BUREAU OF INDIAN STANDARDS

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Learning Science via Standards



IS 374

CM/L-XXXXXXXXXX

CEILING FAN

Lesson 12

May 2023





STANDARDS CLUB
BUREAU OF INDIAN STANDARDS

Nurturing Young Minds as Ambassadors of Quality and Standards



Foreword

Everything around us, whether natural phenomena or manmade products can be explained through science. The product which are used in our daily life are outcome of conscious efforts by the mankind to fulfil and exceed the needs of the present and demands of the future. Students are taught science as part of their school curriculum, to enable them to understand the various scientific laws and principles and also to inculcate the habit of exploring the world through the lens of science. Quality characteristics of any product or service are decided based on the stated and implied needs and are generally described in a document called 'Standard'. Science and standards are inseparable and integral aspect of any product.

Bureau of Indian Standards (BIS), the national standards body of India, is mandated for establishment and promotion of standards and creating a quality ecosystem in the country. This is achieved through developing Indian Standards on products and services through the active involvement of relevant stakeholders and dissemination of information of such standards for their use and implementation across all sectors of economy. Academia, as an important stakeholder of BIS, has been contributing towards development of standards through research activities and providing inputs related to technological advancements in product development, their characteristics and use as well as methods of tests. BIS, on its part has also been promoting standards in academia through a variety of programmes. This has since been institutionalized in the form of "Standards Clubs" which are being established in educational institutions across India to nurture the young minds as ambassadors of quality and standards and prepare them for dealing with these aspects in future.

In this initiative of BIS, called "Learning Science via Standards", a series of Lesson Plans are made elaborating the various scientific concepts, laws and principles to help students understand their practical applications via standards. The series comprises of a variety of subjects for insights into the scientific laws and principles and relating them to the quality characteristics of products used in day-to-day life. First 10 Lesson Plans in the series are released on the occasion of World Consumer Rights Day on 15 Mar 2023.

The Lesson Plans are expected to serve as a useful tool for the teaching fraternity for imparting knowledge on scientific laws and principles through their practical applications in activities and products around us and facilitate an interactive learning experience for the students.

Electric Ceiling Fan

A ceiling fan is a type of fan that is mounted on the ceiling of a room and uses rotating blades to circulate air. Ceiling fans can be powered by electricity and are controlled by a switch or remote control. Fans are primarily used to provide cooling and comfort by moving air around a room. They can also be used to circulate air and improve ventilation. Fans can be found in many different settings, such as homes, offices, factories, and outdoor events. Ceiling fans are a popular and energy-efficient way to improve air circulation and provide comfort in a room.

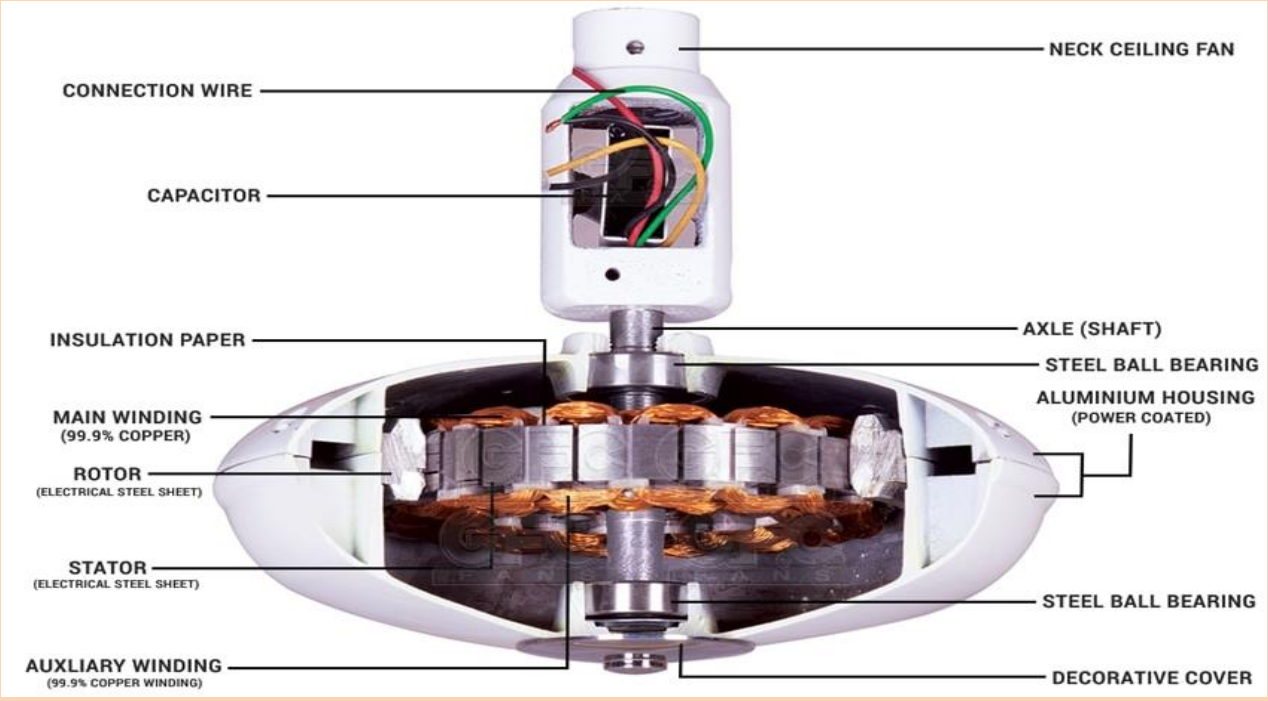
Fans have been used for thousands of years to provide relief from heat and humidity. The first fans were handheld, made of feathers or leaves, and were used by ancient civilizations such as the Greeks, Romans, and Egyptians. Later, fans were also used as status symbols and decorative items. Ceiling fans were first introduced in the United States in the late 1800s. At that time, they were powered by water and used in factories to improve air circulation and cool workers.

First electrically powered fan was invented in 1882 by Philip Diehl.

By the early 1900s, ceiling fans had become more common in homes and were powered by electricity. Today, fans come in various shapes, sizes, and types, and are used for a variety of purposes such as cooling, ventilation, and air circulation.



1. Components of Ceiling Fan:



1.1 Capacitor: Start capacitor is used in electric fans as shown in figure, as we know capacitors stores energy and this stored energy is used to rotate the fan from rest state. This capacitor increases electric fan motor torque and allows motor to rotate rapidly. This capacitor remains in to circuit until only the electric fan reaches predetermined speed, this predetermined speed is usually the 75% of the full speed of fan and when fan reaches the predetermined speed this capacitor is taken out of the circuit by a centrifugal switch and will again be incorporated into circuit when fan comes at rest state.

1.2 Axle: Axle or Shaft (shown in figure) is the metallic rod mostly made up of mild steel. Axle is connected from ceiling to fan housing. It stays at rest motion while bearings supporting the housing over it rotates. It also has arrangement for transfer of current to the stator windings

1.3 Bearings: Ball bearings are used in the electric fan. As shown in figure, two bearings which are link between housing and axle gives the rotary motion to the housing and reduce the friction during rotation.

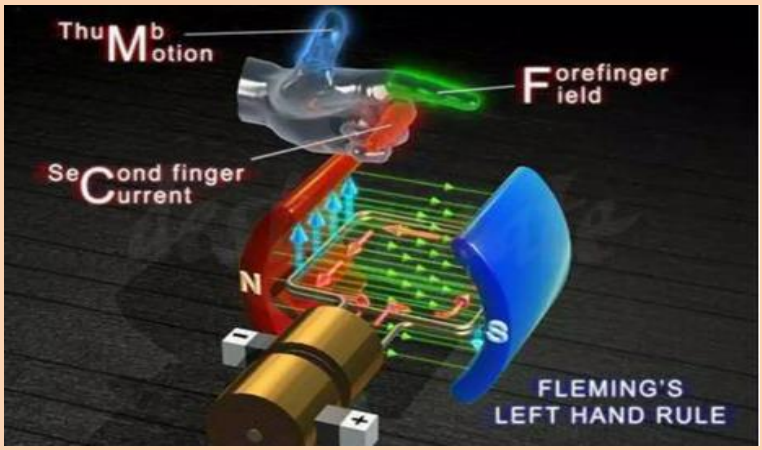
1.4 Stator: Stator winding is simply the stationary winding in the electric fan motor winding. Stator winding means thousands of turns of conducting wire on any non-conducting structure like a coil. This winding has very low resistance. Main purpose of stator winding is to convert given input electric current into magnetic field. The Stator Winding is shown in figure.

1.5 Rotor: Rotor (shown in figure) in the electric motor is the permanent magnetic in the shape of half circles. Usually 2 pcs of Magnets are used in Electric fan but this can change to 3 pcs or to single pc depending upon size and capacity of electric fan.

1.6 Housing: Housing is the outer part of the electric fan which carries stator, rotor and drive shaft bearing assembly on inside and blades on outer sides. Aluminium housing is shown in figure.

1.**7 Blades**: Blades (shown in figure) or wings are the hanging part bolted on the outer area of housing. Three blades are mostly used and their length and the angle of air throw depends upon the size and capacity of electric motor.

2. Working Principle of Electric Ceiling Fan:



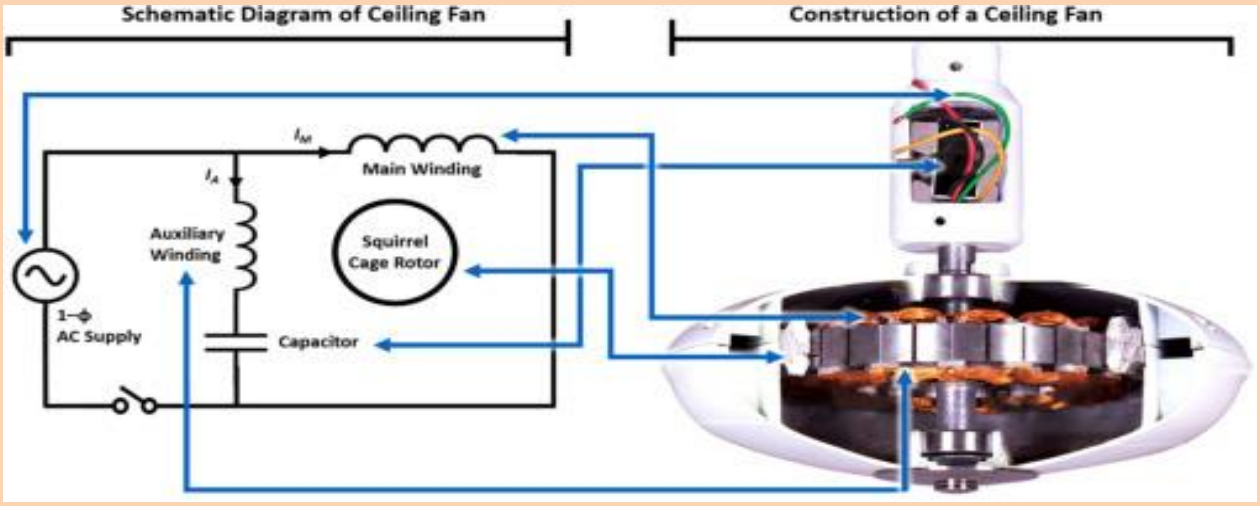
Fleming's Left-Hand Rule

When a current carrying conductor is placed in a magnetic field then it experiences a force due to which it starts to rotate. The direction of rotation can be found by the Fleming's Left-Hand Rule as shown in figure. When the fan motor is turned on or AC is supplied to electric fan, it first reaches the capacitor and Capacitor delivers high energy to the stator windings.

When stator winding energizes, it develops the rotating magnetic field

which forces the rotor to rotate in the direction of rotating magnetic field. In this way electrical energy is converted into mechanical energy which causes the rotor and housing to spin and the blades attached to the housing throws away the air nearby it while creating cooling effect. The blades are angled in such a way that they push the air downwards as they rotate. This creates a column of air that moves around the room.

As the air moves, it increases the rate of heat transfer through convection. This means that the air passing over our skin takes away the heat that our body emits, providing us with a cooling effect. In summary, the scientific principle behind the operation of an electric ceiling fan is based on the laws of thermodynamics and fluid dynamics. The fan creates a column of air that moves around the room, increasing heat transfer through convection and providing a cooling effect.

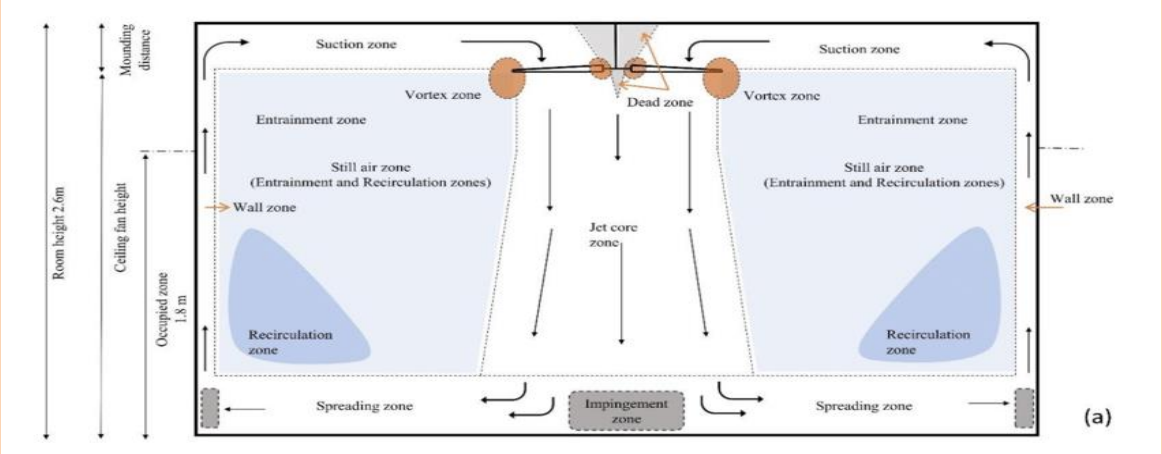


Schematic Diagram of Ceiling Fan

3.0 Scientific Principles

Electromagnetic Induction: The principle of electromagnetic induction is used to generate the magnetic field that makes the motor spin. The motor in a ceiling fan uses a coil of wire and a permanent magnet to create a rotating magnetic field, which causes the motor to spin.

Aerodynamics: The science of aerodynamics is used in the design of ceiling fans to optimize airflow and reduce noise. The shape and angle of the fan blades are designed to create a specific amount of airflow at different speeds.



Centrifugal Force: The centrifugal force generated by the rotating blades of a ceiling fan creates a pressure difference that causes air to flow from high-pressure areas to low-pressure areas. This creates the cooling effect that makes a ceiling fan effective.

Conservation of Energy: The principle of conservation of energy is used in the design of ceiling fans to ensure that they are energy-efficient. Ceiling fans are designed to consume as little energy as possible while still providing the desired airflow.

Electrical Safety: Ceiling fans are designed to comply with electrical safety standards to prevent electrical shock or fire hazards. The Indian Standard IS 374 specifies the requirements for electrical safety testing of ceiling fans, including insulation resistance, ground continuity, and dielectric strength.

Mechanical Safety: Ceiling fans are also designed to comply with mechanical safety standards to prevent injury or damage to property. The Indian Standard IS 374 specifies the requirements for mechanical safety testing of ceiling fans, including stability, blade retention, and guard integrity.

Noise Level: The noise level of ceiling fans is an important factor in their performance evaluation. The Indian Standard IS 374 specifies the maximum allowable noise level for ceiling fans, which is measured in decibels (dB).

Airflow: The airflow of ceiling fans is also an important factor in their performance evaluation. The Indian Standard IS 374 specifies the minimum airflow requirement for ceiling fans, which is measured in cubic meters per minute (m^3/min).

The principles of electromagnetism, aerodynamics, centrifugal force, and energy conservation are all essential to the functioning and performance of ceiling fans. Compliance with safety standards and performance requirements, as specified in the Indian Standard IS 374, ensures that ceiling fans are safe, efficient, and effective.

4. Working of Electric Celling fan

Heat Resistance Material

Heat-resistant materials in fans should have properties such as low thermal conductivity, low coefficient of thermal expansion, corrosion resistance, strength and durability, electrical insulation, and chemical resistance to ensure safe and efficient operation in high-temperature environments.

Resistance to rusting

Rusting or corrosion is a common phenomenon of metals especially when in moist conditions. Since contact of water is continuously stored in the water heater, rusting/corrosion is a common problem. This can be avoided by using corrosion resistant materials for construction of fans like Stainless Steel.

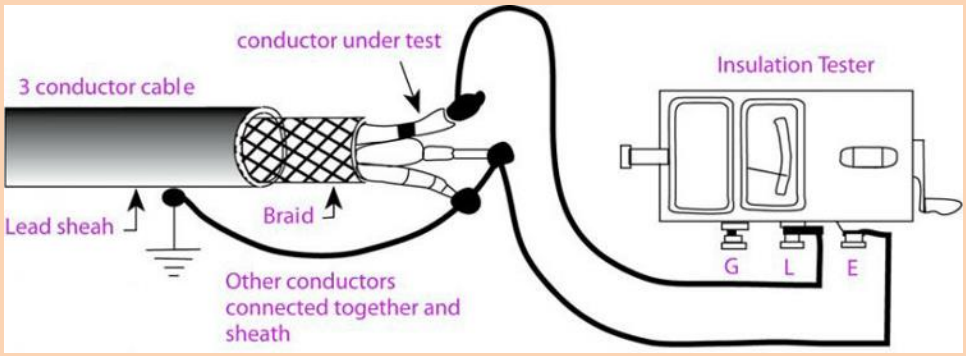
Moisture Resistance

The enclosure of the appliance shall provide the degree of protection against moisture in accordance with the classification of the appliance. Appliances shall be proof against humid conditions that may occur in normal use.

High Voltage strength in fans is the ability of the electrical insulation of the fan to withstand high voltage stresses without breaking down. The principle is based on the fact that the electrical insulation of a component will deteriorate when it is subjected to high voltage stress. The purpose is to ensure that the electrical insulation in the fan is capable of withstanding the electrical stresses it will encounter during normal operation. It helps to identify any weaknesses in the electrical insulation before they become a safety hazard or cause the fan to fail. It is also a requirement for compliance with safety standards and regulations.

Insulation resistance

It is an important concept in electric fans, as it refers to the ability of the fan's insulation to resist the flow of electricity. This is essential for preventing electrical faults and minimizing the risk of electric shock to users. Insulation resistance is typically measured using a high voltage tester, which applies a high voltage to the insulation to test its resistance. The insulation resistance can be affected by factors such as humidity, temperature, and the quality of the insulation material used. Therefore, proper maintenance and regular inspection of the insulation is important to ensure that the fan remains safe and functional. Poor insulation resistance will cause the short circuit in the windings.



Insulation Resistance Testing

Protection against access to live parts

Appliances shall be constructed and enclosed so that there is adequate protection against accidental contact with live parts. Live parts of built-in appliances, fixed appliances and appliances delivered in separate units, shall be protected at least by basic insulation before installation or assembly.

Transient overvoltage

In fans Transient overvoltage refers to a short-term voltage surge or spike that exceeds the normal operating voltage of the fan. These voltage surges can be caused by lightning strikes, switching of electrical loads, or other electrical disturbances. Transient overvoltage in fans can cause damage to the electrical components of the fan, leading to reduced efficiency or premature failure. Surge protection devices are used to protect the fan from transient overvoltage by diverting the excess voltage or current away from the sensitive electrical components of the fan and into a protective device.

5. BEE 5 Star rated Fan



BEE (Bureau of Energy Efficiency) 5 Star rating is a certification given to energy-efficient products in India. Products that meet the required energy efficiency standards set by BEE are eligible for this rating.

BEE 5 Star rated products are highly efficient and consume less energy than products with lower ratings. This means that they not only help reduce your electricity bills but also contribute to a cleaner environment by reducing carbon emissions.

Some other examples of BEE 5 Star rated products include air conditioners, refrigerators, LED bulbs, and televisions.

6. Some interesting facts about ceiling fans

1) The first ceiling fans were invented in the late 1800s.
2) The first ceiling fans were powered by water turbines.
3) The first electric ceiling fans were invented in the early 1900s.
4) Ceiling fans were originally designed to cool down living spaces, but they can also be used to heat a room by creating a downdraft.
5) The average ceiling fan uses about 50 watts of electricity, which is less than a 100-watt light bulb.
6) Ceiling fans can help to improve air circulation in a room, which can help to reduce allergens and improve respiratory health.
7) Ceiling fans can be used to create a variety of different looks in a room, from traditional to modern.
8) Ceiling fans can be made from a variety of materials, including metal, wood, and plastic.

6. Questionnaire

1. What was the year of the invention of the first electric ceiling fan?
a) 1950
b) 1882
c) 2005
d) 1900

Answer: b) 1882

2. What is the purpose of a ceiling fan?
a) To generate heat in a room
b) To cool a room by creating a wind-chill effect
c) To humidify a room
d) To dehumidify a room

Answer: b) To cool a room by creating a wind-chill effect

3. How does a ceiling fan help save energy?
a) By consuming more electricity than air conditioning units
b) By reducing the need for air conditioning
c) By reducing the need for heating
d) *By generating heat during the winter months*

Answer: b) By reducing the need for air conditioning

4. What is the typical range of watts used by a ceiling fan?
a) 50-1000 watts
b) 10-120 watts
c) 500-1000 watts
d) 200-400 watts

Answer: b) 10-120 watts

5. What are some additional features that modern ceiling fans come with?
a) Remote control
b) LED lighting
c) Smart controls
d) All of the above

Answer: d) All of the above

6. What scientific principle allows a ceiling fan to cool a room?
a) Boyle's law
b) Bernoulli's principle
c) Newton's third law of motion
d) The law of conservation of energy

Answer: b) Bernoulli's principle

7. What type of electric motor is commonly used in ceiling fans?
a) AC motor

b) DC motor
c) Universal motor
d) Stepper motor

Answer: a) AC motor

8. How does changing the direction of a ceiling fan affect its airflow?
a) It doesn't affect the airflow
b) It causes the fan to produce hot air instead of cool air
c) It causes the fan to reverse the airflow, creating a draft effect
d) It causes the fan to generate more noise

Answer: c) It causes the fan to reverse the airflow, creating a draft effect

9. What is the purpose of a capacitor in a ceiling fan motor?
a) To store energy
b) To regulate the voltage
c) To control the speed of the motor
d) To convert AC to DC

Answer: c) To control the speed of the motor

10. What is the purpose of the blade pitch in a ceiling fan?
a) To generate heat
b) To determine the direction of the airflow
c) To increase the speed of the fan
d) To optimize the airflow for efficient cooling

Answer: d) To optimize the airflow for efficient cooling

11. What is the function of the rotor in a ceiling fan motor?
a) To generate a magnetic field
b) To store energy
c) To convert electrical energy into mechanical energy
d) To regulate the speed of the motor

Answer: c) To convert electrical energy into mechanical energy

12. How does the shape of the blades of a ceiling fan affect its efficiency?
a) Blades with a curved shape are more efficient than straight blades
b) Blades with a straight shape are more efficient than curved blades
c) The shape of the blades has no effect on efficiency
d) Blades with a concave shape are more efficient than convex blades

Answer: a) Blades with a curved shape are more efficient than straight blades

13. What scientific principle explains why a ceiling fan can help distribute warm air in a room during the winter months?
a) Convection
b) Radiation
c) Evaporation
d) Boyle's law

Answer: a) Convection

7. Sample Questions:

Question: **Which fault causes a fan to run slow?**

Answer: A faulty capacitor may cause a ceiling fan to run slowly or quit running altogether. The capacitor should be replaced by an electrician.

Question: **What length down rod should be used with a ceiling fan?**

Answer: For optimum performance, ceiling fan blades should be at least 2.4 m from the floor but no higher than 2.8 m in order to best cool a room.

Question - What energy transformation takes place in a simple electric fan?

Answer- Electrical energy - Kinetic energy
When we switch on a fan, the fan converts a significant portion of the electrical energy into kinetic energy of the fan blades. Some part of electric energy is converted into heat. So the correct energy transformation will be: Electrical energy → Kinetic energy.

Question: What kind of motor used in ceiling fans?

Answer: In conventional ceiling fans, single phase permanent split capacitor induction motor is used. These motors consume minimum power and hence, are also known as fractional kilowatt motors.

Question: Which kind of motor AC or DC used in ceiling fan?

Answer: Most ceiling fans, as well as most household appliances, use AC motors, as AC is the type of current distributed by power companies. AC motors function by being connected directly to a power source. This power source is what creates the moment of force required to rotate the motor's rotor.

Lesson Plan Subjects

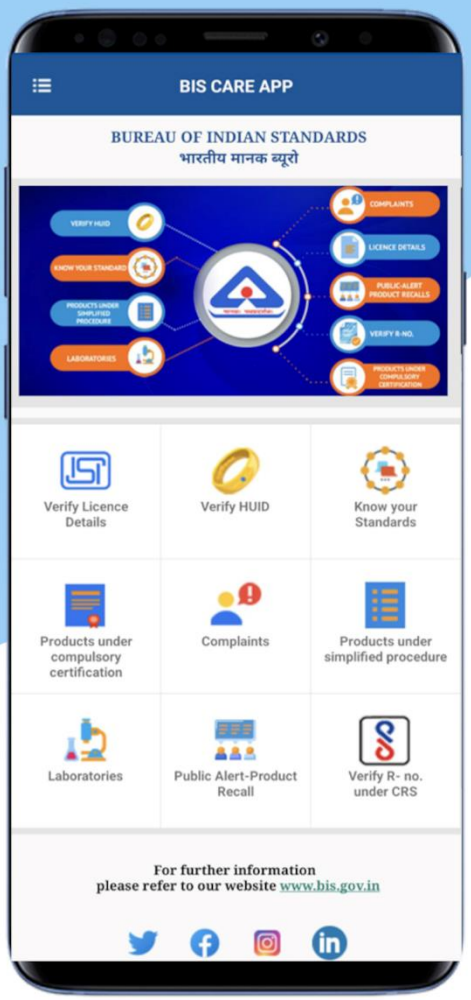
Published

1.	Caustic Soda	**11.**	Boric Acid
2.	Football	**12.**	Ceiling Fan
3.	Cement	**13.**	Cables
4.	Gas Stove	**14.**	Ceramics Tiles
5.	Geyser	**15.**	Rear View Mirrors
6.	Helmet	**16.**	Headphones
7.	LED Bulb	**17.**	Milk Powder
8.	LPG Cylinders	**18.**	Pressure Cooker
9.	Cement Ash Brick	**19.**	Plywood
10.	Paints	**20.**	Multipurpose dry batteries

Forthcoming…

21.	Drinking Water	**37.**	PVC Pipes
22.	Electric Iron	**38.**	Bicycle
23.	Electric Mixer	**39.**	Refrigerator
24.	Family Sized Biogas Plant	**40.**	Solar Flat Plate Collector
25.	Fire Extinguisher	**41.**	Solid and Hollow Block
26.	Ballpoint pen	**42.**	Stainless Steel
27.	Power Threshers	**43.**	Steel Bar
28.	Conduits	**44.**	Submersible Pump set
29.	CNG Cylinders	**45.**	Thermometer
30.	Precast Concrete	**46.**	Tyres for buses and trucks
31.	Pasteurized Milk	**47.**	Vacuum Flask
32.	Hearing Aids	**48.**	Water Meter
33.	Paving Block	**49.**	Water Storage Tank
34.	Microwave Oven	**50.**	Weighing balance
35.	Loudspeakers	**51.**	Wheel Rim
36.	Plugs and Socket	**52.**	Geosynthetics

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