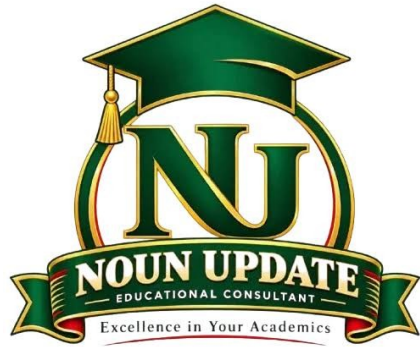




PHY107

GENERAL PHYSICS PRACTICAL I

STUDY MATERIAL

An independent, expanded laboratory learning companion

5 STUDY MODULES • 13 TOPIC UNITS • CLICKABLE CONTENTS

SOURCE CLARITY The uploaded extract and NOUN's public legacy manual are marked PHY191, not PHY107. The linked PHY107 course page requires login. This independent educational companion draws on their overlapping practical topics; its module structure is editorial, not a verified official 2026 PHY107 unit list.

Prepared by NOUN Update • October 2026. Not an official NOUN publication.

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HOW TO STUDY THIS COMPANION

Start with the current PHY107 eLearn material if you have access. Use this workbook to reinforce general-physics practical techniques: measurement, error analysis, best-fit graphs, oscillations, properties of matter and experimental reporting. Do not assume every legacy experiment is prescribed for your current PHY107 assessment.

1. Read the topic explanation and relate the quantity measured to the instrument.
2. Derive the linear graph equation: identify x, y, slope and intercept before plotting.
3. Perform only supervised observations; record real values immediately in your notebook.
4. Practise the worked example without looking at the solution.
5. Review the formula sheet, sample report and independent practice questions.

THE NAMING DIFFERENCE MATTERS The uploaded DOCX is a PHY191 extract. NOUN currently identifies your requested course as PHY107 on eLearn. This resource is labelled a PHY107 companion, with legacy PHY191 material used only as supporting reference.

MODULE 1 | Laboratory Foundations

Editorial study grouping based on the historical PHY191 practical outline. The current PHY107 eLearn unit order is not publicly verifiable.

UNIT 1 | Graphs and Relationships in Physics

REFERENCE ROUTE: Legacy PHY191 Unit 1

LEARNING OUTCOME Turn measured pairs into informative graphs and extract physical constants from slopes and intercepts.

Concept and explanation

The experimenter normally chooses or controls an independent variable (x) and measures a dependent variable (y). A graph is therefore more than a sketch: it tests the mathematical relation between the quantities. Select axes, label the physical quantity and SI unit, choose a scale that uses most of the graph paper, plot accurately and draw the best-fitting line rather than connecting noisy points one by one.

The simplest straight-line rule is $y = mx + c$. The slope m is the change in y divided by the corresponding change in x ; the intercept c is the value predicted when x is zero. Both can carry physical units. A straight line through the origin indicates proportionality when measurement errors are compatible with zero intercept.

Non-linear data may be linearised only when the theoretical model supports it. For $y = ax^2$, plot y against x^2 ; for $T = a \sqrt{L}$, plot T^2 against L . A logarithmic graph can linearise a power law, but students must label transformed axes and not confuse the slope of a transformed graph with the original quantity.

Essential formula(s)

$$y = mx + c; \quad m = (y_2 - y_1)/(x_2 - x_1)$$

For $y = ax^2$, $a = \text{slope of } y \text{ against } x^2$

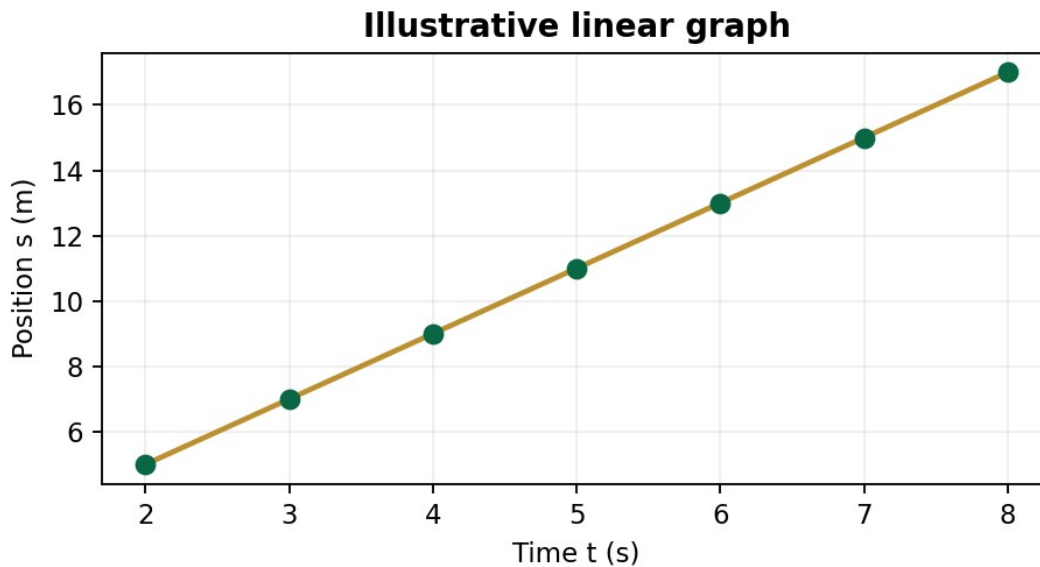
Suggested apparatus

Graph paper or plotting software, ruler, pencil, measuring data and calculator.

Supervised practical and analysis sequence

1. Decide which variable is controlled and which is measured.
2. Tabulate paired readings including units and repeated measurements if available.
3. Choose well-spaced axes and plot points at their measured coordinates.
4. Fit an appropriate line or smooth curve following the expected model; do not force all points onto the line.
5. Choose two widely separated points on the fitted line to obtain $\Delta y/\Delta x$, not necessarily two raw data points.

6. Report slope, intercept, derived constant and units.



NOUN Update illustration with synthetic values (not actual experiment readings).

WORKED EXAMPLE If a distance-time plot goes through fitted points (2 s, 5 m) and (8 s, 17 m), slope = $(17 - 5)/(8 - 2) = 2 \text{ m s}^{-1}$. Intercept = 1 m. Hence $s = 2t + 1$ (using metres and seconds).

Errors and precautions

- Use plotted best-fit points to calculate gradient.
- Do not plot t against s when asked for s against t .
- Include units on axes and on any calculated slope.

REVISION CHECKPOINT Independent variable $\rightarrow$ x-axis; dependent variable $\rightarrow$ y-axis. Gradient has units $[y]/[x]$. The line need not pass through the origin.

UNIT 2 | Measurement and Significant Figures

REFERENCE ROUTE: Legacy PHY191 Unit 2

LEARNING OUTCOME Read instruments consistently, express accuracy and precision, and report appropriately rounded results.

Concept and explanation

Practical physics uses fundamental SI quantities such as length, mass, time, temperature and electric current, from which velocity, density and force can be derived. Instrument selection must match the range and resolution of the measurement: a metre rule for a large length; vernier calipers or a micrometer for smaller dimensions; a stopwatch for timing.

Accuracy means closeness to the correct value, while precision concerns agreement among repeated measurements. A very precise set of readings can all be wrong if the zero is offset. Resolution is the smallest division or detectable change; uncertainty quantifies the plausible spread in a measured quantity.

When reporting, use an appropriate number of significant figures and always state units. Convert lengths consistently before calculating physical constants. Repeating measurements helps reveal scatter but cannot automatically remove a fixed zero error.

Essential formula(s)

$$\text{Mean } \bar{x} = (x_1 + x_2 + \dots + x_n)/n$$

$$\text{Density } \rho = m/V; \text{ speed } v = s/t$$

Suggested apparatus

Metre rule, stopwatch, vernier calipers, micrometer, thermometer, balance and notebook.

Supervised practical and analysis sequence

1. Inspect instrument and zero setting before use.
2. Read scale at eye level to reduce parallax.
3. Record raw readings with their displayed precision and units.
4. Repeat when appropriate; calculate the mean and estimate uncertainty.
5. Convert to coherent SI units before substituting into a formula.
6. Round derived answers only at the end of the calculation.

WORKED EXAMPLE Measured length readings: 12.4, 12.6 and 12.5 cm. Mean = $(12.4 + 12.6 + 12.5)/3 = 12.5$ cm. Half-range estimate = $(12.6 - 12.4)/2 = 0.1$ cm, giving approximately 12.5 ± 0.1 cm.

Errors and precautions

- State the precision of the instrument; do not imply more digits than measurements support.
- Beware parallax, backlash and zero errors.
- Do not mistake precision for accuracy.

REVISION CHECKPOINT Always convert centimetres to metres before substituting into an SI-based formula.

UNIT 3 | Error and Uncertainty Analysis

REFERENCE ROUTE: Legacy PHY191 Unit 3

LEARNING OUTCOME Identify error types and express the reliability of experimental results.

Concept and explanation

Measurements are affected by random fluctuations and systematic effects. Random errors make repeated readings scatter; systematic errors bias readings in a particular direction. Mistiming a pendulum can produce random scatter; a consistently incorrect clock calibration introduces systematic error.

Absolute uncertainty is expressed in the same unit as the measurement. Fractional uncertainty equals absolute uncertainty divided by the measured value, and percentage uncertainty is 100 times that ratio. The legacy reference gives introductory treatments of uncertainty and graph-derived error.

For products and quotients, the sum of fractional uncertainties gives a useful conservative estimate in first-year practical work. For independent small random uncertainties, a root-sum-of-squares approach may be more appropriate, depending on the instructed method; never combine the two methods without saying which has been used.

Essential formula(s)

Percentage uncertainty = $(\Delta x/x) \times 100\%$

If $z = ab/c$, conservative estimate: $\Delta z/z \approx \Delta a/a + \Delta b/b + \Delta c/c$

Suggested apparatus

Repeated measurement sets, graph paper, calculator and laboratory record.

Supervised practical and analysis sequence

1. Identify likely sources of random and systematic error.
2. Repeat observations and check for gross mistakes.
3. Estimate absolute uncertainty in each input.
4. Propagate uncertainty through the chosen formula using the instructed method.
5. Report final answer and uncertainty to sensible precision.
6. Recommend practical precautions tied to identified sources.

WORKED EXAMPLE For $v = s/t$ with $s = 0.63 \pm 0.02$ m and $t = 1.71 \pm 0.10$ s, $v \approx 0.368$ m/s. Conservative fractional uncertainty $\approx 0.02/0.63 + 0.10/1.71 \approx 0.0903$, so $\Delta v \approx 0.033$ m/s. Report $v \approx (0.37 \pm 0.03)$ m/s. This worked answer explicitly uses linear addition.

Errors and precautions

- State how uncertainty was estimated.
- Do not report an uncertain result with excessive decimals.
- Recognise that repeating readings will not fix a systematic bias.

REVISION CHECKPOINT Absolute uncertainty has units; percentage uncertainty does not.

MODULE 2 | Pendulums and Spring Systems

Editorial study grouping based on the historical PHY191 practical outline. The current PHY107 eLearn unit order is not publicly verifiable.

UNIT 4 | Experiment 1: Gravitational Acceleration by Simple Pendulum

REFERENCE ROUTE: Legacy PHY191 Experiment 1

LEARNING OUTCOME Estimate local gravitational acceleration from period and pendulum length.

Concept and explanation

For small angular displacements a simple pendulum approximately undergoes simple harmonic motion. Its period is $T = 2\pi\sqrt{L/g}$, where L is measured from the pivot to the centre of the bob and g is gravitational acceleration. Squaring gives $T^2 = (4\pi^2/g)L$.

When T^2 is graphed vertically against L horizontally, the gradient $m = 4\pi^2/g$. Therefore $g = 4\pi^2/m$. Measuring many complete oscillations rather than one reduces the relative impact of reaction-time error. The small-angle assumption is important.

Essential formula(s)

$$T = 2\pi\sqrt{L/g}$$

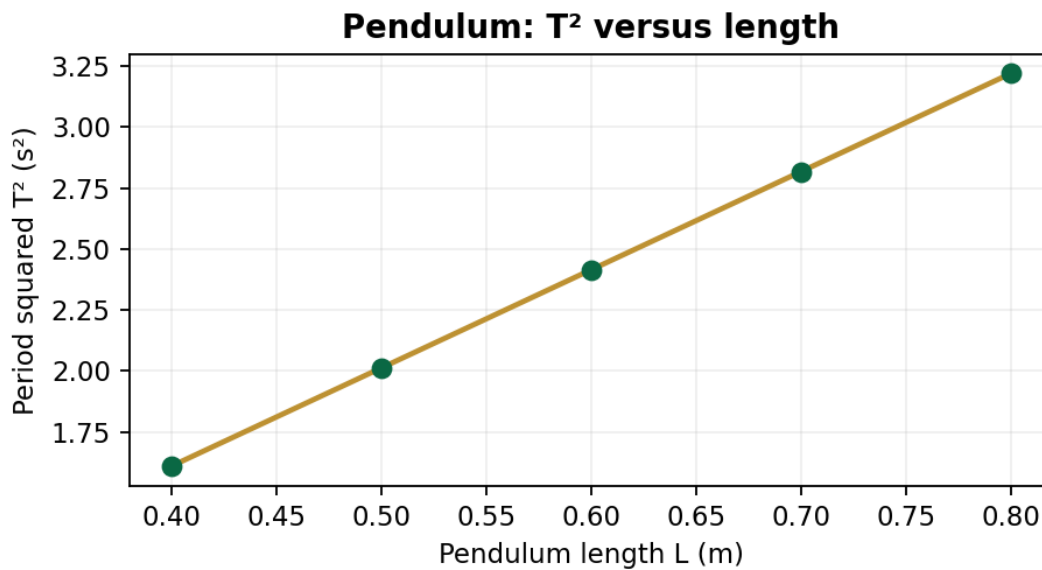
$$T^2 = (4\pi^2/g)L; \quad g = 4\pi^2/m \text{ where } m \text{ is slope of } T^2 \text{ versus } L$$

Suggested apparatus

Pendulum bob, light thread, split cork, retort stand, metre rule and stopwatch.

Supervised practical and analysis sequence

1. Suspend a bob and measure L from pivot to centre of bob.
2. Displace only through a small angle; release without a push.
3. Time 20 complete oscillations twice for a chosen length.
4. Find average t and $T = t/20$; then compute T^2 .
5. Repeat for several lengths and plot T^2 against L .
6. Calculate slope and $g = 4\pi^2/\text{slope}$.



NOUN Update illustration with synthetic values (not actual experiment readings).

WORKED EXAMPLE Suppose the best-fit slope of T^2 against L is $4.03 \text{ s}^2/\text{m}$. Then $g = 4\pi^2/4.03 = 9.80 \text{ m/s}^2$ (approximately).

Errors and precautions

- Keep the swing angle small and the pivot secure.
- Time enough oscillations and repeat readings.
- Measure to the centre of the bob, not the bottom.

REVISION CHECKPOINT Plot T^2 against L , not T against L , when extracting g with a straight-line graph.

UNIT 5 | Experiment 2: Pendulum Plot and Height of a Room

REFERENCE ROUTE: Legacy PHY191 Experiment 2

LEARNING OUTCOME Use a pendulum graph and its intercept to estimate an inaccessible length, as described in the legacy manual.

Concept and explanation

The older practical manual follows its first pendulum experiment with a variant involving pendulum lengths measured relative to an overhead suspension point. When the available vertical distance is H and an auxiliary measured height is h , the working pendulum length can take the form $L = H - h$, giving $T^2 = (4\pi^2/g)(H - h)$.

A graph of T^2 against h is a straight line with negative slope $-4\pi^2/g$ and horizontal intercept $h = H$, provided h is measured from the same reference level as H . This graphical idea is valuable: physically meaningful intercepts can reveal an unmeasured geometric constant.

The actual lab apparatus and reference datum must be established with an instructor. Different mounting arrangements change the sign and interpretation of the intercept; never copy the equation without checking your length definitions.

Essential formula(s)

If $L = H - h$: $T^2 = (4\pi^2/g)(H - h)$

Slope = $-4\pi^2/g$; x-intercept = H

Suggested apparatus

Secure overhead pendulum support, bob, thread, metre rule or tape and stopwatch.

Supervised practical and analysis sequence

1. Define the room-height reference level and record how h is measured.
2. For several values of h , measure the corresponding effective pendulum length.
3. Time repeated oscillations and calculate T^2 .
4. Plot T^2 against h as appropriate to the selected geometry.
5. Use the x-intercept to estimate H and the gradient to estimate g .
6. Compare H against a direct measurement under safe supervision.

WORKED EXAMPLE For a T^2 -versus- h line represented by $T^2 = 11.6 - 4.0h$, with h in metres and T in seconds, the horizontal intercept is $H = 11.6/4.0 = 2.90$ m. Estimated $g = 4\pi^2/4.0 \approx 9.87$ m/s².

Errors and precautions

- Do not lean over heights or suspend heavy objects without approval.
- Check the definition of h and L before plotting.
- Use the intercept of the fitted line, not the nearest data point.

REVISION CHECKPOINT A physical intercept is meaningful only when the experimental reference datum has been defined.

UNIT 6 | Experiment 3: Force Constant of a Spring

REFERENCE ROUTE: Legacy PHY191 Experiment 3

LEARNING OUTCOME Test Hooke's law and find a spring force constant from load-extension data.

Concept and explanation

Within the elastic range, the extension e of a spring is proportional to applied force F . Hooke's law is $F = ke$, where k is the force constant in N/m. The straight-line gradient of F against e equals k .

The experiment needs the unstretched reference length so extension can be found as loaded length minus original length. If a mass m is suspended vertically, use $F = mg$, taking g about 9.81 m/s^2 unless a value is specified. When the spring is permanently deformed after unloading, measurements beyond the elastic limit should not be used to validate Hooke's law.

Essential formula(s)

$$F = ke; e = L - L_0$$

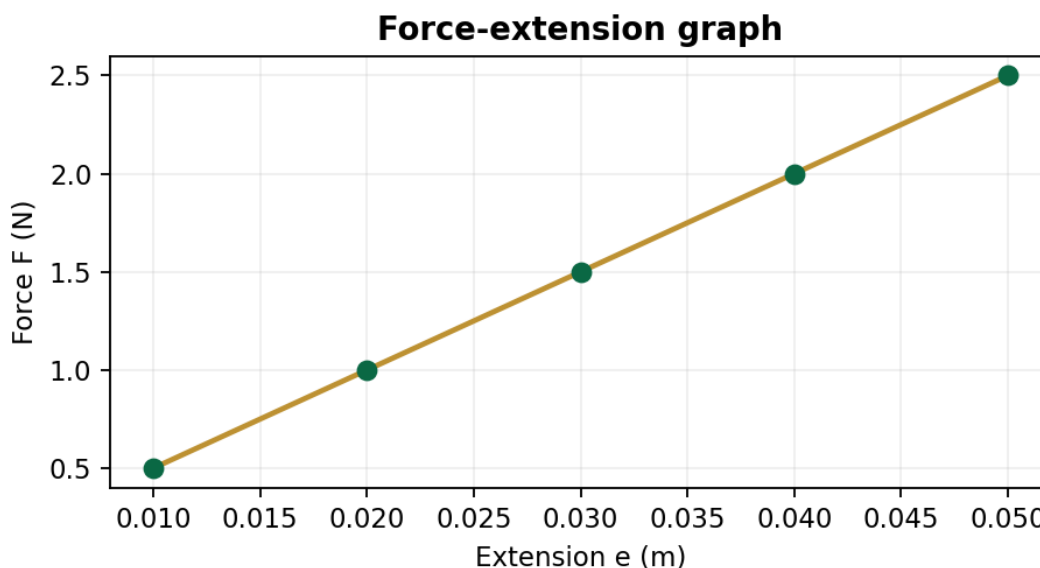
$$k = \text{slope of } F \text{ against } e \text{ (N/m)}$$

Suggested apparatus

Helical spring, retort stand, mass hangers and slotted masses, ruler.

Supervised practical and analysis sequence

1. Set a stable ruler next to the suspended unloaded spring.
2. Record original length L_0 .
3. Add mass steps gently and record length at each load.
4. Compute extension $e = L - L_0$ and force $F = mg$.
5. Plot F vertically against e and calculate the gradient.
6. Check that the spring returns to original length when unloaded.



NOUN Update illustration with synthetic values (not actual experiment readings).

WORKED EXAMPLE If the fitted F - e graph rises from 0.50 N at $e = 0.010 \text{ m}$ to 2.00 N at $e = 0.040 \text{ m}$, $k = (2.00 - 0.50)/(0.040 - 0.010) = 50 \text{ N/m}$.

Errors and precautions

- Do not overload beyond the elastic limit.
- Avoid parallax in ruler readings.
- Wait for motion to settle before recording length.

REVISION CHECKPOINT Plot F against e to obtain k directly; plotting e against F instead gives $1/k$.

UNIT 7 | Experiment 4: Effective Mass of a Vibrating Spring

REFERENCE ROUTE: Legacy PHY191 Experiment 4

LEARNING OUTCOME Use oscillation periods to estimate spring constant and effective spring mass.

Concept and explanation

An attached mass on a vertical spring oscillates with period $T = 2\pi\sqrt{(M + m_{\text{eff}})/k}$, where M is the added mass and m_{eff} represents the part of the spring mass participating in vibration. For a uniform ideal spring, m_{eff} is approximately one-third of its own mass, but real conditions may differ.

Squaring yields $T^2 = (4\pi^2/k)M + (4\pi^2/k)m_{\text{eff}}$. A plot of T^2 against M has slope $4\pi^2/k$ and vertical intercept equal to slope times m_{eff} . The horizontal intercept is $-m_{\text{eff}}$. The sign is a useful check.

Essential formula(s)

$$T^2 = (4\pi^2/k)(M + m_{\text{eff}})$$

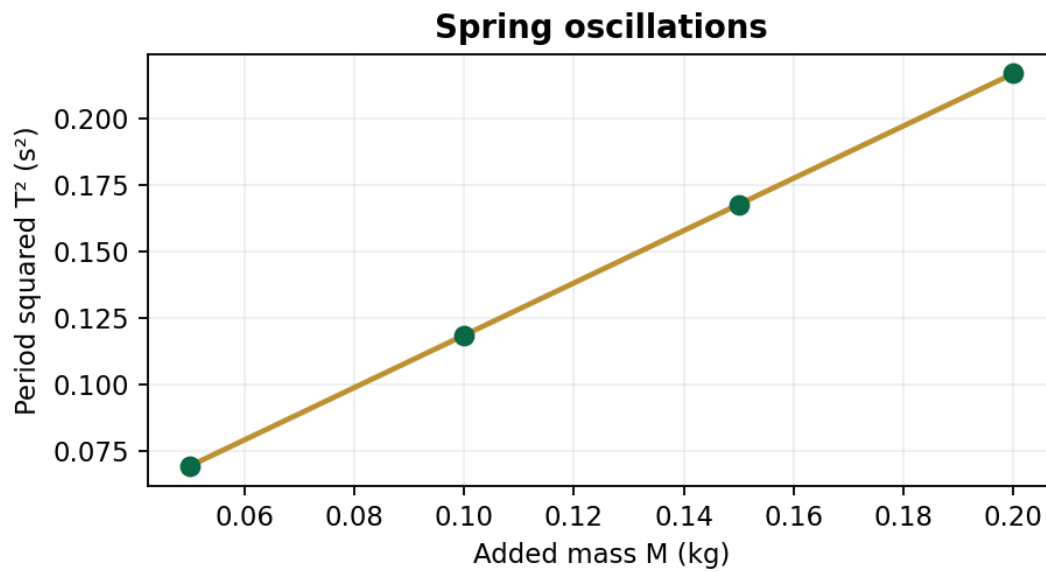
$$k = 4\pi^2/\text{slope}; \quad m_{\text{eff}} = \text{intercept/slope}$$

Suggested apparatus

Spring, multiple known masses, retort stand and stopwatch.

Supervised practical and analysis sequence

1. Secure the spring vertically and attach a safe mass.
2. Displace slightly and time several complete oscillations.
3. Repeat timings, then compute T and T^2 .
4. Repeat at different added masses M .
5. Plot T^2 against M to obtain slope and intercept.
6. Calculate $k = 4\pi^2/\text{slope}$ and $m_{\text{eff}} = \text{intercept/slope}$.



NOUN Update illustration with synthetic values (not actual experiment readings).

WORKED EXAMPLE A T^2 - M graph has slope $1.00 \text{ s}^2/\text{kg}$ and intercept 0.020 s^2 . Then $k \approx 39.5 \text{ N/m}$ and $m_{\text{eff}} = 0.020 \text{ kg} = 20 \text{ g}$.

Errors and precautions

- Use small amplitudes and avoid sideways swinging.
- Secure the spring and avoid falling masses.
- Record added mass in kilograms.

REVISION CHECKPOINT Horizontal intercept is $-m_{\text{eff}}$, not $+m_{\text{eff}}$.

MODULE 3 | Fluids and Calorimetry

Editorial study grouping based on the historical PHY191 practical outline. The current PHY107 eLearn unit order is not publicly verifiable.

UNIT 8 | Experiment 5: Surface Tension by Capillary Rise

REFERENCE ROUTE: Legacy PHY191 Experiment 5

LEARNING OUTCOME Estimate the surface tension of water from its rise in a narrow capillary tube.

Concept and explanation

Water can rise in a narrow clean glass tube because the upward component of surface-tension force balances the weight of the elevated water column. In an ideal capillary, the relation is $h = 2\gamma\cos\theta/(\rho gr)$, where γ is surface tension, θ the contact angle, ρ liquid density and r tube radius.

For clean water on glass the contact angle may be approximated as zero, making $\cos\theta$ approximately one. This simplifies $\gamma \approx h\rho gr/2$. A narrow tube produces a greater capillary rise. Temperature, cleanliness and meniscus measurements affect results.

Essential formula(s)

$$h = 2\gamma\cos\theta/(\rho gr)$$

$$\gamma = h\rho gr/(2\cos\theta)$$

Suggested apparatus

Capillary tubes, distilled water, beaker, ruler or travelling microscope and support.

Supervised practical and analysis sequence

1. Set up clean narrow tubes vertically in distilled water.
2. Allow the level to settle and locate the meniscus correctly.
3. Measure rise h above free liquid surface.
4. Determine the tube internal radius r using approved measurement equipment.
5. Record water temperature and use appropriate density.
6. Calculate γ , noting the contact-angle approximation.

WORKED EXAMPLE If $h = 0.029$ m, $r = 0.00050$ m, $\rho = 1000$ kg/m³, $g = 9.81$ m/s² and $\theta \approx 0^\circ$, $\gamma = (0.029 \times 1000 \times 9.81 \times 0.00050)/2 = 0.0711$ N/m.

Errors and precautions

- Glass capillaries can break; use supervised handling.
- Keep the tube vertical and glass clean.
- Read the meniscus without parallax.

REVISION CHECKPOINT Capillary rise h is inversely related to tube radius r under otherwise equal

conditions.

UNIT 9 | Experiment 6: Latent Heat of Fusion of Ice

REFERENCE ROUTE: Legacy PHY191 Experiment 6

LEARNING OUTCOME Determine specific latent heat of fusion using calorimetry and energy conservation.

Concept and explanation

During melting at its melting point, ice absorbs energy without a temperature rise. Specific latent heat of fusion L_f is the energy per unit mass needed to change ice into water at the same temperature. In a simple calorimeter the energy lost by warm water and calorimeter equals the energy to melt ice plus warm the resulting meltwater to final equilibrium temperature.

For ice initially at 0°C and ignoring calorimeter heat capacity, $m_w c (\theta_i - \theta_f) = m_i L_f + m_i c \theta_f$. For greater accuracy add the calorimeter's water equivalent or heat capacity term to the left. Ice should be wiped dry, and heat exchange with the surroundings should be minimised.

Essential formula(s)

$$m_w c (\theta_i - \theta_f) = m_i L_f + m_i c \theta_f \text{ (neglecting calorimeter heat)}$$

$$L_f = [m_w c (\theta_i - \theta_f) - m_i c \theta_f] / m_i$$

Suggested apparatus

Lagged calorimeter, balance, thermometer, warm water and dried ice at approximately 0°C .

Supervised practical and analysis sequence

1. Weigh empty calorimeter and the calorimeter with warm water.
2. Record mass of water and initial water temperature.
3. Add small dry ice pieces under supervision and stir gently.
4. Record the final stable temperature after all ice melts.
5. Determine melted ice mass from the difference in total masses.
6. Apply energy balance with or without calorimeter correction, as instructed.

WORKED EXAMPLE For $m_w = 0.250\text{ kg}$, $\theta_i = 25^\circ\text{C}$, $\theta_f = 12^\circ\text{C}$, $m_i = 0.035\text{ kg}$ and $c = 4200\text{ J kg}^{-1}\text{ K}^{-1}$, $L_f = [0.25 \times 4200 \times 13 - 0.035 \times 4200 \times 12] / 0.035 = 339,600\text{ J/kg}$ (neglecting calorimeter heat).

Errors and precautions

- Dry the ice to exclude extra liquid water.
- Minimise environmental heat exchange and stir gently.
- Check that the final temperature is taken after complete melting.

REVISION CHECKPOINT Latent heat is associated with change of state, not a change in temperature.

MODULE 4 | Friction Experiments

Editorial study grouping based on the historical PHY191 practical outline. The current PHY107 eLearn unit order is not publicly verifiable.

UNIT 10 | Experiment 7: Limiting Static Friction

REFERENCE ROUTE: Legacy PHY191 Experiment 7

LEARNING OUTCOME Find the coefficient of limiting static friction between two contacting surfaces.

Concept and explanation

Static friction acts to oppose the onset of sliding, increasing up to a limiting value. At impending motion the limiting friction F_{lim} is approximately $\mu_s N$, where N is the normal reaction and μ_s the coefficient of static friction.

On a horizontal plane with negligible other vertical forces, $N = mg$. The coefficient is dimensionless. The relationship can be tested by recording the force needed to initiate motion as the normal load changes, then plotting limiting friction against normal reaction.

Essential formula(s)

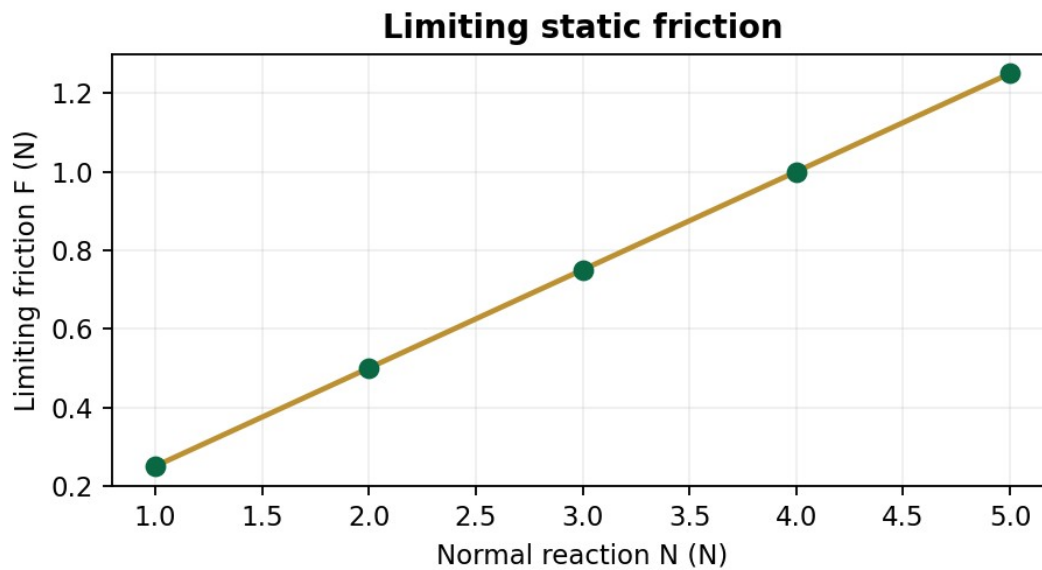
$$F_{\text{lim}} = \mu_s N; \mu_s = F_{\text{lim}}/N$$

Suggested apparatus

Wooden block, smooth board, string, pulley with masses or spring balance and added loads.

Supervised practical and analysis sequence

1. Position the block on a level surface.
2. Measure block mass and optional added mass.
3. Increase pulling force slowly until the block just begins to slide.
4. Record F_{lim} and corresponding normal force N .
5. Repeat for different normal loads and surfaces.
6. Plot F_{lim} against N ; use the slope as μ_s .



NOUN Update illustration with synthetic values (not actual experiment readings).

WORKED EXAMPLE If the maximum friction before movement is 0.60 N for a normal reaction of 2.40 N, then $\mu_s = 0.60/2.40 = 0.25$.

Errors and precautions

- Pull steadily without jerking.
- Keep board horizontal and surfaces clean.
- Distinguish the onset of motion from friction during sliding.

REVISION CHECKPOINT Limiting static friction is measured just as the block begins to move.

UNIT 11 | Experiment 8: Static Friction on an Inclined Plane

REFERENCE ROUTE: Legacy PHY191 Experiment 8

LEARNING OUTCOME Estimate the static friction coefficient from the critical angle at which sliding begins.

Concept and explanation

On an inclined plane at angle θ the weight component parallel to the surface is $mg \sin\theta$, while the normal reaction is $mg \cos\theta$. When the object is just about to slide, $mg \sin\theta = \mu_s mg \cos\theta$, giving $\mu_s = \tan\theta$.

The coefficient depends on the contact surfaces, and in the ideal treatment does not depend on block mass. Take repeated critical-angle measurements and make sure the plane is raised gradually.

Essential formula(s)

$$N = mg \cos\theta; F_{\text{parallel}} = mg \sin\theta$$

$$\mu_s = \tan\theta_{\text{critical}}$$

Suggested apparatus

Tiltable board, wooden block, protractor or angle gauge and support.

Supervised practical and analysis sequence

1. Place a clean block on the inclined surface.
2. Raise the plane gradually until the block is just about to slide.
3. Record the critical angle θ .
4. Lower and repeat at several attempts or block orientations.
5. Calculate mean critical angle and $\mu_s = \tan\theta$.
6. Compare with the horizontal pulling method when available.

WORKED EXAMPLE If a block just begins to slide at $\theta = 18^\circ$, then $\mu_s = \tan(18^\circ) \approx 0.325$.

Errors and precautions

- Avoid sudden movement of the board.
- Keep fingers out of the block's path.
- Read angle at initial movement, not after acceleration downhill.

REVISION CHECKPOINT The tangent relation is valid at the threshold of sliding under the ideal assumptions.

MODULE 5 | Relative Density

Editorial study grouping based on the historical PHY191 practical outline. The current PHY107 eLearn unit order is not publicly verifiable.

UNIT 12 | Experiment 9: Relative Density of a Liquid

REFERENCE ROUTE: Legacy PHY191 Experiment 9

LEARNING OUTCOME Use a specific gravity bottle to find the relative density of kerosene or another suitable liquid.

Concept and explanation

Relative density compares liquid density with water density at specified conditions. For the same bottle volume, the density ratio equals the ratio of the mass of test liquid to the mass of water that fills the bottle.

Weigh the clean dry empty bottle as m_0 ; filled with water as m_w ; filled with liquid as m_l . The mass of water is $m_w - m_0$ and mass of liquid is $m_l - m_0$. Relative density is $(m_l - m_0)/(m_w - m_0)$. All measurements must use comparable fill conditions and temperature.

Essential formula(s)

$$RD_{\text{liquid}} = (m_l - m_0)/(m_w - m_0)$$

$$\rho_{\text{liquid}} = RD_{\text{liquid}} \times \rho_{\text{water}}$$

Suggested apparatus

Specific gravity bottle with stopper, balance, distilled water, test liquid and cloth for drying.

Supervised practical and analysis sequence

1. Clean and dry the bottle; record m_0 .
2. Fill with distilled water, position stopper and remove surface drops; record m_w .
3. Empty, dry and refill with the approved test liquid; record m_l .
4. Calculate the two liquid masses after subtracting bottle mass.
5. Compute RD from their ratio and record temperature.
6. If density is needed, multiply RD by water density at the reference temperature.

WORKED EXAMPLE Empty bottle = 24 g; bottle + water = 74 g; bottle + kerosene = 64 g. Water mass = 50 g, kerosene mass = 40 g, so $RD = 40/50 = 0.80$.

Errors and precautions

- Dry the exterior before each weighing.
- Avoid trapped air bubbles and temperature mismatch.
- Handle flammable liquids only as approved; no ignition sources.

REVISION CHECKPOINT Relative density has no unit, since it is a ratio of densities.

UNIT 13 | Experiment 10: Relative Density of Insoluble Granules

REFERENCE ROUTE: Legacy PHY191 Experiment 10

LEARNING OUTCOME Determine the relative density of sand or another insoluble granular solid by displacement in a specific gravity bottle.

Concept and explanation

An insoluble solid displaces water from a completely filled density bottle. The mass of displaced water corresponds to the volume of the solid. Comparing the dry solid's mass with that water mass gives relative density.

Use m_0 for empty bottle, m_s for bottle plus dry solid, m_w for bottle plus water and m_{sw} for bottle plus solid plus enough water to the fill mark. Solid mass is $m_s - m_0$. The displaced-water mass equals $m_s + m_w - m_0 - m_{sw}$. Air trapped among granules artificially reduces the liquid mass and distorts the result.

Essential formula(s)

Mass of solid = $m_s - m_0$

Mass of displaced water = $m_s + m_w - m_0 - m_{sw}$

$RD_{\text{solid}} = (m_s - m_0) / (m_s + m_w - m_0 - m_{sw})$

Suggested apparatus

Specific gravity bottle, balance, dry clean sand, distilled water and suitable funnel.

Supervised practical and analysis sequence

1. Weigh dry empty bottle, m_0 .
2. Add clean dry insoluble granular sample and weigh, m_s .
3. Determine bottle-plus-water mass, m_w , at the same volume mark.
4. Fill the bottle containing the solid with water; remove air bubbles and weigh, m_{sw} .
5. Compute displaced-water mass and relative density.
6. Repeat as instructed, noting sample identity and temperature.

WORKED EXAMPLE $m_0 = 25$ g, $m_s = 45$ g, $m_w = 75$ g, $m_{sw} = 87$ g. Solid mass = 20 g; displaced water mass = $45 + 75 - 25 - 87 = 8$ g; $RD = 20/8 = 2.50$.

Errors and precautions

- Do not use soluble or reactive samples.

- Remove bubbles trapped between granules.
- Keep fills, stopper position and bottle temperature consistent.

REVISION CHECKPOINT Insoluble-solid RD compares the mass of solid with equal-volume displaced water.

CORE FORMULA SHEET

Topic	Formula / interpretation
Graphs and Relationships in Physics	$y = mx + c$; $m = (y_2 - y_1)/(x_2 - x_1)$ For $y = ax^2$, $a = \text{slope of } y \text{ against } x^2$
Measurement and Significant Figures	Mean $\bar{x} = (x_1 + x_2 + \dots + x_n)/n$ Density $\rho = m/V$; speed $v = s/t$
Error and Uncertainty Analysis	Percentage uncertainty $= (\Delta x/x) \times 100\%$ If $z = ab/c$, conservative estimate: $\Delta z/z \approx \Delta a/a + \Delta b/b + \Delta c/c$
Experiment 1: Gravitational Acceleration by Simple Pendulum	$T = 2\pi\sqrt{L/g}$ $T^2 = (4\pi^2/g)L$; $g = 4\pi^2/m$ where m is slope of T^2 versus L
Experiment 2: Pendulum Plot and Height of a Room	If $L = H - h$: $T^2 = (4\pi^2/g)(H - h)$ Slope $= -4\pi^2/g$; x-intercept $= H$
Experiment 3: Force Constant of a Spring	$F = ke$; $e = L - L_0$ $k = \text{slope of } F \text{ against } e \text{ (N/m)}$
Experiment 4: Effective Mass of a Vibrating Spring	$T^2 = (4\pi^2/k)(M + m_{\text{eff}})$ $k = 4\pi^2/\text{slope}$; $m_{\text{eff}} = \text{intercept/slope}$
Experiment 5: Surface Tension by Capillary Rise	$h = 2\gamma \cos\theta/(\rho g r)$ $\gamma = h\rho g r/(2\cos\theta)$
Experiment 6: Latent Heat of Fusion of Ice	$m_w c(\theta_i - \theta_f) = m_i L_f + m_i c \theta_f$ (neglecting calorimeter heat) $L_f = [m_w c(\theta_i - \theta_f) - m_i c \theta_f]/m_i$
Experiment 7: Limiting Static Friction	$F_{\text{lim}} = \mu_s N$; $\mu_s = F_{\text{lim}}/N$
Experiment 8: Static Friction on an Inclined Plane	$N = mg \cos\theta$; $F_{\text{parallel}} = mg \sin\theta$ $\mu_s = \tan\theta_{\text{critical}}$
Experiment 9: Relative Density of a Liquid	$RD_{\text{liquid}} = (m_l - m_0)/(m_w - m_0)$ $\rho_{\text{liquid}} = RD_{\text{liquid}} \times \rho_{\text{water}}$
Experiment 10: Relative Density of Insoluble Granules	Mass of solid $= m_s - m_0$ Mass of displaced water $= m_s + m_w - m_0 - m_{sw}$ $RD_{\text{solid}} = (m_s - m_0)/(m_s + m_w - m_0 - m_{sw})$

SI reminder: length m; time s; mass kg; force N; density kg/m³; acceleration m/s²; surface tension N/m; specific latent heat J/kg. Graph gradients carry y-unit divided by x-unit.

LABORATORY REPORT TEMPLATE

The supplied PHY191 extract expects the date, aim, table of observations, graph, gradient/constant, error estimation where possible and conclusion. The following is an expanded NOUN Update fill-in template. It is not a substitute for the reporting format prescribed by your current tutor.

DATE AND TITLE

Date, course, experiment title and report number.

AIM

State the physical constant or relation to be determined.

READINGS

Include raw measured quantities, SI units and repeated measurements.

GRAPH

Axes, labels, best-fit curve/line, slope and intercept.

CALCULATIONS

Write symbolic formula, substitute readings with units and find answer.

ERRORS

Record uncertainty in input and derived result; list relevant precautions.

RESULT AND CONCLUSION

State numerical result with units, whether trend agrees with theory, and limitations.

TEN EXPERIMENTS AT A GLANCE

Experiment	Determination / graph
1	Gravitational Acceleration by Simple Pendulum $T^2 = (4\pi^2/g)L$; $g = 4\pi^2/m$ where m is slope of T^2 versus L
2	Pendulum Plot and Height of a Room Slope = $-4\pi^2/g$; x-

	intercept = H
3	Force Constant of a Spring $k = \text{slope of } F \text{ against } e \text{ (N/m)}$
4	Effective Mass of a Vibrating Spring $k = 4\pi^2/\text{slope}$; $m_{\text{eff}} = \text{intercept/slope}$
5	Surface Tension by Capillary Rise $\gamma = h\rho g r/(2\cos\theta)$
6	Latent Heat of Fusion of Ice $L_f = [m_w c(\theta_i - \theta_f) - m_i c \theta_f]/m_i$
7	Limiting Static Friction $F_{\text{lim}} = \mu_s N$; $\mu_s = F_{\text{lim}}/N$
8	Static Friction on an Inclined Plane $\mu_s = \tan\theta_{\text{critical}}$
9	Relative Density of a Liquid $\rho_{\text{liquid}} = \text{RD}_{\text{liquid}} \times \rho_{\text{water}}$
10	Relative Density of Insoluble Granules $\text{RD}_{\text{solid}} = (m_s - m_0)/(m_s + m_w - m_0 - m_{sw})$

Study questions for every practical: Which quantity is directly measured? Which is calculated? What graph is plotted? What constant does the slope or intercept represent? What are the units? Which systematic and random uncertainties affect the answer?

SKILL CHECKS

Unit 1 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 2 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 3 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 4 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 5 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 6 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 7 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 8 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 9 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 10 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 11 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 12 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

Unit 13 review

Explain the aim; show the defining formula; justify the axis choice and describe two plausible precautions in this practical.

SOURCE & SCOPE NOTICE

This is an independently written NOUN Update study aid for General Physics Practical I. It is not the official PHY107 2026_2 course material, and it has not been checked against the private lessons inside the current eLearn course.

User-supplied source: four-page DOCX extract headed “PHY 191 — General Physics Practical I”, covering preparatory precautions, lab-report order, independent/dependent variables, and linear graphs. Those subjects directly inform Units 1–3 here.

Public primary reference: National Open University of Nigeria, PHY191: General Physics Practical I (91-page historical courseware, 2000s-era publication). Link:

<https://nou.edu.ng/coursewarecontent/PHY191.pdf> . Its outline includes graphs, measurement, error analysis and ten named experiments; the expanded worked examples, study explanations and assessments in these NOUN Update documents are newly written.

Course identification: NOUN eLearn lists “General Physics Practical I (NOUN-PHY107_262)” at <https://elearn.nou.edu.ng/course/view.php?id=17217> , but its content redirects unauthenticated access to the login page. The live PHY107 syllabus, prescribed experiments, assessment and schedules must be verified by an authorised student or tutor before publishing this as a complete course-equivalent resource.

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SAFETY NOTE Perform experiments only in a supervised laboratory. Do not operate elevated pendulums, glass capillaries, heated equipment or flammable liquids without an approved protocol, appropriate PPE and access to trained staff.