BUREAU OF INDIAN STANDARDS

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Learning Science via Standards



IS 366

CM/L-XXXXXXXXXX

Electric Iron

Lesson 23

July 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. Second Set of 10 Lesson Plans were released on 10 Jun 2023 by Hon'ble Minister of State during the Governing Council Meeting of BIS.

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 Iron



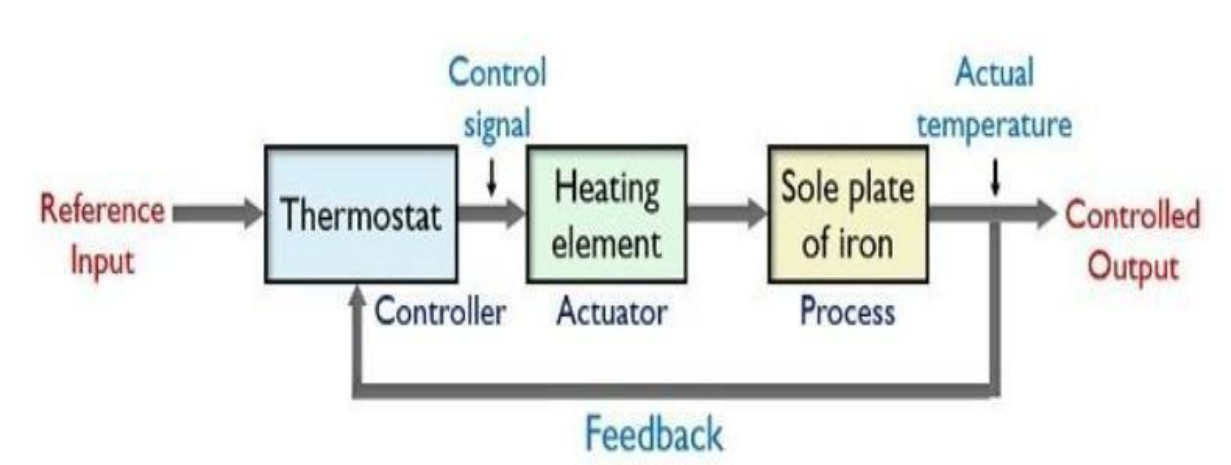
The electric iron, an essential household appliance, has a history rooted in the late 19th century. The initial designs incorporated a heated metal plate that glided over fabrics to remove wrinkles. The earlier Irons were used with coal as heating medium. In 1882, Henry W. Seeley created the first electric iron with a heating element inside. It featured an adjustable thermostat, providing better temperature control.



Subsequent advancements led to the development of lighter and more efficient models. Today, electric irons utilize a heated soleplate and often include additional features like steam functions and non-stick coatings, making ironing clothes a simpler and more convenient task. The evolution of electric irons has greatly contributed to household chores by making the process of ironing faster, more effective, and user-friendly, revolutionizing the way we care for our garments.

1. Working Principle

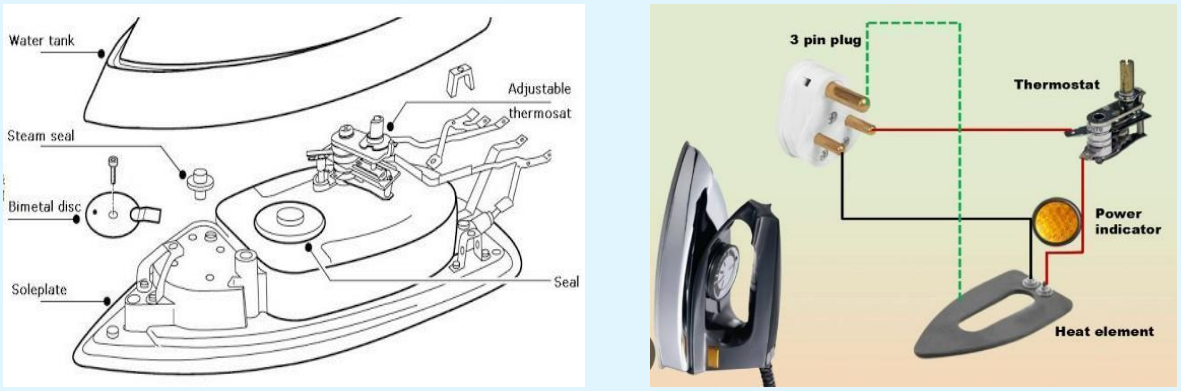
When the electric iron is plugged in and switched on, the current flows through the heating coil. The heating coil is made of a high resistance material that heats up quickly when electricity flows through it. The heat generated by the coil is transferred to the base plate of the iron through conduction. The base plate is made of a metal that is a good conductor of heat and is designed to be smooth and flat so that it can be pressed against clothing to remove wrinkles. When the base plate is pressed against clothing, the heat from the plate is transferred to the fabric through conduction, which causes the fibers in the fabric to relax and straighten out, removing wrinkles .



Basic block diagram of Automatic Electric Iron

The electric iron is a remarkable appliance that employs various components to achieve its functionality, based on scientific principles and laws.

2. Components and their functions



Electric Iron & major parts

a) **Heating Element:** The heating element is the core component of an electric iron. It is typically made of a high-resistance alloy such as nichrome wire. When an electric current flows through the heating element, its resistance causes it to generate heat according to Joule's Law, which states that the heat produced is proportional to the square of the current multiplied by the resistance.

b) **Thermostat:** The thermostat is responsible for controlling and maintaining the desired temperature of the iron. It consists of a bimetallic strip that expands or contracts with temperature changes. As the iron heats up, the bimetallic strip bends, disconnecting the power supply and preventing overheating. When the temperature drops below the set level, the strip straightens, allowing electricity to flow again.

c) **Soleplate:** The soleplate is the flat, smooth surface of the iron that comes into direct contact with the fabric. It is usually made of materials like stainless steel or ceramic. The soleplate's function is to evenly distribute heat across its surface and provide a smooth gliding motion while ironing.

d) **Steam System:** Many electric irons incorporate a steam system to aid in wrinkle removal. This system consists of a water tank, a steam chamber, and tiny vents on the soleplate. Water from the tank is pumped into the steam chamber, where it is heated to produce steam. The steam is then released through the vents, allowing it to penetrate and relax the fabric's fibers, making it easier to remove wrinkles.

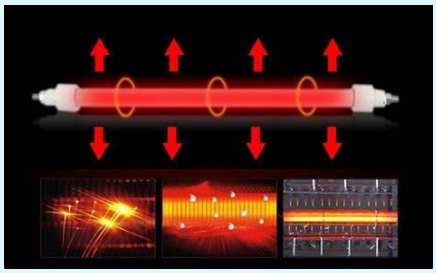
e) **Pilot lamp:** The pilot lamp is an indicator for electric iron. It is housed in the cover plate of the electric iron. One end of the pilot lamp is connected to supply, while the other end is connected to the heating element. A shunt resistance is provided across the pilot lamp which assists in providing a voltage drop.

f) **Handle**: The handle is used to hold the iron while ironing. It is usually made of plastic or rubber material to prevent heat from transferring from the soleplate to the handle and burning your hand.

g) **Turning knob or tightening screw**: Turning Knob is used to adjust the temperature of the iron.

3. Various Concepts and Laws of Science in Electric Iron

a) **Joule's Law of Heating:** Joule's law of heating states that the heat produced in a conductor is directly proportional to the square of the current passing through it, the resistance of the conductor, and the duration of the current flow. In the context of an electric iron, this law explains that the amount of heat generated in the heating element is determined by the current, resistance of the element and the time it is powered.



The formula for heat produced (Q) is given by

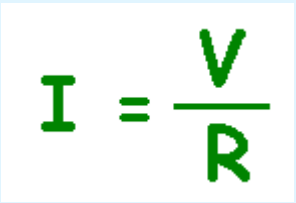
$$Q = I^2.R.t,$$ where I is the current, R is the resistance, and t is the time.

b) **Energy Conservation:** The concept of energy conservation is a fundamental principle in physics that applies to various systems, including the operation of electric irons. It states that energy cannot be created or destroyed; it can only be converted from one form to another or transferred between objects or systems.

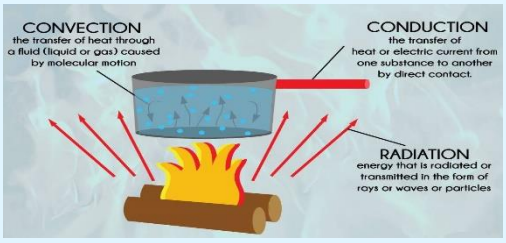


Electric irons rely on the conversion of electrical energy into thermal energy. When the iron is plugged into an electrical outlet, the flow of electrons through the circuit generates heat in the heating element. This conversion is governed by the principles of electrical energy transfer and conservation.

c) **Resistance:** The heating element in an electric iron is typically made of a high-resistance alloy, such as Nichrome Wire. According to Ohm's Law, the current flowing through a conductor is directly proportional to the voltage applied and inversely proportional to the resistance of the conductor. The high resistance of the heating element causes a significant amount of heat to be generated when current passes through it.



d) **Heat Transfer:** Heat transfer plays a fundamental role in the functioning of an electric iron. As the heating element becomes hot, it transfers thermal energy to the iron's soleplate through conduction. The soleplate then transfers heat to the fabric through conduction as well. These heat transfer processes adhere to the principles of conduction, which states that heat is transferred from a higher temperature region to a lower temperature region through direct contacts.

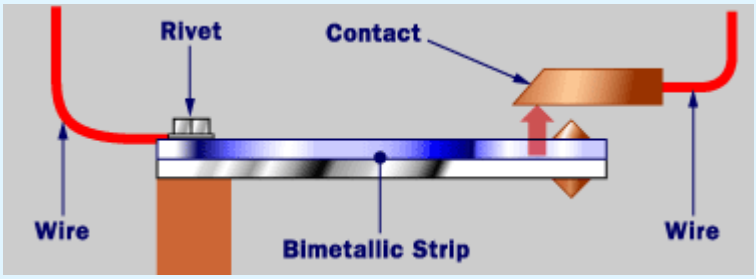


e) **Thermodynamics:** The operation of an electric iron also involves principles from thermodynamics. The iron's thermostat controls the temperature by monitoring changes in temperature and expanding or contracting a bimetallic strip. This action regulates the flow of electrical current to maintain a consistent temperature within the desired range. The principles of thermodynamics, such as heat transfer, energy conservation, and temperature regulation, govern this aspect of the electric iron's operation.

f) **Bimetallic Strip and Concept of Thermal Expansion:** The concept of a bimetallic strip is based on the differential expansion of two metals with different coefficients of thermal expansion. A bimetallic strip consists of two thin strips of different metals, usually brass and iron, bonded together. When subjected to temperature changes, the metals expand or contract at different rates, causing the strip to bend or straighten.

The principle behind a bimetallic strip is rooted in the fact that different metals have distinct expansion properties. One metal in the strip expands more than the other when heated. As a result, the strip bends towards the side with the metal that expands more. When the temperature decreases, the metals contract, and the strip returns to its original position.

Bimetallic strips have practical applications in various devices, including thermostats and temperature-controlled switches. In a thermostat, for instance, a bimetallic strip is used to regulate temperature. As the temperature rises, the strip bends, disconnecting a circuit or adjusting a valve to control the heating or cooling system. Once the temperature decreases, the strip straightens, allowing the circuit or valve to resume its normal operation.



General Schematic diagram of working of Bimetallic Strip

Questions:

Q1. What are various modes of Heat Transfer?

Q2. What is Joule-Heating?

Q3. Why is Nichrome wire commonly used in heating elements of Electric Iron?

Q4. Which metal wire commonly used in Incandescent light bulb?

Answers:

A1. i. Conduction is the transfer of energy from one molecule to another by direct contact. ii. Convection is the movement of heat by a fluid such as water or air from hot to cold medium. iii. Radiation is the transfer of heat by electromagnetic waves.

A2- Joule heating, also known as resistive, resistance, or Ohmic heating, is the process by which the passage of an electric current through a conductor produces heat.

A3- Properties of high resistance, stability, oxidation resistance, and fast thermal response makes nichrome wire an ideal choice for heating elements in electric irons.

A4- The metal wire is typically tungsten. Tungsten is chosen for its high melting point, which allows the wire to reach the extremely high temperatures necessary for incandescence, the emission of visible light due to the wire's heat.

4. General Safety Aspect and Instruction in Electric Iron



- Electric Iron must not be left unattended while it is connected to the supply.
- Plug must be removed from the socket-outlet before the water reservoir is filled with water. (for steam iron)
- Filling aperture for water in steam iron must not be opened during use.
- 16 ampere socket (Power socket) is used for supply of electric iron.

5. Protection against access to Live Parts



- Appliances shall be constructed and enclosed so that there is adequate protection against accidental contact with live parts.
- Appliances and their surroundings shall not attain excessive temperature in normal use.
- The appliances/electronic circuits shall be designed & applied so that a fault condition would not cause the appliance unsafe with regard to electric shock, fire hazard, mechanical hazard or dangerous malfunction.

6. Provision for Earthing

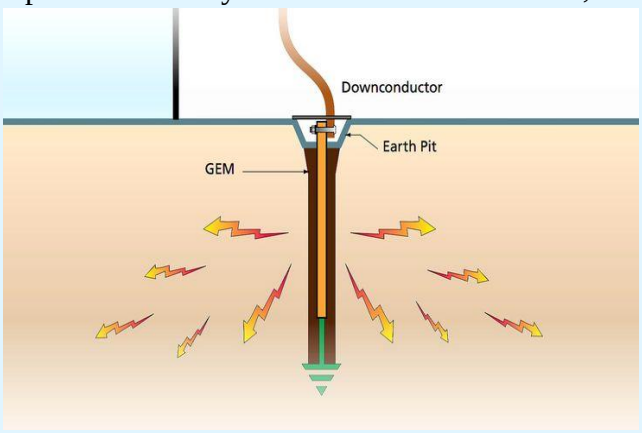
The concept of provision for earthing in electric irons is a safety measure implemented to protect users from electric shock and ensure electrical safety. Earthing involves connecting the metal parts of the iron, such as the chassis or body, to the ground through a dedicated wire or conductor.

Let us understand the provisions of earthing in an electric iron

i. **Grounding Connection:** A wire or conductor is connected to the metal parts of the iron, typically by attaching it to a metal plate or terminal. This wire serves as the grounding conductor.

ii. **Grounding Path:** The grounding conductor is then connected to a reliable ground source, such as a grounding electrode, a grounding rod driven into the earth, or a metallic cold-water pipe that extends into the ground. This creates a grounding path.

iii. **Electrical Faults:** In the event of an electrical fault, such as a short circuit or a breakdown in the insulation of the iron, the grounding path provides an alternative route for the electric current to flow. Instead of passing through a person who may be in contact with the iron, the current is diverted into the ground.

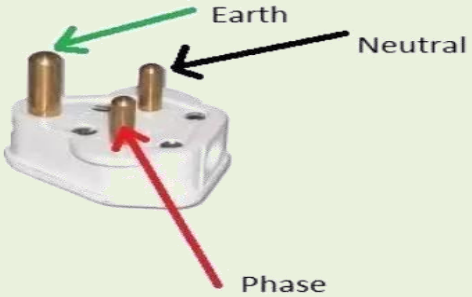


iv. **Safety Protection:** By connecting the metal parts of the iron to the ground, any excess or stray electrical current is safely discharged, minimizing the risk of electric shock. This helps protect users from potential electrical hazards and provides an added layer of safety.

The provision for earthing in electric irons is an important safety feature that helps prevent electrical accidents and ensures the safe operation of the appliance. Therefore, it is essential to follow the manufacturer's instructions and guidelines regarding earthing and regularly inspect the earthing system to maintain its effectiveness.

Thoughts to Ponder: Current flows easily through the least resistance path. Keeping this in mind, should the resistance of Earth be 'high' or 'low'?

Home-Task: Can you locate the 'earthing pit' near your school or home? Click a picture and share with your friends.



7. Major Tests Conducted on Electric Iron

i. Drop Test

The drop test is an important evaluation conducted on electric products, including electric irons, to assess their durability and resistance to impact. The primary purpose of the drop test is to determine how well an electric iron can withstand accidental drops or impacts during use, transportation, or mishandling. It helps identify potential weaknesses in the iron's construction, components, or assembly that could lead to malfunction or safety hazards.

ii. **Temperature Distribution Test**

Temperature distribution testing in electric irons is conducted to assess how heat is distributed across the soleplate during operation. This test ensures that the iron provides uniform heating, enabling consistent ironing results without damaging the fabric.



iii. **Temperature Rise Test**

The temperature rise test is conducted on electric irons to assess the increase in temperature of various components during normal operation. This test helps ensure that the iron operates within safe temperature limits and avoids excessive heating that could pose a risk to users or damage the appliance

iv. **Flexing Test**

The flexing test, also known as flex durability test, is performed on electric irons to evaluate the endurance and resistance of their power cords and cables to repeated bending and flexing. This test ensures that the cords can withstand normal usage conditions without developing faults or electrical hazards



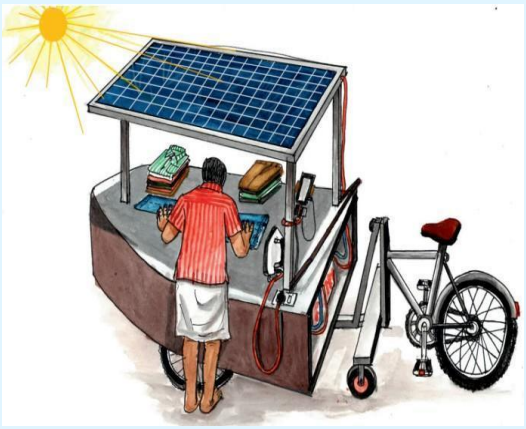
v. Endurance Test

The endurance test is conducted on electric irons to assess their long-term durability and reliability under continuous or extended usage conditions. This test helps ensure that the iron can withstand prolonged operation without experiencing performance degradation or mechanical failures.



8. How we can make electric iron more environment friendly?

- Vinisha (IGNITE 2019 Awards, National Innovation Foundation- India) has designed a mobile ironing cart, which uses solar panels to power a steam iron box. This can be powered by pre-charged batteries, electricity or diesel-powered generators in the absence of sunlight. The most important benefit of solar ironing carts is that it eliminates the need for coal for ironing. For earning extra income, the ironing cart can be fitted with a coin-operated GSM PCO, USB charging points and mobile recharging.



- The RRR Concept for making products more environment friendly.



- Incentivize sellers of new products to buy-back old products and support recycling.



- The standard may make provisions for manufacture of electric iron which uses a very efficient heating element so that it can achieve the set temperature by consuming less power.

9. Interesting Facts about Electric Iron

- The first electric iron was invented in the late 19th century, but it wasn't until the early 20th century that electric irons became widely used. Prior to that, people relied on heavy and cumbersome flat irons that were heated on stoves or fireplaces.
- The earliest electric irons were incredibly heavy, weighing around 15 pounds or more. They were often made of solid cast iron and required significant arm strength to manoeuvre.
- Electric irons have evolved over time to incorporate various safety features. One such feature is the automatic shut-off, which turns off the iron when it's left unattended for a certain period. This helps prevent accidents and reduces the risk of fires.
- Steam irons, which are now commonly used, were introduced in the 20th century. They utilize built-in water tanks and steam vents to release bursts of steam, making it easier to remove wrinkles from fabrics.
- Some modern electric irons come with advanced features like temperature control, self-cleaning functions, and even wireless capabilities. These advancements make ironing more efficient and convenient for users, allowing for customization and ease of use.

10. Questionnaire

Q1. What is the purpose of the heating element in an electric iron?
a) To generate steam
b) To circulate air
c) To produce heat
d) To regulate temperature

Q2. Which material is commonly used for the soleplate of an electric iron due to its excellent heat conduction?
a) Plastic
b) Aluminum
c) Glass
d) Rubber

Q3. What safety feature is typically present in modern electric irons to prevent overheating?
a) Auto shut-off
b) Temperature control dial
c) Steam generator
d) Cordless operation

Q4. Which of the following is NOT a benefit of using steam in an electric iron?
a) Enhanced crease removal
b) Improved fabric sterilization
c) Reduced electricity consumption
d) Faster ironing process

Q5. How does the thermostat in an electric iron contribute to efficient ironing?
a) It controls the iron's weight
b) It adjusts the steam pressure
c) It regulates the temperature
d) It determines the water level

Answers:
A1. c
A2. b
A3. a
A4. b
A5. c

Lesson Plan Subjects

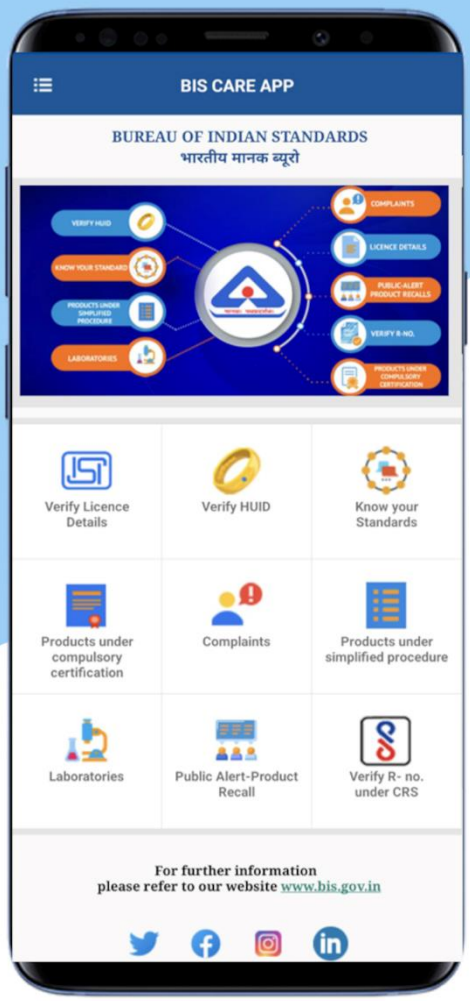
Published

1.	Caustic Soda	**16.**	Headphones
2.	Football	**17.**	Milk Powder
3.	Cement	**18.**	Pressure Cooker
4.	Gas Stove	**19.**	Plywood
5.	Geyser	**20.**	Multipurpose dry batteries
6.	Helmet	**21.**	Ballpoint Pen
7.	LED Bulb	**22.**	Bicycle
8.	LPG Cylinders	**23.**	Electric Iron
9.	Cement Ash Brick	**24.**	Loudspeakers
10.	Paints	**25.**	Pasteurized Milk
11.	Boric Acid	**26.**	Paver Blocks
12.	Ceiling Fan	**27.**	Plugs and Socket
13.	Cables	**28.**	Solar Flat Plate Collectors
14.	Ceramics Tiles	**29.**	Precast Concrete
15.	Rear View Mirrors	**30.**	Stainless Steel

Forthcoming…

31.	Drinking Water	**42.**	PVC Pipes
32.	Electric Mixer	**43.**	Refrigerator
33.	Family Sized Biogas Plant	**44.**	Solid and Hollow Block
34.	Fire Extinguisher	**45.**	Steel Bar
35.	Power Threshers	**46.**	Submersible Pump set
36.	Conduits	**47.**	Thermometer
37.	CNG Cylinders	**48.**	Tyres for buses and trucks
38.	Hearing Aids	**49.**	Vacuum Flask
39.	Microwave Oven	**50.**	Water Meter
40.	Water Storage Tank	**51.**	Wheel Rim
41.	Weighing balance	**52.**	Geosynthetics

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