Name : …….. Practicum: ……

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EXPERIMENT 1: MEASUREMENT AND UNCERTAINTY

Course Learning Outcome:
Solve problems related to Physics of motion, force and energy, waves, matter and thermodynamics
(C4, PLO 4, CTPS 3, MQF LOD 6)

Learning Outcomes:
At the end of this lesson, students will able to describe technique of measurement and determine uncertainty of length of various objects.

Student Learning Time:

Face-to-face	Non face-to-face
1 hour	1 hour

Direction: Read over the lab manual and then answer the following question.

Introduction

1. Complete **Table 1**

Basic Quantity	Symbol	SI Unit (with symbol)	Measuring Instrument
Length	*l*		
Mass	*m*		
Time	*t*		
Electric Current	*I*		
Temperature	*T*		

Table 1

2. …….. is used to measure the diameter of a coin.

3. Micrometer screw gauge is usually used to measure the …… of a thin wire or the ……. of paper.

4. Complete **Table 2**

Measuring Apparatus	Sensitivity	Uncertainty
Meter rule	0.1 cm	±0.1cm
Vernier calipers	0.01 cm	
Micrometer screw gauge		±0.01mm
Travelling microscope		±0.01mm
Thermometer	0.1°C	
Voltmeter	0.1 V	
Ammeter		±0.1A

Measuring Apparatus	Sensitivity	Uncertainty
Electronic Balance	0.01 g	

Table 2

5. State **TWO** types of reading;

   i. ……

   ii. ……

6. The repeated reading for a measurement is given as *a*, *b*, *c*, *d*, *e*, and *f*. Write the equation of Average Value and Uncertainty.

	EQUATION
Average Value, $\bar{x}$	
Uncertainty, $\Delta\bar{x}$	

Experiment

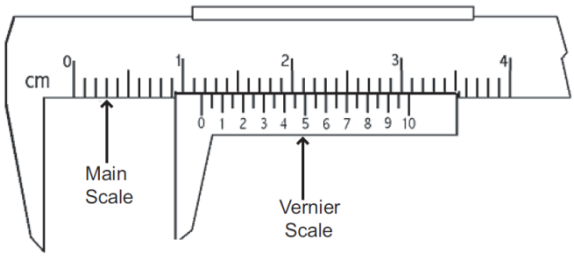
7. Complete **Table 3**

Measurement	Measuring Instrument	Uncertainty/ Smallest scale	Type of reading (single point/two point/Vernier scale)
Length of a metal rod			Two points
Length and width of a laboratory book			Two points
Mass of a ball bearing			Single Point
Diameter of a ball bearing			Vernier scale
Diameter of a coin			Vernier scale
External diameter of a glass rod			Vernier scale

Table 3

8. Determine the reading for the following measurements:

   i.

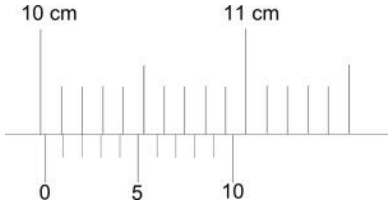


Main scale :……..

Vernier scale :……..

Actual reading :……

   ii.

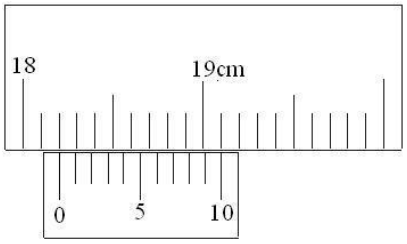


Main scale :……

Vernier scale :……

Actual reading :……...

iii.

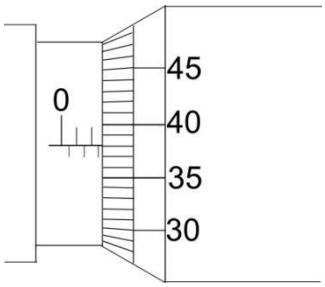


Main scale :…….

Vernier scale :……..

Actual reading:…….

iv.

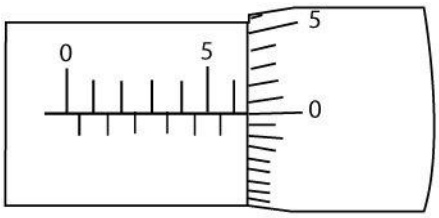


Main scale :……

Vernier scale :……

Actual reading :……

v.



Main scale :……..

Vernier scale :……..

Actual reading:…….

9. The repeated readings of the diameter, d of a ball bearing are 2.50 mm, 2.52 mm, 2.51 mm and 2.50 mm.

   i. Calculate the Average Value and Uncertainty. Write the result as $(\bar{d} \pm \Delta\bar{d})$

ii. What instrument/apparatus is used for this measurement?

……

iii. From 10.1, calculate the volume, *V* of the ball bearing.

iv. Write the result as $(\overline{V} \pm \Delta\overline{V})$

……

Data Analysis

10. Complete **Table 4.**

No	Length of Scientific Calculator (Model Casio fx-570ES PLUS), L (cm)	$\left\|\overline{L} - L_i\right\|$ (cm)
1	15.42	
2	15.55	
3	15.30	
4	15.48	
5	15.49	
6	15.45	
7	15.55	
	Average, $\overline{L}$=	$\Delta\overline{L}$=

Table 4

11. Express your answer as $(\overline{L} \pm \Delta\overline{L})$

12. Calculate the percentage of uncertainty,

13. State THREE precautions of this experiment:

i. ……...

ii. ……..

iii. ……

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EXPERIMENT 2 : FREE FALL AND PROJECTILE MOTION

Course Learning Outcome:
Solve problems related to **Physics of motion**, force and energy, waves, matter and thermodynamics **(C4, CLO 2, PLO 4, CTPS 3, MQF LOD 6)**

Learning Outcomes:
At the end of this lesson, students will able to describe experiment to determine acceleration due to gravity using free fall and projectile motion.

Student Learning Time:

Face-to-face	Non face-to-face
1 hour	1 hour

Direction: Read over the lab manual and then answer the following question.

Introduction

1. What is meant by free fall motion?

   …….

   …….

2. Under free fall motion the acceleration of an object is also known as gravitational acceleration or acceleration due to gravity. What is the symbol and SI unit of this type of acceleration?

   …….

3. What is the value of acceleration due to gravity at the surface of Earth?

   …….

4. Projectile motion of an object is the motion of an object which is projected or thrown. Under a gravitational field **when the air resistance is not present**, projectile motion can be considered as a free fall motion. State **TWO** differences between free fall motion and projectile motion?

   …….

   …….

   …….

   …….

   …….

5. State the law applied in these experiment

   …….

Experiment

6. How do we release the steel ball to form
   (a) free fall motion

   ……
   ……

   (b) Projectile motion

   ……
   ……
   ……

7. State the measurement *apparatus* involved. (e.g. type / name of equipment) for both experiment.

   ……
   ……
   ……

8. State the related variables that need to be recorded in this experiment?

	Free fall motion	Projectile motion
Manipulated variable (change on purpose)		
Responding variable (what is measured)		

9. Construct the table to record the related values for free fall and projectile motion experiment.
   (a) Free Fall Motion

   (b) Projectile Motion

10. How do you obtained the value of *t* for projectile motion from the graph of free fall motion experiment?

    ……

    ……

Data Analysis

11. a) Write the equations related to both experiments in order to determine the acceleration due to gravity, g.

    b) Sketch a suitable graph for
    i) Free fall motion ii) Projectile motion

    c) How the acceleration due to gravity, g can be determine from the graphs.

12. List down the precautions of the experiments.
    a) ……...
    b) ……...
    c) ……...

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EXPERIMENT 3: ENERGY

Course Learning Outcome:
Solve problems related to Physics of motion, **force and energy**, waves, matter and thermodynamics **(C4, PLO 4, CTPS 3, MQF LOD 6)**

Learning Outcomes:
At the end of this lesson, students will able to explain the experiment to determine the acceleration due to gravity, g from the experiment.

Student Learning Time:

Face-to-face	Non face-to-face
1 hour	1 hour

Direction: Read over the lab manual and then answer the following question.

Introduction

1. State the law of conservation of energy.

   ……

2. State the gravitational potential energy and kinetic energy.

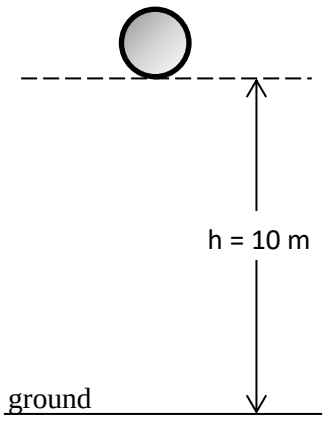
   ……

   ……

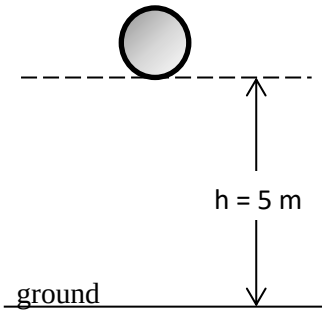
3. What is the symbol and SI unit of gravitational potential energy and kinetic energy?

Energy	gravitational potential energy	kinetic energy
Symbol		
Unit		

4. Based on the situations below, answer the questions:



SITUATION A



SITUATION B

a) Using the conservation of energy, determine the velocity of the ball just before it reaches the ground.

b) From the answers calculated in question (a), what can we deduce about the relation between the released height and the velocity of the ball before hitting the ground?

……

Experiment

5. What is the energy owned by the ball bearing when it is attached to the free fall adapter?

……

6. What is the usage of the photo gate?

……

7. State the change in mechanical energy in this experiment.

……

8. State the related variables that need to be recorded in this experiment?
   a) Manipulated variable

   ……

   b) Responding variable

   ……

9. How the final velocity of ball bearing is determined?

Data Analysis

10. An equation for a straight line graph is y = mx + c, where y is the quantity on the vertical axis and x is the quantity on the horizontal axis as shown in **FIGURE 1**.

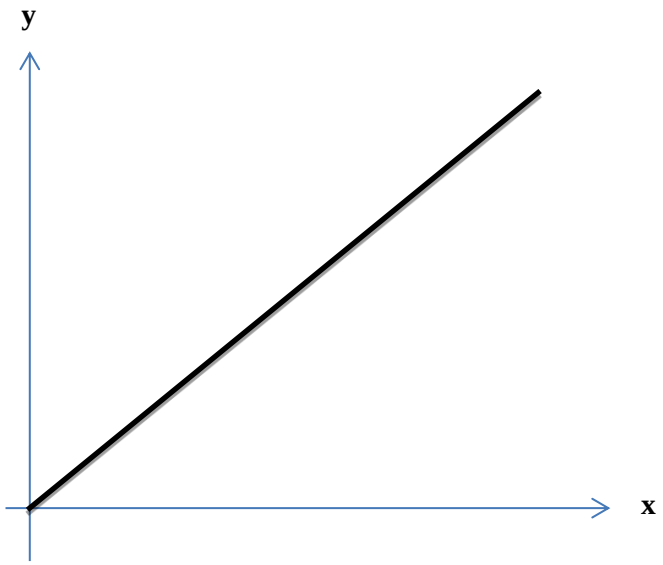


FIGURE 1

The velocity of ball bearing, v is related to the height of released (h) by the following equation:

$$v^2 = 2gh \_\_\_\_\_ (1)$$

where *g* is the acceleration due to the gravity.

a) Based on the equation (1) and the graph, determine the variables for *x* axis and *y* axis

b) From the graph what does the gradient, *m* represents?

……

c) From the gradient of the graph, how can we determine the value of *g*.

11. List **THREE** precautions of the experiment:

i. ……

ii. ……

iii. ……

12. State two types of errors during experiment and give an example for each error.

……

……

13. Based on the situation below identify either random or systematic error.

Situation	Random Error/Systematic Error
Wind keeps blowing in the surrounding using the experiment. This shall affect the velocity measured in this experiment. The best way to solve this is by conducting this experiment in the closed area or vacuum space.	
Some of the numbers on the timer's display was broken and missing. Thus the reading can be taken only to the nearest decimal point.	
Instead of using the hand to release the ball bearing, it is suggested that the ball can be released using the automatic control or trigger.	
Sometimes the time measured is hardly detected by the photo gates. This is due to the position of the gates where the ball bearing failed to hit the motion sensor. Therefore, the free fall adapter and photo gates must be realigned properly.	

Name : …….. Practicum: ……

Matric Number: ……..

EXPERIMENT 4: ROTATIONAL MOTION OF A RIGID BODY

Course Learning Outcome:
Solve problems related to Physics of motion, **force and energy**, waves, matter and thermodynamics **(C4, PLO 4, CTPS 3, MQF LOD 6)**

Learning Outcomes:
At the end of this lesson, students will able to explain the experiment to determine the moment of inertia of a fly-wheel from experiment.

Student Learning Time:

Face-to-face	Non face-to-face
1 hour	1 hour

Direction: Read over the lab manual and then answer the following question.

Introduction

1. What is a rigid body?

   ……

2. What is meant by moment of inertia?

   ……

   ……

3. What is the symbol and SI unit for moment of inertia?

   ……

4. Moment of inertia depends on ……..…. and …….

5. Complete **TABLE 4** with correct analogues between linear motion and rotational motion.

Linear Motion	Rotational Motion
Mass, m	
Acceleration, a	
Net force, F	

6. A motor capable of producing a constant torque of 100 Nm is connected to a flywheel which rotates with an angular acceleration of 1000 rad s^{-2}. Calculate moment of inertia of the flywheel.

Experiment

7. Sketch a free body diagram for fly-wheel and falling slotted mass.
   a) Free body diagram of fly-wheel b) Free body diagram of falling slotted mass

8. By referring to the free body diagram in 7(a) and 7(b), deduce equation by using Newton's 2nd Law of motion.

9. For this experiment, identify

   a) the manipulated variable

   …….

   b) the responding variable

   …….

10. Complete the observation table with the suitable equation.

Acceleration	Angular acceleration	Tension in the string

Data Analysis

11. Write the equation of the graph of α against T

12. Base on the linear graph equation $y = mx + c$, fill in the suitable quantity by referring the equation in question 11 :

    a) *y-axis* :……..
    b) *x-axis* : ……..
    c) gradient, *m* : ……..
    d) *y*–interception : ……..

13. How do we determine the value of inertia of a fly-wheel from this graph?

14. List **THREE** precautions of this experiment
    i. ……
    ii. ……
    iii. ……

Name : …….. Practicum: ……

Matric Number: ……..

EXPERIMENT 5: SIMPLE HARMONIC MOTION (SHM)

Course Learning Outcome:
Solve problems related to Physics of motion, force and energy, **waves**, matter and thermodynamics
(C4, PLO 4, CTPS 3, MQF LOD 6)

Learning Outcomes:
At the end of this lesson, students will able to:
1. explain the experiment to determine the acceleration due to gravity, g using a simple pendulum.
2. describe the effect of large amplitude oscillation to the accuracy of g obtained from the experiment

Student Learning Time:

Face-to-face	Non face-to-face
1 hour	1 hour

Direction: Read over the lab manual and then answer the following question.

Introduction

1. What is a simple pendulum?

   ……

2. Motion of an object that returns to its initial position after a fixed time interval is called

   ……

3. In SHM, state two quantities that proportional to the object's displacement

   i. ……..

   ii. ……..

4. The condition for the simple pendulum to perform SHM are

   a) The mass of the spherical bob is ……..

   b) The …… of the string is negligible

   c) Amplitude of oscillation is ……

5. Does the period of oscillation of simple pendulum depend on mass?

   (Yes / No)

Experiment

6. How to determine the period of a simple pendulum for a given number, n of oscillation?

   ……

7. If we vary the length of a pendulum, the period will change. Construct an appropriate table to record the data of length, *l*, time taken, *t* and corresponding T and T^2.

8. What is the title of the graph that needs to be plotted in this experiment?

   ……

9. Which procedure that investigates the effect of large amplitude of oscillation and state the related angle used.

   ……

Data Analysis

10. How to determine the value of g from the gradient of the graph.

11. How to calculate the percentage of error between the value $g_{experiment}$ and $g_{standard}$? Take $g_{standard} = 9.81\ m\ s^{-2}$.

12. Predict what would happen to the value of *g* if **large amplitude** is used.

    ……

13. List **THREE** precautions of this experiment

    i. ……

    ii. ……

    iii. ……

Name : …….. Practicum: ……

Matric Number: ……..

EXPERIMENT 6: STANDING WAVES

Course Learning Outcome:
Solve problems related to Physics of motion, force and energy, **waves**, matter and thermodynamics **(C4, PLO 4, CTPS 3, MQF LOD 6)**

Learning Outcomes:
At the end of this lesson, students will able to explain the experiment to investigate standing waves formed in stretched string.

Student Learning Time:

Face-to-face	Non face-to-face
1 hour	1 hour

Direction: Read over the lab manual and then answer the following question.

Introduction

1. What is the meaning of standing waves?

   ……

2. Sketch standing wave formed in a stretch string and label the node (N) and antinode (A).

3. How standing wave is formed?

   ……

   ……

   ……

4. What is the symbol and SI unit for mass per unit length?

   ……

Experiment

5. State the manipulative and responding variables in this experiment.

   ……

6. Construct the table for the value of m and *l*.

7. Sketch free body diagram to show that T = W.

8. Suggest a way to determine the actual value for mass per unit length of the string/wire used in this experiment.

   ……

   ……

9. Suggest how to identify the position of two consecutive nodes formed in the string / wire.

   ……

Data analysis

10. Write the equation that relates period, T and frequency, f.

11. Sketch the graph to show the relationship between T and ℓ^2.

12. Construct the observation table.

13. How do you determine the mass per unit length from this graph?

    ……

14. Throughout the experiment the terminals are connected to AC power supply. In your opinion why does this essential?