CAMERON BALLOONS

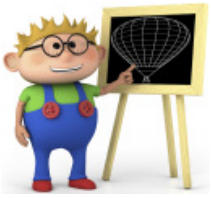
Teacher's Resources -

Hot-Air Ballooning

Issue 1

Teacher's Notes and Resources

Contents



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Lastly, If you have any further questions – email enquiries@cameronballoons.co.uk and we will do our best to help.

1) Cameron Balloons - Ballooning & Airship History & Notable Flights

19th Sept. 1783 A sheep, duck and cockerel became the first air travellers, launched by the Montgolfier brothers

21st Nov. 1783 Pilatre de Rozier, a science teacher, & the Marquis d'Arlandes, an infantry officer, became the first human air travellers when, in a hot-air balloon, they flew for 9 km (5.5 m) over Paris in the Montgolfier Brothers balloon. **First manned balloon flight took place on 21st November 1783.**

1784 Vincent Lunardi's hydrogen balloon took off from London watched by a crowd of 100,000 including the Prince of Wales. It flew for one hour minutes and travelled 13 miles

25th Aug. 1784 James Tytler The Grand Edinburgh Fire Balloon First hot-air balloon flight in the United Kingdom

7th Jan. 1785 Frenchaman Jean- Pierre Blanchard and American John Jefferies crossed the English Channel by gas balloon, carrying a letter – **the world's first air mail** & **the first Channel Crossing**, Dover to Foret de Guines, Calais 1h30m

15th June 1785 Pilatre de Rozier & Pierre Romain - **the first Roziere flight** Tour de Calais

29th June 1785 George Biggin & Ms. Letitia Sage - **First woman to fly in UK**

1794 A balloon was **first used in war as an observation post** during the battle of Fereus between France & Austria

1797 **First parachute jump from balloon** was made by Frenchman AJ Garnerin, who dropped 3,000 feet from a gas balloon

1825 The Robertson's, a family of balloon pioneers, broke altitude records a cross the world. Eugene Robertson reached 21,000ft, an American record

1854 The first powered flight – a steam engine-driven airship created and built by engineer Henri Giffard

5th Sept. 1862 **Altitude: 9000m** - Henry Coxwell & James Glaisher - "Mammoth"

1868 The **first air show** at London's Crystal Palace

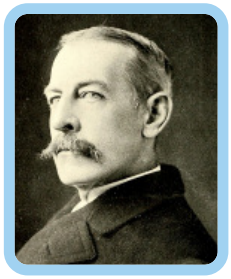
1876 The **first British Balloon Corps** was founded.It developed the use of steel storage cylinders for hydrogen, ending the need to make gas on the battlefield. At the siege of Paris, balloons carried passengers, pigeons and mail.

1884 La France, **the first electric-powered dirigible**, was launched. A dirigible, or blimp, is an engine-powered bag of gas with a passenger gondola. It has no internal framework – unlike an airship, which has a structure supporting gas bags

1897 Swedish aeronaut Solomon Andrew tried to fly a balloon to the North Pole. He did not make it

1899 The Boer war – balloons were used for used for observation

1900 Count Von Zeppelin founded the Company for the Promotion of Airships and the Zeppelin Corporation.The first Zeppelin airship, the LZ1 was a giant (420ft, 39ft diameter) which used two Daimler engines to fly at 30mph. Zeppelins soon operated daily passenger flights



James Gordon Bennett Jr.

1906 American newspaperman, Gordon Bennett, sponsored the first balloon race. Sixteen gas balloons took off from Paris and the winner, an Englishman landed in Yorkshire 22 hours later. The Gordon Bennett Gas Balloon Competition Cup is still held today

7 Aug. 1910 E T Willows - Willows airshipFlight from Cardiff to London 224km 10h

1915 **The first air raids**, as Zeppelins bombed Britain, British fighter pilots found that incendiary shells quickly set fire to the airships

6th Nov. 1918 G Meager & Capt. TB Williams 1892-1980 Airship Pilot no. 28 SR1
First flight from Italy to UK: Ciampino, Rome to Pulham, England

6th July 1919 Major George H Scott, captain + 29 crew - HMA R34
First Atlantic crossing by airship (East Fortune - Mineola NY)
First double crossing of Atlantic by any aircraft

1929 **The first circumnavigation of the world by airship** – the Graf Zeppelin. It travelled 1,000 miles a day for 21 days, carrying 20 passengers in the comfort of a luxury liner

1930 The largest British-made airship, the R101 crashed on it's maiden flight and 48 people died in five million cubic feet of flaming hydrogen. The British airship industry never recovered from the tragedy.

8th Nov. 1836 Charles Green, Robert Holland, Thomas Monck-Mason London - Nassau 608km, 18 hours, **first long distance flight,** first use of trailrope

24th July 1937 Charles Green, Robert Cocking - Death of Cocking in attempted parachute descent.

1937 The giant German airship, Hindenburg, exploded while landing in America – 62 of the 97 passengers survived but the era of dangerous hydrogen-powered airships was over

1944 Japan launched Fo-Gas, small, wind-driven hydrogen gas balloons packed with high explosives, on the west coast of America. They caused six casualties and minor damage.

1953 American Ed Yost adds 20th Century technology to 18th century innovation – a blow torch, the basis of the propane burner design, used in modern hot-air balloons.

10th July 1958 Distance: 1930.8 km - Colin & Rosemary Mudie, Tim & Bushy Eiloart - G-APOB RFD 53300

12th Dec. 1958 A Eiloart, Tim Eiloart, Colin & Rosemary Mudie - G-APOB RFD53300 Atlantic Attempt E-W (Tenerife -) 1930 km, 94h30m

1960 The era of modern hot-air balloons began as a balloon lifted from Nebraska with a propane-powered burner filling a 31 thousand cu.ft, 40ft diameter envelope

1963 Ed Yost and colleague Don Picard take their new style hot-air balloon to Europe

25th Mar. 1963	Ed Yost and Don Piccard - Raven "Channel Champ" **First Channel crossing by hot air** 3h17m
15th Aug. 1967	Gerry Turnbull, Don Cameron, Mark Westwood **First cross-country flight in a British-made modern hot air balloon** Weston-on-the-Green – Bicester airfield - Bristol Belle G-AVTL
1970	Don Cameron, aeronautical engineer starts his hot-air balloon manufacturing business in Bristol. Cameron Balloons was formally founded on 1st April 1971.
21st Aug. 1972	Don Cameron & Mark Yarry First crossing of Swiss Alps by hot air (Zermatt Switzerland – Biella Italy) G-AZUW Cameron Balloons A-140
17th Nov. 1972	Gron Edwards & Richard Barr - First release of parachutist in a modern hot-air balloon (Staffordshire) G-BANG Cameron Balloons O-84
4th Jan. 1973	Don Cameron & Teddy Hall **First public flight of a hot-air airship** (Newbury at Icicle meet) G-BAMK Cameron Balloons D-96
17th Apr. 1973	Duration: 3h 01m Don Cameron G-BAGI Cameron Balloons O-31
17th Apr. 1973	Distance: 54.0km Don Cameron G-BAGI Cameron Balloons O-31
25th Jan. 1974	Altitude: 13971m Julian Nott & Felix Pole G-BBGN Cameron Balloons A-375
21st Nov. 1975	Don Cameron, J Costa de Beauregard, Chris Davey G-BCFZ Cameron Balloons A-500 Channel crossing, duration record 18h 55m (Melbury Bubb UK – Angers France)
21st Nov. 1975	Duration: 18h 56m Don Cameron & Jean Costa de Beauregard & Christopher Davey G-BCFZ Cameron Balloons A-500
21st Dec. 1975	Duration: 6h 01m Nigel Tasker G-BCEU Cameron Balloons O-42
25th Aug. 1977	Altitude: 9296m Geoff Green G-BEXV Cameron Balloons O-56
25th Jan. 1978	Distance: 564.47km Philip Clark G-BEPO Cameron Balloons N-77
30th July 1978	Don Cameron & Christopher Davey Atlantic attempt (St Johns Newfoundland – 48N/7W) 3339 km, 96h24m G-BIAZ Cameron Balloons AT-165
30th July 1978	Duration: 96h 24m Don Cameron, Christopher Davey G-BIAZ Cameron Balloons AT165
30th July 1978	Distance: 3339.086km Don Cameron, Christopher Davey G-BIAZ Cameron Balloons AT165
12 Oct. 1978	Altitude: 6941m Geoff Green G-COOL Cameron Balloons O-31
1970-1980	Hot-air ballooning takes off with new synthetic materials & smaller, lighter burners, all mostly made in the UK
30th Sept. 1980	Distance: 675.0km Geoff Green, Cameron Balloons A-140
31st Oct. 1980	Altitude: 16805m Julian Nott G-BIDT Cameron Balloons A-375
26th Aug. 1981	Duration: 1h 12m / Distance: 10.636km Don Cameron Airship G-BGEP Cameron Balloons D-38
1st Sept. 1982	Duration: 1h 23m / Distance: 24.4km / Altitude: 1585m Geoff Green Airship G-SMHK Cameron Balloons D-38

1st Nov. 1984 Altitude: 4101.4m / Distance: 58.89km Julian Nott, Spider Anderson, Brian Smith G-BLHF Nott/Cameron Balloons

20th Nov. 1984 5415.4m / 2391.47km / Duration: 33h 8m 42s
Julian Nott & Spider Anderson G-BLHF Nott/Cameron Balloons

9th Mar. 1985 Duration: 6h 30m 26s / Distance: 155.11km
Jacques Soukup & Don Cameron G-CICI Cameron Balloons R-15

2nd Sept. 1986 H Brink, W Hageman, E Brink - Atlantic crossing St Johns Newfoundland - Amsterdam 4183km 51h14m Cameron Balloons Roziere-225

4th Nov. 1986 Richard Barr & Oliver Holmes Crossing Irish Sea. (Glendaloch, Co Wicklow - Aberporth, Wales) G-BMVI Cameron Balloons O-105

6th Oct. 1987 Distance: 163.98km Lindsay Muir G-BNFG Cameron Balloons O-77

11th Jan. 1988 Distance: 375.1km / Duration: 7h 15m Karen Coombes & Maria Roche G-BNFN Cameron Balloons N-105

18th Aug. 1988 Henk Brink
First balloon flight with 50 people aboard.
(Leylstad Airport - Holland) "Nashua 1" Cameron Balloons A-850

22nd Oct. 1988 Duration: 6h 36m Lindsay Muir G-BNFG Cameron Balloons O-77

3rd Oct. 1990 Don Cameron & Gennadi Oparin
First flight from UK to Soviet Union (Cardington - Ledurga)
46h Doctus G-BRGU Cameron Balloons R-60Duration: 45h 13m
Distance: 1705.2km / Altitude: 5029.2m

12th Oct. 1990 Distance: 94.86km Don Cameron Airship G-BRDU Cameron Balloons DG-14

14th Feb. 1992 Thomas Feliu & Jesus Gonzales Green G-BRGU Cameron Balloons R-60
First Atlantic Crossing East to West
5093km 130h 30m (Canary Islands – Venezuela)

16th Sept. 1992 **First Transatlantic Balloon Race** from Bangor, Maine, USA - Chrysler
W Verstraeten & B Piccard - G-BUFA Cameron Balloons Roziere-77 to North Spain

E Krafft & J Maas - G-BUFB Cameron Balloons Roziere-77 to mid-Atlantic

Don Cameron & Rob Bayly - G-BUFC Cameron Balloons R-77 to Figuera da Foz, Portugal

E Louwman & G Hoogslage - G-BUFD Cameron Balloons Roziere-77 to Celtic Sea

R Abruzzo & T Bradley - G-BUFE Cameron Balloons Roziere-77 to Morocco

21st Sept. 1992 Duration: 124h 34m 15s Distance: 4823.725km

Don Cameron & Rob Bayly G-BUFC Cameron Balloons R-77

17th Oct. 1992 Distance: 70.789 km / Duration: 3h 09m Mark Shemilt G-BEUY Cameron Balloons N-31

6th Mar. 1993 Duration: 7h 02m 38s Julia Dean G-ULIA Cameron Balloons V-77

9th Aug. 1993 Duration: 7h 17m 32s Christine Luffingham G-BPLF Cameron Balloons V-77

7th Jan. 1994 Duration: 8h 03m Mark Shemilt G-BAMD Cameron Balloons N-42

20th Mar. 1994 Duration: 7h 7m 46s / Distance: 120.5km
Jacqueline Hibberd G-BUPP Cameron Balloons V42

22nd Feb. 1995	Steve Fossett **First solo Pacific flight** (Seuol, Korea - Mendham, Canada) 8748km G-BVUO Cameron Balloons Roziere-150
20th Jan. 1997	Steve Fossett Round-the-world attempt (St Louis USA to India) 146h 44m 16673.81km Cameron Balloons Roziere-210
7th Feb. 1998	Bertrand Piccard, Andy Elson, Wim Verstraeten HB-QBV Cameron Balloons Roziere-500 Round the world (RTW) attempt, world duration record 233h 55m (Chateau d'Oex, Switzerland - Sitkwin Minhla, Myanmar)
12th Feb. 1998	Altitude: 6961m Lindsay Muir G-SKIL Cameron Balloons N-77
19th Nov. 1998	Duration: 10h 41m 7s Mark Shemilt G-BUPP Cameron Balloons V-42
7th Mar. 1999	Andy Elson, Colin Prescott G-CWCW Cameron Balloons Roziere-900 World duration record. Longest flight of any aircraft to date - 17d 17h 41m (Almeria, Spain - 33 deg 54 min N, 138 deg 17.12 min E nr Japan)
21st Mar. 1999	Bertrand Piccard, Brian Jones **First round-the-world balloon flight, absolute distance, duration,** AM-15 altitude. Longest flight of any aircraft to date.(Chateau D'Oex, Switzerland - Mut, Egypt)19d 21h 55m 40813km (45633 km track) HB-BRA Cameron Balloons Roziere-R650. Duration: 19d 21h 47m Distance: 40814km Altitude: 11737m Time Round the World: 15d 10h 24m
3rd Jun. 2000	David Hempleman-Adams Flight to within one degree of the North Pole Spitzbergen & return to within 300 km of Sptzbergen) Duration: 132h 22m G-BYZX Cameron Balloons Roziere-90
3rd Jun. 2000	Duration: 132h 22m David Hempleman-Adams G-BYZX Cameron Balloons R-90
4th July 2002	Steve Fossett G-RTWI Cameron Balloons R-550 **First Solo Flight around the world** (Australia to Australia) Time around the world: 324hours 10minutes
26th Sept. 2003	David Hempleman-Adams Cameron Balloons G-BYZX Cameron Balloons Roziere-90 Solo Atlantic crossing in an open basket. Sussex, New Brunswick USA to Blackpool, England. 4423 km in 83hours 17minutes.

For more information about each entry please refer to the BBAC Sporting Handbook on the BBAC website www.bbac.org

British Balloon Museum & Library

And, further historical information and other notable flights can be found here on The British Balloon Museum & Library pages

www.bbml.org.uk

2) The origins of flight and its role in 18th Century Science by D. A. Cameron M.B.E.

The development of the balloon allowing man to fly for the first time was an inevitable consequence of the scientific enlightenment and the changes in the human understanding of matter, which formed part of the intellectual processes of the eighteenth century. Among these were the final dispatch of Aristotle's theory of four elements (earth, air, fire and water), the fall of the phlogiston theory, and the discovery that different kinds of gases exist.

The first man-carrying Montgolfier balloon took to the air on 21st November 1783. It is difficult in our technology-sated society to appreciate the excitement, which it caused. The sensation was greater by far than that which came in more recent times from man's first landing on the moon, and no film star or pop musician has experienced the adulation which was bestowed on the first aeronauts.

First Paris, and then the whole of Europe, became balloon mad. Balloons became the subject of innumerable prints, and featured in the designs of wallpapers, fabrics and in the shape of ladies' dresses. They appeared on snuff boxes and porcelain and were used as inlaid designs on furniture. There were balloon chandeliers and balloon clocks, and balloons used in satirical cartoons. Even today when most people have had no personal experience of a man-carrying balloon, its popularity as a decorative motif persists.

The origins of great events often become surrounded by mythology and so it has been with the invention of the balloon. Some have said that Madame Montgolfier's chemise took off when placed by the fire to air, others that the brothers observed the wrapping-paper of a conical sugar loaf, which when thrown on the fire, filled with hot air and floated up the chimney without igniting. There are other similar legends which are the equivalent of Newton's apple or Watt's kettle. The truth does not make such a good story superficially, but is really much more interesting once it is understood. As in so many other inventions the origin is found in the interacting stimulus of other minds communicating over both distance and time by means of the written word.

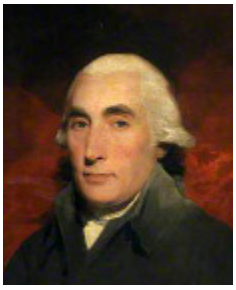
The idea of the balloon was not unique to the Montgolfier brothers although they deserve all honour for being the first to bring it to realisation.

An Italian Jesuit priest, Francesco de Lana-Terzi had reasoned that a ship could be lifted into the air by four evacuated copper globes. The scheme had practical problems, but this was of no concern as the Jesuit explained. Since god had not intended man to fly, any serious attempt to do so would be blasphemous, and for that reason his researches were intended as a theoretical exercise only. One suspects that he may have come under some kind of pressure, and experienced the restraint on investigation which later affected Galileo, and for which other investigators suffered execution by burning in the name of religion.

Fortunately a more liberal attitude prevailed in other parts of Europe. It was a time when chemistry was still influenced by alchemy, and it was still possible for a scholar to know the

whole of known science. Four of these "natural philosophers" laid the foundation from which came the conquest of the air.

They were:



Joseph Black

Henry Cavendish

Joseph Priestley

Antoine Lavoisier

The phlogiston theory had been developed to explain fire. It had long been known that only some materials burn, usually leaving a residue of ash or "calx" which will not burn. The process of fire was regarded as the release of phlogiston from the original material which seemed to be a compound of its calx with phlogiston.

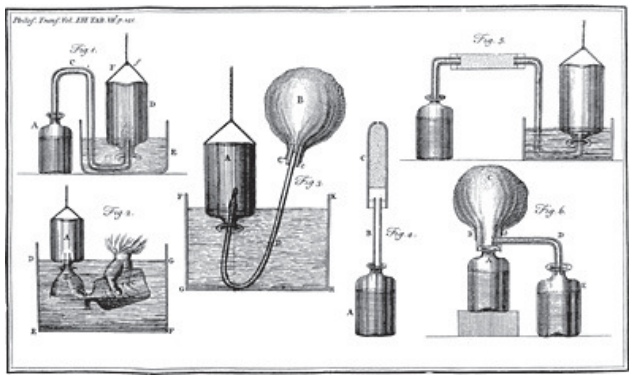
Although Black, Cavendish, Priestley and Lavoisier all began by believing the phlogiston theory, it was Lavoisier who, by quantitative methods, showed that combustion was combination with oxygen, rather than the release of phlogiston.

Joseph Black was a professor of chemistry at Glasgow University and later at Edinburgh. He was the first to show that there were various kinds of gas in addition to ordinary air and led to the invention of the balloon.

In the 1750's Black studied the gas produced by the action of acids on solid magnesia. It turned lime-water milky, it would not support a flame, and an unfortunate mouse confined in it was quickly asphyxiated. He called this new substance "fixed air" and we know it today as carbon dioxide.

Henry Cavendish was an immensely wealthy recluse and spent most of his time to scientific research. In 1766 he published a group of papers entitled "Experiments on Factitious Air". By this he meant any kind of gas which could be extracted from solid or liquid materials.

He showed that acid acting on metals gave off a gas which exploded on contact with a flame. This gas, known today as hydrogen, he named "inflammable air". It was becoming clear that gases were different entities and that air was not an element.



Henry Cavendish - Experiments on Factitious Air

Soon after the publication of Cavendish's work on inflammable air, Black, by this time a professor at Glasgow University, became aware of it. At a supper party for a group of friends he filled the allantois (the thin foetal membrane) of a calf with hydrogen, and allowed it to float up to the ceiling. His guests were impressed and looked hard for the thread which must have lifted it.

Years later, when it was suggested that Black should share the honour as an originator of lighter than air flight he honourably disagreed, writing that his experiment although a "striking example of Mr Cavendish's discovery, was so very obvious that any person might have thought of it; but I certainly never thought of making large artificial bladders, and making these lift heavy weights and carry men up into the air. I have not the least suspicion that this was thought of anywhere before we began to hear of its being attempted in France."

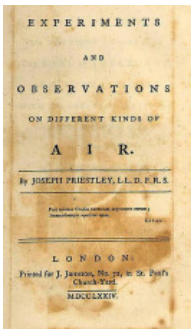
Priestley took the exploration of gases further, publishing in 1772 his "Observations on Different Kinds of Air". He described the preparation of several gases. In the 11 years between this publication and the first balloon flight, Priestley went on to discover eight more new gases. In

1774 he found that a gas obtained by heating the calx of mercury would make a flame burn brighter, and would allow a mouse in a bell jar to survive for twice as long as in ordinary air. Because this new gas helped things to burn, he reasoned that it must be deficient in phlogiston, thus helping to allow the phlogiston to leave the burning substance. He called it "dephlogisticated air". We would know it today as oxygen.

It was also Priestley who first tried dissolving fixed air, or carbon dioxide, into water as a drink, and "soda water" became fashionable as a result.

It was about this time that Lavoisier began to seriously question the phlogiston theory. He showed that the calxes of metals, sulphur and phosphorous were always heavier than the original material. This suggested that they were combining with something in the air, not releasing something into it. In time he showed that the weight taken up in combustion was precisely equal to the weight of oxygen gas which had disappeared, and dealt a final blow to phlogiston in his "Reflexions sur le phlogistique" published in 1783, the year of the first manned flight. He also showed that water was a compound of hydrogen and oxygen, thus ending the status of water as an element.

This then, was the intellectual background against which Joseph and Etienne Montgolfier started to form their ideas. In a conversation with Sir John Sinclair in 1785 Joseph Montgolfier mentioned that as paper manufacturers his brother and himself had maintained an interest in chemical researches and had early considered the idea of lighter than air flight, and that their interest had been reawakened on reading a paper about Dr Black's experiments. It is known that Joseph Montgolfier had obtained Priestley's "Observations on Different Kinds of Air" on the appearance of its French translation in 1776, so we can be sure that they were well-informed about the current trends in science.



It is thought that the Montgolfiers learned to produce hydrogen but had little success at containing it. It will pass through papers or woven fabrics like a sieve. This led them to search for alternatives and their discovery that the rarefied air produced by combustion could serve as a lifting agent.

It seems strange to us today to learn that the Montgolfiers never quite understood that it was the expansion of the air due to heat, rather than the particular qualities of the gas emanating from the fire which gave the lift. In the state of knowledge of the time it was much more plausible to assume that this was yet another new gas which had been discovered. The Montgolfiers chose their fuels carefully to give what seemed to be the best quality of lifting gas, and in one demonstration had chosen such a foul concoction of materials that the royal party were obliged to retire to a greater distance because of the smell!

The first public demonstration took place on 5th June 1783 in the central square of Annonay before the officials, nobles and peasantry of the Vivarais district. The balloon sailed upwards, a plain white sphere with its sections joined by rows of buttons. It landed on the posts of the vines outside the town. (It is one of my own most pleasant memories that I made a flight, in a hot air balloon of my own construction, from the Montgolfier "ancienne papeterie" in Annonay, with the most direct descendant of the family, and Bill Malpas a ballooning friend, as passengers, on an anniversary of this flight. We too had trouble finding a convenient landing spot, and landed in a vineyard. That evening we dined in the house in which the Montgolfier brothers lived at the time of their invention.- D.C.)

Annonay, 1783

The news of the first public demonstration at Annonay spread to informed circles in Paris at the Academy of Sciences, and sparked off a rival project led by Professor Charles. Lavoisier was a member of the commission which planned these balloon experiments.

Naturally it was assumed that the gas involved must be inflammable air (hydrogen). Charles, together with the brothers Robert, succeeded in containing it by using a fine silk cloth coated with a rubber solution. It frequently happens in

engineering that the knowledge that something has been done already by a rival (or in this case the mistaken belief) seems to make the impossible possible.

A public subscription was opened to help to pay for the project. Their first balloon was a very small one, only 12 feet in diameter, but its appearance above the walls of the experimenters' yard on a tether line was already enough to begin the balloon fever which was to seize Paris. A huge crowd assembled in the Place des Victoires. It rapidly got out of control, and had to be prevented from forcing an entry to the compound.

A hurried change of plan was decided. The scene for the event was changed to the more spacious Champ de Mars where the Eiffel Tower now stands. The balloon was moved there secretly, tied to a small cart, at dead of night with an escort of soldiers bearing flaming torches. Miraculously the hydrogen did not ignite. On the next day, the 27th August, the crowds packed every available space on the ground, the roof tops surrounding buildings and every other vantage point which could be found. At 5 p.m., to the echoes of a single cannon shot, the gravity-defying globe lifted into the air. The crowd gave an excited roar, and watched in wonderment as it rose to 1000 metres and disappeared into cloud. A few moments later it emerged again into clear air, and remained visible until it was lost to sight over the Paris skyline.

The little balloon fell to earth at Gonesse where the terrified villagers, regarding it as an evil supernatural manifestation, destroyed it with farm implements.

The news of these goings-on spread to England also, and George III wrote to Sir Joseph Banks, President of the Royal Society, offering finance for "air globe experiments". The Society declined, writing that "no good whatever could result from them as the properties by which such a globe acts, are as well known as if twenty experiments were made." Years later the British Defence authorities would declare that no useful military purpose could be foreseen for the aeroplane. The lesson is often repeated that innovation requires freedom and competition and that it is killed by monopoly and centralised authority. In this case the competition came from France.

The Montgolfier brothers had arrived in Paris by the time of the ascent of Charles' "Globe", and together with a fellow paper maker, Reveillon, constructed a balloon for a larger demonstration.

Montgolfiere Brothers, 19th September 1783

It flew at Versailles before the Royal party, members of the Academy, and an enormous crowd on 19th September 1783. It carried aloft a sheep, a cock and a duck which were restored to earth without significant mishap. The stage was set for the first manned ascent.

Both teams had their man-carrying balloons in construction at the same time, and the rivalry must have been intense, but it was the Montgolfier balloon which won the race. After a few days of tether flying, the balloon was prepared at the Chateau de la Muette before the King and Queen. The pilots were Pilatre de Rozier, a daring young member of the Academy, and the Marquis d'Arlandes, a nobleman who had been instrumental in obtaining the necessary royal permissions.

The Marquis wrote a truly charming account of his experience in which he describes himself as cowardly and idle, and gives all the credit to de Rozier. At one point de Rozier chides him for being idle at stoking the fire with straw bundles, saying "If you look at the river in that fashion, you will be likely to bathe in it soon! Some fire, my dear friend, some fire!" This need to pay attention to the timing of the burner is entirely recognisable to the modern hot-air balloonist, although the means to do it today are rather more convenient. The first manned flight landed in open space near to the present Place d'Italie, and about a mile and a half from the starting point.

The Charles team had been far from idle during these preparations. Their hydrogen balloon had been most competently prepared, and in one

prototype had solved many of the technical problems in balloon design, and established a form which was to remain little changed over the next two hundred years. The red and yellow sphere was exhibited, filled with air, in the Tuileries Palace only a few days after the Montgolfier ascent, and on 1st December Charles and the elder Robert ascended together from the Tuileries garden.

The public excitement was greater than anything previously known. It has been estimated that 400,000 people, about half the population of the city at the time, assembled to see the event. The ascent of the balloon was described at the time as deeply moving, causing in the vast crowd, first a stunned silence, and then a roar of voices in salute as the balloon sailed away. Asked why she wept one old woman said "Alas! When they shall have discovered the means of escaping death, I shall not be able to take advantage of them."

Six years after the first manned flight in 1789 the French Revolution was beginning just as the revolution in chemical science was nearing its end. Lavoisier's "Traite elementaire de chimie" presented chemistry in essentially its modern form, and the old ideas of the existence of only four elements, and of phlogiston were consigned to history. This development had been an essential precursor of the conquest of the air, and made possible the invention of the balloon. The Montgolfiers deserve in full the honour which they have received, but we can understand how the growth of knowledge would probably have made their invention inevitable before the end of the eighteenth century.

Over two hundred years later, we have seen great advances in the human being as a flying animal. Yet the balloon remains little changed from its eighteenth century form, a vehicle of pleasure and spectacle, confined to follow the direction of the wind. In some ways its very impracticality is its charm, and we can understand the words of Charles describing his flight of 1st December 1783 when he said:

"Nothing will ever equal that moment of joyous excitement which filled my whole being when I felt myself flying away from the earth".

We can experience the same pleasure, and also feel pride that our ancient means of flight is a symbol of the scientific enlightenment and the triumph of reason over superstition.

CHRONOLOGY

1750's Black discovers fixed air
1766 Cavendish publishes "Experiments on Factitious Air"
1766+ Black demonstrates allantois rising to ceiling
1772 Priestley publishes "Experiments on Different kinds of Air"
1776 Montgolfier reads French translation of Priestley
1783 Lavoisier publishes "Reflexions sur le Phlogistique"
1783 June 4: Public demonstration at Annonay
1783 Aug 27: Prof Charles unmanned hydrogen balloon - Champ de Mars
1783 Sept 19: Versailles ascent with animals
1783 Nov 12: Lavoisier shows composition of water
1783 Nov 21: First manned ascent - Pilatre de Rozier & the Marquis d'Arlandes - Chateau de la Muette
1783 Dec 1: Manned Charliere flight
1789 Lavoisier: Traite elementaire de chimie

REFERENCES:

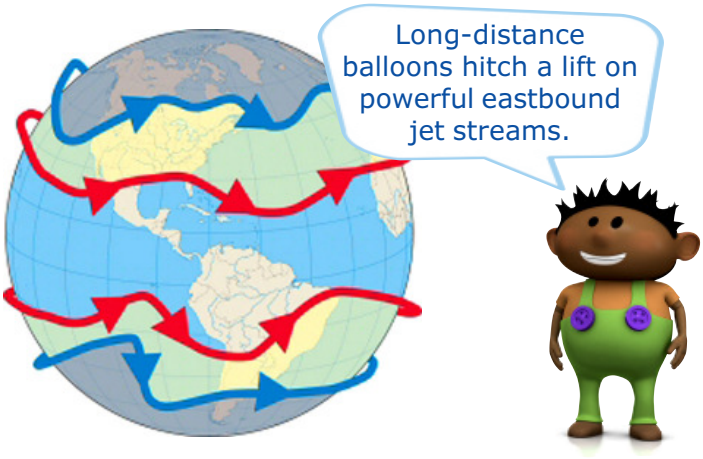
C. Dollfuss: "L'Histoire Aeronautique"
L. T. C. Rolt: "The Aeronauts", Longmans 1966
A. F. Scott: "Invention of the Balloon &the Birth of Chemistry", Scientific American, Vol 250, No. 1, Jan 84.

3) Ordnance Survey Map teaching resource links and information.

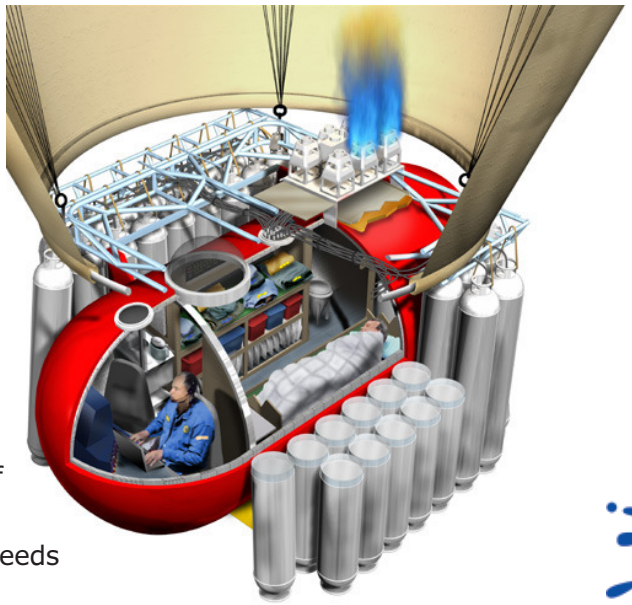
http://www.ordnancesurvey.co.uk/education-research/index.html

Ordnance Survey

4) Ballooning: The ins & outs, the ups & downs



The first passenger-carrying balloon, built by the brothers Montgolfier, landed in a heap in Paris in 1783. Two centuries later, Man has flown to the Moon and back, so why does circumnavigation of the Earth by hot-air balloon remain so elusive?



The main problem for long-haul balloonists is the weather. There is a small window around December and January when the jet streams around the Northern Hemisphere are at their most powerful, reaching speeds of up to 400kph (about 250mph).

Since all the pilot can do is control the balloon's altitude, he needs to hitch a ride with the winds if he is to make it round the world.

To take full advantage of the jet streams, a balloon needs to go up as high as 12km (seven miles).

The high-tech option is to go up in a sealed and pressurised cabin, which allows the crew to breathe and keep warm at extreme altitudes.

The main drawback, aside from the expense and the weight of the capsule, is that this technology is highly experimental and much can go wrong.

The American Steve Fossett managed to get half way round the world last year in the Solo Spirit, which carried an unpressurised capsule. But he had to endure temperatures of minus 20 Celsius.

Going up and staying up

Classic hot-air balloons rise because warm air is lighter than cold air. A propane gas burner is used to heat the air inside the nylon or polyester balloon. The hotter it gets the higher it goes.

The five global challengers all use a Roziere design, named after its original inventor, the 18th century French physicist and aerostatics pioneer, Francois Pilâtre de Rozier.

It was revived and improved 20 years ago by Don Cameron, a leading British expert in hot-air ballooning.

His Bristol-based company Cameron Balloons Ltd. has designed all the balloons in the race - except that of the British team, Virgin Global Challenger.

The Roziere has a double skin, or envelope, which is filled with both hot air and contains a helium balloon.

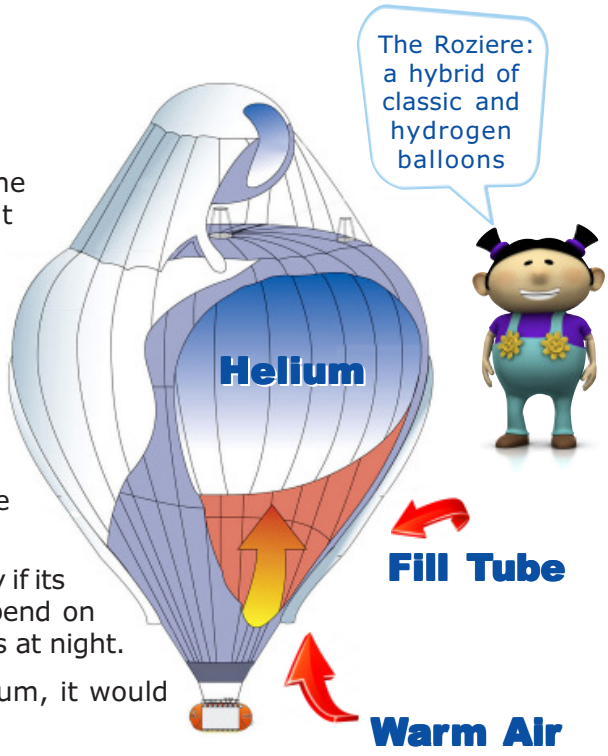
The advantage of this type of balloon is that, as the sun goes down and the balloon's air gets cooler, it does not have to jettison ballast to slow its descent, while hot-air burners can be switched on to stabilise the craft's altitude.

Only a tiny quantity of propane or kerosene is required to heat the helium.

At the start of the voyage, the sphere is only half-filled with helium. During the ascent, decreased pressure and rising gas temperature caused by the heat of the sun expand the helium to full "cruising" volume.

The system is designed to vent helium gas automatically if its pressure becomes excessive. So Roziere balloons depend on the heat of the sun by day and the heat of propane gas at night.

Even if the balloon experienced a major loss of helium, it would remain aloft, turning into a classic hot-air balloon.



Technical Data

Solo Spirit - built by Cameron Balloons Ltd

Capsule:	Composite gondola - unpressurised. Steve Fossett had to breathe oxygen through a mask for most of the flight.
Creature comforts:	Single bunk with sleeping bag, bucket for a toilet.
Balloon:	Roziere containing 270,000 cubic feet (7645.563 cubic metres) of helium and an 80,000 cubic foot (2265.352 cubic metre) hot-air cone
Power:	Propane burners

J Renee - built by Cameron Balloons Ltd

Capsule:	Cuboid gondola with six-inch thick walls - unpressurised.
Balloon:	Roziere with 200,000 cu ft (5663.38 cu m) helium cell and 100,000 cu ft (2831.69 cu m) hot-air cone
Creature comforts:	Special heater, custom-designed to maintain temperature within the gondola at a minimum of 45 F when the outside temperature is -50 F
Power:	Propane burners

Breitling Orbiter II - built by Cameron Balloons Ltd

Capsule:	Cylindrical capsule
Balloon:	Roziere balloon, envelope volume 529,000 cu ft (14979.6401cu m)
Power:	Kerosene burners and solar panels to supply batteries that power an on-board computer which controls the life-support system

* All the balloons use satellite equipment to communicate with their control centres and transmit vital information about the craft's position and altitude. Communications instruments are powered by batteries.

*Note: Other balloons have been built, flown and even broken-records since this BBC article was published.

Teacher's Resources -
Hot-Air Ballooning

About the author

Hannah Cameron has been working for Cameron Balloons since 1993 and is one of the Directors, a hot-air balloon pilot, a hot-air balloon instructor and a theory examination hot-air balloon licence ground examiner, she works full time, is married, has two children and 6 hens!

'I normally have to write a lot of in-depth or serious information for work and so this has been heaps of fun to do – I hope you enjoy it, as well as learn lots of useful things, about our lighter-than-air sport.'

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