.

The number 605 in Khmer numerals, from an inscription from 683 AD. An early use of zero as a decimal figure.

Records show that the Ancient Greeks seemed unsure about the status of 0 as a number: they asked themselves "how can 'nothing' be something?" leading to interesting philosophical and, by the Medieval period, religious arguments about the nature and existence of 0 and the vacuum. The paradoxes of Zeno of Elea depend in large part on the uncertain interpretation of 0. (The ancient Greeks even questioned whether 1 was a number.)

The late Olmec people of south-central Mexico began to use a true zero (a shell glyph) in the New World possibly by the 4th century BC but certainly by 40 BC, which became an integral part of Maya numerals and the Maya calendar. Mayan arithmetic used base 4 and base 5 written as base 20. Sanchez in 1961 reported a base 4, base 5 "finger" abacus.

By 130 AD, Ptolemy, influenced by Hipparchus and the Babylonians, was using a symbol for 0 (a small circle with a long overbar) within a sexagesimal numeral system otherwise using alphabetic Greek numerals. Because it was used alone, not as just a placeholder, this Hellenistic zero was the first *documented* use of a true zero in the Old World. In later Byzantine manuscripts of his *Syntaxis Mathematica* (*Almagest*), the Hellenistic zero had morphed into the Greek letter omicron (otherwise meaning 70).

Another true zero was used in tables alongside Roman numerals by 525 (first known use by Dionysius Exiguus), but as a word, *nulla* meaning *nothing*, not as a symbol. When division produced 0 as a remainder, *nihil*, also meaning *nothing*, was used. These medieval zeros were used by all future medieval computists (calculators of Easter). An isolated use of their initial, N, was used in a table of Roman numerals by Bede or a colleague about 725, a true zero symbol.

An early documented use of the zero by Brahmagupta (in the *Brāhmasphuṭasiddhānta*) dates to 628. He treated 0 as a number and discussed operations involving it, including division. By this time (the 7th century) the concept had clearly reached Cambodia as Khmer numerals, and documentation shows the idea later spreading to China and the Islamic world.

Negative numbers

Further information: History of negative numbers

The abstract concept of negative numbers was recognized as early as 100 BC – 50 BC in China. *The Nine Chapters on the Mathematical Art* contains methods for finding the areas of figures; red rods were used to denote positive coefficients, black for negative. The first reference in a Western work was in the 3rd century AD in Greece. Diophantus referred to the equation equivalent to $4x + 20 = 0$ (the solution is negative) in *Arithmetica*, saying that the equation gave an absurd result.

During the 600s, negative numbers were in use in India to represent debts. Diophantus' previous reference was discussed more explicitly by Indian mathematician Brahmagupta, in *Brāhmasphuṭasiddhānta* 628, who used negative numbers to produce the general form quadratic formula that remains in use today. However, in the 12th century in India, Bhaskara gives negative roots for quadratic equations but says the negative value "is in this case not to be taken, for it is inadequate; people do not approve of negative roots."

European mathematicians, for the most part, resisted the concept of negative numbers until the 17th century, although Fibonacci allowed negative solutions in financial problems where they could be interpreted as debts (chapter 13 of *Liber Abaci*, 1202) and later as losses (in *Flos*). At the same time, the Chinese were indicating negative numbers by drawing a diagonal stroke through the right-most non-zero digit of the corresponding positive number's numeral. The first use of negative numbers in a European work was by Nicolas Chuquet during the 15th century. He used them as exponents, but referred to them as "absurd numbers".

As recently as the 18th century, it was common practice to ignore any negative results returned by equations on the assumption that they were meaningless, just as René Descartes did with negative solutions in a Cartesian coordinate system.

Rational numbers

It is likely that the concept of fractional numbers dates to prehistoric times. The Ancient Egyptians used their Egyptian fraction notation for rational numbers in mathematical texts such as the Rhind Mathematical Papyrus and the Kahun Papyrus. Classical Greek and Indian mathematicians made studies of the theory of rational numbers, as part of the general study of number theory. The best known of these is Euclid's *Elements*, dating to roughly 300 BC. Of the Indian texts, the most relevant is the Sthananga Sutra, which also covers number theory as part of a general study of mathematics.

The concept of decimal fractions is closely linked with decimal place-value notation; the two seem to have developed in tandem. For example, it is common for the Jain math sutra to include calculations of decimal-fraction approximations to pi or the square root of 2. Similarly, Babylonian math texts had always used sexagesimal (base 60) fractions with great frequency.

Irrational numbers

Further information: History of irrational numbers

The earliest known use of irrational numbers was in the Indian Sulba Sutras composed between 800 and 500 BC. The first existence proofs of irrational numbers is usually attributed to Pythagoras, more specifically to the Pythagorean Hippasus of Metapontum, who produced a (most likely geometrical) proof of the irrationality of the square root of 2. The story goes that Hippasus discovered irrational numbers when trying to represent the square root of 2 as a fraction. However Pythagoras believed in the absoluteness of numbers, and could not accept the existence of irrational numbers. He could not disprove their existence through logic, but he could not accept irrational numbers, so he sentenced Hippasus to death by drowning.

The 16th century brought final European acceptance of negative integral and fractional numbers. By the 17th century, mathematicians generally used decimal fractions with modern notation. It was not, however, until the

19th century that mathematicians separated irrationals into algebraic and transcendental parts, and once more undertook scientific study of irrationals. It had remained almost dormant since Euclid. In 1872, the publication of the theories of Karl Weierstrass (by his pupil Kossak), Heine (*Crelle*, 74), Georg Cantor (Annalen, 5), and Richard Dedekind was brought about. In 1869, Méray had taken the same point of departure as Heine, but the theory is generally referred to the year 1872. Weierstrass's method was completely set forth by Salvatore Pincherle (1880), and Dedekind's has received additional prominence through the author's later work (1888) and endorsement by Paul Tannery (1894). Weierstrass, Cantor, and Heine base their theories on infinite series, while Dedekind founds his on the idea of a cut (Schnitt) in the system of real numbers, separating all rational numbers into two groups having certain characteristic properties. The subject has received later contributions at the hands of Weierstrass, Kronecker (Crelle, 101), and Méray.

The search for roots of quintic and higher degree equations was an important development, the Abel–Ruffini theorem (Ruffini 1799, Abel 1824) showed that they could not be solved by radicals (formulas involving only arithmetical operations and roots). Hence it was necessary to consider the wider set of algebraic numbers (all solutions to polynomial equations). Galois (1832) linked polynomial equations to group theory giving rise to the field of Galois theory.

Continued fractions, closely related to irrational numbers (and due to Cataldi, 1613), received attention at the hands of Euler, and at the opening of the 19th century were brought into prominence through the writings of Joseph Louis Lagrange. Other noteworthy contributions have been made by Druckenmüller (1837), Kunze (1857), Lemke (1870), and Günther (1872). Ramus (1855) first connected the subject with determinants, resulting, with the subsequent contributions of Heine, Möbius, and Günther, in the theory of Kettenbruchdeterminanten.

Transcendental numbers and reals

Further information: History of π

The existence of transcendental numbers was first established by Liouville (1844, 1851). Hermite proved in 1873 that *e* is transcendental and Lindemann proved in 1882 that π is transcendental. Finally, Cantor showed that the set of all real numbers is uncountably infinite but the set of all algebraic numbers is countably infinite, so there is an uncountably infinite number of transcendental numbers.

Infinity and infinitesimals

Further information: History of infinity

The earliest known conception of mathematical infinity appears in the Yajur Veda, an ancient Indian script, which at one point states, "If you remove a part from infinity or add a part to infinity, still what remains is infinity." Infinity was a popular topic of philosophical study among the Jain mathematicians c. 400 BC. They distinguished between five types of infinity: infinite in one and two directions, infinite in area, infinite everywhere, and infinite perpetually.

Aristotle defined the traditional Western notion of mathematical infinity. He distinguished between actual infinity and potential infinity—the general consensus being that only the latter had true value. Galileo Galilei's *Two New Sciences* discussed the idea of one-to-one correspondences between infinite sets. But the next major advance in the theory was made by Georg Cantor; in 1895 he published a book about his new set theory, introducing, among other things, transfinite numbers and formulating the continuum hypothesis.

In the 1960s, Abraham Robinson showed how infinitely large and infinitesimal numbers can be rigorously defined and used to develop the field of nonstandard analysis. The system of hyperreal numbers represents a rigorous method of treating the ideas about infinite and infinitesimal numbers that had been used casually by mathematicians, scientists, and engineers ever since the invention of infinitesimal calculus by Newton and Leibniz.

A modern geometrical version of infinity is given by projective geometry, which introduces "ideal points at infinity", one for each spatial direction. Each family of parallel lines in a given direction is postulated to converge to the

corresponding ideal point. This is closely related to the idea of vanishing points in perspective drawing.

Complex numbers

Further information: History of complex numbers

The earliest fleeting reference to square roots of negative numbers occurred in the work of the mathematician and inventor Heron of Alexandria in the 1st century AD, when he considered the volume of an impossible frustum of a pyramid. They became more prominent when in the 16th century closed formulas for the roots of third and fourth degree polynomials were discovered by Italian mathematicians such as Niccolò Fontana Tartaglia and Gerolamo Cardano. It was soon realized that these formulas, even if one was only interested in real solutions, sometimes required the manipulation of square roots of negative numbers.

This was doubly unsettling since they did not even consider negative numbers to be on firm ground at the time. When René Descartes coined the term "imaginary" for these quantities in 1637, he intended it as derogatory. (See imaginary number for a discussion of the "reality" of complex numbers.) A further source of confusion was that the equation

seemed capriciously inconsistent with the algebraic identity

which is valid for positive real numbers a and b, and was also used in complex number calculations with one of a, b positive and the other negative. The incorrect use of this identity, and the related identity

in the case when both a and b are negative even bedeviled Euler. This difficulty eventually led him to the convention of using the special symbol i in place of to guard against this mistake.

The 18th century saw the work of Abraham de Moivre and Leonhard Euler. De Moivre's formula (1730) states:

and to Euler (1748) Euler's formula of complex analysis:

The existence of complex numbers was not completely accepted until Caspar Wessel described the geometrical interpretation in 1799. Carl Friedrich Gauss rediscovered and popularized it several years later, and as a result the theory of complex numbers received a notable expansion. The idea of the graphic representation of complex numbers had appeared, however, as early as 1685, in Wallis's *De Algebra tractatus*.

Also in 1799, Gauss provided the first generally accepted proof of the fundamental theorem of algebra, showing that every polynomial over the complex numbers has a full set of solutions in that realm. The general acceptance of the theory of complex numbers is due to the labors of Augustin Louis Cauchy and Niels Henrik Abel, and especially the latter, who was the first to boldly use complex numbers with a success that is well known.

Gauss studied complex numbers of the form $a + bi$, where a and b are integral, or rational (and i is one of the two roots of $x^2 + 1 = 0$). His student, Gotthold Eisenstein, studied the type $a + b\omega$, where ω is a complex root of $x^3 - 1 = 0$. Other such classes (called cyclotomic fields) of complex numbers derive from the roots of unity $x^k - 1 = 0$ for higher values of k. This generalization is largely due to Ernst Kummer, who also invented ideal numbers, which were expressed as geometrical entities by Felix Klein in 1893.

In 1850 Victor Alexandre Puiseux took the key step of distinguishing between poles and branch points, and introduced the concept of essential singular points. This eventually led to the concept of the extended complex plane.

Prime numbers

Prime numbers have been studied throughout recorded history. Euclid devoted one book of the *Elements* to the theory of primes; in it he proved the infinitude of the primes and the fundamental theorem of arithmetic, and presented the Euclidean algorithm for finding the greatest common divisor of two numbers.

In 240 BC, Eratosthenes used the Sieve of Eratosthenes to quickly isolate prime numbers. But most further development of the theory of primes in Europe dates to the Renaissance and later eras.

In 1796, Adrien-Marie Legendre conjectured the prime number theorem, describing the asymptotic distribution of primes. Other results concerning the distribution of the primes include Euler's proof that the sum of the reciprocals of the primes diverges, and the Goldbach conjecture, which claims that any sufficiently large even number is the sum of two primes. Yet another conjecture related to the distribution of prime numbers is the Riemann hypothesis, formulated by Bernhard Riemann in 1859. The prime number theorem was finally proved by Jacques Hadamard and Charles de la Vallée-Poussin in 1896. Goldbach and Riemann's conjectures remain unproven and unrefuted.

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