Laboratory Work Guide
FUNDAMENTAL OF HHYSICS

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EXPERIMENT 1

MEASSUREMENT AND UNCERTAINTY

A. Objectives:

1. Measure mass of object and its uncertainty.
2. Meassure volume of object and its uncertainty
3. Determine density of mass and its uncertainty

B. Matterial/Apparatus

1. Cube of metal (object)
2. Meassuring glass
3. Mass Balancing

C. Procedure

1. Meassure mass of object using balancing. Repeat this activity until 5 times, then write the results in Table 1 below!
   Table 1. Mass of Object

No	m (g)
1	
2	
3	
4	
5	

2. Meassure the volume of object. Repeat this activity until 5 times, then write the results in Table 2!
   Table 2. Mass of Object

No	V (cm^3)
1	
2	
3	
4	
5	

D. Data Analysis

1. Table 3. Data Analysis of Mass

No	m (g)	$\lvert m - \overline{m} \rvert$ (g)
1		
2		
3		
4		
5		
$\sum$		

The average mass:

$$\overline{m} = \frac{\sum m}{n} = \frac{\sum m}{5} = ...$$

The uncertainty of mass:

$$\Delta m = \frac{\sum \lvert m - \overline{m} \rvert}{n} = \frac{\sum \lvert m - \overline{m} \rvert}{5} = ...$$

Result of mass object: $m = \left(\overline{m} \pm \Delta m\right) = ...$

2. Table 4. Data Analysis of Volume

No	V (cm^3)	$\lvert V - \overline{V} \rvert$ (cm^3)
1		
2		
3		
4		
5		
$\sum$		

The average volume:

$$\overline{V} = \frac{\sum V}{n} = \frac{\sum V}{5} = ...$$

The uncertainty of mass:

$$\Delta V = \frac{\sum \lvert V - \overline{V} \rvert}{n} = \frac{\sum \lvert V - \overline{V} \rvert}{5} = ...$$

Result of mass object: $V = \left(\overline{V} \pm \Delta V\right) = ...$

3. Determine the density

$$\rho = \left(\rho \pm \Delta\rho\right) = ...$$

EXPERIMENT 2. CALORIMETER

A. Goal

Determine the specific heat capacity of substance (Alluminium)

B. Equipment/Material

Calorimeter, thermometer, stirer, bunsen burner, tripot, electronics balance, alluminium, water, chemical glass.

C. Principle

Specific heat of Alluminium (c) can be determined using Black's principle using equation:

$$c = \frac{(m_k c_k + m_w c_w)(T - T_i)}{m(T_a - T)} \qquad (1)$$

Where: T: equilibrium temperatur

T_i: initial temperatur of calorimeter system (water and calorimeter)

T_a: initial temperatur of Alluminium

C. Procedur

4. Meassure the mass of calorimeter and stirer m_k
5. Meassure the mass of Alluminium m
6. Poure water in calorimeter about 2/3 part of volume of the calorimeter
7. Meassure the mass of calorimeter and water
8. Determine the mass of water m_w
9. Using chemical glass which is filled with water and alluminium, heat the chemical glass using bunsen burner until the water boiled.
10. Meassure the temperature of Alluminium T_a
11. Meassure the initial temperature of calorimeter system T_i
12. Put the alluminium in calorimeter
13. Stir the calorimeter system using stirer until the equilibrium temperature occured
14. Meassure the equilibrium temperature T

D.Data of Experiment

No.	m_k(gram)	m(gram)	m_w(gram)	T_a(^{o}C)	T_i(^{o}C)	T(^{o}C)

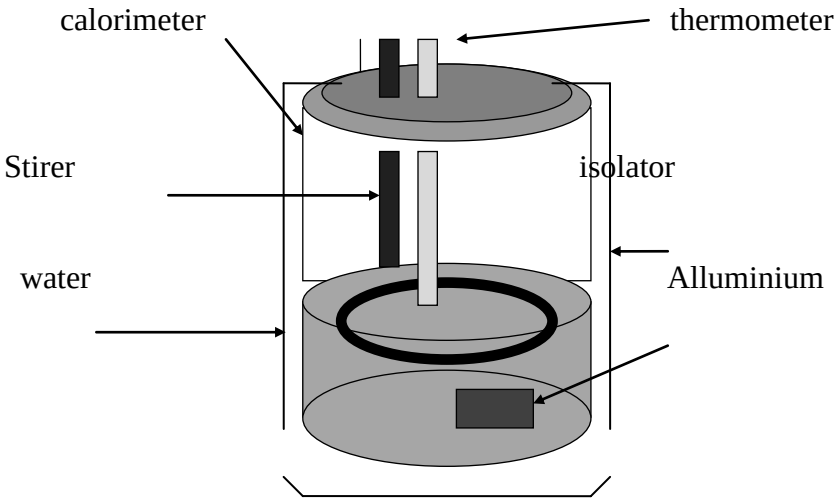


Figure1. Calorimeter

E. Data Analysis

1. Determine the specific heat of alluminium using equation (1)!

$$c = \frac{(m_k c_k + m_w c_w)(T - T_i)}{m(T_a - T)}$$

c =

ooOoo

EXPERIMENT 3. SPEED OF SOUND IN AIR

A. Goal

Determine speed of sound in air based on resonance of sound in air coulumn

B. Material and Apparatus

1. Audio Frequency Generator (AFG)
2. Amplifier
3. Glass tube equiped by scales
4. Speaker
5. Water

C. Principle

Relation between velocity of wave (v), frequency (f), and wave length (λ) can be written:

$$v = f\lambda \quad (1)$$

Relation between the length of air column and wave length of sound when resonance is occurred can be written:

$$L_n = (2n-1)\frac{\lambda}{4} + k \quad (2)$$

Where :

λ = wave length of sound (meter)

L_n = length of air column at n ressonance (meter)

n = n = 1,2,3,4,…..

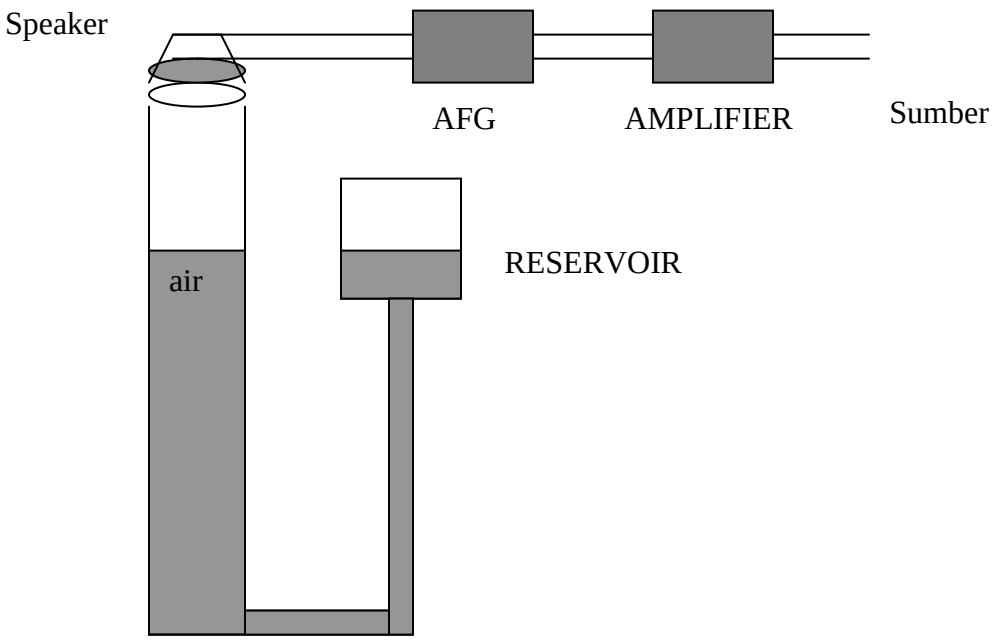
k = 0.3 x diameter of tube

D. Procedure

1. Switch on the amplifier and AFG
2. Adjust the AFG in certain frequency, meassure the frequency f
3. Move down ward the water level in tube until the first resonance is occurred, then meassure the length of air column L_1
4. Move down ward the water level in tube until the second ressonance is occurred, then meassure the length of air column L_2

E. Data of Experiment

No	f (hertz)	n =1 L_1 (cm)	n =2 L_2 (cm)	n =3 L_3 (cm)
1				



Gambar 1. Skema Percobaan

F. Data Analysis

Determine the speed of sound in air.

n	f (Hz)	k=0.3d (cm)	L_n (cm)	$\lambda = \frac{4(L_n - k)}{2n-1}$ (cm)	$v = f\lambda$ (cm/s)
1					
2					
3					

EXPERIMENT 4. THERMOCOUPLE

A. Goal

Determine the Seebeck constant (s) of thermocouple

B. Equipment and material

1. Thermocouple
2. Thermometer
3. Voltmeter
4. Ice
5. Water

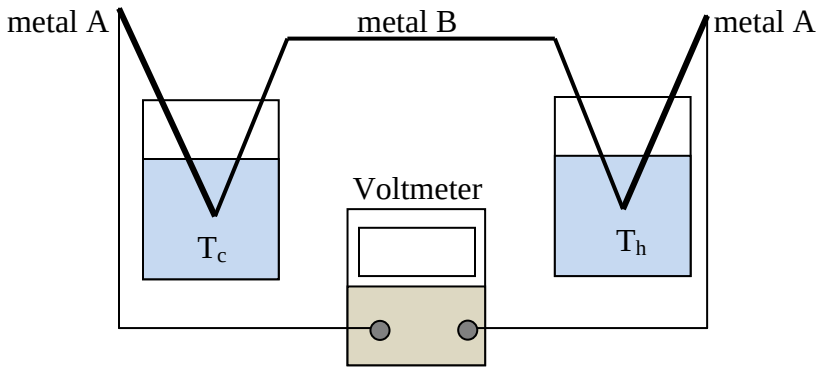
C. Principle

Relation between the hot junction temperature (T_h), cold junction temperatur (T_c), and the Seebeck potential (V) can be written:

$$V = S(T_h - T_c) \quad (1)$$

Where S = Seebeck Constant

D. Procedure



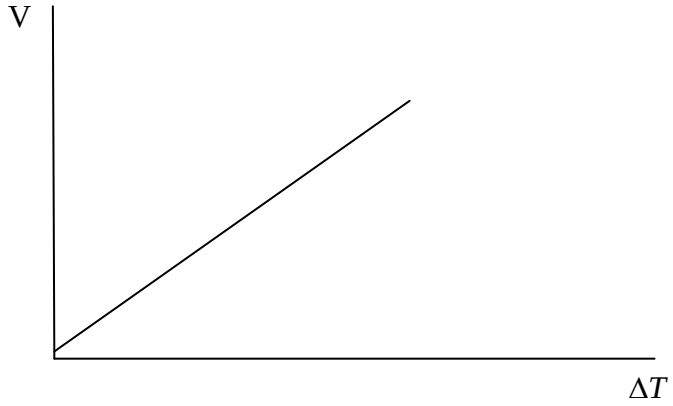
1. Set the apparatus as shown in figure above.
2. Meassure the themperature of cold junction T_c
3. Meassure the themperature of hot junction T_h
4. Meassure the Seebeck potential V using digital voltmeter
5. Increase themperature of hot junction using heater
6. Repeat step 2-5 until four times

E. Data of Experiment

No	T_c (^oC)	T_h (^oC)	V (volt)
1			
2			
3			
4			
5			

F. Data Analysis

Make a graph the relation between Seebeck potential V and gradient of temperature $\Delta T = T_h - T_c$



The Seebeck constant S can be determined by compute the gradient of graph above.

$$S = \frac{\Delta V}{\Delta(\Delta T)} = \text{.....} = \text{.....}$$

EXPERIMENT 5. PARARELY PLATE CAPACITOR

A. Goal

Determine the electric permitivity of dielectric material

B. Equipment and material

1. Pararely plate capacitor
2. Capacitymeter
3. Connected cable
4. PVC plate

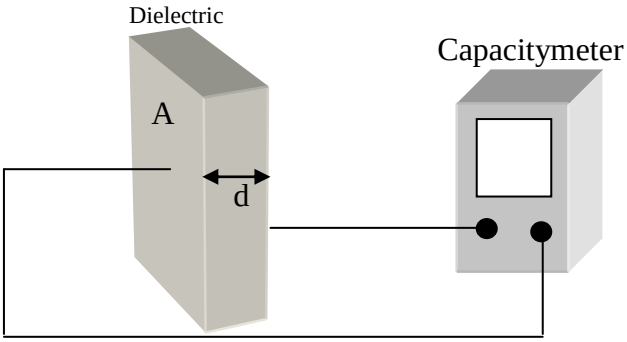
C. Principle

Relation between capacity of capacitor *C* and and the distance of both plates in pararely plate capacitor *d* can be written:

$$C = \frac{\varepsilon A}{d} \qquad (1)$$

Where ε = electric permitivity of material, A = area of plate

D. Procedure



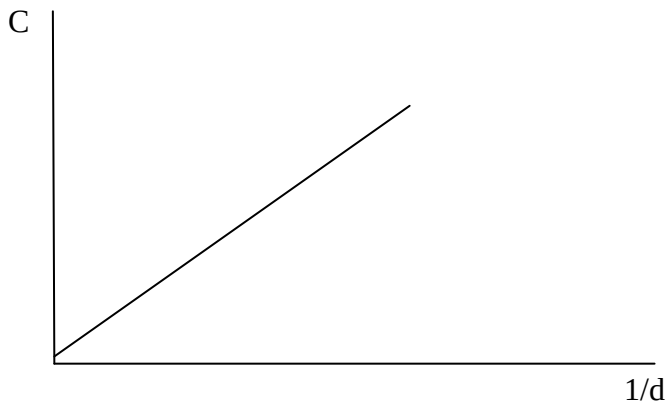
1. Set the apparatus as shown in figure above.
2. Meassure the distance between both plates d
3. Meassure the capacity of capacitor C
4. Repeat steps 2 until 3 four times in difference distance
5. Write data in table below

E. Data of Experiment

No	d (mm)	C (^oC)	C (µF)
1			
2			
3			
4			
5			

F. Data Analysis

Make a graph the relation between capacity of capacitor C and 1/d



The electric permitivity of the dielectric material can be determined by compute the gradient of graph above.

Gradient:

$$m = \frac{\Delta C}{\Delta(1/d)} = \text{.....} = \text{.....}$$

Electric permitivity:

$$m = \varepsilon A$$

$$\varepsilon = \frac{m}{A} = \text{.....}$$

EXPERIMENT 6. RESISTOR

A. Goal

Determine and meassure the ressistivity of resistor

B. Equipment and material

1. Resistor
2. Ohmeter
3. Connected cable

C. Principle

Resistivity of resistor can be determined by reading colour band as follows:

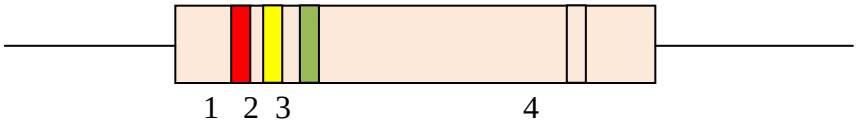


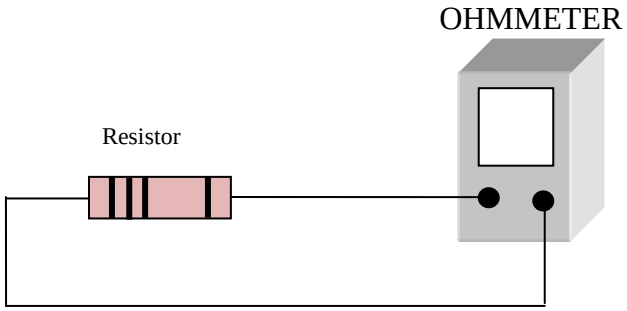
Figure 1. Resistor

Band 1st	**Band 2nd**	**Band 3rd**	**Band 4th (Tolerance)**		
			Gold	**Silver**	**None**
1st Number	**2nd Number**	**Multiplier**	**5%**	**10%**	**20%**

Color	1st	2nd	Multiplier	Tolerance
Black	0	0	1	
Brown	1	1	10	±1%
Red	2	2	100	±2%
Orange	3	3	1,000	
Yellow	4	4	10,000	
Green	5	5	100,000	±0.5%
Blue	6	6	1,000,000	±0.25%
Violet	7	7	10,000,000	±0.1%
Gray	8	8	100,000,000	±0.05%
White	9	9	1,000,000,000	
Gold			0.10	±5%
Silver			0.01	±10%
None				±20%

Figure 2

D. Procedure



1. Set the apparatus as shown in figure above.
2. Determine the resistivity of resistor based on colour bands.
3. Meassure the the resistivity of resistor using Ohmmeter
4. Write data in table below

E. Data of Experiment

No	Resistor	R (ohm) Determined using colour band	R (ohm) Meassured by ohmeter
1	Resistor 1		
2	Resistor 2		
3	Resistor 3		

F. Data Analysis

Compare the results of resistivity which determined by colour band and the resistivity which meassured by Ohmmeter!

No	Meassured by colour band			Meassured by ohmeter R (ohm)	Note
	R (ohm)	ΔR = tolerance x R (ohm)	Result R ± ΔR (ohm)		
1					
2					
3					

EXPERIMENT 7. CRO

A. Goal

1. Meassure a peak to peak voltage V_{pp} .
2. Meassure frequency of sinusoidal wave

B. Equipment and material

1. CRO
2. AFG
3. AC Power Source
4. Connected cable

C. Principle

V_{pp} can be determined by reading the number of div and volt/div in screen of CRO.

$$V_{pp} = number\ of\ div \times volt/div$$

Frequency can be determined by reading the number of div and time/div in one wave length

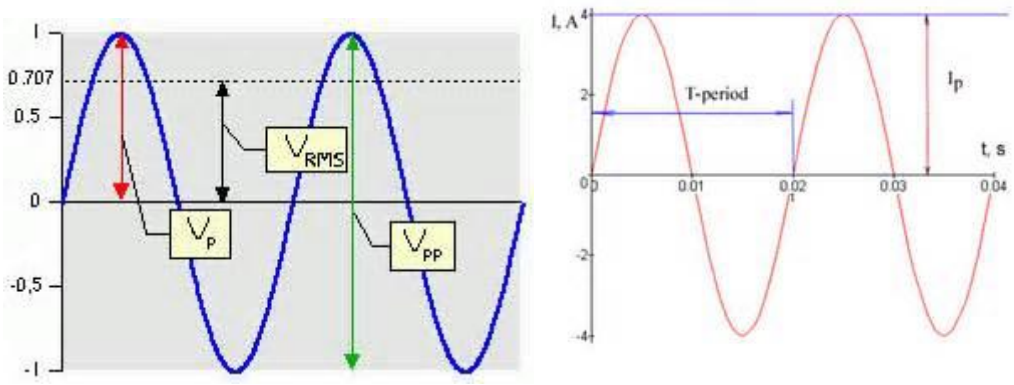


Figure 1. Sinusoidal Wave

D. Procedure

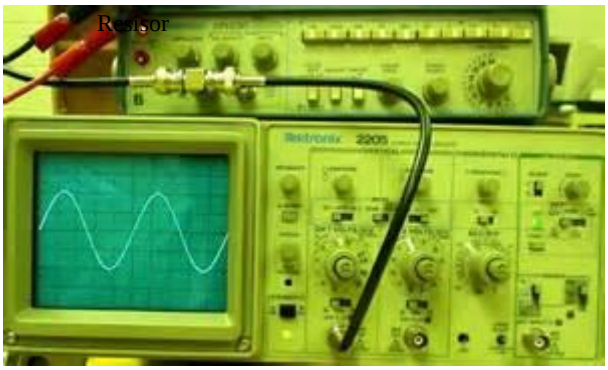


Figure 2. CRO

1. Set the apparatus as shown in figure above.
2. Determine the number of div from peak to peak.
3. Determine the chanel volt/div.
4. Determine the number of div in one wave length.
5. Determine the chanel of time/div
6. Write data in table below

7. Data of Experiment

Meassurement V_{pp}

No	Number of div	Volt/div	V_{pp} (volt)
1			
2			
3			

Meassurement frequency

No	Number of div	Time/div	f (Hz)
1			
2			
3			

8. Data Analysis

Determine the V_{pp} and frequence of AC power source.