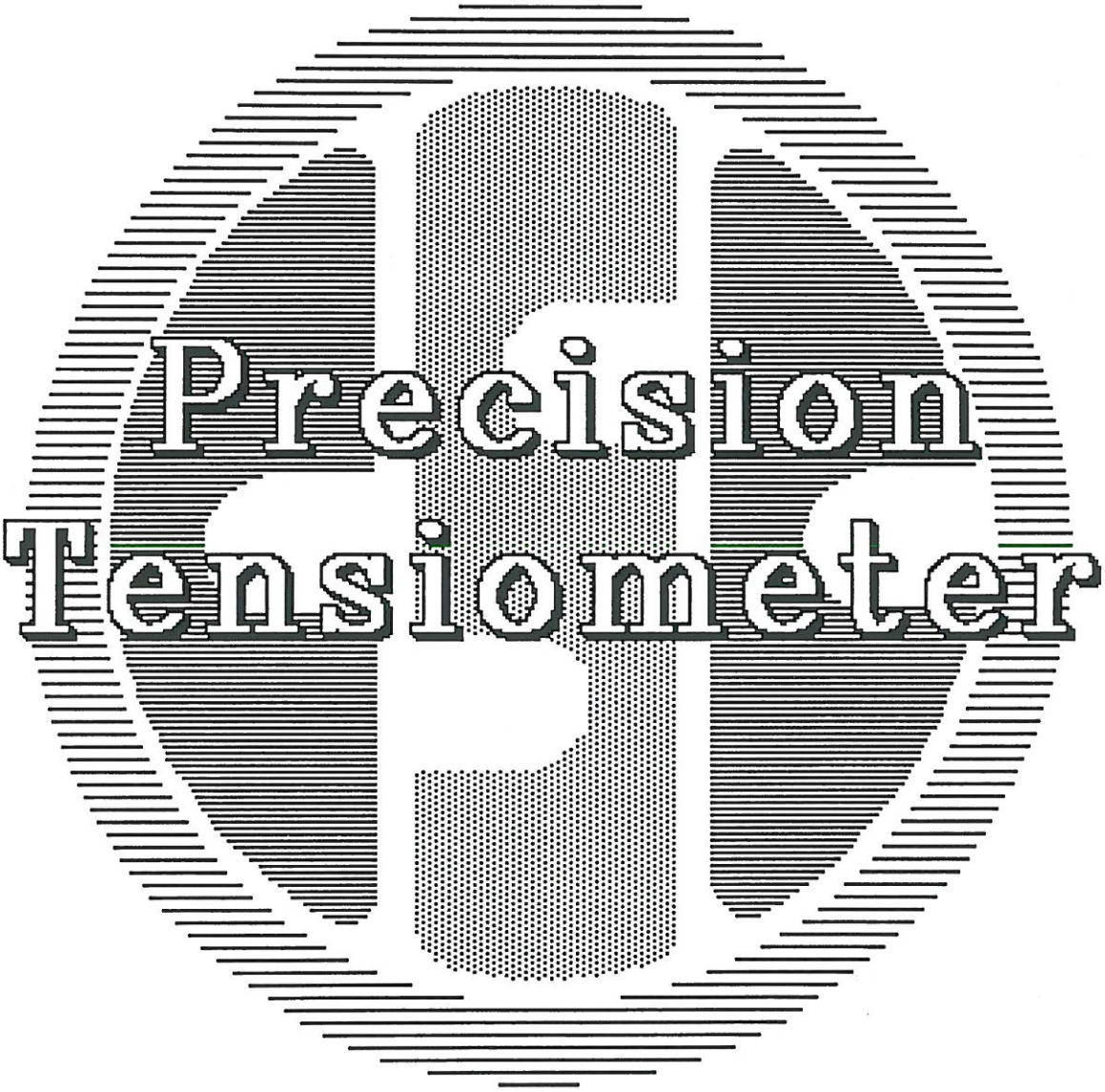
First Time User Guide



Getting Started

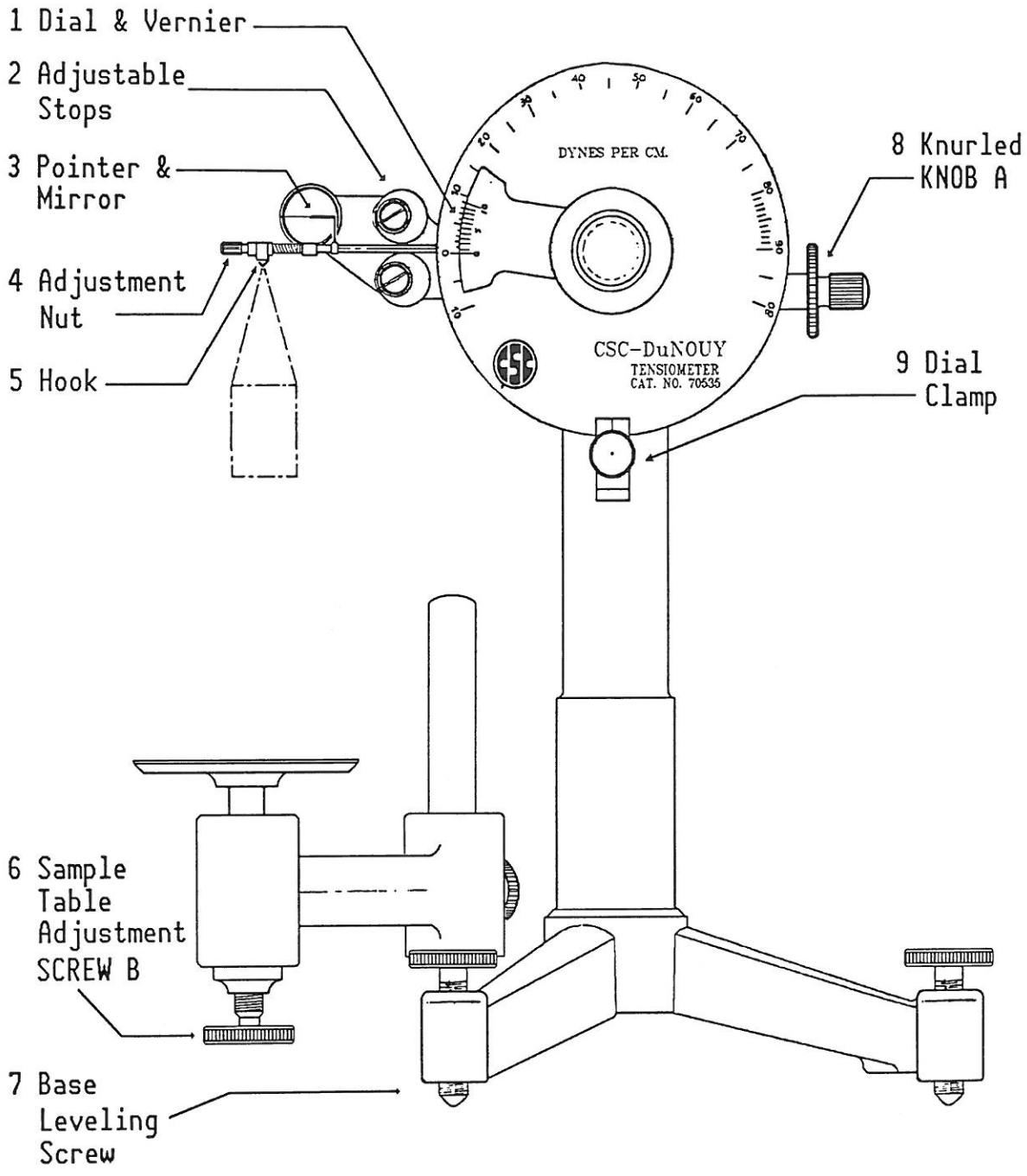
Removal From the Storage Container

Two screws pass through the bottom of the storage container to hold your tensiometer in place.

A. Locate the wingnuts found inside the storage container directly behind the front two legs of the Tensiometer. Loosen wingnuts and remove screws.

B. Slide the tensiometer and its wooden platform out of the storage container.

C. Remove the tensiometer from the wooden platform by detaching the three fastening screws located on the bottom of the platform. These three screws thread through the bottom of the platform into each tensiometer leg.


1 Dial & Vernier
2 Adjustable Stops
3 Pointer & Mirror
4 Adjustment Nut
5 Hook
6 Sample Table Adjustment SCREW B
7 Base Leveling Screw
8 Knurled KNOB A
9 Dial Clamp
DYNES PER CM.
CSC-DuNOUY
TENSIOMETER
CAT. NO. 70535

Getting Started
Precision Tensiometer

Familiarize yourself with the following:

1. Dial and Vernier
2. Adjustable stops
3. Pointer and Mirror
4. Adjustment nut
5. Hook
6. Sample table adjustment screw (**B**)
7. Base leveling screws
8. Knurled knob (**A**)
9. Dial clamp
10. Tensiometer ring in small wood container

Getting Started
Precision Tensiometer

Set-up

1. Hang the tensiometer ring from the torsion arm hook.

2. Loosen adjustable stops to allow free movement of the torsion arm.

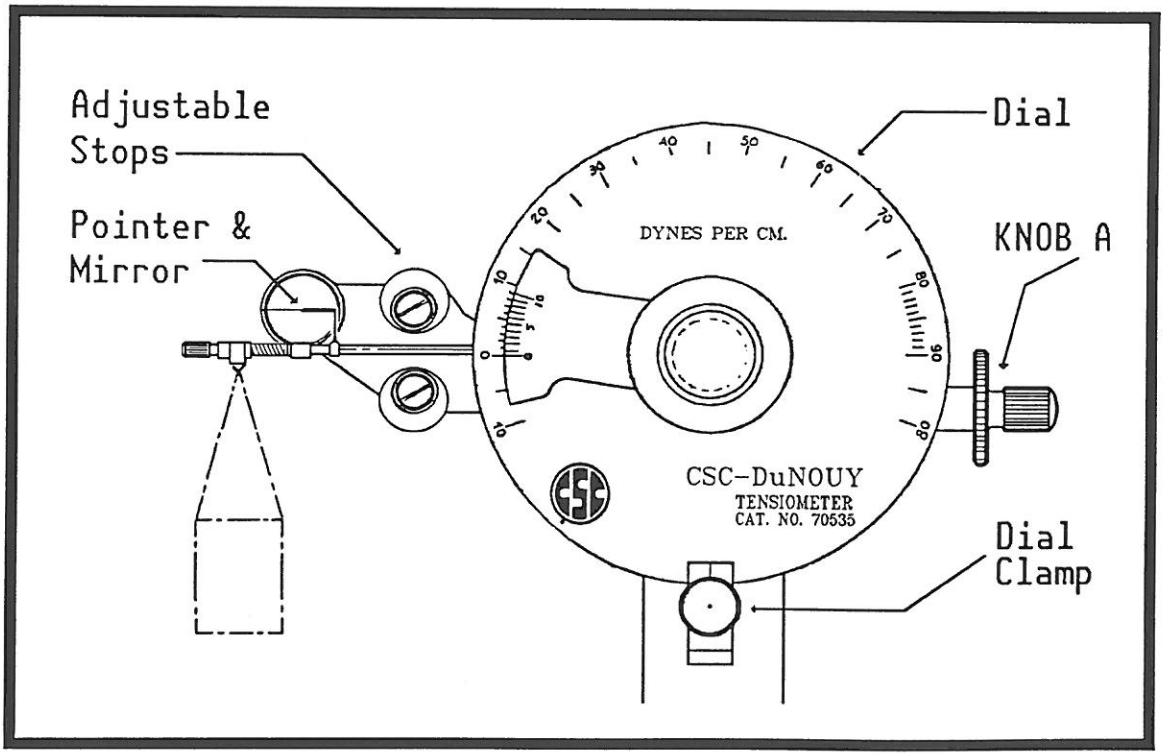
Zeroing the Tensiometer

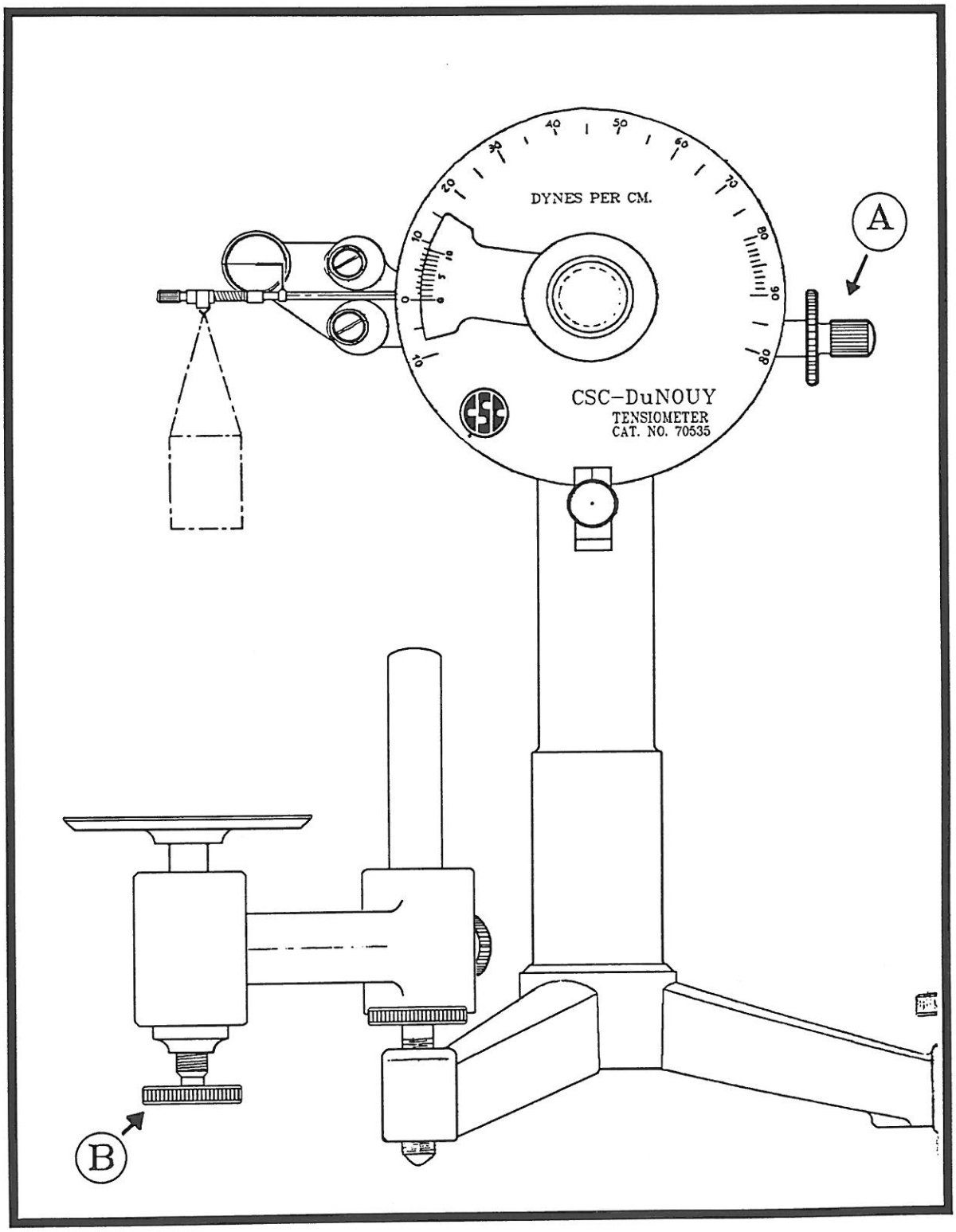
1. Align pointer on torsion arm with line on mirror by turning knurled knob (**Knob A**).

2. Loosen dial clamp

3. Turn dial so the zero on the dial lines up with the zero on the vernier.

4. Tighten dial clamp.




DYNES PER CM.
CSC-DuNOUY
TENSIOMETER
CAT. NO. 70535
A
B

Getting Started
Precision Tensiometer

Getting Comfortable with the Tensiometer

Measure the surface tension of water (any quality)

1. Pour water into a clean container:
   a. Plastic or glass petri dish
   b. Plastic or glass beaker

2. Turn sample table adjustment screw (**screw B**) so sample table is at highest position.

3. Place container with water on sample table.

4. Raise sample table and immerse ring by:
   a. Loosening nut on back end of sample table assembly.
   b. Raising assembly to immerse ring (about 1/8 inch or 3 mm) beneath water surface.
   c. Tighten nut to secure assembly.

> To get fast, accurate surface tension measurements
> **keep the pointer lined up with the line on the mirror.**

5. Turn **Knob A** towards you (raise the ring) **WHILE turning screw B** to lower the sample table.

6. **Keep the pointer lined up with the line on the mirror**.

7. Continue adjusting knob A and screw B simultaneously until ring snaps through water surface.

NOTE: *This may be difficult at first. After a few tries you'll be able to turn both knobs at the same time. Concentrate only on the pointer and make steady turns with both hands. You'll see the pointer snap up when the ring breaks through the surface.*

Getting Started
Precision Tensiometer

Run another reading on the same sample

1. Turn **Knob A** away from you, returning vernier to zero.

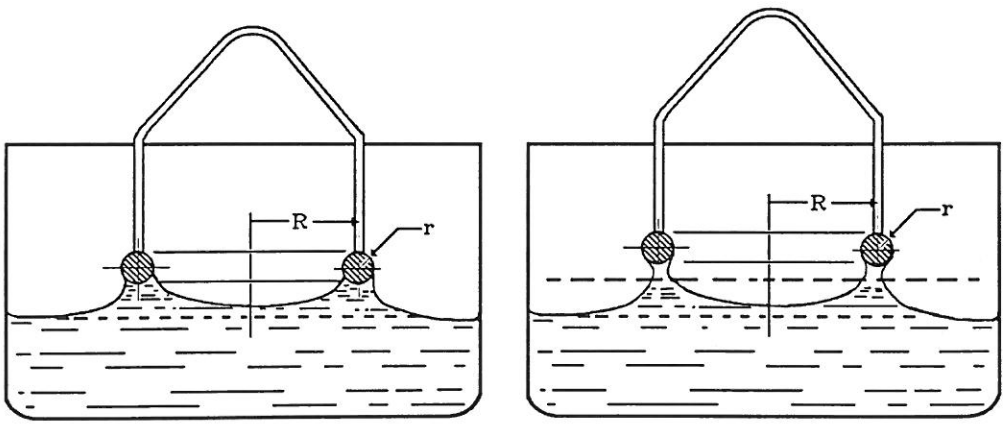
2. Raise sample table by turning **Screw B**.

3. Ring should be beneath water surface. If not, lay your finger on the far left side of the torsion arm to nudge the ring below the surface.

NOTE: *DO NOT adjust the zero on the vernier.*

4. Run another surface tension test.

5. After a few attempts your results should all be within 0.5 dynes.



Ring pulling through surface.

Ring at breaking point.

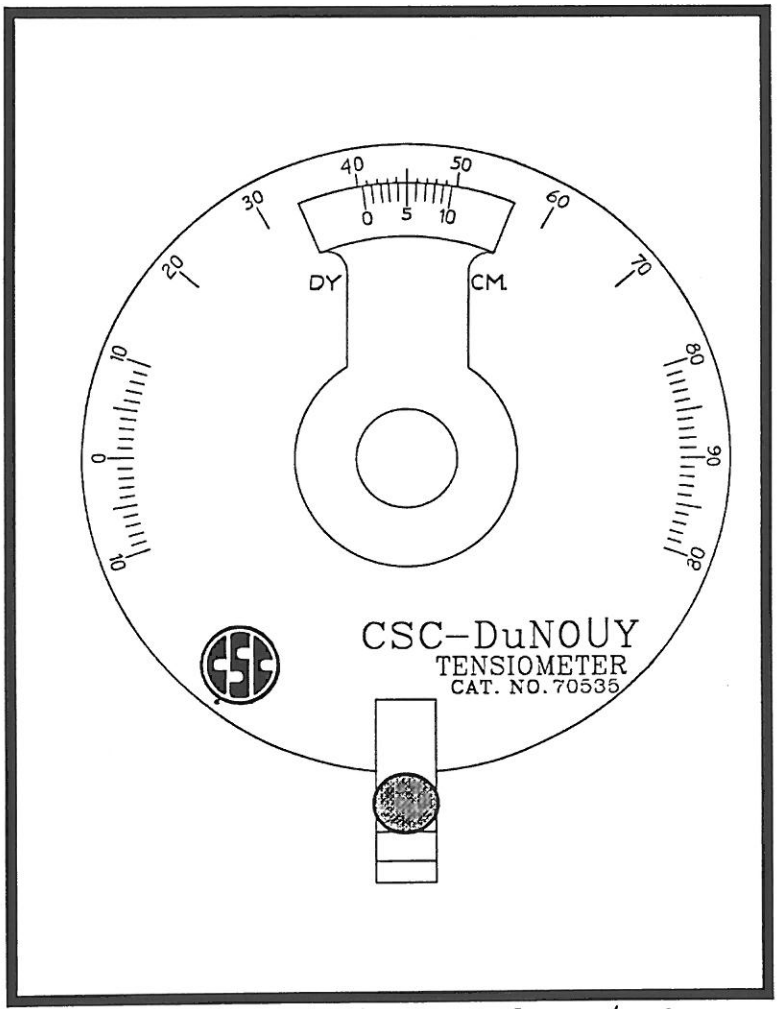
Reading the vernier

To determine surface tension reading to 0.1 dyne:

1. Find the number on the dial that precedes the zero on the vernier. This shows your dynes/cm2.

2. To determine surface tension to 1/10th of one dyne find the next hashmark on the vernier (to the right of the zero) which lines up with a hashmark on the dial. This is your 0.1 dyne reading.

3. If two hashmarks line up your reading will be in 5/100ths. (35.25, 77.85 dynes).



This dial reading is 40.5 dynes/cm2.

Calibration

You'll need:
1. A weight between 500 and 800 mg (0.5 to 0.8 grams). A paperclip weighed to the closest milligram (0.001 g) works well.
2. A strip of paper that fits on the ring.

You'll simulate a surface tension test by placing a known weight on the ring and checking the reading on your dial.

Calibration Formula

$$p = \frac{Mg}{2L} \quad or \quad READING = \frac{weight \times gravity}{2 \times Circumference}$$

M = Mass, or weight in grams

g = gravity for your location, in cm/sec2

L = ring circumference, printed on the wood ring case

Here are a few listings for gravity across the U.S. Choose one that's close to you or contact the National Geophysical Data Center in Bolder, Colorado. (303) 497-6120.

Tucson, AZ	979.2	Louisville, KY	979.9
Monterey, CA	979.9	Petuxent, MD	980.88
Chicago, IL	980.3	Minneapolis, MN	980.58
Urbana, IL	980.18	Washington, DC	980.1

Calibration

Check the Calibration

1. Calculate your calibration reading.

   Example: $\frac{\text{weight x gravity}}{\text{2 x circumference}} = \frac{\text{0.5 x 980.3}}{\text{2 x 5.992}} = 40.91$

2. Hang your ring from the hook on the torsion arm.

3. Place the paper strip on the ring.

4. *Zero the tensiometer*
   a. Line pointer with mirror line
   b. Loosen clamp, turn outside dial to line up zeros. Tighten clamp.

5. Place weight on paper strip.

6. Turn **Knob A** until pointer realigns with mirror line.

7. Your reading should be within 0.5 dynes of calculated value.

If your reading is:	
LOW	HIGH
Lengthen the arm. Turn adjustment nut on torsion arm COUNTER-CLOCKWISE.	**Shorten** the arm. Turn adjustment nut on torsion arm CLOCKWISE.

One complete turn is equal to about 3 dynes/cm.

If you've adjusted the torsion arm length your zero point will change. Rezero the instrument and check your calibration again.

For an accurate gravity value for your city, please call CSC Scientific at 1-800-458-2558 and ask for extension 227.

Getting Up To Speed

You've now seen how the tensiometer works and calibrated your instrument.

To get up to speed you'll need:

A. Spirit Level or water container with a line running the circumference of the container.

B. Distilled water

C. Plastic or glass petri dish/beaker

Level the Tensiometer

Level the tensiometer by placing the spirit level on the sample table. Raise or lower the base leveling screws until level.

You also can level your tensiometer by using a container with a line running the circumference of the container. Fill the container to the line with water. Place the container on the sample table. Raise or lower the base leveling screws until the water traces the line.

Checking Your Accuracy

After leveling your calibrated tensiometer, run a surface tension test on distilled water.

Don't forget to *rezero* the tensiometer if you've checked calibration.

Your reading should be **77.5 dynes** for distilled water at 20 degrees Celsius, +/- 0.5 dynes.

If your reading is LOWER than 77.0 dynes:

1. Check your sample dish. Plastic Petri dishes are best for initial testing. Avoid using aluminum pans due to lubricant contamination. Flushing the sample dish with hot water will usually wash away impurities that lower surface tension.

2. Clean ring with a gas flame. Flame only the areas to be immersed in your sample. Flaming the ring to a dull red will burn off impurities that cause inaccurate readings. Examine your ring for bends due to mishandling.

3. Use a fresh sample of distilled water.

4. Make sure you've zeroed your dial with the vernier.

Getting Up To Speed

Getting repeatable results

Run a surface tension test on the same sample. Raise the sample table and return the vernier to zero.

DO NOT readjust zero.

Continue tests on the same sample until you feel comfortable with your readings.

Getting a *fast, accurate* reading

Once you trust the results you're getting, repeat measurements on the same sample as fast as possible.

Concentrate on the pointer and mirror. Make fluid movements when lowering the sample table and raising the ring at the same time.

You should get accurate, repeatable results with a 15-20 second test.

Tensiometer Ring

Your Tensiometer achieves its high degree of accuracy in part due to the nature of the Tensiometer Ring.

The ring is composed of a combination of platinum and iridium. Platinum has a constant contact angle of zero, which ensures constant repeatable results. Iridium adds strength to the bendable platinum.

The tensiometer ring is fragile and can be easily bent during cleaning or by dropping it.

You should occaisionally examine the ring for bends, broken contacts and the roundness of the ring.

Examining the Ring	
STAND RING ON A TABLE, CHECKING THESE THREE AREAS:	
Ring Legs (Stirrups)	1. Looking at legs from the side, line up legs in same plane. 2. Stand a straight edge behind the legs. 3. Legs should be straight. 4. Legs should meet bottom of ring at 90 degree angle.
Flatness	All points of round ring should touch the table.
Roundness	Ring should be round.

NOTE: The ring is very delicate. If you need to manually straighten the ring, be gentle. If ring is broken or bent beyond repair, RING REPAIR IS AVAILABLE THROUGH CSC. Call 800-458-2558 for further help.

Cleaning

Cleanliness of the ring and sample container is critical to accurate surface tension measurements.

Surface Tension of Water at Different Temperatures		
Celsius	Fahrenheit	Corrected Surface Tension
0	32	75.83
5	40	75.09
10	50	74.36
15	59	73.62
20	68	72.88
21	70	72.73
22	71	72.58
23	73	72.43
24	75	72.29
25	77	72.14
26	79	71.99
27	81	71.84
28	82	71.69
29	84	71.55
30	86	71.40
35	95	70.66
40	104	69.92

Reference

Surface Tension of Various Liquids at 20 d C	
Name	Corrected Surface Tension
Acetone	23.7
Ethyl Alcohol	22.27
Glycerol	63.0
Glycol	47.7
Isoproyl Alcohol	21.7
Methyl Alcohol	22.6
Methyl Ethyl Ketone	24.6

II. Something you should know

The Platinum-Iridium Ring is the most delicate part of this instrument. A bend or break can occur due to mishandling while cleaning or storing the ring.

Do not use disposable aluminum pans as sample containers. They contain a surfactant which contaminates your sample. Plastic disposable petri dishes are best.

The third segment helps you perform quick, accurate measurements.

10. You may wish to see how sensitive your Tensiometer is. Add a little soap or surfactant to your water, then take a reading.

NOTE: 77.5 dynes is the uncorrected surface tension.

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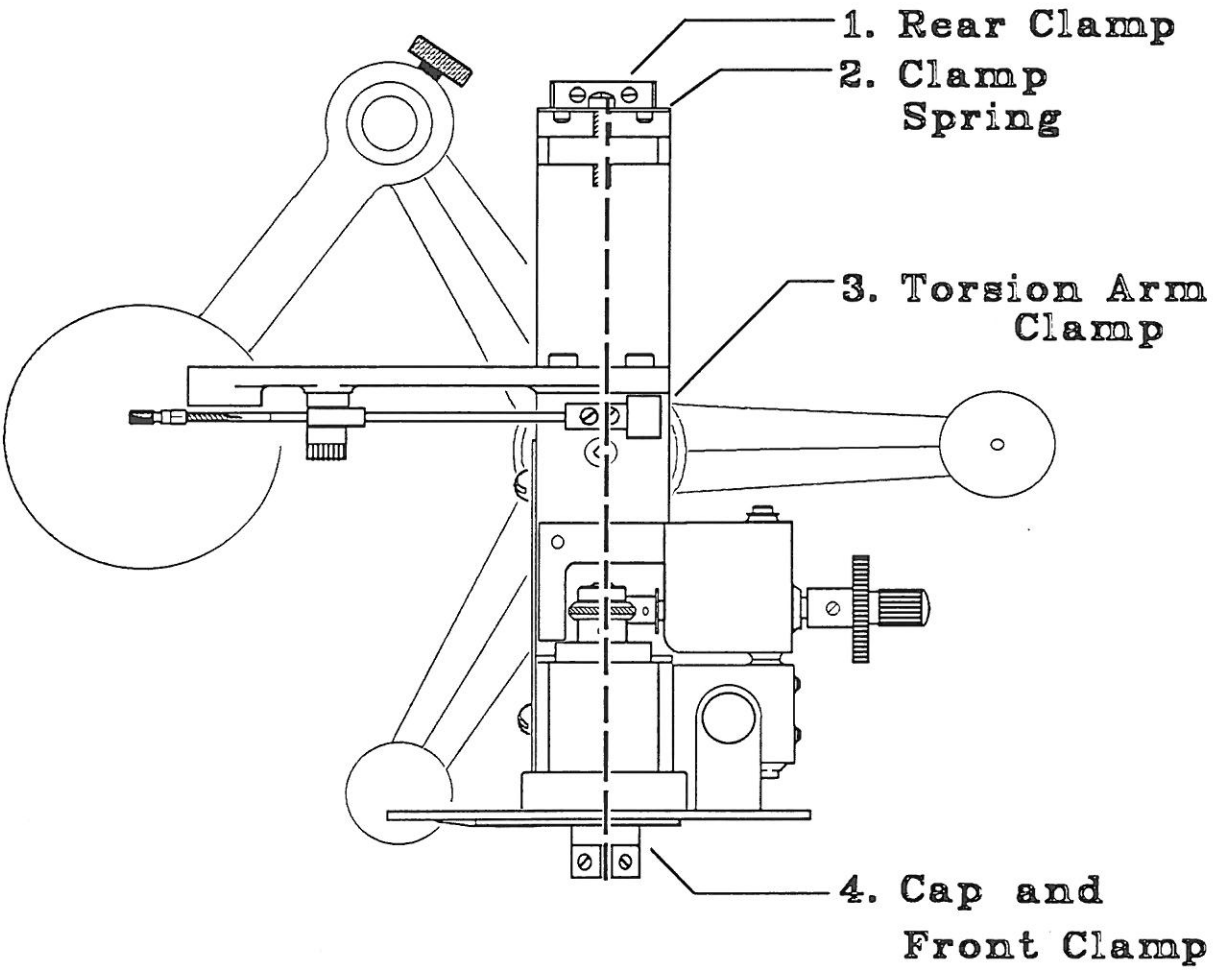
The unique sensitivity of your CSC Tensiometer depends upon the torsion wire and the gears that turn it. Through normal, daily use it may become necessary to replace the torsion wire. Torsion wires typically last five to ten years before requiring replacement.

Each wire must be individually calibrated to a particular instrument. After replacing the wire, you'll reduce the diameter of the wire by sanding with fine sand paper. Extra torsion wires are supplied with each instrument.

To change the torsion wire, you'll need:

1. A very small flat-head screwdriver.
2. A regular size flat-head screwdriver.
3. A small Allen Wrench (size: _____).
4. Fine or extra fine sandpaper.
5. Torsion wire (CSC P/N 70531-011).
6. A calibration weight 500 - 800 mg.
7. Tensiometer Ring


1. Rear Clamp
2. Clamp Spring
3. Torsion Arm Clamp
4. Cap and Front Clamp

Removing the Old Wire

1. Remove the torsion wire cover held in place by two screws.

2. Release tension on the wire

   A. Locate the screw on the rear clamp spring at the back of the Tensiometer.

   B. Tighten the screw until the support touches the post. This releases the tension in the wire.

3. Remove dial cap

   Using a small Allen wrench, remove the cap located on the instrument dial.

4. Loosen clamps and remove wire

   A. Using the small screwdriver, loosen the two screws that clamp the wire to the front of tensiometer.

   B. Loosen the two screws that clamp the wire at the back.

   C. Loosen the 2 screws on the torsion arm.

   D. Pull the old wire through.

Putting In the New Wire

Note that all wire clamps (at front, rear and on the torsion arm) have a slight groove that "bites" into the wire when properly attached. The wire should rest in the groove before tightening the clamp.

1. New Wire

   A. Feed the new wire through the front clamp, the torsion arm clamp and the rear clamp.

   B. At front, lay wire in groove and tighten clamps.

   C. At rear, pull wire taught and tighten screws on clamp.

2. Tension on the Wire

   Loosen the screw on the rear clamp spring, putting tension into the new wire.

3. Attach arm to wire

   A. Before securing the torsion arm to the wire, turn **Knob A** on the right side of the tensiometer so the vernier is at the 7 O'Clock position of the dial. (Lower left on the dial).

   B. Tighten torsion arm clamps so the torsion arm is horizontal to the wire.

To provide support when tightening the torsion arm clamp, slide a folded piece of paper between the clamp and the instrument assembly. Remove the paper after tightening the clamp.

4. Confirm the torsion arm is properly attached:

   A. No part of the arm should touch the mirror assembly.

   B. Hang the ring on the torsion arm hook. By turning **Knob A**, the arm should move freely up and down.

   C. Make sure the torsion arm is proprly fastened to the wire. Zero the tensiometer. Turn the vernier to about 50 to 60 dynes and return to zero again. The pointer should still line up with the line on the mirror.

Sanding the Wire		
Initial Reading: 45.5 dynes Target Reading: 59.7 dynes		
READING	# TIMES SANDED (Back and Forth)	NEW READING
45.5	40	47.5
47.5	80	51.1
51.1	30	53.0
53.0	30	57.5
57.5	7	58.2
58.2	7	58.9
58.9	3	59.4
TOTAL:	**197**	

Sanding the Wire for Calibration

1. Adjust torsion arm length half way with knurled nut.

2. Check the calibration of your instrument.

   A. The dial reading will be less than your calculated value.

   B. The calculated value (calibration) is your TARGET. You will sand the wire ROUND, checking calibration frequently, until you achieve the target/calibrated value.

3. Sandpaper

   A. Cut a few pieces of fine sand paper about 1/4" x 1".

   B. Fold the 1" side of the sandpaper so grit is face to face.

5. Sand the wire

   A. Hold the sandpaper between thumb and forefinger.

   B. Sand the wire ROUND between the torsion arm and front gears while turning knob A back and forth.

A flat wire will fold and break. Turn Knob A back and forth to sand the wire ROUND.

6. Reset zero, check calibration and continue sanding

   A. Reset zero and check calibration frequently. Your zero point moves as you reduce the radius of the wire.

   B. Continue sanding and checking calibration until you get withing **five (5) dynes** of your target value.

7. When you get within **Five (5) dynes of your calculated value**:

   A. Sand back and forth **three (3) times**, reset zero, then check calibration. This avoids over shooting your target value.

   B. Continue short sanding, zeroing and checking calibration until you're within 0.25 dynes of your target.

   C. Adjust arm length with knurled nut if needed to complete calibration.

Replacing the Torsion Wire

After Calibration

It's usually necessary to reset the arm so the zero on the vernier is at the 9 O'Clock position on your dial.

If your vernier is not at 9 O'Clock:

1. Loosen screws on torsion arm clamp (use paper support).

2. Turn **Knob A** clockwise so vernier is at 7 O'Clock position on the dial.

3. Reattach arm to wire.

4. Hang ring on hook.

5. Zero the Tensiometer by turning **Knob A** counter clockwise.

If your vernier is STILL not at 9 O'Clock:

Your tensiometer has a vernier stop at the 6 O'Clock position to prevent accidentally breaking the torsion wire. The dial clamp holds the vernier stop in place.

1. Examine your zero position on the dial.

2. Determine the difference between your zero position and the 7 O'Clock position where you initially attached the arm.

3. Loosen torsion arm screws.

4. Loosen dial clamp.

5. Turn **Knob A** clockwise, bringing vernier past 7 O'Clock to your new estimated position.

6. Reattach arm to wire.

7. Zero the Tensiometer by turning **Knob A** counter clockwise.

8. Tighten dial clamp.

Correction Factor

The reading given by the tensiometer dial is <u>apparent</u> surface tension. <u>Actual</u> surface tension is found by applying a correction factor.

Your tensiometer measures the amount of force required to pull the ring through a liquid surface. Resistance, by the nature of the ring, and from sample density, produces a slightly higher surface tension reading.

Correction Factor Properties	
Ring	Sample
* Radius of the ring * Radius of the wire	* Lower phase density (sample) * Upper phase density (Air = 0)

The correction factor offsets properties of both ring and sample at the point of detachment.

The difference between actual and apparent readings is typically less than six percent. Some readings, however, may differ from the true value by as much as 30 percent.

$$A = P * F$$

A = Actual Surface Tension

P = Apparent Surface Tension (dial reading)

F = Correction Factor

Correction Factor

Determine correction factor with the following formula:
(OR Refer to graph)

$$F = 0.7250 + \sqrt{\frac{0.01452P}{C^2\,(D-d)} + 0.04534 - \frac{1.679r}{R}}$$

F = Correction Factor

P = Reading

C = Ring Circumference (printed on ring container)

D = Density of Lower Phase (Sample)

d = Density of Upper Phase (Air)

R = Radius of Ring

r = Radius of the Ring Wire

Not done, use FP, also check r and R, verify in Fisher manual. Get r value from the ring guy.s

Actual Surface Tension = P * F

CSC NOS. 70535 AND 70545

P = Apparent Reading
F = Correction Factor
D = Density of lower liquid
d = Density of upper air (Air = 0)

FIGURE 5

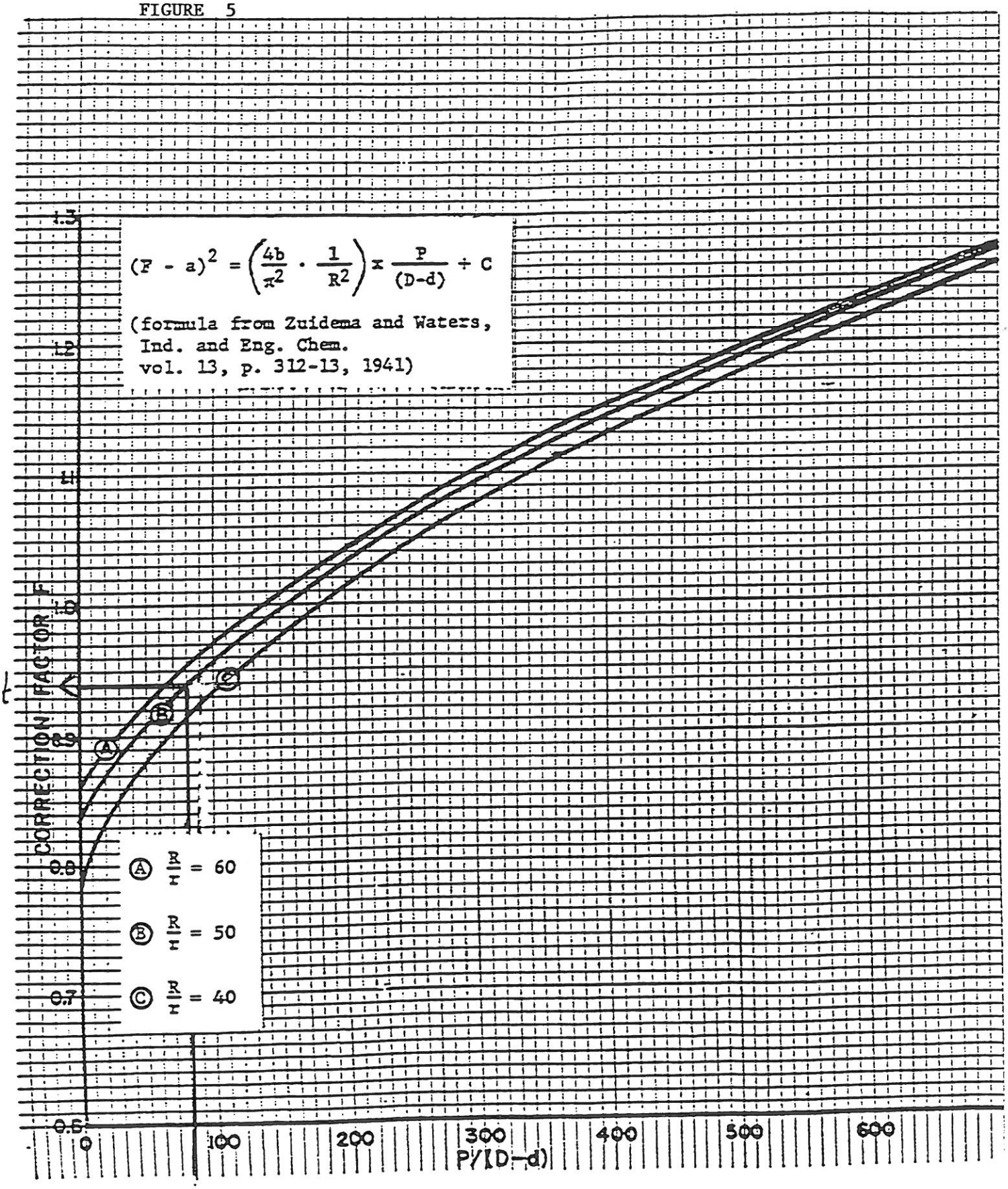


FIG. 5 CORRECTION FACTOR FOR SURFACE AND INTERFACIAL TENSION

EXAMPLE OF CORRECTION FACTOR

ACTUAL SURFACE TENSION = P * F

P = APPARENT SURFACE TENSION (dial reading)
F = CORRECTION FACTOR
D = DENSITY OF LOWER LIQUID
d = DENSITY OF F UPPER AIR (AIR = 0)

P - (D-d)

76.5 - .9984 (water density) - .0 (air density)

76.5 - .9984 = 76.6

76.6	*	0.94	=	72.0
(P) Apparent		(F) Correction Factor		Actual Surface Tension