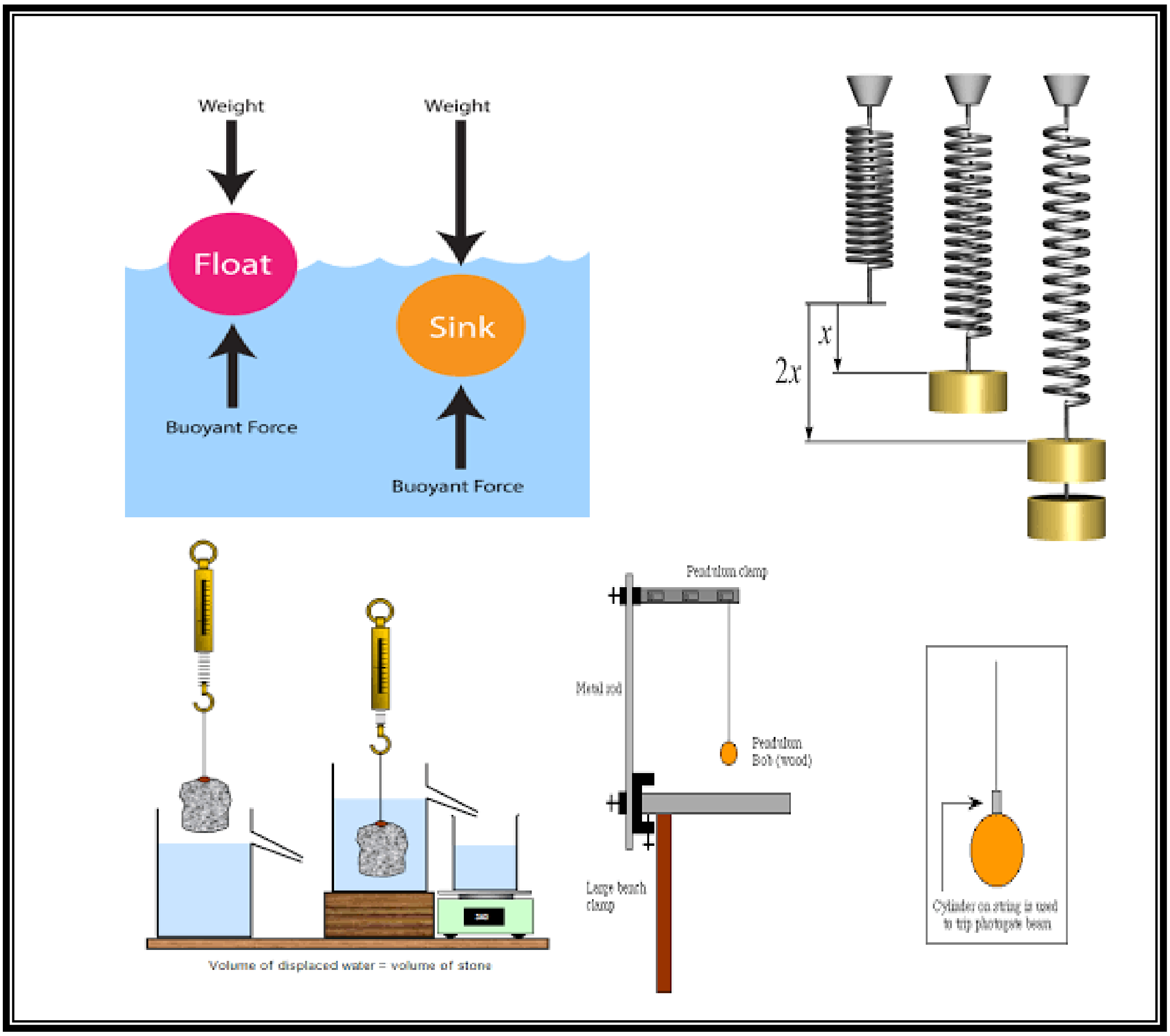
Course Code: [PHY 001] **Course Name: Practical Physics (1)**

Notebook in

Practical Physics (1)



Basic Science Department
2022

LIST OF EXPERIMENTS

1. SIMPLE PENDULUM
2. VISCOSITY
3. ARCHIMEDES' PRINCIPLE
4. LATENT HEAT
5. HOOKE'S LAW

Dear Learner,

We hope you enjoy studying practical physics in the Department of Basic Sciences at the Higher Technological Institute on the 10^{th} of Ramadan city. Like any other branch of science, in Physics too you search for scientific truth by verifying the facts. Hence, learning by doing has an important role in especially in Physics. The practical physics is designed to encourage development of such skills in order to make learning effective. Therefore, lots of activities have been incorporated even in the study material of Physics course. In this Physics Laboratory notebook, you will find a list of experiments in the end. Some of these experiments are indeed very simple and you will be able to perform them even on your own. But for others, you may require some guidance. In this Physics Laboratory notebook, we have tried to incorporate all the required guidelines to perform the experiments. Each experiment in this Note Book has detailed instructions about how to perform the experiment and has observation tables in which you can record your data. Before starting an experiment, read the instructions given in the laboratory notebook carefully and record the observations in the tables honestly. I am sure, at the end of each experiment, you may like to assess your understanding about that experiment. In case you have any doubts or problems while performing the experiments or otherwise, feel free to ask your Physics Teacher or write to us. We hope you will enjoy doing experiments.

Wishing you all the success.

(Basic Science Department, Physics)

تعليمات معامل الفيزياء

1 المعمل مكانك فحافظ عليه.

2 الالتزام بالحضور في المواعيد المحددة لكل مجموعة.

3 يمنع الحضور بدون مذكرة المعمل.

4 مراعاة النظام والهدوء أثناء الدخول إلى المعمل وأثناء الخروج منه.

5 الجلوس في الأماكن المحددة فقط وعدم الجلوس على المنضدة.

6 اغلاق الهاتف المحمول.

7 ممنوع تناول الطعام والشراب في المعمل.

8 عدم العبث بالأجهزة الكهربائية، كما يجب التحقق من صحة توصيل الدوائر الكهربية من قبل المعيد المسئول قبل تشغيلها حفاظاً على سلامتكم وسلامة الأجهزة.

9 ترتيب الأدوات والأجهزة، وإعادة كل شيء مكانه والحرص على أن يكون المكان نظيفاً ومرتباً بعد الانتهاء من التجربة.

10 المعمل ليس مكاناً للعب واللهو، ولا مكاناً للتسلية وتبادل الحديث والسمر، بل هو مكان لتحصيل العلم.

أسرة المعمل

Introduction to Physics Laboratory

The aim of the laboratory exercise is to give the student an insight into the significance of the physical ideas through actual manipulation of apparatus, and to bring him or her into contact with the methods and instruments of physical investigation. Each exercise is designed to teach or reinforce an important law of physics which, in most cases, has already been introduced in the lecture and textbook. Thus, the student is expected to be acquainted with the basic ideas and terminology of an experiment before coming to the laboratory. The exercises in general involve measurements, graphical representation of the data, and calculation of a final result. The student should bear in mind that equipment can malfunction and final results may differ from expected values by what may seem to be large amounts. This does not mean that the exercise is a failure. The success of an experiment lies rather in the degree to which a student has mastered the physical principles involved, understood the theory and operation of the instruments used and realized the significance of the final conclusions.

The student should know well in advance which exercise is to be done during a specific laboratory period. The laboratory instructions and the relevant section of the text should be read before coming to the laboratory. All of the apparatus at a laboratory place is entrusted to the care of the student working at that place, and he or she is responsible for it. At the beginning of each laboratory period it is the duty of the student to check over the apparatus and be sure that all of the items listed in the instructions are present and in good condition. Any deficiencies should be reported to the instructor immediately. The procedure in each of these exercises has been planned so that it is possible for the prepared student to perform the experiment in the scheduled laboratory period. Data sheets should be initialed by your instructor or TA. Each student is required to submit results and the discussion requested in the instructions.

Laboratory Manners

1 Eating and drinking are not permitted in the labs.

2 You are responsible for reading and understanding the section in the manual on the scheduled experiment before coming to the lab class.

3 Apparatus should not be taken from another position. If something is missing, notify the instructor, and either equipment will be replaced or appropriate adjustments will be made.

4 Students should be distributed as evenly as possible among the available positions.

5 At the end of the period the equipment should left neatly arranged for the next class. Nonfunctioning equipment should be reported before leaving. All papers and personal items have to be removed.

Laboratory Notebook

Each student will keep a lab notebook, which is a vital practice for any scientist. The purpose of the notebook is to record all aspects of the experiment. If you are unsure if something is important then write it down anyway. Be neat, concise, clear and legible when writing in your notebook.

Graphical Representation of Data

Graphs are an important technique for presenting scientific data. Graphs can be used to suggest physical relationships, compare relationships with data, and determine parameters such as the slope of a straight line. There is a specific sequence of steps to follow in preparing a graph.

1 Arrange the data to be plotted in a table.

2 Decide which quantity is to be plotted on the x-axis (the abscissa),

usually the independent variable, and which on the y-axis (the ordinate), usually the dependent variable.

3 Choose a scale for each axis, that is, how many units on each axis represent a convenient number of the units of the variable represented on that axis.

4 Scales should be chosen so that the data span almost all of the graph paper, and also make it easy to locate arbitrary quantities on the graph.

5 Label the major divisions on each axis.

6 Write a label in the margin next to each axis which indicates the quantity being represented and its units.

7 Plot each point. The recommended style is a dot surrounded by a small circle. A small cross or plus sign may also be used.

8 Draw a smooth curve that comes reasonably close to all of the points. Whenever possible we plot the data or simple functions of the data so that a straight line is expected.

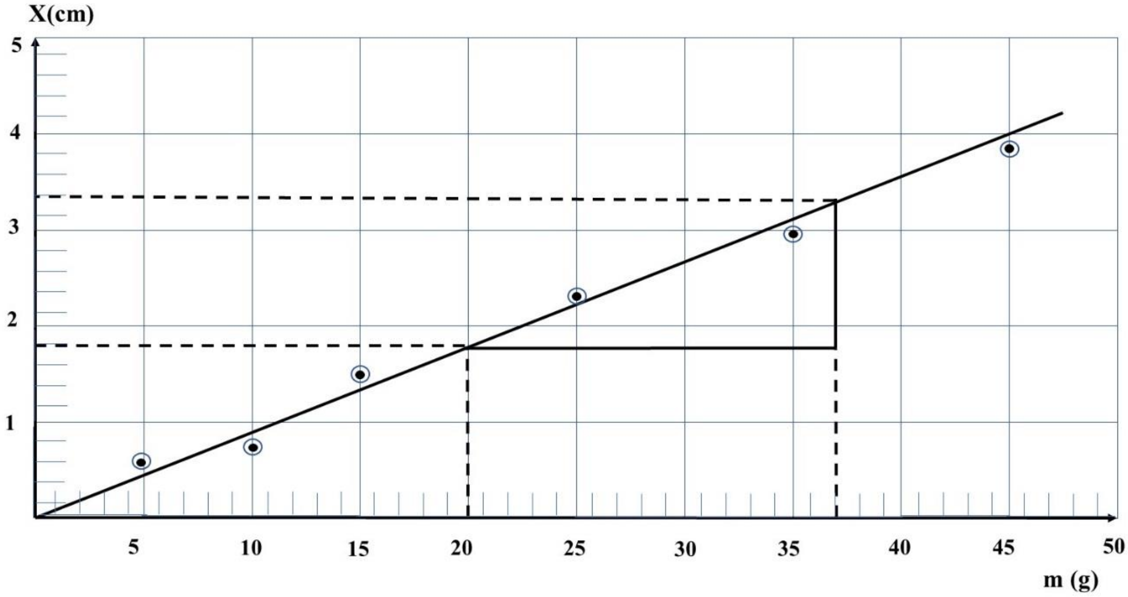
9 If the slope of the line is to be determined, choose two points on the line whose values are easily read and that span almost the full width of the graph. These points should not be original data points.

10 The uncertainty of the slope may be estimated as the larger uncertainty of the two end points, divided by the interval between them.

Example:

Use the following results to find the value of the force constant of a spring as it obeys Hooke's law (F=kX).

m (g)	5	10	15	25	35	45
X (cm)	0.6	0.8	1.6	2.4	3	3.9



$$\text{Slope} = \frac{\Delta X}{\Delta m} = \frac{3.4 - 1.8}{(37-20)x10^{-3}} = 0.0941$$

$$k = \frac{F}{X} = \frac{mg}{X} = g\,\frac{m}{X} = \frac{g}{\text{Slope}}$$

$$k = \frac{g}{\text{Slope}} = \frac{980}{0.0941} = 10414.5\ \frac{\text{dyne}}{\text{cm}} = 10.42\ \frac{N}{m}$$

SI Units

"SI" stands for "System International" and is the set of physical units agreed upon by international convention. The SI units are sometimes also known as MKS units, where MKS stands for "meter, kilogram, and second." In 1939, the CCE recommended the adoption of a system of units based on the meter, kilogram, second, and ampere. The name International System of Units (SI) was given to the system by the 11th CGPM in 1960. At the 14th CGPM in 1971, the current version of the SI was completed by adding the mole as base unit for amount of substance, bringing the total number of base units to seven. The seven fundamental units are summarized in the following table.

Physical quantity	**Symbol**	**Unit abbreviation**	**Unit name**
Length	l	m	Meter
Mass	m	kg	Kilogram
Time	t	s	Second
Current	I	A	Ampere
Temperature	T	K	Kelvin
Luminous Intensity	L_v	cd	Candela
Amount of Substance	n	mol	Mole

The derived SI units consist of combinations of the seven base units, and are summarized in the following table.

Quantity	Symbol	SI symbol	SI unit
Area	A	m^2	square meter
Volume	V	M^3	cubic meter
Plane Angle	θ	rad	radian
Solid Angle	Ω	sterrad	steradian
Frequency	f	Hz	Hertz
Velocity	v	ms^{-1}	meters per second
Acceleration	a	ms^{-2}	meters per second squared
Force	F	N	Newton
Pressure	P or p	Pa	Pascal
Power	P	W	Watt
Energy	E	J	Joule
Voltage	V	V	Volt
Resistance	R	Ω	Ohm
Conductance	G	S	Siemens
Charge	Q	C	Coulomb
Capacitance	C	F	Farad
Magnetic Flux	Φ	Wb	Weber
Magnetic Flux Density	B	T	Tesla
Inductance	L	H	Henry
Luminous Flux	F	lm	lumen
Illumination	E	lx	lux
Activity	A	Bq	Becquerel
Energy Dose		Gy	Gray
Equivalent Dose		Sv	Sievert

In 1960, the 11th CGPM adopted a first series of prefixes and symbols of prefixes to form the names and symbols of decimal multiples and submultiples of SI units. Over the years, the list has been extended as summarized in the following table.

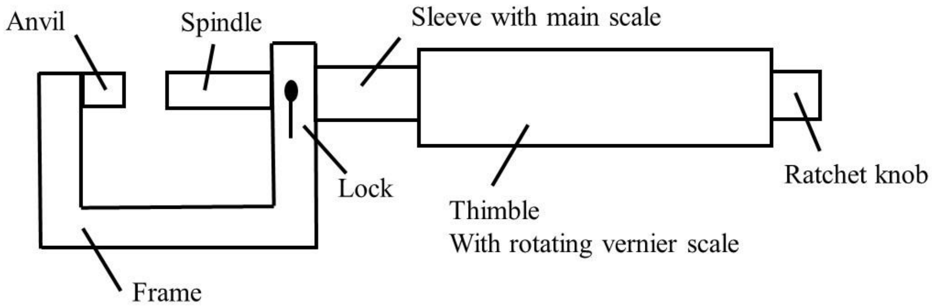
SI Prefixes and Symbols

Factor	Decimal Representation	Prefix	Symbol
10^{18}	1,000,000,000,000,000,000	exa	E
10^{15}	1,000,000,000,000,000	peta	P
10^{12}	1,000,000,000,000	tera	T
10^{9}	1,000,000,000	giga	G
10^{6}	1,000,000	mega	M
10^{3}	1,000	kilo	k
10^{2}	100	hecto	h
10^{1}	10	deka	da
10^{0}	1		
10^{-1}	0.1	deci	d
10^{-2}	0.01	centi	c
10^{-3}	0.001	milli	m
10^{-6}	0.000 001	micro	µ
10^{-9}	0.000 000 001	nano	n
10^{-12}	0.000 000 000 001	pico	p
10^{-15}	0.000 000 000 000 001	femto	f
10^{-18}	0.000 000 000 000 000 001	atto	a

Length Measurements

The precision of length measurements may be increased by using a device that uses a sliding Vernier scale. Two such instruments that are based on a Vernier scale which you will use in the laboratory to measure lengths of objects are the Vernier calipers and the micrometer screw gauge. These instruments have a main scale (in millimeters) and a sliding or rotating Vernier scale.

The Micrometer Screw Gauge

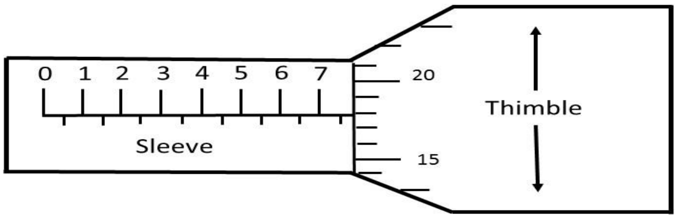


The micrometer screw gauge is used to measure even smaller dimensions than the Vernier calipers. The micrometer screw gauge also uses an auxiliary scale (measuring hundredths of a millimeters) which is marked on a rotary thimble. Basically, it is a screw with an accurately constant pitch (the amount by which the thimble moves forward or backward for one complete revolution). The micrometers in our laboratory have a pitch of 0.50 mm (two full turns are required to close the jaws by 1.00 mm). The rotating thimble is subdivided into 50 equal divisions. The thimble passes through a frame that carries a millimeter scale graduated to 0.5 mm. The jaws can be adjusted by rotating the thimble using the small ratchet knob. This includes a friction clutch which prevents too much tension being applied. The thimble must be rotated through two revolutions to open the jaws by 1 mm.

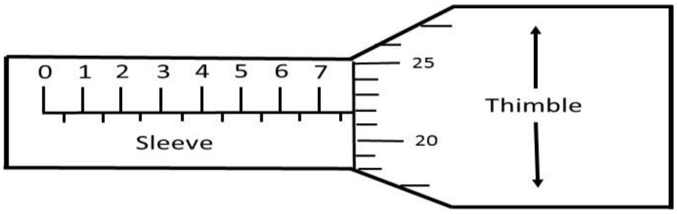
In order to measure an object, the object is placed between the jaws and the thimble is rotated using the ratchet until the object is secured. Note that the ratchet knob must be used to secure the object firmly between the jaws, otherwise the instrument could be damaged or give an inconsistent reading. The manufacturer recommends 3 clicks of the ratchet before taking the reading. The lock may be used to ensure that the thimble does not rotate while you take the reading.

The first significant figure is taken from the last graduation showing on the sleeve directly to the left of the revolving thimble. Note that an additional half scale division (0.5 mm) must be included if the mark below the main scale is visible between the thimble and the main scale division on the sleeve. The remaining two significant figures (hundredths of a millimeter) are taken directly from the thimble opposite the main scale.

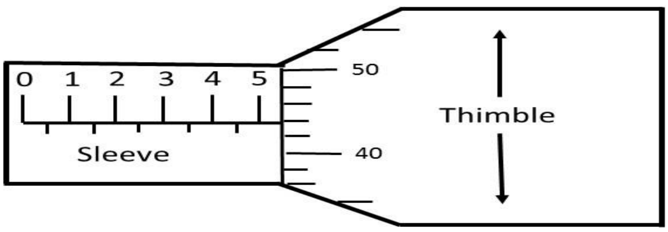
Examples:



The reading is [7 + 0.5 + 0.18 = 7.68 mm].



The reading is [7 + 0.5 + 22 = 7.72 mm].



The reading is [5 + 0.42 = 5.42 mm].

Taking a zero reading

Whenever you use a Vernier calipers or a micrometer screw gauge you must always take a zero reading i.e. a reading with the instrument closed. This is because when you close your calipers, you will see that very often (not always) it does not read zero. Only then open the jaws and place the object to be measured firmly between the jaws and take the open reading. Your actual measurement will then be the difference between your open reading and your zero reading.

1. Simple Pendulum

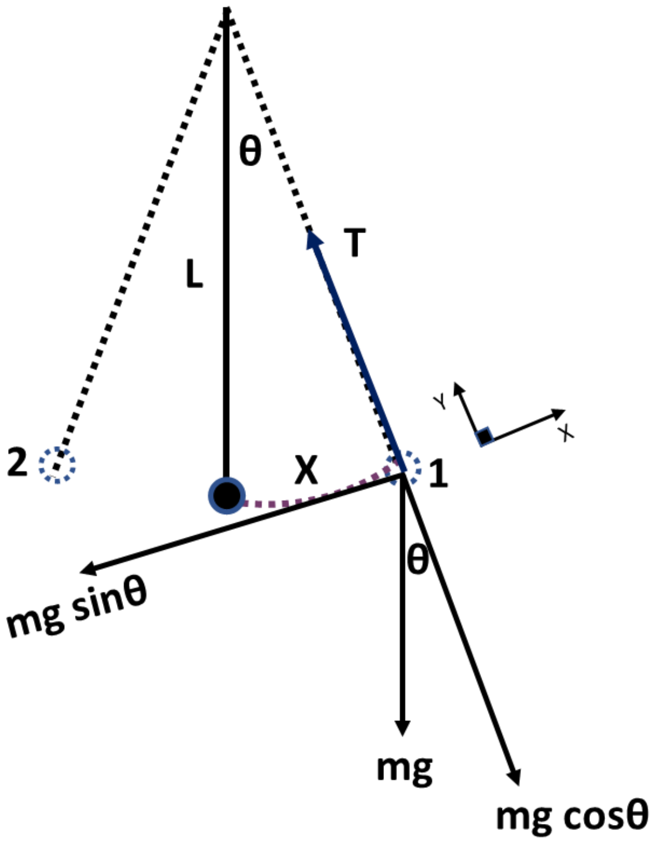
Aim:

Determination of ……………………………………………………………………………...

……………………………………………………………………………………………

This experiment is an application of ……………………………….

Theory:



The pendulum moves with type of simple harmonic motion which defined as "***cyclic motion repeats itself periodically***".The simple pendulum consists of small heavy particle of matter (called bob) of mass (m) susspended from a stand, the length of the pendulum (L) is to be measured from the point of suspension to the center of the bob.

For a small angular displacement (x), The restoring force acting on the bob along the x-axis can be written as:

$$F = -m\,g\sin\theta$$

[Since, $F = m\,a$ (Newton's second law) where (a) is the acceleration]

$$m\,a = -m\,g\sin\theta$$

$$a = -g\sin\theta$$

for small θ, ($\sin\theta \approx \theta = x/L$)

$$a = -\left(\frac{g}{L}\right)x$$

This equation represents a simple harmonic motion of the form:

$$a = -\omega^2 x$$

where, ω is the angular frequency.

$$[\omega^2 = \frac{g}{L}]$$

$$\left(\frac{2\pi}{T}\right)^2 = \frac{g}{L}$$

where, T is the periodic time.

$$\left[g = 4\pi^2\frac{L}{T^2}\right]$$

Apparatus:

Stand, pendulum bob, thread, meter stick and stop watch.

Procedure:

1. Set up the apparatus as shown in figure above.
2. Start with the length of the thread (L= …cm) from the point of suspension to the center of the bob by a meter stick.
3. Measure the time for 10 complete oscillations, (T_{10}) using the stop watch, then find the time for one complete oscillation (T)

4. Repeat the experiment several times by increasing the thread (L) by (10cm) each time.
5. Draw a graph between T^2 (as y-axis) and L (as x-axis) and show that it is a straight line.
6. From the slope of the straight line calculate the acceleration due to gravity using the relation [$g = 4\pi^2 \frac{1}{slope}$]

Calculations and Results:

L (.........)	T_{10} (.........)	$T=T_{10}/10$ (.........)	T^2 (.........)

$g = 4\pi^2 [\frac{1}{slope}]$ =..(   )

2. Viscosity

Aim:

Determination of ………………………………………………………………………………...

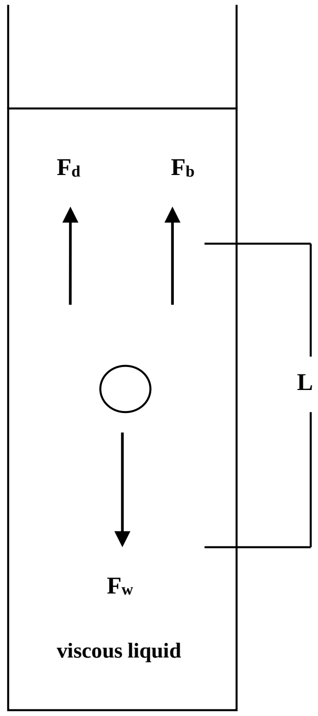
Viscosity is a property appears in ……..……………………………………..

Theory:

What is viscosity?

Real fluid has a certain amount of internal friction, which is called viscosity. Viscosity exists in both liquids and gases, and is essentially the frictional force between the adjacent layers of fluid as the layers move past one another. In liquids, viscosity appears due to the cohesive forces between the molecules. In gases, it arises from collisions between the molecules.

Determination of the coefficient of viscosity of a liquid using the falling ball viscometer:



When a sphere is placed in an infinite incompressible Newtonian fluid, it initially accelerates due to gravity. After this brief transient period, the sphere achieves a constant terminal velocity. For the velocity to be steady (no change in linear momentum), Newton's second law requires that the three forces acting on the sphere, the weight force (F_w), the buoyant force (F_b), and the drag force (F_d) balance. These forces all act vertically and are as follows:

1. The weight force of the sphere $\left[F_w = V\rho_s g = \left(\frac{4}{3}\pi r^3\right)\rho_s g\right]$

   [V is the volume of the sphere, r is the radius of the sphere, ρ_s is the density of the material of the sphere and g is the acceleration due to gravity]

2. The buoyant force $\left[F_b = V\rho_L g = \left(\frac{4}{3}\pi r^3\right)\rho_L g\right]$

[ρ_L is the density of the viscous liquid]

3. The drag force $[F_d = 6\pi r\eta V_T]$

[V_T is the terminal velocity and η is the coefficient of viscosity of the viscous liquid].

$$F_w = F_b + F_d$$

$$\left(\frac{4}{3}\pi r^3\right)\rho_s g = \left(\frac{4}{3}\pi r^3\right)\rho_L g + 6\pi r\eta V_T$$

$$\left(\frac{4}{3}\pi r^3\right)g(\rho_s - \rho_L) = 6\pi r\eta V_T$$

$$4r^2 g(\rho_s - \rho_L) = 18\eta V_T$$

$$D^2 g(\rho_s - \rho_L) = 18\eta V_T$$

where, [$D^2 = 4r^2$, D is the diameter of the sphere].

$$\left[\eta = \frac{g(\rho_s - \rho_L)}{18}\ \frac{D^2}{V_T}\right]$$

Apparatus:

Measuring cylinder, glycerin, small spheres of different diameters, micrometer and stop watch.

Procedure:

1. Fill the measuring tube with glycerin.
2. Fix a distance [L = 70 cm] between two marks in the middle area of the liquid.
3. Measure the diameters of the spheres using the micrometer.
4. Record the time t of the falling of the spheres through the defined distance L.
5. Calculate the terminal speed of each sphere [$V_T = L/t$].

6. Tabulate the results.
7. Draw a graph between V_T as y-axis and D^2 as x-axis.
8. Determine the slope of the graph.
9. Calculate the value of the coefficient of viscosity using the relation $\left[\eta = \frac{g(\rho_s - \rho_L)}{18} \frac{D^2}{V_T}\right]$

Calculations and Results:

D (……..)	D^2 (……..)	t (……..)	$V_T = L/t$ (……..)

Given: [L = 70 cm, ρ_s = 7.8 g/cm^3, ρ_L = 1.26 g/cm^3 and g = 980 cm/s^2]

$\eta = \frac{g(\rho_s - \rho_L)}{18} \left[\frac{1}{slope}\right]$= ……………………………………………………………………( )

3. Archimedes' Principle

Aim:

Determination of:

1.	**3.**
2.	**4.**

This experiment is an application of ………………………………..

Theory:

1. Definitions:

Density: is the mass of any material per unit its volume.

Relative density: is the density of the material to the density of water at the same temperature.

2. Archimedes' principle:

Archimedes' principle states that "*an object submerged in a fluid is buoyed by a force (F_b) that is equal to the weight of the displaced fluid*".

Firstly, if the solid body immersed in a water:

$$W_1 = \rho_s V g \qquad (1)$$

$$(F_B)_w = W_1 - W_2 \quad , \quad F_B = \rho_w V g \qquad (2)$$

$$W_1 - W_2 = \rho_w V g \qquad (3)$$

Divided equation (1) by (3)

$$\frac{W_1}{W_1 - W_2} = \frac{\rho_s V g}{\rho_w V g} = \frac{\rho_s}{\rho_l} = RD_s \qquad (4)$$

$$\therefore RD_s = \frac{W_1}{W_1 - W_2}$$

<u>where:</u>

W_1 is the weight of the solid body in air (real weight).

W_2 is the of the solid body when immersed in water (apparent weight)

F_b (water) is the buoyant force of water on the body.

Secondly, if the solid immersed in a liquid:

$$(F_B)_w = W_1 - W_2 \quad , \quad F_B = \rho_w V g \qquad (2)$$

$$W_1 - W_2 = \rho_w V g \qquad (3)$$

$$(F_B)_l = W_1 - W_3 \quad , \quad F_B = \rho_l V g \qquad (2)$$

$$W_1 - W_3 = \rho_l V g \qquad (3)$$

Divided equation (1) by (3)

$$\frac{W_1 - W_3}{W_1 - W_2} = \frac{\rho_l V g}{\rho_w V g} = \frac{\rho_l}{\rho_l} = RD_l \qquad (4)$$

$$\therefore RD_l = \frac{W_1 - W_3}{W_1 - W_2}$$

<u>where:</u>

W_3 is the weight of the solid body when immersed in liquid (apparent weight).

F_b (liquid) is the buoyant force of liquid on the body

<u>Apparatus:</u>

Solid sphere, vertical balance, beaker, water and glycerin.

Procedure:

1. Adjust the balance.

2. Find the weight of the solid sphere in air (W_1).

3. Find the weight of the solid sphere when immersed totally in water (W_2).

4. Find the weight of the solid sphere in glycerin (W_3).

5. Tabulate the results.

6. Find [RD_S, ρ_s, RD_L and ρ_L] using the relations:

$$RD_s = \frac{W_1}{W_1 - W_2}$$

$$\rho_s = RD_s \times 1000 \ \frac{kg}{m^3}$$

$$RD_L = \frac{W_1 - W_3}{W_1 - W_2}$$

$$\rho_L = RD_L \times 1000 \ \frac{kg}{m^3}$$

Calculations and Results:

W_1 = ...	W_2 = ...	W_3 = ...
1. RDs = ...		
2. ρ_s = ...		
3. RD_L = ...		
4. ρ_L = ...		

4. The Latent heat

Aim:

Determination of ………………………………………………………………………………...

This experiment is an application of ……………………………….

Theory:

Specific heat (C)

is defined as the quantity of thermal energy needed to raise the temperature of one gram of pure substance by one degree Celsius.

$$C = \frac{Q}{m\Delta T} \quad \left[\frac{J}{kg\ °k} \ \text{ or } \ \frac{cal}{g\ °C}\right]$$

Latent heat (L)

is defined as the quantity of thermal energy needed to change of one gram of pure substance from one phase to another phase at the same temperature.

$$L = \frac{Q}{m} \quad \left[\frac{J}{kg} \ \text{ or } \ \frac{cal}{g}\right]$$

If a piece of ice of mass (m_{ice}) nearly at zero degree Celsius is putted into a calorimeter of mass (m_c) filled with water of mass (m_w) at initial temperature (T_1) each of the water and calorimeter loss a thermal energy and reached at thermal equilibrium state with final temperature (T_2) by means only of specific heat.

$$Q_w = m_w c_w (T_1 - T_2)$$

$$Q_c = m_c c_c (T_1 - T_2)$$

On the other hand, the ice gains a thermal energy via two procedures:

1. Latent heat to change its phase from solid to liquid (water) at the same temperature (zero degree Celsius).

2. Specific heat to raise its temperature from (zero degree Celsius) to the final temperature T_2.

$$Q_{ice} = m_{ice} L_f + m_{ice} c_w (T_2 - 0)$$

ΔT is the temperature difference.

c_w is the specific heat of water.

c_c is the specific heat of calorimeter.

At thermal equilibrium:

$$Q_{lost} = Q_{gained}$$

$$Q_{lost\ by\ water} + Q_{lost\ by\ calorimeter} = Q_{gained\ by\ ice}$$

$$m_w c_w (T_1 - T_2) + m_c c_c (T_1 - T_2) = m_{ice} L_f + m_{ice} c_w (T_2 - 0)$$

$$[m_w c_w + m_c c_c](T_1 - T_2) = m_{ice} L_f + m_{ice} c_w T_2$$

$$\therefore \quad \left[L_f = \frac{[(m_w c_w + m_c c_c)(T_1 - T_2)] - m_{ice} c_w T_2}{m_{ice}} \right]$$

Apparatus:

Calorimeter, digital balance, thermometer, water, ice and isolated box.

Procedure

1. Determine the mass of the empty calorimeter cup (m_c) using the digital scale balance.
2. Fill the calorimeter cup to about half full with water.
3. Determine the mass of the calorimeter cup and water [$m_{c,w}$].
4. Calculate the mass of the added water, [$m_w = [m_{c,w}] - m_c$].
5. Measure and record the initial temperature of the water, (T_1).
6. Put a suitable amount of ice in the calorimeter.
7. Keep the calorimeter with its containing in the isolated box.
8. Keep the mixture well stirred.

9. When all the ice has melted, measure the equilibrium temperature, (T_2).
10. Measure the combined mass of the calorimeter cup and water, which now includes water from the melted ice [$m_{c,w,ice}$].
11. Calculate the mass of the ice, m_{ice} = [$m_{c,w,ice}$] - [$m_{c,w}$].
12. Calculate the latent heat of fusion of ice L_f using the relation:

$$\mathbf{L_f = \frac{[(m_w c_w + m_c c_c)(T_1 - T_2)] - m_{ice}\, c_w T_2}{m_{ice}}}$$

.

<u>Calculations and Results:</u>

m_c = ... m_w = ... T_1 = ... T_2 = ... m_{ice} = ...
L_f = ...

Ginen: $c_w = 1 \ \frac{\text{cal}}{\text{g °C}}$ and $c_c = 0.09245 \ \frac{\text{cal}}{\text{g °C}}$

Note, $1 \frac{\text{cal}}{\text{g}} = 4186 \ \frac{\text{J}}{\text{kg}}$

5. Hooke's Law

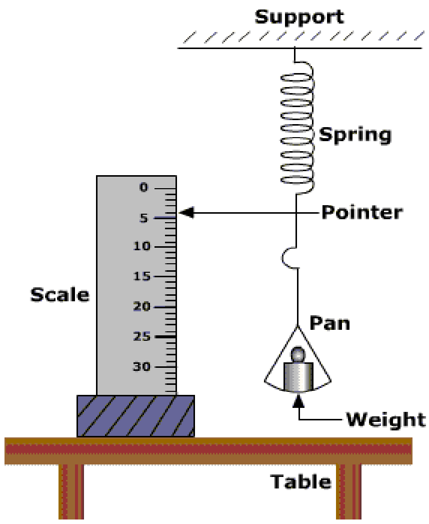
Aim:

Determination of the force constant or elastic constant of a spring.

This experiment is an application of ………………………………..

Theory:

When a spring is stretched by an applied force, a restoring force F is produced. Due to the restoring force, simple harmonic motion is caused in a straight line in which the acceleration and the restoring force are directly proportional to the displacement X of the vibrating load from the equilibrium position.



$$F = -K X.$$

The force is opposite in direction to the displacement.

The constant K is known as the force constant of the spring. This is the force, expressed in Newton, which will produce an elongation of one meter in the spring. The value of K depends not only on the kind of elastic material under consideration but also on its dimensions and shape.

Hooke's law applies, as long as the material is within its elastic limit. Once a sufficient amount of force has been applied, so as to extend the material beyond its elastic limit, the material enters its plastic region. With the material in its plastic region, the force applied causes permanent displacement of the material.

Apparatus:

Helical spring, set of known masses, tap scale and stand rod.

Procedure:

1. Set up the apparatus as shown in Figure above.
2. Record the starting position of the spring (before hanging the mass)
3. Start with a suitable mass m.
3. Measure the increase in the length of the spring X.
4. Repeat the experiment several times by increasing the weight m.
5. Draw a graph between X (as y-axis) and m (as x-axis) and show that it is a straight line.
6. From the slope of the straight line calculate the [k = g/slope] dyne/cm

Calculations and Results:

m (………)	X(………)

Given: $g = 980\ cm/s^2$

$$K = \frac{g}{slope} = \text{……………………………………………………}$$

Note: 1 dyne = 10^{-5} N