**📘 GRADE 9 – INTEGRATED SCIENCE**

**🌟 Strand: Mixtures, Elements and Compounds**

**Sub-strand 1.1: Structure of the Atom**

**🎙 Integrated Science Grade 9 – Activity Introduction**

"Welcome to Grade 9 Integrated Science — your journey into matter, life, and energy. You will explore atoms, elements, metals, alloys, and water hardness; discover how plants and animals feed, grow, reproduce, and depend on each other; and investigate curved mirrors and waves that power technology. Get ready to experiment, explore, and think like a scientist — the adventure starts now."

**📚 LESSON 1: Structure of the Atom – (Protons, Neutrons, Electrons)**

**🎯 Lesson Learning Outcomes**

By the end of this lesson, learners will be able to:

✅ Define an atom as the smallest particle of an element that can take part in a chemical change  
✅ Identify the three main subatomic particles: protons, neutrons, and electrons  
✅ Describe the **location** of each subatomic particle (nucleus or energy levels)  
✅ State the **electrical charge** of each particle (positive, negative, neutral)  
✅ Explain why an atom is electrically neutral

**🎬 Lesson Introduction**

🎙 **Voiceover Script**:

“Hello, Grade 9 scientists! Welcome to the **invisible universe of atoms**. Everything around you – your desk, your book, even your body – is made up of incredibly tiny building blocks called atoms.  
Today, you will dive deep into the core of atoms and discover their parts: protons 🟥, neutrons 🟩, and electrons 🟦. Are you ready to uncover what makes matter?”

**🎯 Activity 1: 🧠 Think & Match – “Name That Particle!”**

🎙️ **Activity Introduction** 🎤  
“Atoms are made of even smaller particles. Each has its own charge and place to stay. In this challenge, match each particle to its correct charge and location inside the atom. Think carefully and drag them to where they belong. Ready? Let us begin!”

**Developer Guide**  
• Draggables: Proton 🔴, Neutron ⚪, Electron 🔵  
• Drop Zones (x6 total):  
o Charges: ➕ Positive, ➖ Negative, ◼ Neutral  
o Locations: 🧠 Nucleus, 🌀 Energy Level  
• Each particle must be matched to both drop zones (use a two-column matching format).  
• Add snap animation on drop.  
• Trigger real-time feedback (correct/incorrect) after all matches are made.  
• Use particle icons and subtle motion loop (e.g., electron orbit animation if possible).

**Learner Instructions (On Screen)**  
Drag each particle to the correct:  
• Charge: ➕ Positive, ➖ Negative, ◼ Neutral  
• Location: 🧠 Nucleus or 🌀 Energy Level  
You must match both properties correctly for each particle.

**Hint (On Screen)**  
• Protons are positive and in the nucleus.  
• Neutrons are neutral and in the nucleus.  
• Electrons are negative and in energy levels.

**Activity Content**

|  |  |  |
| --- | --- | --- |
| **Particle** | **Charge** | **Location** |
| Proton 🔴 | ➕ Positive | 🧠 Nucleus |
| Neutron ⚪ | ◼ Neutral | 🧠 Nucleus |
| Electron 🔵 | ➖ Negative | 🌀 Energy Level |

**Facilitative Feedback (Per Choice)**  
**Proton 🔴**  
• ➕ ➕ Positive: ✅ "Correct! Protons are always positively charged."  
• 🧠 Nucleus: ✅ "Excellent! Protons live inside the nucleus."  
• 🌀 Energy Level: ❌ "Protons do not orbit the nucleus. Try again."  
• ◼ Neutral: ❌ "Neutral is for neutrons. Protons are positive."

**Neutron ⚪**  
• ◼ Neutral: ✅ "Correct! Neutrons have no charge."  
• 🧠 Nucleus: ✅ "Yes! Neutrons stay in the nucleus with protons."  
• ➖ Negative: ❌ "Negative charge belongs to electrons, not neutrons."  
• 🌀 Energy Level: ❌ "Neutrons are too heavy to orbit. Try again."

**Electron 🔵**  
• ➖ Negative: ✅ "Correct! Electrons carry a negative charge."  
• 🌀 Energy Level: ✅ "Well done! Electrons move in energy levels around the nucleus."  
• ➕ Positive: ❌ "Positive charges are for protons, not electrons."  
• 🧠 Nucleus: ❌ "Electrons do not stay in the nucleus. Think again."

🎙️ **Activity Conclusion** 🎤  
“Fantastic work! You have correctly matched the particles of the atom. Now you know that protons and neutrons live inside the nucleus, while electrons move around in energy levels. Understanding this helps us explore how elements behave and bond. Keep going!”

**🎯 Activity 2: 🔍 Hotspot Click – “Explore the Atom”**

🎙️ **Activity Introduction** 🎤  
“Atoms are tiny but full of important parts. In this exploration, click different zones on an atom to uncover what happens in each one. Discover where electrons zoom, and where protons and neutrons stay. Are you ready to dive inside an atom? Click to explore!”

**Learner Instructions (On Screen)**  
Click on the atom’s parts to reveal what each region contains and what role it plays.

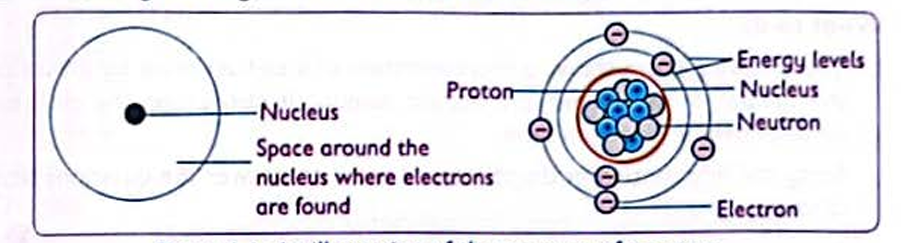
**Media Tags**  
• [🎞️ Static atom diagram with clickable zones]  
• [🎞️ Labels: Nucleus, 1st Energy Level, 2nd Energy Level]  
• [🎧 Narration voice clips for each pop-up fact]  
• [🎨 Optional: Glow-on-hover or pointer icon for clickable regions]

**Hint (On Screen)**  
• The nucleus is in the centre.  
• The first energy level is closest to the nucleus.  
• The second energy level surrounds the first.  
Remember:  
• Protons and neutrons are in the nucleus.  
• Electrons live in energy levels.

**Developer Guide**  
• Use a high-resolution atom illustration with at least 3 interactive hotspots:

1. 🧠 Nucleus (centre)
2. 🌀 First Energy Level (inner orbit)
3. 🌀 Second Energy Level (outer orbit)  
   • When a learner clicks a zone:  
   o Display a fact box (positioned beside the hotspot)  
   o Trigger an audio narration of the same content  
   • Include logic to track all 3 zones clicked, and display a “Well Done” message once complete.

**Activity Content (Hotspot Interactions)**



|  |  |
| --- | --- |
| **Hotspot** | **📖 Pop-up Text** |
| 🧠 Nucleus | “This is the core of the atom. It holds positively charged protons and neutral neutrons.” |
| 🌀 1st Energy Level | “This level can hold up to 2 electrons. These electrons spin close to the nucleus.” |
| 🌀 2nd Energy Level | “This shell can hold up to 8 electrons. It is farther from the nucleus than the first.” |

🎙️ **Activity Conclusion** 🎤  
“You have successfully uncovered the atom’s hidden zones. Remember, protons and neutrons stay in the nucleus, while electrons zoom around in energy levels. Great exploring!”

**🎯 Activity 3: ⚡ Real-Life Scenario – “What Sticks?”**

🎙️ **Activity Introduction** 🎤  
“Everyday electric shocks and static cling are signs that tiny particles are on the move. In this activity, you will explore real-life events caused by static electricity and choose the correct particle responsible. Read each scenario, select your answer, and learn from the feedback. Let us go!”

**Developer Implementation Guide**  
• Present one scenario per screen.  
• Radio-button MCQ with Submit button per scenario.  
• Show feedback immediately upon submission.  
• Optional: Add "Retry" button per incorrect answer.

**Learner Instructions (On Screen)**  
Read each scenario, select your answer, and submit to see feedback.

**Hint (On Screen)**  
Electrons are the only atomic particles that can move and create electric charges.

**Activity Content – Scenarios, Options, and Facilitative Feedbacks**

**🧪 SCENARIO 1: Balloon and Hair**

📖 Scenario:  
"After rubbing a balloon on your hair, it sticks to the wall. What particle caused this sticky surprise?"

💭 Options and Facilitative Feedbacks:  
• ☐ Protons  
❌ Protons stay inside the nucleus and do not transfer between materials.  
• ☐ Neutrons  
❌ Neutrons are neutral and also remain in the nucleus. They do not cause electric charge.  
• ☐ Electrons ✅  
✅ Correct! Electrons moved from your hair to the balloon, giving the balloon a negative charge that sticks to neutral objects.

**🧪 SCENARIO 2: Wool Sweater Shock**

📖 Scenario:  
"You take off a wool sweater and feel a zap in your fingers. What is being transferred between your skin and the sweater?"

💭 Options and Facilitative Feedbacks:  
• ☐ Neutrons  
❌ Neutrons do not carry electric charge and cannot be transferred between materials.  
• ☐ Electrons ✅  
✅ Correct! Electrons jumped from the sweater to your skin or vice versa, creating a small electric shock.  
• ☐ Heat particles  
❌ Heat is not made of particles that cause shocks. The sensation is caused by electric discharge, not temperature change.

**🧪 SCENARIO 3: Plastic Comb and Paper**

📖 Scenario:  
"You comb your hair with a plastic comb, then bring it near small pieces of paper. They jump to the comb. What caused this?"

💭 Options and Facilitative Feedbacks:  
• ☐ Electrons ✅  
✅ Correct! Electrons moved from your hair to the comb. The comb became negatively charged and attracted the neutral paper.  
• ☐ Neutrons  
❌ Neutrons do not carry charge and do not move during combing.  
• ☐ Atoms as a whole  
❌ Atoms cannot leave objects. Only electrons can transfer and create electric effects.

**🧪 SCENARIO 4: Plastic Slide Shock**

📖 Scenario:  
"After sliding down a plastic slide, you touch a metal pole and get shocked. What particle caused the spark?"

💭 Options and Facilitative Feedbacks:  
• ☐ Protons  
❌ Protons are locked in the nucleus and cannot move from one object to another.  
• ☐ Electrons ✅  
✅ Correct! Electrons built up due to friction on the slide. They jumped to the metal pole and created a spark.  
• ☐ Neutrons  
❌ Neutrons do not move or carry electric charge.

**🧪 SCENARIO 5: Clingy Clothes**

📖 Scenario:  
"Freshly dried clothes cling together in the dryer. What particle is behind this static cling?"

💭 Options and Facilitative Feedbacks:  
• ☐ Protons  
❌ Protons remain inside the nucleus. They are not transferred during drying.  
• ☐ Electrons ✅  
✅ Correct! Electrons moved between the clothes due to friction. Now they have opposite charges and attract each other.  
• ☐ Neutrons  
❌ Neutrons are neutral and cannot cause objects to attract.

🎙️ **Activity Conclusion** 🎤  
“You have completed your journey through static electricity in real life! In each scenario, electrons were the key players. They are the only atomic particles that can move and create electric charges. Well done on connecting particle behaviour to your world!”

**🎯 Activity 4: 🧩 Puzzle Game – “Atom Builder”**

🎙️ **Activity Introduction** 🎤  
“Atoms are like tiny puzzles made of special pieces. In this game, you will build your own atom by placing the nucleus, protons, neutrons, and electrons where they belong. Think carefully — every particle has a place and a role. Let us construct the atom together!”

**Learner Instructions (On Screen)**

1. Drag the nucleus to the atom centre.
2. Add protons (🔴) and neutrons (⚪) into the nucleus.
3. Drag electrons (🔵) into the correct energy levels:  
   o 1st shell: up to 2 electrons  
   o 2nd shell: up to 8 electrons

**Hint (On Screen)**  
• Protons are red and go in the nucleus.  
• Neutrons are grey and also stay in the nucleus.  
• Electrons are blue and orbit in shells outside the nucleus.  
• First shell holds 2 electrons.  
• Second shell holds up to 8 electrons.

**Media Suggestions**  
• [🎞️ Drag-and-drop puzzle frame with atom outline]  
• [🎞️ Particle icons: 🔴 Protons, ⚪ Neutrons, 🔵 Electrons]  
• [🎞️ Snap animation + glowing outline when correctly placed]

**Developer Guide**  
• Divide the activity into 3 phases:  
Phase 1: Drag nucleus into centre slot  
Phase 2: Drag multiple protons/neutrons into nucleus  
Phase 3: Drag electrons into two distinct orbit shells (drag logic must validate electron limits per shell)  
• Use auto-lock when a piece is placed correctly  
• Play facilitative feedback after each item drop  
• Include “Reset Puzzle” and “Try Again” buttons

**Puzzle Interactions and Facilitative Feedbacks**  
**Placing the Nucleus**  
• ✅ Correct placement:  
“Good start! The nucleus is the centre of the atom. Now let us fill it with particles.”  
• ❌ Wrong placement:  
“The nucleus must go at the atom’s core. Look for the centre slot.”

**🔴 Placing Protons**  
• ✅ In nucleus:  
“Correct! Protons are positively charged and sit in the nucleus.”  
• ❌ In energy shells:  
“Protons do not orbit. Move them into the centre — the nucleus.”

**⚪ Placing Neutrons**  
• ✅ In nucleus:  
“Well done! Neutrons stay in the nucleus and have no charge.”  
• ❌ In orbitals:  
“Neutrons belong in the centre. Only electrons orbit.”

**🔵 Placing Electrons – 1st Shell**  
• ✅ Up to 2 in 1st shell:  
“Excellent! The first shell holds a maximum of 2 electrons.”  
• ❌ More than 2 in 1st shell:  
“Too many! The first shell can only hold 2 electrons. Try the next shell.”

**🔵 Placing Electrons – 2nd Shell**  
• ✅ Up to 8 in 2nd shell:  
“Great! The second shell can hold up to 8 electrons.”  
• ❌ More than 8 in 2nd shell:  
“Careful! The second shell is full after 8 electrons.”

🎙️ **Activity Conclusion** 🎤  
“Amazing construction! You have placed every part of the atom correctly. Protons and neutrons stay in the nucleus, while electrons orbit in energy levels. Understanding this structure is key to exploring chemistry. Keep building your science knowledge!”

**🎯 Activity 5: 🔡 Atom Vocabulary – “Crossword Puzzle”**

🎙️ **Activity Introduction** 🎤  
“Atoms have a language of their own. In this crossword challenge, your mission is to solve each hint using words we have learned. Each answer unlocks part of the atomic world. Are you ready to decode the structure of an atom one word at a time?”

**Media Suggestions**  
• [📊 Crossword grid with active typing cells]  
• [🔘 Buttons: Check Answer, Reveal Answer, Reset Puzzle]  
• [🎧 Optional audio narration for each hint and feedback]

**Developer Notes**  
• Use a 7×7 responsive crossword grid with real-time validation.  
• Correct entries turn green; incorrect entries shake or highlight red briefly.  
• Enable “Check” button for each word and a “Reveal” button that unlocks the correct term after one failed attempt.  
• Display facilitative feedback for each hint below the puzzle when submitted.

**Learner Instructions (On Screen)**  
• Click any square to begin.  
• Read the hint and type your answer.  
• Use Check to verify your answer.  
• Use Reveal if you need help.

**Activity Content – Hints and Answer List**

**🔠 Across**

1. Positively charged particle (6 letters) → Proton
2. Basic unit of matter (4 letters) → Atom
3. Negative particle in an atom (8 letters) → Electron

**🔡 Down**  
2. Central part of atom (7 letters) → Nucleus  
3. Neutral particle (7 letters) → Neutron  
4. Region where electrons are found (6 letters) → Shells

**Facilitative Feedback Per Hint**  
**Across Hints**  
**1 Across: Proton**  
• ✅ Correct! Protons are found in the nucleus and carry a positive charge.  
• ❌ Hint: This particle is found in the centre and is positively charged.

**2 Across: Atom**  
• ✅ Well done! The atom is the basic unit of all matter.  
• ❌ Hint: This is the smallest building block of matter.

**3 Across: Electron**  
• ✅ Correct! Electrons are negatively charged and orbit the nucleus.  
• ❌ Hint: This particle is tiny, negatively charged, and found in shells.

**Down Hints**  
**2 Down: Nucleus**  
• ✅ Excellent! The nucleus is the centre of the atom, containing protons and neutrons.  
• ❌ Hint: This part is dense and found at the atom's core.

**4 Down: Neutron**  
• ✅ Correct! Neutrons are neutral and found in the nucleus.  
• ❌ Hint: This particle has no charge and sits next to protons.

**6 Down: Shells**  
• ✅ Great job! Shells are energy levels where electrons orbit the nucleus.  
• ❌ Hint: Electrons move in these circular paths around the nucleus.

🎙️ **Activity Conclusion** 🎤  
“Brilliant work! You have unlocked the key terms that describe the building blocks of matter. Understanding these words helps you speak the language of atoms like a true scientist. Keep up the sharp thinking!”

**✅ Key Takeaways:**

* An atom is the smallest particle of an element that can take part in chemical reactions.
* It is made up of protons (positive), neutrons (neutral), and electrons (negative).
* Protons and neutrons (nucleons) are found in the nucleus, while electrons occupy energy levels around it.
* Atoms are electrically neutral because the number of protons equals the number of electrons.
* Atomic models/diagrams are used to illustrate atomic structure.

**📚 LESSON 2: Atomic Number & Mass Number of Elements**

**🎯 Lesson Learning Outcomes**

By the end of this lesson, learners should be able to:

✅ Define **atomic number** as the number of protons in an atom  
✅ Define **mass number** as the total number of protons and neutrons in an atom  
✅ Identify atomic number and mass number from an element’s symbol representation (e.g., ¹²C₆)  
✅ Calculate the number of neutrons in an atom using atomic and mass numbers  
✅ Recognize that **all atoms of the same element** have the same atomic number

**🎬 Lesson Introduction**

🎙️ **Voiceover Script:**

“🔬 Scientists need a precise way to identify and describe different atoms.  
Just like you have a **name** and an **ID number**, atoms have special identifiers too!  
In this lesson, we will explore:  
💠 The **Atomic Number** – which gives an atom its identity (number of protons)  
💠 The **Mass Number** – which tells how heavy an atom is (protons + neutrons)  
🔍 Let us decode atomic symbols like real scientists!”

**🎯 Activity 1: 📘 Table Complete – “Fill the Atom Info”**

🎙️ **Activity Introduction** 🎤  
“Chemists use tables to organise facts about atoms. In this challenge, your job is to complete missing information using what you know about atomic number, mass number, protons, and neutrons. Some values are already filled in. Use them to solve the rest. Let us complete the atom profiles!”

👨‍💻 **Developer Guide**

* Use a responsive editable table layout with 5 rows.
* Lock correct entries after submission to prevent editing.
* Auto-highlight incorrect entries with red border.
* Add “Check Answer” and “Try Again” buttons per row.
* Trigger feedback narration after completion.
* Include reset table option.

📜 **Learner Instructions (On Screen)**

1. Use the periodic table logic:
   * Atomic Number = Number of Protons
   * Mass Number = Protons + Neutrons
2. Click into the empty cells and type your answer.
3. Use the Check button to get feedback on each row.
4. Try to complete all rows correctly.

💡 **Hint**

* Atomic Number = Protons
* Mass Number = Protons + Neutrons
* Neutrons = Mass Number – Protons
* Use addition and subtraction carefully

📊 **Activity Content**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Protons** | **Neutrons** | **Atomic Number** | **Mass Number** |
| Oxygen | 8 | 8 | 8 | 16 |
| Fluorine | 9 | 10 | 9 | 19 |
| Sodium | 11 | ❓ | 11 | ❓ |
| Neon | ❓ | 10 | 10 | ❓ |
| Nitrogen | ❓ | ❓ | 7 | 14 |

💬 **Facilitative Feedback Per Cell**

**Sodium Row:**

* Neutrons = 12 → ✅ Correct! 23 (Mass) – 11 (Protons) = 12 Neutrons.
* Mass Number = 23 → ✅ Great! 11 (Protons) + 12 (Neutrons) = 23.

**Neon Row:**

* Protons = 10 → ✅ Correct! Atomic number equals protons.
* Mass Number = 20 → ✅ Correct! 10 + 10 = 20.

**Nitrogen Row:**

* Protons = 7 → ✅ Correct! Atomic number = protons.
* Neutrons = 7 → ✅ Correct! 14 (Mass) – 7 (Protons) = 7 Neutrons.

❌ **If Incorrect (any field):**

* Check your calculation: Mass Number is the total of protons and neutrons.
* Remember: Protons always equal the atomic number of the element.
* Neutrons = Mass Number – Protons. Try again!

🎙️ **Activity Conclusion** 🎤  
“Excellent work! You now understand how to calculate the building blocks of atoms. Scientists use these numbers to predict how elements behave. You are well on your way to mastering atomic structure.”

**🎯 Activity 2: 🧪 Symbol Builder – “Atomic Code Maker”**

🎙️ **Activity Introduction** 🎤  
“Scientists use a special code to describe atoms. Each atomic symbol includes the element name, atomic number, and mass number — and they must be placed correctly. In this activity, you will build atomic symbols by dragging each number and element into the right spot. Let us crack the atomic code!”

👨‍💻 **Developer Guide**

* Build a draggable grid with three zones:
  + Top-left (superscript) → Mass Number
  + Centre → Element Symbol
  + Bottom-left (subscript) → Atomic Number
* Use snapping effect and real-time answer validation.
* Show “Check Symbol” button per attempt.
* Include reset button and visual reference panel.

📜 **Learner Instructions (On Screen)**

1. Drag the correct mass number to the top-left position (superscript).
2. Drag the correct atomic number to the bottom-left position (subscript).
3. Drag the correct element symbol to the centre.
4. Check your answer to get feedback.

💡 **Hint**

* Mass Number = Protons + Neutrons → goes top-left.
* Atomic Number = Number of Protons → goes bottom-left.
* Element Symbol → goes in the centre.
* Example format:

CopyEdit

  ²³

 Na

  ₁₁

📊 **Activity Content**

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Mass Number** | **Atomic Number** | **Element** |
| ²³Na₁₁ | 23 | 11 | Na |
| ³⁵Cl₁₇ | 35 | 17 | Cl |
| ¹⁴C₆ | 14 | 6 | C |
| ¹²Mg₁₂ | 12 | 12 | Mg |
| ⁴⁰Ca₂₀ | 40 | 20 | Ca |

💬 **Facilitative Feedback**

**²³Na₁₁ (Sodium)**

* 🔼 Mass Number ²³: ✅ Correct! Mass number is written as a superscript.
* 🔽 Atomic Number ₁₁: ✅ Correct! Atomic number is always in subscript.
* 🔤 Na: ✅ Perfect! Na is the symbol for Sodium.
* ❌ If misplaced: Mass number must be on top, atomic number at the bottom.

**³⁵Cl₁₇ (Chlorine)**

* 🔼 ³⁵: ✅ Mass number is 35 for Chlorine.
* 🔽 ₁₇: ✅ Atomic number of Chlorine is 17.
* 🔤 Cl: ✅ Cl is the correct symbol for Chlorine.
* ❌ Incorrect placement: Cl must stay in the centre.

**¹⁴C₆ (Carbon)**

* 🔼 ¹⁴: ✅ Mass number = 14.
* 🔽 ₆: ✅ Atomic number for Carbon is 6.
* 🔤 C: ✅ C is the symbol for Carbon.
* ❌ Wrong number/placement: Mass is always top-left.

**¹²Mg₁₂ (Magnesium)**

* ✅ Well done! Magnesium has 12 protons and a mass number of 12.
* ❌ Incorrect number: Check the periodic table.

**⁴⁰Ca₂₀ (Calcium)**

* ✅ Great! Atomic number is 20, mass number 40.
* ❌ Atomic number error: Must match the number of protons.

🎙️ **Activity Conclusion** 🎤  
“You have successfully created correct atomic symbols. The mass number tells us how heavy the atom is, and the atomic number tells us how many protons it has. This skill helps scientists identify isotopes and compare elements. Excellent coding!”

**🎯 Activity 3: 🔍 Hotspot Click – “Decode the Symbol”**

🎙️ **Activity Introduction** 🎤  
“Each atomic symbol contains hints about what makes an atom unique. By clicking on the parts of the symbol, you will uncover the meaning behind every number and letter. Explore carefully, and learn how to read atomic identities.”

💡 **Hint**

* Mass Number = Protons + Neutrons → Top-left.
* Atomic Number = Number of Protons → Bottom-left.
* Chemical Symbol = 1–2 letters representing the element → Centre.

👨‍💻 **Developer Guide**

* Create 3 interactive hotspots per symbol:
  1. Superscript → Mass Number
  2. Subscript → Atomic Number
  3. Centre → Element Symbol
* Each hotspot triggers an explanatory pop-up (no correct/incorrect logic).
* After all hotspots in all symbols are clicked, show conclusion narration.

📜 **Learner Instructions (On Screen)**  
Click on the mass number, atomic number, and chemical symbol in each atomic symbol to reveal their meaning.

📊 **Activity Content 🧪 Symbols to Explore (Each with 3 Clickable Parts)**

**🔍 Symbol 1: ¹⁴N₇**

**🔼 14 — *Mass Number***

🧾 *This is the* ***mass number****, which equals the total number of protons and neutrons in the atom. For Nitrogen, that means 7 protons + 7 neutrons = 14.*

**🔽 7 — *Atomic Number***

🧾 *This is the* ***atomic number****. It tells you the number of protons in the atom. Nitrogen has 7 protons.*

**🔤 N — *Chemical Symbol***

🧾 *This is the* ***chemical symbol*** *for Nitrogen. Every element has a unique one- or two-letter code.*

**🔍 Symbol 2: ²³Na₁₁**

**🔼 23 — *Mass Number***

🧾 *This is the* ***mass number*** *for Sodium. It represents the total number of protons and neutrons. Sodium has 11 protons and 12 neutrons: 11 + 12 = 23.*

**🔽 11 — *Atomic Number***

🧾 *This is the* ***atomic number****. It shows that Sodium has 11 protons. It also defines the element.*

**🔤 Na — *Chemical Symbol***

🧾 *This is the* ***chemical symbol*** *for Sodium. ‘Na’ comes from the Latin name Natrium.*

**🔍 Symbol 3: ⁴⁰Ca₂₀**

**🔼 40 — *Mass Number***

🧾 *This is the* ***mass number****. Calcium has 20 protons and 20 neutrons. The mass number is their sum: 20 + 20 = 40.*

**🔽 20 — *Atomic Number***

🧾 *This is the* ***atomic number****. It shows that Calcium has 20 protons. This number also tells us how the atom behaves chemically.*

**🔤 Ca — *Chemical Symbol***

🧾 *This is the* ***chemical symbol*** *for Calcium. Symbols are used worldwide to represent elements.*

🎙️ **Activity Conclusion** 🎤  
“You have now decoded how atomic symbols work. You can identify how many protons, neutrons, and which element each symbol represents. This knowledge helps you interpret data about any atom on the periodic table.”

**✅ Key Takeaways:**

* **Atomic number (Z):** Number of protons, used to identify elements.
* **Mass number (A):** Protons + neutrons; always ≥ atomic number.
* **Atomic representation:** Written as \prescriptAZX\prescript{A}{Z}\mathrm{X} (e.g., \prescript126C\prescript{12}{6}\mathrm{C}).
* **Isotopes:** Atoms of the same element with same atomic number but different mass numbers (different neutrons).

**📚 LESSON 3: Electron Arrangement of Elements**

**🎯 Learning Outcomes**

By the end of this lesson, learners should be able to:

✅ State the maximum number of electrons that can occupy the first three energy levels: **2**, **8**, **8**  
✅ Write electron configurations for the first 20 elements (e.g., Sodium → **2.8.1**)  
✅ Apply the rule: **Lower energy levels are filled before higher ones**  
✅ Identify **valence electrons** (electrons in the outermost shell)

**🎬 Lesson Introduction**

🎙 **Voiceover Script:**

“⚙️ Electrons are not scattered randomly – they live in **energy levels**, like passengers on different floors of a building.  
🧠 In this lesson, we will ride the **Energy Level Express** and learn how electron arrangements explain how elements behave during chemical reactions. All aboard!”

**🎯 Activity 1: 🔢 Sequence Builder – “Shell Fill Game”**

**🎤 Activity Introduction**

“Electrons do not just float around randomly—they follow a special rule! Just like seats in a bus or riders in an elevator, electrons fill energy levels in order. In this game, drag electrons to the correct shell. Start from the first shell and move outward. Ready to fill the atom?”

**👨‍💻 Developer Guide**

* Display 3 concentric shells with drop zones.
* Provide draggable electrons as ⚪ icons.
* On drop:
  + Lock electron into the shell.
  + Count electrons per shell.
* When all electrons are placed, validate full configuration.
* Trigger feedback popup based on accuracy.

**📋 Learner Instructions (On-Screen)**

Drag each ⚪ electron to its correct shell.

* The first shell holds a maximum of 2 electrons.
* The second shell holds up to 8 electrons.
* The third shell holds up to 8 electrons.

Drop electrons one at a time into each ring. Watch out for the limits!

**💡 Hint**

Shell Filling Rules:

* 1st shell → Max 2 electrons.
* 2nd shell → Max 8 electrons.
* 3rd shell → Max 8 electrons.

Examples:

* Lithium (3 electrons): 2 in 1st shell, 1 in 2nd → 2.1
* Fluorine (9 electrons): 2 in 1st, 7 in 2nd → 2.7
* Argon (18 electrons): 2 in 1st, 8 in 2nd, 8 in 3rd → 2.8.8

**📊 Activity Content**

|  |  |  |
| --- | --- | --- |
| **Element** | **Atomic Number** | **Correct Configuration** |
| Hydrogen | 1 | 1 |
| Helium | 2 | 2 |
| Lithium | 3 | 2.1 |
| Beryllium | 4 | 2.2 |
| Fluorine | 9 | 2.7 |
| Neon | 10 | 2.8 |
| Magnesium | 12 | 2.8.2 |
| Sulfur | 16 | 2.8.6 |
| Argon | 18 | 2.8.8 |

**💬 Facilitative Feedback**

**If Dropping Into Shell 1:**

* ✅ 1st or 2nd electron: First shell is filling correctly. It holds a maximum of 2 electrons.
* ❌ 3rd or more: First shell is full. Move to the next energy level.

**If Dropping Into Shell 2:**

* ✅ Up to 8th electron: Second shell is filling properly. It can hold up to 8 electrons.
* ❌ 9th or more: Second shell is full. Use the third shell next.

**If Dropping Into Shell 3:**

* ✅ Up to 8 electrons: Third shell is now filling. Keep going until you use all electrons.
* ❌ Any drop before shell 1 or 2 are full: You cannot skip a shell. Fill inner shells first.

**🎤 Activity Conclusion**

“You have placed all the electrons in the correct shells. Electrons always fill the closest shells first, just like people filling seats in the front of a bus. You are now able to build electron configurations for real elements!”

**🎯 Activity 2: 🎮 Guessing Game – “Name That Element!”**

**🎤 Activity Introduction 🎤**

“Each atom has its own unique fingerprint—its electron arrangement. In this guessing game, your job is to identify the correct element based on how its electrons are arranged across energy levels. Think like a detective. The total number of electrons equals the atomic number!”

**👨‍💻 Developer Guide**

* For each question:
  + Display a **Hint** such as "2.8.2".
  + Present four multiple-choice options.
  + Only one correct answer based on total electrons.
* After the learner makes a choice:
  + Show specific facilitative feedback for that choice.
  + Allow a “Check Answer” button before moving on.
* At the end:
  + Show general feedback narration.
* Optional: Add “Retry Incorrect Only” flow.

**📋 Learner Instructions (On-Screen)**

You will be shown an electron arrangement.  
Choose the element whose atomic number matches the total electrons.  
You may use a periodic table if needed.

**💡 Hint**

* Electron arrangement shows how electrons fill shells in order: 2 → 8 → 8 → 18.
* Total electrons = Atomic Number.
* Example: **2.8.1 = 11 electrons → Sodium (Na)**.
* Add up the numbers in the arrangement, then find the element with that atomic number.

**📊 Activity Content – Sample Questions**

**🧩 Question 1**

**Hint:** 2.8.2  
Choices:

* ☐ Calcium
* ☐ Sodium
* ☑ Magnesium
* ☐ Neon

Facilitative Feedback:

* **Calcium:** Calcium has 20 electrons. 2.8.2 adds up to 12.
* **Sodium:** Sodium has 11 electrons. This arrangement has 12.
* **Magnesium:** ✅ Correct. Magnesium has 12 electrons arranged as 2 in the 1st shell, 8 in the 2nd, and 2 in the 3rd.
* **Neon:** Neon has 10 electrons. Check your total again.

**🧩 Question 2**

**Hint:** 2.5  
Choices:

* ☐ Oxygen
* ☑ Nitrogen
* ☐ Carbon
* ☐ Fluorine

Facilitative Feedback:

* **Oxygen:** Oxygen has 8 electrons. 2.5 adds up to 7.
* **Nitrogen:** ✅ Correct. 2 + 5 = 7 electrons. Nitrogen has atomic number 7.
* **Carbon:** Carbon has 6 electrons. This clue points to 7 electrons.
* **Fluorine:** Fluorine has 9 electrons. This clue has only 7.

**🧩 Question 3**

**Hint:** 2.8.8.1  
Choices:

* ☐ Calcium
* ☐ Argon
* ☑ Potassium
* ☐ Chlorine

Facilitative Feedback:

* **Calcium:** Calcium has 20 electrons. This configuration adds up to 19.
* **Argon:** Argon has 18 electrons. This configuration has 19.
* **Potassium:** ✅ Correct. Potassium has 19 electrons: 2 + 8 + 8 + 1.
* **Chlorine:** Chlorine has 17 electrons. This arrangement shows more than that.

**🧩 Question 4**

**Hint:** 2.8.6  
Choices:

* ☐ Chlorine
* ☑ Sulphur
* ☐ Phosphorus
* ☐ Neon

Facilitative Feedback:

* **Chlorine:** Chlorine has 17 electrons. 2.8.6 = 16.
* **Sulphur:** ✅ Correct. Sulphur has 16 electrons. 2 + 8 + 6 = 16.
* **Phosphorus:** Phosphorus has 15 electrons. This clue totals 16.
* **Neon:** Neon has only 10 electrons.

**🧩 Question 5**

**Hint:** 2.8  
Choices:

* ☐ Oxygen
* ☐ Fluorine
* ☑ Neon
* ☐ Carbon

Facilitative Feedback:

* **Oxygen:** Oxygen has 8 electrons. This configuration adds up to 10.
* **Fluorine:** Fluorine has 9 electrons.
* **Neon:** ✅ Correct. Neon has a full second shell: 2 + 8 = 10 electrons.
* **Carbon:** Carbon has 6 electrons. This configuration has 10.

**🎤 Activity Conclusion 🎤**

“Well done! You have successfully matched electron arrangements to their elements. Electron configuration is a key to understanding atomic structure and periodic placement. Keep practising to strengthen your scientific deduction skills!”

**🎯 Activity 3: 🧪 Fix the Mistake! – “Error Buster”**

**🔧 Type:** Error Spotting & Correction  
**🎯 Target Skill:** Apply atomic number knowledge and shell capacity rules to fix electron arrangement errors

**🎙️ Activity Introduction 🎤**

**Narration:**  
"Atoms must follow strict rules when filling up with electrons. But someone made a mistake in the arrangements! Your job is to spot the error and fix it by dragging the electrons to the correct shells. Are you ready to be the error buster?"

**👨‍💻 Developer Guide Instructions**

* Display each configuration visually with electrons shown in shell rings.
* Use drag-and-drop logic for moving electrons between shells.
* Add snap zones with capacity limits:
  + Shell 1 → Max 2
  + Shell 2 → Max 8
  + Shell 3 → Max 8
* Allow learners to reconfigure electrons and click **“Submit Fix”**.
* After submission, display **specific facilitative feedback** for correct and incorrect answers.
* End screen shows conclusion narration.

**📋 Learner Instructions (On-Screen)**

1. Look at the atom’s current configuration.
2. Count the total electrons shown.
3. Check the element’s atomic number.
4. Drag and drop electrons to the correct shells based on filling rules (2–8–8).
5. Submit your fix to receive feedback.

**💡 Hint Panel (On-Screen)**

**Shell Filling Rules:**

* 1st shell → Max 2 electrons
* 2nd shell → Max 8 electrons
* 3rd shell → Max 8 electrons

**Hints:**

* Count all shown electrons and compare with the correct atomic number.
* Fix overflowed or missing shells.
* Remember: Atomic Number = Total Electrons.

**🧪 Activity Content with Specific Facilitative Feedback**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Case** | **Element** | **Incorrect Arrangement(s)** | **Correct Arrangement** | **Correct Feedback** | **Incorrect Feedbacks** |
| **1** | Helium | 2.1 | 2 | **Correct:** Helium has 2 electrons, all in the first shell. Corrected well. | **If 2.1:** Helium has only 2 electrons. First shell is full; no electrons should go to the second. |
| **2** | Fluorine | 2.6, 3.6 | 2.7 | **Correct:** Fluorine’s atomic number is 9 → 2 in 1st shell, 7 in 2nd. | **If 2.6:** Fluorine has 9 electrons. Only 8 shown here. One is missing from the second shell. **If 3.6:** The second shell should be filled before moving to the third. |
| **3** | Sodium | 2.9, 3.8 | 2.8.1 | **Correct:** Sodium has 11 electrons. You have arranged them correctly. | **If 2.9:** The second shell cannot hold more than 8. Excess electron must go to the third shell. **If 3.8:** First shell is incomplete; always fill shells in sequence. |
| **4** | Neon | 2.6.2, 2.7.1 | 2.8 | **Correct:** Neon’s configuration is stable and full at 10 electrons. Good fix. | **If 2.6.2:** Third shell should not be used before the second is full. Neon has only 10 electrons. **If 2.7.1:** Second shell must be completed to 8 before placing any electrons in the third shell. |
| **5** | Magnesium | 2.10, 3.7.2 | 2.8.2 | **Correct:** Magnesium has 12 electrons. 2 + 8 + 2 = 12. Fixed correctly. | **If 2.10:** Second shell max is 8. Move 2 electrons to the third shell. **If 3.7.2:** First shell must always contain 2 electrons before filling the others. |

**🎙️ Activity Conclusion 🎤**

**Narration:**  
"You have spotted and fixed the atomic errors successfully. This shows that you understand how electrons fill energy levels based on atomic number. Keep practising, and you will become a master of atomic accuracy."

**🎯 Activity 4: ⚖️ Scenario-Based Comparison – “Who Reacts Faster?”**

**🧪 Type:** Scenario-Based MCQ (React & Predict)  
**🎯 Target Skill:** Predict chemical behaviour using outer shell electrons in realistic situations

**🎙️ Activity Introduction 🎤**

**Narration:**  
"Different elements react in different ways based on how full or empty their outer shells are. In this game, you will step into real-life science scenarios. Use the clues from electron arrangements to decide which element is more likely to react, gain, or lose electrons. Think like a chemist in action!"

**👨‍💻 Developer Guide Instructions**

* Display realistic scenarios with supporting context text.
* Use two diagram icons per question (e.g., atom shells or electron configurations).
* Present MCQ interaction per scenario with three clear options.
* Show **specific facilitative feedback** for both correct and incorrect responses.
* Allow learners to retry specific scenarios from a summary screen.
* Conclude with general narration.

**📋 Learner Instructions (On-Screen)**

1. Read each scenario carefully.
2. Use the electron arrangement to compare the elements.
3. Choose the element that best answers the question based on reactivity or electron behaviour.
4. Submit your choice and review the feedback to understand your selection.

**💡 Hint Panel (On-Screen)**

**Key Reminders:**

* Atoms with 1 or 2 outer electrons → likely to lose electrons → More reactive metals.
* Atoms with 6 or 7 outer electrons → likely to gain electrons → More reactive non-metals.
* Full outer shells (e.g., 2.8.8) → Stable, not reactive.
* Total electrons = Atomic Number.
* Use the outermost shell to make your decision.

**🧪 Scenario-Based Questions with Feedback**

**🧩 Scenario 1: Battery Builder**

**Scenario:**  
A battery manufacturer is selecting a metal that will easily give away its outermost electron. Two samples arrive:

* Sample A: 2.8.1
* Sample B: 2.8.2

**Question:**  
Which metal is more likely to lose electrons and be used in the battery?

**Choices:**

* ☐ Sample B (2.8.2)
* ☑ Sample A (2.8.1)
* ☐ Both are equal

**Facilitative Feedbacks:**

* **Sample A:** Correct. One valence electron is easier to lose, so it reacts faster.
* **Sample B:** Two valence electrons take more energy to remove. Check again.
* **Both:** One sample is clearly more reactive than the other.

**🧩 Scenario 2: Reactive Rescue**

**Scenario:**  
A chemist is trying to capture harmful gases in the lab using a highly reactive non-metal. She has:

* Gas A: 2.6
* Gas B: 2.8.6

**Question:**  
Which gas is more likely to gain electrons quickly in a chemical reaction?

**Choices:**

* ☑ Gas A
* ☐ Gas B
* ☐ Both react equally

**Facilitative Feedbacks:**

* **Gas A:** Correct. Fewer energy levels = stronger pull on electrons.
* **Gas B:** More shells reduce attraction to new electrons.
* **Both:** Not quite. The one with fewer shells gains electrons more easily.

**🧩 Scenario 3: Inert or Alert?**

**Scenario:**  
An experiment needs a gas that does not react with anything. The lab has two cylinders:

* Cylinder A: 2.8
* Cylinder B: 2.8.7

**Question:**  
Which gas is chemically stable?

**Choices:**

* ☑ Cylinder A
* ☐ Cylinder B
* ☐ Both

**Facilitative Feedbacks:**

* **Cylinder A:** Correct. Full outer shell = stable noble gas.
* **Cylinder B:** One electron short = very reactive.
* **Both:** Only one has a full outer shell.

**🧩 Scenario 4: Quick Metal Reaction**

**Scenario:**  
You are testing metals in water to see which reacts violently. You test:

* Metal X: 2.8.8.1
* Metal Y: 2.8.8.2

**Question:**  
Which metal is more reactive in water?

**Choices:**

* ☑ Metal X
* ☐ Metal Y
* ☐ Neither

**Facilitative Feedbacks:**

* **Metal X:** Correct. Easier to lose 1 valence electron = faster reaction.
* **Metal Y:** Two valence electrons = more stable than 1. Less reactive.
* **Neither:** Look at valence electrons. One has clear reactivity advantage.

**🧩 Scenario 5: Bond Builder**

**Scenario:**  
You are forming a compound. You need an element that wants to gain 1 electron. Two options:

* Element A: 2.8.6
* Element B: 2.8.7

**Question:**  
Which element is most likely to gain one electron to become stable?

**Choices:**

* ☐ Element A
* ☑ Element B
* ☐ Both

**Facilitative Feedbacks:**

* **Element B:** Correct. Needs only 1 more to complete its outer shell.
* **Element A:** Needs 2 electrons—not as close to full shell.
* **Both:** Only one needs just one more to become stable.

**🎙️ Activity Conclusion 🎤**

**Narration:**  
"You have analysed real-world reactions based on valence electrons. Whether choosing metals for batteries or gases for safe storage, you now understand how to compare elements using electron behaviour. Well done!"

**✅ Key Takeaways:**

* Electrons occupy **energy levels (shells):** 1st = 2, 2nd = 8, 3rd = 8 (first 20 elements), 4th starts at Potassium.
* **Electron configuration** shows distribution of electrons (e.g., Calcium = 2.8.8.2).
* **Dot and cross diagrams** represent electrons around the nucleus.
* These diagrams highlight **valence electrons**, helping predict reactivity.

**📚 LESSON 4: Energy Level Diagrams (Dot or Cross)**

**🎯 Learning Outcomes**

By the end of this lesson, learners should be able to:

✅ Represent electron arrangements using **dot (•)** or **cross (×)** diagrams  
✅ Interpret dot and cross diagrams to determine **electrons per energy level**  
✅ Draw simple dot/cross diagrams for the **first 20 elements**  
✅ Identify an element based on its **electron diagram**

**🎬 Lesson Introduction**

🎙 **Voiceover Script:**

“🎨 Did you know atoms can be drawn like diagrams? That is right! Scientists use **dot (•)** and **cross (×)** diagrams to show how electrons are arranged around the nucleus.  
In this lesson, you will learn how to create and analyse these amazing atomic visuals – all while sharpening your science AND artistic skills.  
🎯 Get your virtual pencil ready — it is time to draw the invisible!”

**🎯 Activity 1: ✍️ Drawing Canvas – “Sketch That Atom”**

**🧪 Type:** Interactive Drawing Lab  
**🎯 Target Skill:** Use dots or crosses to represent electrons in the correct shells based on atomic number

**🎙️ Activity Introduction 🎤**

**Narration:**  
"Every atom has a unique structure. In this activity, you will use dots or crosses to sketch electrons in the correct energy levels. Think like a chemist and draw like a scientist!"

**👨‍💻 Developer Guide Instructions**

* Display a static atom template with:
  + Centre nucleus (not interactive)
  + Three concentric shell zones (clickable drop zones)
* Learner interaction:
  + Click to place • or ×
  + Count each dot per shell
* Tool buttons:
  + **Undo:** Removes last-placed electron
  + **Clear:** Clears all dots
  + **Check:** Triggers validation and feedback based on atomic number
* Feedback system:
  + Show **specific facilitative feedback** for correct and incorrect arrangements.
  + Keep shell capacity rules enforced during placement to guide learners.

**📋 Learner Instructions (On-Screen)**

1. Click on each shell to place electrons as • or ×.
2. Use the atom’s atomic number to determine the total number of electrons.
3. Follow the filling rules:
   * 1st shell: maximum 2 electrons
   * 2nd shell: maximum 8 electrons
   * 3rd shell: maximum 8 electrons
4. Use the tools provided:
   * **Undo:** Remove last dot
   * **Clear:** Start over
   * **Check:** Submit your diagram for feedback

**💡 Hint Panel (On-Screen)**

**Electron Shell Rules:**

* Shell 1 → Up to 2 electrons
* Shell 2 → Up to 8 electrons
* Shell 3 → Up to 8 electrons

**Examples:**

* Hydrogen (1) → 1 dot in 1st shell
* Carbon (6) → 2 in 1st, 4 in 2nd → 2.4
* Neon (10) → 2 in 1st, 8 in 2nd → 2.8
* Sodium (11) → 2 in 1st, 8 in 2nd, 1 in 3rd → 2.8.1

**🧪 Activity Content and Facilitative Feedback**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Atomic Number** | **Expected Sketch (by shell)** | **Correct Feedback** | **Incorrect Feedback Examples** |
| Hydrogen | 1 | 1 in 1st | Correct. Hydrogen has 1 electron in the first shell only. | If more than 1 in 1st: Hydrogen only has 1 electron, check the atomic number. |
| Helium | 2 | 2 in 1st | Correct. Helium’s first shell is full at 2 electrons. | If 1 in 1st: Helium has 2 electrons; one is missing. |
| Lithium | 3 | 2 in 1st, 1 in 2nd | Correct. Lithium’s configuration is 2.1. | If 3 in 1st: First shell can only hold 2 electrons; move one to second shell. |
| Carbon | 6 | 2 in 1st, 4 in 2nd | Correct. Carbon has 6 electrons arranged as 2.4. | If 3 in 1st: First shell max is 2. If 2 in 1st, 5 in 2nd: Too many electrons for carbon; check total count. |
| Neon | 10 | 2 in 1st, 8 in 2nd | Correct. Neon has a full outer shell at 2.8, making it stable. | If 2 in 1st, 7 in 2nd: Missing one electron. If 3rd shell used: Neon only needs two shells. |
| Sodium | 11 | 2 in 1st, 8 in 2nd, 1 in 3rd | Correct. Sodium’s configuration is 2.8.1. | If 2 in 1st, 9 in 2nd: Second shell can only hold 8; move extra to third shell. |
| Magnesium | 12 | 2 in 1st, 8 in 2nd, 2 in 3rd | Correct. Magnesium has 12 electrons arranged as 2.8.2. | If 2 in 1st, 10 in 2nd: Second shell max is 8; move 2 to third shell. |
| Phosphorus | 15 | 2 in 1st, 8 in 2nd, 5 in 3rd | Correct. Phosphorus has 15 electrons arranged as 2.8.5. | If 2 in 1st, 9 in 2nd, 4 in 3rd: Second shell cannot hold more than 8; adjust distribution. |

**🎙️ Activity Conclusion 🎤**

**Narration:**  
"You have successfully drawn atoms with the correct electron arrangements. Understanding how to represent electrons in shells helps you identify atomic properties and predict chemical behaviour. Keep practising to master the skill of atomic sketching."

**🎯 Activity 2: 🧠 Diagram Detective – “MCQ Challenge”**

**📘 Objective:**  
Use visual representations of atoms to determine electron arrangement or atomic identity.

**🎙️ Activity Introduction**   
"Put on your science detective hat! Each atom diagram shows how electrons are arranged in shells. Look closely, count carefully, and match it with the right answer."

**👨‍💻 Developer Guide Instructions**

* Display clean atomic diagrams (2 or 3 shells).
* Electrons marked as dots (•) or crosses (×) on shells.
* One MCQ prompt below each diagram with four options.
* Auto-check on selection and trigger **specific facilitative feedback**.
* Use animation to highlight selected electron shells when correct/incorrect.

**📋 Learner Instructions (On-Screen)**

1. Study each dot and cross diagram of an atom carefully.
2. Count the electrons in each shell.
3. Choose the correct electron arrangement or element name that matches the diagram.
4. Review the feedback to understand why your choice was correct or incorrect.

**💡 Hint Panel (On-Screen)**

**Key Reminders:**

* Shell 1 → maximum 2 electrons
* Shell 2 → maximum 8 electrons
* Shell 3 → maximum 8 electrons
* Electrons fill shells from the inside out.
* Atomic number = total number of electrons.

**🧪 Activity Content with Specific Facilitative Feedback**

**🔍 Question 1**

**Diagram:**

* 2 electrons in 1st shell
* 8 electrons in 2nd shell

**Question:**  
What is the electron arrangement?

|  |  |  |
| --- | --- | --- |
| **Option** | **Correct/Incorrect** | **Facilitative Feedback** |
| 2.7 | ❌ Incorrect | 2.7 means 7 in the second shell, but this one has 8. Count carefully. |
| 2.8 | ✅ Correct | First shell has 2 electrons, second shell is full with 8. |
| 2.9 | ❌ Incorrect | Too many in the second shell. The maximum is 8 electrons. |
| 8.2 | ❌ Incorrect | Shells fill from the inside out. This order is reversed. |

**🔍 Question 2**

**Diagram:**

* 2 electrons in 1st shell
* 8 electrons in 2nd shell
* 1 electron in 3rd shell

**Question:**  
Which element is this?

|  |  |  |
| --- | --- | --- |
| **Option** | **Correct/Incorrect** | **Facilitative Feedback** |
| Neon | ❌ Incorrect | Neon has 2.8 and no electrons in the third shell. |
| Sodium | ✅ Correct | Sodium has electron arrangement 2.8.1, atomic number 11. |
| Fluorine | ❌ Incorrect | Fluorine has only 9 electrons: 2.7. |
| Magnesium | ❌ Incorrect | Magnesium has 2 electrons in the third shell, not 1. |

**🔍 Question 3**

**Diagram:**

* 2 electrons in shell 1
* 4 electrons in shell 2

**Question:**  
What is the total number of electrons?

|  |  |  |
| --- | --- | --- |
| **Option** | **Correct/Incorrect** | **Facilitative Feedback** |
| 8 | ❌ Incorrect | 2 + 4 = 6. Check the second shell again. |
| 6 | ✅ Correct | This is carbon with electron arrangement 2.4. |
| 7 | ❌ Incorrect | Too high. Count each electron carefully. |
| 10 | ❌ Incorrect | That would be neon. This atom has fewer electrons. |

**🎙️ Activity Conclusion 🎤**

**Narration:**  
"You did a great job analysing atomic diagrams! Visual decoding of atoms is a powerful skill in chemistry. Keep practising, and soon you will be able to identify any element by its electron structure."

**🎯 Activity 3: 🔄 Drag & Drop – “Complete the Diagram”**

**📘 CBC Learning Objective:**  
Construct visual representations of atoms by arranging electrons in the correct energy levels based on given electron configurations.

**🎙️ Activity Introduction 🎤**

**Narration:**  
"Get ready to build atoms! Your mission is to drag electrons into the correct shells based on the atomic configuration provided. Follow the shell filling rules: the first shell holds 2, the second holds 8, and the third also holds up to 8. Let us complete these atoms together!"

**👨‍💻 Developer Guide Instructions**

* **Structure:**
  + Provide a base template of an atom: a nucleus and 3 concentric shell rings.
  + Display draggable electron icons (⚪ or ×).
  + Provide the target electron configuration on-screen (e.g., "2.5").
  + Lock drag zones to shell rings (drop zones).
  + Snap electrons to orbit and count placements.
  + Include **Check My Atom** and **Try Again** buttons.
* **Visuals to Include:**
  + Blank atom shell diagram: centre nucleus + 3 energy levels.
  + Electron tokens with drag-and-drop interactivity.
  + [Optional] SFX: soft drag, click, and “correct” confirmation chime.

**📋 Learner Instructions (On-Screen)**

1. Read the electron arrangement shown.
2. Drag the correct number of electrons onto each shell.
3. Click **Check My Atom** to receive feedback.

**💡 Hint Panel (On-Screen)**

**Electron Shell Rules:**

* Shell 1 → maximum 2 electrons
* Shell 2 → maximum 8 electrons
* Shell 3 → maximum 8 electrons
* Fill shells from the inside out.

**Examples:**

* Oxygen (2.6) → Oxygen has 8 electrons. First shell fills first.
* Nitrogen (2.5) → Nitrogen has 7 electrons. Start with 2 in the first.
* Neon (2.8) → Neon is a stable gas. Fill both shells completely.
* Fluorine (2.7) → Fluorine needs just one to fill the outer shell!

**🧪 Activity Content and Facilitative Feedback**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Electron Arrangement** | **Hint (On-Screen Prompt)** | **Correct Feedback** | **Incorrect Feedback Examples** |
| Oxygen | 2.6 | Oxygen has 8 electrons. First shell fills first. | ✅ Great work! You placed each electron where it belongs. | ❌ If 3 in 1st shell: The first shell only holds 2 electrons. Move extras to the next level. ❌ If fewer than 8 total: Recount your total electrons. You may have left some behind. ❌ If 3rd shell used: Shells must be filled from the inside out. |
| Nitrogen | 2.5 | Nitrogen has 7 electrons. Start with 2 in the first. | ✅ Correct! Your placement matches nitrogen’s electron structure. | ❌ If 1st shell incomplete: Always fill the first shell before the second. ❌ If total is not 7: Check the atomic number and count again. ❌ If 3rd shell used: The third shell is not needed for nitrogen. |
| Neon | 2.8 | Neon is a stable gas. Fill both shells completely. | ✅ Perfect! Neon’s configuration is 2.8, making it stable. | ❌ If less than 8 in 2nd shell: A full second shell for neon must have 8 electrons. ❌ If 3rd shell used: Neon does not require a third shell. ❌ If 1st shell not full: Always fill from the first shell outwards. |
| Fluorine | 2.7 | Fluorine needs just one to fill the outer shell! | ✅ Correct! Fluorine has 2 in the first shell and 7 in the second. | ❌ If 2nd shell full at 8: That would make it neon, not fluorine. ❌ If fewer than 7 in 2nd shell: Check the total — fluorine has 9 electrons. ❌ If 3rd shell used: Fluorine only needs two shells. |

**🎙️ Activity Conclusion 🎤**

**Narration:**  
"Well done, atom builder! Your diagram now shows how electrons are arranged in real atoms. Remember: electrons always fill from the lowest energy level up. You are now one step closer to mastering atomic structure!"

**🎯 Activity 4: 🔎 Compare the Visuals – “Spot the Difference”**

**🎙️ Activity Introduction 🎤**  
"Time to become an electron detective! Look closely at the atom diagrams. Each dot or cross shows an electron. The outermost ring tells you how reactive an atom is. Ready to spot the key differences?"

**👨‍💻 Developer Guide Instructions**

* **Structure:**
  + Display two side-by-side dot-and-cross diagrams with labelled shells.
  + Pose one multiple-choice question with 3 or 4 options for each comparison.
  + Add **Check Answer** button.
  + If the answer is wrong, highlight the correct shell with animation.
* **Interactions:**
  + Highlight selected shells when hovered or clicked.
  + Optional pop-up hint on the outer shell: *“This is the valence shell!”*
* **Media Assets:**
  + Diagrams for: Sodium (2.8.1), Magnesium (2.8.2), Aluminium (2.8.3), Fluorine (2.7), Neon (2.8), Chlorine (2.8.7).

**📋 Learner Instructions (On-Screen)**

1. Look at the two diagrams carefully.
2. Focus on the outermost shell — this is the valence shell.
3. Read the question below the diagrams.
4. Choose the correct option that answers the question.
5. Click **Check Answer** to see feedback.

**💡 Hint Panel (On-Screen)**

**Key Reminders:**

* The valence shell is the outermost electron shell.
* Atoms with 1–3 valence electrons usually lose them during bonding.
* Atoms with 5–7 valence electrons usually gain electrons to fill their shell.
* A full outer shell (e.g., 2.8 or 2.8.8) means the atom is stable and not reactive.

**🧪 Activity Content with Specific Facilitative Feedback**

**Scenario 1: Sodium (2.8.1) vs Magnesium (2.8.2)**

**Question:** Which atom has more electrons in its outer shell?

|  |  |  |
| --- | --- | --- |
| **Choice** | **Correct/Incorrect** | **Facilitative Feedback** |
| Sodium | ❌ Incorrect | Sodium’s last shell contains 1 electron, not more than magnesium. Check the second ring on both diagrams. |
| Magnesium | ✅ Correct | Magnesium has 2 electrons in the outermost shell. Sodium has only 1. |
| Both have the same | ❌ Incorrect | Sodium has 1, magnesium has 2 in the outermost shell — they are not the same. |

**Scenario 2: Magnesium (2.8.2) vs Aluminium (2.8.3)**

**Question:** Which element is more likely to lose 3 electrons during bonding?

|  |  |  |
| --- | --- | --- |
| **Choice** | **Correct/Incorrect** | **Facilitative Feedback** |
| Magnesium | ❌ Incorrect | Magnesium has 2 outer electrons and typically loses only 2, not 3. |
| Aluminium | ✅ Correct | Aluminium has 3 outer electrons and tends to lose all three to become stable. |
| Neither | ❌ Incorrect | One of them — aluminium — is highly likely to lose 3 electrons. Look at the third shell. |

**Scenario 3: Fluorine (2.7) vs Neon (2.8)**

**Question:** Which atom is more chemically reactive?

|  |  |  |
| --- | --- | --- |
| **Choice** | **Correct/Incorrect** | **Facilitative Feedback** |
| Fluorine | ✅ Correct | Fluorine needs just 1 more electron to complete its shell, making it highly reactive. |
| Neon | ❌ Incorrect | Neon already has a full outer shell with 8 electrons. It is very stable and does not easily react. |
| Both | ❌ Incorrect | Only fluorine is reactive — neon is a noble gas, stable and inert. |

**Scenario 4: Sodium (2.8.1) vs Chlorine (2.8.7)**

**Question:** Which atom is more likely to lose an electron?

|  |  |  |
| --- | --- | --- |
| **Choice** | **Correct/Incorrect** | **Facilitative Feedback** |
| Sodium | ✅ Correct | Sodium has 1 valence electron and easily loses it to become stable. |
| Chlorine | ❌ Incorrect | Chlorine tends to gain 1 electron to complete its shell — not lose. |
| Neither | ❌ Incorrect | Sodium often loses its single outer electron. Review the electron arrangement. |

**🎙️ Activity Conclusion**   
"Well done comparing valence electrons! The number in the outer shell tells us whether an atom will lose or gain electrons. This is key in predicting how it reacts with other elements."

**✅ Key Takeaways:**

* Elements are classified by **electron arrangement** and **physical/chemical properties**.
* **Metals:** 1–3 valence electrons (e.g., Na = 2.8.1, Mg = 2.8.2).
* **Non-metals:** 5–8 valence electrons (e.g., O = 2.6, Cl = 2.8.7).
* **Metalloids:** 4 valence electrons, showing both metal and non-metal properties (e.g., Si, B).
* **Exceptions:** Hydrogen, Helium, Boron, and Silicon have special cases.

**📚 LESSON 5: Metals vs Non-Metals**

**🎯 Learning Outcomes:** By the end of this lesson, learners should be able to:

✅ Classify elements as **metals**, **non-metals**, or **metalloids** using their **electron arrangement**  
✅ Apply the general rule:  
 • 1–3 valence electrons → likely **metal**  
 • 5–8 valence electrons → likely **non-metal**  
✅ Identify **exceptions** to the rule (Hydrogen, Helium)  
✅ Define the term **metalloid** and give an example (e.g., Silicon)

**🎬 Lesson Introduction**

🎙 **Voiceover Script:**

“⚖️ The periodic table is like a giant element sorting map.  
Some elements are shiny and conduct electricity—these are **metals**. Others are dull and insulators—these are **non-metals**.  
🧪 The secret lies in the **outermost electrons**, also called **valence electrons**.  
In this lesson, we will classify elements using their electron arrangements and learn about the mysterious middle group—**metalloids**.  
Let us start sorting!”

**🎯 Activity 1: 📦 Element Sorter – “Classify That Atom!”**

**🎙️ Activity Introduction**   
"Atoms can be grouped by their behaviour. Metals love to lose electrons, non-metals tend to gain, and metalloids are in between. Your task is to drag each element into the correct category. Let the sorting begin!"

**👨‍💻 Developer Guide Instructions**

* **Interface Elements:**
  + Draggable element icons (e.g., Na, O, Mg, Si, etc.)
  + Tooltips with electron arrangements on hover.
  + Sorting bins labelled:
    - 🔧 Metals
    - 🍃 Non-metals
    - ⚖️ Metalloids
* **Functionality:**
  + Visual snap-in animation when element is dropped.
  + Tick (✔) or cross (✖) animation on placement.
  + Instant audio and text feedback.
  + Allow learners to reattempt until all are correct.

**📋 Learner Instructions (On-Screen)**

1. Look at the electron arrangement of the element.
2. Drag the element into the correct category bin: Metals, Non-metals, or Metalloids.
3. Release to place it in the bin.
4. Check the feedback to see if your classification is correct.

**💡 Hint Panel (On-Screen)**

**Classification Reminders:**

* **Metals:** Usually have 1–3 valence electrons, lose electrons easily.
* **Non-metals:** Usually have 5–8 valence electrons, tend to gain or share electrons.
* **Metalloids:** Share properties of both metals and non-metals.

**🧪 Activity Content with Facilitative Feedback**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Electron Arrangement** | **Correct Category** | **Correct Feedback** | **Incorrect Feedback** |
| Na | 2.8.1 | 🔧 Metals | ✅ Correct! Sodium has 1 outer electron and is a typical metal. | ❌ Sodium has 1 outer electron. That means it gives away electrons like metals do. |
| Mg | 2.8.2 | 🔧 Metals | ✅ Magnesium has 2 valence electrons—classic metal behaviour. | ❌ Magnesium is a metal—it loses 2 electrons easily. |
| Al | 2.8.3 | 🔧 Metals | ✅ Aluminium has 3 outer electrons—metals often have 1 to 3. | ❌ Aluminium is a metal—it loses 3 electrons to form positive ions. |
| C | 2.4 | 🍃 Non-metals | ✅ Carbon has 4 outer electrons—it does not lose them easily. | ❌ Carbon has 4 electrons in its outer shell—it tends to share or gain, not lose like metals. |
| O | 2.6 | 🍃 Non-metals | ✅ Oxygen needs 2 electrons to fill its outer shell. A reactive non-metal! | ❌ Oxygen gains electrons. That is a sign of a non-metal. |
| F | 2.7 | 🍃 Non-metals | ✅ Fluorine has 7 outer electrons—wants to gain 1. | ❌ Fluorine gains electrons to complete its outer shell. This is non-metal behaviour. |
| Ne | 2.8 | 🍃 Non-metals | ✅ Neon is a noble gas—full outer shell makes it stable. | ❌ Neon has a full outer shell, making it inert and a non-metal. |
| H | 1 | 🍃 Non-metals (special case) | ✅ Hydrogen is an exception—it behaves like a non-metal. | ❌ Hydrogen is a non-metal—it shares electrons in bonding. |
| He | 2 | 🍃 Non-metals (special case) | ✅ Helium has a full outer shell of 2—it is inert. | ❌ Helium is a noble gas—it is chemically inactive and belongs with non-metals. |
| Si | 2.8.4 | ⚖️ Metalloids | ✅ Silicon sits between metals and non-metals. It has properties of both. | ❌ Silicon is a metalloid—it shares properties of both metals and non-metals. |

**🎙️ Activity Conclusion 🎤**

**Narration:**  
"Well done sorting! Metals usually have 1 to 3 valence electrons and lose them. Non-metals have 5 to 8 and gain or share electrons. Metalloids are in between. Classifying atoms helps us predict how they behave in reactions."

**🎯 Activity 2: 🎭 Real-Life Scenarios – “Choose the Right Material”**

**🎙️ Activity Introduction**   
"Every day, people choose materials without realising it—conductors, insulators, shiny or dull, hard or brittle. In this game, you will help different characters select the right type of material for their tasks. Use what you know about metals and non-metals to make wise decisions."

**👨‍💻 Developer Guide Instructions**

* **Game Type:** Multiple-scenario decision-making role-play.
* **Layout:** One character and one scenario per screen, with two or three clickable options.
* **Feedback Mode:** Instant popup with hint-based explanation.
* **Visuals:** Each character has a themed illustration and prop icon (e.g., wire, pan, bulb).
* **Answer Buttons:** Clearly labelled — “Metal,” “Non-metal” (optional third choice: “Metalloid”).
* **Functionality:**
  + Highlight correct choice in green, incorrect in red.
  + Allow learner to retry after incorrect selection.

**📋 Learner Instructions (On-Screen)**

1. Read each character’s scenario carefully.
2. Think about the properties of metals and non-metals.
3. Click the option that best matches the required material.
4. Review the feedback to understand why your choice was correct or incorrect.

**💡 Hint Panel (On-Screen)**

**Material Selection Reminders:**

* **Metals:** Shiny, malleable, good conductors of heat and electricity, strong.
* **Non-metals:** Dull, brittle, poor conductors (insulators), low density.
* Always match the property needed in the scenario with the correct material type.

**🧪 Activity Content with Specific Facilitative Feedback**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scenario** | **Prompt** | **Options** | **Correct/Incorrect** | **Facilitative Feedback** |
| **1: Beryl’s Circuit Wire** | Beryl wants a shiny material that conducts electricity for her science project. | Metal | ✅ Correct | Metals are good electrical conductors and often shiny. |
|  |  | Non-metal | ❌ Incorrect | Non-metals are usually poor conductors of electricity. |
| **2: Zara’s Decoration Base** | Zara needs a brittle, insulating material for her model house walls. | Non-metal | ✅ Correct | Non-metals like carbon or sulphur are brittle and insulate well. |
|  |  | Metal | ❌ Incorrect | Metals are not brittle—they are malleable and conduct heat. |
| **3: Kevin’s Cooking Pan** | Kevin is shopping for a frying pan that heats up quickly and is durable. | Metal | ✅ Correct | Metals conduct heat efficiently and are strong—perfect for cookware. |
|  |  | Non-metal | ❌ Incorrect | Non-metals do not conduct heat well and might break under high temperatures. |
| **4: Amina’s Light Bulb Support** | Amina is choosing a material for the part of a bulb that holds the wire but must not conduct electricity. | Non-metal | ✅ Correct | Non-metals like glass or plastic insulate and prevent current flow. |
|  |  | Metal | ❌ Incorrect | Metals conduct electricity, which is unsafe for insulating components. |
| **5: Timo’s Jewellery Design** | Timo wants a material that can be easily polished and shaped for beautiful jewellery. | Metal | ✅ Correct | Metals like gold and silver are malleable and shiny—perfect for jewellery. |
|  |  | Non-metal | ❌ Incorrect | Non-metals are not easily shaped and are rarely shiny. |
| **6: Fiona’s Science Fair Model** | Fiona is building a temperature-sensitive model and needs a good heat conductor. | Metal | ✅ Correct | Metals allow heat to pass through them easily. |
|  |  | Non-metal | ❌ Incorrect | Non-metals do not conduct heat well. |

**🎙️ Activity Conclusion**   
"You made informed decisions by linking each character’s need to the right type of material. Understanding the properties of metals and non-metals helps us choose wisely in real life. Keep practising and you will become a material expert!"

**🎯 Activity 3: 🧪 Challenge – “Count the Valence Electrons!”**

**🎙️ Activity Introduction**   
"Every element hides a secret in its outer shell. That secret? The valence electrons! These outer electrons determine how elements react and combine. In this challenge, count the valence electrons from each arrangement. Stay sharp—outermost shell only!"

**👨‍💻 Developer Guide Instructions**

* **Activity Type:** Multiple-choice valence electron quiz.
* **Question Format:** Electron arrangement given; learner selects the number of valence electrons.
* **Display:** Show arrangement numerically and as an optional visual diagram.
* **Feedback Mechanism:** Provide facilitative feedback for each choice.
* **Audio:** Clicking, counting SFX; success chimes for correct answers.
* **Interactivity:** Allow retry after incorrect selection before moving to the next question.

**📋 Learner Instructions (On-Screen)**

1. Look at the electron arrangement given in the question.
2. Focus on the **outermost shell** only.
3. Select the number that represents the valence electrons.
4. Check the feedback to see if your choice was correct or incorrect.

**💡 Hint Panel (On-Screen)**

**Key Reminders:**

* Valence electrons are the electrons in the **outermost shell**.
* The **first shell** can hold up to 2 electrons, the **second shell** up to 8, and the **third shell** also up to 8.
* Do not add all electrons together — only count the ones in the **last shell**.

**🧪 Activity Content with Specific Facilitative Feedback**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Question** | **Electron Arrangement** | **Option** | **Correct/Incorrect** | **Facilitative Feedback** |
| Q1 | 2.8.6 | 2 | ❌ Incorrect | These belong to the first shell. Valence electrons are only in the outermost shell. |
|  |  | 8 | ❌ Incorrect | This is the second shell. Check the last shell for valence electrons. |
|  |  | 6 | ✅ Correct | The outermost shell has 6 electrons—these are the valence electrons. |
|  |  | 16 | ❌ Incorrect | That is the total number of electrons, not the valence electrons. |
| Q2 | 2.1 | 1 | ✅ Correct | Only 1 electron sits in the outermost shell, so the valence number is 1. |
|  |  | 2 | ❌ Incorrect | The first shell has 2, but it is not the outermost in this case. |
|  |  | 3 | ❌ Incorrect | Count carefully. There are only 2 shells—check the last one. |
|  |  | 0 | ❌ Incorrect | There is 1 electron in the outermost shell. |
| Q3 | 2.8.8.1 | 8 | ❌ Incorrect | This is from the third shell. But there is a fourth shell with more electrons. |
|  |  | 1 | ✅ Correct | The outermost shell has 1 electron—this is the valence count. |
|  |  | 17 | ❌ Incorrect | This is the total of all electrons. Focus only on the last shell. |
|  |  | 0 | ❌ Incorrect | There is 1 electron in the outermost shell. |
| Q4 | 2.5 | 5 | ✅ Correct | The outer shell has 5 electrons. |
|  |  | 2 | ❌ Incorrect | This is from the first shell, not the outermost. |
|  |  | 7 | ❌ Incorrect | Look closely. Only 5 are in the last shell. |
|  |  | 10 | ❌ Incorrect | That is more than the total electrons. |
| Q5 | 2.8.7 | 7 | ✅ Correct | The third shell holds 7 electrons, making them valence electrons. |
|  |  | 8 | ❌ Incorrect | That is the number in the second shell, not the outermost. |
|  |  | 1 | ❌ Incorrect | Only 1 electron would be found in atoms like sodium. Look again. |
|  |  | 17 | ❌ Incorrect | That is the total number of electrons. |

**🎙️ Activity Conclusion**  
"Fantastic! You have mastered the skill of counting valence electrons. These outermost electrons explain how atoms bond, react, and form compounds. Keep using this skill to classify and predict element behaviour!"

**🎯 Activity 4: 🔍 Outer Shell Detective – “Click the Clue”**

**🎙️ Activity Introduction**   
"Every element hides its identity in its outer shell. In this challenge, put on your detective cap and examine different atomic diagrams. Click the outermost shell to uncover what type of element it is. The number of valence electrons will help you decide—metal, non-metal, noble gas, or metalloid!"

**👨‍💻 Developer Guide Instructions**

* **Type:** Clickable Hotspot / Reveal Interaction.
* **Interface Layout:**
  + Show each atom diagram (dot/cross diagrams) one at a time.
  + Highlight the outermost shell with a subtle glow or ring.
  + Clicking the highlighted shell reveals the explanation.
* **Elements to Include:** Sodium (2.8.1), Chlorine (2.8.7), Silicon (2.8.4), Helium (2), Magnesium (2.8.2), Neon (2.8), Carbon (2.4).
* **Audio:** Click sound + reveal narration.

**📋 Learner Instructions (On-Screen)**

1. Look at the given atomic diagram.
2. Click the **outermost shell** to reveal the classification explanation.
3. Read the explanation to learn how valence electrons determine the element’s type.

**💡 Hint Panel (On-Screen)**

**Classification Reminders:**

* **Metals:** 1–3 valence electrons, tend to lose electrons.
* **Non-metals:** 5–7 valence electrons, tend to gain electrons.
* **Noble gases:** Full outer shells, very stable and unreactive.
* **Metalloids:** Often have 4 valence electrons, showing properties of both metals and non-metals.

**🧪 Clickable Elements & Facilitative Feedbacks**

**🔸 Element: Na (2.8.1)**

**Click Hotspot:** Outermost shell  
**Revealed Feedback:**  
“1 electron in the outer shell. This means sodium is a **metal**. Metals usually have 1 to 3 valence electrons, making them good at losing electrons in reactions.”

**🔸 Element: Cl (2.8.7)**

**Click Hotspot:** Outermost shell  
**Revealed Feedback:**  
“7 valence electrons—almost a full shell! This makes chlorine a **non-metal**. Non-metals typically have 5 to 7 outer electrons and gain electrons easily.”

**🔸 Element: Si (2.8.4)**

**Click Hotspot:** Outermost shell  
**Revealed Feedback:**  
“4 electrons in the outer shell. That is right in the middle! This makes silicon a **metalloid**, showing both metal and non-metal properties.”

**🔸 Element: He (2)**

**Click Hotspot:** Outer shell (only one shell)  
**Revealed Feedback:**  
“2 electrons, which completely fills the first shell. Helium is a **noble gas**, very stable and non-reactive.”

**🔸 Element: Mg (2.8.2)**

**Click Hotspot:** Outer shell  
**Revealed Feedback:**  
“2 electrons in the outer shell. That classifies magnesium as a **metal**. It easily loses electrons to form positive ions.”

**🔸 Element: Ne (2.8)**

**Click Hotspot:** Outer shell  
**Revealed Feedback:**  
“A full outer shell with 8 electrons. Neon is a **noble non-metal**—it does not react easily due to its stability.”

**🔸 Element: C (2.4)**

**Click Hotspot:** Outer shell  
**Revealed Feedback:**  
“4 valence electrons. Carbon is a **non-metal**, but with its 4 outer electrons, it can form many types of bonds.”

**🎙️ Activity Conclusion**   
"Fantastic detective work! You examined outer shells and used valence electrons to unlock each element’s identity. This skill helps scientists predict element behaviour and how they interact with others in chemical reactions."

**🎯 Activity 5: 🔡 Word Hunt – “Atomic Vocabulary Search”**

**🎙️ Activity Introduction**   
"Get ready to boost your atomic vocabulary! In this challenge, you will search for six important science terms hidden in the word grid. These words are clues that help us understand how elements behave and how they are classified. Look carefully—some may be hiding diagonally or backwards!"

**👨‍💻 Developer Guide Instructions**

* **Type:** Interactive Word Search.
* **Display:** 12x12 word grid with interactive click-to-highlight feature.
* **Interactions:**
  + Clicking or dragging across a correct word highlights it.
  + Trigger sound and glow feedback on correct selections.
* **Audio:** Tap/click sound effects on selections.
* **Grid Word Bank (Visible to Learner):**
  + Metal
  + Nonmetal
  + Metalloid
  + Electron
  + Valence
  + Shiny
* **Grid Rules:**
  + Random filler letters should not form distractor scientific words.
  + Reveal definitions as bonus pop-ups after each correct word is found.

**📋 Learner Instructions (On-Screen)**

1. Look at the word bank to see the six target science terms.
2. Search the 12x12 letter grid carefully — words can be horizontal, vertical, diagonal, forwards, or backwards.
3. Click and drag to highlight each word you find.
4. Read the pop-up definition after finding a word.

**💡 Hint Panel (On-Screen)**

**Tips for Success:**

* Start by looking for the first or last letter of a target word.
* Scan the grid in rows and columns for familiar patterns.
* Remember, words can be hidden backwards or diagonally.
* Review the definitions to help recall the spelling and meaning of each term.

**🧪 Activity Content – Target Words and Pop-up Definitions**

|  |  |
| --- | --- |
| **Target Word** | **Pop-up Definition** |
| **Metal** | Elements that are shiny, good conductors of heat and electricity, and often malleable. |
| **Nonmetal** | Elements that are poor conductors and often brittle in solid form. |
| **Metalloid** | Elements that have both metallic and non-metallic properties. |
| **Electron** | A tiny negatively charged particle found in energy levels around the nucleus. |
| **Valence** | The number of electrons in the outermost shell of an atom. |
| **Shiny** | A physical property of metals that reflects light, making them glossy or lustrous. |

**🎙️ Activity Conclusion**   
"Fantastic vocabulary hunt! These terms help you speak the language of atoms. Knowing them will make it easier to classify elements and predict how they behave in chemical reactions."

**✅ Key Takeaways:**

* Classification helps **understand chemical behaviour**.
* It allows **prediction of reactions and uses** of elements.
* Learners should **model elements** (e.g., Oxygen atom with beads).
* Practice **classifying real-world elements**.
* Reflect on how classification affects **technology, industry, and health**.

**Sub-strand: 1.2 Metals and Alloys**

**Lesson 1: Physical properties of metals (state, ductility, malleability, electrical and thermal conductivity)**

**🎓 Learning Outcomes**

By the end of this lesson, learners should be able to:

* ✅ Identify common metals and non-metals found in the environment
* ✅ Describe the physical state of metals at room temperature (mostly solid, except mercury)
* ✅ Define and demonstrate malleability (hammering) and ductility (wire drawing)
* ✅ Investigate and explain electrical conductivity of metals
* ✅ Investigate and explain thermal conductivity of metals
* ✅ Differentiate between metals and non-metals based on these physical properties

**🎙️ Lesson Introduction**

👋 Hello, Grade 9 scientist! In the last sub-strand, we explored the tiny world inside atoms. Now, let us zoom out to the big, useful world of metals! They are all around us – in coins, kitchen pans, and even dental fillings. What makes them so special? Their amazing physical properties! In this lesson, we will discover why metals are shiny, strong, bendy, and great conductors of heat and electricity. Get ready to explore the fantastic properties of metals!

**🎯 Activity 1: 📦 Sort It Out – “Metal or Non-Metal?”**

**🎙️ Activity Introduction**

“Welcome to the sorting zone! You are about to become a material detective. Look closely at each item and decide whether it belongs to the metal bin or the non-metal bin. Think about how each item looks, feels, and behaves. Are they shiny? Strong? Good conductors? Let the sorting begin!”

**👨‍💻 Developer Guide Instructions**

* **Type**: Drag-and-Drop Matching Game
* **Interactive Bins**:
  + 🔧 Metals
  + 🍃 Non-Metals
* **Draggable Items (Images or Icons)**:
  + 🧲 Copper wire
  + 🧻 Aluminium foil
  + 🪛 Iron nail
  + 🔑 Metal key
  + 🧴 Plastic bottle
  + 🍷 Glass bottle
  + 🌲 Wooden stick
* **Interaction Mechanics**:
  + Click and drag items into bins.
  + Immediate visual feedback (correct = green border + “ding”, incorrect = red border + “buzz”).
  + Optional **"Check"** button for final feedback.
* **Audio Tags**:
  + 🔔 Correct: “Ding!”
  + 🔕 Incorrect: “Buzz!”
* **Feedback Rules**:
  + Display **specific correct** and **specific incorrect** facilitative feedback for each item dropped.
  + Show **general conclusion narration** after all items are sorted.

**📋 Learner Instructions (On-Screen)**

1. Drag each item to the bin you think it belongs in.
2. Decide based on the item’s **appearance**, **texture**, and **ability to conduct heat or electricity**.
3. Use the **Hint** button if you are not sure.
4. When all items are sorted, click **Check** to see your results.

**💡 Hint (On-Screen)**

* **Metals**: Usually shiny, strong, heavy, and good conductors of heat and electricity.
* **Non-Metals**: Often dull, brittle, lightweight, and poor conductors of heat and electricity.

**🧩 Activity Content – Item-by-Item Feedback Table**

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Correct Bin** | **✅ Correct Feedback** | **❌ Incorrect Feedback** |
| 🧲 Copper Wire | 🔧 Metal | “Correct. Copper is shiny and an excellent conductor of electricity.” | “Try again. Copper is shiny and used to conduct electricity—this is a metal.” |
| 🧻 Aluminium Foil | 🔧 Metal | “Well done. Aluminium is lightweight, shiny, and a metal used in food packaging.” | “Check again. Aluminium is shiny and used for cooking and wrapping food—it is a metal.” |
| 🪛 Iron Nail | 🔧 Metal | “Yes. Iron is strong and magnetic—common features of metals.” | “Not quite. Iron is heavy, magnetic, and strong—a typical metal.” |
| 🔑 Metal Key | 🔧 Metal | “Correct. Most keys are made of durable metal alloys.” | “Incorrect. Keys are made from metal alloys because they are strong and durable.” |
| 🧴 Plastic Bottle | 🍃 Non-Metal | “Good job. Plastics are lightweight and do not conduct electricity.” | “Oops! Plastic is not shiny or conductive. It belongs in the non-metal bin.” |
| 🍷 Glass Bottle | 🍃 Non-Metal | “Correct. Glass is brittle, transparent, and non-metallic.” | “Not quite. Glass may look shiny, but it is fragile and not metallic.” |
| 🌲 Wooden Stick | 🍃 Non-Metal | “Well done. Wood is a non-metal because it does not conduct heat or electricity.” | “Incorrect. Wood is an insulator and belongs in the non-metal bin.” |

**🎙️ Activity Conclusion**

“Great job sorting! You now understand how to identify metals and non-metals based on their properties like conductivity, shininess, and strength. Keep observing the materials around you—they all have a story!”

**🎯 Activity 2: 🔍 Hotspot Click – “Explore Metal Properties**

**🎙️ Activity Introduction 🎙️ *(Mic Icon)***

“Get ready to investigate the hidden powers of metals! This block of metal holds clues about its physical properties. Click on each part—the shiny surface, the wire, the heat zone, and more—to uncover what makes metals so useful. Your mission: explore and learn one property at a time!”

**👨‍💻 Developer Guide Instructions**

* **Type**: Hotspot Exploration / Clickable Diagram
* **Visual Element**: Static image of a metal block showing:
  + ✨ Polished surface
  + 🧊 Solid edge
  + ⚡ Attached metal wire
  + 🔥 A flame or heat source touching the block
* **Hotspot Labels & Coordinates**:
  + **Surface (Top)** – Label: “Shiny Surface”
  + **Side (Corner)** – Label: “Solid Block”
  + **Wire Attached** – Label: “Wire”
  + **Area with Flame Touch** – Label: “Heat Source”
* **Interaction Mechanics**:
  + On click → Zoom in + show animated text bubble with explanation
  + Narration pop-up + voice-over for each hotspot
  + Each hotspot is clickable once until **Restart** is selected

**📋 Learner Instructions (On-Screen)**

1. Look closely at the metal block image.
2. Click on each labelled hotspot to discover a property of metals.
3. Read and listen to the explanation for each property.
4. Click all hotspots to complete the activity.

**💡 Hint (On-Screen)**

Metals are usually shiny, solid at room temperature, and conduct heat and electricity very well. Look for clues on the image that match these properties.

**🧩 Activity Content – Hotspots and Explanations**

|  |  |
| --- | --- |
| **Hotspot** | **Popup Explanation** |
| ✨ Shiny Surface | “Metals are lustrous—they reflect light and have a shiny appearance. This shine is due to the way metal atoms allow light to bounce off their surface, making them attractive for jewellery, coins, and decorative objects.” |
| 🧊 Solid Block | “Most metals are solids at room temperature, except mercury which is liquid. They are usually dense, hard, and compact, which makes them strong and long-lasting for building structures and making tools.” |
| ⚡ Wire | “Metals allow electric current to pass easily through them because of free-moving electrons in their structure. This property, called electrical conductivity, makes them ideal for wiring, electronics, and power transmission.” |
| 🔥 Heat Source | “Metals are excellent heat conductors because energy passes quickly through their particles. This is why they are used in cookware, radiators, and other applications where quick and even heating is needed.” |

**🎙️ Activity Conclusion**

“Excellent exploration! You have now uncovered the key properties of metals. Their shine, solid state, and ability to conduct heat and electricity make them essential in homes, machines, and tools. These properties explain why metals are chosen for so many everyday and industrial uses.”

**🎯 Activity 3: 🧪 Virtual Lab – "Conductivity Test"**

**🎙️ Activity Introduction 🎙️ *(Mic Icon)***

“Welcome to your virtual lab station! Here is a simple circuit with a battery and bulb. Your task is to test different materials and decide whether they conduct electricity. Drag a material into the test zone and observe what happens. Will the bulb light up? Let us investigate!”

**👨‍💻 Developer Guide Instructions**

* **Activity Type**: Virtual Simulation – Circuit Tester
* **Visual Setup**: Battery 🔋 + Bulb 💡 + Break in Circuit [Socket to insert material]
* **Test Materials**:
  1. 🧵 Copper wire
  2. 🔩 Iron nail
  3. 📎 Aluminium foil
  4. 🍴 Plastic spoon
  5. 🧽 Rubber band
  6. 🌳 Wood stick
  7. 🧫 Glass rod
  8. ✏️ Graphite (pencil lead)
* **Interaction**:

1. Drag item into gap in the circuit.
2. Bulb lights up (conductor) or stays off (insulator).
3. Show explanation pop-up.

* **Visual Cues**:
  1. Green glow for conductors.
  2. Grey outline for insulators.
* **Audio Cues**:
  1. 💡 Bulb ON chime for conductors.
  2. 🔕 Soft buzzer for insulators.

**📋 Learner Instructions (On-Screen)**

1. Drag a material into the circuit gap.
2. Observe whether the bulb lights or stays off.
3. Read the explanation to learn why the material is a conductor or insulator.
4. Test all materials to complete the activity.

**💡 Hint (On-Screen)**

Conductors allow electricity to pass and will light the bulb. Insulators block electricity and keep the bulb off. Most metals are conductors, while most plastics, glass, and rubber are insulators.

**🧪 Activity Content – Materials and Explanations**

|  |  |  |
| --- | --- | --- |
| **Material** | **Bulb Result** | **Explanation** |
| 🧵 Copper Wire | 💡 Lights Up | Copper is a highly efficient conductor because its outer electrons move freely, allowing electricity to flow easily. This is why it is widely used in electrical wiring. |
| 🔩 Iron Nail | 💡 Lights Up | Iron conducts electricity well, although not as efficiently as copper. It is often used in tools and structural components rather than wiring. |
| 📎 Aluminium Foil | 💡 Lights Up | Aluminium is a lightweight metal that conducts electricity effectively, which is why it is used in power lines and cables. |
| 🍴 Plastic Spoon | 🚫 Bulb Off | Plastic is made from polymers that do not have free electrons, so it does not allow electric current to pass. This makes it useful for insulation and safety. |
| 🧽 Rubber Band | 🚫 Bulb Off | Rubber prevents the movement of electric charge, making it an excellent insulator for coating wires and handling electrical tools. |
| 🌳 Wood Stick | 🚫 Bulb Off | Dry wood does not conduct electricity well because it lacks free-moving charged particles. It is often used for tool handles in electrical work. |
| 🧫 Glass Rod | 🚫 Bulb Off | Glass is an insulator because its tightly bound electrons cannot move freely. It is used in bulbs, insulators, and protective coverings. |
| ✏️ Graphite (Pencil Lead) | 💡 Lights Up | Graphite, a form of carbon, conducts electricity because its carbon atoms form layers with delocalised electrons that can move freely. |

**🎙️ Activity Conclusion 🎙️ *(Mic Icon)***

“You have now explored how different materials behave in an electric circuit. Conductors like copper, aluminium, iron, and graphite allow electricity to flow, lighting the bulb. Insulators like plastic, rubber, wood, and glass block the flow of electricity, keeping the bulb off. This knowledge is key for choosing safe and effective materials in electrical work.”

**🎯 Activity 4: 🎮 Mini-Game – "Shape Shifter Challenge"**

**🎙️ Activity Introduction 🎙️ *(Mic Icon)***

“Metals have superpowers! They can bend, flatten, or stretch without breaking. In this game, you will explore how metals behave when hammered or pulled. Watch the short scenario or read the description and choose the property shown: Is it malleability or ductility? Let us test your science instincts!”

**👨‍💻 Developer Guide Instructions**

* **Type**: Decision-Based Mini-Game
* **Rounds**: 6 scenario-based multiple-choice questions
* **Choices for Each Round**:
  + 🔨 Malleability
  + 🧵 Ductility
  + ❌ Hardness (Distractor)
  + ❌ Elasticity (Distractor)
* **Interaction**:
  + Display a scene or animation followed by 4 clickable answer buttons.
  + Provide specific feedback for each choice made.
  + Use appropriate sound effects for correct and incorrect answers.

**📋 Learner Instructions (On-Screen)**

1. Read or watch each scenario carefully.
2. Decide which property of metal is being shown.
3. Click on your chosen answer.
4. Read the feedback to understand why it is correct or incorrect.

**💡 Hint (On-Screen)**

* **Malleability**: The ability of a metal to be hammered or pressed into thin sheets without breaking.
* **Ductility**: The ability of a metal to be stretched into thin wires without breaking.
* **Hardness**: The resistance of a material to being scratched or dented.
* **Elasticity**: The ability of a material to return to its original shape after being stretched or compressed.

**🧪 Activity Content – Scenarios, Choices, and Feedback**

**Scenario 1**

**Text**: A blacksmith hammers a heated metal sheet into a flat pan.

* 🔨 Malleability ✅ → “This shows malleability – the ability to be hammered into sheets.”
* 🧵 Ductility ❌ → “This is not being pulled into wire, so it is not ductility.”
* ❌ Hardness ❌ → “Hardness is about resisting scratches, not reshaping.”
* ❌ Elasticity ❌ → “Elasticity refers to returning to original shape, which is not shown here.”

**Scenario 2**

**Text**: Copper is stretched into long, thin wire in a factory.

* 🔨 Malleability ❌ → “Hammering is malleability. Here, the metal is being stretched.”
* 🧵 Ductility ✅ → “Ductility is the ability to be drawn into wire.”
* ❌ Elasticity ❌ → “Elasticity is about bouncing back, not permanent shaping.”
* ❌ Hardness ❌ → “Hardness is unrelated to forming wire.”

**Scenario 3**

**Text**: A goldsmith rolls gold into ultra-thin foil for decoration.

* 🔨 Malleability ✅ → “Rolling into thin sheets is an example of malleability.”
* 🧵 Ductility ❌ → “The metal is not being stretched into wire.”
* ❌ Elasticity ❌ → “Elasticity is not about permanent shaping like this.”
* ❌ Hardness ❌ → “Rolling into foil does not test hardness.”

**Scenario 4**

**Text**: Aluminium is drawn into wire for power lines.

* 🔨 Malleability ❌ → “Malleability is shaping by hammering, not stretching.”
* 🧵 Ductility ✅ → “This is a perfect example of ductility.”
* ❌ Hardness ❌ → “Hardness is about resisting scratching, not forming wire.”
* ❌ Elasticity ❌ → “The metal is not bouncing back, so it is not elasticity.”

**Scenario 5**

**Text**: A stamping machine presses soft metal into a coin shape.

* 🔨 Malleability ✅ → “This is malleability – shaping by pressing or hammering.”
* 🧵 Ductility ❌ → “It is not being drawn into wire.”
* ❌ Hardness ❌ → “Coin-making uses softness, not resistance to scratches.”
* ❌ Elasticity ❌ → “Elasticity is not shown in pressing operations.”

**Scenario 6**

**Text**: Gold is stretched into very thin threads for jewellery.

* 🔨 Malleability ❌ → “Malleability involves flattening, not pulling into thread.”
* 🧵 Ductility ✅ → “Gold is highly ductile and ideal for thread making.”
* ❌ Elasticity ❌ → “Elasticity does not apply. Gold is permanently stretched here.”
* ❌ Hardness ❌ → “Hardness does not describe the ability to stretch into wire.”

**🎙️ Activity Conclusion**

“You have now mastered the difference between malleability and ductility. Malleable metals can be hammered or pressed into thin sheets, while ductile metals can be stretched into wires. These properties make metals essential in construction, wiring, manufacturing, and decorative applications.”

**✅ Key Takeaways:**

* **Physical state:** Mostly solid at room temperature (except mercury).
* **Conductivity:** Good conductors of heat and electricity due to free electrons.
* **Mechanical properties:** Malleable (sheets) and ductile (wires).
* **Appearance:** Shiny when cut/polished; some tarnish quickly.
* **Examples & demonstrations:** Iron, copper, aluminium, etc.; shown through conductivity, malleability, and ductility tests.

**🧪 LESSON 2: Composition of Alloys (Steel, Stainless Steel, Bronze, Brass, Duralumin)**

**🌟 Learning Outcomes**

By the end of this lesson, learners should be able to:

* ✅ Define an alloy as a uniform mixture of two or more metals, or of a metal and a non-metal
* 🔎 Identify the main components of common alloys:
  + Steel → Iron + Carbon
  + Stainless Steel → Iron + Carbon + Chromium (+ Nickel)
  + Bronze → Copper + Tin
  + Brass → Copper + Zinc
  + Duralumin → Aluminium + Copper (+ Magnesium/Silicon)
* 💡 Explain why alloys are made (to improve properties like strength, hardness, corrosion resistance)
* 🧰 Recognize common items made from specific alloys

**🎤 Voice-over Introduction**

"🔬 Pure metals are useful, but alloys are even better! Alloys are like recipes—mixing metals (and sometimes non-metals) to make new materials that are stronger, shinier, and more resistant to rust. Let us explore some famous alloys and what makes them so special."

**🎯 Activity 1: 🧪 Mixing It Up – “Alloy Builder”**

**🎙️ Activity Introduction**

"Metals become stronger or more useful when mixed with other metals or non-metals to form alloys. In this simulation, your challenge is to build the right alloy by dragging the correct components into the builder box. Then, match that alloy to the object it helps make. Let us test your material science skills!"

**👨‍💻 Developer Guide Instructions**

* **Type**: Two-step drag-and-drop simulation.
* **Step 1**: Drag the correct element(s) into the Alloy Builder Box.
* **Step 2**: Drag the created alloy to the correct Object Card.
* **Required Functionality**:
  + Show alloy name and list of components used after building.
  + Give specific facilitative feedback for correct and incorrect builds.
  + Give specific facilitative feedback for correct and incorrect matches.
  + Allow replay option after completion.
* **Interactive Elements**:
  + Draggable element icons: Fe, C, Cu, Zn, Sn, Cr, Al.
  + Draggable object images: Padlock (🔐), Medal (🏅), Trumpet (🎺), Kitchen Sink (🚰), Airplane Body (✈️).
* **Audio**:
  + Click sound when adding elements.
  + Drop sound when matching alloy to object.

**📋 Learner Instructions (On-Screen)**

1. Drag the correct element(s) into the Alloy Builder Box to make the alloy.
2. Check the alloy name that appears.
3. Drag the alloy to the object that is made from it.
4. Read the feedback carefully before going to the next round.

**💡 Hint (On-Screen)**

* **Alloy**: A mixture of two or more elements, usually metals, to improve properties.
* **Steel**: Iron + Carbon → Strong and durable.
* **Bronze**: Copper + Tin → Decorative and corrosion-resistant.
* **Brass**: Copper + Zinc → Good for instruments and fittings.
* **Stainless Steel**: Iron + Chromium (+ Carbon) → Rust-resistant and shiny.
* **Duralumin**: Aluminium + Copper → Light and strong for aircraft.

**🧪 Activity Content – Build + Match Combinations and Feedback**

**Alloy 1: Steel**

* **Builder Components**: Iron + Carbon
* **Correct Object**: Padlock (🔐)  
  **Feedback – Building**
* Iron + Carbon ✅ → "Correct! You made Steel – strong and durable."
* Iron + Chromium ❌ → "This is Stainless Steel, not plain Steel. Try removing Chromium."
* Copper + Zinc ❌ → "That makes Brass, not Steel. Try again!"  
  **Feedback – Matching**
* Padlock ✅ → "Yes! Steel is used for strong items like padlocks."
* Trumpet ❌ → "Think again. Steel is too heavy and dull for trumpets."

**Alloy 2: Bronze**

* **Builder Components**: Copper + Tin
* **Correct Object**: Medal (🏅)  
  **Feedback – Building**
* Copper + Tin ✅ → "Great! You built Bronze – used since ancient times."
* Copper + Zinc ❌ → "That forms Brass, not Bronze. Try replacing Zinc with Tin."
* Iron + Carbon ❌ → "That gives you Steel, not Bronze."  
  **Feedback – Matching**
* Medal ✅ → "Perfect! Bronze is often used for trophies and medals."
* Sink ❌ → "Not quite. Bronze is decorative, not for plumbing."

**Alloy 3: Brass**

* **Builder Components**: Copper + Zinc
* **Correct Object**: Trumpet (🎺)  
  **Feedback – Building**
* Copper + Zinc ✅ → "Well done! Brass is shiny and great for musical instruments."
* Copper + Tin ❌ → "That would make Bronze. Switch to Zinc."
* Iron + Chromium ❌ → "That gives Stainless Steel – not suitable for trumpets."  
  **Feedback – Matching**
* Trumpet ✅ → "Correct! Brass is used in trumpets because it is acoustic and easy to shape."
* Medal ❌ → "Oops! Medals are usually bronze, not brass."

**Alloy 4: Stainless Steel**

* **Builder Components**: Iron + Chromium (+ Carbon optional)
* **Correct Object**: Kitchen Sink (🚰)  
  **Feedback – Building**
* Iron + Chromium ✅ → "Excellent! Stainless Steel resists rust and shines."
* Iron + Carbon only ❌ → "That gives plain Steel. Add Chromium for stainless property."
* Copper + Tin ❌ → "Incorrect. That forms Bronze, not Stainless Steel."  
  **Feedback – Matching**
* Sink ✅ → "Yes! Stainless Steel is perfect for clean, shiny kitchen sinks."
* Medal ❌ → "Not quite. Medals are not made from stainless steel."

**Alloy 5: Duralumin**

* **Builder Components**: Aluminium + Copper
* **Correct Object**: Airplane Body (✈️)  
  **Feedback – Building**
* Aluminium + Copper ✅ → "Correct! Duralumin is light and strong – great for aircraft."
* Aluminium + Zinc ❌ → "Not quite. Zinc does not form Duralumin. Try Copper."
* Iron + Carbon ❌ → "Steel is too heavy for aircraft. Think light metals!"  
  **Feedback – Matching**
* Airplane ✅ → "Awesome! Duralumin makes lightweight aircraft bodies."
* Trumpet ❌ → "Try again. Duralumin is not used in musical instruments."

**🎙️ Activity Conclusion**

"Superb alloy engineering! You have explored how metals combine to form useful materials like Steel, Bronze, Brass, Stainless Steel, and Duralumin. Each alloy is chosen for its special strength, shine, or resistance to rust. You are now ready to design with metals like a real scientist!"

**🎯 Activity 2: 🔍 Hotspot Click – “Inside an Alloy”**

**🎙️ Activity Introduction 🎙️ *(Mic Icon)***

"Alloys are not just metal mixtures—they are science-built materials! In this activity, you will explore how atoms are arranged inside pure metals compared to alloys. Click each hotspot to uncover the hidden science behind why alloys are often stronger and more useful than pure metals."

**👨‍💻 Developer Guide Instructions**

* **Type**: Hotspot Exploration – Clickable Diagram
* **Assets Required**:
  + Two high-quality diagrams:
    1. Regular arrangement of atoms in pure metals.
    2. Disrupted atomic arrangement in alloys (different sized atoms).
  + Clearly labelled hotspots:

1. Uniform atoms
2. Distorted arrangement
3. Grain boundaries
4. Impurity atoms

* **Interactive Behaviour**:
  + Clicking a hotspot reveals a narrated pop-up with an informative explanation.
  + Each explanation is linked to a specific physical property or behaviour of metals vs alloys.
  + Visual highlight when hotspot is clicked.
* **Audio**: Optional click and reveal sounds; narration for each revealed section.
* **Interface Tip**: Use a magnifying glass icon for hover cursor.

**📋 Learner Instructions (On-Screen)**

1. Study the diagrams of a pure metal and an alloy.
2. Click on each hotspot to learn about that part of the structure.
3. Read and listen to the explanation carefully.
4. Click all hotspots to complete the activity.

**💡 Hint (On-Screen)**

* Pure metals have atoms of the same size, neatly arranged in layers.
* Alloys contain different-sized atoms, making them stronger.
* Grain boundaries and impurity atoms help stop cracks and corrosion.

**🧪 Activity Content – Hotspots and Explanations**

|  |  |
| --- | --- |
| **Hotspot** | **Explanation** |
| **Uniform Atoms in Pure Metal** | "In pure metals, atoms are arranged in a neat, repeating pattern with all atoms the same size. This regular structure allows the layers to slide over each other easily when force is applied, which is why many pure metals are softer and more malleable." |
| **Irregular Atom Sizes in Alloy** | "When atoms of different sizes are present, the regular pattern is disrupted. These uneven sizes make it harder for the layers to slide past one another, increasing the alloy’s strength and making it more resistant to bending or denting." |
| **Grain Boundaries in Alloy** | "Alloys are made up of many small crystals, each with a slightly different arrangement of atoms. The points where these crystals meet are called grain boundaries. These boundaries block the movement of atoms, making the material more resistant to cracks and deformation." |
| **Impurity Atoms Added to Alloy** | "Impurity atoms are added to change the properties of a metal. Because they differ in size and type from the main atoms, they distort the structure, which can increase strength, improve corrosion resistance, or help the alloy withstand heat." |

**🎙️ Activity Conclusion 🎙️ *(Mic Icon)***

"Excellent work! You have just uncovered the atomic-level difference between soft, bendable metals and their stronger, more durable alloy versions. By adding different atoms, we can change how metals behave—stronger, harder, and more useful. That is the real magic of alloys!"

**🎯 Activity 3: 🎭 Scenario – “Choose the Right Alloy”**

**🎙️ Activity Introduction 🎙️**

"Different jobs need different materials—and not all metals can do the same task. In this scenario challenge, you will help solve real-world problems by choosing the most suitable alloy for the task. Read carefully, think about the properties needed, and make your choice!"

**👨‍💻 Developer Guide Instructions**

* **Format**: One scenario per screen containing:
  + Scenario text.
  + Three clickable alloy choices.
  + Visuals or icons per scenario (e.g., sink, plane, trumpet, medal, door handle).
  + Immediate feedback per choice (✅ / ❌ icon + text explanation).
* **Assets Needed**:
  + Illustrations of real-world items (kitchen sink, aircraft, trumpet, medal, door handle).
  + Interactive choice buttons with alloy names and hover-tooltips describing properties and components.
* **Feedback Mechanism**:
  + Display both **correct** and **incorrect** facilitative feedback per choice.
* **Tracking**: Record correct answers for end-of-activity summary.

**📋 Learner Instructions (On-Screen)**

1. Read each scenario carefully.
2. Click the alloy you think is best suited for the job.
3. Read the feedback to understand why your choice is right or wrong.
4. Continue until all scenarios are completed.

**💡 Hint (On-Screen)**

* Stainless steel is rust-resistant.
* Duralumin is light but strong.
* Brass is shiny and resists tarnish.
* Bronze is durable and traditional for awards.

**🧪 Activity Content – Scenarios, Choices, and Facilitative Feedback**

|  |  |  |
| --- | --- | --- |
| **Scenario** | **Choices** | **Feedback** |
| **Rust-Free Kitchen Sink** 📝 "You are installing a kitchen sink. It must not rust or corrode easily." | **Iron** ❌ | "Iron rusts quickly when exposed to water, making it unsuitable for sinks." |
|  | **Steel** ❌ | "Steel is strong but can corrode if not treated or coated." |
|  | **Stainless Steel** ✅ | "Stainless steel contains chromium, which forms a protective layer that prevents rusting, making it ideal for kitchen sinks." |
| **Lightweight Aircraft Body** 📝 "An engineer needs a strong but lightweight material for building an airplane." | **Bronze** ❌ | "Bronze is heavy and not practical for aircraft construction." |
|  | **Cast Iron** ❌ | "Cast iron is too brittle and heavy for aircraft use." |
|  | **Duralumin** ✅ | "Duralumin is an aluminium alloy that is both light and strong, making it perfect for aircraft bodies." |
| **Musical Instrument** 📝 "You are making a shiny trumpet that must sound great and resist corrosion." | **Lead** ❌ | "Lead is dull, heavy, and unsuitable for making musical instruments." |
|  | **Copper** ❌ | "Copper is shiny but too soft for shaping into precise musical tubes." |
|  | **Brass** ✅ | "Brass is shiny, corrosion-resistant, and produces excellent sound quality, making it perfect for trumpets." |
| **Medal for Sports Award** 📝 "The sports committee wants a durable and symbolic metal for medals." | **Aluminium** ❌ | "Aluminium is lightweight but lacks the traditional appearance and weight for medals." |
|  | **Zinc** ❌ | "Zinc is not as durable or decorative as traditional medal alloys." |
|  | **Bronze** ✅ | "Bronze is durable, attractive, and historically used for medals, making it an ideal choice." |
| **Elegant Door Handle** 📝 "A hotel designer wants stylish, non-tarnishing handles for guest room doors." | **Tin** ❌ | "Tin is too soft for door handles and lacks an attractive finish." |
|  | **Iron** ❌ | "Iron rusts and tarnishes easily, which is not suitable for decorative handles." |
|  | **Brass** ✅ | "Brass is shiny, strong, and resists tarnishing, making it perfect for stylish door handles." |

**🎙️ Activity Conclusion**

"Outstanding choices! You matched the alloys to their perfect real-world uses. Alloys are carefully designed by mixing elements to give just the right properties. Great job applying your science skills to practical problems!"

**🎯 Activity 4: 🔄 Sequence the Steps – “How Stainless Steel is Made”**

**🎙️ Activity Introduction**

“Have you ever wondered how stainless steel becomes shiny and rust-free? In this task, you will rebuild the process step-by-step—from digging iron from the ground to polishing the final product. Observe each stage and drag it into the correct order!”

**👨‍💻 Developer Guide Instructions**

* **Type**: Ordering / Sequencing Task
* **Display Style**: Vertical or horizontal drag-and-drop list
* **Assets Needed**:
  + [📸] Visual cards for each step (e.g., iron ore, furnace, metal mix, mould, polish)
  + [🔉] Short audio narration clips per step (optional for accessibility)
  + Progress tracker with icons for each attempt
* **Interaction Logic**:
  + Each time a learner completes the order, show individual feedback for each step
  + Use snap animations and simple transition effects for engagement
  + Unlock 🏅 badges after each successful try

**📋 Learner Instructions (On-Screen)**

1. Read the description of each stage carefully.
2. Drag and drop the steps into the sequence you think is correct.
3. Submit your sequence to check your answers.
4. Review the feedback and adjust until the order is correct.

**💡 Hint (On-Screen)**

* The process begins with obtaining the main raw material.
* Strengthening and corrosion-resisting elements are added before melting.
* Shaping happens after melting and mixing.
* Polishing is always the last stage.

**🧩 Activity Content – Steps to Sequence (Correct Order with feedbacks)**

1. **Extract Iron from Ore**  
   "This is the raw material stage. Dig the iron out of the earth."
2. **Add Carbon and Chromium**  
   "Carbon strengthens. Chromium adds rust protection."
3. **Melt and Mix the Materials**  
   "All ingredients go into a furnace to become one metal."
4. **Cast and Cool the Mixture into Shape**  
   "Now the liquid metal is poured into shapes and left to cool."
5. **Polish for Corrosion Resistance**  
   "The surface is polished for smoothness and rust resistance."

**🗨️ Facilitative Feedback for Each Choice**

* **If Step 2 placed first:**  
  ❌ "Before adding anything, iron must be extracted from ore."
* **If Step 3 placed before Step 2:**  
  ❌ "You cannot melt it before adding all elements—Carbon and Chromium come first."
* **If Step 4 placed before Step 3:**  
  ❌ "You can only cast and cool once the mixture is molten."
* **If Step 5 placed too early:**  
  ❌ "Polishing is the final step, after shaping the metal."

**🎙️ Activity Conclusion**

“Excellent sequencing! Stainless steel production follows a precise process—from raw material to a corrosion-resistant finish. You now understand the science and engineering behind everyday metal items!”

**✅ Key Takeaways:**

* **Alloys** are uniform mixtures of metals (or metals with non-metals), made by mixing in molten form then cooling.
* **Purpose:** Increase hardness, strength, resistance to corrosion, or improve appearance.
* **Examples:** Steel (Fe + C), Stainless Steel (Fe + Cr + Ni + C), Brass (Cu + Zn), Bronze (Cu + Sn), Duralumin (Al + Cu + Mn + Mg).
* Alloy particles **block atom sliding**, making them stronger than pure metals.

**🧰 LESSON 3: Uses of Metals and Alloys in Day-to-Day Life**

**🌟 Learning Outcomes**

By the end of this lesson, learners should be able to:

* Identify the uses of specific metals and alloys in everyday life based on their properties
* Relate the properties of a metal/alloy (e.g., strength, lightness, conductivity, resistance to corrosion) to its specific use
* Name items made from Sodium, Magnesium, Aluminium, Copper, Iron, Gold, Silver, Brass, Steel, Bronze, Duralumin, and Stainless Steel
* Appreciate the importance of metals and alloys in modern society

**🎤 Lesson Introduction**

"🌍 Metals and alloys are incredibly useful in our daily lives! From the lightweight aluminium in your drink cans to the strong steel in bridges, every metal is chosen for its special traits. Let us explore how these materials power our world – from planes to pans!"

**🎯 Activity 1: 🔗 Drag-and-Drop Matching – "Match the Metal to Its Use"**

**🎙️ Activity Introduction 🎙️**

“Metals and alloys are everywhere—from the cables that power your devices to the shiny rings we wear. In this challenge, match each metal or alloy to the object it is best used to make. Use your knowledge of their special properties to find the perfect match!”

**👨‍💻 Developer Guide Instructions**

* **Activity Type**: Drag-and-Drop Matching
* **Draggables**: Icons with metal or alloy names  
  *(Copper, Aluminium, Steel, Gold, Brass, Stainless Steel, Bronze)*
* **Drop Zones**: Images or icons of common items  
  *(Jewellery, Sink, Trumpet, Can, Wire, Car Body, Coin)*
* **Functionality**:
  + Enable snapping of dragged items into targets
  + SFX: **Click** → drag, **Pop** → correct, **Buzz** → incorrect
  + Tooltip on hover: shows property *(e.g., “Copper – Good conductor”)*
  + Provide instant **facilitative feedback** on each drop
  + Unlock end-of-activity badge when all matches are correct

**🖥️ Learner Instructions (On-Screen)**

1. Look at the list of metals and alloys on the left.
2. Drag each metal or alloy to the object it is most commonly used for.
3. Use the hints to guide your choices.
4. After each drop, read the feedback to confirm or adjust your answer.

**💡 Hint (On-Screen)**

* Think about the property of each metal or alloy.
* Which ones resist rust? Which are good conductors? Which are shiny or light?
* Match based on use, not just appearance.

**📋 Activity Content – Matching Pairs + Property Clues**

|  |  |  |
| --- | --- | --- |
| **Metal / Alloy** | **Item** | **Key Property** |
| 🥫 Aluminium | Drink Can | Lightweight, corrosion-resistant |
| ⚡ Copper | Electrical Wire | Excellent conductor |
| 💍 Gold | Jewellery | Shiny, unreactive, soft |
| 🚗 Steel | Car Body | Strong and durable |
| 🚰 Stainless Steel | Sink | Rust-resistant, shiny |
| 🎺 Brass | Trumpet | Acoustic, malleable |
| 🏅 Bronze | Medals | Harder than pure copper, tough |

**💬 Facilitative Feedbacks (Per Choice)**

**🥫 Aluminium**

* ✅ “Great match! Aluminium is light and does not rust, making it perfect for cans.”
* ❌ “Think again. This metal should be light and rust-proof. What do we drink from?”

**⚡ Copper**

* ✅ “Correct! Copper is an excellent conductor, perfect for electric wiring.”
* ❌ “Oops! Which metal is known for allowing electricity to flow easily?”

**💍 Gold**

* ✅ “Spot on! Gold is shiny, unreactive, and used for luxury jewellery.”
* ❌ “Try again. Which metal stays shiny and does not tarnish?”

**🚗 Steel**

* ✅ “Well done! Steel is tough and perfect for building strong car bodies.”
* ❌ “Hint: Cars need a strong, affordable metal that holds shape.”

**🚰 Stainless Steel**

* ✅ “Yes! Stainless steel resists rust—perfect for sinks and kitchens.”
* ❌ “Remember, kitchen sinks need a metal that can resist water and corrosion.”

**🎺 Brass**

* ✅ “Fantastic! Brass has great acoustic properties, perfect for instruments.”
* ❌ “Think of a metal that makes clear, rich sounds in music instruments.”

**🏅 Bronze**

* ✅ “Good job! Bronze is harder than copper and used in medals.”
* ❌ “Look for a metal alloy that symbolizes strength and honour.”

**🎙️ Activity Conclusion**

“Well matched! Each metal or alloy has a unique strength—from conducting electricity to resisting rust or producing music. You have successfully connected each one to its everyday use—this is how science powers our modern world!”

**🎯 Activity 2: 🧠 Scenario-Based Decision Game – Choose the best metal or Alloy**

**🎙️ Activity Introduction**

“Metals and alloys help us build safe bridges, design aircrafts, and wire homes. In this challenge, step into the shoes of an engineer or designer. Read each real-world task, choose the best metal or alloy, and explain your decision using the properties you know!”

**👨‍💻 Developer Guide Instructions**

* **Activity Type**: Scenario-Based Decision Game
* **Scenario Presentation**: Text-based scenarios with visual icons or background images
* **Choices**: 3–4 clickable metal/alloy options per scenario
* **Selection Action**: Learner clicks choice → immediate facilitative feedback appears
* **Reinforcement Feature**: “Why This Works” button reveals property hint after attempt
* **Audio**: Voice-over reading scenario, choices, and responses
* **Visual Assets**:
  + Icons/images for bicycle, sink, wire, bridge, medal
* **Interactivity Notes**:
  + Highlight correct choice with ✅ green glow
  + Incorrect choice with ❌ red glow
  + Use gentle sound cues: “bell” for correct, “soft buzz” for incorrect

**🖥️ Learner Instructions (On-Screen)**

1. Read the real-world engineering scenario carefully.
2. Click the metal or alloy you think is most suitable for the task.
3. Read the feedback to understand why your choice is correct or incorrect.
4. Use the “Hint” if you need extra guidance before answering.

**💡 Hint (On-Screen)**

Think about the property needed: strength, lightness, corrosion resistance, conductivity, or appearance. Match these to the metals or alloys you know.

**📋 Activity Content – Scenarios, Choices & Feedback**

**📘 Scenario 1: Build a lightweight bicycle frame**

*"You are designing a bicycle frame. It must be strong but very light."*

|  |  |
| --- | --- |
| **Choice** | **Feedback** |
| ❌ Iron | “Iron is strong but too heavy for bikes. Look for something lighter.” |
| ❌ Gold | “Gold is heavy and soft—unsuitable for building frames.” |
| ✅ Aluminium | “Aluminium is lightweight and resistant to corrosion—great for bicycle frames.” |
| ✅ Duralumin | “Duralumin is a strong, lightweight alloy—perfect for high-performance bike frames.” |

**📘 Scenario 2: Design a corrosion-resistant kitchen sink**

*"You are choosing a metal for a kitchen sink that will not rust or corrode."*

|  |  |
| --- | --- |
| **Choice** | **Feedback** |
| ❌ Steel | “Steel rusts when exposed to water. Think about what prevents rust.” |
| ❌ Copper | “Copper is shiny but corrodes over time and stains easily.” |
| ✅ Stainless Steel | “Stainless steel resists rust and keeps its shine—ideal for kitchens.” |
| ❌ Bronze | “Bronze is durable but less common in wet kitchen environments.” |

**📘 Scenario 3: Make a flexible, conductive wire**

*"You need a material that conducts electricity well and can bend easily."*

|  |  |
| --- | --- |
| **Choice** | **Feedback** |
| ❌ Brass | “Brass is used in instruments, not wires. Look for better conductivity.” |
| ❌ Iron | “Iron conducts poorly and is too rigid for wire.” |
| ✅ Copper | “Copper is highly conductive and flexible—perfect for wiring.” |
| ✅ Aluminium | “Aluminium is a good conductor and light—also used in power cables.” |

**📘 Scenario 4: Construct a strong, durable bridge**

*"You are selecting the main structural metal for a large bridge."*

|  |  |
| --- | --- |
| **Choice** | **Feedback** |
| ❌ Gold | “Gold is too soft and expensive for structural work.” |
| ✅ Steel | “Steel is strong, durable, and ideal for load-bearing structures like bridges.” |
| ❌ Aluminium | “Aluminium is light but lacks the strength for long-span bridges.” |
| ❌ Bronze | “Bronze is tough but not commonly used in large structural designs.” |

**📘 Scenario 5: Craft a medal for a sports competition**

*"The sports committee wants a decorative and durable metal for medals."*

|  |  |
| --- | --- |
| **Choice** | **Feedback** |
| ❌ Aluminium | “Aluminium is light but not traditionally used for awards.” |
| ✅ Brass | “Brass has a golden appearance and is easy to mould into decorative medals.” |
| ❌ Stainless Steel | “Stainless steel is rust-resistant but lacks the classic look of medals.” |
| ✅ Bronze | “Bronze is traditional for medals—it is hard and aesthetically appealing.” |

**🎙️ Activity Conclusion**

“Fantastic reasoning! You applied knowledge of properties like strength, conductivity, and corrosion resistance to make the right material choices for real-world needs. Well done!”

**🎓 Activity 3: 📊 Interactive Table – “Properties vs. Uses”**

**🎙️ Activity Introduction 🎙️ *(Mic Icon)***

“Every metal has a secret power—some are shiny, some are strong, some resist rust. In this activity, click on different metals or alloys in the table. Discover what makes each special and how that connects to how we use them in daily life.”

**👨‍💻 Developer Guide Instructions**

* **Activity Type**: Clickable Table / Diagram Exploration
* **Interface Design**: Interactive table with two sections:
  + **Column A**: List of metals/alloys (e.g., Copper, Aluminium, Steel, Gold, Brass, Bronze, Stainless Steel)
  + **Column B**: Clickable “Hotspot” icons that reveal **property** and **common use** when selected.
* **Visual Behaviour**: Clicking a metal opens a pop-up card (modal) or expands a section under the row with text and icon.
* **Audio Integration**: Voice-over narrates the property and use upon reveal.
* **Hints**: Shown on screen before selection.

**🖥️ Learner Instructions (On-Screen)**

1. Click on a metal or alloy name in the table.
2. Read the property and common use when it appears.
3. Think about why this property makes the material suitable for that use.

**💡 Hint (On-Screen)**

* “Think about which materials are used where water or heat are involved.”
* “Is the metal meant to conduct electricity, or hold up heavy weight?”
* “Does the use require beauty, strength, or both?”

**📋 Activity Content – Table with Properties and Uses**

|  |  |  |
| --- | --- | --- |
| **Metal / Alloy** | **Property** | **Common Use** |
| **Copper** | High electrical conductivity | Electrical wiring, motors |
| **Aluminium** | Lightweight and corrosion-resistant | Cans, aircraft, ladders |
| **Steel** | Strong and durable | Construction beams, vehicles |
| **Gold** | Shiny and unreactive | Jewellery, circuit boards |
| **Brass** | Attractive, corrosion-resistant alloy | Musical instruments, decorations |
| **Bronze** | Hard and resistant to wear | Medals, sculptures |
| **Stainless Steel** | Resists rust and staining | Kitchen sinks, medical tools |

**🎙️ Activity Conclusion**

“Fantastic work! You have connected each material’s property to how it is used in the real world. That is how scientists and engineers think—by linking structure to function.”

**✅ Key Takeaways:**

* **Metals** are chosen for uses based on durability, conductivity, appearance, and corrosion resistance.
* **Metal uses:** Aluminium (pots, planes), Copper (cables), Iron (tools), Sodium (detergents), Gold/Silver (jewellery).
* **Alloy uses:** Stainless steel (cutlery, surgical tools), Brass (instruments, handles), Bronze (statues, medals), Duralumin (aircraft frames).
* Everyday **items from alloys** include spoons, keys, locks, taps, and bells.

**🌧️ LESSON 4: Rusting (Causes, Effects, Prevention)**

**🌟 Learning Outcomes**

By the end of this lesson, learners should be able to:

* Define rusting as the corrosion of iron/steel in the presence of oxygen and water/moisture
* Identify the conditions necessary for rusting
* Describe the effects of rusting (weakening, damage, economic loss)
* Explain prevention methods: painting, oiling, galvanizing, sacrificial protection
* Demonstrate understanding through a simulated rusting experiment

**🎤 Voice-over Intro:**

"⚠️ Have you ever seen a reddish-brown coating on old iron objects? That is rust! It is more than just dirt—it is a chemical reaction that slowly destroys iron and steel. Let us find out what causes rust and how to stop it!"

**🎓 Activity 1: 🧪 Virtual Lab – “Rusting Race”**

**🎙️ Activity Introduction**

"You are now a virtual lab assistant. Your task is to test how iron nails rust under different conditions. Set up each test tube with different combinations of air, water, and salt. Predict, then observe the results. Let the Rusting Race begin!"

**👨‍💻 Developer Guide Instructions**

* **Type**: Virtual Experiment / Simulation
* **Set-Up**:
  + 5 clickable animated test tubes labelled A–E.
  + Learner selects conditions (air, water, salt water, sealed).
  + Prediction step before starting reaction.
* **Interaction**:
* Learner drags and drops the correct materials into the test tube.
* Learner predicts outcome by choosing from prediction icons.
* Learner clicks **“Start Reaction”** to animate rusting process.
* After animation, result appears with facilitative feedback.

**🖥️ Learner Instructions (On-Screen)**

1. Select a test tube.
2. Drag and drop the correct materials into it.
3. Choose your prediction icon.
4. Click **“Start Reaction”** to see the results.
5. Compare your prediction with what happens in the experiment.

**💡 Hints (On-Screen)**

* “Rust forms when iron reacts with oxygen and water together.”
* “Sealing or removing one ingredient (air or water) stops rust.”
* “Salt speeds up rusting—think about sea water!”

**🧪 Activity Content – Test Tube Conditions & Expected Results**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test Tube** | **Condition** | **Expected Rusting Outcome** | **Icon Summary** |
| **A** | Air only | ❌ No Rust | 🌫️ No moisture present |
| **B** | Water only (sealed, no air) | ❌ No Rust | 💧 No oxygen present |
| **C** | Air + Water | ✅ Rust | 🌫️ + 💧 Rusting occurs |
| **D** | Salt Water + Air | ✅⚡ Fast Rust | 🧂 + 💧 + 🌫️ Salt accelerates rust |
| **E** | Sealed, oil-covered water | ❌ No Rust | 🔒 Air blocked by oil |

**💬 Facilitative Feedback for Each Prediction & Observation**

**Test Tube A – Air only (🌫️)**

* ✅ “Great thinking! Without water, rusting does not happen.”
* ❌ “Not quite. Air alone cannot cause rust—moisture is also needed.”

**Test Tube B – Water only (💧)**

* ✅ “Spot on! Without air (oxygen), the nail stays rust-free.”
* ❌ “Water alone is not enough. Air must be present too.”

**Test Tube C – Air + Water (🌫️ + 💧)**

* ✅ “Correct! Both air and water together cause rust to form.”
* ❌ “Think again. Rusting always needs both moisture and air.”

**Test Tube D – Salt Water + Air (🧂 + 💧 + 🌫️)**

* ✅ “Excellent! Salt speeds up the rusting process greatly.”
* ❌ “Missed it! Salt in water makes iron rust even faster.”

**Test Tube E – Sealed with oil (🔒)**

* ✅ “Yes! Blocking air prevents the rusting reaction.”
* ❌ “Try again. Oil seals off oxygen, so no rust forms.”

**🎙️ Activity Conclusion**

“You completed the rusting race like a true scientist! You now understand that rusting only occurs when both air and water are present—and how salt can make it worse. Great job controlling variables and predicting outcomes!”

**🎓 Activity 2: 🛡️ Mini-Game – “Stop the Rust!”**

**🎙️ Activity Introduction**

“Rust is trying to take over! Your mission is to protect metal objects by choosing the best rust prevention method for each situation. Each shield you choose could save the metal—or let it decay. Let us block the rust!”

**👨‍💻 Developer Guide Instructions**

* **Type**: Prevention Strategy / Decision Game
* **CBC Competency**: Investigate rust prevention methods and apply them in real-world contexts.
* **Set-Up**:
  + Show 5 illustrated real-life metal items: 🛳️ Ship hull, 🚪 Garden gate, 🔧 Tools, 🚗 Car underside, 🏗️ Building beams.
  + Provide 3 clickable rust prevention options per scenario.
  + Trigger **immediate visual and text-based feedback** upon selection.
* **Game Flow**:
* Display object with short environmental description.
* Learner selects best rust prevention method.
* Feedback and effect displayed (shield appears for correct choice / rust spreads for incorrect).
* **Audio**: Voice-over for scenario, options, and feedback.
* **Tracking**: Count correct first-attempt answers to trigger badges.

**🖥️ Learner Instructions (On-Screen)**

1. Read each scenario carefully.
2. Think about the environment and metal’s exposure.
3. Click the rust prevention method that works best.
4. See if your shield holds or rust wins.

**💡 Hints (On-Screen)**

* “If water is involved, think about sealing or sacrificing.”
* “Stationary objects need permanent coatings.”
* “Salt water speeds up rust—stronger shields are needed.”

**🧪 Activity Content – Scenarios, Choices & Feedback**

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario & Description** | **Choices** | **Correct Feedback (✅)** | **Incorrect Feedbacks (❌)** |
| **🛳️ Ship Hull in Sea Water** | 🖌️ Paint 🧴 Oil 🧲 Attach Sacrificial Zinc Block ✅ | 🛡️ “Excellent! Sacrificial zinc corrodes first, saving the ship’s hull.” | 🖌️ “Not enough! Paint may wear off quickly in seawater.” 🧴 “Oil would wash off in salty waves—try again.” |
| **🚪 Outdoor Garden Gate** | 🖌️ Paint ✅ 🧴 Oil 🧲 Zinc Block | 🎨 “Great! Paint forms a barrier that blocks moisture and air.” | 🧴 “Oil helps, but rain can wash it away over time.” 🧲 “Zinc blocks are better for water-submerged items.” |
| **🔧 Metal Tools Stored in Shed** | 🧴 Oil ✅ 🖌️ Paint 🧲 Zinc Block | 🧴 “Correct! Oil coats and protects tools in dry storage.” | 🖌️ “Painting tools can be messy and wears off during use.” 🧲 “Zinc is too extreme for simple storage needs.” |
| **🚗 Car Underside** | 🖌️ Paint 🧲 Galvanising (Zinc coating) ✅ 🧴 Oil | 🧲 “Yes! Galvanising protects the underside from water and road salt.” | 🖌️ “Paint chips easily under a moving car—try again.” 🧴 “Oil would wear off quickly from road friction.” |
| **🏗️ Metal Beams in a Building Frame** | 🖌️ Paint ✅ 🧲 Zinc Block 🧴 Oil | 🎨 “Spot on! Paint is the best choice for exposed structural beams.” | 🧲 “These are not submerged in water—zinc is unnecessary.” 🧴 “Oil is not ideal for permanent structures.” |

**🎙️ Activity Conclusion**

“Fantastic! You matched rust prevention strategies to real-life situations. Rust cannot win when you apply science correctly!”

**🎓 Activity 3: 🔄 Sequencing – "Painting to Prevent Rust"**

**🎙️ Activity Introduction**

“Painting metal prevents rust only when done properly. Your task is to drag each step into the correct order. Think carefully! Start with preparation, then layering, and end with care. Ready to paint like a professional?”

**👨‍💻 Developer Guide Instructions**

* **Activity Type**: Step-by-Step Sequencing Task
* **UI Setup**:
  + Display six draggable cards/icons, each with visuals and step titles.
  + Sequence slots numbered 1–6 for drop targets.
  + Use subtle animations to snap cards into place.
* **Design Tips**:
  + Include sound effects for dragging/dropping and completion chime.
  + Use icons and clean visuals to enhance clarity.
  + Optional completion popup upon correct order.

**🖥️ Learner Instructions (On-Screen)**

1. Read all steps carefully.
2. Drag and drop them into the order you think is correct.
3. Follow the process from preparation to inspection.
4. Review feedback after placing all steps.

**💡 Hints (On-Screen)**

* “Start with cleaning before any coatings.”
* “Primer comes before paint.”
* “Finish with checking for damage over time.”

**🪜 Steps to Sequence (Correct Order)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Step** | **Icon** | **Action** | **Hint** | **Correct Feedback (✅)** | **Incorrect Feedback (❌)** |
| 1 | 🧼 | Clean metal surface | Remove rust, grease, or dirt before anything else | ✅ “Well done! Cleaning ensures coating sticks properly.” | ❌ “Start by cleaning. A dirty surface will cause peeling and rust underneath.” |
| 2 | 🧪 | Apply primer | Primer sticks to bare metal and helps paint adhere | ✅ “Correct! Primer bonds to the surface and helps paint last longer.” | ❌ “Primer must go first to help the paint stick to clean metal.” |
| 3 | 🎨 | Apply paint | The first protective layer against air and moisture | ✅ “Good! This layer blocks oxygen and moisture from the metal.” | ❌ “Paint is applied after primer, not before it.” |
| 4 | 🌬️ | Let dry | Paint must dry fully before more coats | ✅ “Yes! Drying prevents mixing layers and gives a smooth finish.” | ❌ “Drying is key! Paint needs time to harden before the next layer.” |
| 5 | ➕ | Add second coat | Second coat gives stronger and longer-lasting protection | ✅ “Perfect! The extra coat increases durability and rust resistance.” | ❌ “Second coats are only added after the first coat is completely dry.” |
| 6 | 👁️ | Inspect regularly | Watch for chips, scratches, or rust spots after painting | ✅ “Exactly! Regular checks keep rust from starting again.” | ❌ “Inspections happen after painting is complete—not at the start.” |

**🎯 Common Incorrect Sequencing Feedback**

* If ‘Apply Paint’ is placed before ‘Apply Primer’: ❌ “Primer must go first to help paint stick.”
* If learner starts with ‘Apply Paint’ instead of ‘Clean Surface’: ❌ “Start by cleaning. Dirt causes peeling and rust.”
* If ‘Let Dry’ is missing or out of order: ❌ “Drying is key before adding another coat.”
* If ‘Inspect Regularly’ is placed first or too early: ❌ “Inspections happen after painting is complete.”

**✅ Correct Sequence Order**

1. 🧼 Clean metal surface
2. 🧪 Apply primer
3. 🎨 Apply paint
4. 🌬️ Let dry
5. ➕ Add second coat
6. 👁️ Inspect regularly

**🎙️ Activity Conclusion**

“Excellent sequencing! You now know how to stop rust using a proper painting process. Every layer counts—from cleaning to inspection. Keep applying your knowledge in real projects!”

**✅ Key Takeaways:**

* **Rusting** is the corrosion of iron/steel, producing hydrated iron (III) oxide.
* **Conditions:** Requires both oxygen and moisture.
* **Experiments:** Shown using boiled water, oil, calcium chloride, and exposed nails.
* **Effects:** Weakens strength, spoils appearance, reduces magnetism/conductivity.
* Leads to **higher maintenance costs**, especially in coastal/industrial areas.

**🔵 LESSON 5: Appreciate the Importance of Common Alloys in Daily Life**

**🎯 Learning Outcomes:**

By the end of the lesson, learners will be able to:

* Recognize how alloys improve on pure metals.
* Identify the role of alloys in specific everyday items.
* Appreciate the importance of alloys in industries, homes, and transport.

**🔊 Lesson Introduction**

🎙️ “Imagine building bridges with pure iron — they would rust and break too easily. Alloys are the superheroes of modern life. Let us explore why these metal mixtures are so important to you and the world around you!”

**🧠 Activity 1: Alloy Detective – “Where Am I Used?”**

**🎙️ Activity Introduction**

“Welcome, Alloy Detective! Alloys are everywhere — from your kitchen to the skies. Your task is to explore different everyday objects and figure out why alloys are chosen for each. Click an object, think carefully, and pick the correct reason for its alloy use. Let us investigate!”

**👨‍💻 Developer Guide Instructions**

* **Activity Type**: Clickable image hotspots + scenario-based MCQs
* **Interactivity**:
  + Each object is displayed as a high-quality realistic image.
  + On click: an overlay appears with a **1-question multiple-choice quiz** and **voiceover**.
* **Hotspots (4)**:
* 🔧 Stainless Steel Spoon
* 🚿 Brass Water Tap
* 🌉 Steel Bridge
* 🥇 Bronze Medal

**🖥️ Learner Instructions (On-Screen)**

1. Click on any object to reveal its quiz.
2. Read the question carefully.
3. Choose the correct reason why the alloy is used.
4. Review the feedback after your selection.

**💡 Hints (On-Screen)**

* “Think about the properties that make this alloy perfect for the job.”
* “Does the item need strength, resistance to rust, or an attractive finish?”
* “Some alloys mix metals to combine the best features of both.”

**📎 Activity Content**

**🔧 Object: Stainless Steel Spoon**

**Question:** Why is this alloy used here?  
A) It rusts easily  
✅ B) It is strong, shiny, and does not corrode  
C) It is very soft  
D) It is cheap like wood

**Explanation:** Stainless steel is made from iron, chromium, and nickel. The chromium prevents rust, making the spoon hygienic and durable.

**Facilitative Feedbacks:**

* ✅ **“Correct. Stainless steel keeps your spoon strong and rust-free!”**
* ❌ **“Incorrect. Stainless steel is used because it resists rust, not because of softness or cost.”**

**🚿 Object: Brass Water Tap**

**Question:** Why is brass used for taps?  
A) It breaks easily  
✅ B) It resists rust and looks shiny  
C) It conducts electricity  
D) It melts in water

**Explanation:** Brass, made from copper and zinc, does not rust and is safe for water fittings.

**Facilitative Feedbacks:**

* ✅ **“Correct. Brass is durable and corrosion-resistant — perfect for plumbing.”**
* ❌ **“Incorrect. Brass does not rust or melt — it is chosen for durability and appearance.”**

**🌉 Object: Steel Bridge**

**Question:** Why is steel used in bridges?  
A) It is decorative  
B) It is waterproof  
✅ C) It is strong and supports heavy loads  
D) It is used in medals

**Explanation:** Steel, an alloy of iron and carbon, provides strength, durability, and resistance to tension.

**Facilitative Feedbacks:**

* ✅ **“Correct. Steel’s strength supports heavy traffic and long spans.”**
* ❌ **“Incorrect. Steel is chosen for strength, not decoration or waterproofing.”**

**🥇 Object: Bronze Medal**

**Question:** Why is bronze used in medals?  
A) It rusts quickly  
✅ B) It has a beautiful finish and is durable  
C) It is heavier than gold  
D) It melts easily

**Explanation:** Bronze is made from copper and tin. It does not rust, keeps its shine, and is long-lasting.

**Facilitative Feedbacks:**

* ✅ **“Correct. Bronze lasts long and looks great — ideal for awards!”**
* ❌ **“Incorrect. Bronze does not rust or melt easily — it is used for its appearance and durability.”**

**🎙️ Activity Conclusion**

“Well done! You now understand that alloys are chosen not by chance, but because of their unique strengths. From spoons to skyscrapers — alloys help build a safer and smarter world.”

**🧩 Activity 2: Alloy Crossword Challenge**

**🎙️ Activity Introduction**

“Use what you have learned about alloys to solve this crossword puzzle. Read each clue carefully and type the correct alloy name in the boxes. Each correct word reveals a fact about the alloy you identified. Complete all words to unlock a final message.”

**👨‍💻 Developer Guide Instructions**

* **Type**: Interactive digital crossword with text input boxes (6–8 vertical/horizontal entries)
* **Display**:
  + Grid-based layout with numbered cells
  + Click on a clue number to highlight the correct entry path
* **Interactivity**:
  + Each correctly typed word triggers a pop-up with an alloy fact
  + Full completion unlocks a final congratulatory message
* **Accessibility**:
  + Tooltips or alt text for learners using screen readers

**🖥️ Learner Instructions (On-Screen)**

1. Read each clue carefully.
2. Click the clue number to highlight its position on the grid.
3. Type the correct alloy name in the highlighted boxes.
4. Continue until all words are completed to reveal the final message.

**💡 Hints (On-Screen)**

* “Think about what metals are combined to make this alloy.”
* “Remember where you have seen this alloy in everyday life.”
* “Some alloys are chosen for strength, others for appearance or corrosion resistance.”

**📎 Activity Content – Crossword Clues and Entries**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Direction** | **No.** | **Clue** | **Answer** | **Icon** |
| Across | 1 | An alloy used in medals | bronze | 🏅 |
| Across | 2 | This alloy resists rust in cutlery | stainless | 🍴 |
| Across | 3 | Used in aircraft | duralumin | ✈️ |
| Down | 4 | Copper + zinc | brass | 🚰 |
| Down | 5 | Alloy of iron + carbon | steel | 🏗️ |
| Down | 6 | Soft metal added to copper to make bronze | tin | 🪙 |

**📖 Alloy Facts Revealed Upon Correct Answer**

* **bronze** → “Bronze is harder than copper alone and is used in sculptures and awards.”
* **stainless** → “Stainless steel is a rust-resistant alloy ideal for cutlery and medical tools.”
* **duralumin** → “Duralumin is a lightweight aluminium alloy used in aircraft and bicycles.”
* **brass** → “Brass, made of copper and zinc, is used in taps and musical instruments.”
* **steel** → “Steel is a strong, flexible alloy used in bridges and buildings.”
* **tin** → “Tin is mixed with copper to make bronze. It adds strength and corrosion resistance.”

**🎙️ Activity Conclusion**

“You have uncovered the core of alloy knowledge! Alloys are all around you — and now, you can name them and explain their purpose.”

**✅ Key Takeaways:**

* **Valued properties:** Durability, conductivity, corrosion resistance, malleability, and ductility.
* **Gold:** Rare, attractive, used in jewellery, medals, and investment.
* **Copper:** Crucial for electrical systems.
* **Steel:** Key material in construction, vehicles, and manufacturing.
* **Alloys** often outperform pure metals, offering longer lifespan and better properties.

**Sub-strand: 1.3 Water hardness**

**💧 LESSON 1: Describe the Physical Properties of Water**

**🎯 Lesson Outcomes**

By the end of this lesson, learners should be able to:

1. **Identify and describe** the four physical properties of pure water: colourlessness, odourlessness, tastelessness, and boiling point at 100°C at sea level.
2. **Use interactive experiments and observations** to determine if water from different sources is pure or impure based on its physical properties.

**🔊 Lesson Introduction**

👩‍🔬 “Hello, young scientists! Welcome to our watery world of investigation. Today, we will become water detectives and test if water has any taste, colour, smell — and whether it boils at 100°C. Let us head to the virtual lab and explore the unique physical properties of pure water!”

Absolutely—here are **Activities 1–5** rewritten into the requested structure, keeping **every original word** of your learning content intact (no paraphrasing or shortening), with **mic icons** on introductions and conclusions, **on-screen Hints**, **developer and learner instructions**, and **tables/icons** where helpful.

**🧪 Activity 1: Virtual Lab – “Water Detective Lab: Test the 4 Properties”**

**🎙️ Activity Introduction *(Mic Icon)***

“This is your virtual lab station, young scientist. You will test water’s colour, smell, taste, and boiling point. Carefully observe each reaction and make your decision. Ready your tools — it is time to discover what truly makes water pure.”

**👨‍💻 Developer Guide Instructions**

* **Type:** Virtual Experiment + Clickable Hotspots + Drag-and-Drop
* **Learning Focus:** Investigating the four key physical properties of pure water (colourless, odourless, tasteless, boiling point at 100°C)
* **Icons:** 🧪 🔍 👁️ 👃 👅 🔥
* **Media Tags:**
  + [🎞️ Animated digital lab interface with labelled beaker, Bunsen burner, tripod stand, thermometer]
  + [🎧 Sound FX: Water bubbling, thermometer clicks, drag-and-drop pops]
  + [📊 Live lab report card tracking each completed test]
* **Build Notes:**
  + Provide 4 water samples, each draggable to test stations.
  + Include interactive buttons for sniffing, tasting, boiling.
  + Each test station logs progress with visual checkmarks on a report card.
  + Thermometer must animate gradually, stopping at 100°C.
  + After each successful test, display a “Test Complete” stamp and update a badge tracker.

**📋 Learner Instructions (On-Screen)**

1. Drag the water sample to the correct test station.
2. Perform the test using the provided interactive tools.
3. Select the correct observation from the options given.
4. Continue until all four tests are completed.

**💡 Hint (On-Screen)**

* “Pure water should be colourless, odourless, and tasteless.”
* “Water’s boiling point at sea level is always 100°C.”
* “If you detect colour, smell, or taste — it is not pure water.”

**🔬 Lab Simulation Tasks & Detailed Interactions**

**1️⃣ 👁️ Colour Test**

**Instruction:** Drag the sample to the colour testing panel (virtual chart).  
**Options:**

* 🔵 Blue
* 🔴 Red
* 🟢 Green
* ⚪ Colourless ✅

**Facilitative Feedbacks:**

* ✅ “Excellent! Pure water has no colour. It looks completely clear like clean glass.”
* ❌ “Not quite. A pure substance like water does not appear coloured. Any tint signals contamination or dissolved substances.”

**2️⃣ 👃 Odour Test**

**Instruction:** Click the “Sniff” icon to simulate wafting the scent to your virtual nose.  
**Options:**

* 🌸 Floral
* 😷 Rotten
* 🌿 Minty
* 🚫 Odourless ✅

**Facilitative Feedbacks:**

* ✅ “Correct. Pure water should smell like nothing — truly scent-free.”
* ❌ “Close observation! However, any fragrance suggests an impurity. Pure water must be completely odourless.”

**3️⃣ 👅 Taste Test**

**Instruction:** Click “Taste” button to simulate a hygienic digital taste.  
**Options:**

* 🧂 Salty
* 🍬 Sweet
* 🍋 Sour
* 🚫 Tasteless ✅

**Facilitative Feedbacks:**

* ✅ “Correct! Pure water has no flavour. It is neutral to your tongue.”
* ❌ “Hmm… good thinking, but taste in water indicates dissolved salts or impurities. Pure water = no taste.”

**4️⃣ 🔥 Boiling Point Test**

**Instruction:** Turn on the burner. Monitor bubbles and drag the thermometer into the water. Stop when boiling is observed.  
**Options:**

* 90°C
* 95°C
* ✅ 100°C
* 105°C

**Facilitative Feedbacks:**

* ✅ “Spot on! Pure water boils exactly at 100°C under standard sea-level pressure.”
* ❌ “Try again. Watch when rapid bubbles start forming and the temperature stays steady. That is your boiling point — and for pure water, it is always 100°C at sea level.”

**🎙️ Activity Conclusion *(Mic Icon)***

“Amazing work! You completed all four scientific tests like a true lab expert. You have now confirmed that pure water is colourless, odourless, tasteless, and boils exactly at 100°C at sea level. You are officially a Water Property Pro!”

**🏷️ Activity 2: Diagram Labelling – “Set Up the Boil!”**

**🎙️ Activity Introduction *(Mic Icon)***

“Here is a water boiling station — but it is all mixed up! Drag the correct labels onto the matching parts of the lab diagram. Look closely at the shapes and positions.”

**👨‍💻 Developer Guide Instructions**

* **Type:** Drag-and-Drop Labelling Task
* **Learning Focus:** Identify and correctly position lab apparatus used to heat and measure the boiling point of water
* **Icons:** 🔧 🧫 🔲 🌡️ 🔥 🪜 🧷
* **Media Tags:**
  + [🖼️ High-resolution diagram of a boiling water setup including tripod stand, wire gauze, beaker with water, thermometer, clamp, and Bunsen burner]
  + [🎧 SFX: Snap-to-place sound when label is dropped correctly]
* **Build Notes:**
  + Provide a labelled diagram with blank hotspots for each equipment part.
  + Allow drag-and-drop of six icons.
  + Add glow outline and snapping animation for correct drop zones.
  + Log completion on a lab checklist panel when all parts are labelled correctly.
  + Provide hint toggle that briefly highlights the correct tool shape.
  + Show "assembled" version after success for reflection or screenshot.

**📋 Learner Instructions (On-Screen)**

1. Drag each label to the matching part of the diagram.
2. Use the hint toggle if you need a brief highlight of the correct tool shape.
3. Continue until all six parts are labelled correctly.

**💡 Hint (On-Screen)**

“Look closely at the shapes and positions.”

**🎯 Labels to Drag & Drop**

| **#** | **Label & Target** | **Correct Feedback** | **Incorrect Feedback** |
| --- | --- | --- | --- |
| 1 | 🔥 **Bunsen burner → Below the tripod** | “Correct! The Bunsen burner is placed directly under the tripod to heat the water.” | “Not quite. The Bunsen burner must be under the tripod to heat the container evenly.” |
| 2 | 🧫 **Beaker → On top of wire gauze** | “Right! The beaker holds the water and must rest securely on the gauze.” | “Try again. The beaker must sit on the wire gauze above the flame.” |
| 3 | 🪜 **Tripod stand → Supporting the beaker and gauze** | “Yes! The tripod stand holds everything above the flame at a safe height.” | “Careful! The tripod should surround the Bunsen burner and hold up the beaker.” |
| 4 | 🔲 **Wire gauze → On top of tripod** | “Well done. The gauze spreads the heat evenly and supports the beaker.” | “That is not the right spot. Wire gauze always sits between flame and beaker.” |
| 5 | 🌡️ **Thermometer → Inside beaker (water contact)** | “Good job. The thermometer must touch the water — not just float in air.” | “Oops. Thermometer must be dipped in the water to read temperature accurately.” |
| 6 | 🧷 **Clamp → Holding thermometer in place** | “Perfect! The clamp keeps the thermometer steady and safe from tipping.” | “Check again. The clamp should grip the thermometer — not the beaker.” |

**🎙️ Activity Conclusion *(Mic Icon)***

“Excellent lab setup! You now know how to prepare and label all parts of a water boiling experiment — safely and scientifically. A correct setup ensures accurate results and keeps you safe in the lab.”

**💧 Activity 3: “Pure or Impure?” – Image Sorting**

**🎙️ Activity Introduction *(Mic Icon)***

“Drag each water sample into the correct category: Pure or Impure. Pure water must be colourless, clear, odourless, and free of particles.”

**👨‍💻 Developer Guide Instructions**

* **Type:** Drag-and-Drop Categorisation Game
* **Learning Objective:**
  + Identify physical signs that distinguish pure water from impure water using real-world images
  + Classify water samples correctly based on appearance and source clues
* **Icons:** ✅ ❌ 💦 🔍
* **Media Tags:**
  + [🖼️ High-resolution images: clear drinking water, muddy puddle, tinted tap water, rainwater, jar with debris]
  + [🎧 SFX: Water drop click, snap-to-sort bin]
* **Build Notes:**
  + Create two sorting bins: **PURE WATER ✅** and **IMPURE WATER ❌**
  + Display draggable cards or tiles with water sample photos
  + Each image triggers a text bubble with facilitative feedback upon drop
  + Sorting bin accepts correct images and provides subtle animation (green glow or red shake)
  + Optional: Show a “sorted checklist” completion tracker with tick marks for each correct match

**📋 Learner Instructions (On-Screen)**

1. Drag each image card into **PURE WATER** or **IMPURE WATER**.
2. Read the feedback bubble after each drop.
3. Continue until all images are sorted.

**💡 Hint (On-Screen)**

“Pure water must be colourless, clear, odourless, and free of particles.”

**🖼️ Images to Sort with Feedback**

| **Image** | **Category** | **Feedback** |
| --- | --- | --- |
| Clear glass of water | ✅ Pure Water | “Correct! This is transparent with no particles — a sign of pure water.” |
| Cloudy or murky water | ❌ Impure Water | “This sample is cloudy — suspended particles make it impure.” |
| Blue-tinted water | ❌ Impure Water | “Water should be colourless. This blue tint shows added substances.” |
| Rainwater | ✅ Pure Water | “Yes! Freshly collected rainwater is a natural form of soft, pure water.” |
| Water with floating debris or particles | ❌ Impure Water | “Those floating bits are signs of contamination. This is not pure water.” |

**🎙️ Activity Conclusion *(Mic Icon)***

“Well done! You have successfully identified key visual clues to distinguish pure water from impure. Knowing this helps you stay safe when choosing water for drinking or experiments.”

**🧠 Activity 4: True or False – “Water Myths Busted!”**

**🎙️ Activity Introduction *(Mic Icon)***

“Water is full of surprises — and so are the myths people believe about it! In this activity, you will decide whether each statement is true or false. Use your science brain and everything you have learned so far to separate fact from fiction!”

**👨‍💻 Developer Guide Instructions**

* **Type:** Interactive Quiz with Feedback
* **Icons:** ✅ True / ❌ False / 🧠 Critical Thinking
* **Build Notes:**
  + Each question appears as a card with ✅ TRUE and ❌ FALSE buttons
  + Animate correct answers with a green highlight and tick; incorrect answers with red shake animation
  + Provide specific facilitative feedback for every choice
  + Display live score tracker and reveal badge at end

**📋 Learner Instructions (On-Screen)**

1. Read the statement on the card.
2. Select **TRUE** or **FALSE**.
3. Read the feedback to understand the science behind the statement.

**💡 Hint (On-Screen)**

“Use your science brain and everything you have learned so far to separate fact from fiction!”

**🧩 Quiz Questions with Facilitative Feedback**

**1️⃣ Question:** 🧠 “Pure water has a sweet taste.”

* TRUE ❌ → “Incorrect. Pure water has no taste. Sweetness indicates dissolved substances.”
* FALSE ✅ → “Correct! Pure water is tasteless. Any taste shows impurity.”

**2️⃣ Question:** 🧠 “Water boils at 100°C at sea level.”

* TRUE ✅ → “Well done. Water boils at 100°C under normal atmospheric pressure.”
* FALSE ❌ → “Try again. Under normal conditions, pure water boils exactly at 100°C.”

**3️⃣ Question:** 🧠 “If water smells like chlorine, it is pure.”

* TRUE ❌ → “Incorrect. Chlorine smell signals additives. Pure water has no odour.”
* FALSE ✅ → “Correct. Any detectable smell suggests impurity.”

**4️⃣ Question:** 🧠 “Green-tinted water is clean.”

* TRUE ❌ → “Not quite. Colour in water indicates dissolved or suspended impurities.”
* FALSE ✅ → “Excellent. Water should be completely colourless to be considered pure.”

**🎙️ Activity Conclusion *(Mic Icon)***

“Great job separating facts from myths! You now know what to trust when testing for water purity. Keep observing like a real scientist.”

**🎮 Activity 5: Mini-Game – “Water Detective Challenge”**

**🎙️ Activity Introduction *(Mic Icon)***

“🕵️ Put on your lab coat, Water Detective! A mysterious liquid was discovered in the science lab. Is it really pure water, or something else? Run your tests, check the clues, and solve the case using science!”

**👨‍💻 Developer Guide Instructions**

* **Type:** Decision-Based Mini-Game
* **Learning Objectives:**
  + Apply knowledge of physical properties to determine water purity
  + Strengthen decision-making through observation and testing clues
* **Build Notes:**
  + Display a cartoon-style beaker with magnifying glass and testing icons
  + Each question appears sequentially with options and visual indicators (thermometer, nose icon, water colour palette)
  + Log answers with pop-up feedback for each choice
  + Display progress bar and badge upon full completion

**📋 Learner Instructions (On-Screen)**

1. Select the test icon shown on screen.
2. Choose the observation that matches your test.
3. Read the feedback, then move to the next test.

**💡 Hint (On-Screen)**

“Run your tests, check the clues, and solve the case using science!”

**🧩 Game Questions with Facilitative Feedbacks**

**1️⃣ Test: Boiling Point**  
🧪 Prompt: "You heat the liquid. What is the temperature when it boils?"  
**Options:**

* 90°C ❌ → “Incorrect. That temperature is too low — the liquid is not pure water.”
* 95°C ❌ → “Watch closely — pure water continues to heat up to 100°C before boiling.”
* 100°C ✅ → “Correct. Pure water boils at exactly 100°C at sea level.”
* 105°C ❌ → “Too hot. Water should boil earlier — impurities may be present.”

**2️⃣ Test: Odour**  
👃 Prompt: "You waft the scent of the liquid. What do you detect?"  
**Options:**

* Floral 🌸 ❌ → “Not quite. Any smell means there is a substance dissolved in the water.”
* Rotten 😷 ❌ → “Definitely not pure — rotten smell indicates serious contamination.”
* Odourless ✅ → “Correct. Pure water should have no smell at all.”

**3️⃣ Test: Colour**  
👁️ Prompt: "You observe the liquid in a glass container. What is its colour?"  
**Options:**

* Blue 🔵 ❌ → “Incorrect. Colour in water is caused by impurities.”
* Green 🟢 ❌ → “Try again. Green means dissolved materials — not pure.”
* Red 🔴 ❌ → “Definitely impure — pure water is never coloured.”
* Colourless ⚪ ✅ → “Correct. Pure water is colourless and completely transparent.”

**🎙️ Activity Conclusion *(Mic Icon)***

“Awesome detective work! You used scientific testing to confirm that the liquid was — or was not — pure water. You are now officially certified to investigate water samples like a real laboratory expert!”

**✅ Key Takeaways:**

* **Water is essential** for life and used in homes, industry, and agriculture.
* **Pure water properties:** Colourless, odourless, tasteless, boils at 100 °C (sea level).
* **Source water** may differ in taste, colour, odour, and boiling point due to impurities.
* **Distilled water** is the purity standard, free from dissolved substances.

**💧 LESSON 2: Distinguish Between Hard and Soft Water in Nature**

**🎯 Lesson Outcomes**

By the end of this lesson, learners should be able to:

1. **Differentiate between hard and soft water** based on lathering behaviour, mineral content, and source.
2. **Use virtual experiments and real-life decision-making scenarios** to identify types of water and suggest treatment methods for hard water.

**🔊 Lesson Introduction**

🎙️ “Welcome, water detectives! 💦 Not all water behaves the same. Some bubbles easily with soap — others make it hard to wash. Why? Let us explore how to tell hard and soft water apart, and what you can do when your soap will not lather. Get ready to investigate!”

**🧪 Activity 1: “Shake the Soap!” – Virtual Lather Test**

**🎙️ Activity Introduction**

"Water can be tricky when it comes to soap. Some make big bubbles — others leave ugly scum. Get ready to investigate! In this virtual lab, you will shake six water samples and watch what happens when soap is added. Lather means soft water. Scum means hard water. Let us test and see!"

**👨‍💻 Developer Guide Instructions**

* **UI Setup**:
  + Display six clickable water bottles: Distilled 🧫, Rain 🌧️, Tap 🚰, Borehole 🕳️, River 🏞️, Sea 🌊.
  + Clicking a bottle triggers soap-add animation → “Shake” button → result.
  + Result animations:
    - 💥 Lather = soft water
    - ❌ Scum = hard water
    - ⚠️ Weak foam = intermediate hardness

**🖥️ Learner Instructions (On-Screen)**

1. Click on a sample bottle to add soap.
2. Press the **Shake** button to mix.
3. Watch carefully — is there foam or scum?
4. Decide whether the water is **Soft**, **Hard**, or **Intermediate**.

**💡 Hint**

"Soft water makes soap foam quickly. Hard water leaves a scum ring. Some water gives little foam — this means intermediate hardness."

**📜 Activity Content**

| **💧 Water Type** | **💥 Result** | **🔍 Classification** |
| --- | --- | --- |
| Distilled 🧫 | 💥 Big Lather | ✅ Soft Water |
| Rain 🌧️ | 💥 Lather | ✅ Soft Water |
| Tap 🚰 | ⚠️ Some Lather | 🟡 Intermediate |
| Borehole 🕳️ | ❌ Scum | ❌ Hard Water |
| River 🏞️ | ❌ Scum | ❌ Hard Water |
| Sea 🌊 | ❌ Scum | ❌ Hard Water |

**🗣️ Facilitative Feedbacks**

**Distilled 🧫**  
✅ “Correct. Distilled water is pure and soft — it allows rich lather to form.”  
❌ “Check again — this water is highly purified, it should foam easily.”

**Rainwater 🌧️**  
✅ “Well done! Rainwater is naturally soft and helps soap lather well.”  
❌ “Try again. This water is soft — it lathers quickly without any scum.”

**Tap Water 🚰**  
✅ “That is right. Tap water often contains some minerals, giving partial lather.”  
❌ “Look closely. Tap water usually lathers a bit, but not as much as pure water.”

**Borehole 🕳️**  
✅ “Correct. Borehole water usually contains calcium and magnesium — this causes scum.”  
❌ “Check again — scum formation means the water is hard.”

**River Water 🏞️**  
✅ “Yes. River water often has dissolved minerals that react with soap.”  
❌ “Look at the result — no lather means it is hard water.”

**Sea Water 🌊**  
✅ “Correct. Sea water has high salt content. Soap will not lather in it.”  
❌ “Re-evaluate. Salty sea water is hard — it does not let soap work properly.”

**🎙️ Activity Conclusion**

"Excellent investigation! You discovered that soft water forms lather while hard water leaves scum. Soap works best with soft water — now you understand why laundry behaves differently in different places!"

**💧 Activity 2: “Sort the Water Sources” – Drag-and-Drop Categorisation**

**🎙️ Activity Introduction**

"Different water sources give us different results when we use soap. Some help it foam, while others cause scum. In this activity, you will sort different water sources into soft and hard. Use what you have learned about minerals like calcium and magnesium — and let us get sorting!"

**👨‍💻 Developer Guide Instructions**

* **Bins**:
  + 🟦 Soft Water
  + 🟥 Hard Water
* **Draggable icons**: Rainwater 🌧️, Distilled 🧫, Tap 🚰, Borehole 🕳️, River 🏞️, Sea 🌊, Lake 🏞️, Well 🕳️.
* Correct drops → green snap effect.
* Incorrect → red shake animation.
* Progress bar fills on correct sorts.

**🖥️ Learner Instructions**

1. Drag each water source into the correct bin.
2. Decide whether it is **Soft** or **Hard** water.
3. Watch the bin glow green for correct answers.

**💡 Hint**

"Soft water has few minerals like calcium and magnesium. Hard water contains more minerals — it stops soap from lathering."

**📜 Activity Content**

| **Source** | **Classification** | **Feedback** |
| --- | --- | --- |
| Rainwater 🌧️ | Soft | ✅ “Correct! Rainwater is naturally soft — it has low mineral content.” ❌ “Try again. Rainwater does not contain calcium salts unless polluted.” |
| Distilled 🧫 | Soft | ✅ “Yes! Distilled water is pure and free from minerals.” ❌ “Incorrect. Distilled water is soft because it has no impurities.” |
| Tap 🚰 | Intermediate | ⚠️ “Tap water can vary — some lather, some scum. Location matters.” |
| Borehole 🕳️ | Hard | ✅ “Correct. Borehole water often contains dissolved calcium and magnesium.” ❌ “Remember, borehole water is hard due to mineral content.” |
| River 🏞️ | Hard | ✅ “Good! River water usually carries dissolved salts.” ❌ “Not quite. River water tends to be hard due to minerals.” |
| Sea 🌊 | Hard | ✅ “Yes! Sea water is very hard — it has many salts.” ❌ “Check again. Sea water causes scum with soap.” |
| Lake 🏞️ | Hard | ✅ “Right. Lake water often has mineral runoff from soil.” ❌ “Lake water looks calm but it can be hard due to mineral content.” |
| Well 🕳️ | Hard | ✅ “Correct. Well water gathers minerals from rocks.” ❌ “Remember, well water is commonly hard due to dissolved salts.” |

**🎙️ Activity Conclusion**

"Super sorting! Now you know which natural sources give soft water that lathers, and which give hard water that fights soap. Understanding this helps us make smart choices at home and in the lab."

**🎭 Activity 3: “Everyday Water Woes” – Role-Play & Decision Game**

**🎙️ Activity Introduction**

"Everyday life brings many water-related problems. Some are caused by hard water and some by how we use it. In this activity, you will help different people solve their water problems by choosing the most effective action."

**👨‍💻 Developer Guide Instructions**

* Present **3 scenarios** one after another, using a consistent screen layout.
* Each scenario shows a **character image** and a **problem statement**.
* Provide **3 clickable choice buttons** with icons.
* When a choice is selected, display **immediate facilitative feedback**.
* Track answers; award cumulative badge if **2 or more correct**.

**🖥️ Learner Instructions (On-Screen)**

1. Read each person’s water problem.
2. Choose the best solution from the options.
3. Learn from the feedback after each choice.
4. Try to get at least **2 correct answers** to earn your badge.

**💡 Hint**

"Think about whether the problem is caused by hard water, and if so, what method will remove or reduce the minerals causing it."

**📜 Activity Content**

**🧪 Scenario 1: Aisha’s Laundry Problem**

**Problem**: “Aisha is doing laundry. Her soap is not lathering. Her mum says: ‘We have hard water!’ What should Amina do to solve this problem?”

**Choices & Facilitative Feedbacks**:

1. 🧴 **Use more soap** ❌
   * “That wastes soap. The problem is not the amount — it is that hard water does not lather well due to calcium and magnesium ions.”
2. 🔥 **Boil the water** ✅
   * “Well done! Boiling removes temporary hardness by turning calcium hydrogen carbonate into calcium carbonate, which forms a precipitate.”
3. 🧼 **Switch to detergent** ❌
   * “Detergents can work in hard water, but they are more expensive. Boiling is a better option for temporary hardness.”

**☕ Scenario 2: Grandpa’s Kettle Trouble**

**Problem**: “Grandpa notices a white crust inside his kettle after several boils. He is confused and asks for help.”

**Choices & Facilitative Feedbacks**:

1. 🔄 **Boil the water repeatedly** ❌
   * “Repeating the boiling makes the scale worse. The minerals are still there.”
2. 💊 **Add washing soda to kettle** ❌
   * “No — washing soda is not food-safe. It is meant for laundry water, not drinking water.”
3. 🚿 **Use pre-boiled or distilled water** ✅
   * “Yes! Using softened or distilled water prevents limescale buildup in kettles.”

**🚿 Scenario 3: Musa’s Itchy Skin**

**Problem**: “Musa complains that his skin feels dry and itchy after bathing. His family just moved to a new house that uses borehole water.”

**Choices & Facilitative Feedbacks**:

1. 🧴 **Use more soap when bathing** ❌
   * “More soap in hard water will only increase scum and worsen irritation.”
2. 🧼 **Install a water softener for bathroom taps** ✅
   * “Correct. Softened water is gentler on the skin and helps soap lather better.”
3. 💦 **Switch to cold water showers** ❌
   * “Temperature may help comfort, but it does not solve the hardness problem.”

**🎙️ Activity Conclusion**

"You solved real-life water problems just like a water-use expert! Whether for laundry, bathing, or making tea, you now know when and how to soften water in daily life."

**🔠 Activity 4: “Water Words!” – Word Search Puzzle**

**🎙️ Activity Introduction**

"Get ready to dive into some water science vocabulary! These words are key to understanding how water behaves — especially when it comes to hardness, softness, and lather. Search carefully and find them all!"

**👨‍💻 Developer Guide Instructions**

* Use 10x10 grid, words placed in all directions.
* Ripple animation when a word is found.
* Pop-up explanation for each found word.

**🖥️ Learner Instructions**

1. Scan the grid to find the listed words.
2. Click and drag to highlight them.
3. Read the pop-up to reinforce learning.

**💡 Hint**

"Look for words related to water’s mineral content, sources, and soap reactions."

**📜 Activity Content**

| **Word** | **Explanation** |
| --- | --- |
| LATHER | “Foam formed by soft water with soap.” |
| SCUM | “White residue from hard water and soap.” |
| SOAP | “Cleaning agent affected by hardness.” |
| HARD | “Water with high mineral content.” |
| SOFT | “Water with low mineral content.” |
| RAIN | “Naturally soft water.” |
| BOREHOLE | “Often a source of hard water.” |
| DISTILLED | “Pure water from distillation.” |

**🎙️ Activity Conclusion**

"Excellent work! You decoded all the water-related vocabulary like a science sleuth. Now you can spot water types and their behaviour just from the clues!"

**✅ Key Takeaways:**

* **Soft water:** Lathers easily with soap (e.g., rainwater, distilled water).
* **Hard water:** Forms scum, caused by dissolved calcium/magnesium ions from rocks/soil.
* **Types:** Temporary hardness (hydrogen carbonates, removable by boiling) and permanent hardness (sulphates/chlorides, not removable by boiling).
* **Effects of hard water:** Scale in kettles/pipes, more soap needed, clogging in hot water systems.

**🔧 Lesson 3: Apply Methods of Softening Hard Water in Day-to-Day Life**

**🎯 Lesson Outcomes**

By the end of this lesson, learners will be able to:

1. ⚗️ **Identify and explain** three methods of softening hard water: boiling, adding washing soda, and distillation.
2. 🧪 **Apply appropriate softening methods** to specific household scenarios through simulation, sequencing, and decision-making.

**🔊 Lesson Introduction**

🎙️ “Hard water wasting your soap? Kettle full of white gunk? 😤 No fear! In this lesson, you will explore how to soften hard water using boiling, washing soda, and distillation. Get ready to become a **Soft Water Hero**!”

**🎯 Activity 1: 🔄 Interactive Flowchart – “Choose Your Softening Method”**

**🎙️ Activity Introduction**

"Let us soften the problem! 💧 Hard water can be stubborn, but you have three powerful methods to fight it. Follow each case, choose the correct solution, and observe the science in action!"

**🛠 Developer Guide Instructions**

* Build an interactive flowchart with three clickable scenario branches.
* For each path, trigger:
  + 📽️ Short animated chemical change.
  + 🧪 Visible chemical equation pop-up.
  + 📊 Side bar tracker showing “Softening Success.”
* Keep the exact scenarios, descriptions, and reactions as written.
* No paraphrasing of chemical equations.
* Ensure each path contains correct and incorrect facilitative feedback for each choice.

**🖥 Learner Instructions (On-Screen)**

* "Click on each scenario to choose the correct softening method."
* "Observe the animation and chemical reaction."
* "Decide which method best suits the type of hardness in the water."

**💡 Hints (On-Screen)**

* "Temporary hardness is removed by heat."
* "Permanent hardness needs chemicals or distillation."
* "Consider cost, practicality, and purity required."

**📜 Activity Content**

| **Scenario** | **Method** | **Interactive Features** | **Chemical Reaction** |
| --- | --- | --- | --- |
| Temporary hardness in tap water | 🔥 Boiling | Animation of bubbling water → CaCO₃ solid | Ca(HCO₃)₂ → CaCO₃↓ + H₂O + CO₂ |
| Soap not working in laundry | 🧂 Washing Soda | Drag Na₂CO₃ to water sample → scum forms and settles | Ca²⁺ + Na₂CO₃ → CaCO₃↓ + 2Na⁺ |
| Lab needs pure water | 💧 Distillation | Simulate evaporation and condensation → clear water | — |

"Which method will you choose? Think about the minerals in the water!"

**🗨 Specific Facilitative Feedbacks for Each Scenario**

**Scenario 1: Temporary hardness in tap water**

* 🔥 Boiling – ✅ "Correct! Boiling removes temporary hardness by precipitating calcium carbonate."
* 🧂 Washing Soda – ❌ "Not quite. Washing soda works for permanent hardness, but boiling is the quicker fix here."
* 💧 Distillation – ❌ "Distillation would work, but it is not necessary for temporary hardness in tap water."

**Scenario 2: Soap not working in laundry**

* 🧂 Washing Soda – ✅ "Correct! Washing soda reacts with calcium ions and allows soap to lather."
* 🔥 Boiling – ❌ "Boiling only removes temporary hardness. Soap issues in laundry are often caused by permanent hardness."
* 💧 Distillation – ❌ "Distillation would work but is impractical for laundry purposes."

**Scenario 3: Lab needs pure water**

* 💧 Distillation – ✅ "Correct! Distillation produces pure water free from all dissolved solids."
* 🔥 Boiling – ❌ "Boiling does not remove all dissolved solids — it is not suitable for laboratory-grade purity."
* 🧂 Washing Soda – ❌ "Washing soda removes hardness but not all impurities — not pure enough for lab experiments."

**🎙️ Activity Conclusion**

"Great flow! Now you know when to boil, add soda, or distil. Choose wisely depending on the type of hardness."

**🎯 Activity 2: 🧩 Sequencing Game – “Fix the Distillation Setup”**

**🎙️ Activity Introduction**

"Can you set up a real working distillation unit? 🔧 Drag the parts into the right sequence to build a complete system. Think like a lab scientist!"

**🛠 Developer Guide Instructions**

* Present draggable labelled components of the distillation apparatus in disassembled form.
* Snap-to-slot logic with instant correct/incorrect facilitative feedback for each placement.
* Highlight correct slots with green glow and incorrect slots with red pulse.
* Trigger animated steam/vapour path once completed.
* Keep the original sequence exactly as provided.
* Lock the setup once all components are correctly placed.

**🖥 Learner Instructions (On-Screen)**

* "Drag each component to its correct position in the distillation setup."
* "Arrange the parts in the correct order from heating to collection."
* "Watch the system come to life once completed."

**💡 Hints (On-Screen)**

* "Start where the water sample is heated."
* "Cooling happens after evaporation."
* "The final step is the collection of pure water."

**📜 Activity Content – Correct Sequence and Hints**

| **Step** | **Icon** | **Component** | **Hint** |
| --- | --- | --- | --- |
| 1 | 🧪 | Round-bottom flask | This is where the heating starts. It holds the hard water sample. |
| 2 | 🌡️ | Liebig condenser | This cools the vapour into liquid. It must come after the flask. |
| 3 | 💧 | Cold water inlet and outlet | These regulate cooling. One lets cold water in, the other lets it out. |
| 4 | 🔥 | Heat source | This provides the energy to boil the hard water. |
| 5 | 🧫 | Receiving flask | This catches the pure water after it condenses. |

**🗨 Specific Facilitative Feedbacks**

**Round-bottom flask:**

* ✅ "Correct! This is where the impure water is first heated."
* ❌ "Not quite. This component should hold the hard water sample — try again."

**Liebig condenser:**

* ✅ "Well placed! It cools the vapour into liquid."
* ❌ "This must come immediately after the boiling flask to cool the steam."

**Cold water inlet/outlet:**

* ✅ "Perfect! These keep the condenser cool."
* ❌ "These belong inside the condenser to control the temperature. Try again."

**Heat source:**

* ✅ "Right choice! This initiates boiling of the water."
* ❌ "Check again. This must be under the flask, not after the condenser."

**Receiving flask:**

* ✅ "Well done! This catches the clean water after condensation."
* ❌ "This is the final step. It should not be placed before the condenser."

**🎙️ Activity Conclusion**

"Well done! You correctly built a distillation system. Distillation removes all impurities by boiling the water and collecting the pure vapour. You are now ready to purify water like a professional."

**🎯 Activity 3: 🔬 Virtual Lab – “Boil It or Not?”**

**🎙️ Activity Introduction**

"Welcome to the Water Lab! 🔬 Today you will test different samples to find out if boiling removes hardness. Watch the changes after boiling. Can you tell which type of water becomes soft?"

**🛠 Developer Guide Instructions**

* Create **2 animated boiling test tubes** with interactive soap test buttons.
* Include a **thermometer** and **soap drop** icon.
* Use **drag-to-observation table** function and auto-mark correct lather or scum results.
* After both samples are tested, present **two multiple-choice quiz questions**.
* Give instant correct and incorrect facilitative feedback for each answer.

**🖥 Learner Instructions (On-Screen)**

* "Click each test tube to start boiling the sample."
* "Add soap and observe if lather or scum forms."
* "Record your observation and decide the type of hardness."
* "Answer the questions based on your experiment results."

**💡 Hints (On-Screen)**

* "Boiling can remove some types of hardness but not all."
* "Look for a change from scum to lather after boiling."
* "Permanent hardness does not change after boiling."

**📜 Activity Content – Virtual Lab Summary**

| **Sample** | **After Boiling Result** | **Interpretation** |
| --- | --- | --- |
| A. Calcium hydrogen carbonate | 💥 Lather | Soft Water (Temporary hardness removed) |
| B. Magnesium sulphate | ❌ Scum remains | Hard Water (Permanent hardness remains) |

**🧠 Knowledge Check Questions and Facilitative Feedbacks**

**Question 1:**  
Which sample showed that boiling removed hardness?  
🔘 A) Magnesium sulphate  
🔘 B) Calcium hydrogen carbonate ✅  
🔘 C) Rainwater  
🔘 D) Sea water

* ✅ "Correct! Calcium hydrogen carbonate is responsible for temporary hardness, which is removed by boiling."
* ❌ "Try again. Remember: boiling only removes temporary hardness, not salts like magnesium sulphate."

**Question 2:**  
What kind of hardness cannot be removed by boiling?  
🔘 A) Temporary  
🔘 B) Soft  
🔘 C) Permanent ✅  
🔘 D) Boiling

* ✅ "Correct! Permanent hardness, such as that caused by sulphates, requires other methods like distillation or washing soda."
* ❌ "Boiling works only on temporary hardness. If there is no lather even after boiling, it is permanent hardness."

**🎙️ Activity Conclusion**

"Fantastic! You have discovered that boiling removes temporary hardness, like in calcium hydrogen carbonate. But it does not affect permanent hardness from salts like magnesium sulphate. You are now equipped to test water like a real scientist!"

**🎯 Activity 4: 🦸 Mini-Game – “Soft Water Hero”**

**🎙️ Activity Introduction**

"Hard water problems in the home? 💧 Become a Soft Water Hero! In each situation, choose the correct softening method. Think like a chemist and fix the issue fast!"

**🛠 Developer Guide Instructions**

* Display **3 animated household scenarios** vertically.
* Each scenario should have **three clickable method buttons**: 🔥 Boiling, 🧂 Washing Soda, 💧 Distillation.
* Give **instant correct and incorrect facilitative feedback** when a learner selects an answer.
* Use subtle animations for each scenario outcome (e.g., kettle boiling, soap lathering, distillation in lab).
* Enable a replay button for retrying the activity.
* Unlock a badge if all answers are correct.

**🖥 Learner Instructions (On-Screen)**

* "Read each household problem carefully."
* "Click the best method to soften the water in that situation."
* "Pay attention to whether the hardness is temporary or permanent."

**💡 Hints (On-Screen)**

* "Boiling only removes temporary hardness."
* "Washing soda reacts with calcium ions to make water soft."
* "Distillation gives the purest water by removing all dissolved solids."

**📜 Activity Content – Scenarios and Feedbacks**

**🏠 Scenario 1: The kettle has a white chalky coating.**

**Choices:**

* 🔥 Boiling ✅
  + ✅ "Correct! Boiling removes temporary hardness by turning calcium bicarbonate into an insoluble solid."
* 🧂 Washing Soda
  + ❌ "Try again. Washing soda works, but boiling is faster for temporary hardness in kettles."
* 💧 Distillation
  + ❌ "Distillation would work, but is unnecessary for simple kettle scale. Use boiling first."

**🧼 Scenario 2: Soap refuses to lather during laundry.**

**Choices:**

* 🧂 Washing Soda ✅
  + ✅ "Correct! Washing soda reacts with calcium ions and makes the water soft for soap to work."
* 🔥 Boiling
  + ❌ "Boiling only removes temporary hardness. This might be permanent hardness."
* 💧 Distillation
  + ❌ "Too expensive for washing clothes. Try washing soda instead."

**🧪 Scenario 3: The school lab needs completely pure water for an experiment.**

**Choices:**

* 💧 Distillation ✅
  + ✅ "Correct! Distillation removes all dissolved solids and gives pure water."
* 🔥 Boiling
  + ❌ "Boiling does not remove all impurities. Distilled water is required for lab use."
* 🧂 Washing Soda
  + ❌ "Washing soda removes hardness but not all minerals. Not suitable for lab-grade purity."

**🎙️ Activity Conclusion**

"Excellent decisions! You chose the right softening method for each situation. Hard water does not stand a chance when you are around!"

**✅ Key Takeaways:**

* **Temporary hardness removal:** Boiling (breaks hydrogen carbonates) or adding sodium carbonate (precipitates Ca/Mg).
* **Permanent hardness removal:** Sodium carbonate, calcium hydroxide, or distillation.
* **Methods:** Boiling/distillation = physical; chemical softening = reactions.
* **Practical tip:** Washing soda is cheap and widely available (e.g., Lake Magadi).

**💧 Lesson 4: Outline Advantages and Disadvantages of Hard and Soft Water**

**🎯 Lesson Outcomes**

By the end of this lesson, learners will be able to:

* ⚖️ Compare and explain at least three advantages and three disadvantages of hard and soft water.
* 🧠 Make real-life decisions based on the benefits and challenges of using hard or soft water in daily life.

**🔊 Lesson Introduction**

🗣️ “Is hard water really bad for you? Is soft water always good? Let us not jump to conclusions! In this lesson, you will weigh the pros and cons of hard and soft water like a real scientist. Let us begin our investigation!”

**🎯 Activity 1: ✅❌ Table Sort – "Pros and Cons of Water Types"**

**🎙️ Activity Introduction**

"Water can be helpful or harmful depending on how we use it. Let us play a sorting game! Can you decide which facts about water are advantages and which are disadvantages? Drag carefully — every choice matters!"

**🛠 Developer Guide Instructions**

* Display an **interactive table** split into **two draggable zones**:
  + **Left column:** ✅ Advantages
  + **Right column:** ❌ Disadvantages
* Each fact about water is on a draggable **token card**.
* **Hover tooltips** show the “Hint” before a learner drops the card.
* Correct placements **glow green**; incorrect ones **shake with a red outline** and prompt retry.
* Allow learners to **rearrange until all are correct**.

**🖥 Learner Instructions (On-Screen)**

* "Drag each fact about water into the correct column: ✅ Advantage or ❌ Disadvantage."
* "Think about how each fact affects health, cost, and daily use."
* "If a card shakes, try placing it in the other column."

**💡 Hints (On-Screen)**

* "Advantages are positive effects for health, taste, or cost."
* "Disadvantages are harmful effects or cause extra cost or damage."

**📜 Activity Content – Cards to Sort with Facilitative Feedback**

|  |  |  |  |
| --- | --- | --- | --- |
| **Card** | **Correct Column** | **✅ Correct Feedback** | **❌ Incorrect Feedback** |
| Provides calcium for bones | ✅ Advantage | "✅ Yes! Hard water supplies calcium, essential for strong bones." | "❌ That is not a disadvantage. Bones need calcium — this is a health benefit." |
| Wastes soap | ❌ Disadvantage | "✅ Correct. Hard water reacts with soap, reducing its effectiveness." | "❌ No, this wastes money and soap — it is not an advantage." |
| Tastes better | ✅ Advantage | "✅ Some prefer the mineral-rich taste of hard water." | "❌ Taste preference is not a drawback — try again." |
| Leaves scum on taps | ❌ Disadvantage | "✅ Yes! Scum is a buildup caused by hard water minerals." | "❌ Scum on taps damages plumbing — it is a disadvantage." |
| Protects against lead poisoning | ✅ Advantage | "✅ Right. A mineral coating in pipes can prevent lead from dissolving." | "❌ Actually, this is protective, not harmful — place it as an advantage." |
| Clogs water pipes | ❌ Disadvantage | "✅ Correct. Scale from hard water can block or damage pipes." | "❌ That damages plumbing — this belongs under disadvantages." |
| Safe for drinking | ✅ Advantage | "✅ Yes! Both hard and soft water are safe to drink under normal conditions." | "❌ This is not a disadvantage — safety is a benefit." |
| May leach lead (soft water) | ❌ Disadvantage | "✅ Good observation. Soft water may dissolve lead in old pipes." | "❌ This is a health concern — not an advantage." |
| Makes soap last longer | ✅ Advantage | "✅ Correct. Soft water lathers easily, reducing soap use." | "❌ No — this saves money and soap. Move it to the advantage side." |
| Damages boilers | ❌ Disadvantage | "✅ Well done. Hard water can cause scaling in heating systems." | "❌ This causes repair costs — definitely a disadvantage." |

**🎙️ Activity Conclusion**

"Well done! You correctly weighed the pros and cons of hard and soft water. Understanding both sides helps us make smart choices in daily life."

**🧩 Activity 2: Crossword Puzzle – “Water Wisdom Grid”**

**🎙️ Activity Introduction**

"Water terms are all around you — in science, at home, and even in your kettle! Use your knowledge to solve this crossword puzzle. Each clue reveals a word linked to soft or hard water. Let us see how many you can crack!"

**🛠 Developer Guide Instructions**

* Display a **6-word interactive crossword grid** with **animated ripple effects** for each correct word.
* Each square should **auto-check and lock** when correct.
* Provide **automatic marking** of correct or incorrect entries.
* **Highlight** the entire grid once all words are correct.
* Play a **completion animation** when the puzzle is solved.

**🖥 Learner Instructions (On-Screen)**

* "Click on a clue number to highlight its answer space."
* "Type the correct answer in the highlighted boxes."
* "Press Enter or click away to check your entry."
* "Continue until all six words are complete."

**💡 Hints (On-Screen)**

* "All answers are related to water hardness or softness."
* "Think about minerals, chemical reactions, and water treatment methods."
* "Some clues may have similar or repeated answers."

**📜 Activity Content – Crossword Clues and Answers**

| **Clue Number** | **Clue** | **Answer** | **Letters** |
| --- | --- | --- | --- |
| 1 | Mineral in hard water good for bones | CALCIUM | 7 |
| 2 | White deposit in kettles | SCUM | 4 |
| 3 | Soft water lacks this taste | FLAT | 4 |
| 4 | Forms when soap reacts with hard water | SCUM | 4 |
| 5 | Method to remove all hardness | DISTILLATION | 12 |
| 6 | Type of hardness removable by boiling | TEMPORARY | 9 |

**🎙️ Activity Conclusion**

"Brilliant work! You have cracked the water wisdom grid. These words will help you speak like a water science expert — keep it flowing!"

**🔍 Activity 3: Click-the-Scum – “Where is the Evidence?”**

**🎙️ Activity Introduction**

"Let us investigate where hard water leaves its mark in the home! Explore the bathroom and find all the hidden signs of scum, scale, and mineral stains. Look closely — water never lies!"

**🛠 Developer Guide Instructions**

* Use a **detailed bathroom illustration** with **4 clickable hotspots**.
* Each hotspot reveals a **label box** with a **visual hint** and **voiceover explanation**.
* Disable random clicking — **all hotspots must be explored** to complete the activity.
* Maintain a **click memory tracker** to show “Explored” status for each hotspot.
* Trigger a **completion animation** when all clues are found.

**🖥 Learner Instructions (On-Screen)**

* "Look around the bathroom picture and click where you think there is evidence of hard water."
* "Each hotspot will reveal an explanation about water hardness."
* "You must find and click all clues to complete the investigation."

**💡 Hints (On-Screen)**

* "Check places where water is often used."
* "Look at surfaces that are frequently in contact with soap or boiling water."
* "Hard water leaves visible marks over time."

**📜 Activity Content – Hotspots and Explanations**

|  |  |  |
| --- | --- | --- |
| **Hotspot** | **Hint** | **Explanation** |
| 🚿 Showerhead | "Water sprays from here daily" | Scum builds up on showerheads when calcium in hard water reacts with soap, creating a white or grey film. |
| 🚰 Sink Tap | "Where you wash your hands" | Hard water minerals settle at outlets like taps, forming white scale that can block water flow. |
| 🛁 Bathtub | "Where you relax after a long day" | After bathing, hard water leaves a thin film of soap scum on the tub surface, caused by minerals combining with soap. |
| ☕ Kettle Spout (optional) | "Where boiling happens" | Limescale forms in kettles when calcium salts in hard water are deposited during repeated boiling. |

**🎙️ Activity Conclusion**

"Excellent observation! You identified all the spots where hard water shows its effects. Now you can trace evidence like a real water detective."

**✅ Key Takeaways:**

* **Hard water advantages:** Provides minerals (Ca/Mg), safer in lead pipes, pleasant taste.
* **Hard water disadvantages:** Wastes soap, forms scum/scale, blocks pipes, lowers heating efficiency.
* **Soft water advantages:** Saves soap, gentle on skin/fabrics, prevents scale, no stains on clothes.
* **Soft water disadvantages:** Lacks minerals, may dissolve lead, flat taste, unsuitable for low-sodium diets (if softened with sodium).

**🏠 Lesson 5: Appreciate the Applications of Soft and Hard Water in Day-to-Day Life**

**🎯 Lesson Outcomes**

By the end of this lesson, learners will be able to:

* 💧 Identify appropriate uses of hard and soft water in homes, health, and industry.
* 🧠 Justify water use decisions using real-life case studies and their understanding of mineral content and lathering ability.

**🔊 Lesson Introduction**

🗣️ “Welcome water wizards! 🧙‍♂️ You have learned the science — now it is time to apply it. When should we use hard water? Where is soft water better? Explore the house, solve real problems, and prove you know how water matters in daily life.”

**🏠 Activity 1: Interactive Map – “Water Use Around the House”**

**🎙️ Activity Introduction**

"Explore the house and decide where soft water or hard water should be used. Each choice affects health, cleaning, appliances, or plants. Think like a home scientist and plan smart water use!"

**🛠 Developer Guide Instructions**

* Use a **top-view diagram of a house** with **five clickable zones**.
* On each click, display:
  + Water type selection (radio buttons or toggle: Hard / Soft)
  + Submit button
  + Explanation box revealing why that water type is best for that location.
* Disable the next hotspot until the current one is completed.
* Log progress as each location is explored.
* Trigger a **completion animation** when all 5 zones are done (e.g., house glows).

**🖥 Learner Instructions (On-Screen)**

* "Click on each location in the house to decide if hard water or soft water is best there."
* "Select your answer and read the explanation for why that choice is recommended."
* "Visit all areas to complete your water plan."

**💡 Hints (On-Screen)**

* "Think about the effects of minerals in water."
* "Consider health, cleaning, and appliance maintenance."
* "Some uses benefit from minerals, others do not."

**📜 Activity Content – Locations and Explanations**

|  |  |  |
| --- | --- | --- |
| **Location** | **Best Choice** | **Explanation** |
| 🍽️ Kitchen Tap | Hard Water | Hard water contains calcium and magnesium, which are healthy minerals for drinking. |
| 👚 Washing Machine | Soft Water | Soft water lathers well, reduces detergent use, and prevents mineral deposits on clothes. |
| 🚿 Shower | Soft Water | Soft water is gentle on hair and skin, preventing dryness and avoiding soap scum buildup. |
| 🔥 Water Heater | Soft Water | Soft water prevents scale formation inside heating coils, extending appliance life. |
| 🌿 Garden Hose | Hard Water | Minerals in hard water can benefit plants and support healthy growth. |

**🎙️ Activity Conclusion**

"You are now a certified Water Planner! Knowing where to use soft or hard water helps save appliances, protect health, and care for nature."

**🎭 Activity 2: Case Study – “Juma’s Grandparents’ Water Woes”**

**🎙️ Activity Introduction**

"Juma has noticed problems while staying at his grandparents’ rural home. The water causes soap to fail, a white layer coats the kettle, and the pipes are very old. Can you help him make the best decisions to solve these challenges using your science skills?"

**🛠 Developer Guide Instructions**

* Display an illustrated **story card** showing:
  + Juma beside a laundry bucket with no lather
  + A white-scaled kettle
  + Old lead pipes with rust
* Present **six clickable checkboxes** under the question:  
  **“Which of these are good decisions Juma should make?”**
* Allow **multiple selections**.
* Give **specific correct and incorrect facilitative feedback** for each choice.
* Lock completion until all options have been clicked at least once.
* Trigger completion animation once all correct options are selected without selecting incorrect ones.

**🖥 Learner Instructions (On-Screen)**

* "Read Juma’s situation carefully."
* "Click on the decisions you think will help Juma and his grandparents."
* "Some decisions are good, others are not — think before you select."
* "You may select more than one option."

**💡 Hints (On-Screen)**

* "Think about how to remove hardness in water."
* "Consider both health and appliance protection."
* "Avoid solutions that waste resources."

**📜 Activity Content – Scenario Recap**

**Scenario:**  
Juma visits his grandparents. Their water causes soap not to lather, the kettle has white scale, and pipes are old. They want to continue using the water but avoid waste and health problems.

**📋 Decisions and Facilitative Feedbacks**

|  |  |  |
| --- | --- | --- |
| **💬 Option** | **Correct?** | **Facilitative Feedback** |
| 🔥 Boil water before laundry | ✅ | "Correct. Boiling removes temporary hardness by forming insoluble calcium carbonate." |
| 🧂 Add washing soda to laundry | ✅ | "Right! Washing soda removes calcium and magnesium ions — improving lather." |
| 💧 Drink the hard water | ✅ | "Yes! Hard water contains calcium and magnesium which are good for bones and muscles." |
| 🔁 Replace pipes with non-lead ones | ✅ | "Great choice. Soft water can dissolve lead, so replacing old pipes prevents health risks." |
| ❌ Use more soap than usual | ❌ | "Try again. This wastes soap and money. It does not solve the hardness issue." |
| ❌ Ignore the white deposits | ❌ | "Not a good decision. These deposits can damage kettles and heating appliances over time." |

**🎙️ Activity Conclusion**

"Excellent work! You helped Juma and his grandparents make smart, science-based water decisions. You now understand the effects of hard water and how to manage it at home!"

**🧩 Activity 3: Matching Game – “Water for Every Use”**

**🎙️ Activity Introduction**

"Different types of water are better suited for different tasks. Some are rich in minerals, while others are better for washing. Let us find the best match! Can you pair each household use with the right type of water?"

**🛠 Developer Guide Instructions**

* **Interface:** Provide a clean drag-and-drop interface with two labelled categories:  
  🟩 **Hard Water**  
  🟦 **Soft Water**
* **Draggable Items:**
  + Drinking
  + Laundry
  + Bathing
  + Cooking
  + Gardening
* Each correct match triggers a **✅ icon** and correct facilitative feedback.
* Each incorrect match triggers a **❌ icon** and incorrect facilitative feedback.
* Allow retry after incorrect attempts.
* Unlock completion animation when all matches are correct.

**🖥 Learner Instructions (On-Screen)**

* "Drag each household use to the correct water type category."
* "Think about the benefits or disadvantages of each water type."
* "You may try again if you make a mistake."

**💡 Hints (On-Screen)**

* "Hard water contains calcium and magnesium minerals."
* "Soft water lathers easily and prevents scum buildup."
* "Some uses require minerals, others need soap efficiency."

**📋 Activity Content – Matching Pairs and Feedback**

|  |  |  |  |
| --- | --- | --- | --- |
| **Use** | **Correct Match** | **✅ Correct Facilitative Feedback** | **❌ Incorrect Facilitative Feedback** |
| 🍶 Drinking | 🟩 Hard Water | "Yes. Hard water contains minerals like calcium that are beneficial to health." | "Try again. Soft water lacks important minerals needed in drinking water." |
| 👕 Laundry | 🟦 Soft Water | "Correct. Soft water allows soap to lather better and avoids stains on clothes." | "Not quite. Hard water reacts with soap, forming scum and using more detergent." |
| 🚿 Bathing | 🟦 Soft Water | "Well done. Soft water feels gentle on skin and does not cause soap buildup." | "Recheck. Hard water often causes dryness and scum during bathing." |
| 🍲 Cooking | 🟩 Hard Water | "Yes. Using hard water in cooking supplies essential minerals in food." | "Try again. Cooking with soft water may remove important dietary minerals." |
| 🌿 Gardening | 🟩 Hard Water | "Right! Plants benefit from the minerals in hard water, especially calcium and magnesium." | "Oops. Soft water lacks nutrients that help plants grow." |

**🎙️ Activity Conclusion**

"Excellent judgment! You matched each task to the right water type. Knowing which type to use makes daily life healthier, easier, and more efficient."

**✅ Key Takeaways:**

* **Hard water uses:** Drinking and cooking (mineral benefits), preventing lead pipe corrosion.
* **Soft water uses:** Washing clothes, bathing, cleaning, and hot water systems (avoids scale).
* **Soft water advantages:** Saves soap, prevents staining, gentler on skin/hair.
* **Knowledge of water type** helps select the right water for tasks and reduce costs/damage.