General Physics I

Lab Manual – Undergraduate Physics (Core) Programme

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VIMALA PUBLICATIONS

General Physics I

(Lab Manual for Undergraduate Physics – Core Programme)

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To our beloved students….

PREFACE

Post Graduate and Research Department of Physics, Vimala College is proud to come up with a lab manual for General Physics I, a practical paper for the Undergraduate Physics students of the core programme. This compilation aims to present the theory and procedures of the undergraduate experiments prescribed in the 2019 syllabus revision in a simplified manner. The manual is structured in a way to incorporate relevant theory, procedure, diagrams and graphical representations of each experiment. A brief idea on how to perform the calculations from the recorded observations is provided as and when required. Necessary tips, viva questions and model questions pertaining to each experiment have been included. The standard operating procedures (SOP) to be adopted while in laboratory, other relevant physical data and pictures of components are also incorporated as appendix to give the students further insight on lab experiments explained in the book.

We wish that the book unveils the joy of experimentation to the physics students at the under graduate level.

Department of Physics

Vimala College

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Department of Physics

Vimala College

Semester 1 to 4 - Core Course V

PHY6B16: PRACTICAL I

72 hours in each semester (Credit - 5)

	Course Outcome	CL	KC	Class Sessions allotted
CO1	Apply and illustrate the concepts of properties of matter through experiments	Ap	P	36
CO2	Apply and illustrate the concepts of electricity and magnetism through experiments	Ap	P	36
CO3	Apply and illustrate the concepts of optics through experiments	Ap	P	36
CO4	Apply and illustrate the principles of electronics through experiments	Ap	P	36

1. Young's modulus - Non uniform bending - using pin and microscope - (load-extension graph)
2. Young's modulus - Uniform bending - using optic lever
3. Moment of inertia - Flywheel (Calculate percentage error and standard deviation)
4. Moment of Inertia - Torsion Pendulum
5. Rigidity modulus - Static torsion
6. Compound pendulum - Acceleration due to gravity, Radius of gyration
7. Katers pendulum - Acceleration due to gravity
8. Liquid lens - Refractive index of liquid and glass - determine R using a) water& b) Buoy's method
9. Spectrometer - Solid prism - Refractive index of the material of the prism, measuring angle of minimum deviation
10. Spectrometer - Solid prism - Dispersive power
11. Searle's vibration magnetometer – a. Ratio of moments b. Searle's and box type vibration magnetometers - m & B_h.
12. Melde's string arrangement - Frequency, relative density of liquid and solid (both modes)
13. Mirror Galvanometer - Figure of merit
14. Potentiometer - Calibration of ammeter

15. Ballistic Galvanometer - BG constant using HMS - then find B_h.
16. Ballistic galvanometer - Comparison of capacitance – Desauty’s method
17. Spectrometer - i-d curve
18. Verification of Thevenin’s theorem and Maximum Power Transfer theorem
19. Lissajous figures – Measurement of frequency and phase shift of sinusoidal signals using CRO
20. Cantilever – Scale and telescope /pin and microscope
21. Single slit diffraction using LASER
22. Determination of dielectric constant of liquid/thin sheet
23. Thermo emf measurement using digital multimeters - study of Seebeck effect
24. Thermal conductivity of a good conductor by Searle’s method.

Books of Study:

1. Electronics lab manual - K A Navas (vol 1 & 2)
2. B.Sc Practical Physics - C L Arora
3. Practical Physics - S L Gupta & V Kumar

Reference Books:

1. Advanced Practical Physics for students – B L Worksnop and H T Flint

CONTENTS

Standard Operating Procedures (SOP) of the lab

General instructions regarding Practical Record

1. Attendance is must for all experiments. Students who miss 25% (or, as per the syllabus followed) experiments shall not be permitted to write the exam.
2. Make up labs are not promoted except under unforeseen circumstances.
3. No eating or drinking is allowed during class in laboratory.
4. The grading guidelines shall be strictly followed as per the syllabus followed for each batch.
5. Each student must submit an individual report for every lab paper.
6. Cover page must include title of every experiment, page number and date.
7. Aim, apparatus, theory and principle, relevant diagrams and procedure must be recorded along with the observations, graphs (optional) and result for every experiment.
8. The students must submit attested lab records for the exam.

SOP for the Safety measures to be followed in the lab

1. Be always alert and attentive in the lab. Follow all written and verbal instructions. Never hesitate to ask your doubts.
2. Do not waste electricity, consumables and water.
3. Do not work alone in the lab without prior permission from the teacher in charge / HoD.
4. Report all accidents, injuries or breakage to the teacher in charge/ lab attendant immediately. Also, report any equipment that you suspect is malfunctioning.
5. Avoid wearing overly-bulky or loose-fitting clothing, or dangling jewelry that may become entangled in your experimental apparatus. Pin or tie black long hair.
6. Use goggles:
   a. when heating anything.
   b. when using any type of projectile or laser experiments
   c. when instructed to do so.
7. Do not perform unauthorized experiments. Get the permission of teacher in charge before you try something original.

8. Be careful when working with apparatus that may be hot. If you must pick it up, use tongs, a wet paper towel, or other appropriate holder.
9. If a thermometer breaks, inform the teacher/lab attendant immediately. Do not touch either the broken glass or the mercury with your bare skin.
10. Ask the teacher to check all electrical circuits before you turn on the power.
11. When working with electrical circuits, be sure that the current is turned off before making adjustments in the circuit.
12. Do not connect the terminals of a battery or power supply to each other with a wire. Such a wire will become dangerously hot.
13. Return all equipment, clean and in good condition, to the designated location at the end of the lab to the concerned staff. Leave your lab area cleaner than you found it.
14. Know locations of laboratory eye wash stations, fire extinguishers and emergency exit routes.
15. Avoid skin and eye contact with all chemicals. Minimize all chemical exposures. Never leave containers of chemicals open.
16. Be vigilant of warning signs when unusual hazards, hazardous materials, hazardous equipment, or other special conditions are present.
17. Do not taste or intentionally sniff chemicals. Never consume and/or store food or beverages or apply cosmetics in areas where hazardous chemicals are used or stored.
18. Wash exposed areas of the skin prior to leaving the laboratory.
19. No cell phone or ear phone usage in the active portion of the laboratories, or during experimental operations.

Appendix

Cathode Ray Oscilloscope (CRO)

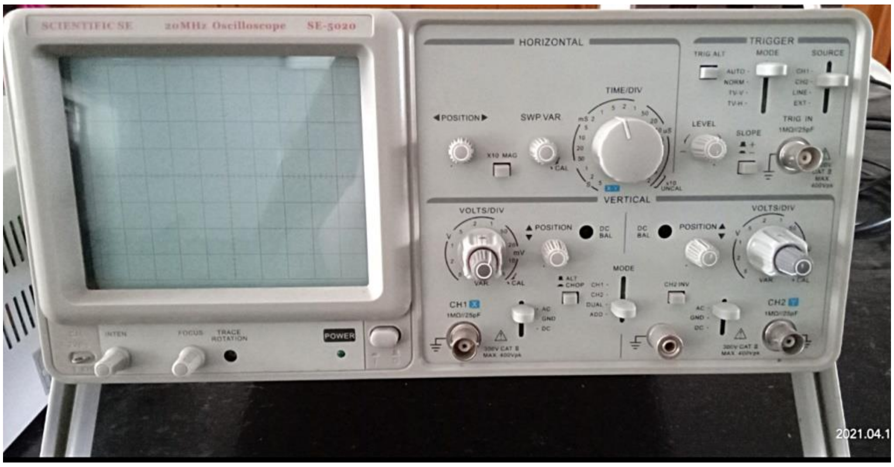


Figure A. Cathode Ray Oscilloscope (CRO)

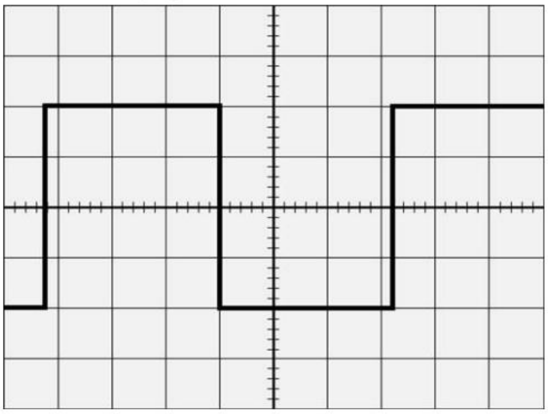
How to Calibrate an Oscilloscope?

The exact steps you need to follow to set up your oscilloscope vary depending on the exact type and model of your scope, so be sure to read the instruction manual that came with your scope. But the general steps should be as follows:

1. Examine all the controls on your scope and set them to normal positions. For most scopes, all rotating dials should be centered, all pushbuttons should be out, and all slide switches and paddle switches should be up.
2. Turn your oscilloscope on. If it's the old-fashioned CRT kind, give it a minute or two to warm up.
3. Set the VOLTS/DIV control to 1. This sets the scope to display one volt per vertical division. Depending on the signal you are displaying, you may need to increase or decrease this setting, but one volt is a good starting point.
4. Set the TIME/DIV control to 1 ms. This control determines the time interval represented by each horizontal division on the display. Try turning this dial to its slowest setting. Then, turn the dial one notch at a time and watch the dot speed up until it becomes a solid line.
5. Set the Trigger switch to Auto. The Auto position enables the oscilloscope to stabilize the trace on a common trigger point in the waveform. If the trigger mode isn't set to Auto, the waveform may drift across the screen, making it difficult to watch.
6. Connect a probe to the input connector. If your scope has more than one input connector, connect the probe to the one labeled A. Oscilloscope probes include a probe point, which you connect to the input signal and a separate ground lead. The ground lead usually has an

alligator clip. When testing a circuit, this clip can be connected to any common ground point within the circuit. In some probes, the ground lead is detachable, so you can remove it when it isn't needed.

7. Touch the end of the probe to the scope's calibration terminal. This terminal provides a sample square wave that you can use to calibrate the scope's display. Some scopes have two calibration terminals, labeled 0.2 V and 2 V. If your scope has two terminals, touch the probe to the 2 V terminal. For calibrating, it's best to use an alligator clip test probe. If your test probe has a pointy tip instead of an alligator clip, you can usually push the tip through the little hole in the end of the calibration terminal to hold the probe in place. It isn't necessary to connect the ground lead of your test probe for calibration.
8. If necessary, adjust the TIME/DIV and VOLTS/DIV controls until the square wave fits nicely within the display.



9. If necessary, adjust the Y-POS control to center the trace vertically.
10. If necessary, adjust the X-POS control to center the trace horizontally.
11. If necessary, adjust the Intensity and Focus settings to get a clear trace.

PHYSICAL CONSTANTS

Table 1.1 Physical Constants of Solids

Substance	Density ($\times 10^3$ Kgm^{-3})	Specific heat capacity ($JKg^{-1}K^{-1}$)	Thermal Conductivity ($Wm^{-1}K^{-1}$)	Young's Modulus ($\times 10^{10}$ Nm^{-2})	Rigidity Modulus ($\times 10^{10}$ Nm^{-2})
Aluminium	2.71	913	201	7.1	2.4 – 2.7
Brass	8.5	370	110	10	3.5
Constantan	8.8	420	23	17	
Copper	8.93	385	385	11.7	3.6
Iron cast	7.15	500	75	11	5.3
Iron wrought	7.85	480	60	19.7	7.7 – 8.3
Lead	11.34	126	35	1.8	
Steel	7.86	420	63	21	7
Cork	0.24	2050	0.05		
Glass crown	2.6	670	1	7.1	
Ice	0.92	2100	2		
Paraffin wax	0.9	2900	0.25		
Ebonite	1.8	1674	0.17		
Rubber	0.91	1600	0.15 – 0.19	0.002	
Wood	0.65		0.15	0.12 – 0.18	
Cardboard	0.91		0.21		

Table 1.2 Physical Constants of Liquids

Substance	Density ($\times 10^3$ Kgm^{-3})	Specific heat capacity ($JKg^{-1}K^{-1}$)	Surface Tension ($\times 10^{-3}$ Nm^{-1})	Coefficient of viscosity ($\times 10^{-3}$ Nsm^{-2})
Carbon tetrachloride	1.632	840	26.8	0.972
Coconut oil	0.91	2050		
Castor oil	0.97		33	9.86
Glycerol	1.262	2400	63	1.495
Kerosene	0.8	2093	30	2
Methyl alcohol	0.791	2500	22.6	0.594
Mercury	13.546	140	472	1.552
Water	0.998 – 1	4190	72.7	0.8 - 1
Sea water	1.025	3900		
Soap solution			20 - 40	

Table 1.3 Density of various substances

Substance	Density (x 10^3 Kgm^{-3})	Substance	Density (Kgm^{-3})
Common salt	2.2	Air	1.293
Copper sulphate	2.28	Carbon dioxide	1.977
Granite	2.7	Hydrogen	0.09
Sand	2.6	Helium	0.179
Brick	2.3	Nitrogen	1.251
Sugar	1.6	Oxygen	1.429
Cork	0.24	Water vapour	0.8

Table 1.4 Wavelengths of spectral lines

Mercury spectrum		Colour	Wavelength (nm)
Colour	Wavelength (nm)		
Violet I	404.65	Sodium D_1	589.59
Violet II	407.78	Sodium D_2	589
Blue	435.83	H_α red	656.3
Greenish blue	491.6	H_β blue green	486.1
Green	546.07	H_γ blue	434
Yellow I	576.96	H_δ	410.2
Yellow II	579.06	K red	766.5

Constants to Remember

1. Refractive index of water – 1.33
2. Refractive index of flint glass – 1.60 – 1.62
3. Refractive index of crown glass – 1.52
4. Velocity of light c = 3 x 10^8 m/s
5. Planck's constant h = 6.626 x 10^{-34} Js
6. Resistivity of Nichrome = 1.1 x 10^{-6} Ωm
7. $B_h = 3.8 \times 10^{-5}$ T
8. Acceleration due to gravity g = 9.8 m/s^2
9. Permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ H/m
10. Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m

Conversions to Remember

1. 1 Kg = 1000 g
2. 1 g = 1000 mg
3. 1 cm = 0.01 m
4. 1 mm = 0.001 m
5. 1 pF = 10^{-12} F
6. 1 µF = 10^{-6} F
7. 1 nm = 10^{-9} m
8. 1 µm = 10^{-6} m

MODEL QUESTIONS

1. Using load-extension curve, determine the Young's modulus of the material of the given bar subjecting it to non-uniform bending. (Pin and microscope are given.)
2. Determine the Young's modulus of the material of the given bar subjecting it to uniform bending by measuring the depression using optic lever.
3. Determine the moment of inertia of a Flywheel.
4. Determine the moment of inertia of a disc about an axis passing through its centre of gravity using torsion pendulum. Two equal masses are given.
5. Determine the rigidity modulus of the material of the given wire using torsion pendulum. Two equal masses are given.
6. Determine the rigidity modulus of the material of the given rod using static torsion apparatus (2 sets).
7. Using the compound pendulum, determine the acceleration due to gravity at the place and the radius of gyration of the pendulum about an axis passing through the centre of gravity.
8. Determine acceleration due to gravity using Katers pendulum.
9. Determine the refractive index of the given liquid by forming a liquid lens of Plano-concave in nature.
10. Determine the refractive index of the material of the lens. Convex lens and mercury are given.
11. Determine the material index of the material of the lens. Convex lens and water are given.
12. Determine the refractive index of the material of the prism using spectrometer.
13. Determine the dispersive power of the material of the prism for two sets of colour.
14. Compare the moments of the given two magnets using Searle's Vibration magnetometer.
15. Determine the dipole moment of a bar magnet and the horizontal component of the earth's magnetic field at the place using box type vibration magnetometer and Searle's Vibration magnetometer.
16. Determine the relative density of given solid and liquid by Melde's arrangement. (Use both modes of vibration).
17. Find out the mass and density of the given solid using Melde's string apparatus in two modes of vibration.
18. Find the figure of merit of the given moving coil galvanometer.
19. Determine the ballistic constant using Hibbert's magnetic standard.
20. Compare the capacitances of two given capacitors using Ballistic galvanometer.

General Physics I

21. Using an i-d curve, determine the refractive index of the material of a prism
22. Verify Thevenin's theorem and maximum power transfer theorem.
23. Using CRO, measure the frequency and phase shift of sinusoidal signals.
24. Using load-extension curve, determine the Young's modulus of the material of the given bar subjecting it to non-uniform bending. (Pin and microscope are given.)
25. Study the single single slit diffraction pattern using laser.
26. Measure the thermo emf using digital multimeter.

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Other books published by the authors

- **Electronics and Python** (Lab Manual for Undergraduate Physics – Core Programme)
- **General Physics II** (Lab Manual for Undergraduate Physics – Core Programme)
- **General Physics & Electronics** (Lab Manual for Undergraduate Physics – Complementary Programme)

General Physics I

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ABOUT DBT STAR COLLEGE SCHEME

The Star College scheme by the Department of Biotechnology of the Government of India. Facilitates improvement in the skills of teachers through FDPs, improved curriculum, and practical training to the students by providing specialised access to infrastructure and consumables. The support provided under the scheme strengthens physical infrastructure in laboratories, library, teaching aids and promotes networking with neighbouring institutes. Hands on training, product oriented projects and projects of day to day relevance. Enhance the interest in students to pursue science at undergraduate level.

ABOUT VIMALA COLLEGE

Vimala College (Autonomous), a first grade women's college under the CMC Management, was established in 1967 in Thrissur District, Kerala, India. The college offers 19 Undergraduate and 16 Postgraduate programmes, and is a Centre for Research in Physics, English, Commerce, Economics, Social Work and Malayalam. The institution was accredited at the national level with a Five Star status in 2001 by the NAAC, and has undergone two subsequent cycles of re-accreditation in 2008 and 2014 and presently holds the top grade A with a CGPA of 3.50 on a 4 point scale. The University Grants Commission (UGC) conferred autonomy in 2015 and identified her as a College with Potential for Excellence in 2016. The College was accorded with DBT-STAR College status in 2019. In the National Institution Ranking Framework (NIRF) 2020, the Ministry of Human Resource Development, Government of India ranked Vimala College among the top Colleges in India.

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