Other Technologies: A Survey

When we deal with humanity's early stages, the word 'technology' applies to any man-made modification of the natural environment — from a stone tool to a woven piece of clothing or a construction. The modules **Chemistry in India**, **Metallurgy in India** (both in class XI) and **Agriculture** (class XII) cover several important technologies of ancient India. Here, we explore a few more.

Harappan Technologies

One mainstay of the Indus or Harappan civilization (2600–1900 BCE for its urban or "Mature" phase) was agriculture. Along with it, ceramic technology developed and produced fine fired bricks as well as pots, which are required to carry water, store seeds and grain, and of course to cook food. Harappans produced wheel-turned pots in various shapes and sizes, some of them glazed or painted. Their pottery was generally covered with a red slip (produced from red ochre, that is, iron oxide), while floral, animal or geometric designs were painted in black. The black pigment was the result of mixing iron oxide with black manganese.

A few examples of classical Harappan pottery (courtesy: Archaeological Survey of India).

Harappan fired bricks had proportions of 1 x 2 x 4 (width equals two heights; length equals two widths) and, besides, were of such quality that those who first encountered them at Harappa and Mohenjo-daro thought they could not be more than two or three centuries old! There was a practical reason for the above proportions, as they permitted alternating courses and therefore stronger walls with the least quantity of bricks — the so-called "English bond" of masonry. Baked or mud bricks were not the only building material: at Dholavira, in the Rann of Kachchh, stone was also used on a huge scale. Harappan cities generally followed a grid plan and boasted a sanitation system that collected used waters from individual bathrooms into municipal drains; those were regularly inspected and cleaned, which testifies to a high level of civic order.

Massive stone work at Dholavira, northern gate of the 'Castle' (courtesy: Archaeological Survey of India).

While soft-stone beads are reported from many Neolithic sites (from about 7000 BCE), Harappan craftsmen took bead-making to a different level and perfected techniques of polishing, colouring, glazing, drilling and bleaching. Their favourite semiprecious stones were carnelian, agate and jasper, but they occasionally made beads out of bone, terracotta or synthetic faience. The long perforated carnelian beads, in particular, were highly prized in royal families of Mesopotamia (see the large necklace *below*); their length-wise drilling with special drill bits represented a technological feat. So did the still mysterious manufacture of micro-beads of steatite (or soapstone), measuring just one millimetre in length and diameter (see just above the large necklace *below*).

A sampling of Harappan jewellery, including gold and semiprecious beads, micro-beads, gold bangles and fillets, and long carnelian beads (source: J.M. Kenoyer).

India's love for bangles is traceable to the Harappans' manufacture of large numbers of gold, bronze, conch-shell, glazed faience or humble terracotta bangles. Weavers used wheel-spun thread and, besides widely used cotton, evidence of silk has recently come to light at two sites. Other crafts included stone and ivory carving, carpet making and inlaid woodwork.

Later pottery

After the Harappan age, major innovations in pottery shifted to the Ganges valley. The Painted Grey Ware (PGW, see an example *right*), from about 1200 BCE, is associated with iron-based cultures. A few centuries later, from around 700 BCE onward, the Northern Black-Polished Ware (NBPW), first found in today's Uttar Pradesh and Bihar, is found in the first cities of the Ganges valley. Both pottery types were produced on fast-spinning wheels using fine clay and fired to a high temperature in kilns under controlled conditions.

Other regions of India eventually produced many other types and styles of pottery, and pottery sherds remain a major source of information for archaeologists, who have meticulously documented all those types and tried to work out their chronologies and regional spreads.

Glass

The first appearance of glass objects in India, according to current knowledge, is from the upper Ganga-Yamuna region and datable to the last centuries of the 2nd millennium BCE, coinciding with the above-mentioned PGW phase. At sites such as Bhagwanpura (Haryana), Kopia (U.P.), glass beads and bangles were found. In the following centuries, glass technology spread all over India. At Taxila (ancient Takṣaśila, now in northern Pakistan), the Bhir mound yielded numerous glass beads of several shapes and colours dated to the 5th century BCE or so. Glass objects and ornaments have also come to light at places like Ujjain, Nasik, Ahichchhatra, Sravasti, Kolhapur, Kaundinya, Brahmagiri, and at several sites of Tamil Nadu (such as Arikamedu). The early Indian glass-makers were skilled at controlling the temperature of fusion, moulding, annealing, blotching and exquisite gold-foiling.

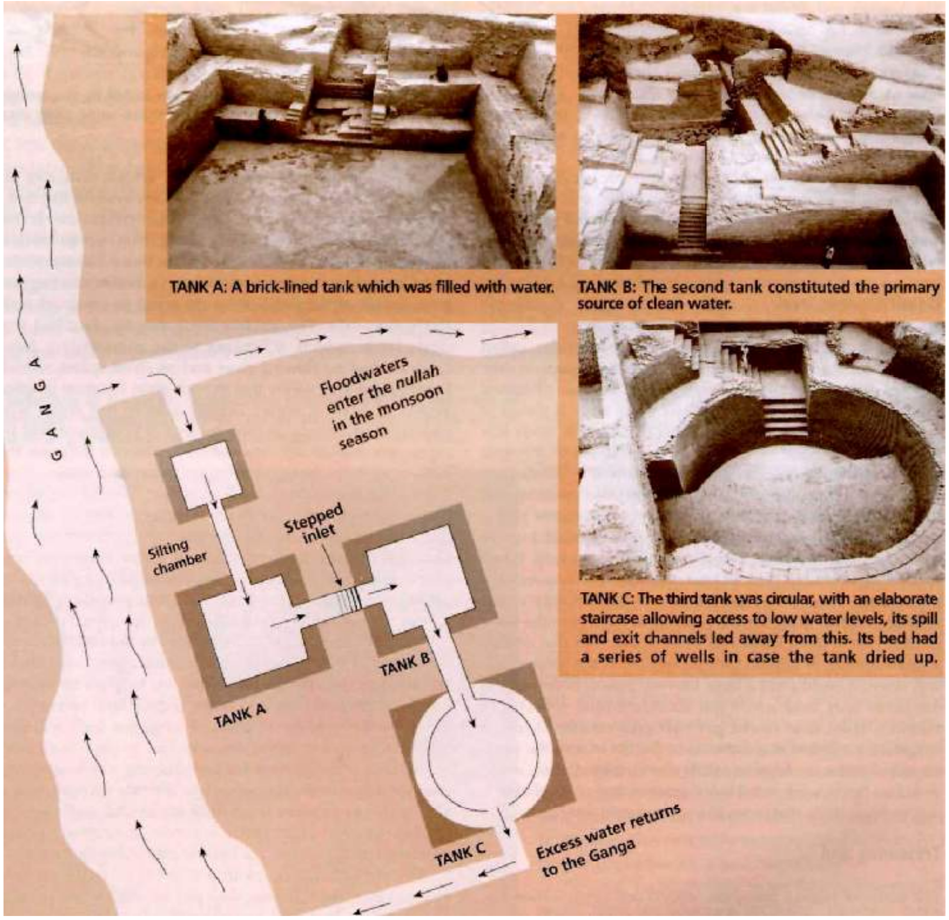
Water Management

Water conservation and management is an area of great importance, and the great variety and sophistication of water structures in ancient India testify to the care with which people harvested and conserved water and managed its distribution.

Dholavira: the eastern reservoir, with the "Castle" in the background (courtesy: Michel Danino; next two photos: courtesy ASI).

Harappans invented trapezoid bricks to construct wells that would not collapse inward under the pressure of underground infiltrations. Dholavira, being located in an arid region, had to ensure enough water storage for its thousands of inhabitants to survive through the year. This was achieved by constructing a series of small dams across two nearby seasonal channels to divert their waters to the city's huge reservoirs; those were also fed

by large-scale water harvesting channelling rainwater through underground drains (*above*). The largest reservoir (*above*), to the east of the "Castle", measured 73 x 29 m and contained at least 20,000 m^3 of water when full. In addition, a step well (*right*) dug at the bottom provided for extended storage by recharging the water table during the monsoon.



Series of interconnected reservoirs at Sringaverapura (source: *Dying Wisdom*, Down to Earth, and Prof. B.B. Lal)

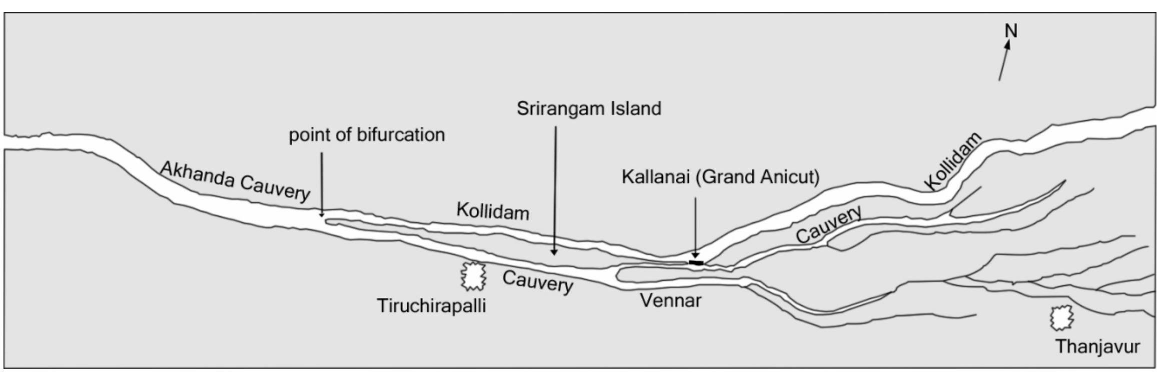
In later periods, we find such networks of reservoirs spreading to other parts of India. In the Ganges valley, excavations at Sringaverapura (ancient Śṛṅgaverapura, see *above*) brought to light a simple but effective series of interconnected reservoirs, some of them with a well dug at the bottom. The reservoirs were fed by a channel from the Ganges, and the level of the last reservoir's overflow was so adjusted that any excess water would be returned to the Ganges.

Wells have been made in many shapes — circular, square, vertical or horizontal — and sizes, and with bricks, stone or terracotta rings. There is a long way from Dholavira's modest step well to those of classical times, especially in Gujarat and Rajasthan, which are not only engineering marvels but works of art. (*Right:* a step well at Chand Baori in Rajasthan, built in the 9th century; it has 3500 narrow steps in 13 levels.)

The Rani Ki Vav step well of Patan, Gujarat (courtesy: Michel Danino)

India also experimented with various kinds of dams, the simplest being the earthen embankment meant to contain a reservoir or divert a stream. In Tamil Nadu, some 1,800 years ago King Karikāla Cōḻa built a much more ambitious dam, the

Kallaṇai or Grand Anicut on the Kāveri (Cauvery) river, downstream of the Srirangam island. Still visible today (in restored form), at 320 m long and 20 m wide, it is an ingenious device which stops the Kāveri from emptying itself into its own northern distributary, the faster and steeper Kollidam (or Coleroon), preserving much of the river's water for irrigation in the Kāveri's lower delta.



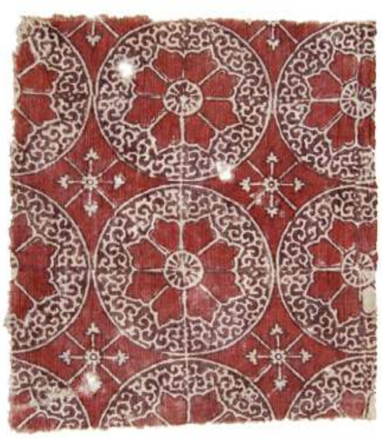
The *Kallaṇai* or Grand Anicut in its restored form *(above)*; a map highlighting its role in keeping the Kāveri and the Kollidam separate (*above* courtesy: Michel Danino; *below* courtesy: Chitra Krishnan & Srinivas Veeravalli).

The humblest but perhaps most important water structure was the village pond or reservoir. What made it important was not so much its ability to recharge ground water, but also its being connected to many neighbouring ponds — sometimes in networks extending over hundreds of kilometres, as in Karnataka and Tamil Nadu. Such networks, which enabled water-rich areas to contribute to less favoured ones, were maintained by village committees, which disappeared when the colonial administration took over — and so did most of the reservoirs in their care.

Textile Technology

The Vedas refer to various types of garments as well as fabrics such as wool (*avi, śāmulya*) or silk (*tārpya*), also to weaving and looms. Later on, cotton appears (*karpāsa*) and we get some information on weaving skills from Buddhist literature: for instance, when Āmrapāli, a courtesan from the kingdom of Vaiśalī, goes to meet Gautama Buddha, she is said to have worn a richly woven semi-transparent sari. The Ajanta paintings (see **Painting** module), among others, are also a rich source of information on clothes worn some 2,000 years ago and on the techniques of weaving, including different dyes, which have been related to vegetal as well as mineral pigments.

By the time trade with the Roman Empire reached its peak (see **Trade** module), India was a major exporter of textiles, specially cotton and silk. Such evidence has come, for instance, from recent excavations at Berenike, an Egyptian port on the Red Sea where goods from India were unloaded to be carried overland to the Mediterranean port of Alexandria for further sea transport. A little later (from the 5th century CE), hoards of fragments of cotton material from Gujarat were found in Egyptian tombs at Fustat (*left*). India exported



cotton to China, silk to Indonesia and all the way to the Far East. Indeed, until the colonial era, textile production was one of the chief sources of India's wealth.

Some of India's specialties in the field have been the following:

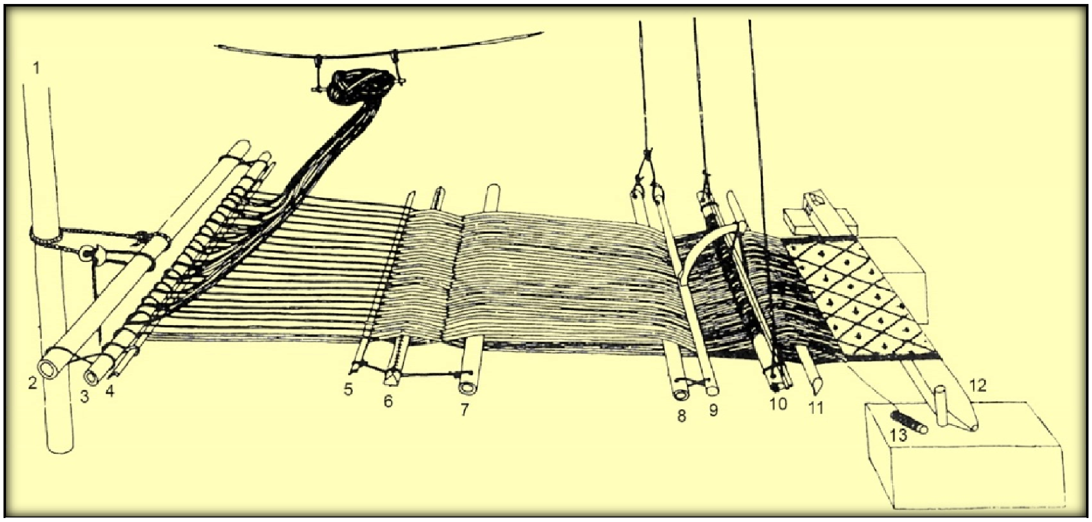
- **Muslin**: this thin, loosely woven cotton fabric is highly suitable for hot climates. It was introduced into Europe from Bengal in the 17th century, and one way to test its fineness was to pass a piece of it through a finger ring.
- **Calico** is a plain-woven textile made from unbleached cotton; it was originally from Kozhikode or Calicut (in Kerala), hence its name.
- **Chintz** (*right*) is a form of calico printed with floral and other colour patterns. From the 17th century, when it was first brought to Europe by Portuguese and Dutch traders, chintz became so popular — the so-called "Calico craze" — that some European mills suffered; as a result it was banned in France (1686) and England (1720).

- India also produced large quantities of coarser but very useful fabrics from fibres such as **hemp** (*bhāṅga* in early texts, extracted from the bark of cannabis), **flax** or **linen** (*kṣauma,* a plant widely cultivated for its linseed oil), and **jute** (cultivated especially in Bengal).

- Fabrics — especially cotton and silk — often provided supports for much painted, printed or embroidered artwork (see an example *right*, from Gujarat), whether the resulting piece was to be worn as a sari or brocade or hung as tapestry.

(Source for above three photos: Wikipedia)

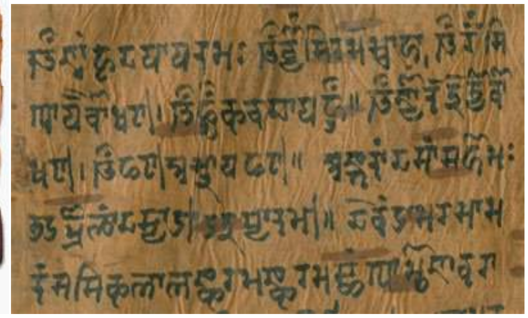
Two important daughter technologies of textile deserve a brief mention: weaving technology, which saw the development of complex looms, with different regional characteristics, and dyeing technology, with dyes extracted from both vegetal and mineral sources: blue usually from indigo, red from various plants such as madder, yellow from turmeric, pomegranate rind or mango bark, black from iron acetate. With such a variety of textiles, it may appear surprising that relatively few types of dresses were woven, but that is because Indians learned the art of wearing simple dresses in myriad ways. The sari, a case in point, is archaeologically attested a few centuries BCE, such as in this stone relief (*right*) from Vaiśalī.



A sketch of a *pāṭolā* loom used in many parts of India. Its parts are: (1) pole for fastening the loom; (2) warp beam; (3) ditto; (4) stick; (5), (6), (7) cross-mechanism with indented stick; (8) shed rod; (9) pressure bar with handle; (10) heddle rod mechanism and heddles; (11) sword; (12) breast beam; (13) shuttle. (Adapted from Lotika Varadarajan and Krishna Amin Patel.)

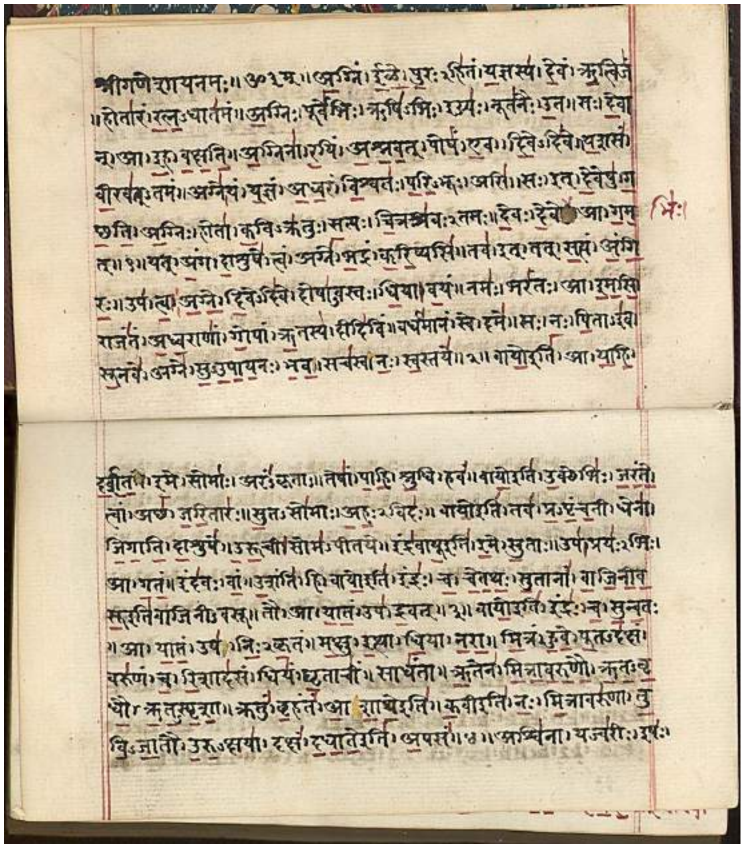
Writing Technology

India even now possesses a wealth of manuscripts running into many millions. Traditionally, they were written on materials such as birch bark (*bhūrja pattra*) and palm leaves. Birch bark was mainly used for north Indian scripts, and the writing was done with ink made of finely ground charcoal powder in a medium of gum, or soot from oil lamps. With palm leaves, there was no ink; rather, a sharp point was used to tear the leaf's surface film; it would then be smeared with a paste of charcoal powder mixed in oil, and wiped off, leaving the charcoal to adhere to the incised characters. In both cases, considerable skills were developed to preserve manuscripts from insects and fungi. Even then, manuscripts could rarely be preserved for more than a few centuries; as a result, scholars regarded it as a duty to copy old manuscripts afresh every few generations.

(Left) A palm-leaf manuscript with its wooden protective cover (source: D. Udaya Kumar et al.); *(Right)* A manuscript from Kashmir, in Sharada script, painted on birch bark (source: Wikipedia).

The art of paper-making was introduced into India by the eleventh century CE, perhaps from China through Nepal. The earliest extant Indian paper manuscript (in the Ashutosh Museum, Kolkata) is datable to 1105 CE; it was made from the fibres of a mountain plant. By the latter half of the 15th century, Kashmir was producing paper of attractive quality from the pulps of rags and hemp, with lime and soda added to whiten the pulp. Sialkot, Zafarabad, Patna, Murshidabad, Ahmedabad, Aurangabad and Mysore were among the well-known centres of paper production. A British traveller to Surat in 1689, J. Ovington, described long scrolls of paper, 3 m in length and 30 cm in width, which were “smooth, slick and shining”. Several other European visitors from the 15th to the 18th century testify that Indian paper was of high quality and exported to countries like Persia. However, in the 19th century, production of hand-made paper declined with the emergence of paper mills.

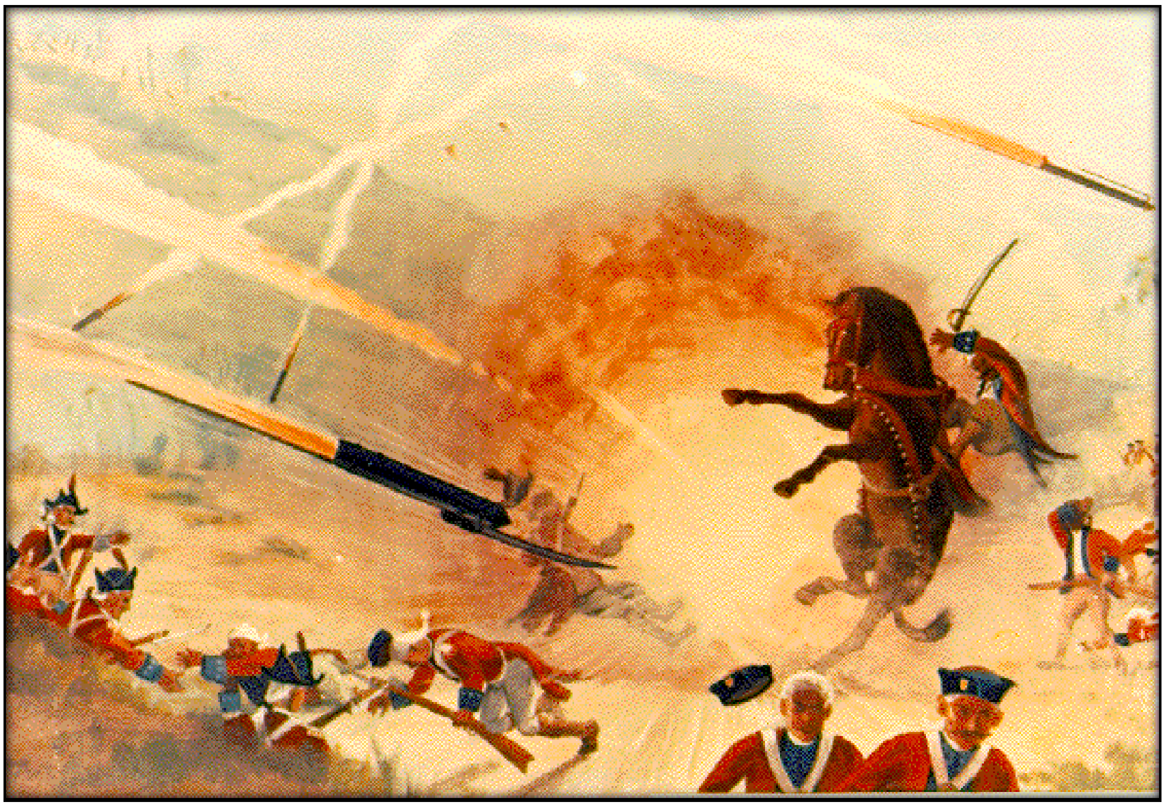


A manuscript of the Rig-Veda inked on Indian paper, early 19th century
(courtesy: Wikipedia)

Pyrotechnics

Pyrotechnic practices, or fireworks, appear to have been current in India in the 13th or 14th century. Gunpowder became an article of warfare at the beginning of the 16th century: the Indian craftsmen were quick to learn the technique from the Mughals and to evolve suitable explosive compositions. A 16th- or 17th-century Sanskrit treatise contains a description of how the gunpowder can be prepared using saltpetre, sulphur and charcoal in different ratios for use in different types of guns.

From the 16th century onward, rockets too began being used in wars waged in India, as testified by military annals of the period. For instance, the Mahrattas are reported to have fired rockets at the 1761 Battle of Panipat which they lost to the Afghans. Hyder Ali, the 18th-century ruler of Mysore, and his son and successor, Tipu Sultan, used rockets to great effect in the Anglo-Mysore Wars against the British East India Company, with a "rocket corps" of thousands of men. The rockets consisted of a tube of soft hammered iron about 20 cm long and 4 to 8 cm in diameter, closed at one end and strapped to a shaft of bamboo about 1 m long, with a sword often fitted at the other end. The iron tube contained well-packed black powder propellant. Though not very accurate, when fired en masse they could cause damage as well as panic among the troops. The British lost no time in taking a few rockets to England for closer study, which ended up boosting rocket technology in European warfare.



A painting by Charles Hubbell depicting Indian rockets raining down on East Indian Company soldiers in the 1780 Battle of Guntur (source: http://history.msfc.nasa.gov/rocketry/11.html).

Cosmetics and Perfumes

Cosmetics and perfumes were an article of trade with the Romans (along with textiles, spices and timber) and are described at some length in Varāhamihira's *Bṛhat Saṁhitā*: scented water for bathing, scented hair oil, perfume for cloths, for the mouth, scented tooth sticks are among the described items. Varāhamihira also created a mathematical table (based on the same principle as Pascal's triangle) to combine fundamental scents in various ways, resulting in 1,820 combinations!

Ghana	*Vālaka*	*Śaibya*	*Karpûra*
Uśira	*Nāgapuṣpa*	*Vyāghranakha*	*spṛkkā*
Aguru	*Madanaka*	*Nakha*	*Tagara*
Dhānya	*Karcûra*	*Coraka*	*Candana*

16			
15	120		
14	105	560	
13	91	455	1820
12	78	364	1365
11	66	286	1001
10	55	220	715
9	45	156	495
8	36	120	330
7	28	84	210
6	21	56	126
5	15	35	70
4	10	20	35
3	6	10	15
2	3	4	5
1	1	1	1

Varāhamihira's list of 16 fundamental perfumes, to be systematically combined in various proportions (from *Bṛhat Samhitā*).

Perfume making became increasingly popular and often catered to the needs of religious ceremonies and royal baths, the latter particularly during the Mughal period. The *Āin-i-Akbarī* speaks of the "Regulations of the Perfume Office of Akbar"; the *āttar* of roses was a popular perfume, the discovery of which is attributed to the mother of Nurjehan.

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The above is just a small sampling of technologies perfected in India. They are part of India's traditional knowledge systems. Some of them may no longer be applicable today, but even those remain important to understand the evolution of ideas and techniques. On the other hand, several traditional technologies remain relevant even today, for instance metallurgical techniques, ecological and agricultural traditions, water management, Ayurveda and various local health traditions. Besides, there remains considerable scope for documenting, testing, assessing and sometimes streamlining India's enormous wealth of traditional knowledge systems.

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Further Reading

1. Anil Agarwal & Sunita Narain, (eds), *Dying Wisdom: Rise, Fall and Potential of India's Traditional Water-Harvesting Systems*, Centre for Science and Environment, New Delhi, 1997
2. D.P. Agrawal, *Harappan Technology and its Legacy,* Rupa & Infinity Foundation, New Delhi, 2009
3. A.K. Bag, (ed.), *History of Technology in India,* Vol. 1: *From Antiquity to c. 1200 AD*, Indian National Science Academy, New Delhi, 1997
4. Arun Kumar Biswas, *Minerals and Metals in Ancient India,* D.K. Printworld, New Delhi, 1996
5. Kalyan Kumar Chakravarty, Gyani Lal Badam, & Vijay Paranpye, (eds), *Traditional Water Management Systems of India*, Indira Gandhi Rashtriya Manav Sangrahalaya, Bhopal, and Aryan Books International, New Delhi, 2006
6. Dharampal, *Indian Science and Technology in the Eighteenth Century,* Academy of Gandhian Studies, Hyderabad, 1971, republ. Other India Bookstore, Goa, 2000
7. K.V. Mital, (ed.), *History of Technology in India,* vol. 3: *From 1801 to 1947 AD*, Indian National Science Academy, New Delhi, 2001

Internet Resources (all URLs accessed in May 2013)

- "What the Ancients Did for Us: India", BBC TV series
  www.youtube.com/watch?v=mSiuO-OzaKc
- "What The Ancients Knew: India", Discovery Channel Documentary
  https://www.youtube.com/watch?v=0NX15cz5124
- Centre for Indian Knowledge Systems: www.ciks.org
- Indian Journal of Traditional Knowledge:
  www.niscair.res.in/sciencecommunication/ResearchJournals/rejour/ijtk/ijtk0.asp
- Traditional Knowledge Digital Library:
  www.tkdl.res.in/tkdl/langdefault/common/Home.asp?GL=Eng

Comprehension

1. Mentioning a few technologies of ancient India, define the term 'technology' in your words.
2. Where do we find the earliest evidence of glass in India?
3. Write a note on each of the following findings from the Harappan civilization:
   - ceramics
   - pottery
   - beads
   - jewellery
4. Write a few sentences on water management in Harappan cities.
5. Prepare a brief note on the design and use of water reservoirs and dams in ancient India.
6. Naming a few fabrics, describe India's textile technology.
7. What do you understand by pyrotechnics?

Activities

- List a few technologies of the Harappan period that you find are still in practice in various parts of India.
- Collect images of Harappan pottery and put up a display. Pay attention to the details of their sizes, shapes, colours and designs. Now work in groups, focusing on the following points:
    - Why are these pots in the shapes they are?
    - In what ways could those pots have been used in that period?
    - If you were to change their designs, shapes, sizes or uses, what would it be and why?
    - Sketch out similar or alternative designs.

Projects

- Prepare a presentation on manuscripts and development of writing technology in India.
- Document the textile heritage of India. Elucidate your project with images of traditional weaves and prints of various parts of India. Collect information on the fading and dying textile traditions and also the scope of Indian textile treasure in the international market.

Extended Activities

- Dipping water levels are matter of concern for all. Visualize the effects on future generations. Interact with senior citizens to ascertain the number of extinct wells and other water bodies in the surrounding area. You may also visit some ponds and *baories* to understand the rainwater storage system in your area. Document your information and prepare an action plan showing how the community can be involved and authorities be approached to restore the dilapidated water bodies of your area. Share your information with the school.

- In a group, visit a traditional crafts person in your area, for instance a traditional metal worker, handloom weaver or bead maker. Document his or her techniques, raw materials, finished goods as well as living conditions. In your report, include some thoughts on the future prospects of this particular craft.

Other Technologies:
A Selection from Primary Texts

Gemmology

Kauṭilya's *Arthaśāstra* attached great importance to the qualities and properties of various gems and minerals as a source of wealth for the state. Here are some examples of listed semiprecious stones:

> The Superintendent of the treasury shall, in the presence of qualified persons, admit into the treasury whatever he ought to, gems (*ratna*) and articles of superior or inferior value. ...
>
> Oyster-shells, conch-shells, and other miscellaneous things are the wombs of pearls. ... That which is big, circular, without bottom (*nistalam*), brilliant, white, heavy, soft to the touch, and properly perforated is the best. ...
>
> That which is characterised with blue lines, that which is of the colour of the flower of *kalāya* [a kind of bean], or which is intensely blue, which possesses the colour of *jambu* fruit [rose apple], or which is as blue as the clouds is the *indranīla* gem, *nandaka* [pleasing gem], *sravanmadhya* [that which appears to pour water from its centre], *sītavṛṣṭi* [that which appears to pour cold shower], and *sūryakānta* [sunstone] are other forms of gems.
>
> Gems are hexagonal, quadrangular, or circular possessed of dazzling glow, pure, smooth, heavy, brilliant, transparent (*antargataprabha*) and illuminating; such are the qualities of gems.
>
> Faint colour, sandy layer, spots, holes, bad perforation, and scratches are the defects of gems.

Vimalaka [pure], *sasyaka* [plant-like], *anjanamūlaka* [deep dark], *pittaka* [like the bile of a cow], *sulabhaka* [easily procurable], *lohitaka* [red], *amṛtāṁśuka* [of white rays], *jyotīrasaka* [glowing], *maileyaka*, *ahicchattraka* [procured in the country of Ahicchattra], *kūrpa*, *pūtikūrpa* and *sugandhikūrpa*, *kṣīrapaka*, *śukticūrnaka* [like the powder of an oyster shell], *śilāpravālaka* [like coral], *pulaka*, *sūkrapulaka* are varieties of inferior gems.

The rest are metallic beads (*kācamaṇi*). (*Arthaśāstra*, 2.11, tr. R. Shamasastry.)

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Water Management

In this brief extract from a long series of increasingly meritorious acts, culminating in the practice of truth, the *Mahābhārata* views the digging of water reservoirs as far more important than that of wells. Indeed, a tank restores water to the earth, while a well draws from it.

> ... The dedication of a tank is more meritorious than that of a hundred wells. ... (*Mahābhārata, Ādi Parva*, section 74, tr. K.M. Ganguli)

*

The *Śiva Purāṇa* has a long description of the evils awaiting us in the *kali yuga*. Among them, this one reflects the attention that was paid to water structures and nature conservation:

> [In the *kali yuga*, the merchant class has] "abandoned holy rites such as digging wells and tanks, and planting trees and parks." (*Śiva Purāṇa*, II.1.23)

*

Kauṭilya's *Arthaśāstra* pays great attention to water management and irrigation techniques. Interestingly, and unlike today, access to water through public or private waterworks was not free; it was taxed at various rates. Various penalties were also prescribed for obstructing or diverting a water course, causing fields to be flooded, building a well or a dam on someone else's land, for not maintaining waterworks, or for ailing to cooperate in the building of an irrigation tank. A few extracts:

For building or improving irrigation facilities the following exemptions from payment of water rates shall be granted:

- New tanks and embankments: five years
- Renovating ruined or abandoned water works: four years
- Clearing water works over-grown with weeds: three years

Waterworks such as reservoirs, embankments and tanks can be privately owned and the owner shall be free to sell or mortgage them. The ownership of tanks shall lapse, if they had not been in use for a period of five years, except in cases of distress.

Anyone leasing, hiring, sharing or accepting a waterwork as a pledge, with the right to use them, shall keep them in good condition. Owners may give water to others (by dredging channels or building suitable structures), in return for a share of the produce grown in the fields, parks or gardens. In the absence of the owner, either charitable individuals or the people of a village acting together, shall maintain waterworks. (3.9 & 3.10)

The following are the taxes to be paid for use of water for cultivation:

- From waterworks built by the King: manually transported: one-fifth of the produce; carried by bullocks: one-fourth; lifted by mechanism into channels: one-third.

- From natural reservoirs: irrigated from rivers, lakes, tanks and springs: one-fourth of produce. (2.24)

No one irrigating his field from a reservoir or tank shall cause danger to the ploughed or sown field of another. The water from a lower tank shall not submerge a field fed from a higher tank built earlier. A higher tank shall not prevent the filling up of a lower tank, except when the latter has not been in use for three years.

No one shall: (a) let water out of dams out of turn; (b) obstruct, through negligence, the [rightful] use of water by others; (c) obstruct a customary water course in use; (d) make a customary water course unusable [by diverting the water]; (e) build a dam or a well on land belonging to someone else or (f) sell or mortgage, directly or indirectly, a bund or embankment built and long used as a charitable public undertaking except when it is in ruins or has been abandoned. (3.9 & 3.10, tr. L.N. Rangarajan)

*

Strabo, a 1st-century BCE Greek geographer, recorded the following, which matches Kauṭilya's above description:

Among [the officials], the first keep the rivers improved and the land re-measured, as in Egypt, and inspect the closed canals from which the water is distributed into the conduits, in order that all may have an equal use of it. (Strabo, *Geography,* 50, excerpt from R.C. Majumdar (ed.), *The Classical Accounts of India*. Calcutta: Firma KLM. 1981)

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In the Tamil epic *Shilappadikāram* by Iḷaṅgō Aḍigaḷ (see **Literatures** module), Kaṇṇagi and her husband Kōvalan travel to Madurai. On the way, they cross the Kāveri river in full flow. The author notes:

> But finding her movement arrested by the barrier — the anicut with its doorway — she noisily leaps beyond it in the sportive mood natural to her first freshes. No sound other than this can be heard. We can hear there neither the sound of the bucket, not of the water-lift; neither the usually loud *pecottah* [a water-lifting mechanism], not the palm-leaf basket used in irrigation. (*Cilappatikaram*, canto X, tr. V.R. Ramachandra Dikshitar, 1939, republ. International Institute of Tamil Studies, Chennai, 2004).

This is a reference to the Grand Anicut mentioned in the above Survey. Its "doorway" probably refers to the dam's sluices. Note the existence of water-lifting mechanisms with buckets and baskets for irrigation.

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Finally, numerous inscriptions record constructions of tanks (*tatāka*) and ponds (*vāpi*), also their maintenance: desilting, repair of embankments, sluices, irrigation channels.... Water diviners are sometimes mentioned as paying taxes. In some inscriptions, care was taken (as mentioned in the *Arthaśāstra,* above) that a new dam should not affect an older one, which should be allowed to fill first; the new dam was designed to store water in times of excess.

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Textiles and Garments

The accounts of classical Greek and Roman geographers and historians have some useful information on Indian textiles and dress styles.

They cover their persons down to the feet with fine muslin, are shod with sandals, and coil round their heads cloths of linen (cotton). They hang precious stones as pendants from their ears, and persons of high social rank, or of great wealth, deck their wrist and upper arm with bracelets of gold. ... (Quintus Curtius Rufus, 1st century CE, *History of Alexander the Great,* VIII.9)

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The dress worn by the Indians is made of cotton, as Nearchus tells us ... But this cotton is either of a brighter white colour than any cotton found elsewhere, or the darkness of the Indian complexion makes their apparel look so much the whiter. They wear an under-garment of cotton which reaches below the knee half-way down to the ankles, and also an upper garment which they throw partly over their shoulders, and partly twist around their head. (Arrian, 2nd century CE, *Indika,* XVI)

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Contrary to their simplicity in general, [Indians] like to adorn themselves, for they wear apparel embroidered with gold and use ornaments set with precious stones, and wear gay-coloured linen garments, and are accompanied with sun-shades. For, since they esteem beauty, they practise everything that can beautify their appearance. (Strabo, 1st century BCE, *Geography,* 54, above excerpts taken from R.C. Majumdar (ed.), *The Classical Accounts of India*. Calcutta: Firma KLM. 1981)

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This testimony is by the 7th-century CE Chinese pilgrim Xuansang (or Hsüan-tsang or Hiuen Tsiang):

> Their clothing is not cut or fashioned; they mostly affect fresh-white garments; they esteem little those of mixed colour or ornamented. The men wind their garments round their middle, then gather them under the armpits, and let them fall down across the body, hanging to the right. The robes of the women fall down to the ground; they completely cover their shoulders. They wear a little knot of hair on their crowns, and let the rest of their hair fall loose. ... On their heads the people wear caps (crowns), with flower-wreaths, and jewelled necklets. Their garments are made of *Kiau-she-ye* [*kauśeya,* silk] and of cotton. *Kiau-she-ye* is the product of the wild silkworm. They have garments also of Ts'o-mo (*kṣauma*), which is a sort of hemp; garments also made of *Kien-po-lo* (*kambala*) which is woven from fine goat-hair; garments also made from *Ho-la-li*. This stuff is made from the fine hair of a wild animal: it is seldom this can be woven, and therefore the stuff is very valuable, and it is regarded as fine clothing. (Xuansang, *Buddhist Records of the Western World,* Book II, 7, tr. Samuel Beal. London: Kegan Paul, Trench, Trübner, 1906)

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Perfumes and Cosmetics

Varāhamihira explains the preparation of various perfumes and cosmetics:

> A scented water fit for the washing of a king's head is prepared with equal quantities of woody cassia, costus (*Saussurea lappa*), *reṇukā* (*Piper aurantiacum*), *nalikā* (*Hibiscus cannabinus*), *spṛkkā* (*Bryonopsis laciniosa*?), *rasa* or *bola* (*Commiphora myrrha*), *tagara* (*Valeriana wallichii*), *vālaka* (*Aporosa lindieyana*), *nāgakesara* (*Mesua ferrea*) and *pattra* (*Laurus cassia*).

A hair oil having the perfume of the *campaka* flower (*Michelia champaca*) is made by mixing together equal quantities of the powders of *mañjiṣṭhā* (*Rubia cordifolia*), *vyāghranakha* (a tree or cuttlefish bone), *nakha* (shell perfume), woody cassia, costus (*Saussurea lappa*) and *bola* (*Commiphora myrrha*) and the whole thing being mixed with the oil of *Sesamum indicum,* being heated by the sun's rays. ...

Take one part each of *śatapuṣpā* (*Pimpinella anisum*), *kunduruka* (*Boswellia serrata*), sandalwood and *priyaṅgu* (*Aglaia roxburghiana*), and two each of *nakha* (shell perfume) and *turuṣka* (*Tagetes erecta*?), and fumigate the mixture with jiggery and *nakha*. This becomes a good scent.

Many delightful perfumes are made from *harītakī* (*Terminalia chebula*), *śaṅkha* (*nakha*), *ghana* (*Cyperus rotondus*?), *bola, vālaka,* jaggery, costus, benzoin and *mustaka* bulbs by mixing them in proportions indicated by multiples of $1/9^{th}$. ...

Take equal quantities of woody cassia, *uśīra* (*Vetiveria zizanioides*) and *pattra* (*Laurus cassia*) and a half of the above of small cardamoms (*Elettaria cardamomum*) and pound them together into fine powder, which should be mixed (reinforced) with musk and camphor. This will make an excellent toilet powder [perfume for clothes].

The *gandhārṇava* [ocean of perfumes] is prepared from the following sixteen substances, if every four of them are permuted variously at will and that in one, two, three or four parts. The substances are *Cyperus rotondus, Aporosa lindieyana,* benzoin, camphor, *Vetiveria zizanioides, Mesua ferrea,* cuttlefish bone, *Bryonopsis laciniosa, Aquilaria agallocha, Randia dumetorum,* shell perfume, *Valeriana wallichii*, coriander, *Hedychium spicatum, Scirpus articulates* and *candana.*

In no perfume should more than one part of coriander be used, as its smell is too strong. Camphor, being stronger still in smell, should be used in a still lesser proportion. These two, therefore, ought not to be mixed in two, three or four parts.

All the above-named products should be fumigated separately, and not in a mixture, with turpentine, resin, jaggery and shell perfume; then they should be mixed with musk and camphor.

Out of the group of 16 substances, the number of perfumes that can be prepared by selecting any four at a time will be 1820. (*Bṛhat Saṁhitā,* ch. 77, tr. M.R. Bhat)

Comprehension

1. Name a few gems as mentioned in *Arthaśāstra*.
2. How can you identify the defects in gems?
3. Name some varieties of inferior gems.
4. Write a note on Indian perfumes and cosmetics.
5. 'The dedication of a tank is more meritorious than that of a hundred wells' — explain.

Activities

- 'Water is life'. Organize a water conservation campaign in your school presenting information on our ancient wisdom of water management, storage, distribution, and the rules and regulations regarding use / misuse of water.
- Read the primary text on garments and textiles. Work in groups to

- sketch the garments as documented by historians and travellers and put up a display;
- hold a fashion show of the garments and jewellery with other accessories as explained in the text.