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THE SCIENCE OF SWIMMING POOLS

Core Unit - I
Swimming and Chemistry

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Environment and Physical Education: Integrating STEM through Sports

Core Unit One: Swimming and Chemistry

Introduction

The Chemistry & Swimming core unit invites you to look at water in a completely new way. Instead of seeing a pool or lake as “just water,” you will begin to see it as a living chemical system that can help or harm swimmers depending on its properties. In this unit, you will discover how a few key ideas from chemistry—such as pH, chlorine, temperature, and clarity—directly affect safety, comfort, and performance in the water. Each lesson links what you already know from everyday swimming experiences (red eyes, feeling cold, getting tired quickly) with clear scientific explanations.

The first lesson of this unit is to help you test and interpret basic water quality parameters using simple tools. You will learn how to measure pH with colour strips, how to read a thermometer correctly, and how to observe water clarity with a more scientific eye. You will then use these measurements to decide whether different water samples are suitable for safe swimming. By the end of this part, you should be able to explain why a pool with “good numbers” feels comfortable, and why a pool with “bad numbers” might cause eye irritation, skin problems, or infection risks.

The second lesson is designed to help you connect water chemistry to human health and swimming performance. You will explore how the same chemical conditions you measure—such as low or high pH, too little or too much chlorine, cold or warm water—change what happens inside a swimmer’s body. You will analyse short scenarios and test results to answer questions like: Why do muscles feel slower in cold water? Why can very warm water be dangerous during long training sessions? How can mismanaged pool chemistry harm both swimmers and the environment?

Throughout the unit, you will work like a team of “swimming scientists”: observing, measuring, discussing, and making evidence-based decisions. The goal is not only to learn chemistry facts, but also to use them to take smarter, safer decisions whenever you swim—whether in a school pool, a public pool, or natural water.

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Learning goals

Orientation learning goals	In this Unit I will learn how to
Learning goal 1	Students will test and interpret basic water quality parameters (pH, temperature, clarity) using simple tools and explain how these affect swimmer safety and comfort.
Learning goal 2	Students will analyze how water chemistry influences swimming performance and health, connecting chemical properties to real-world swimming scenarios and proposing improvements for safe pool conditions.

Lesson 1: pH Scale and Swiming Pools

Introduction

Welcome to the first lesson of our Chemistry & Swimming unit! Today you will become water quality detectives. Have you ever wondered why some pools make your eyes sting while others feel perfect? Or why swimming in a cold lake feels so different from a warm pool? The answer lies in water chemistry—specifically pH, temperature, and clarity. In this lesson, you'll use simple tools to test real water samples and discover what makes water "swim-ready." Understanding these factors helps us stay safe and swim better while also protecting our environment.

Key STEM Knowledge That Will Be Taught

pH Scale (Detailed): *RECAP / VIDEO*
pH measures how acidic or basic (alkaline) water is on a scale from 0-14. A pH of 7 is neutral (pure water). Below 7 is acidic (like lemon juice), above 7 is basic (like soap). For swimming pools, the ideal pH range is 7.2-7.6.

- Too low pH (acidic, <7.0): Corrodes pool equipment, stings eyes/skin, damages swimsuits.
- Too high pH (basic, >7.8): Makes chlorine less effective against germs, causes cloudy water and scaling.

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- Why it matters for swimming: Proper pH keeps chlorine working to kill bacteria while protecting swimmers' health.

Temperature Effects:
Ideal pool temperature is 25-28°C for comfort and performance.

- Cold water (<24°C): Muscles stiffen, increases cramp risk, reduces speed/endurance.
- Warm water (28-30°C): Feels comfortable but can cause overheating/fatigue during long swims.
- Measurement: Use a simple thermometer—accuracy to nearest degree is enough.

Water Clarity (Visual Observation):
Clear water = healthy. Cloudy/murky = possible contamination or chemical imbalance.

Lesson One - Activity

Activity Introduction:
You will test 4 different water samples: tap water, bottled water, pool water (if available/safe), and a "mystery" sample (e.g., slightly dirty water). Using pH strips, thermometers, and your eyes, decide which water is "swim-ready" and why. Work in teams of 3-4.

Tool Requirements (per team):

- 4 small clear containers with water samples (50ml each, labelled A-D).
- pH test strips (universal, colour chart included).
- Digital or alcohol thermometer.
- Flashlight (for clarity check).
- Worksheet with data table, pH colour chart, and safe ranges.
- Disposable gloves (hygiene).
- Timer/stopwatch.

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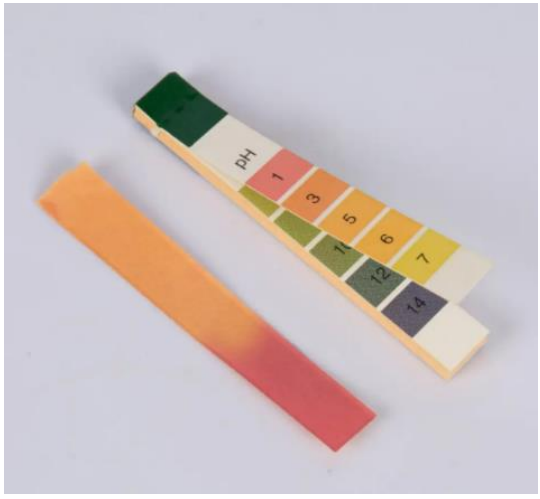
Detailed Steps: (*VIDEO on how to use it*)

Step 1: Safety & Setup (5 min)

- Wash hands, put on gloves.
- Each team gets their 4 water samples and tools.
- Copy safe ranges to worksheet: pH 7.2-7.6 ✓, Temp 25-28°C ✓, Clear ✓.

Step 2: Visual & Temperature Check (10 min)
For each sample (A-D):
a) Hold flashlight behind—is water clear or cloudy? Record: Clear/Cloudy/Slightly cloudy.
b) Insert thermometer, wait 30 seconds—record temperature to nearest degree.
c) Compare to safe range using worksheet chart.



Step 3: pH Testing (15 min)
a) Dip pH strip in water for 2 seconds, remove, wait 10 seconds.
b) Match strip colour to chart—record pH value.
c) Note colour change time/accuracy.

Step 4: Team Analysis (10 min)
For each sample, give Swim Safety Score (0-3):

- +1 if pH in safe range.
- +1 if temp in safe range.
- +1 if clear.

Score 3 = Swim-ready ✓ | Score 2 = Caution ⚠ | Score 0-1 = Not safe ✗

Step 5: Class Share & Discussion (10 min)

- One rep per team reports: "Sample [X] scored [Y]. We think it's [safe/caution/not safe] because..."
- Class votes on "best" and "worst" samples.

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Descriptive Interpretation of each possible results

Reflection: *Understanding Water Quality and Team Decisions*
After completing this experiment, your team might have noticed that not all water that *looks* clean is necessarily *safe* for swimming. Clear water can sometimes have the wrong pH level, while slightly cloudy water might still be within a safe range. This activity shows that data and observations work best together—we must use tools, not just our eyes, to make scientific judgments.

Possible Observations and Meanings:

- Tap Water: Often has a pH close to neutral (around 7), but chlorine or minerals may slightly raise or lower it. If it met all safety ranges, it represents how public systems regulate water for balance and safety.
- Bottled Water: May appear clean but can have varying pH levels depending on brand or mineral content. If the pH was outside the "swim-ready" range, students can reflect that what's *good for drinking* isn't always *ideal for swimming.*
- Pool Water: Usually treated with chemicals for hygiene, so the pH could be slightly high. This can spark discussion about why chemical control in pools matters for health, comfort, and equipment protection.
- "Mystery" Sample: Likely scored low due to clarity or pH. Teams can interpret this as why environmental testing is essential before any human activity in water bodies—natural water may be affected by pollution or temperature shifts.

Takeaway:
Safe water doesn't just "look" clean—it meets *specific measurable conditions.* Science helps us confirm what we can't always see. In sports and daily life, this skill of checking facts and testing safely supports both environmental awareness and responsible decision-making.

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Lesson 2: Body as a Swimmer

Introduction

Great job testing water in previous lesson! Now we connect those measurements to your body as a swimmer. How does acidic water irritate your eyes? Why does cold water make muscles slow? Why does chlorine matter for staying healthy? Today you'll analyze your test results, match water conditions to swimmer symptoms, and design a "perfect pool" recipe. This shows how chemistry keeps swimming safe, comfortable, and high-performing while protecting the environment.

Key STEM Knowledge That Will Be Taught

Chlorine Chemistry (Detailed): (*VIDEO REFERENCE*)
Chlorine (as hypochlorous acid at proper pH) kills bacteria/viruses in water. Ideal free chlorine: 1-3 ppm.

- Too low (<1 ppm): Germs survive, risk of infections (ear, skin).
- Too high (>5 ppm): Strong smell, eye/skin irritation, asthma trigger.
- pH-Chlorine Link: At pH 7.2-7.6, chlorine is most effective (~70% active form).

Temperature & Physiology:
Body core temp ~37°C. Water temp affects heat loss/gain.

- Cold Shock (<20°C): Breathing quickens, grip weakens, panic risk.
- Optimal (25-28°C): Maintains muscle function, allows focus on technique.
- Hyperthermia (>30°C): Faster fatigue, dehydration risk despite being "in water."

Clarity & Health: Turbid water hides hazards (underwater objects) and indicates chemical imbalance/contaminants.

Lesson two - Activity

Using Lesson 1's data + "symptom cards," analyze how water chemistry affects swimmers. Then create your "Perfect Pool Recipe" poster showing ideal conditions and why they matter.

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Tool Requirements (per team):

- Lesson 1's test data worksheets.
- 12 "Swimmer Symptom Cards" (conditions → effects).
- Large poster paper/markers.
- "Perfect Pool Template" (pH dial, temp gauge, chlorine bar).
- Access to pH/chlorine safe range charts.

Here is the complete set of 12 "Swimmer Symptom Cards" for Lesson Two of the Chemistry & Swimming Core Unit. Each card features a specific water chemistry condition on one side and its effect on swimmers on the other. Print them as 3x5 cards (double-sided) or display digitally. Include simple icons for visual learners.

Card Set Instructions for Teachers:

Size: Small cards (easy to sort/manipulate).

Design: Front = Condition (pH/temp/chlorine value + icon). Back = Symptom + simple explanation.

Icons: Use eye/tear for irritation, snowflake for cold, flame for heat, bacteria for infection.

Sorting Categories: Eyes/Skin, Muscle/Breathing, Infection Risk, Comfort/Performance.

Details about 12 Symptom Cards:

Card 1: Low pH (Acidic)

Front: pH 6.0 🧪💧 (Lemon juice range)
Back: Eyes sting like lemon juice. Acidic water irritates eye membranes. Skin feels tight/dry. Pool equipment corrodes faster.

Card 2: High pH (Basic)

Front: pH 8.2 🧼💧 (Soap range)
Back: Itchy skin and cloudy water. Basic water dries skin/hair. Chlorine works poorly – scaling on pool walls.

Card 3: Low Chlorine

Front: Chlorine 0.5 ppm 🦠🚫 (Too little disinfectant)
Back: Infection risk (ears, skin). Germs/bacteria survive. Water may smell "flat" or develop algae.

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Card 4: High Chlorine

Front: Chlorine 6 ppm 👃 🔥 (Strong bleach smell)
Back: Red eyes, coughing, asthma trigger. Irritates lungs/respiratory system. Strong chemical odor.

Card 5: Cold Water

Front: 19°C ❄️ 💧 (Below comfortable)
Back: Muscle cramps + shivering. Body loses heat fast (vasoconstriction). Grip weakens, speed drops 5-10%.

Card 6: Very Warm Water

Front: 32°C 🔥 💧 (Hot tub range)
Back: Quick fatigue + overheating. Can't cool via sweat (already wet). Heart rate spikes after 15-20 min.

Card 7: Cloudy Water

Front: Turbid/Milky 🌫️ 💧 (Can't see bottom)
Back: Hidden hazards + slip risk. Obscures underwater objects. Indicates chemical imbalance/contaminants.

Card 8: Low pH + High Chlorine Combo

Front: pH 6.5 + Chlorine 5 ppm ⚠️ 🔥
Back: Double irritation: burning eyes + fast chlorine loss. Acid eats chlorine quickly – pool needs constant refill.

Card 9: High Temperature + Low Chlorine

Front: 30°C + Chlorine 0.8 ppm 🌡️ 🦠
Back: Warm + germy = perfect bacteria breeding. Heat speeds bacterial growth when chlorine is weak.

Card 10: Perfect Balance (Control)

Front: pH 7.4 + Chlorine 2 ppm + 26°C ✅ 💧
Back: Eyes comfortable, muscles relaxed, chlorine effective. Ideal for training/PE – focus on technique, not discomfort.

Card 11: Strong Chlorine Smell + High pH

Front: Chlorine smell + pH 8.0 👃 🧼
Back: Dry skin + ineffective disinfection. High pH traps chlorine as "inactive" form – germs survive despite smell.

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Card 12: Cold + Cloudy

Front: 21°C + Cloudy ❄️ 🌫️
Back: Stiff muscles + can't see hazards. Cold slows reaction time; murkiness hides drain covers/underwater objects.

It is advisable that students make these cards to better understand the connection between cause and it's symptoms.

FRONT SIDE OF A CARD

CONDITIONS
Low pH (Acidic)
pH 6.0
(Lemon juice range)

BACK SIDE OF A CARD

EFFECTS
Low pH (Acidic)

Eyes sting, like lemon juice. Acidic water irritates eye membranes. Skin feels tight/dry. Pool equipment corrodes faster

How to Use in Lesson Two (10-Minute Setup)

Distribute: 4 cards per team of 3 (rotate if needed).

Sorting Challenge: Place cards face-up. Sort into 4 piles:

Eyes/Skin Problems (Cards 1,2,4,8,11)

Muscle/Breathing Issues (Cards 5,6,12)

Infection Risk (Cards 3,9)

General Safety (Cards 7,10)

Match to Lesson 1's Data: "Which of our test samples matches Card X?"

Discussion: "Why does [condition] cause [symptom]? Link to pH/temp/chlorine."

Visual Design Tip: When creating these 12 cards Use color coding – Red border = dangerous, Yellow = caution, Green = ideal. Add simple body outline showing affected body part (eyes, lungs, legs).

These 12 cards create concrete, memorable links between chemistry numbers and real swimmer experiences!

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Detailed Steps:

Step 1: Symptom Matching (15 min)
Distribute Symptom Cards (examples):

- "pH 6.0" → "Eyes sting, metal taste."
- "Chlorine 0.5 ppm" → "Water smells flat, possible germs."
- "Temp 19°C" → "Muscles cramp, shivering."
- "Cloudy water" → "Can't see bottom, slip hazard."

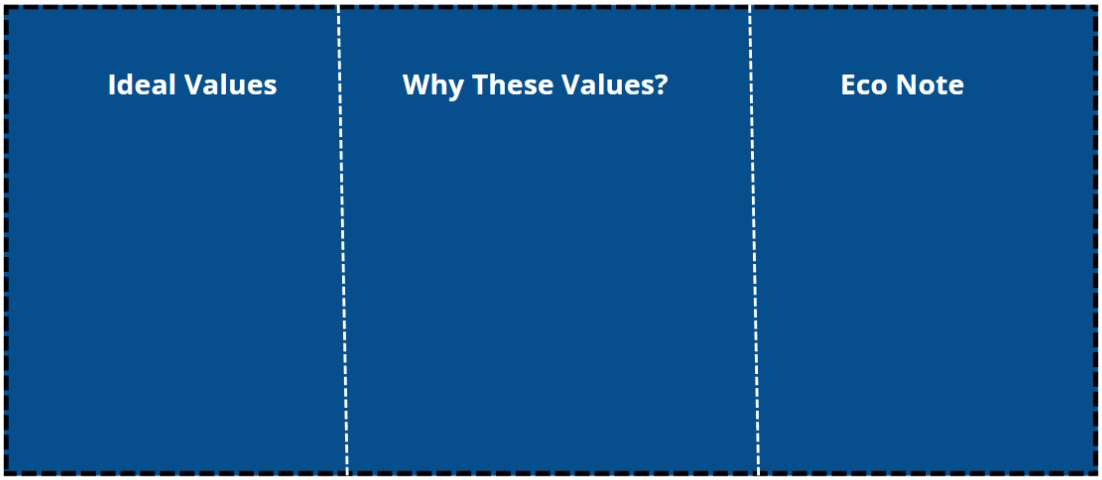
Task: Sort cards into 4 categories on table:

- Eyes/Skin problems.
- Muscle/Breathing issues.
- Infection risk.
- Comfort/Performance drop.

Step 2: Data Review & Connection (10 min)
Review your test results:

- Which sample had worst pH? Match to symptom.
- Which was coldest? Match to effect.
- Write 2-3 sentences for each sample Eg / "Sample X would cause [symptom] because [chemistry reason]."

POSTER STRUCTURE FOR PERFECT POOL



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Step 3: Perfect Pool Design (20 min)
On poster template, teams create:
a) Ideal Values: Draw pH dial at 7.4, temp at 27°C, chlorine "2 ppm," water "crystal clear."
b) Why These Values? 3-4 bullet points per parameter (e.g., "pH 7.4: Eyes comfortable + chlorine works best").Also write Swimmer Benefits .
d) Eco Note: "Balanced chemistry = less harsh chemicals = better for environment."

Step 4: Perfect Pool Gallery Walk (10 min)
Posters around room. Teams add 1 sticky note comment to 2 other posters: "Great point about..." or "I agree because..." Reflection (5 min):
Individual: "One water chemistry fact I will remember when swimming is..."

Important take aways

Core Unit 1 on Chemistry & Swimming leaves you with several important takeaways that you can use both in the classroom and every time you enter the water. First, you gain a clear understanding that pool or open-water conditions are not random: pH, chlorine levels, temperature, and clarity all follow simple rules, and when these rules are respected, swimming becomes safer and more comfortable. You learn how to read these parameters using basic tools, transforming a pool test strip or thermometer into meaningful information about your eyes, skin, breathing, and infection risk. Second, you see that water chemistry directly affects performance: cold water can slow muscles and increase the chance of cramps, overly warm water can make you tire and overheat faster, and poorly balanced pH or chlorine can distract you with irritation or make you ill, reducing your ability to train or compete. Third, you practice thinking like a “swimming scientist”—observing, measuring, interpreting, and then making decisions based on evidence rather than guesswork. This helps you move from “the water feels weird” to “this water is probably outside the safe range because…”. Finally, the unit emphasises responsibility: as a swimmer, teammate, or future coach, you share in the duty to notice unsafe water conditions, speak up, and contribute to healthier, more sustainable use of pools and natural waters.

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