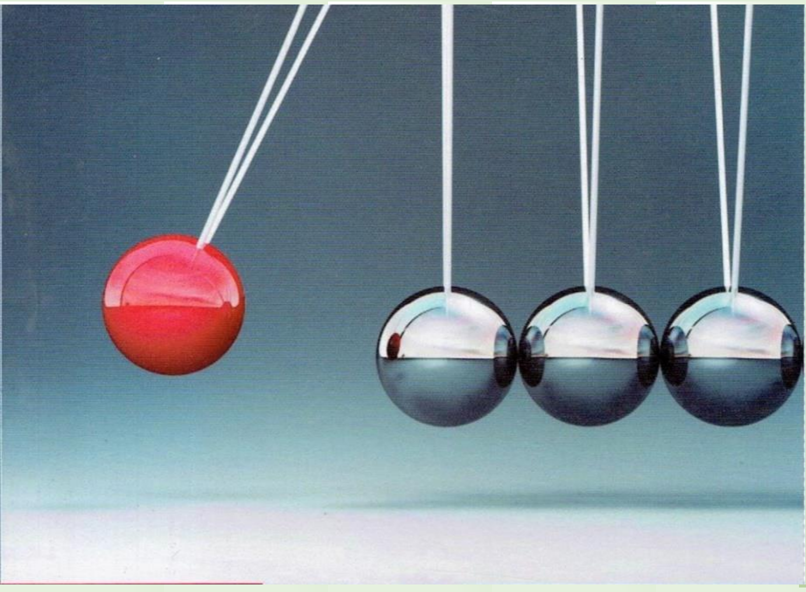
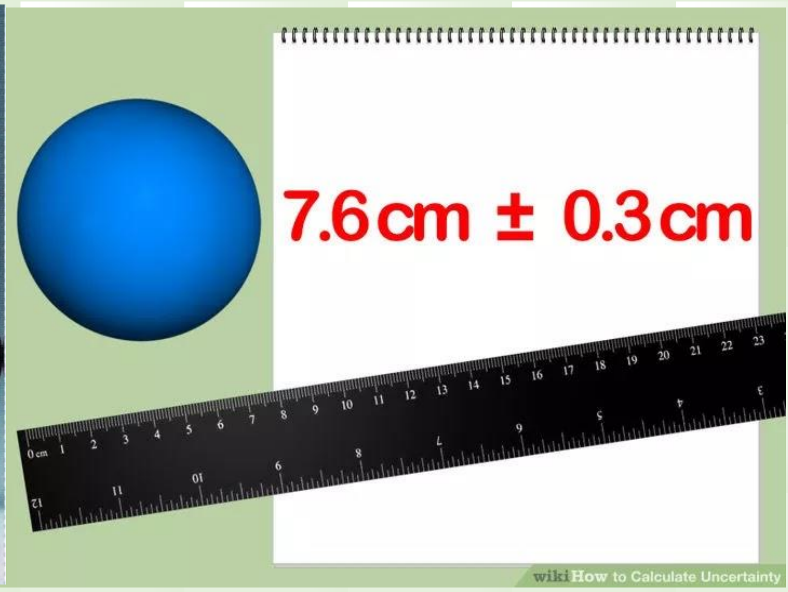
Student Guide for Biophysics (Experimental Part)

For 1st grad Faculty of physical therapy





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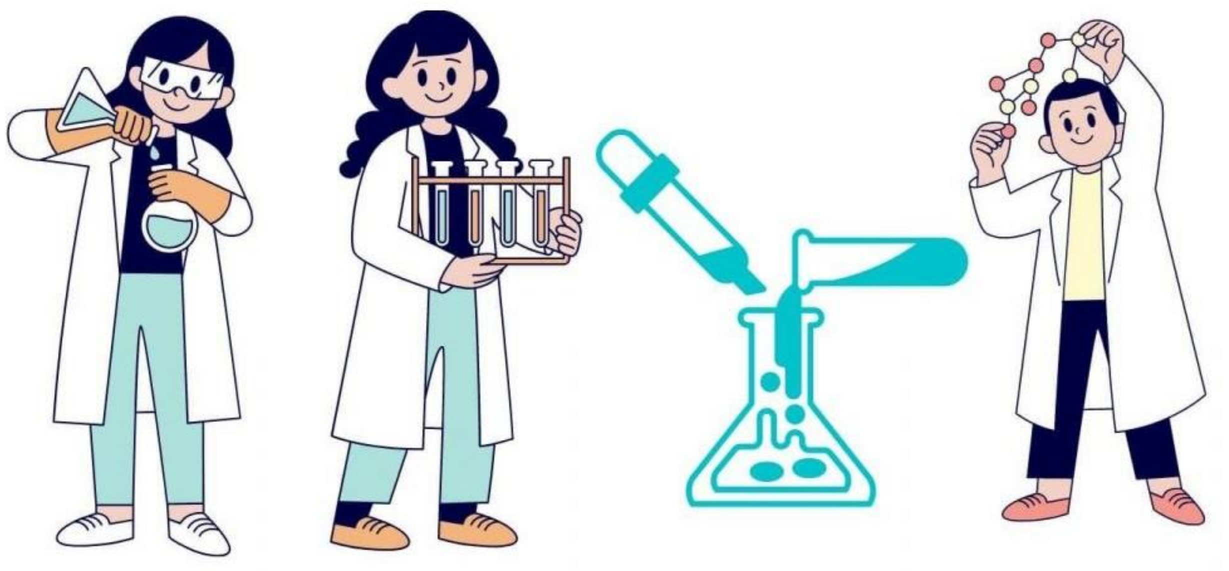
Part (I) experimental manual



Introduction to experimental physics manual

The present manual contains a collection of laboratory experiment for 1st grade student of faculty of physical therapy. The selection of experiments was done to cover a certain topic from the student lectures. It includes the explanation of different physical phenomena and its mathematical expression. Moreover, the methods of conducting experiments to prove the physical concepts and the theoretical background of each experiment.

This manual was written to improve the practical skills of student as well as increase their understand to the physical concept. The author hope that student after finishing this semester could gain a good experience in performing experiments with different equipment with a high accuracy. Also, gain the experience to analyze the scientific data using the suitable tools to extract information.

Dr. Alaa Hassan Said

Graphing in physics

Graphing is an important procedure used by scientist to display the data that is collected during a controlled experiment. Most results in science are presented in scientific journal articles using graphs. Graphs present data in a way that is easy to visualize for humans in general, especially someone unfamiliar with what is being studied. They are also useful for presenting large amounts of data or data with complicated trends in an easily readable way. There are three main types of graphs:

- **Pie/circle graphs**: Used to show parts of a whole.
- **Bar graphs**: Used to compare amounts.
- **Line graphs**: Use to show the change of one piece of information as it relates to another change.

Both bar and line graphs have an "X" axis (horizontal) and a "Y" axis (vertical).

Parts of a Graph:

- **Title:** Summarizes information being represented in ANY graph.
- **Independent Variable:** The variable that is controlled by the experimenter, such as, time, dates, depth, and temperature. This is placed on the **X** axis.
- **Dependent Variable:** The variable that is directly affected by the I.V. It is the result of what happens as time, dates, depth and temperature are changed. This is placed on the **Y** axis.
- **Scales for each Variable:** In constructing a graph, one needs to know where to plot the points representing the data. In order to do this a scale must be employed to include all the data points.

One commonly used graph in physics and other sciences is the line graph, probably because it is the best graph for showing how one quantity changes in response to the other.

Analysing a Graph Using Its Equation

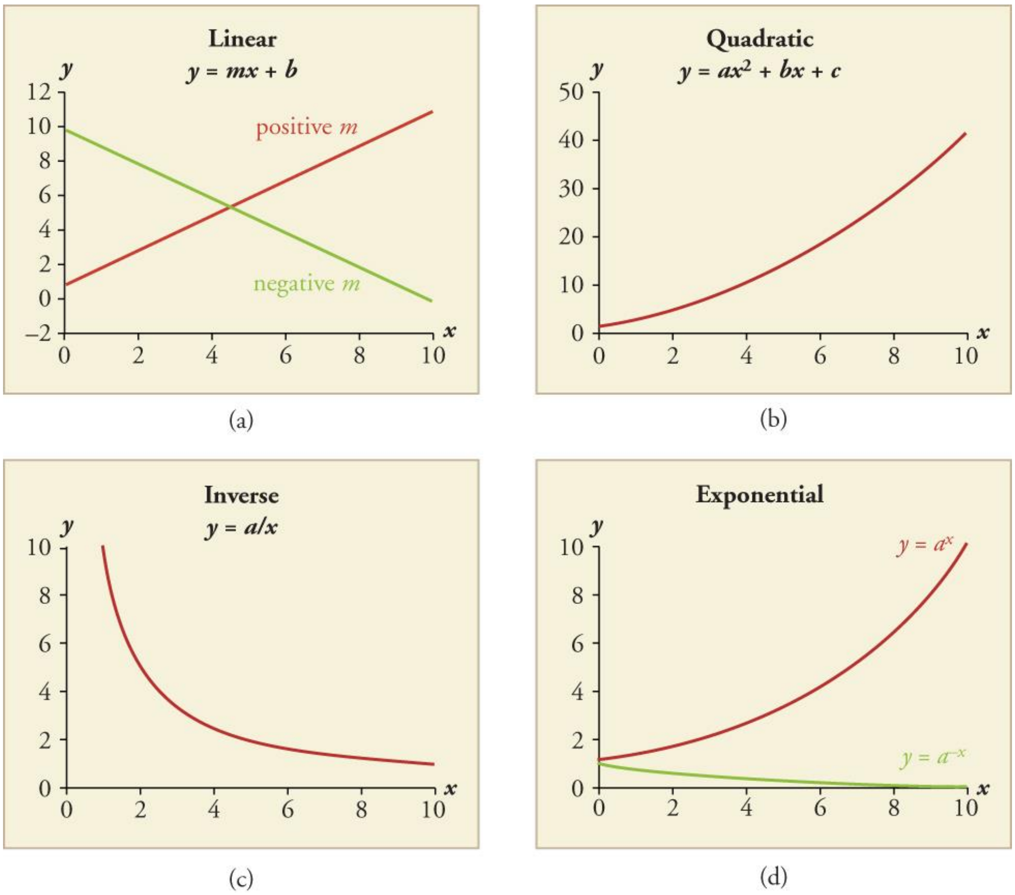
One way to get a quick snapshot of a dataset is to look at the equation of its trend line. If the graph produces a straight line, the equation of the trend line takes the form

$$y=mx+b$$

The b in the equation is the y-intercept while the m in the equation is the slope. This value describes how much the line on the graph moves up or down on the y-axis along the line's length. The slope is found using the following equation

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

Another commonly seen relationship is the **exponential relationship**, in which a change in the independent variable produces a proportional change in the dependent variable. As the value of the dependent variable gets larger, its rate of growth also increases. For example, bacteria often reproduce at an exponential rate when grown under ideal conditions. As each generation passes, there are more and more bacteria to reproduce. As a result, the growth rate of the bacterial population increases every generation



Experiment (1): The Simple Pendulum

Aims:

1- Determine value of gravitational acceleration **(g)** using simple pendulum.

Theory:

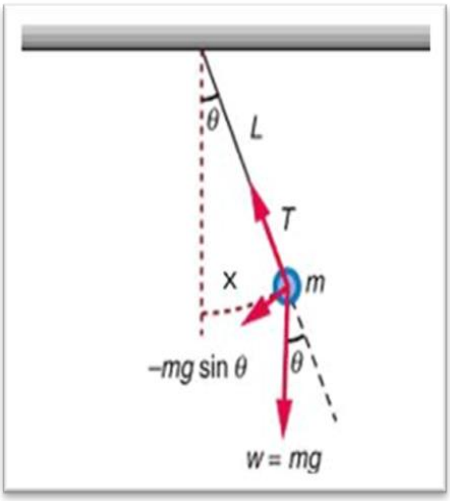
Simple Harmonic Motion is the movement that repeats itself in specific periods of time in which the acceleration with which the body moves are directly proportional to the displacement away from the resting position and its direction is opposite to the direction of the increase in displacement.

$$a = -w^2 x$$

A pendulum is a body suspended from a fixed support so that it swings freely back and forth under the influence of gravity.

Mathematical formulation:

$$T^2 = \frac{4\pi^2}{g} L$$



Where;

T is the Periodic time.

g the gravitational acceleration.

L is the Pendulum length.

Tools:

Simple pendulum – Stopwatch - Ruler.

Procedure:

1- Take a strong thread about one meter long and tie its one end to the hook of the ball. Fix the other end of thread in a metal holder.

2- Set the pendulum length L (from the center of the ball to the fixed point on the metal holder) to 10 cm.

3- Now displace the ball about 5 degrees from its mean position to one side and leave it gently, it should not vibrate sideways.

4- Record the time in seconds which the pendulums take to make 10 full periods.

5- Calculate the **Periodic time** $\mathbf{T = \frac{t_{10}}{10}}$.

6- Increase the pendulum length **L** and repeat steps 3-5.

7- Plot the relation between $\mathbf{T^2}$ on the vertical axis and **L** on the horizontal axis. with slope equals $\frac{4\pi^2}{g}$

8- Calculate the gravitational acceleration **(g)**.

Results:

L	t_{10}	$T = \frac{t_{10}}{10}$	T^2

g = ………………………. cm/sec^2

Graph title: …………………………………………………………………………………

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Date: ……………………………………………………………………………………

Observations: ……………………………………………………………………………

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Experiment (2): Surface Tension

Aims:

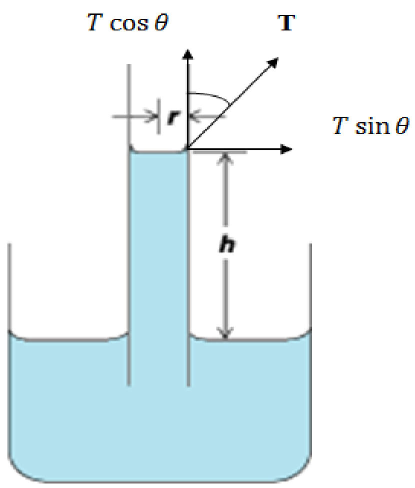
1- Measuring the surface tension by using the capillary action.

Theory:

Surface tension is the tendency of a liquid to reduce its surface area to a minimum value. It is known that the force that affects the direction of perpendicular to the unit length of the liquid surface. Surface tension is measured in newtons per meter ($N\ m^{-1}$), or dynes per centimeter.

Mathematical formulation:

When we put capillary tube in a liquid, the liquid rises in the tube until it reaches as a certain height (h), the liquid affects by two forces, one of them lift the liquid up and the other lows the liquid down and the two forces are equal.



$$F_1 \downarrow = mg = V \rho g = h \pi r^2 \rho g$$

$$F_2 \uparrow = 2\pi r T \cos\theta$$

$$F_1 \downarrow = F_2 \uparrow$$

$$\pi r^2 h \rho g = 2\pi r T \cos\theta$$

$$T = \frac{h \rho g r}{2\cos\theta}$$

When θ is very small ($\cos\theta = 1$)

$$T = \frac{h \rho g r}{2}$$

Where **T** is **Surface tension**

Tools:

1- Capillary tube.
2- Water cup.
3- Mass of mercury.
4- Sensitive balance.
5- bottle.
6- Ruler.

Procedure:

1- Clean the capillary tube well.
2- Place the capillary tube in a cup filled with water.
3- Slowly move the tube so that the bottom remains submerged in water and fix the tube.
4- Notice the height of the water inside the tube to a certain extent and then stabilized it.
5- Measure the distance between the water surface of the cup until the end of the height of the water with the capillary tube and record the height (h).
6- Specifies the radius of the tube:
   - By means of a rubbers tube fixed on the capillary tube and with drawing the amount of mercury connected.
   - Measure the length of the mercury inside the capillary tube (L).
   - The weight of the empty bottle (M_1).
   - Remove the mercury in the tube in the bottle and weight it (M_2).
   - The weight of mercury can be set (**$M=M_2-M_1$**).

$$\mathbf{M = L\,\pi\, r^2 \rho_1}$$

   - With knowledge M, L, ρ_1 (mercury density = 13.6 gm/cm^3), we can set the tube radius **(r).**
7- With knowledge g, ρ (water density = 1 gm/cm^3), we can set the surface tension (**T**).

Results:

the height of water **(h)** = ……………………..………. cm

The weight of the bottle **M_1**= …………………. Gm The weight of the bottle and mercury **M_2**= …………………………. Gm Weight of mercury **M**= …………... gm

The length of the mercury column in the tube **L** = ………………………… cm

The radius of the tube **(r)** = ………………………… Cm

Surface tension **T**= ………………………………… **dyne/cm**.

Experiment (3): viscosity's coefficient (Stokes's method)

Aims:

1- determine the viscosity's coefficient of a liquid by Stokes's method.

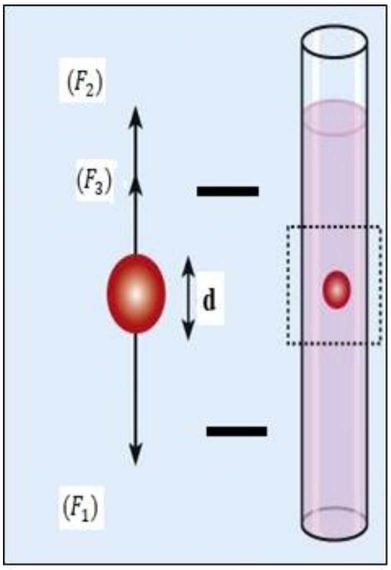
Theory:

Viscosity is the property that characterizes the fluid in terms of its response to movement or the movement of objects within it, as well as the property by which the fluid resists its movement or the movement of objects in it.

viscosity coefficient. It is defined as the force that affects a unit area of a liquid that changes the rate of velocity by a unit amount between two layers, the distance between them is equal to one. The viscosity coefficient is measured in **dyne. sec/cm^2**.

Mathematical formulation:

The **Stokes method** relies on the top of a metal ball falling into a glass tube containing a viscous liquid under the influence of its own weight downwards. In this case, the force acting on the ball is



1- Weight force ($F_1 \downarrow$)

$$\mathbf{F_1 \downarrow = m_1 g = \frac{4}{3}\pi r^3 \rho_1 g}$$

2- Fluid force of the ball ($F_2 \uparrow$)

$$\mathbf{F_2 \uparrow = m_2 g = \frac{4}{3}\pi r^3 \rho_2 g}$$

3- Viscosity Strength ($F_3 \uparrow$)

$$\mathbf{F_3 \uparrow = 6\,\pi\,\eta\,V\,r}$$

When the ball is moving at a constant speed, the equation for the forces is

$$\mathbf{F_3 \uparrow + \quad = F_2 \uparrow \quad F_1 \downarrow}$$

$$\mathbf{\frac{4}{3}\pi r^3 \rho_1 g = \frac{4}{3}\pi r^3 \rho_2 g + 6\,\pi\,\eta\,V\,r}$$

$$\therefore \quad \mathbf{\eta = \frac{2}{9}(\rho_1 - \rho_2)\,g\,\frac{r^2}{V}}$$

where **r** is the radius of the sphere, $\boldsymbol{\rho_1}$ is the density of the ball material, $\boldsymbol{\rho_2}$ is the density of the fluid, **V** is the final velocity, and **η** is the viscosity coefficient of the fluid.

Tools:

1- A cylindrical glass tube filled with the liquid.

2- Small balls of different diameters.

3- Micrometer.

4- Stopwatch.

5- Ruler.

Procedure:

1- Fill a glass tube about one meter with the liquid.

2- Mark two points on the tube, which the distance **d** between these two points is equal to 50 cm.

3- Using a micrometer, determine the radius of metal balls and note it.

4- Allow to a metal ball with radius **r** to fall inside the filled tube and record the time in seconds **t** required to pass the distance **d**.

5- Calculate the velocity **V** of the ball **V= d/t.**

6- Repeat the steps 4 and 5 for different ball.

7- Plot the relation between **V** on the horizontal axis and $\mathbf{r^2}$ on the vertical axis to get a straight line with slope $\mathbf{r^2/v}$.

8- Calculate the viscosity coefficient **(η)**.

Results:

r (cm)	r^2	t (sec)	$v = d/t$

The density of the ball material ρ_1 **= 7.8 gm/cm**^{3}

The density of the fluid ρ_2 **= 1.26 gm/cm**^{3}

d =………………………… cm

η = ………………………… dyne * sec/cm^2

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Experiment (4): Linear modulus of elasticity (Young's modulus)

Aims:

1- Determine the Young's modulus of a bar fixed at one end.

2- Determine the Young's modulus of a bar fixed at both ends.

Theory:

In physics and materials science, **elasticity** is the ability of a body to resist a distorting influence and to return to its original size and shape when that influence or force is removed.

Stress: It is the force acting per unit area. (**Newton / m^2 or dyne / cm^2**)

Strain: is the body's relative response to an applied stress and is equal to the change in the body relative to its original dimensions. It has no units or dimensions because it is a ratio.

Longitudinal modulus of elasticity (**Young modulus**), It is the ratio between the longitudinal stress to the longitudinal strain and its unit **dyne/cm^2**.

$$\mathbf{E} = \frac{\mathbf{F/A}}{\mathbf{\Delta L/L_O}}$$

Where;

E is the Young's modulus (modulus of elasticity).

F is the force exerted on an object under tension.

A is the actual cross-sectional area.

Δ**L** is the amount by which the length of the object changes.

$\mathbf{L_O}$ is the original length of the object.

1-Determine the Young's modulus of a bar fixed at one end.

Mathematical formulation:

$$\mathbf{E} = \frac{\mathbf{M}}{\mathbf{y_0}} \frac{\mathbf{4\,g\,L^3}}{\mathbf{b\,d^3}}$$

Where;

M is the mass.

g is the Gravitational acceleration.

L is the length of the bar.

$\mathbf{y_0}$ is the amount of decrease in height.

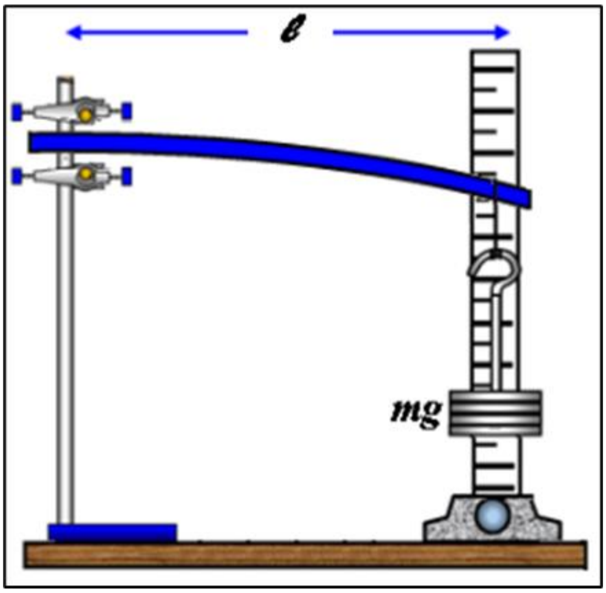
b is the bar width.

d is the bar thickness.

Tools:

Metal bar - Stand - Caliper - Ruler – Weights.

Procedure:



1- Fix an end of the rod using a clamp.
2- Measure the length (**L**), the width (**b**) and the thickness (**d**) of the bar.
3- Fix a meter scale vertically behind the bar before its end by about 10 cm and note the height (**y**).
4- Suspend a weight 50g before the end of the bar and record the height (y_1).
5- load a 50g mass carefully onto the hanger and recording the height (y_1).
6- After reaching the maximum load, the hanger is unloaded in the same steps of 50 gm and the readings (y_2) are noted again.
7- Calculate (y_0) from the equation ($y_0 = y - \frac{y_2+y_1}{2}$).
8- Plot the relation between **M** in grams on the vertical axis, and y_0 in centimeters on the horizontal axis. We get a straight line whose slope is M/y_0.
9- Calculate the Young's coefficient (**E**).

Results:

M (gm)	y_1	y_2	Average of height $\frac{y_2+y_1}{2}$	y_0 (cm)

y =………… cm **L =…………… cm** **b =………………...cm**

d =…..…......cm **E = …………………… dyne/cm²**

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2- Determine the Young's modulus of a bar fixed at both ends.

Mathematical formulation:

$$\mathbf{E} = \frac{\mathbf{M}}{\mathbf{y_0}} \frac{\mathbf{g\,L^3}}{\mathbf{4\,b\,d^3}}$$

Where;

M is the Mass.

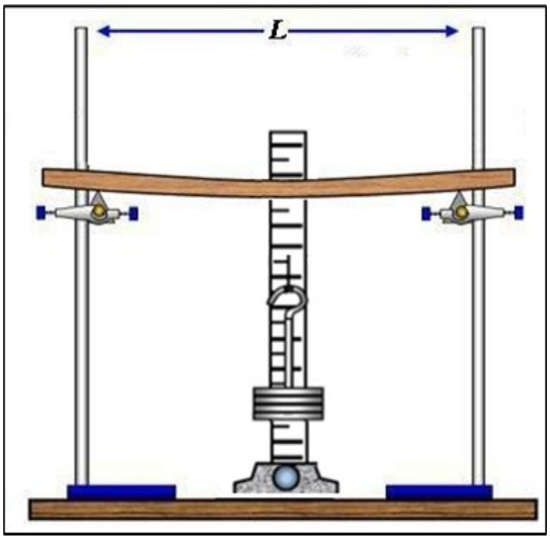
g is the Gravitational acceleration.

L is the length of the bar.

$\mathbf{y_0}$ is the amount of decrease in height.

b is the bar width.

d is the bar thickness.



Tools:

Metal bar - Stand - Caliper - Ruler – Weights.

Procedure:

1- Fix both ends of the bar using a clamp.
2- Measure the length (**L**), the width (**b**) and the thickness (**d**) of the bar.
3- Fix a meter scale vertically behind the bar in the middle of it and note the height (**y**).
4- Suspend a weight **50g** in the middle of the bar and record the height ($\mathbf{y_1}$).
5- load a 50g mass carefully onto the hanger and recording the height ($\mathbf{y_1}$).
6- After reaching the maximum load, the hanger is unloaded in the same steps of 50 gm and the height ($\mathbf{y_2}$) are noted again.
7- Calculate (y_0) from the equation **(**$\boldsymbol{y_0 = \mathrm{y} - \frac{y_2+y_1}{2}}$**).**
8- Plot the relation between **M** in grams on the vertical axis, and $\boldsymbol{y_0}$ in centimeters on the horizontal axis. We get a straight line whose slope is $\mathbf{M/y_0}$.
9- Calculate the Young's coefficient **E**.

Results:

M (gm)	y_1	y_2	Average of height $\frac{y_2 + y_1}{2}$	y_0 (cm)

y =……………… ………. cm

L =………………………… cm **b =……………………….…..cm**

d =…………………….……....cm **E = ………………………… dyne/cm^2**

Graph title: ………………………………………………………………………………

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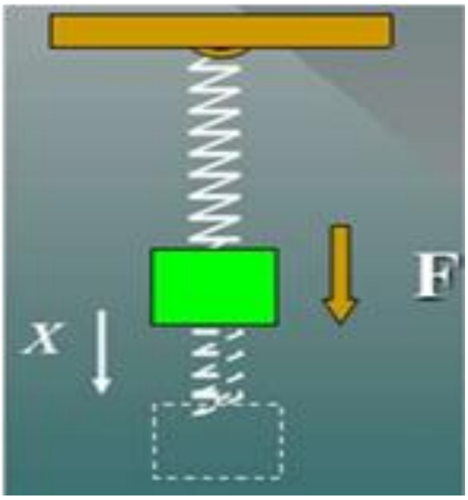
Experiment (5): The Hooke's Law

Aims:

1- Achieving Hooke's law experimentally and determining the spring constant.

Theory:

In physics and materials science, **elasticity** is the ability of a body to resist a distorting influence and to return to its original size and shape when that influence or force is removed.



Elastic Spring: A spring is an example of an elastic body that can be deformed by stretching. A restoring force F acts in the direction opposite the displacement of the oscillating body.

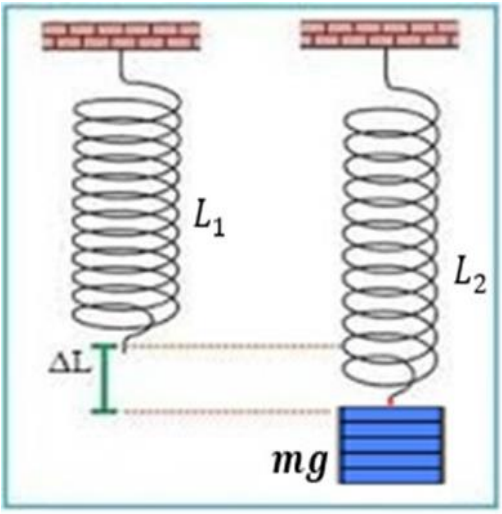
Hooke's law, states that before an elastic limit the force on a spring to push it back is linearly proportional to the distance.

$$\mathbf{F = K\,x}$$

Mathematical formulation:

$$\mathbf{F = K\,\Delta L}$$

$$\mathbf{m = \frac{K}{g}\,\Delta L}$$



Where;

M is the mass suspend in the spring.

g the gravitational acceleration.

k Hooke's constant.

ΔL the spring displacement.

Tools:

Spring - Stand - Ruler – Weights.

Procedure:

1- Set the original spring length (**L_1**).

2- Hang a suitable weight (**20gm**) at the end of the spring and measure the length of the spring after hanging the weight (**L_2**).

3- Calculate the amount of elongation **($\Delta L = L_2 - L_1$)**.

4- Increase the mass of the hanging weight several times and each time calculate the amount of elongation.

5- Record the results in a table and plot the relation between mass **M** on the vertical axis and elongation **ΔL** on the horizontal axis.

6- Given the slope of the straight line and the gravitational acceleration, calculate the value of Hooke's constant.

Results:

M (gm)							
L_2							
ΔL							

g = 980 cm/sec^2

L_1 =………………………… cm

k = …………………… dyne/cm

Graph title: ……………………………………………………………………………

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Date: ………………………………………………………………………………..….

Observations: ………………………………………………………………………

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Experiment (6): Speed of Sound in Air (Resonance Tube)

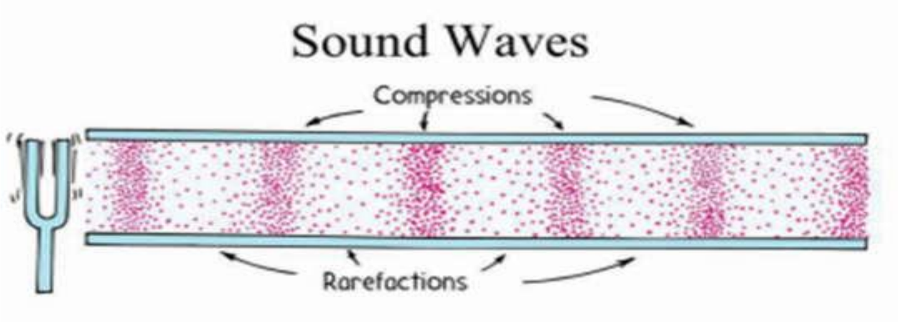
Aims:

1- Determine the speed of sound in air at room temperature using a resonance tube.

Theory:

In physics, **sound** is a vibration that propagates as an acoustic wave, through a transmission medium such as a gas, liquid or solid.

Sound Waves: A longitudinal wave consists of compression and rarefaction.



The wavelength (λ) in a longitudinal wave is the distance between two consecutive points that are in phase.

Resonance in physics, it describes the phenomenon of increased amplitude that occurs when the frequency of a periodically applied force is equal or close to a natural frequency of the system on which it acts.

Mathematical formulation:

$$\mathbf{L = \frac{V}{4} * \frac{1}{\nu} - 0.6 * r}$$

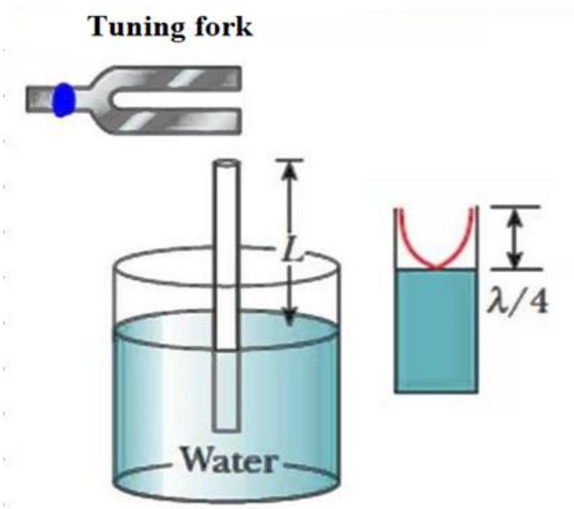
Where;

L is the air column length.

V is the speed of sound.

ν is the frequency.

r is the radius of the air column.



Tools:

A bucket filled with water – Ruler - Tuning fork - Open-ended hollow cylinder.

Procedure:

1- Insert the tube of a radius **(r)** into the water filled beaker.
2- Activate the tuning fork of a frequency (**ν**) and hold it above the tube.
3- Slowly lift the tube and the tuning fork out of the water filled beaker.
4- Listen for resonance and stop.
5- Measure the length of the air column (**L**) from the water level to top of the tube.
6- Change tuning fork frequency and repeat procedure.
7- Plot the relation between (**L**) on the vertical axis and (1/ν) on the horizontal axis, and from the slope set the sound velocity (**v**).

Results:

Frequency ν (Hz)	**1/ν (Hz^{-1})**	**Air Column Length L (cm)**

V =.............................. **cm/sec**

r =.............................. **Cm**

Graph title: ………………………………………………………………………………

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Date: ………………………………………………………………………………………

Observations: ……………………………………………………………………………

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Experiment (7): The specific heat capacity of a solid body (Mixture Method)

Aims:

1- Determine the specific heat capacity of Lead using the mixture method.

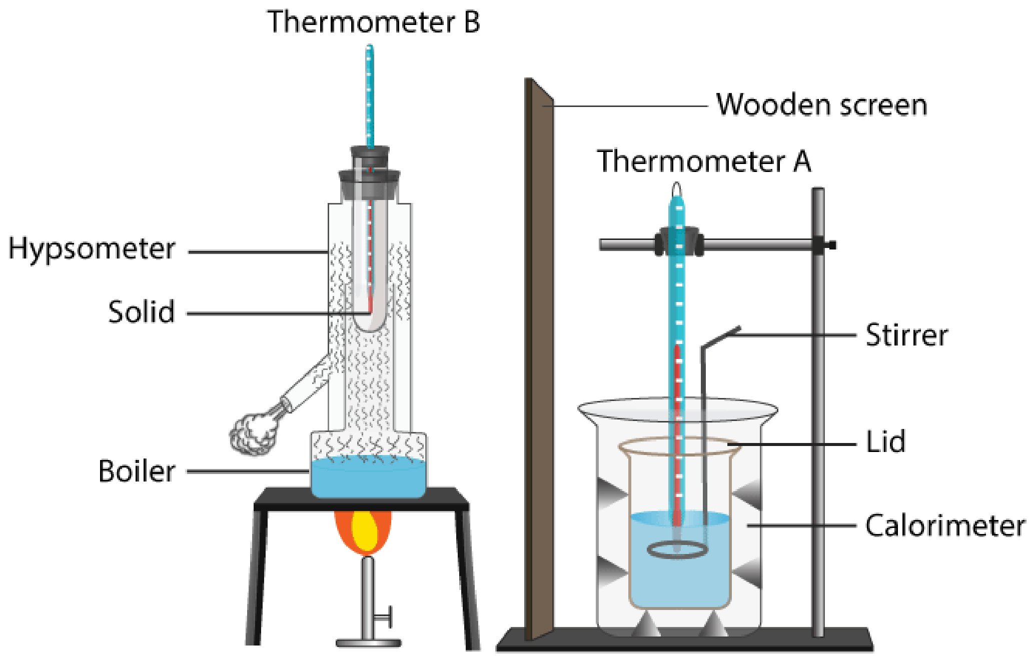
Theory:

If one body touches another body and their temperatures are different, the higher body loses a quantity of its heat and the other body gains it until their temperature is equal, and the amount of heat lost by the first body is equal to the amount of heat gained by the other body. The amount of heat (**Q**) is directly proportional to the mass of the body (M) and the change in temperature (**Δt**), where:

$$\mathbf{Q \ \alpha \ M \ \Delta t}$$

$$\mathbf{Q = C_p \ M \ \Delta t}$$

In thermodynamics, **the specific heat capacity** (C_p) of a substance is the amount of heat needed to raise the temperature of one gram of a substance one Celsius and its unit is (**Call. gm^{-1}. ^{0}C^{-1}**).



Mathematical formulation:

$$C_p = \frac{\left(m_1 C_{p_1} + m_2 C_{p_2}\right)(T_2 - T_1)}{m \,.\, (T - T_2)} \qquad (1)$$

Where;

C_p is the solid specific heat capacity.

C_{p_1} is the calorimeter specific heat capacity.

C_{p_2} is the water specific heat capacity.

m is the solid mass.

m_1 is the calorimeter mass.

m_2 is the water mass.

T is the temperature of the solid before mixture.

T_1 is the temperature of water and calorimeter before mixture.

T_2 is the temperature of the group after mixture (Equilibrium temperature).

Tools:

1- Caliber contains a small amount of water and is thermally insulated by placing it in an external caliber with an insulating material between them to reduce heat loss.
2- Sensitive scale.
3- Thermometer.

Procedure:

1- Weight an empty calorimeter with the balance. Ensure that calorimeter is clean and dry (m_1).
2- Pour the given water in the calorimeter. Make sure that the quantity of water taken would be sufficient to completely submerge the given solid in it. Weight the calorimeter with water and hence note the mass of the given water quantity (m_2).
3- Place the calorimeter in its insulating cover. Measure the temperature of the water taken in the calorimeter. Record the temperature of the water and the calorimeter (T_1).
4- Place a suitable amount of the solid in the tube and turn in until it closed and then put a thermometer inside the tube to measure the temperature of the solid (**T**).
5- Start heating and wait for the temperature to rise by an appropriate amount (90°C) and record the temperature of the solid (**T**).
6- Let the solid falls in the insulating calorimeter by turning the tube and record the temperature of the mixture (T_2).
7- Finally, weight the group (calorimeter, water and the solid) and determine the mass of the solid (**m**).

8- By knowing the specific heat of calorimeter substance (**C_{p_1}= 0.1 Call. gm^{-1}. ^{0}C^{-1}**) as well as of the water (**C_{p_2}= 1 Call. gm^{-1}. ^{0}C^{-1}**) and by substituting in equation (**1**) it is possible to calculate the specific heat of the solid body (**C_p**).

Results:

C_{p_1} = **0.1 Call. gm^{-1}. ^{0}C^{-1}**.

C_{p_2} = **1 Call. gm^{-1}. ^{0}C^{-1}**.

m_1 =………………………… **gm**. **m_2** =………………………… **gm**.

T_1 =…………………………….... **^{0}C**. **T_2** =…………………………….... **^{0}C**.

T =…………………………….... **^{0}C.**

m =………………………… **gm**.

C_p =………………….. **Call. gm^{-1}. ^{0}C^{-1}**.

Experiment (8): The Coefficient of Linear Thermal Expansion (Jenter Method)

Aims:

1- Determine the coefficient of linear thermal expansion of a copper rod.

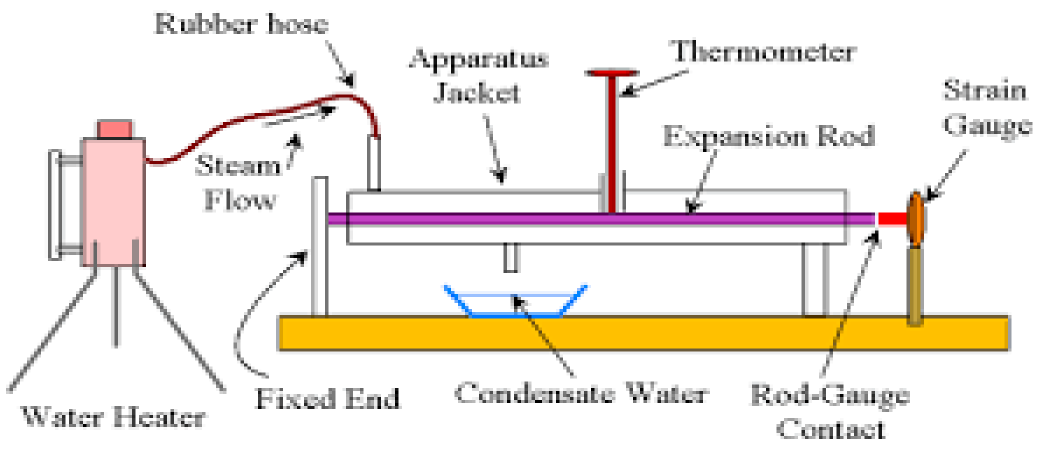
Theory:

Thermal expansion is the tendency of matter to change its shape, area, volume, and density in response to a change in temperature.

In thermodynamics, **the coefficient of linear thermal expansion (α_L)** is the relative increase in the length of a metal rod when heated by one Celsius degree and its unit is ($^0C^{-1}$).

$$\alpha_L = \frac{\Delta L/L}{\Delta T}$$

Where **L** the initial rod length and **ΔL** change of linear dimension, **ΔT** change in temperature, α_L the coefficient of linear thermal expansion.



Mathematical formulation:

$$\alpha_L = \frac{L_2 - L_1}{L_1(T_2 - T_1)}$$

Where;

L_1 is the rod length at initial temperature T_1.

L_2 is the rod length at temperature T_2.

T_1 is the initial temperature.

T_2 is the temperature after heating.

α_L the coefficient of linear thermal expansion

Tools:

Thermometer - Copper rod - Spherometer - Ruler - Water vapor source - Bunsen flame.

Procedure:

1- Measure the length of the metal rod before heating ($\mathbf{L_1}$) and the initial temperature ($\mathbf{T_1}$).

2- Adjust the front of the spherometer so that it touches the tip of the free rod and take a reading ($\mathbf{s_1}$).

3- Pass a stream of water vapor, and wait for the thermometer reading to hold at temperature ($\mathbf{T_2}$) greater than 90°C.

4- Take the spherometer reading again ($\mathbf{s_2}$).

5- The difference between the two readings of the spherometer represents the increase in the length of the metal rod ($\Delta \mathbf{L} = \mathbf{L_2} - \mathbf{L_1} = \mathbf{s_2} - \mathbf{s_1}$).

6- By substituting in equation, you can get the coefficient of linear thermal expansion of the copper rod ($\boldsymbol{\alpha_L}$).

Results:

$\mathbf{L_1}$ =………………………… **cm.** $\mathbf{T_1}$ =…………………………... ^{0}**C.**

$\mathbf{s_1}$ =………………………… **cm.** $\mathbf{T_2}$ =……………………………... ^{0}**C.**

$\mathbf{s_2}$ =………………………… **cm.**

$\mathbf{L_2} = (\mathbf{s_2} - \mathbf{s_1}) + \mathbf{L_1}$ = ……………… **cm.**

$\boldsymbol{\alpha_L}$ = ………………………… ^{0}**C**$^{-1}$

Student supervisor assessment

Experiment No.	Date	The student did the experiment	The student draws the graph	The student interpreted the	The student understands and	The student's supervisor's
1		☐	☐	☐	☐	
2		☐	☐	☐	☐	
3		☐	☐	☐	☐	
4		☐	☐	☐	☐	
5		☐	☐	☐	☐	
6		☐	☐	☐	☐	
7		☐	☐	☐	☐	
8		☐	☐	☐	☐	

Part (II) (Quizzes)

Quiz (1)

1- <u>Write the dimensions of:</u>

Velocity – acceleration – force – work – density – pressure

2- Using the dimension analysis check the correction of the following equations:

- $v^2 = {v_0}^2 + 2a$
- $F = m\,\frac{v^2}{r}$
- $T = 2\pi\sqrt{\frac{L}{g}}$

3- Using the given data in the table draw the following formula:

$$L = \frac{V}{4}\frac{1}{v} - 0\cdot 6\,r$$

ν (Hz)	256	256	320	384	520
L (cm)	35	35	27	22	15

4- Using the dimension analysis, complete the following table:

Physical quantity	Dimension	unit
Density	……………………..	……………………..
……………………..	$[M^1\ L^2\ T^{-3}]$	……………………..
……………………..	……………………..	dyne g^{-1}

5- The density of material depends on mass and volume, using the dimension analysis drive the expression for the density?

6- For the equation F α $A^a\ v^b\ d^c$, where F is the force, A is the area, v is the velocity and d is the density, find the values of a, b and c?

Quiz (2)

Q1:Compare between:

1- Elastic deformation and plastic deformation

2- Types of levers

3- Stress and Strain

4- Ductile and Brittle materials

Q2: Show that the human body organs have some elastic properties?

Q3: Draw stress – strain curve and explain why stress can decrease with the increase of strain?

Q4: Define the following terms:

Atmospheric pressure- Absolute Pressure - Surface tension - Contact angle

Q5: Discuss the role of pressure in the respiratory system?

Q6: Explain how the surface tension control the size of the alveoli?

Q7: A wire of length 2 m and cross-sectional area 10^{-4} m^2 is stretched by a load 102 kg. The wire is stretched by 0.1 cm. Calculate longitudinal stress, longitudinal strain and Young's modulus of the material of wire.

Q8: A mild steel wire of radius 0.5 mm and length 3 m is stretched by a force of 49 N. calculate a) longitudinal stress, b) longitudinal strain c) elongation produced in the body if Y for steel is 2.1×10^{11} N/m^2.

Q9: A tank filled with water of up to 5m height. Calculate the pressure exerted on the bottom of the tank. (Acceleration due to Gravity = 9.8 m/sec^2, Density of water = 1000 kg / m^3).

Q10: The pressure exerted by a liquid at a depth of 2.5 m is 36750 Pa. What is the density of the liquid, Gravity = 9.8 m/sec^2?

Quiz (3)

1- **Write on the different scales of temperature?**

2- **Illustrate the heat transfer modes?**

3- **<u>Define the following:</u>**

Heat capacity – specific heat capacity – latent heat- Thermoregulation- Energy- Work – Power - Anabolism – Catabolism- energy conservation law – work& energy theorem – kinetic energy – potential energy.

4- **Discuss the applications of Thermography?**

5- **What are the human energy systems?**

6- **Illustrate the human Body energy consumption?**

7- **Using the conversion between the temperature scales, complete the following table:**

Celsius (°C)	Kelvin (K)	Fahrenheit (°F)
120	……………………..	……………………..
……………………..	320	……………………..
……………………..	……………………..	-18

Quiz (4)

1- **<u>Define the following terms:</u>**

Sound – wavelength – amplitude – frequency – doppler effect

2- **<u>Compare between:</u>**

- Electromagnetic waves and mechanical waves
- Transverse waves and longitudinal waves
- Ultrasound transducers
- Ultrasound display mods
- Different types of resolutions

3- **What are the main characteristics of sound waves?**

4- **What is effect of the following parameters on the speed of the sound waves:**

Medium type – Temperature – Density of the medium – Viscosity of the medium

5- **Describe the mechanism of hearing?**

6- **Discuss applications of ultrasound?**

7- **Illustrate the mechanism of ultrasound image formation?**

8- **What are the components of an Ultrasound machine?**

Quiz (5)

1- Classify the different types of ionizing radiation?

2- Discuss the radiation units?

3- <u>Write a short not on:</u>

- ✓ Photoelectric effect
- ✓ Compton scattering
- ✓ Pair production
- ✓ Coherent scattering
- ✓ Photodisintegration

4- What is the radiation exposure sources?

5- <u>Define the following terms:</u>

Prompt somatic effects – delayed somatic effects- deterministic effects- threshold dose- Stochastic effects.

6- <u>Compare between:</u>

- Direct and indirect effect of radiation
- Radiosensitive and radioresistance cells

7- Discus the radiation exposure modifier?

8- Illustrate the component of X-ray tube and the mechanism of X- ray production?

9- Write on the properties and medical applications of X- ray?

10- Discuss the mechanism of CT scan?

11- Compare between axial and spiral scanning?

Quiz (6)

1- What is the conditions for Suitable radionuclides?

2- <u>Write short not about:</u>

- Gamma camera Collimators
- Scintillation detector
- **Photomultiplier tube**

3- <u>Compare between:</u>

- SPECT and PET scan
- Static and dynamic planer imaging

4- <u>Define the following terms:</u>

Half-Life - Mean- Life - Physical half-life - Biological half-life - Effective half-life – septal penetration