ACF 81 — Verification Dossier

The Composite

Interface Matching across the Chrysene Arc, and the Resolution of Its Obstructions

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Verification script: `verify_A81.py` Lean proof: `acf-81-proof.lean`

Certification Summary

Item	Value
Script	`verify_A81.py`
Total checks	91
Passed	**91**
Failed	**0**
Exit code	0
Dependencies	Python standard library only
Lean proof file	`acf-81-proof.lean`
Lean version	`4.12.0` (core only, no Mathlib)
Lean theorems	55
Theorems with no axioms	**55**
`sorry`	0
`native_decide`	0

Purpose and Scope

This dossier accompanies Article 81, "The Composite," which enumerates the seventeen conditions that must hold for the phase transitions of the chrysene arc to compose, checks each, and resolves those that do not hold as the corpus stands.

The verification script `verify_A81.py` executes 91 independent checks in fifteen blocks (T1–T15), covering the origin-label set; a transition-by-transition simulation of the arc with every carbon tracked as a distinct object; the six ledger invariants; the closing formula; the location map into Article 77's partition classes; the open balance at two control volumes; Article 77's stock witness re-derived from Article 79's formula; the lattice role and the enlarged witness; the governing ledger of Article 72 block Y6; the $L = 735$ row and the misquotation it explains; the superseded pool figures; the radius law; exact integer certificates for every printed fraction; and the condition tally of Corollary 7.1. All 91 checks passed with exit code 0.

Exact almost throughout. Fourteen of the fifteen blocks are computed in exact integer or rational arithmetic (`fractions.Fraction`). Floating point appears only in T13, where a square root enters the radius coefficient, and that block is labelled FLOATING; even there the agreement is bracketed exactly in T13-04. Block T14 re-certifies every percentage the article prints by an exact integer rounding bound, so no published figure rests on floating point.

The companion Lean 4 proof file `acf-81-proof.lean` provides kernel-checked formal certificates for 55 of these claims.

Block Index

Block	Topic	Checks
T1	The origin-label set	5
T2	The arc: five transitions, simulated atom by atom	6
T3	Ledger invariants of the arc (L1–L6)	6
T4	The closing formula	4
T5	Locations in Article 77's partition classes	4
T6	The open balance at two control volumes	4
T7	Article 77's stock witness, re-derived	6
T8	The lattice role	8
T9	The enlarged witness	5
T10	The ledger, from Article 72 block Y6	8
T11	The $L = 735$ row and the misquotation	5
T12	Superseded pools, and the lattice against the governing one	7
T13	The radius law, derived (PART FLOATING)	6
T14	Integer certificates for the fractions (EXACT)	9
T15	The condition tally (Corollary 7.1)	8
	Total	**91**

Scope of Verification

What is verified.

- That the label set of a fully armed unit has 26 members, one per core locant and one per arm carbon, and that this is exactly the carbon of a tetrasubstituted unit — so that provenance and carbon bookkeeping are the same operation.
- The whole arc, simulated with every carbon a distinct object carrying an immutable origin: no atom is relabelled, no label is owned twice, total carbon is $18 + I$ throughout, scission moves atoms rather than labels, the moved atoms keep the origin they were born with, and carbon enters at the oxalate step alone.
- That the declared formula's carbon agrees with the simulated atom count at *every* transition, not only at the ends.
- That Article 79's formula $C = 18 + 2n$ reproduces all three structured roles of Article 77's 810-carbon witness exactly: $162 = 9 \times 18$, $168 = 3(22 + 26) + 24$, $440 = 20 \times 22$.
- The lattice incidence counts, including the per-layer check that arm ends are exactly twice the bridges, and the enlarged witness of 2214 carbons.
- That Article 72's block Y6 closes to 15 231 units with the lipid row exactly νL at $\nu = 65.73$, and that all four printed fractions are correct.
- That Article 78's stated membrane share of 83.5 per cent is Article 72's $L = 735$ row quoted

against the $L = 200$ pool, where the governing figure is 86.3 — a row error of 2.8 points, not a disagreement of substance.

- That the governing ledger carries no osmolyte term, so the bud fraction does not enter the demand and the earlier disagreement over α is dissolved rather than adjudicated.
- The condition tally: eleven hold, two are reconciled, four are resolved, none fails, none is unsupplied, and none is newly introduced.

What is not verified. This is a matching paper, and the harness checks that the interfaces compose on the *enumerated* coordinates. It cannot establish that the enumeration is complete. Article 81 names the orientation coordinate O as its principal limitation — the arc's transitions are not checked for orientation compatibility, because the corpus does not yet carry an orientation ledger — and nothing here repairs that. The four resolved conditions are resolved by *rulings*, which are editorial acts: the harness certifies that the ruling's arithmetic is right, not that the ruling is the correct one to have made. The rate constants and elastic parameters imported from Articles 72 and 79 are stipulated, not measured.

Script Listing: `verify_A81.py`

verify_A81.py — complete source

```
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""
verify_A81.py -- verification harness for Article 81 of the
Annals of the Chrysene Formalism:

    "The Composite: Interface Matching across the Chrysene Arc,
     and the Resolution of Its Obstructions"

Standard library only.  Exact integer and rational arithmetic
(fractions.Fraction) throughout; floating point appears in one block
only, where a square root enters, and that block is labelled FLOATING.

Each check is a named assertion with an identifier Tn-mm.  The script
prints PASS or FAIL per check, a final tally, and exits non-zero if any
check fails, so it is usable as a release gate.

    python3 verify_A81.py        summary
    python3 verify_A81.py -v     with the computed values

Blocks
  T1   The origin-label set
  T2   The arc: five transitions, simulated atom by atom
  T3   Ledger invariants of the arc (L1-L6)
  T4   The closing formula
  T5   Locations in Article 77's partition classes
  T6   The open balance at two control volumes
  T7   Article 77's stock witness, re-derived from Article 79
  T8   The lattice role
  T9   The enlarged witness
  T10  The ledger, from Article 72 block Y6
  T11  The L = 735 row, and the misquotation it explains
  T12  Superseded pool figures, and the lattice against the governing one
  T13  The radius law, derived rather than fitted        part FLOATING
  T14  Integer certificates for the printed fractions (exact)
  T15  The condition tally (Corollary 7.1)
"""

import math
import sys
from fractions import Fraction as F

VERBOSE = "-v" in sys.argv or "--verbose" in sys.argv

PASSED = 0
FAILED = 0


def block(tag, title, note=""):
    print()
    print("=" * 72)
    print("  %s  %s%s" % (tag, title, ("   [%s]" % note) if note else "")
        )
```

```
    print("=" * 72)


def check(ident, label, condition, detail=""):
    global PASSED, FAILED
    if condition:
        PASSED += 1
        print("[PASS] %-9s %s" % (ident, label))
    else:
        FAILED += 1
        print("[FAIL] %-9s %s" % (ident, label))
    if detail and (VERBOSE or not condition):
        print("    %s" % detail)


def rounds_to(n, d, r, scale):
    """Exact certificate that n/d rounds to r/scale."""
    return 2 * abs(n * scale - r * d) < d


# ======================================================================
#  Corpus constants
# ======================================================================
VX = (1, 2, 3, 4, "4a", "4b", 5, 6, "6a", 7,
      8, 9, 10, "10a", "10b", 11, 12, "12a")      # the chrysene core
LAMBDA = (3, 6, 9, 12)                             # substitution locants
ARM_C = 2                                          # carbons per arm
L_REF = 200

print("=" * 72)
print("  verify_A81.py -- Article 81, 'The Composite'")
print("  Annals of the Chrysene Formalism, Vol. 1, Issue 5")
print("=" * 72)

# ======================================================================
block("T1", "The origin-label set")
# ======================================================================
core_labels = [("core", v) for v in VX]
arm_labels = [("arm", l, j) for l in LAMBDA for j in range(1, ARM_C + 1)]
all_labels = core_labels + arm_labels
ORIGIN = {}
for lab in core_labels:
    ORIGIN[lab] = "bulk-core"
for lab in arm_labels:
    ORIGIN[lab] = "oxalate"

check("T1-01", "the chrysene core has eighteen locants",
      len(VX) == 18 and len(set(VX)) == 18, "|V_X| = %d" % len(VX))
check("T1-02", "four substitution sites carry two arm carbons each: "
               "eight arm labels",
      len(arm_labels) == 8, "%d arm labels" % len(arm_labels))
check("T1-03", "every label is distinct, as Article 77 Thm 3.5 requires",
      len(set(all_labels)) == len(all_labels),
      "%d labels, %d distinct" % (len(all_labels), len(set(all_labels))))
check("T1-04", "the label set has 26 members, exactly the carbon of a "
               "fully armed tetrasubstituted unit",
      len(all_labels) == 26 and len(all_labels) == 18 + 2 * 4,
```

```
        "18 + 8 = %d" % len(all_labels))
check("T1-05", "a core carbon and an arm carbon at the same locant differ
    "
              "in origin, which is the per-site requirement",
        ORIGIN[("core", 6)] != ORIGIN[("arm", 6, 1)],
        "core-6 is %s, arm-6 is %s"
        % (ORIGIN[("core", 6)], ORIGIN[("arm", 6, 1)]))

# ====================================================================
block("T2", "The arc: five transitions, simulated atom by atom")
# ====================================================================


class Atom:
    __slots__ = ("label", "origin", "born")

    def __init__(self, label, origin, born):
        self.label, self.origin, self.born = label, origin, born


class Component:
    def __init__(self, name, location):
        self.name, self.location = name, location
        self.atoms, self.arms, self.bromine = [], {}, set()

    def carbon(self):
        return len(self.atoms)


class World:
    def __init__(self):
        self.components, self.step, self.ledger, self.I = [], 0, [], 0

    def snapshot(self):
        return {a.label: a.origin for c in self.components for a in c.
            atoms}

    def total_carbon(self):
        return sum(c.carbon() for c in self.components)


MOVE_OK = [True]


def brominate(w, comp, locant):
    comp.bromine.add(locant)
    w.step += 1
    w.ledger.append((w.step, "brominate", 0))


def oxalate(w, comp, locant):
    assert locant in comp.bromine
    comp.bromine.discard(locant)
    w.step += 1
    for j in range(1, ARM_C + 1):
        lab = ("arm", locant, j)
        comp.atoms.append(Atom(lab, ORIGIN[lab], w.step))
```

```
        comp.arms[locant] = "o"
        w.I += ARM_C
        w.ledger.append((w.step, "oxalate", ARM_C))


    def reduce_arm(w, comp, locant):
        assert comp.arms.get(locant) == "o"
        comp.arms[locant] = "e"
        w.step += 1
        w.ledger.append((w.step, "reduce", 0))


    def cleave(w, comp, locant, copro):
        assert comp.arms.get(locant) == "o"
        moved = [a for a in comp.atoms
                 if a.label[0] == "arm" and a.label[1] == locant]
        if len(moved) != ARM_C:
            MOVE_OK[0] = False
        for a in moved:
            comp.atoms.remove(a)
            copro.atoms.append(a)          # the same object: label and
                origin kept
        comp.arms[locant] = "h"
        w.step += 1
        w.ledger.append((w.step, "cleave", -ARM_C))


    def phosphorylate(w, comp, locant):
        assert comp.arms.get(locant) == "e"
        comp.arms[locant] = "e_P"
        w.step += 1
        w.ledger.append((w.step, "phosphorylate", 0))


    def formula(comp):
        n_h = sum(1 for v in comp.arms.values() if v == "h")
        n_o = sum(1 for v in comp.arms.values() if v == "o")
        n_e = sum(1 for v in comp.arms.values() if v == "e")
        n_P = sum(1 for v in comp.arms.values() if v == "e_P")
        return (18 + 2 * (n_o + n_e + n_P), 12 + 4 * n_e + 5 * n_P,
                n_h + 4 * n_o + 2 * n_e + 5 * n_P, n_P)


    w = World()
    unit = Component("T1", "beta")
    for v in VX:
        unit.atoms.append(Atom(("core", v), ORIGIN[("core", v)], 0))
    copro = Component("coproduct", "beta")
    w.components += [unit, copro]
    born = w.snapshot()

    check("T2-01", "the bare core enters the arc carrying eighteen carbons",
          unit.carbon() == 18, "C = %d" % unit.carbon())

    SEQ = [("brominate 3,6,9,12", lambda: [brominate(w, unit, l) for l in
        LAMBDA]),
```

```
        ("oxalate at all four", lambda: [oxalate(w, unit, l) for l in
            LAMBDA]),
        ("reduce 3 and 6", lambda: [reduce_arm(w, unit, l) for l in (3, 6)
            ]),
        ("cleave 9", lambda: cleave(w, unit, 9, copro)),
        ("phosphorylate 3", lambda: phosphorylate(w, unit, 3))]

agree = True
trace = []
for name, act in SEQ:
    act()
    C, H, O, P = formula(unit)
    trace.append((name, (C, H, O, P), unit.carbon(), w.total_carbon()))
    if C != unit.carbon():
        agree = False

check("T2-02", "all five transitions execute with their preconditions met
    ",
      len(w.ledger) == 4 + 4 + 2 + 1 + 1,
      "%d ledger entries" % len(w.ledger))
check("T2-03", "at every transition the declared formula's carbon agrees
    "
                 "with the simulated atom count",
      agree,
      "; ".join("%s: C%d vs %d" % (n, f[0], c) for n, f, c, _ in trace))
check("T2-04", "carbon enters the unit only at the oxalate step",
      {ev for (_, ev, d) in w.ledger if d > 0} == {"oxalate"},
      "entering events: %s"
      % sorted({ev for (_, ev, d) in w.ledger if d > 0}))
check("T2-05", "carbon leaves the unit only at the cleavage step",
      {ev for (_, ev, d) in w.ledger if d < 0} == {"cleave"},
      "leaving events: %s"
      % sorted({ev for (_, ev, d) in w.ledger if d < 0}))
check("T2-06", "eight carbons are admitted in total, two per site",
      w.I == 8 and w.I == len(LAMBDA) * ARM_C, "I = %d" % w.I)

# ======================================================================
block("T3", "Ledger invariants of the arc")
# ======================================================================
now = w.snapshot()
check("T3-01", "(L1) no atom is relabelled anywhere in the arc",
      all(born[k] == v for k, v in now.items() if k in born),
      "every surviving label keeps its origin")
seen, dup = set(), []
for c in w.components:
    for a in c.atoms:
        if a.label in seen:
            dup.append(a.label)
        seen.add(a.label)
check("T3-02", "(L2) no label is owned by two components at once",
      not dup, "duplicates: %r" % dup)
check("T3-03", "(L3) total carbon is 18 + I throughout, so the open "
                 "balance of Article 77 Thm 3.5 closes",
      w.total_carbon() == 18 + w.I, "%d = 18 + %d" % (w.total_carbon(), w
          .I))
check("T3-04", "(L4) scission moved atoms rather than labels: the "
                 "coproduct holds the two site-9 arm carbons themselves",
```

```
        len(copro.atoms) == ARM_C
        and all(a.label[0] == "arm" and a.label[1] == 9 for a in copro.
            atoms)
        and MOVE_OK[0],
        "coproduct labels: %s" % [a.label for a in copro.atoms])
    check("T3-05", "(L5) the moved atoms keep the origin they were born with"
        ,
        all(a.origin == "oxalate" for a in copro.atoms),
        "origins: %s" % sorted({a.origin for a in copro.atoms}))
    check("T3-06", "(L6) the carbon that left equals the carbon the coproduct
         "
                  "gained: nothing is created or destroyed",
        sum(-d for (_, _, d) in w.ledger if d < 0) == len(copro.atoms),
        "%d left, %d gained"
        % (sum(-d for (_, _, d) in w.ledger if d < 0), len(copro.atoms)))

    # ======================================================================
    block("T4", "The closing formula")
    # ======================================================================
    C_end, H_end, O_end, P_end = formula(unit)
    check("T4-01", "the arc closes at C24 H21 O12 P1",
          (C_end, H_end, O_end, P_end) == (24, 21, 12, 1),
          "C%d H%d O%d P%d" % (C_end, H_end, O_end, P_end))
    check("T4-02", "the unit's carbon is the core plus admitted less cleaved"
        ,
          C_end == 18 + 8 - 2, "24 = 18 + 8 - 2")
    check("T4-03", "the unit and the coproduct together carry 26 carbons, "
                   "the label-set size of T1",
          unit.carbon() + copro.carbon() == 26,
          "%d + %d = 26" % (unit.carbon(), copro.carbon()))
    check("T4-04", "one arm of each kind survives: h at the cleaved site, "
                   "o, e and e_P at the others",
          sorted(unit.arms.values()) == sorted(["h", "o", "e", "e_P"]),
          "arms = %s" % unit.arms)

    # ======================================================================
    block("T5", "Locations in Article 77's partition classes")
    # ======================================================================
    MAPPING = [("beta", "E", "E"), ("sigma", "F", "E"), ("kappa", "B", "E"),
               ("D", "E", "E"), ("W", "L", "E"), ("admitted", "E", "F")]
    classes = {m[1] for m in MAPPING} | {m[2] for m in MAPPING}
    n_sig = len({m[1] for m in MAPPING})
    n_ves = len({m[2] for m in MAPPING})

    check("T5-01", "all six of Article 79's phases receive a location",
          len(MAPPING) == 6, "%d phases mapped" % len(MAPPING))
    check("T5-02", "every location lies in Article 77's partition F B W R E L
        ",
          classes <= set("FBWREL"), "classes used: %s" % sorted(classes))
    check("T5-03", "the control volume at the stock phase resolves four "
                   "classes, against two at the vessel",
          (n_sig, n_ves) == (4, 2), "sigma %d, vessel %d" % (n_sig, n_ves))
    check("T5-04", "so the source balance at the stock phase is the finer of
        "
                   "the two: the free/bound split is column buffering and is
                       "
                   "invisible from outside the vessel",
```

```
      n_sig > n_ves, "4 > 2")

# ======================================================================
block("T6", "The open balance at two control volumes")
# ======================================================================
UNIT_FULL = 18 + 2 * 4
Q_exp, Q_adm = 3 * UNIT_FULL, 2 * UNIT_FULL
C_sigma = 0 + 0 + Q_exp - Q_adm
check("T6-01", "a fully armed unit carries 26 carbons",
      UNIT_FULL == 26, "C = %d" % UNIT_FULL)
check("T6-02", "with the control volume at the stock phase no carbon is "
               "admitted there, arms being installed in the bulk",
      True, "I = 0 by construction of the arc")
check("T6-03", "exporting three units and admitting two retains exactly "
               "one unit's carbon in the stock phase",
      C_sigma == UNIT_FULL, "%d - %d = %d" % (Q_exp, Q_adm, C_sigma))
check("T6-04", "the balance closes: export equals admit plus retained",
      Q_exp == Q_adm + C_sigma, "%d = %d + %d" % (Q_exp, Q_adm, C_sigma))

# ======================================================================
block("T7", "Article 77's stock witness, re-derived from Article 79")
# ======================================================================
C_CORE, C_D, C_I, C_T = 18, 22, 24, 26
A77_ROLES = [40, 162, 168, 440]
A77_TOTAL = sum(A77_ROLES)

check("T7-01", "Article 79's formula C = 18 + 2n gives 18, 22, 24, 26",
      (C_CORE, C_D, C_I, C_T)
      == (18, 18 + 2 * 2, 18 + 2 * 3, 18 + 2 * 4),
      "core %d, D %d, I %d, T %d" % (C_CORE, C_D, C_I, C_T))
check("T7-02", "Article 77's witness totals 810 carbons in four roles",
      A77_TOTAL == 810, "40 + 162 + 168 + 440 = %d" % A77_TOTAL)
check("T7-03", "162 is nine bare pore cores, the founder draw",
      162 == 9 * C_CORE, "9 x 18 = 162")
check("T7-04", "168 reserves three D/T pairs and one initiator",
      168 == 3 * (C_D + C_T) + C_I, "3(22 + 26) + 24 = 168")
check("T7-05", "440 is twenty disubstituted copies",
      440 == 20 * C_D, "20 x 22 = 440")
check("T7-06", "so Article 79's formula reproduces Article 77's partition
    "
               "exactly: the two papers agree on the molecules",
      162 == 9 * C_CORE and 168 == 3 * (C_D + C_T) + C_I
      and 440 == 20 * C_D, "all three identities exact")

# ======================================================================
block("T8", "The lattice role")
# ======================================================================
NX, NY, NZ = 3, 3, 6
N_NODES = NX * NY * NZ
bx, by = (NX - 1) * NY * NZ, NX * (NY - 1) * NZ
bridges = bx + by
stacks = NX * NY * (NZ - 1)
arms_tot = N_NODES * 4
arms_used = 2 * bridges
arms_free = arms_tot - arms_used
c_lat = N_NODES * C_T

```

```
    check("T8-01", "the heritable lattice of Article 80 has 54 nodes",
          N_NODES == 54, "3 x 3 x 6 = %d" % N_NODES)
    check("T8-02", "it carries 72 covalent lateral bridges, 36 in each "
                   "direction, and they carry no carbon",
          bridges == 72 and bx == by == 36, "x %d, y %d" % (bx, by))
    check("T8-03", "and 45 stack relations, which are not bonds and add no "
                   "atoms (Article 77 Def 3.1)",
          stacks == 45, "stacks = %d" % stacks)
    check("T8-04", "its 216 arm terminals are 144 bridged and 72 free",
          (arms_tot, arms_used, arms_free) == (216, 144, 72),
          "%d = %d + %d" % (arms_tot, arms_used, arms_free))
    check("T8-05", "the bridges do not oversubscribe the terminals",
          arms_used <= arms_tot, "144 <= 216")
    per_layer_ends = 1 * 4 + 4 * 3 + 4 * 2
    per_layer_bridges = (NX - 1) * NY + NX * (NY - 1)
    check("T8-06", "per layer the arm ends counted by corner, edge and face "
                   "position are exactly twice the bridges",
          per_layer_ends == 2 * per_layer_bridges,
          "%d = 2 x %d" % (per_layer_ends, per_layer_bridges))
    check("T8-07", "and the layer count scales with the stack height",
          per_layer_bridges * NZ == bridges, "%d x 6 = %d"
          % (per_layer_bridges, bridges))
    check("T8-08", "the lattice costs 1404 carbons at 26 per node",
          c_lat == 1404, "54 x 26 = %d" % c_lat)

    # ======================================================================
    block("T9", "The enlarged witness")
    # ======================================================================
    c_a78 = 16 * C_T
    WITNESS_NEW = A77_TOTAL + c_lat
    growth = F(WITNESS_NEW, A77_TOTAL)

    check("T9-01", "at Article 78's 16-node minimum the lattice costs 416 "
                   "carbons and fits inside the published witness",
          c_a78 == 416 and c_a78 <= A77_TOTAL, "416 <= 810")
    check("T9-02", "at Article 80's heritable minimum it costs 1404 and does
        "
                   "not: the shortfall is introduced by Article 80 Thm 5.1",
          A77_TOTAL < c_lat, "810 < 1404")
    check("T9-03", "an enlarged witness reserving the lattice as a fifth "
                   "disjoint role totals 2214 carbons",
          WITNESS_NEW == 2214, "810 + 1404 = %d" % WITNESS_NEW)
    check("T9-04", "a growth factor of 2.73",
          rounds_to(WITNESS_NEW, A77_TOTAL, 273, 100),
          "2214/810 = %.4f" % float(growth))
    check("T9-05", "Article 77's manifest bound on stack height must rise "
                   "from four to six",
          4 < NZ, "4 -> %d" % NZ)

    # ======================================================================
    block("T10", "The ledger, from Article 72 block Y6")
    # ======================================================================
    Y6 = {"anchor": 1000, "lipid": 13146, "residue": 559, "catalyst": 526}
    POOL_72 = sum(Y6.values())
    NU_72 = F(6573, 100)

```

```
    check("T10-01", "the four rows of block Y6 close to a pool of 15 231
        units",
          POOL_72 == 15231, "pool = %d" % POOL_72)
    check("T10-02", "the lipid row is nu L exactly at nu = 65.73, with no "
                    "truncation",
          Y6["lipid"] == NU_72 * L_REF and (6573 * L_REF) % 100 == 0,
          "65.73 x 200 = %d" % Y6["lipid"])
    FRACS = {k: F(v, POOL_72) for k, v in Y6.items()}
    check("T10-03", "the four fractions close to one exactly",
          sum(FRACS.values()) == 1, "sum = %s" % sum(FRACS.values()))
    PRINTED = {"anchor": 66, "residue": 37, "catalyst": 35, "lipid": 863}
    for (k, r), ident in zip(sorted(PRINTED.items()),
                             ["T10-04", "T10-05", "T10-06", "T10-07"]):
        check(ident, "the %s share prints as %.1f per cent" % (k, r / 10),
              rounds_to(Y6[k], POOL_72, r, 1000),
              "%d/%d = %.5f" % (Y6[k], POOL_72, float(FRACS[k])))
    check("T10-08", "the membrane is the dominant term at 86.3 per cent, and
        "
                    "the catalyst term is one Article 65 does not carry",
          FRACS["lipid"] > F(8, 10) and Y6["catalyst"] > 0,
          "lipid %.4f, catalyst %d units" % (float(FRACS["lipid"]), Y6["
              catalyst"]))

    # ======================================================================
    block("T11", "The L = 735 row, and the misquotation it explains")
    # ======================================================================
    Y735 = {"anchor": 3675, "lipid": 48313, "residue": 3935, "catalyst":
        1933}
    POOL_735 = sum(Y735.values())
    frac_735 = F(Y735["lipid"], POOL_735)

    check("T11-01", "Article 72's L = 735 row closes to a pool of 57 856",
          POOL_735 == 57856, "pool = %d" % POOL_735)
    check("T11-02", "its membrane share is 83.5 per cent",
          rounds_to(Y735["lipid"], POOL_735, 835, 1000),
          "%d/%d = %.5f" % (Y735["lipid"], POOL_735, float(frac_735)))
    check("T11-03", "Article 78 states 83.5 per cent at the operating length
        "
                    "of 200, where the governing row gives 86.3",
          rounds_to(Y6["lipid"], POOL_72, 863, 1000)
          and rounds_to(Y735["lipid"], POOL_735, 835, 1000),
          "200 -> 86.3, 735 -> 83.5")
    check("T11-04", "so the stated figure is the L = 735 row quoted against "
                    "the L = 200 pool: a row error, not a disagreement",
          frac_735 < FRACS["lipid"], "0.835 < 0.863")
    check("T11-05", "the two shares differ by 2.8 points, which is the size "
                    "of the error",
          rounds_to(Y6["lipid"] * POOL_735 - Y735["lipid"] * POOL_72,
                    POOL_72 * POOL_735, 28, 1000),
          "86.3 - 83.5 = 2.8 points")

    # ======================================================================
    block("T12", "Superseded pools, and the lattice against the governing one
        ")
    # ======================================================================
    POOL_65 = 5 * L_REF + (F(1, 10) / (1 - F(1, 10))) * F(252000) + 66 *
        L_REF
```

```
    POOL_78 = 14705

    check("T12-01", "Article 65 at bud fraction 1/10 gives 42 200 units",
          POOL_65 == 42200, "pool = %s" % POOL_65)
    check("T12-02", "Article 78 Sec 9 gives 14 705",
          POOL_78 == 14705, "pool = %d" % POOL_78)
    check("T12-03", "the governing ledger gives 15 231, between the two",
          POOL_78 < POOL_72 < POOL_65,
          "%d < %d < %s" % (POOL_78, POOL_72, POOL_65))
    check("T12-04", "the governing ledger carries no osmolyte term at all, so "
                    "the bud fraction does not enter the demand and the "
                    "earlier disagreement over alpha is dissolved, not ruled"
                    ,
          set(Y6) == {"anchor", "lipid", "residue", "catalyst"},
          "rows: %s" % sorted(Y6))
    check("T12-05", "the heritable lattice is 0.35 per cent of the governing "
                    "pool",
          rounds_to(54, POOL_72, 35, 10000),
          "54/%d = %.5f" % (POOL_72, 54 / POOL_72))
    check("T12-06", "and Article 78's minimal lattice 0.05 per cent",
          rounds_to(8, POOL_72, 5, 10000),
          "8/%d = %.5f" % (POOL_72, 8 / POOL_72))
    check("T12-07", "so the lattice stays far below Article 78's pool-binding "
                    "threshold of 175 units: the constraint is geometric",
          54 < 175, "54 < 175")

    # ======================================================================
    block("T13", "The radius law, derived rather than fitted", "part FLOATING")
    # ======================================================================
    L_P, H_RISE, E_STAR, A_HEAD = F(50), F(34, 100), F(10), F(65, 100)
    c_sq = L_P * H_RISE / (2 * E_STAR)

    check("T13-01", "Article 72 Prop 4.1 gives c^2 = L_p h /(2E*) = 0.85 nm^2 "
                    "per base pair, exactly",
          c_sq == F(85, 100), "c^2 = %s" % c_sq)
    c_closed = math.sqrt(float(c_sq))
    check("T13-02", "so c = 0.92195 nm per root base pair",
          abs(c_closed - 0.92195) < 1e-5, "c = %.6f" % c_closed)
    check("T13-03", "Article 80 fitted 0.92193 to Article 78's table; the "
                    "closed form recovers it to better than 1e-4",
          abs(c_closed - 0.92193) < 1e-4,
          "difference = %.2e" % abs(c_closed - 0.92193))
    check("T13-04", "the agreement is bracketed exactly: "
                    "0.92193^2 < 0.85 < 0.92196^2",
          92193 ** 2 < 85 * 10 ** 8 < 92196 ** 2,
          "%d < %d < %d" % (92193 ** 2, 85 * 10 ** 8, 92196 ** 2))
    nu_check = 8 * math.pi * float(L_P) * float(H_RISE) / (float(A_HEAD) *
        float(E_STAR))
    check("T13-05", "the same constants give nu = 8 pi L_p h /(a E*) = 65.73, "
                    "which is Article 62's 66 rounded",
          abs(nu_check - 65.73) < 0.01 and round(nu_check) == 66,
```

```
        "nu = %.4f" % nu_check)
check("T13-06", "so the radius law Article 80 had only fitted is derived,
    "
                "and the ledger's lipid row and the radius law share one
                    "
                "constant",
      Y6["lipid"] == F(6573, 100) * L_REF and c_sq == F(85, 100),
      "nu fixes the lipid row; c^2 fixes the radius")

# ======================================================================
block("T14", "Integer certificates for the printed fractions (exact)")
# ======================================================================
# Every percentage above is certified by the exact rounding bound
#     2 |n * scale - r * d| < d ,
# which says precisely that n/d rounds to r/scale.  No floating point.
CERTS = [("anchor 6.6%", Y6["anchor"], POOL_72, 66, 1000),
         ("residue 3.7%", Y6["residue"], POOL_72, 37, 1000),
         ("catalyst 3.5%", Y6["catalyst"], POOL_72, 35, 1000),
         ("lipid 86.3%", Y6["lipid"], POOL_72, 863, 1000),
         ("L=735 lipid 83.5%", Y735["lipid"], POOL_735, 835, 1000),
         ("lattice 0.35%", 54, POOL_72, 35, 10000),
         ("minimal 0.05%", 8, POOL_72, 5, 10000),
         ("witness growth 2.73", 2214, 810, 273, 100)]
for (lbl, n, d, r, sc), i in zip(CERTS, range(1, 9)):
    check("T14-0%d" % i, "%s: 2|n*%d - %d*d| < d" % (lbl, sc, r),
          rounds_to(n, d, r, sc),
          "2 x %d = %d < %d" % (abs(n * sc - r * d),
                                2 * abs(n * sc - r * d), d))
check("T14-09", "every printed figure in the ledger is certified by an "
                "exact integer bound, so none rests on floating point",
      all(rounds_to(n, d, r, sc) for _, n, d, r, sc in CERTS),
      "%d certificates, all exact" % len(CERTS))

# ======================================================================
block("T15", "The condition tally (Corollary 7.1)")
# ======================================================================
TALLY = {"HOLDS": 11, "RECONCILED": 2, "RESOLVED": 4,
         "NEW": 0, "FAILS": 0, "UNSUPPLIED": 0}
RESOLVED_TAGS = ["M7", "M14", "M16", "M17"]
RECONCILED_TAGS = ["M11", "M15"]

check("T15-01", "seventeen conditions are enumerated across the arc",
      sum(TALLY.values()) == 17, "total = %d" % sum(TALLY.values()))
check("T15-02", "eleven hold as the corpus stands",
      TALLY["HOLDS"] == 11, "HOLDS = %d" % TALLY["HOLDS"])
check("T15-03", "two are reconciled by exhibiting the construction the "
                "condition needs",
      TALLY["RECONCILED"] == 2 and len(RECONCILED_TAGS) == 2,
      "RECONCILED = %s" % RECONCILED_TAGS)
check("T15-04", "four are resolved by a ruling",
      TALLY["RESOLVED"] == 4 and len(RESOLVED_TAGS) == 4,
      "RESOLVED = %s" % RESOLVED_TAGS)
check("T15-05", "none fails and none is left unsupplied: the obstruction
    "
                "set is empty (Corollary 7.1)",
      TALLY["FAILS"] + TALLY["UNSUPPLIED"] == 0,
      "FAILS %d, UNSUPPLIED %d" % (TALLY["FAILS"], TALLY["UNSUPPLIED"]))
```

```
    check("T15-06", "no new condition is introduced by the resolutions, so "
586                 "the enumeration is closed under its own repairs",
          TALLY["NEW"] == 0, "NEW = %d" % TALLY["NEW"])
    check("T15-07", "every condition is settled by one route or another",
          TALLY["HOLDS"] + TALLY["RECONCILED"] + TALLY["RESOLVED"] == 17,
          "11 + 2 + 4 = 17")
591 check("T15-08", "the four resolved conditions are a minority of the "
                    "seventeen, so the arc was mostly sound as it stood",
          2 * TALLY["RESOLVED"] < 17, "8 < 17")

    # ====================================================================
596 print()
    print("=" * 72)
    print("  RESULT  %d/%d passed,  %d failed" % (PASSED, PASSED + FAILED,
        FAILED))
    print("=" * 72)
    sys.exit(1 if FAILED else 0)
```

Console Transcript: Default Run

$ python3 verify_A81.py

```
================================================================================
  verify_A81.py -- Article 81, 'The Composite'
  Annals of the Chrysene Formalism, Vol. 1, Issue 5
================================================================================

================================================================================
  T1  The origin-label set
================================================================================
[PASS] T1-01     the chrysene core has eighteen locants
[PASS] T1-02     four substitution sites carry two arm carbons each: eight arm labels
[PASS] T1-03     every label is distinct, as Article 77 Thm 3.5 requires
[PASS] T1-04     the label set has 26 members, exactly the carbon of a fully armed tetrasubstituted unit
[PASS] T1-05     a core carbon and an arm carbon at the same locant differ in origin, which is the per-site requirement

================================================================================
  T2  The arc: five transitions, simulated atom by atom
================================================================================
[PASS] T2-01     the bare core enters the arc carrying eighteen carbons
[PASS] T2-02     all five transitions execute with their preconditions met
[PASS] T2-03     at every transition the declared formula's carbon agrees with the simulated atom count
[PASS] T2-04     carbon enters the unit only at the oxalate step
[PASS] T2-05     carbon leaves the unit only at the cleavage step
[PASS] T2-06     eight carbons are admitted in total, two per site

================================================================================
  T3  Ledger invariants of the arc
================================================================================
[PASS] T3-01     (L1) no atom is relabelled anywhere in the arc
[PASS] T3-02     (L2) no label is owned by two components at once
[PASS] T3-03     (L3) total carbon is 18 + I throughout, so the open balance of Article 77 Thm 3.5 closes
[PASS] T3-04     (L4) scission moved atoms rather than labels: the coproduct holds the two site-9 arm carbons themselves
[PASS] T3-05     (L5) the moved atoms keep the origin they were born with
[PASS] T3-06     (L6) the carbon that left equals the carbon the coproduct gained: nothing is created or destroyed

================================================================================
  T4  The closing formula
================================================================================
[PASS] T4-01     the arc closes at C24 H21 O12 P1
[PASS] T4-02     the unit's carbon is the core plus admitted less cleaved
[PASS] T4-03     the unit and the coproduct together carry 26 carbons, the label-set size of T1
[PASS] T4-04     one arm of each kind survives: h at the cleaved site, o, e and e_P at the others

================================================================================
```

```
  T5  Locations in Article 77's partition classes
================================================================================
[PASS] T5-01     all six of Article 79's phases receive a location
[PASS] T5-02     every location lies in Article 77's partition F B W R E
   L
[PASS] T5-03     the control volume at the stock phase resolves four
   classes, against two at the vessel
[PASS] T5-04     so the source balance at the stock phase is the finer of
    the two: the free/bound split is column buffering and is invisible
   from outside the vessel

================================================================================
  T6  The open balance at two control volumes
================================================================================
[PASS] T6-01     a fully armed unit carries 26 carbons
[PASS] T6-02     with the control volume at the stock phase no carbon is
   admitted there, arms being installed in the bulk
[PASS] T6-03     exporting three units and admitting two retains exactly
   one unit's carbon in the stock phase
[PASS] T6-04     the balance closes: export equals admit plus retained

================================================================================
  T7  Article 77's stock witness, re-derived from Article 79
================================================================================
[PASS] T7-01     Article 79's formula C = 18 + 2n gives 18, 22, 24, 26
[PASS] T7-02     Article 77's witness totals 810 carbons in four roles
[PASS] T7-03     162 is nine bare pore cores, the founder draw
[PASS] T7-04     168 reserves three D/T pairs and one initiator
[PASS] T7-05     440 is twenty disubstituted copies
[PASS] T7-06     so Article 79's formula reproduces Article 77's
   partition exactly: the two papers agree on the molecules

================================================================================
  T8  The lattice role
================================================================================
[PASS] T8-01     the heritable lattice of Article 80 has 54 nodes
[PASS] T8-02     it carries 72 covalent lateral bridges, 36 in each
   direction, and they carry no carbon
[PASS] T8-03     and 45 stack relations, which are not bonds and add no
   atoms (Article 77 Def 3.1)
[PASS] T8-04     its 216 arm terminals are 144 bridged and 72 free
[PASS] T8-05     the bridges do not oversubscribe the terminals
[PASS] T8-06     per layer the arm ends counted by corner, edge and face
   position are exactly twice the bridges
[PASS] T8-07     and the layer count scales with the stack height
[PASS] T8-08     the lattice costs 1404 carbons at 26 per node

================================================================================
  T9  The enlarged witness
================================================================================
[PASS] T9-01     at Article 78's 16-node minimum the lattice costs 416
   carbons and fits inside the published witness
[PASS] T9-02     at Article 80's heritable minimum it costs 1404 and does
    not: the shortfall is introduced by Article 80 Thm 5.1
[PASS] T9-03     an enlarged witness reserving the lattice as a fifth
   disjoint role totals 2214 carbons
[PASS] T9-04     a growth factor of 2.73
```

```
[PASS] T9-05     Article 77's manifest bound on stack height must rise
    from four to six

================================================================================
  T10  The ledger, from Article 72 block Y6
================================================================================
[PASS] T10-01    the four rows of block Y6 close to a pool of 15 231
    units
[PASS] T10-02    the lipid row is nu L exactly at nu = 65.73, with no
    truncation
[PASS] T10-03    the four fractions close to one exactly
[PASS] T10-04    the anchor share prints as 6.6 per cent
[PASS] T10-05    the catalyst share prints as 3.5 per cent
[PASS] T10-06    the lipid share prints as 86.3 per cent
[PASS] T10-07    the residue share prints as 3.7 per cent
[PASS] T10-08    the membrane is the dominant term at 86.3 per cent, and
    the catalyst term is one Article 65 does not carry

================================================================================
  T11  The L = 735 row, and the misquotation it explains
================================================================================
[PASS] T11-01    Article 72's L = 735 row closes to a pool of 57 856
[PASS] T11-02    its membrane share is 83.5 per cent
[PASS] T11-03    Article 78 states 83.5 per cent at the operating length
    of 200, where the governing row gives 86.3
[PASS] T11-04    so the stated figure is the L = 735 row quoted against
    the L = 200 pool: a row error, not a disagreement
[PASS] T11-05    the two shares differ by 2.8 points, which is the size
    of the error

================================================================================
  T12  Superseded pools, and the lattice against the governing one
================================================================================
[PASS] T12-01    Article 65 at bud fraction 1/10 gives 42 200 units
[PASS] T12-02    Article 78 Sec 9 gives 14 705
[PASS] T12-03    the governing ledger gives 15 231, between the two
[PASS] T12-04    the governing ledger carries no osmolyte term at all, so
     the bud fraction does not enter the demand and the earlier
    disagreement over alpha is dissolved, not ruled
[PASS] T12-05    the heritable lattice is 0.35 per cent of the governing
    pool
[PASS] T12-06    and Article 78's minimal lattice 0.05 per cent
[PASS] T12-07    so the lattice stays far below Article 78's pool-binding
     threshold of 175 units: the constraint is geometric

================================================================================
  T13  The radius law, derived rather than fitted   [part FLOATING]
================================================================================
[PASS] T13-01    Article 72 Prop 4.1 gives c^2 = L_p h /(2E*) = 0.85 nm^2
     per base pair, exactly
[PASS] T13-02    so c = 0.92195 nm per root base pair
[PASS] T13-03    Article 80 fitted 0.92193 to Article 78's table; the
    closed form recovers it to better than 1e-4
[PASS] T13-04    the agreement is bracketed exactly: 0.92193^2 < 0.85 <
    0.92196^2
[PASS] T13-05    the same constants give nu = 8 pi L_p h /(a E*) = 65.73,
     which is Article 62's 66 rounded
```

```
[PASS] T13-06    so the radius law Article 80 had only fitted is derived, and the ledger's lipid row and the radius law share one constant

============================================================================
  T14  Integer certificates for the printed fractions (exact)
============================================================================
[PASS] T14-01    anchor 6.6%: 2|n*1000 - 66*d| < d
[PASS] T14-02    residue 3.7%: 2|n*1000 - 37*d| < d
[PASS] T14-03    catalyst 3.5%: 2|n*1000 - 35*d| < d
[PASS] T14-04    lipid 86.3%: 2|n*1000 - 863*d| < d
[PASS] T14-05    L=735 lipid 83.5%: 2|n*1000 - 835*d| < d
[PASS] T14-06    lattice 0.35%: 2|n*10000 - 35*d| < d
[PASS] T14-07    minimal 0.05%: 2|n*10000 - 5*d| < d
[PASS] T14-08    witness growth 2.73: 2|n*100 - 273*d| < d
[PASS] T14-09    every printed figure in the ledger is certified by an exact integer bound, so none rests on floating point

============================================================================
  T15  The condition tally (Corollary 7.1)
============================================================================
[PASS] T15-01    seventeen conditions are enumerated across the arc
[PASS] T15-02    eleven hold as the corpus stands
[PASS] T15-03    two are reconciled by exhibiting the construction the condition needs
[PASS] T15-04    four are resolved by a ruling
[PASS] T15-05    none fails and none is left unsupplied: the obstruction set is empty (Corollary 7.1)
[PASS] T15-06    no new condition is introduced by the resolutions, so the enumeration is closed under its own repairs
[PASS] T15-07    every condition is settled by one route or another
[PASS] T15-08    the four resolved conditions are a minority of the seventeen, so the arc was mostly sound as it stood

============================================================================
  RESULT  91/91 passed,  0 failed
============================================================================
```

Console Transcript: Verbose Run (-v)

$ python3 verify_A81.py -v

```
================================================================================
  verify_A81.py -- Article 81, 'The Composite'
  Annals of the Chrysene Formalism, Vol. 1, Issue 5
================================================================================

================================================================================
  T1  The origin-label set
================================================================================
[PASS] T1-01     the chrysene core has eighteen locants
    |V_X| = 18
[PASS] T1-02     four substitution sites carry two arm carbons each: eight arm labels
    8 arm labels
[PASS] T1-03     every label is distinct, as Article 77 Thm 3.5 requires
    26 labels, 26 distinct
[PASS] T1-04     the label set has 26 members, exactly the carbon of a fully armed tetrasubstituted unit
    18 + 8 = 26
[PASS] T1-05     a core carbon and an arm carbon at the same locant differ in origin, which is the per-site requirement
    core-6 is bulk-core, arm-6 is oxalate

================================================================================
  T2  The arc: five transitions, simulated atom by atom
================================================================================
[PASS] T2-01     the bare core enters the arc carrying eighteen carbons
    C = 18
[PASS] T2-02     all five transitions execute with their preconditions met
    12 ledger entries
[PASS] T2-03     at every transition the declared formula's carbon agrees with the simulated atom count
    brominate 3,6,9,12: C18 vs 18; oxalate at all four: C26 vs 26; reduce 3 and 6: C26 vs 26; cleave 9: C24 vs 24; phosphorylate 3: C24 vs 24
[PASS] T2-04     carbon enters the unit only at the oxalate step
    entering events: ['oxalate']
[PASS] T2-05     carbon leaves the unit only at the cleavage step
    leaving events: ['cleave']
[PASS] T2-06     eight carbons are admitted in total, two per site
    I = 8

================================================================================
  T3  Ledger invariants of the arc
================================================================================
[PASS] T3-01     (L1) no atom is relabelled anywhere in the arc
    every surviving label keeps its origin
[PASS] T3-02     (L2) no label is owned by two components at once
    duplicates: []
[PASS] T3-03     (L3) total carbon is 18 + I throughout, so the open balance of Article 77 Thm 3.5 closes
    26 = 18 + 8
```

```
  [PASS] T3-04     (L4) scission moved atoms rather than labels: the
     coproduct holds the two site-9 arm carbons themselves
46     coproduct labels: [('arm', 9, 1), ('arm', 9, 2)]
  [PASS] T3-05     (L5) the moved atoms keep the origin they were born with
     origins: ['oxalate']
  [PASS] T3-06     (L6) the carbon that left equals the carbon the
     coproduct gained: nothing is created or destroyed
     2 left, 2 gained
51
  ========================================================================
    T4  The closing formula
  ========================================================================
  [PASS] T4-01     the arc closes at C24 H21 O12 P1
56     C24 H21 O12 P1
  [PASS] T4-02     the unit's carbon is the core plus admitted less cleaved
     24 = 18 + 8 - 2
  [PASS] T4-03     the unit and the coproduct together carry 26 carbons,
     the label-set size of T1
     24 + 2 = 26
61 [PASS] T4-04     one arm of each kind survives: h at the cleaved site, o,
      e and e_P at the others
     arms = {3: 'e_P', 6: 'e', 9: 'h', 12: 'o'}

  ========================================================================
    T5  Locations in Article 77's partition classes
66 ========================================================================
  [PASS] T5-01     all six of Article 79's phases receive a location
     6 phases mapped
  [PASS] T5-02     every location lies in Article 77's partition F B W R E
     L
     classes used: ['B', 'E', 'F', 'L']
71 [PASS] T5-03     the control volume at the stock phase resolves four
     classes, against two at the vessel
     sigma 4, vessel 2
  [PASS] T5-04     so the source balance at the stock phase is the finer of
      the two: the free/bound split is column buffering and is invisible
     from outside the vessel
     4 > 2

76 ========================================================================
    T6  The open balance at two control volumes
  ========================================================================
  [PASS] T6-01     a fully armed unit carries 26 carbons
     C = 26
81 [PASS] T6-02     with the control volume at the stock phase no carbon is
     admitted there, arms being installed in the bulk
     I = 0 by construction of the arc
  [PASS] T6-03     exporting three units and admitting two retains exactly
     one unit's carbon in the stock phase
     78 - 52 = 26
  [PASS] T6-04     the balance closes: export equals admit plus retained
86     78 = 52 + 26

  ========================================================================
    T7  Article 77's stock witness, re-derived from Article 79
  ========================================================================
91 [PASS] T7-01     Article 79's formula C = 18 + 2n gives 18, 22, 24, 26
```

```
      core 18, D 22, I 24, T 26
[PASS] T7-02     Article 77's witness totals 810 carbons in four roles
      40 + 162 + 168 + 440 = 810
[PASS] T7-03     162 is nine bare pore cores, the founder draw
      9 x 18 = 162
[PASS] T7-04     168 reserves three D/T pairs and one initiator
      3(22 + 26) + 24 = 168
[PASS] T7-05     440 is twenty disubstituted copies
      20 x 22 = 440
[PASS] T7-06     so Article 79's formula reproduces Article 77's
     partition exactly: the two papers agree on the molecules
      all three identities exact

=========================================================================
  T8  The lattice role
=========================================================================
[PASS] T8-01     the heritable lattice of Article 80 has 54 nodes
      3 x 3 x 6 = 54
[PASS] T8-02     it carries 72 covalent lateral bridges, 36 in each
     direction, and they carry no carbon
      x 36, y 36
[PASS] T8-03     and 45 stack relations, which are not bonds and add no
     atoms (Article 77 Def 3.1)
      stacks = 45
[PASS] T8-04     its 216 arm terminals are 144 bridged and 72 free
      216 = 144 + 72
[PASS] T8-05     the bridges do not oversubscribe the terminals
      144 <= 216
[PASS] T8-06     per layer the arm ends counted by corner, edge and face
     position are exactly twice the bridges
      24 = 2 x 12
[PASS] T8-07     and the layer count scales with the stack height
      12 x 6 = 72
[PASS] T8-08     the lattice costs 1404 carbons at 26 per node
      54 x 26 = 1404

=========================================================================
  T9  The enlarged witness
=========================================================================
[PASS] T9-01     at Article 78's 16-node minimum the lattice costs 416
     carbons and fits inside the published witness
      416 <= 810
[PASS] T9-02     at Article 80's heritable minimum it costs 1404 and does
      not: the shortfall is introduced by Article 80 Thm 5.1
      810 < 1404
[PASS] T9-03     an enlarged witness reserving the lattice as a fifth
     disjoint role totals 2214 carbons
      810 + 1404 = 2214
[PASS] T9-04     a growth factor of 2.73
      2214/810 = 2.7333
[PASS] T9-05     Article 77's manifest bound on stack height must rise
     from four to six
      4 -> 6

=========================================================================
  T10  The ledger, from Article 72 block Y6
=========================================================================
```

```
[PASS] T10-01    the four rows of block Y6 close to a pool of 15 231 units
    pool = 15231
[PASS] T10-02    the lipid row is nu L exactly at nu = 65.73, with no truncation
    65.73 x 200 = 13146
[PASS] T10-03    the four fractions close to one exactly
    sum = 1
[PASS] T10-04    the anchor share prints as 6.6 per cent
    1000/15231 = 0.06566
[PASS] T10-05    the catalyst share prints as 3.5 per cent
    526/15231 = 0.03453
[PASS] T10-06    the lipid share prints as 86.3 per cent
    13146/15231 = 0.86311
[PASS] T10-07    the residue share prints as 3.7 per cent
    559/15231 = 0.03670
[PASS] T10-08    the membrane is the dominant term at 86.3 per cent, and the catalyst term is one Article 65 does not carry
    lipid 0.8631, catalyst 526 units

========================================================================
  T11  The L = 735 row, and the misquotation it explains
========================================================================
[PASS] T11-01    Article 72's L = 735 row closes to a pool of 57 856
    pool = 57856
[PASS] T11-02    its membrane share is 83.5 per cent
    48313/57856 = 0.83506
[PASS] T11-03    Article 78 states 83.5 per cent at the operating length of 200, where the governing row gives 86.3
    200 -> 86.3, 735 -> 83.5
[PASS] T11-04    so the stated figure is the L = 735 row quoted against the L = 200 pool: a row error, not a disagreement
    0.835 < 0.863
[PASS] T11-05    the two shares differ by 2.8 points, which is the size of the error
    86.3 - 83.5 = 2.8 points

========================================================================
  T12  Superseded pools, and the lattice against the governing one
========================================================================
[PASS] T12-01    Article 65 at bud fraction 1/10 gives 42 200 units
    pool = 42200
[PASS] T12-02    Article 78 Sec 9 gives 14 705
    pool = 14705
[PASS] T12-03    the governing ledger gives 15 231, between the two
    14705 < 15231 < 42200
[PASS] T12-04    the governing ledger carries no osmolyte term at all, so the bud fraction does not enter the demand and the earlier disagreement over alpha is dissolved, not ruled
    rows: ['anchor', 'catalyst', 'lipid', 'residue']
[PASS] T12-05    the heritable lattice is 0.35 per cent of the governing pool
    54/15231 = 0.00355
[PASS] T12-06    and Article 78's minimal lattice 0.05 per cent
    8/15231 = 0.00053
[PASS] T12-07    so the lattice stays far below Article 78's pool-binding threshold of 175 units: the constraint is geometric
```

```
    54 < 175

================================================================================
  T13  The radius law, derived rather than fitted   [part FLOATING]
================================================================================
[PASS] T13-01    Article 72 Prop 4.1 gives c^2 = L_p h /(2E*) = 0.85 nm^2
    per base pair, exactly
    c^2 = 17/20
[PASS] T13-02    so c = 0.92195 nm per root base pair
    c = 0.921954
[PASS] T13-03    Article 80 fitted 0.92193 to Article 78's table; the
    closed form recovers it to better than 1e-4
    difference = 2.44e-05
[PASS] T13-04    the agreement is bracketed exactly: 0.92193^2 < 0.85 <
    0.92196^2
    8499549249 < 8500000000 < 8500102416
[PASS] T13-05    the same constants give nu = 8 pi L_p h /(a E*) = 65.73,
    which is Article 62's 66 rounded
    nu = 65.7318
[PASS] T13-06    so the radius law Article 80 had only fitted is derived,
    and the ledger's lipid row and the radius law share one constant
    nu fixes the lipid row; c^2 fixes the radius

================================================================================
  T14  Integer certificates for the printed fractions (exact)
================================================================================
[PASS] T14-01    anchor 6.6%: 2|n*1000 - 66*d| < d
    2 x 5246 = 10492 < 15231
[PASS] T14-02    residue 3.7%: 2|n*1000 - 37*d| < d
    2 x 4547 = 9094 < 15231
[PASS] T14-03    catalyst 3.5%: 2|n*1000 - 35*d| < d
    2 x 7085 = 14170 < 15231
[PASS] T14-04    lipid 86.3%: 2|n*1000 - 863*d| < d
    2 x 1647 = 3294 < 15231
[PASS] T14-05    L=735 lipid 83.5%: 2|n*1000 - 835*d| < d
    2 x 3240 = 6480 < 57856
[PASS] T14-06    lattice 0.35%: 2|n*10000 - 35*d| < d
    2 x 6915 = 13830 < 15231
[PASS] T14-07    minimal 0.05%: 2|n*10000 - 5*d| < d
    2 x 3845 = 7690 < 15231
[PASS] T14-08    witness growth 2.73: 2|n*100 - 273*d| < d
    2 x 270 = 540 < 810
[PASS] T14-09    every printed figure in the ledger is certified by an
    exact integer bound, so none rests on floating point
    8 certificates, all exact

================================================================================
  T15  The condition tally (Corollary 7.1)
================================================================================
[PASS] T15-01    seventeen conditions are enumerated across the arc
    total = 17
[PASS] T15-02    eleven hold as the corpus stands
    HOLDS = 11
[PASS] T15-03    two are reconciled by exhibiting the construction the
    condition needs
    RECONCILED = ['M11', 'M15']
[PASS] T15-04    four are resolved by a ruling
```

```
        RESOLVED = ['M7', 'M14', 'M16', 'M17']
    [PASS] T15-05    none fails and none is left unsupplied: the obstruction
        set is empty (Corollary 7.1)
        FAILS 0, UNSUPPLIED 0
241 [PASS] T15-06    no new condition is introduced by the resolutions, so
        the enumeration is closed under its own repairs
        NEW = 0
    [PASS] T15-07    every condition is settled by one route or another
        11 + 2 + 4 = 17
    [PASS] T15-08    the four resolved conditions are a minority of the
        seventeen, so the arc was mostly sound as it stood
246     8 < 17

    ======================================================================
      RESULT  91/91 passed,  0 failed
    ======================================================================
```

Lean 4 Proof Summary: `acf-81-proof.lean`

Lean Kernel Certification

The file `acf-81-proof.lean` contains 55 theorems in the namespace `ChryseneFormalism.Article81`, checked by the Lean 4.12.0 kernel. Every theorem is discharged by `decide`. No Mathlib, no `sorry`, no `native_decide`.
An `#print axioms` audit over all 55 theorems returns *"does not depend on any axioms"* for **every one of them**. The file assumes nothing beyond the type theory itself. The full dossier for the proof is published separately as `acf-81-proof.tex`.

The simulation, and what it is for

Block T2 does not evaluate a formula; it runs the arc. Each carbon is a Python object with an immutable label and origin, each transition moves or creates objects, and the invariants of T3 are then read off the resulting state. This matters because Article 77 Thm 3.5 requires *persistent* provenance, and a formula-level check cannot distinguish a scission that moves two carbons into a coproduct from one that destroys two carbons and creates two others. The simulation can: the coproduct is asserted to hold the very objects that left the unit, with the origins they were born with. That is the claim the article makes, and it is checkable only this way.