□ PHYS1050 / □ PHYS1250
Ref. (Staff Use)____________

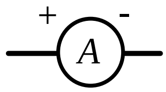
Laboratory Worksheet

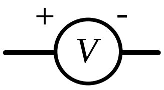
Experiment NE04 - RC Circuit

Department of Physics

The University of Hong Kong

Name: ____________________ Student ID: _____________________ Date: ______________________

Draw a schematic diagram of the ***charging*** RC circuit with ammeter sensor 

and voltmeter sensor 

. Note that the voltmeter sensor connect to the potential difference across the capacitor in parallel while the ammeter sensor is used to find out the current pass through the circuit. (Hints: Consider figure 2 in the lab manual and beware the polarities of meters)

Data Log

Please fill in the results of your experiments in the following tables.

Experiment 1: Measurements of time constant

Table 1.1 Charging with 10 ohm resistor

Inverse exponent: $A(1-e^{-Cx})+B$	Value		
	1st trial	2nd trial	Average value
A (Scale factor)			
B (Y offset)			
C (exponent)			
Mean square error			
Root MSE			

Table 1.2 Discharging with 10 ohm resistor

Natural exponent: $Ae^{-Cx}+B$	Value		
	1st trial	2nd trial	Average value
A (Scale factor)			
B (Y offset)			
C (exponent)			
Mean square error			
Root MSE			

Table 1.3 Charging with 33 ohm resistor

Inverse exponent: $A(1-e^{-Cx})+B$	Value		
	1st trial	2nd trial	Average value
A (Scale factor)			
B (Y offset)			
C (exponent)			
Mean square error			
Root MSE			

Table 1.4 Discharging with 33 ohm resistor

Natural exponent: $Ae^{-Cx}+B$	Value		
	1st trial	2nd trial	Average value
A (Scale factor)			
B (Y offset)			
C (exponent)			
Mean square error			
Root MSE			

Table 1.5 Charging with 100 ohm resistor

Inverse exponent: $A(1-e^{-Cx})+B$	Value
A (Scale factor)	
B (Y offset)	
C (exponent)	
Mean square error	
Root MSE	

Table 1.6 Discharging with 100 ohm resistor

Natural exponent: $Ae^{-Cx}+B$	Value
A (Scale factor)	
B (Y offset)	
C (exponent)	
Mean square error	
Root MSE	

Experiment 2: Measurements of capacitance

Table 2.1 Plot the curve of charge stored in capacitor vs. Potential difference across the capacitor at final stage

Potential difference across the capacitor at final stage	Area under the current-time curve (i.e. charge stored in capacitor)
0V	0As
(a) Charging with 100 ohm resistor with 1.5V Battery	
(b) Charging with 100 ohm resistor with 3.0V Battery	

Table 2.2 curve fitting of charge stored in capacitor vs. Potential difference across the capacitor at final stage

Charging with 100 ohm resistor with 1.5V and 3.0 V battery	
Proportion fit Ax	Value
A (Scale factor)	
Mean square error	
Root MSE	

Calculation and Analysis

Please use the data logged above to finish this section.

Experiment 1

1. **Using the data in tables 1.1, 1.3 and 1.5 to complete the table 1.7, calculate the experimental value of capacitance for different resistors in *charging phase* of RC circuit. The theoretical value of capacitance could be found on the body of the capacitor. What is the physical meaning of the average value of C (exponent)?** (Hints: Comparing the inverse exponent fitting curve with equation (9))

Table 1.7 Finding out the capacitance of the capacitor by using the charging RC circuit

Resistor	Average value of C (exponent) in charging phase	Experiential value of capacitance $= \frac{1}{\text{Resistor} \times \text{Average value of C (exponent)}}$	Percentage difference between the experiential and theoretical values of capacitance $= \frac{\text{Theoretical} - \text{Experimental}}{\text{Theoretical}} \times 100\%$
10Ω			
33Ω			
100Ω			

The physical meaning of the average value of C (exponent) is

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2. **According to previous question, are the experimental values of capacitance larger or smaller than the theoretical values of that? Why?**
   (Hints: the definition of capacitance is the amount of charges stored in a capacitor for a given potential difference across it)

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3. **According to the data in tables 1.1 to 1.6, calculate the experimental value of time constants for charging and discharging phase of RC circuit.**

Table 1.8

	Charging	Discharging	Theoretical value of time constant	Charging	Discharging
Resistor	Average experimental value of time constant			Percentage difference between the experimental and theoretical values of time constant $= \frac{\text{Experimental - Theoretical}}{\text{Theoretical}} \times 100\%$	
10Ω					
33Ω					
100Ω					

Is the experimental time constant larger or smaller than the theoretical values? What might cause discrepancy between them?

(Hints: The meaning of time constant = RC and the shown resistors and capacitor are not the only electronic elements.)

4. **As the resistance of the resistor increasing, what are the trends on experimental time constant and the percentage difference between the experimental and theoretical values of time constant?**

Experiment 2

5. **Will the current-time graph decrease to zero? Why?** (Hints: consider equation (13))

6. **In Table 2.1 and Table 2.2, why we do not simply use the 3.0V and 1.5V values of battery as the value of potential difference across the capacitor when it is fully charged?**

7. **Using the table 2.2 in data log, what is experiential values of capacitance? By comparing this value with the values you found in table 1.7 in Discussion Q. 1 and the theoretical values of the capacitance marked on the capacitor, which experiment do you prefer to find out the capacitance? Experiment 1 or Experiment 2? Why?**
   (Hints: Considering equation (1) to find out the experiential values of capacitance)