Experimental Tasks A + B + C

Time : 3 hrs
Marks :40

Very Important Instructions

The first 15 minutes are to be used ONLY for reading the question paper and planning of the experimental tasks.

You MAY NOT write anything during this period, even on the Question Paper.

After 15 minutes, you will be given the answer sheets and a signal to start the experiments.

You will then have a further 3 hours to complete the examination.

Task: A Pendulum (14 marks for this task)

Examination Rules:

1. You are not allowed to bring any tools **except** any personal medicine or any personal medical equipment.
2. You must sit at your designated table.
3. Before the examination starts, you must check the stationery and any tools (pen, ruler, calculator) provided by the organizers.
4. You must check the question paper and answer sheet. Raise your hand, if you find any missing sheets. You may start only when given the signal by the organizers.
5. During the examination, you are not allowed to leave the examination room except in an emergency and for that the examination supervisor/volunteer/invigilator will accompany you.
6. You are not to disturb any other competitor or disrupt the examination. In case any assistance is needed, you may raise your hand and the nearest supervisor will come to help.
7. You may not question or discuss the examination problems with anyone other than your team members. You must stay at your table until the time allocated for the examination is over, even if you have finished the examination or you do not want to continue working.
8. A signal will indicate the end of the allotted time for the examination. You are not allowed to write anything on the answer sheet after the allocated time is over. You must leave the room quietly after all the answer sheets have been collected.

Experimental Tasks A + B + C

Time : 3 hrs
Marks :40

Read the following instructions carefully:

1. While you are in the examination hall, you should wear safety spectacles at all times. While doing your experimental task, always wear your lab coat, safety goggles, and hand gloves.
2. Handle each and every apparatus and chemicals with care.
3. Do not try to taste or smell any chemical substance.
4. Chemicals are very safe if handled and disposed of properly.
5. Ensure that you keep the answer sheet and question paper away from liquids.
6. Place all waste papers and used material in the waste basket provided.
7. Immediately report all accidents, injuries, however minor they may be, to the invigilator/supervisor/volunteer present.
8. Eating of any kind of food is strictly prohibited during the experimental task.
9. You are expected to work safely, to behave socially, and to keep the equipment and work environment clean. When carrying out discussions with your teammates, keep your voice low.
10. Do not leave the examination hall until you have permission to do so. Ask an invigilator/supervisor/volunteer if you need to use the bathroom.
11. You may start working only when the start signal is given.
12. You have 3 hours to complete the experimental tasks and to record your results on the yellow answer sheets. You must stop your work immediately after the stop command is given.
13. Be sure that your team has a complete set of the question paper (3 copies) and 2 types of answer sheets (1 white copy for rough work and 1 yellow copy for final answers). **ONLY YELLOW ANSWER SHEETS WILL BE EVALUATED.**
14. Use only the pen and calculator provided.
15. ID code must be written on every page of the final (yellow) answer sheets. Each team member must sign on the front page of the final (yellow) answer sheets.

16. All results must be written in the designated boxes on the **yellow answer sheets**. **Data written elsewhere will not be evaluated.**
17. After completing the task, put all the equipment back to its original place. Make sure you clean your work place.
18. After the stop command is given, put all papers inside the envelope kept on the desk. Wait for the volunteer to check and collect it.

Experimental Tasks A + B + C

Time : 3 hrs
Marks :40

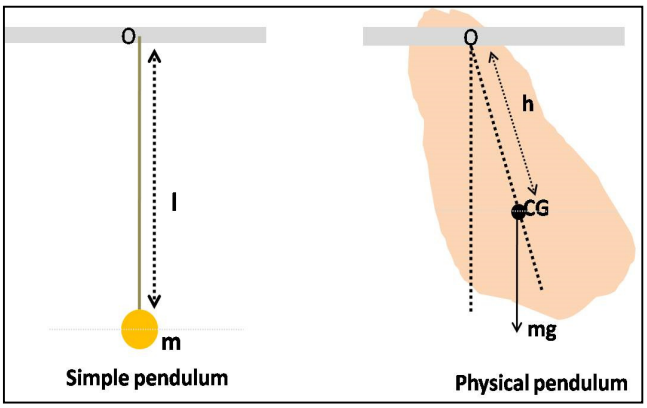
Task **A:** This task is divided into three parts:

A1: To determine the centre of gravity of a triangular plate, A.
A2: To record the time period of oscillation for different suspension points for the plate.
A3: To analyze the above data and results.

A *simple pendulum* consists of a point mass m suspended from a string of fixed length l and negligible mass, the other end of which is fixed to a rigid support O. For small displacements from the equilibrium position (shown in the figure below), the point mass m executes simple harmonic motion with time period, T (time taken for one oscillation):

$$T = 2\pi\sqrt{\frac{l}{g}}$$

where g is the acceleration due to gravity.



A much wider variety of situations that involve small oscillations may be described in terms of a *physical pendulum*, also called a "compound pendulum". Using this concept, we can describe the motion of a rigid body of mass m, of arbitrary shape and size. It is pivoted at O (called the "point of suspension", as shown in the above figure). For small displacements, such a physical pendulum executes simple harmonic motion, with time period

$$T = 2\pi\sqrt{\frac{I_0}{mgh}}$$

Here I_0 is the *moment of inertia* about an axis passing through the point of suspension, h is the distance of the point of suspension from the *centre of gravity* (CG), and g is the acceleration due to gravity.

Moment of inertia (I_0) is a quantity measuring the resistance offered by a body against its rotational motion. It is always referred to with respect to an axis of rotation and it depends on the body's shape. For a point mass m, the moment of inertia I_0 is given by $I_0 = mr^2$, where r is the distance of the point mass from the axis of rotation.

In this experiment we consider a triangular plate of mass m which oscillates in its own plane. Its moment of inertia about an axis passing through its point of suspension O is given by:

$$I = m(K^2 + h^2)$$

where K is called the radius of gyration.

The time period of oscillation of the physical pendulum is therefore

$$T = 2\pi\sqrt{\frac{K^2 + h^2}{gh}}$$

The time period can also be written as $T = 2\pi\sqrt{\frac{L}{g}}$

where $L = \frac{K^2}{h} + h$ is called the length of an equivalent simple pendulum.

A point S, on the other side of the CG and at a distance of $h' = \frac{K^2}{h}$ from the CG (along the line joining O and CG) is called the "point of oscillation". The oscillations with the point of suspension O are then equivalent to having all the mass concentrated at S.

Experimental Tasks A + B + C

Time : 3 hrs
Marks :40

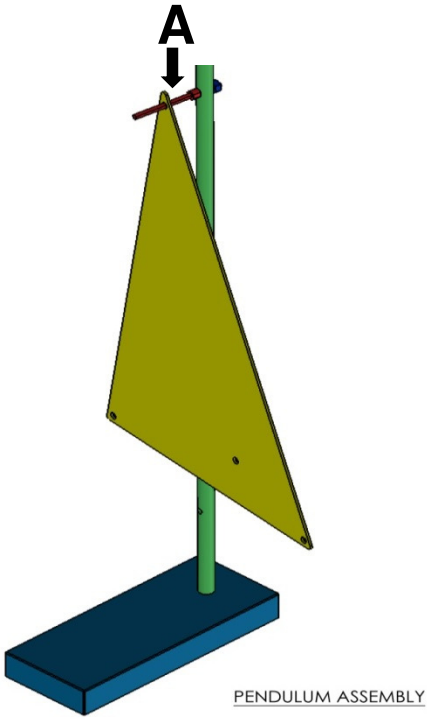
You are supplied with the following:

	Quantity
Clamp Stand	1
Triangular plate	1
Fulcrum rod with knife edge for suspension	1
Plumb line	1
Ruler	1
Stop watch Same stopwatch to be used for Task B	1

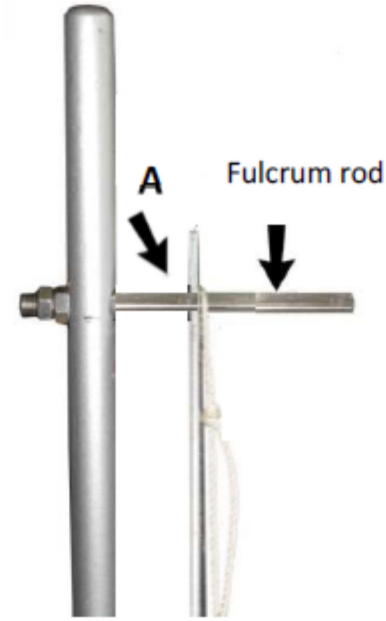
A1 To determine the centre of gravity (CG) of triangular plate, A.

Procedure:

1. Suspend the triangular plate **A** from the fulcrum rod (mounted on the clamp stand) by one of the three holes provided at the three corners of the triangle (see the figure below).



PENDULUM ASSEMBLY



2. Ensure that the suspended plate is stationary. Pass the loop of the string on the rod and hang the plumb line through the fulcrum rod (as shown in the figure above). Using a ruler and pencil, mark a straight line on the plate along the string.

3. Repeat the same procedure by suspending the plate through a different hole. The intersection of the two lines gives the CG. Use a pencil to mark it as 'X' on the plate.

   Mark the two lines and the point 'X' also on the large sized sheet of paper (provided to you) with a drawing of the triangular plate on it. Label it as **Sheet 1**.

   Please write ID codes of all team members and the Country Code on **Sheet 1**.

   [A.Q1: 1.0 mark]

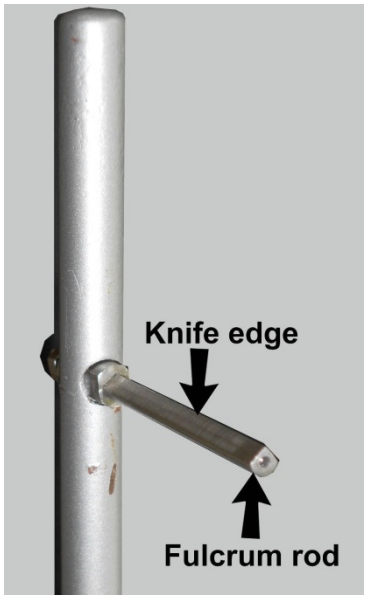
4. Suspend the plate through a different hole and repeat steps 1 and 2. This line should also pass through the CG. Show the line on **Sheet 1** also.

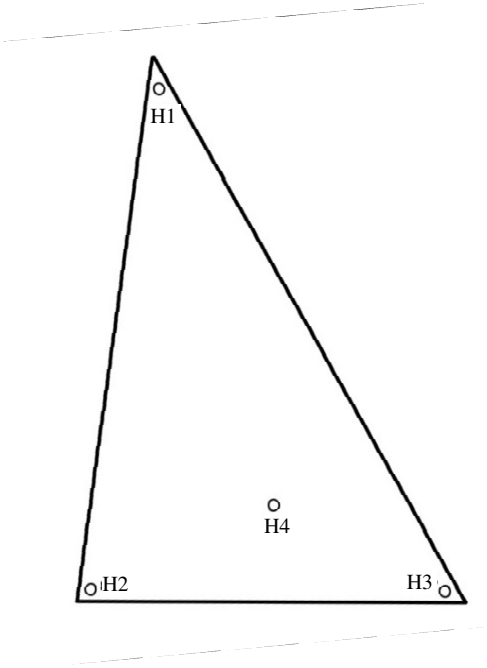
Note: The correct determination of CG is very important as any error here will introduce a corresponding error in the measurement of h, which will be used later.

A2 To record the time period of oscillation for different suspension points for the plate.

Procedure:

1. Suspend the plate from hole **H1** using the fulcrum rod. Ensure that the plate is almost at the centre of the fulcrum rod and resting on the knife edge (see the figure below). This is important to reduce damping of the oscillations and, hence, to minimize error in determining the time period of oscillations.





Note: Measure all distances from the top end of all the holes.

2. Measure the distance **h** between hole **H1** and the **CG** you marked in the previous part of the experiment. (Measure the distance from the top end of hole **H1**). Write it in **Table A.1 in the yellow answer sheet**.

3. Set the plate into oscillation (with small amplitude) and ensure that these oscillations occur mostly in the plane of the plate.

4. Using the stop watch, measure the time taken for 50 oscillations. Repeat three times and write each reading in **Table A.1 in the yellow answer sheet.**

5. Repeat the above steps for holes **H2**, **H3**, and **H4.**

[A.Q2: 4.0 marks]

A3 To analyze the above data and determine

a) the acceleration due to gravity
b) the radius of gyration of the plate about an axis passing through its CG normal to the plane of the triangle;
c) the positions of the corresponding points of oscillation from the CG for two points of suspension; and
d) the lengths of the equivalent simple pendulum for these two points of suspension.

Procedure:

1. Using the data in **Table A.1**, plot a graph of hT^2(y-axis in ms^2) versus h^2 (x-axis in m^2) on the grid provided in the answer sheet (**Grid 1**).

[A.Q3: 2.0 marks]

2. Draw a straight line through the points (best fit) and determine the slope s and the y-intercept c.

   Using these values of s and c, and the expression for the time period of a physical pendulum, determine the values of g in ms^{-2} and K in units of metres. Enter the values of s, c, g, and K in **Table A.2 in the yellow answer sheet.**

[A.Q4: 3.0 marks]

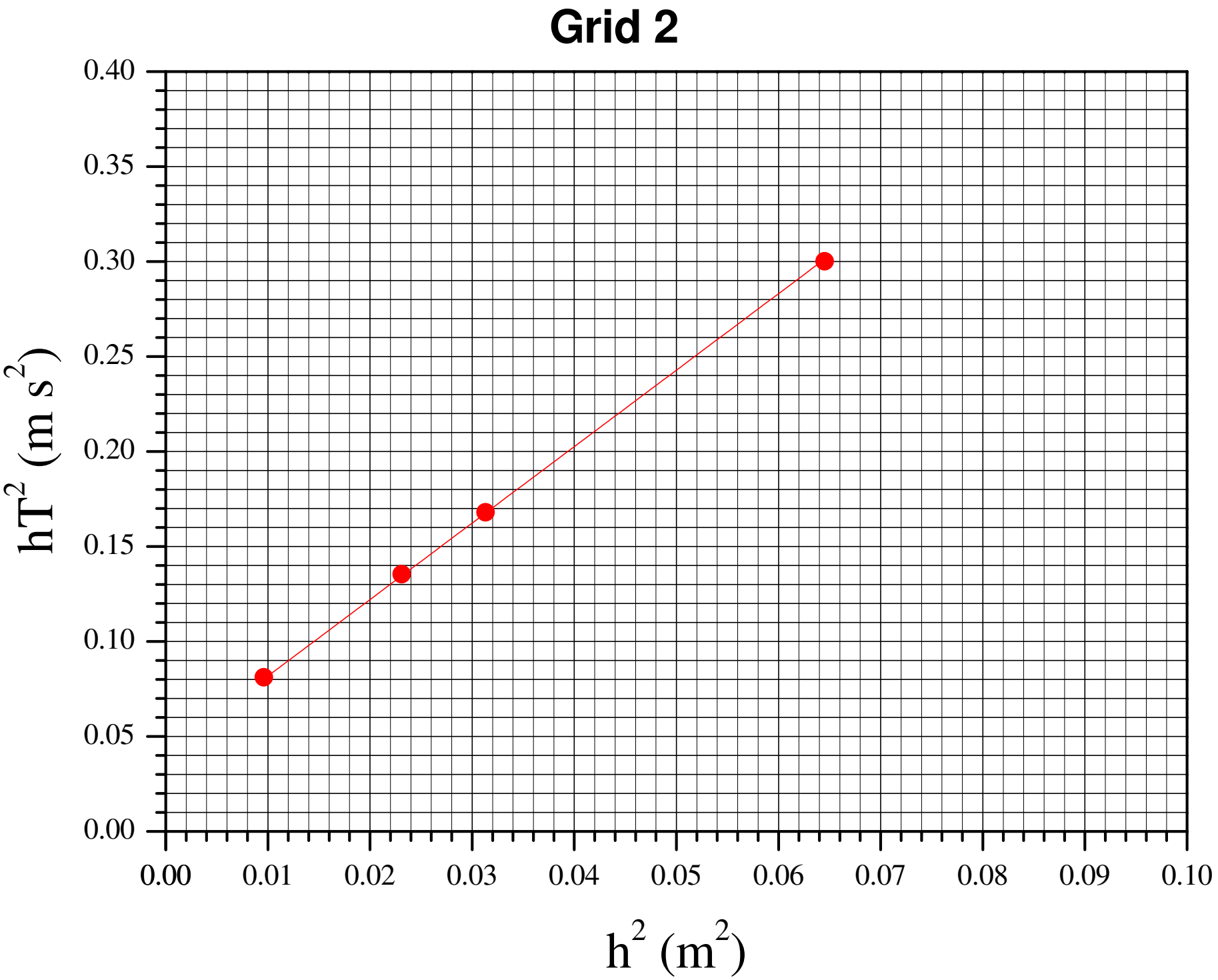
3. For holes **H1** and **H4**, calculate the positions of the corresponding points of oscillation from the CG (h'). Write it in **Table A.3 in the yellow answer sheet**. On the large sized sheet of paper (**Sheet 1**), mark the positions of the points of oscillation **J1** and **J4** corresponding to the holes **H1** and **H4, respectively.**

[A.Q5: 3.0 marks]

4. Determine the length (L) of the equivalent simple pendulum when the plate is suspended from **H1** and **H4**. Write your answer in **Table A.4 in the yellow answer sheet.**

[A.Q6: 1.0 mark]

Space for rough work


Grid 2
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
hT2 (m s2)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
h2 (m2)

Task: B Milk (20 marks for this task)

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18. After the stop command is given, put all papers inside the envelope kept on the desk. Wait for the volunteer to check and collect it.

Task B: In this set of experiments we will investigate,

B1 The buffering capacity of milk.
B2 Enzymatic digestion of milk proteins.
B3 Estimating the calcium content of milk.

B1 The buffering capacity of milk

India is one of the largest milk producing countries in the world. A large part of the credit for this goes to the world's biggest agricultural development programme, Operation Flood, initiated and sustained by **Dr. Verghese Kurien**, known as the "Father of the White Revolution" for his billion-litre idea.

Milk is a source of many nutrients. It consists of 87% water and 13% solids suspended or dissolved in water, in the form of proteins (3.5%), carbohydrates (4.7%), fats (4.0%) and vitamins/minerals (0.8%). The major milk sugar is lactose, which is water soluble. Milk fat is in the form of globules emulsified in water. The most abundant protein in milk is casein, which exists as a suspension of particles called casein micelles. Each micelle consists of thousands of casein molecules; the micelles are, in turn, bound together by Ca^{2+}. The casein micelles and fat globules give milk its white colour and deflect light rays passing through it. Milk is slightly acidic with a pH between 6.4-6.8. Curdling of milk occurs when the pH of milk is reduced to 5.0. At this pH, the milk casein molecules clump together and precipitate. Milk is known to have a good buffering capacity.

You are supplied with the following:

	Labeled as ….	**Quantity Supplied**
Milk	**Milk**	100 ml in red cap plastic jar
3% (v/v) acetic acid solution	**AA**	10 ml in sample container AA
3% (w/v) sodium carbonate solution	**SC**	10 ml in sample container SC
Water bottle	**Water**	1000 ml in bottle
100 ml glass beakers	**W, Exp**	2
20ml graduated syringe	**A**	1
1 ml graduated syringes	**B, C**	2
pH papers; range 2 to 10.5		2 booklets
Wash bottle		1
Glass rod		1
Tissue roll and Waste bucket		1 each

Procedure

1. Pour water from the water bottle into the beaker **W** until it is roughly full.
2. Transfer 40 ml of water into the beaker **Exp,** using syringe **A**.
3. Measure the pH of the water in beaker **Exp.** For this, dip the given pH paper strip in the water in the beaker for a few seconds. Take out the dipped pH paper and observe the colour change; match the colour with the pH range provided on the leaflet. Write the pH in the **box in the yellow answer sheet.**

[B.Q1.A: 0.25 marks]

4. Measure the pH of sodium carbonate solution supplied in the sample container **SC**. Write the pH in the **box in the yellow answer sheet.**

[B.Q1.B: 0.25 marks]

5. Add 0.1 ml of sodium carbonate solution to the water in beaker **Exp** using syringe **B**. Stir well with the glass rod and measure its pH with a pH paper. Write the new pH value observation **Table B.1 in the yellow answer sheet.**

6. Continue adding 0.1 ml of sodium carbonate solution and write the pH values in **Table B.1 in the yellow answer sheet**, till the pH of the solution reaches 10. Also write the total volume of sodium carbonate solution added.

[B.Q2: 1.0 mark]

7. Now wash the beaker **Exp** and glass rod so that no traces of the previous solution remain. Wipe it with tissue paper.
8. Add 40 ml of water in to the washed beaker **Exp** using syringe **A**.
9. Measure the pH of acetic acid in sample container **AA**. Write the pH in the **box in the yellow answer sheet.**

[B.Q1.C: 0.25 marks]

10. Add 0.1ml of given acetic acid solution to the water in beaker **Exp**, using syringe **C.** Stir well with the glass rod and measure the pH with a pH paper. Record the pH value in the **Table B.1 in the yellow answer sheet.**
11. Continue adding 0.1ml of acetic acid solution and write the pH values **in Table B.1 in the yellow answer sheet,** till the pH of the solution reaches 4. Also write the total volume of acetic acid solution added.

[B.Q2. 1.0 mark]

12. Now wash the beaker **Exp** and glass rod so that no traces of the previous solution remain. Wipe it with tissue paper.
13. Use syringe **A** to add 40 ml of milk to the washed beaker **Exp**.
14. Measure the pH of the milk using the pH paper. Write the pH in the **box in the yellow answer sheet.**

[B.Q1.D: 0.25 marks]

15. Using syringe **B**, add 0.5 ml of sodium carbonate solution to the milk in beaker **Exp**. Stir well with the glass rod and measure the pH. Write the pH value in **Table B.2 in the yellow answer sheet.**
16. Keep adding 0.5 ml of sodium carbonate solution till the pH value of the milk sample reaches 10.
17. Write the pH value for each addition in observation **Table B.2 in the yellow answer sheet.** Also write the total volume of sodium carbonate solution added.

[B.Q3: 1.0 mark]

18. Now wash the beaker **Exp** and glass rod so that no traces of the previous solution remain. Wipe it with tissue paper.

19. Use syringe **A** to again add 40 ml of milk in to the washed beaker **Exp**.
20. Using syringe **C**, add 0.5 ml of acetic acid solution to the milk in beaker **Exp**. Stir well with the glass rod and measure the pH. Keep adding 0.5 ml of acetic acid solution till the pH value of the milk sample reaches 4.
21. Write the pH value for each addition in **observation Table B.2 in the yellow answer sheet.** Also write the total volume of acetic acid solution added.

[B.Q3: 1.0 mark]

22. Wash the beaker **Exp** and glass rod, dry it with tissue, and keep it ready for the next task.

Questions

From your observations in **Tables B.1** and **B.2**,write on **the yellow answer sheet** whether the following two statements are true (T) or false (F).

a) You require more acetic acid solution to lower the pH of milk to 4 than to lower the pH of water to 4.
b) You require less sodium carbonate solution to raise the pH of milk to 10 than to raise the pH of water to 10.

[B.Q4: 1.0 mark]

As compared to water, milk resists change in pH of the resulting solution when acetic acid is added. This is because components of milk:

a) lead to increase in concentration of the OH^- ions in the resulting solution
b) prevent increase in concentration of the free H^+ ions in the resulting solution
c) lead to decrease in concentration of CH_3COO^- ions in the resulting solution

Write the correct option in the appropriate box in **the yellow answer sheet**.

[B.Q5: 1.0 mark]

B2 Enzymatic digestion of milk protein

To measure the change in opacity of milk due to digestion of milk proteins with trypsin (a protease)

Addition of trypsin to milk breaks down casein. This causes the milk to become translucent. The rate of reaction can be measured by determining the time it takes for the milk to turn translucent. You will use a photodiode in your measurements. A photodiode is a device that converts light into electrical current which you will measure using a digital multimeter. You will also use a light emitting diode (LED) as a light source.

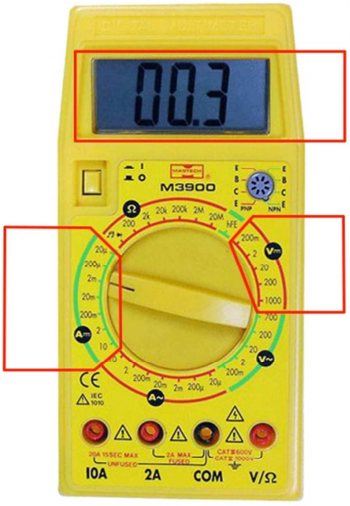
You are supplied with the following:

	Labeled as...	**Quantity Supplied**
Power supply; 500 mA, 3 V		1
Acrylic set-up with photodiode (see photo on page 9)		1
White LED		1
Digital multimeter		1
Test tube	**ED**	1
Milk		As supplied for Task B1
Trypsin	**TE**	5 ml in a test tube
Water		As supplied for Task B1
Graduated syringe(1ml)	**TE**	1
Graduated syringe (12 ml)	**W**	1
Stop watch		1
Dropper		1
Sticky paper		

Note: The white LED has a white base. The blue LED has a coloured base.

The photo below is that of a multimeter. Your multimeter may be either yellow or black.

Multimeter knob is to be positioned in this region for current measurement
2μA is the minimum range of current measurement
10A is the maximum range



If display read *-1*, it implies range is insufficient. Shift the knob to higher range. Working in higher range than required will result in loss of accuracy

For this experiment DO NOT keep the knob in A ~V ~Ω

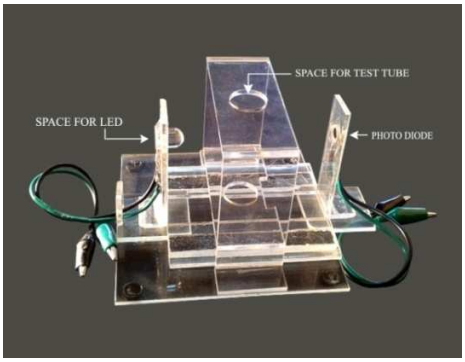
Multimeter knob is to be in this region for voltage measurement

To measure current

To Measure Voltage

1. Press MODE button, if the Stopwatch is on Time Mode, to bring it to Stop Watch Mode. 0:00 00
2. Press SPLIT/RESET button to reset the Stopwatch to Zero.
3. Press START/STOP button to start the Stopwatch.
4. Press START/STOP button to stop the Stopwatch.
5. In Stopwatch mode START/STOP button should be used to start and stop as many times as required.

Stopwatch



Acrylic set-up with photodiode

Procedure

1. Mount the White LED in the space provided on the fixed part of the acrylic stand, as shown in the photograph above. You may have to use sticky paper provided to you to ensure that the LED is mounted tightly.
2. Connect the White LED to the Power supply such that shorter leg of the LED connects to black wire. Then switch the power supply on. The LED should glow brightly.
3. Set the multimeter in the current mode and 2 mA current range.
4. Connect the photodiode mounted on the movable part of the acrylic stand to the multimeter.
5. Add 10 ml of water to test tube **ED** using syringe **W*;*** use tissue paper to wipe the outer surface of **ED** so that it is completely dry. Then place the test tube in the space provided for it on the acrylic stand.
6. Ensure that the light from the LED passes through the water in the test tube and falls on the photodiode. Orient the test tube such that the light is not blocked by the label.
7. Adjust the positions of the photodiode and test tube by carefully sliding either the mounted photodiode or the test tube holder such that the current reading on the multimeter maximizes. Record the maximum current I_W **in the yellow answer sheet.**

[B.Q6.A: 0.5 mark]

Note that for subsequent readings these positions of the photodiode and test tube holder must remain the same.

8. Remove the test tube from the acrylic stand and pour out the water.
9. Add 5 ml of water in test tube **ED** and then add 5 ml of milk to it with the help of syringe **W.** Mix well by gently tapping the test tube. Wipe the outside of the test tube with tissue paper to ensure that it is dry. Carefully place the test tube in the space provided on the acrylic stand and record the current I_0 **in the yellow answer sheet**.

[B.Q6.B: 0.5 mark]

10. Keep the stopwatch ready to start.
11. Use syringe **TE** to add 1 ml of trypsin to this milk sample in the test tube. Mix thoroughly using the plastic dropper. Ensure that test tube holder stand is at its original place (where previous readings were taken).
12. Immediately start the stopwatch.
13. Read the current on the multimeter at 15 seconds intervals and record the values in **Table B.3 in the yellow answer sheet.**

14. Continue recording the values of current up to **7** minutes.

[B.Q7: 2.0 marks]

15. Discard the solution and wash the test tube.

Graph plotting

Plot a graph of current versus time in the grid provided in the answer sheet.

[B.Q8: 3.5 marks]

Questions

Mark a point K on the graph where the casein concentration is maximum, a point L where the casein concentration is minimum, and a point M where the casein concentration is half-way between maximum and minimum values.

[B.Q9: 1.0 mark]

If the increase in current is proportional to the amount of digested casein and maximum current represents complete digestion of casein, deduce from the graph the time taken for digestion of 50% casein.

[B.Q10: 1.0 mark]

B3 Estimation of calcium content in milk

Calcium content in milk can be estimated by a special form of titration using a reagent called **Na_2EDTA**. Na_2EDTA reacts with metal ions in 1:1 proportion irrespective of the charge on the metal ion. Indicators used in such titrations are called metal-ion indicators. The indicator used in the present experiment is Eriochrome black T **(EBT)**.

You are supplied with the following:

	Labeled as ...	**Quantity Supplied**
Trypsin-treated milk	**CM**	100 ml in a volumetric flask
Water		As supplied in task B1
100 ml glass beaker	**HM**	1
10 ml graduated syringe	**CM**	1
100 ml conical flask	**HM**	1
Buffer solution pH 10	**BF**	Three 5 ml test tubes with screw caps
Dropper		1
Eriochrome Black T indicator	**EBT**	Dropping bottle
Burette 25 ml (on a stand)		1
Na_2EDTA solution (0.0027 M)	**EDTA**	80 ml in plastic bottle
Funnel		1

Procedure:

1. Add the Na_2EDTA solution to the burette using the funnel.
2. Write the initial burette reading in **Table B.4 in the yellow answer sheet**
3. Dilute the given trypsin-treated milk in the volumetric flask **CM** with water up to the mark. Insert the stopper and shake the solution well to homogenize it.
4. Now pour out the homogenized solution into beaker **HM**.
5. Add 10 ml of homogenized solution, using syringe **CM,** to the conical flask **HM**.
6. Add 10 ml of water to it, using syringe **W**.
7. Now add all the supplied buffer amount from *one* of the test tubes **BF**.
8. Add 5 drops of **EBT** indicator from the dropping bottle. The colour of the solution will change to red (pinkish red).

9. Titrate this solution in the conical flask **HM** with Na_2EDTA from the burette. Continue till the colour of the solution changes initially to purple and then to the first appearance of blue (which is the end point).
10. Write the final burette reading in **Table B.4 in the yellow answer sheet**
11. Repeat the titrations twice.
12. Enter your readings in the observation **Table B.4 in the yellow answer sheet.**
13. Calculate the volume of the solution needed for titration I, II and III. Write the values in **Table B.4 in the yellow answer sheet.**
14. Calculate the average volume.

[B.Q11: 3.5 marks]

Question:

Deduce the amount in milligrams of Ca^{2+} per 10 ml of the diluted solution (the atomic weight of Ca is 40).

[B.Q12: 1.0 mark]

Space for rough work

Task: C Tomato (6 marks for this task)

Examination Rules:

1. You are not allowed to bring any tools **except** any personal medicine or any personal medical equipment.
2. You must sit at your designated table.
3. Before the examination starts, you must check the stationery and any tools (pen, ruler, calculator) provided by the organizers.
4. You must check the question paper and answer sheet. Raise your hand, if you find any missing sheets. You may start only when given the signal by the organizers.
5. During the examination, you are not allowed to leave the examination room except in an emergency and for that the examination supervisor/volunteer/invigilator will accompany you.
6. You are not to disturb any other competitor or disrupt the examination. In case any assistance is needed, you may raise your hand and the nearest supervisor will come to help.
7. You may not question or discuss the examination problems with anyone other than your team members. You must stay at your table until the time allocated for the examination is over, even if you have finished the examination or you do not want to continue working.
8. A signal will indicate the end of the allotted time for the examination. You are not allowed to write anything on the answer sheet after the allocated time is over. You must leave the room quietly after all the answer sheets have been collected.

Read the following instructions carefully:

1. While you are in the examination hall, you should wear safety spectacles at all times. While doing your experimental task, always wear your lab coat, safety goggles, and hand gloves.
2. Handle each and every apparatus and chemicals with care.
3. Do not try to taste or smell any chemical substance.
4. Chemicals are very safe if handled and disposed of properly.
5. Ensure that you keep the answer sheet and question paper away from liquids.
6. Place all waste papers and used material in the waste basket provided.
7. Immediately report all accidents, injuries, however minor they may be, to the invigilator/supervisor/volunteer present.
8. Eating of any kind of food is strictly prohibited during the experimental task.
9. You are expected to work safely, to behave socially, and to keep the equipment and work environment clean. When carrying out discussions with your teammates, keep your voice low.
10. Do not leave the examination hall until you have permission to do so. Ask an invigilator/supervisor/volunteer if you need to use the bathroom.
11. You may start working only when the start signal is given.
12. You have 3 hours to complete the experimental tasks and to record your results on the answer sheets. You must stop your work immediately after the stop command is given.
13. Be sure that your team has a complete set of the question paper (3 copies) and 2 types of answer sheets (1 white copy for rough work and 1 yellow copy for final answers). **ONLY YELLOW ANSWER SHEETS WILL BE EVALUATED.**
14. Use only the pen and calculator provided.
15. ID code must be written on every page of the final (yellow) answer sheets. Each team member must sign on the front page of the final (yellow) answer sheets.

16. All results must be written in the designated boxes on the **yellow answer sheets**. **Data written elsewhere will not be graded.**

17. After completing the task, put all the equipment back to its original place. Make sure you clean your work place.

18. After the stop command is given, put all papers inside the envelope kept on the desk. Wait for the volunteer to check and collect it.

Task C: In this experiment we will extract lycopene from tomato and study its absorbance

Tomatoes are one of the main ingredients of pizzas. Tomatoes have two ingredients, lycopene and β-carotene, which are antioxidants and very good for health. They are soluble in oil but not water and, hence, in many parts of the world tomatoes are cooked in oil. Red tomatoes can contain as much as 50 mg of lycopene per kilogram of tomato.

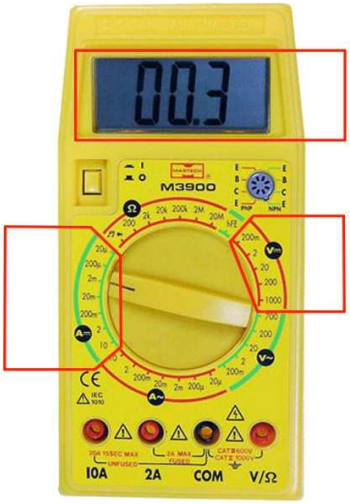
In order to test the presence of lycopene in tomatoes, we shall dissolve tomato concentrate in an extracting solvent made up of petroleum ether and ethanol; we shall allow the solution to settle. The lycopene-rich solution separates out, resulting in two immiscible liquids. The top solution will be carefully separated out; its moisture content will be removed by using magnesium salts (which are hygroscopic in nature).

You are supplied with the following:

	Labelled as…	Quantity Supplied
Tomato Concentrate	**TP**	In 50 ml beaker
Extracting Solvent	**ES**	(20ml) in 50 ml tube
Anhydrous Magnesium sulphate	**$MgSO_4$**	(1.5g) in a plastic container
Sodium chloride	**NaCl**	In plastic container
Test tube with stopper	**FL**	1
Test tubes	**Ab, UL**	2
Funnel		1
Glass rod		1
Filter paper		3
12 ml syringe	**SS**	1
Wash Bottle		1
White LED and Photodiode acrylic set-up		1
50 ml beaker	**SS**	1
Test tube stand		1
Blue LED		1
Bag containing acrylic collar for test tubes	**Collar**	
Dropper		
Multimeter		as in task B

The photo below is that of a multimeter. Your multimeter may be either yellow or black.

Multimeter knob is to be positioned in this region for current measurement
2μA is the minimum range of current measurement
10A is the maximum range



If display read *-1*, it implies range is insufficient. Shift the knob to higher range. Working in higher range than required will result in loss of accuracy

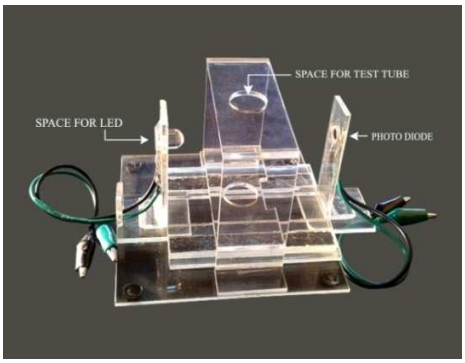
For this experiment DO NOT keep the knob in A ~V ~Ω

Multimeter knob is to be in this region for voltage measurement

To measure current

To Measure Voltage

1. Press MODE button, if the Stopwatch is on Time Mode, to bring it to Stop Watch Mode. 0:00 00
2. Press SPLIT/RESET button to reset the Stopwatch to Zero.
3. Press START/STOP button to start the Stopwatch.
4. Press START/STOP button to stop the Stopwatch.
5. In Stopwatch mode START/STOP button should be used to start and stop as many times as required.



Stopwatch

Procedure *Acrylic set-up with photodiode*

1. **<u>Use the same acrylic apparatus that you used in Task:B2</u>**. Insert a white LED and photo-diode in their respective slots.
2. Half-fill test tube **Ab** with solvent from tube **ES**, using a dropper.
3. Using the acrylic collar provided, place test tube **Ab** in the acrylic apparatus, such that it is located between the LED and the photodiode (*as shown in the photograph).*
4. Adjust the position of the photodiode and the test tube so as to maximize the current in the photodiode which is connected to the multimeter, as described in **TASK: B2.** Please ensure that the label on the test tube does not obstruct the light.
5. Measure the maximum current, I_s, and record your observation in **Table C.1 in the yellow answer sheet.**
6. Replace the WHITE LED with the BLUE LED **without changing the position of either the test tube holder or the photodiode.** Measure the maximum current and record the value in **Table C.1 in the yellow answer sheet.**
7. Pour all the solvent back in test tube **ES**.

Note: Do not disturb the position of the photodiode and the acrylic test tube holder, it is crucial for subsequent readings.

We shall now extract lycopene from tomato concentrate, as follows.

8. Transfer all the solvent from test tube **ES** into the tomato concentrate in beaker **TP**. Stir the mixture well with the glass rod and allow it to settle for 2-3 minutes. Wash the glass rod for further use.
9. Now, filter the solution carefully by using funnel, and filter paper, in test tube **FL**. The red clear solution in test tube **FL** is your lycopene-containing extract (impure).
10. Preparation of saturated solution of NaCl: Take approximately 20 ml water in beaker **SS** using syringe SS; then add all the solid NaCl from container **NaCl,** stir well using the glass rod. Some part of the salt may remain undissolved.
11. Use syringe **SS** to add 10 ml of saturated NaCl solution in test tube **FL** containing lycopene extract. Put the stopper on the test tube and shake gently.
12. Keep the test tube on the test tube stand. Let the liquid in the test tube separate into two distinct layers. This should take about a minute.
13. Using the plastic dropper provided**,** carefully remove most of the upper layer (coloured) into test tube **UL**.

14. Add all the anhydrous $MgSO_4$ from the container labeled **$MgSO_4$** into test tube **UL** and swirl gently to allow water to be absorbed by the salt.
15. The yellow-red coloured solution in test tube **UL** is your lycopene extract (pure).

    We shall now carry out a comparative study of absorbance between solvent and the lycopene extract.

16. Place test tube **UL** in the acrylic apparatus.
17. Using the blue LED, measure the current I_l on the multimeter and record the value in **Table C.1 in the yellow answer sheet.**
18. Replace the blue LED with a white LED.
19. Measure the maximum current and record your respective observations in **Table C.1 in the yellow answer sheet.**
20. Deduce the percentage of light transmitted in each case.

[C.Q1: 3.5 Marks]

Questions

If the test tube **Ab** (containing the solvent) was removed from between the photodiode and the white LED,

a) The current measured would be less than I_s
b) The current measured would be more than I_s
c) The current measured would be equal to I_s

Write the correct option in the appropriate box in the yellow answer sheet.

[C.Q2: 1.0 Mark]

Which of the following can you *deduce from your observations in the experiments* on transmitted light. Indicate your answers as YES (Y) or NO (N) on **the yellow answer sheet**.

a) Lycopene absorbs more blue light relative to other parts of the visible spectrum.
b) Lycopene preferentially absorbs light in the red and yellow parts of the spectrum.
c) Lycopene is an antioxidant.
d) Red and yellow parts of the spectrum are absorbed relatively less compared to blue parts of the spectrum.
e) Blue light passes through the solution better compared to red light.
f) Lycopene absorbs light equally across the spectrum.

[C.Q3: 1.5 Marks]

Space for rough work