Things to Remember For Physics Practical:

General

- A physical quantity is a quantifiable property ascribed to a particular phenomenon, body of substance. It is in the format of (Property) of (Object/Phenomenon).
  Eg. Mass of Sun, Length of Ruler

- Prefixes of physical quantity can be very big and very small, and writing all the 0s out is very tedious. Therefore we express it in scientific notation or standard form.

  10^12 - tera(T)

  10^9 - giga(G)

  10^6 - mega(M)

  10^3 - kilo(k)

  10^-1 - deci(d)

  10^-2 - centi(c)

  10^-3 - milli(m)

  10^-6 - micro(μ)

  10^-9 - nano(n)

  10^-12 - pico(p)

- Order of magnitude is the value rounded off to the nearest power of 10.

- To express in Standard form:
  For Big Numbers
  Step 1: Put a decimal point after the first digit. Ignore the zeros at the end, unless there are numbers between the zeros.
  Step 2: Count the number of digits of the Number(n)
  Step 3: The power of the 10 will be (n-1)
  Eg. 7210000000000000 = $7.21 \times 10^{16-1} = 7.21 \times 10^{15}$

  For Small Numbers
  Step 1: Move the decimal point to the point after the first non-zero digit
  Step 2: Count the number of zeros in front of that non-zero digit
  Step 3: The power of the 10 will be n
  Eg. 0.000000000313 = 3.13×10^{10}

- During Conversion between units, s.f remains the same

- The precision of an instrument is usually its smallest division but is sometimes half the smallest division for the Common test, you only need to know the following:

Precision = Smallest division	**Precision = ½ smallest division**
Electronic Balance	Measuring cylinder (100cm^3)
Meter Rule	
Micrometre	
Vernier caliper	
Stopwatch	
Protractor	

Basic Precision to know:
Ruler (0.1cm/1mm)
Vernier caliper (0.01cm/0.1mm)
Micrometer screw gauge (0.001cm/0.01mm)

- Precision is how close repeated measurements are to one another.
  Accuracy is how close the measurements are to the true result
  Precise but inaccurate results may be caused by systematic errors
  Accurate but imprecise results may be caused by random errors

- **<u>Rules of s.f</u>**
  For +-, Follow the number with the least no. of d.p
  Eg. 7.00(2.d.p) + 5.0(1.d.p) = 12.0(1.d.p)

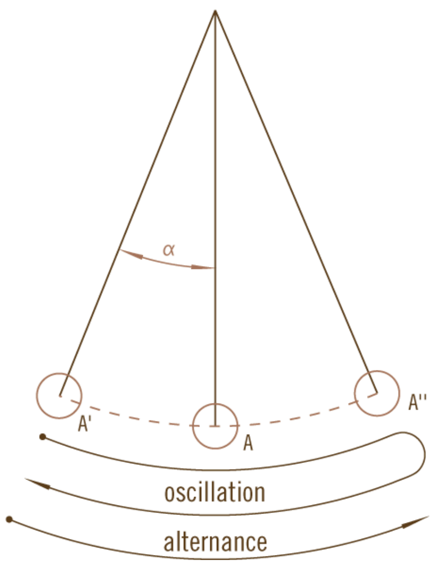
  For ×÷, Follow the number with the least no. of s.f
  Eg. 7.00(3.s.f) **×** 5.0(2.s.f) = 35(2.s.f)

  If measured value is multiplied or divided by a fixed factor, the number of s.f follows the measured value.
  If calculated value uses another calculated value, s.f follow above rules

  In summary,
  $(t_1 + t_2)$ --> follow dp of measure value(smallest dp)
  <t> → sf of measured value(t_1/t_2)
  <t>÷20 → sf of <t>

Practical Test

- **Pendulum**
  Remember the definition of 1 oscillation.



When the pendulum moves from:
A → A” → A → A’ → A
This is one oscillation, and also the recommended way to measure an oscillation during the practical.
When the pendulum hits point A, start the stopwatch.
When the pendulum hits point A the first time, It is NOT an oscillation yet, as it has no hit point A’.
Therefore, one oscillation is Only when the pendulum hits Point A the 2nd time.
In other words, the number of oscillations you want to measure is the Number of times the pendulum hits point A Multiplied by 2 + 1

- The time taken for 1 oscillation is a Period(T)

- When doing Pendulum experiment, the following is the Steps to take:
  Step 1: Make sure your set-up is correct
  Step 2: Before beginning the experiment, make sure the String is straight and not tangled by running your finger through it
  Step 3: When starting the experiment, First make sure that the Pendulum moves straight and does not change the plane it is swinging on by moving to the side, and swinging in one plane instead
  Step 4: Go back to the front, and start the timer when Ready, and when the pendulum hits point A
  Step 5: Stop the timer when it hits point A again, After 20 oscillations
  Step 6: Record and transfer recordings onto table
  Step 7: Repeat Until Table is filled

- The following is Possible Errors that may occur while doing the Pendulum experiment is as follows:
  Human Reaction Time error, where Human reaction time prevents humans from starting and stopping the stopwatch accurately without a few milliseconds of delay. It is Approximately 0.3s. Its Impact can be reduced by increasing the number of oscillations recorded for one reading.

The pendulum is not moving completely on the horizontal plane. This may be caused by wind, human error, etc. I do not recommend you writing this on exam unless they specifically state that you cannot use Human Reaction Time error as an answer.

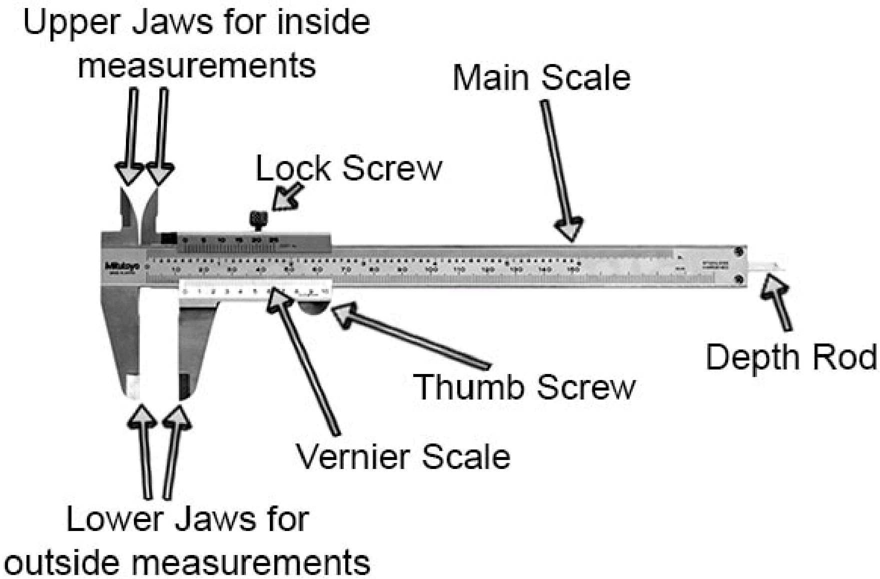
Percentage Error is used to calculate the impact of a certain error. Its formula is:

$$PercentageError = \frac{ExperimentalValue - TheoreticalValue}{Theoracticalvalue}$$

In the case of the Pendulum experiment, it is simplified to:

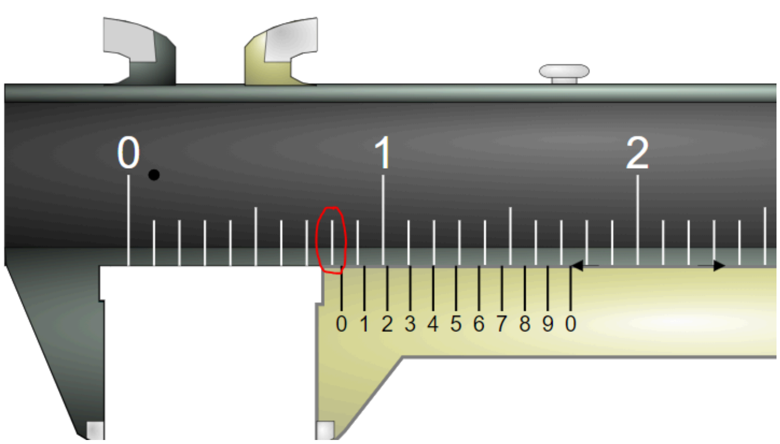
$$PercentageError = \frac{HumanReactionTime}{Time}$$

- **Vernier Caliper**
  Has precision of 0.01cm/0.1mm
  Precise and Accurate at measuring. Is also easier to use then the micrometer screw gauge.
  These are the parts of a Venier Caliper:

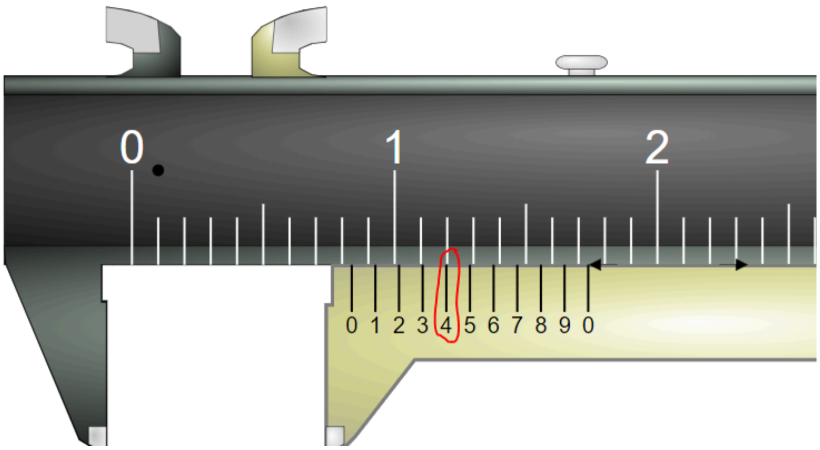


  The **External Jaws** are used to measure The External Diameter of an object/Lengths of objects in General
  The **Internal Jaws** are used to measure the Internal Diameter of an object.

- In Order to measure the Length using the Vernier Caliper:
  Step 1: Check for Zero Error(See below)
  Step 2: Slide the object into the External jaws/Place the Internal Jaw in the interior of the Object
  Step 3: Record the value of the main scale at the point where it lines up with the venier scale, rounded down. This tells you the mm of the object.
  Eg. Below shows a vernier caliper. The point where the main scale lines up with the vernier scale is shown by the red circle, as we have to round down, making it 8mm

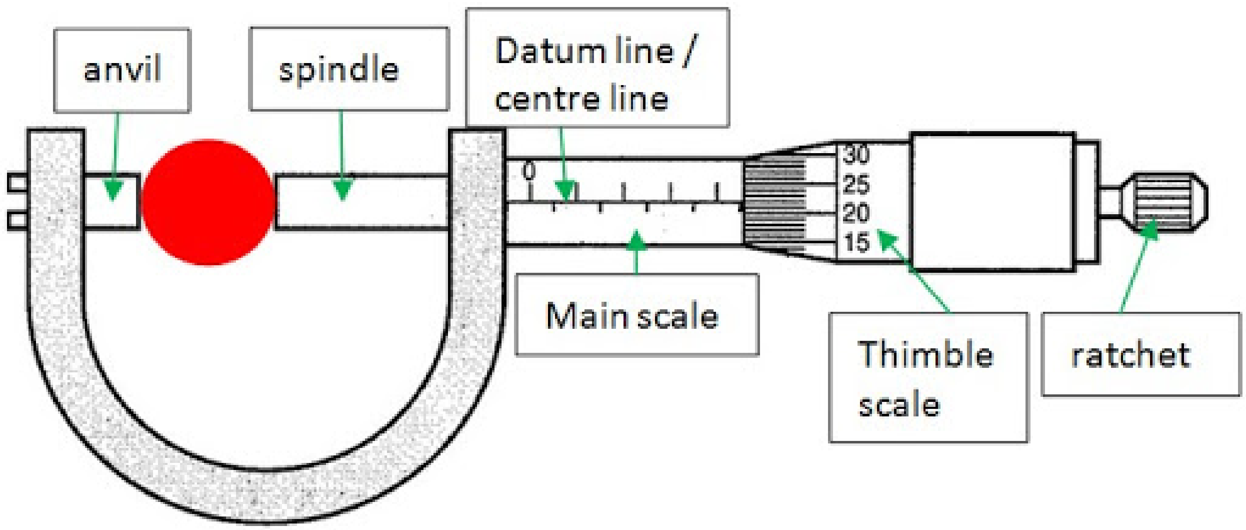


Step 4: Find and record the first mark on the vernier scale which perfectly aligns with any line of the Main scale. This will be your 1 decimal place of the reading in mm.
Eg. From the above example, the mark at 0.4mm on the venier scale perfectly aligns with the 1.2cm line on the Main scale, therefore the decimal of the Reading is .4mm, making the reading 8.4mm

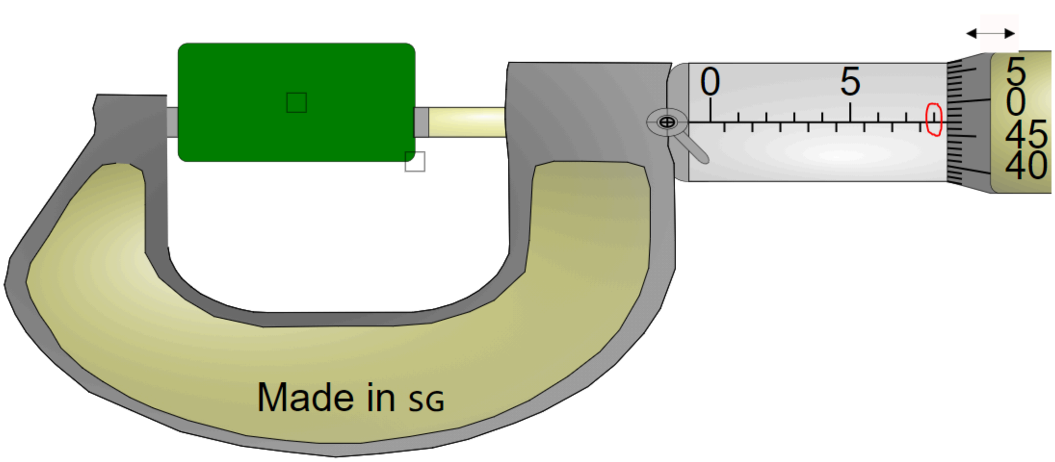


- **<u>Zero Error on the Vernier Calipers</u>**
  Zero Error is how far away from zero the reading in when it is supposed to be zero. To do this, measure the value of the reading when the Venier Calipers is completely closed. When the zero on the vernier scale is to the right of the zero on the main scale, zero error is positive, so you take this reading is subtracted it from all future readings. If, however, the zero on the vernier scale is to the left of the zero on the main scale, zero error is negative, so you will have to add it to all future readings. Note that for zero error, the reading should be read from the back. So when the reading would normally be 0.9mm, it will instead be -0.1mm. In General, the formula for Zero Error is:
  Corrected Reading = Observed reading - Zero Error

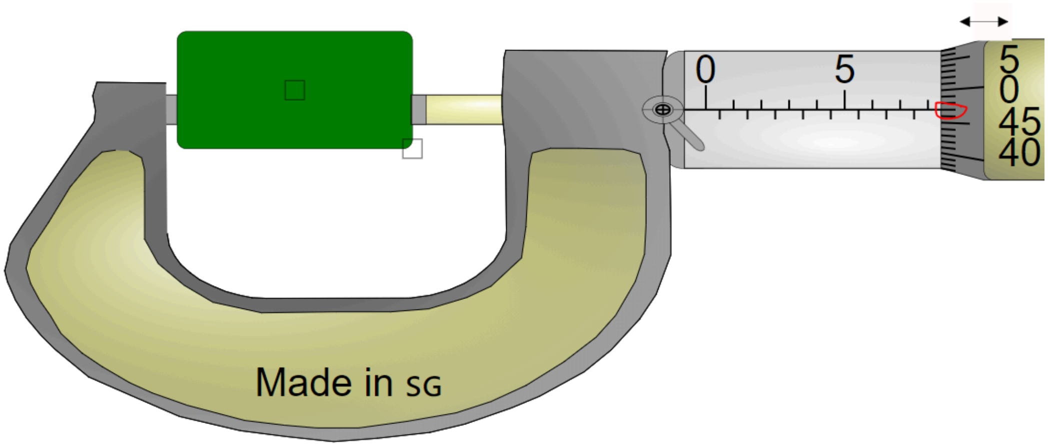
- **<u>Micrometer screw gauge</u>**
  Has precision of 0.001cm/0.01mm
  Very precise measurements, but harder to use, and less accurate at measuring diameter of circular object due to non uniformity of it, as well as the fact that the surface of a round object is not flat.
  These are the parts of a micrometer screwgauge:



- To measure using the Micrometer screwgauge:
  Step 1: Measure the Zero Error(See Below)
  Step 2: Place the object between the anvil and the spindle. Tighten using the thimble, until it the spindle almost touches the object, before tightening using the ratchet instead. This is to prevent excess pressure being exerted on the object which will cause a depression in the object, causing us to not record the true length of the object.
  Step 3: To obtain the first part of the measurement, similar to the Venier Callipers, record the reading on the main scale(each interval is 0.5mm), rounded down. This will be the mm of the measurement + 1st decimal place
  Eg. Below shows a Micrometer Screwgauge. The reading of the Datum line is shown by the Red Circle. It shows a reading of 8.0mm



Step 4: To obtain the second part of the measurement, record the reading of the Thimble scale(Interval of 0.01mm). It should be read from the bottom up. This will allow us to obtain the 2nd decimal place of the object. This will be added to the previous reading to give us the observed reading of the object.
Eg. From the above example, the reading on the Thimble scale is 0.47mm. Therefore the Observed reading is 8.47mm



Zero Error on micrometer screwgauge
Similar to that of the Vernier Caliper, Measure the reading of the screw gauge when it is completely closed. If the 0 of the Thimble scale is below the Centre Line, Zero Error is positive, and one should read from the bottom to measure for Zero Error. However, if the 0 of the Thimble scale is above the Centre Line, Zero Error is negative, and one should read from the top to measure for Zero Error. It uses the same formula, being:
Corrected Reading = Observed reading - Zero Error

- **<u>Table</u>**

  Required Point for Table:

  1. **Heading of each coloumn**
     - Physical quantities should be labelled with correct units.
       Eg. t/s, where t is the physical quantity, and s is the units in seconds.
     - First column should be your independent variable.
       Eg. L/m(Length of string)
     - Next few columns are the the dependent variable
       Eg. t/s(time of x oscillation)
     - Last few columns are the calculated quantities, which include averages.
       Eg. T/s(Period) T^2/s^2(Period squared) (< > means average)

  2. **Quantity specified to correct d.p or s.f**
     - Numerical magnitude of measured quantity should be read to full precision of instrument
       Eg. Precision of Vernier Caliper is 0.1mm, therefore measured quantity should be 7.0mm and not 7mm.
     - Calculated quantities should be calculated to correct d.p or s.f. Numbers that use the calculated quantities should be according to the s.f of the measured value. If the Calculated value uses other calculated values, like Period, s.f should be according to the calculated value used.
       Eg. <t> follows s.f of t_1/t_2 T follows s.f of <t>

  3. **Number of sets of readings**
     - At least 6 sets of readings with different Independant variables values.

  4. **Range of readings**
     - There should be a good spread of Independant variables values
     - Maximise the range of the Independant variables values
       Eg. Correct: 1.0, 0.8, 0.6, 0.4, 0.2, 0.0
       Wrong: 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4

- **<u>Graphs</u>**

  Required points of a Graph

  1. **Axes**
     - Axes should be labelled with physical quantity and its unit.
       Eg. T^2/s^2 against L/m
     - When the question states plot <u>a</u> against <u>b</u>, <u>a</u> will be the y-axis, <u>b</u> will be the x-axis.
     - Ensure that the Axes Occupy the entire graph paper, and start either at the edge of the paper, or one box away from the side of it.

  2. **Scale**
     - No Awkward Scales to be used. Scales should be in intervals of 1,2,4,5,10.
     - Graph should make use of more than ½ the graph paper
     - Graph precision should be ½ the smallest square. In other words, the graph precision is the Interval Divided by 20.
       Eg. Interval = 1, Therefore smallest Division is 1/20 = 0.05.
       Therefore all values in that axis should follow that d.p(2.d.p)

  3. **Plot**
     - Plot points accurately
     - Plotted points must be an x that occupies less space then the smallest square
     - Plotted points should be rounded off to half the smallest square.
     - If Plotted Points look wrong, recheck data, if it is still wrong, circle point and label "anomaly"

  4. **Line**
     - Use a 30cm long ruler
     - To draw a best fit line/curve, draw a line where the difference in the number of plotted points above and below the graph should be +-1, or 0
       Eg. Number of points above the line is 1, Below the line is 2, 2-1 = 1,
       Therefore the best fit line drawn is still valid
     - The line drawn should be of Uniform thickness. If Error is made, erase whole graph and redraw. Try and bring a pencil in case mechanical pencil lead brakes while drawing graph
     - Extend the line completely until it touches the y axis, as well as extend in the other direction.

  5. **Gradient**
     - Draw a Dotted triangle between two point on the graph to calculate gradient.
     - Dot two points with a dot that is the size of ½ smallest square
     - Horizontal distance between the two points should cover >½ the graph

6. **Coordinates**
    - x-intercepts and y-intercepts and plotted points for gradient should be labelled in the form (x,y). Ensure that the y coordinate of the x-intercept is always 0, and that the x coordinate of the y-intercept is always 0
    - Precision of each coordinate should be correct
    - Origin should also be labelled in the form (x,y)

- **<u>Analysis of Graph</u>**

  Required points for Analysis of Graph

  1. **When Calculating Gradient**
      - Should be to the correct s.f
      - Units are not required UNLESS the question specifically does not ask for gradient but instead asks for the rate

  2. **Calculate/measure y-intercept**
      - To measure y-intercept, extend the graph until it cuts the y-intercept, and write it down.
      - To calculate the y-intercept, use the equation y = mx+c, sub a random point on the graph, and solve.
      - Should have units and precision of y-axis

  3. **Describing graph**
      - If Straight line cuts through origin, __ is directly proportional to__
      - If Straight line does not cut through origin, Line is a linear graph that has a positive/negative gradient
      - A curve graph is simply just a non-linear graph
      - If the question asks for a gradient, graph will be a linear graph. If it asks for a gradient at a specific point, it is most likely a curve graph

  4. **Manipulation of Data**
      - Always try to make graph linear. This can be done by making the equation become in the form y = mx + c

        Eg.

        $$T = 2\pi\sqrt{\frac{L}{G}}$$

        Where

        $$m = \frac{2\pi}{\sqrt{g}} \quad y = T \quad x = \sqrt{L}$$

  - Therefore when given m , we will be able to solve for g.

5. **Accuracy**
    - All calculated quantities should be within 10% of teachers data, so experiment still has to be done properly.

- **Reminders**
- Remember your s.f., d.p.
- Remember your Readings and graph should be to their respective precisions
- Remember that One oscillation is the number of times the pendulum hits the middle point x2 + 1
- Remember to record your readings and timings
- Remember the procedures to doing the experiments and using the various measuring equipment
- Remember to check for Zero Error
- Remember the points of a Table
- Remember the points of a Graph
- Remember UNITS

Resources
https://iwant2study.org/lookangejss/01_measurement/ejss_model_Micrometer02/Micrometer02_Simulation.xhtml - Micrometer Experiment

https://iwant2study.org/lookangejss/01_measurement/ejss_model_AAPTVernierCaliper/AAPTVernierCaliper_Simulation.xhtml - Vernier Calipers Experiment

https://quizlet.com/Zhongbob/folders/s3-and-s4-physics?x=1xqt&i=2y4xiv - Quizlet Notes

Give Feedback
https://forms.gle/w1BUVvcjf3RdKZon7

Credits
Zhongbob(3I) -- Made the Docs
Everyone from 3I -- for supporting and helping a lil with the docs :)

With that said, Good Luck for the Physics Practical!