

The Boiling Point Is Not a Property of the Substance, but of the Substance and the Pressure Together

— the same water boils at **70.2315** degrees and at **120.5247**, a span of **50.2932** — drop to **6.2599** kPa and it boils at body temperature — below **611.657** Pa the phenomenon of boiling does not exist at all — [Paper 392]

Yuuki YAMAGISHI (山岸 勇輝)

Yamagishi Complexity Torus Lab, Japan

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— *From thinking to syncing.* —

Abstract

“Water boils at 100 degrees” is a number printed in tables of substances. This paper shows that it holds only under one convention—the boiling point can be moved **50.2932** degrees without altering the water at all. No new theorem or law is claimed. First, the Antoine equation gives **99.9968** degrees for the boiling point at one atmosphere (Section 2). Second, it is **87.5727** degrees on the summit of Mount Fuji, **70.2315** on Everest and **120.5247** in a pressure cooker (Section 2). Third, and this is the core of the paper. The span is **50.2932** degrees, and the water has not changed once (Section 2). Fourth, drop the pressure to **6.2599** kPa and it boils at a body temperature of **37** degrees (Section 3). Fifth, below the triple point at **611.657** Pa the phenomenon of boiling does not exist (Section 3). Sixth, the separator is whether the number is set by the substance alone or by substance and environment together (Section 5).

Scope of this paper (scope note): No new theorem or law is claimed—the vapour-pressure curve, the Antoine equation, the Clausius–Clapeyron relation and the triple point are all known. No thermodynamics is built—the theory of phase equilibrium is not entered. One empirical relation is used to produce numbers. No accuracy is claimed for the Antoine equation—its constants are fitted over 1 to 100 degrees; 120 degrees is an extrapolation and the first decimal is not guaranteed. No altitude–pressure relation is built—standard-atmosphere values are used for the pressures at each altitude; real pressures move with the weather. Superheating is not treated—without nucleation a liquid passes its boiling point; only equilibrium is examined. Mixtures are not treated—boiling-point elevation by solutes and azeotropes are not the subject. Only pure water. Relation to earlier papers: Paper 379 showed that “twice as hot” has three answers—here one “boiling point” differs with the pressure. Paper 386 showed that solubility is set by substance, solvent and temperature—here the boiling point is set by substance and pressure. Paper 384 showed that the frequency term of free-space loss comes from the receiving side—in both, a quantity thought to belong to a thing belongs to a pair. Paper 300 showed that same-root and different-root can be decided—melting point and boiling point are different-root by that criterion. What is added is putting numbers on the boiling point at four pressures, showing a span of 50.2932 degrees, obtaining 6.2599 kPa for boiling at body temperature, exhibiting the triple point as a boundary below which boiling is undefined, and placing the separator at “substance, or substance and environment”.

1. Notation and the Question

Setting: boiling occurs when the vapour pressure of the liquid equals the surrounding pressure. Write the vapour pressure of water with the Antoine equation.

$$\log_{10} P = A - \frac{B}{C + T}, \quad A = 8.07131, B = 1730.63, C = 233.426$$

P in mmHg, T in degrees Celsius. The boiling point is $T = B/(A - \log_{10} P) - C$.

Observation 1.1

the surrounding pressure appears in the formula. The boiling point is a function of P —fix no P and there is no such number.

Observation 1.2

A , B and C are the substance’s side. Change the liquid and those three change— P is not on the water’s side.

Observation 1.3

so the boiling point attaches to a pair.A substance and an environment——neither alone determines it.

Question: “water boils at 100 degrees” is a statement about what?

2. The Same Water Boils at 70 Degrees and at 120

Computation 2.1: boiling point of water against pressure (computed in this paper).

Place	Pressure [mmHg]	Boiling point [deg]
Everest, 8848 m (314 hPa)	235.52	70.2315
Summit of Fuji, 3776 m (638 hPa)	478.54	87.5727
Sea level (1 atm)	760.00	99.9968
Pressure cooker (2 atm)	1520.00	120.5247
Span	—	50.2932

Observation 2.2

this is the core of the paper.Top and bottom differ by 50.2932 degrees——all four rows are pure water, and nothing on the water’s side has changed.

Observation 2.3

the 99.9968 degrees at one atmosphere agrees with the standard value.The independently known 100 degrees——neither the formula nor the constants are off.

Observation 2.4

the inverse also closes. The vapour pressure at 100 degrees comes out as 760.0864 mmHg—the round trip returns.

Observation 2.5

at Everest's 70.2315 degrees an egg will not cook. Below the denaturation temperature of the protein —“boiling” and “hot” are different things.

Observation 2.6

a pressure cooker runs at 120.5247 degrees, and that is what speeds the cooking. It raises the boiling point itself, not the heating—at one atmosphere a bigger flame will not pass 100 degrees.

3. Boiling at Body Temperature; No Boiling Below the Triple Point

Computation 3.1: two extremes (computed in this paper).

Condition	Value
Pressure at which it boils at 37 degrees	46.9533 mmHg = 6.2599 kPa
Triple-point pressure	611.657 Pa = 4.587804 mmHg
Boiling point at that pressure	0.1366 degrees
Below it	no liquid; boiling does not exist

Observation 3.2

6.2599 kPa is about one sixteenth of the Earth's atmosphere. $101.325/6.2599 = 16.19$ —unpressurised at that altitude, the water in a body boils at body temperature.

Observation 3.3

at the triple point the boiling and melting points meet. 0.1366 degrees——two curves crossing at one point.

Observation 3.4

below it, ice becomes gas directly. Sublimation——and the question “what is the boiling point” can no longer be asked.

Observation 3.5

so below a certain pressure the boiling point is undefined. Not a different value: no value——it is not a quantity that belongs in a table as one number.

Observation 3.6

the mean surface pressure on Mars is about 610 Pa, just below the triple point. By coincidence, right at this boundary——whether liquid water can be stable is decided at this one point.

4. The Melting Point Moves Too, by Orders of Magnitude Less

Observation 4.1

the melting point also moves with pressure. But by a different order——one atmosphere moves it about 0.0075 degrees.

Observation 4.2

the difference comes from the size of the volume change. Clapeyron's $dT/dP = T\Delta V/\Delta H$ ——vaporisation changes the volume by a factor of a thousand and more; melting hardly at all.

Observation 4.3

so “melting point” may go in a table of substances. In practice a property of the substance——“boiling point” in the same table invites a misreading.

Observation 4.4

they are different-root by the criterion of Paper 300. The melting point is set by crystal bonding, the boiling point by a balance between vapour pressure and external pressure——both are “a temperature at which the phase changes”, with different roots.

Observation 4.5

the shape is that of Paper 386. There the solubility was set by substance, solvent and temperature together——here the boiling point by substance and pressure. In neither case is it the property of one thing.

5. Separator: Set by the Substance Alone, or by a Pair

Observation 5.1

separator——change the environment and see whether the number moves.

Quantity	Set by	Change by 1 atm	Fit for a table
Boiling point	substance + pressure	about 20 degrees	with the condition stated
Melting point	substance + pressure	about 0.0075 degrees	in practice yes
Molar mass	substance alone	no change	yes

Observation 5.2

only the third row is genuinely a property of the substance. The first two are properties of a pair——put them in the same table and the distinction disappears.

Observation 5.3

the distinction is not one of degree. The melting point is a property of a pair as well——it merely moves too little to notice; in kind it is the same as the boiling point.

Observation 5.4

this separator can be tested. Change the pressure and measure——if it moves, it is a property of a pair.

Observation 5.5

to be honest——the 120.5247 degrees is an extrapolation of the Antoine equation. Its constants are fitted over 1 to 100 degrees——what does not move is that the boiling point is a function of pressure, and that below the triple point it is undefined.

Observation 5.6

one last thing——the number “100” is a way of writing that omits the convention “at one atmosphere”. Omit it long enough and the convention is forgotten——and a forgotten convention is first remembered up a mountain.

6. Roll Call and Closing

1. The boiling point is a function of P (Section 1): **no P , no number.**
2. 99.9968 degrees at one atmosphere (Computation 2.1): **agrees with the standard value.**
3. 70.2315 degrees on Everest (Computation 2.1): **an egg will not cook.**
4. 120.5247 degrees in a pressure cooker (Computation 2.1): **it raises the boiling point itself.**

5. A span of **50.2932** degrees (Computation 2.1): **the water has not changed.**
6. **6.2599** kPa boils at body temperature (Computation 3.1): **one sixteenth of the atmosphere.**
7. **0.1366** degrees at the triple point (Computation 3.1): **boiling meets melting.**
8. Below it, undefined (Observation 3.5): **no value at all.**
9. The melting point moves **0.0075** degrees (Observation 4.1): **the volume change differs.**
10. The melting point is also a pair property (Observation 5.3): **not a matter of degree.**

Closing: “water boils at 100 degrees” is a number printed in tables of substances—but it holds only under one convention. Boiling occurs when the vapour pressure equals the surrounding pressure—in the Antoine equation $\log_{10} P = A - B/(C + T)$, A , B and C are the substance’s side and P is not. The boiling point attaches to a pair, and neither member alone determines it. The same water boils at 70 degrees and at 120—**70.2315** on Everest (314 hPa), **87.5727** on the summit of Fuji (638 hPa), **99.9968** at sea level and **120.5247** in a pressure cooker (2 atm)—a span of **50.2932** degrees. All four rows are pure water and nothing on the water’s side has changed. The **99.9968** at one atmosphere agrees with the standard 100, and the inverse closes: the vapour pressure at 100 degrees comes out as 760.0864 mmHg. At Everest’s 70.2315 degrees an egg will not cook, because “boiling” and “hot” are different things; and a pressure cooker is fast not because it heats harder but because it raises the boiling point itself—at one atmosphere a bigger flame will not pass 100 degrees. Drop the pressure and it boils at body temperature; drop it further and boiling stops existing—at **6.2599** kPa (46.9533 mmHg) water boils at 37 degrees, about one sixteenth of the Earth’s atmosphere, so unpressurised at that altitude the water in a body boils at body temperature. At the triple point, 611.657 Pa, the boiling point is **0.1366** degrees and meets the melting point; below it ice becomes gas directly and the question can no longer be asked. Below a certain pressure the boiling point does not take a different value—it has none. The mean surface pressure on Mars is about 610 Pa, just below the triple point, and whether liquid water can be stable is decided at this one point. The melting point is the same kind of quantity, moving orders of magnitude less—one atmosphere moves it about 0.0075 degrees. The difference comes from Clapeyron’s $dT/dP = T\Delta V/\Delta H$: vaporisation changes the volume by a factor of a thousand and more, melting hardly at all. So “melting point” may go in a table of substances while “boiling point” in the same table invites a misreading. By the criterion of Paper 300 they are different-root: crystal bonding on one side, a balance of pressures on the other. One thing does the separating—change the environment and see whether the number moves. Only the molar mass is genuinely a property of the substance; both the boiling and the melting point are properties of a pair. The distinction is not one of degree—the melting point merely moves too little to notice, and in kind it is the same. The test is to change the pressure and measure. To be honest—the 120.5247 degrees is an extrapolation of the Antoine equation, whose constants are fitted over 1 to 100 degrees. What does not move is that the boiling point is a function of pressure, and that below the triple point it is undefined. One last thing—the number “100” is a way of writing that omits the convention “at one atmosphere”. Omit it long enough and the convention is forgotten. And a forgotten convention is first remembered up a mountain.

References

1. Antoine, C. (1888). Tensions des vapeurs: nouvelle relation entre les tensions et les températures. *Comptes Rendus des Séances de l'Académie des Sciences*.
2. Wagner, W., Pruß, A. (2002). The IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance. *Journal of Physical and Chemical Reference Data*.
3. Atkins, P., de Paula, J. (2014). *Atkins' Physical Chemistry* (10th ed.). Oxford: Oxford University Press.
4. Guildner, L. A., Johnson, D. P., Jones, F. E. (1976). Vapor Pressure of Water at Its Triple Point. *Journal of Research of the National Bureau of Standards*, 80A(3).
5. Yamagishi, Y. (2026). *The Three Hundredth Census: Whether Two Things Share a Root Is Decidable* [Paper 300]. Zenodo. 10.5281/zenodo.22171914
6. Yamagishi, Y. (2026). *“Twice as Hot” Has Three Answers, and Only One Gives a Ratio of 2* [Paper 379]. Zenodo. 10.5281/zenodo.22698802
7. Yamagishi, Y. (2026). *“Free-Space Loss” Is Not a Loss: The Vacuum Absorbs Nothing* [Paper 384]. Zenodo. 10.5281/zenodo.22699073
8. Yamagishi, Y. (2026). *The Solubility Did Not Move at All, and the Dissolution Became a Thousand Times Faster* [Paper 386]. Zenodo. 10.5281/zenodo.22699119

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