Vernier caliper

Project number: 2021-1-DE02-KA220-VET-000029587

PR3/A2: Self-training material for enriching current online experiments

Co-funded by the European Union

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In this guide, we will discuss what Vernier caliper is, how it works, his applications, correct usage, reading techniques, calibration methods, and some of the best options available. Whether you're a seasoned professional or just starting to explore the world of precision measurement, this guide will provide you with valuable insights into the world of Vernier calipers.

I. What is a Vernier caliper?

The vernier caliper is a superstar when it comes to taking highly accurate measurements. This handy tool is used to measure both the internal and external dimensions of objects.

Key Parts:

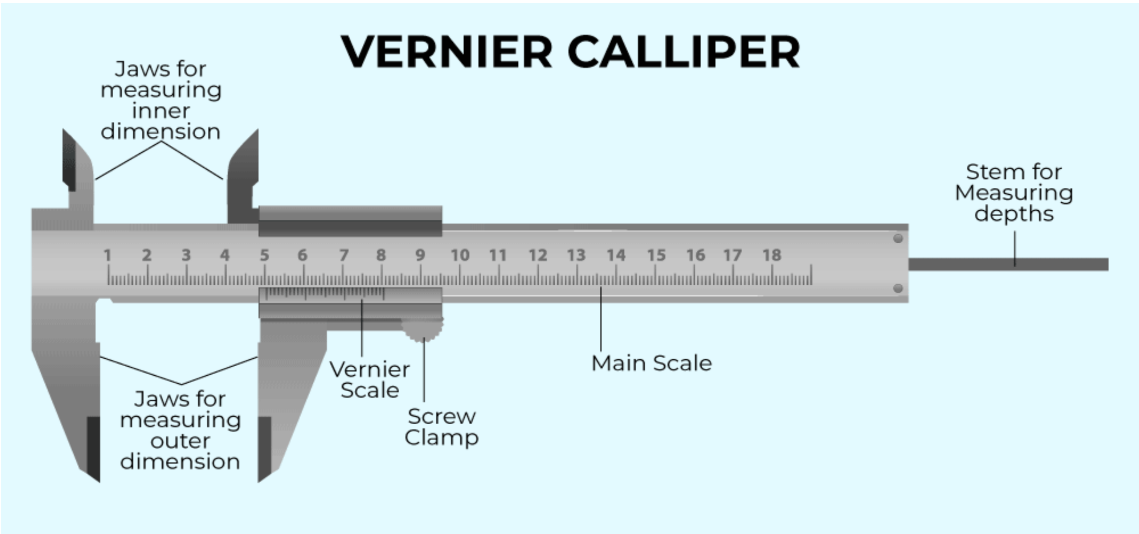
- **Fixed Jaw:** This jaw stays put, acting as a reference point for your measurements. Just like the name suggests, it's fixed in place.
- **Movable Jaw:** This jaw slides along the ruler, allowing you to clamp it onto the object you're measuring.

Small Wonders: measuring with precision

Vernier calipers allow you to measure distances as small as 0.1 millimeters. That's about the thickness of a thin sheet of paper! This impressive accuracy is thanks to a clever design that incorporates a special sliding scale called the vernier scale.

A French mathematician's legacy

The vernier caliper is named after Pierre Vernier, a French mathematician who invented it in 1631. His ingenious design revolutionized precision measurement and is still used today!



The image added below shows a vernier caliper

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II. Parts of a Vernier caliper

The vernier caliper may seem complex, but it's really a collection of ingenious components working together for precise measurements. Here's a breakdown of its key parts:

Setting the stage for measurement:

- **Main Scale:** this is the ruler you use for primary measurements, like the yardstick of the vernier caliper world.
- **Vernier Scale:** this special sliding scale is the secret weapon for achieving high-precision measurements. It works alongside the main scale for those super-fine details.
- **Fixed Jaw:** this jaw stays stationary, providing a stable reference point for your measurements. It acts as the anchor for the main scale.
- **Movable Jaw:** this jaw slides along the ruler, allowing you to clamp it onto the object you're measuring. It's connected to the vernier scale.

Ensuring accuracy:

- **Zero adjustment screw:** before you start measuring, this screw lets you ensure the jaws meet perfectly at the zero mark. Think of it as calibrating the tool for precise readings.
- **Locking screw:** once you've achieved the perfect measurement, this screw locks the movable jaw in place, preventing accidental movement and ensuring an accurate reading.

Jawsome features for different measurements:

- **Lower jaws:** these are the main jaws responsible for measuring external dimensions like width, length, and diameter. The fixed lower jaw is connected to the main scale, while the movable jaw is connected to the vernier scale.
- **Upper jaws:** these smaller jaws are designed to tackle internal measurements like the depth of a hole or the diameter of a pipe. They open and close to reach inside objects.

Additional tools:

- **Depth rod:** this handy rod extends from the end of the main scale and is perfect for measuring the depth of objects like jars or boxes.
- **Thumb screw:** this knob allows you to easily slide the movable jaw for smooth and precise adjustments during measurement.

By understanding these parts and their functions, you can master the art of using a vernier caliper for accurate measurements!

III. Least count of a Vernier caliper

Imagine the vernier caliper as a ruler with two scales. The main scale is like a regular ruler, but the vernier scale is a bit more intricate. It has slightly smaller divisions compared to the main scale.

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The least count is essentially the smallest difference you can measure using the vernier caliper. It's like the tiniest detail you can see on this special ruler. To determine this least count, we take the difference between one small division on the main scale and divide it by the number of even tinier divisions on the vernier scale.

By lining up the marks on these two scales, you can achieve a much more precise measurement than using just the main scale alone. The vernier scale essentially magnifies the smallest measurement on the main scale.

The mathematical formula for the least count of Vernier caliper is:

VC = 1 MSD – 1 VSD

If there are n divisions on the Vernier Scale then if they coincide with (n-1) division on the main scale, now the least count of the Vernier Scale is:

LC = (1 – {n-1}/n)MSD

Where:

- VC is Vernier Constant
- MSD is Main Scale Division
- VSD is Vernier Scale Division
- LC is Least Count

For example, if the main scale has divisions of 1 mm and the vernier scale has 25 divisions, then the least count of the vernier Caliper is 0.01 mm.

IV. What is the Least Count of a digital Vernier caliper?

Unlike traditional vernier calipers that require squinting at tiny lines, digital calipers take the guesswork out of measurements. They boast a super-small "least count," which is the tiniest measurement they can detect. This is typically 0.01 millimeters (mm) or 0.0005 inches, making them much more precise than their analog counterparts.

But the real superpower is the digital display. No more struggling to decipher lines on a scale! The measurement appears clear and bright, reducing the chance of human error and making it perfect for beginners or anyone who needs quick, accurate readings.

This combination of high precision and a user-friendly display makes digital vernier calipers a favorite tool in fields like:

- **Mechanical Engineering:** ensuring parts fit together perfectly.
- **Manufacturing:** maintaining quality control during production.
- **Scientific Research:** taking precise measurements for reliable experiments.

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So, if you need top-notch accuracy and an easy-to-read display, a digital vernier caliper is the way to go!

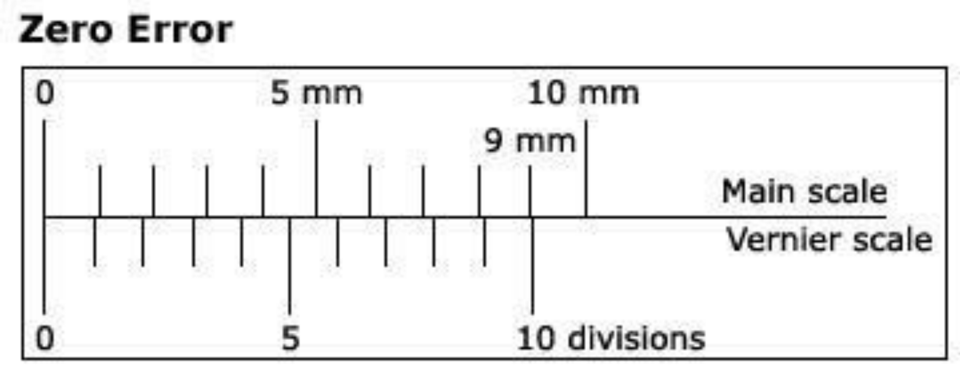
V. What is Zero Error?

Imagine you borrow a ruler, but when you hold the ends together, the "0" marks don't quite line up. That's zero error for a vernier caliper. It happens when the jaws are closed (no object between them) but the vernier scale doesn't read zero.

Causes: this little misalignment can be caused by two culprits:

- **Off-center calibration:** like a slightly bent ruler, the caliper might not have been perfectly adjusted during manufacturing.
- **Bumps and knocks:** rough handling can nudge the parts of the caliper out of whack, similar to how a strong gust of wind could bend a flimsy ruler.

The image below shows the Vernier scale alongside the main scale:



There are two types of zero errors that are:

- Positive Zero Error
- Negative Error

Positive Zero Error

In the case of the positive zero error, the reading is positive and away from the actual reading of 0.00 mm. That is if the reading is 0.06 mm in this case, then the zero error is +0.06 mm.

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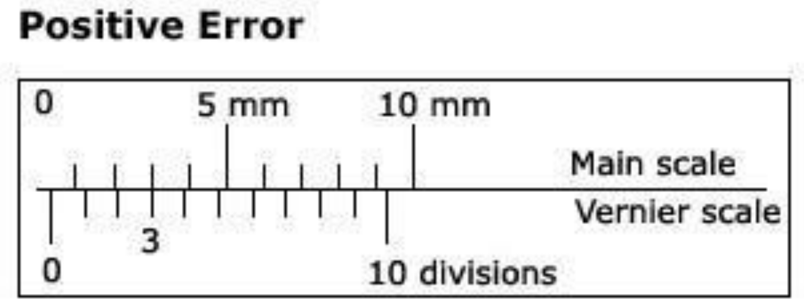
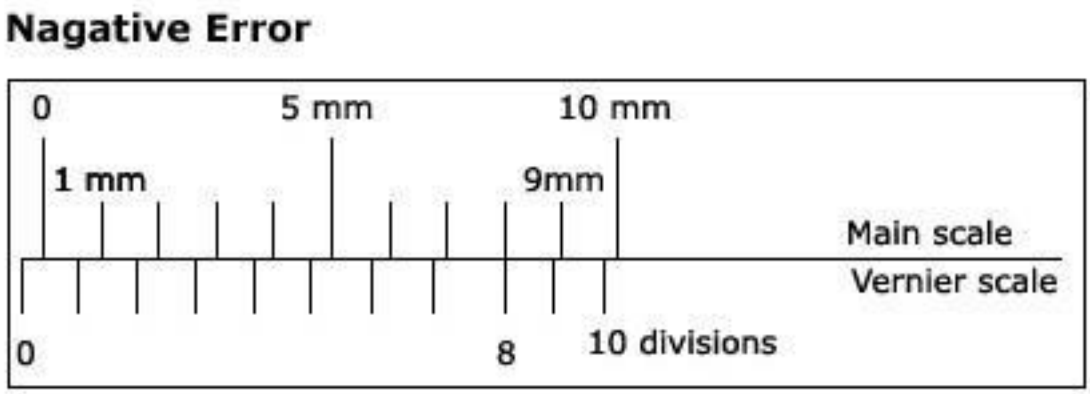


Negative Zero Error

In the case of the negative zero error, the reading is negative and away from the actual reading of 0.00 mm. That is if the reading is 0.06 mm in this case, then the zero error is -0.06 mm.



Zero Error in Vernier calipers

Imagine a mismatch between the caliper's "zero lines" - that's zero error. It happens when you close the jaws (nothing between them) but the vernier scale doesn't show zero. This mismatch can be in two directions:

- Vernier "too far ahead" (positive error): picture the vernier scale like a ruler that's slightly ahead of the main scale. This means the caliper is reading a small measurement even when nothing is there.
- Vernier "lagging behind" (negative error): Think of the vernier scale as a ruler that's behind the main scale. The caliper isn't registering anything when there actually might be a tiny gap between the jaws.

In the case of the Vernier caliper, the zero error is calculated using the formula:

Actual Reading = Main Scale + Vernier Scale

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VI. Common mistakes when reading Vernier caliper measurements

Even though using a vernier caliper seems straightforward, there are a few things that can trip you up. Here's a guide to common mistakes and how to avoid them:

- **Mismatched zeros:** this is like having a ruler where the "0" marks don't meet when closed. Double-check that the vernier scale's zero lines up exactly with the main scale before you measure.
- **Sneaky angles:** looking at the caliper from an angle can create a parallax error, like a magic trick that messes with your perception. To avoid this, look straight down at the vernier and main scales, making sure your eye is lined up perpendicular to them.
- **Decimal point drama:** the vernier scale has its own decimal point, and it can be tricky. Pay close attention to where it lands on the main scale. Does it hit a line exactly, or fall in between? Reading this right is key to getting an accurate measurement.
- **Upside down confusion:** the vernier scale has a specific way it should face. Make sure it's positioned correctly so you can read the numbers and markings easily. Imagine the scale sliding smoothly next to the main scale, not upside down or at a weird angle.
- **Jaw wobble:** if the jaws aren't clean or aligned properly, your measurements will be off. Clean the jaws and make sure they close together perfectly. If they're wonky, the caliper might need some maintenance.
- **Zero error neglect:** just like a scale that needs calibration, vernier calipers can develop a zero error. This means even with nothing between the jaws, it might read a small measurement. Check for zero error regularly by closing the jaws and seeing if the zeros line up. If they don't, keep that error in mind when taking future measurements.

VII. Applications of Vernier calipers

Vernier calipers are used in a variety of applications, including:

- **Building things precise:** vernier calipers are a go-to tool in manufacturing to ensure parts are exactly the right size.
- **Engineering with accuracy:** from bridges to robots, engineers rely on vernier calipers to measure structures and components with precision.
- **Science by the numbers:** scientists use vernier calipers for experiments, taking precise measurements of objects to support their discoveries.
- **Construction done right:** whether it's framing a house or laying pipe, construction workers depend on vernier calipers for accurate measurements of materials.

VIII. Safety Precautions

- **Keep it in top shape:** always use a vernier caliper that's in good working order. A faulty tool can lead to inaccurate measurements and potential safety hazards.
- **Size matters:** make sure the object you're measuring fits within the caliper's range. Trying to squeeze something too big or tiny can damage the caliper or cause injury.
- **Sharp edges? Beware!:** skip using the caliper on sharp or pointed objects. These could damage the instrument or pose a cut risk.

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- **Keep it cool (or warm):** extreme temperatures can affect both the caliper and the object you're measuring. Avoid using it on very hot or cold objects.
- **Safe storage is key:** when you're done, store your vernier caliper in a safe place to prevent damage and keep it out of the way.

IX. How to use a Vernier caliper

1. **Choose the right jaws:** depending on what you're measuring (width, internal diameter, or depth), use the appropriate set of jaws.
2. **Slide the vernier scale:** move the sliding jaw until the object you're measuring fits snugly between the jaws. The vernier scale will slide along the main scale.
3. **Read the main scale:** locate the mark on the main scale that aligns closest to the zero mark on the vernier scale. This whole number value represents the millimeters or centimeters of your measurement.
4. **Read the vernier scale:** now, identify the mark on the vernier scale that lines up perfectly (or most closely) with a mark on the main scale. This value represents the fractional part of your measurement in millimeters or centimeters (depending on the caliper's resolution, typically 0.1mm or 0.05mm).
5. **Add the readings:** to get your final measurement, add the whole number value from the main scale (step 3) to the fractional value from the vernier scale (step 4).

For example:

If the 5mm mark on the main scale aligns with the zero mark on the vernier scale, and the third mark on the vernier scale lines up with a mark on the main scale, your measurement is:

- Main scale: 5mm
- Vernier scale: 0.3mm (since the third mark represents three divisions of 0.1mm)
- Total measurement: 5mm + 0.3mm = 5.3mm

Tips:

- Gently slide the jaws to avoid damaging the object you're measuring
- Make sure the vernier scale is clean and free of debris
- Take multiple measurements for accuracy and record the average
- Consider using a magnifying glass to read the vernier scale more precisely

X. How to measure Vernier caliper?

Taking measurements with a vernier caliper might seem complex, but follow these steps and you'll be a pro in no time!

Step 1: Zero check

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- First things first, make sure your caliper is ready for action. Close the jaws completely with nothing between them.
- Look at the two scales: the main scale and the vernier scale. Ideally, the zero mark on the vernier scale should line up perfectly with the zero mark on the main scale. This ensures there's no "zero error" messing with your measurements.

Step 2: Introducing the object

- Now, let's say you want to measure a ball. Place the ball between the jaws of the vernier caliper.

Step 3: Main scale magic

- Line up the 0 mark on the vernier scale with any whole number mark on the main scale. This whole number is your main scale reading.

Step 4: Vernier scale secrets

- Look closely at the vernier scale. There should be one line on the vernier scale that lines up perfectly (or almost perfectly) with a line on the main scale. This line's position on the vernier scale gives you the vernier scale reading. **Remember, vernier calipers typically measure in tenths or hundredths, so the reading will often involve decimals.**

Step 5: The big reveal!

- Finally, add the main scale reading (whole number) to the vernier scale reading (decimal) to get your final measurement!

Remember: The vernier scale refines the measurement from the main scale, allowing you to take very precise readings. With a little practice, you'll be a vernier caliper whiz!

XI. Tasks on the use of Vernier caliper

Use our online laboratory to solve tasks: https://lab.oleeproject.eu/#

Task #1: A Vernier caliper with no zero error is used to measure the diameter of a cylinder. The zero of the Vernier scale is observed between 4.20 cm and 4.25 cm on the main scale. The Vernier scale consists of 50 divisions, which are equivalent to 2.45 cm. The 11th division on the Vernier scale coincides exactly with one of the divisions on the main scale. What is the diameter of the cylinder?

Task #2: A Vernier caliper is used to measure the diameter of a cylinder. The main scale of the Caliper is calibrated in millimeters, and it is observed that 15 divisions on the main scale are equal in length to 20 divisions on the Vernier scale. When measuring the diameter, the main scale reading is 45 divisions, and the 8th division on the Vernier scale coincides with a division on the main scale. Find the least count of the Vernier caliper and the radius of the cylinder.

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XII. Tasks solving procedure

Task #1: A Vernier caliper with no zero error is used to measure the diameter of a cylinder. The zero of the Vernier scale is observed between 4.20 cm and 4.25 cm on the main scale. The Vernier scale consists of 50 divisions, which are equivalent to 2.45 cm. The 11th division on the Vernier scale coincides exactly with one of the divisions on the main scale. What is the diameter of the cylinder?

Solution: to find the diameter, we consider the following information:

- Smallest division on the main scale = 0.05 cm (4.25 – 4.20)
- Main scale reading = 4.20 cm,
- Vernier coincidence = 24
- Least Count = 0.05 – 2.45/50 = 0.001 cm.

Using these values:

- Diameter = Main Scale Reading + (Vernier Coincidence × Least Count)
- Diameter = 4.20 + 11 × 0.001
- Diameter = 4.211 cm

<u>Thus, the diameter of the cylinder is 4.211 cm</u>

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Solution:

<u>(i) to determine the least count:</u>

- MSD (Main Scale Division) = 0.1 cm
- 20 VSD (Vernier Scale Division) = 15 MSD

Therefore:

- VSD = (19/20) MSD = (15/20) × 0.1 cm = 0.075 cm
- Least Count = MSD – VSD
- Least Count = 0.1 cm – 0.075 cm
- Least Count = 0.025 cm

<u>Thus, the least count of the Vernier caliper is 0.025 cm.</u>

<u>(ii) to find the radius:</u>

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- Main Scale Reading = 45 mm = 4.5 cm
- Diameter = Main scale reading + (vernier coincidence × least count)
- Diameter = 4.5 cm + (8 × 0.025 cm)
- Diameter = 4.5 cm + 0.2 cm
- Diameter = 4.7 cm
- Radius = Diameter/2 = 4.7/2 = 2.35 cm

Thus, the radius of cylinder is 2.35 cm.

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