| □ PHYS1050 / □ PHYS1250 |
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| Ref. (Staff Use)_____ |

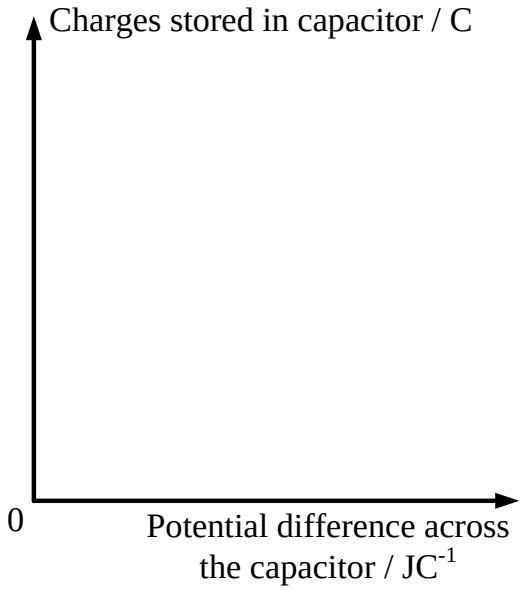
**Pre-Laboratory Worksheet**
**Experiment NE04 - RC Circuit**
**Department of Physics**
**The University of Hong Kong**

**Name: _____ Student ID: _____ Date: _____**

**Remark: Please submit Pre-Laboratory Worksheet to laboratory technician when you arrive the laboratory**

**Background information:**

1. **According to equation (1) in the lab manual, sketch the curve of charges stored in capacitor vs. the potential difference across the capacitor. What is the relationship between the charges stored in capacitor and potential difference across the capacitor?**
   **Also state the physical meanings of the slope of the curve and the area under the curve.** (Hints: Unit of potential difference across the capacitor is $JC^{-1}$.)




2. **What is the physical meaning of the current vs. time graph in Experiment 2:**

_____

_____

_____

_____

**3. Use the equations in the lab manual to complete the following table:**

Suggested solution:

| **Charging** | | | | |
|---|---|---|---|---|
| | Charge stored in capacitor | Current of the circuit | p.d. across capacitor | p.d. across resistor |
| Time | $Q(t)=CV_s\left(1-e^{-\frac{t}{RC}}\right)$ | $I(t)=\frac{V_s}{R}e^{-\frac{t}{RC}}$ | $V_C(t)=V_s\left(1-e^{-\frac{t}{RC}}\right)$ | $V_R(t)=V_s e^{-\frac{t}{RC}}$ |
| $t=0$ | $Q(t=0)=$ | $I(t=0)=$ | $V_C(t=0)=$ | $V_R(t=0)=$ |
| $t\to\infty$ | $Q(t\to\infty)$ $=\lim_{t\to\infty} CV_s\left(1-e^{-\frac{t}{RC}}\right)$ $=$ | $I(t\to\infty)$ $=\lim_{t\to\infty}\frac{V_s}{R}e^{-\frac{t}{RC}}$ $=$ | $V_C(t\to\infty)$ $=\lim_{t\to\infty} V_s\left(1-e^{-\frac{t}{RC}}\right)$ $=$ | $V_R(t\to\infty)$ $=\lim_{t\to\infty} V_s e^{-\frac{t}{RC}}$ $=$ |

| **Discharging** | | | | |
|---|---|---|---|---|
| | Charge stored in capacitor | Current of the circuit | p.d. across capacitor | p.d. across resistor |
| Time | $Q(t)=CV_s e^{-\frac{t}{RC}}$ | $I(t)=-\frac{V_s}{R}e^{-\frac{t}{RC}}$ | $V_C(t)=V_s e^{-\frac{t}{RC}}$ | $V_R(t)=V_s e^{-\frac{t}{RC}}$ |
| $t=0$ | $Q(t=0)=$ | $I(t=0)=$ | $V_C(t=0)=$ | $V_R(t=0)=$ |
| $t\to\infty$ | $Q(t\to\infty)$ $=\lim_{t\to\infty} CV_s e^{-\frac{t}{RC}}$ $=$ | $I(t\to\infty)$ $=\lim_{t\to\infty}\frac{V_s}{R}e^{-\frac{t}{RC}}$ $=$ | $V_C(t\to\infty)$ $=\lim_{t\to\infty} V_s e^{-\frac{t}{RC}}$ $=$ | $V_R(t\to\infty)$ $=\lim_{t\to\infty} V_s e^{-\frac{t}{RC}}$ $=$ |

4. **Use the equations of potential difference across capacitor and resistor during charging and discharging to complete the following table.** Note that the values of potential difference across capacitor and resistor should be in terms of the electromotive force $V_s$ with 2 decimal places.

| | **Charging** | | **Discharging** | |
|---|---|---|---|---|
| Time | $V_C(t) = V_s\left(1 - e^{-\frac{t}{RC}}\right)$ | $V_R(t) = V_s e^{-\frac{t}{RC}}$ | $V_C(t) = V_s e^{-\frac{t}{RC}}$ | $V_R(t) = V_s e^{-\frac{t}{RC}}$ |
| $t = \tau = RC$ | | | | |
| $t = 2\tau = 2RC$ | | | | |
| $t = 3\tau = 3RC$ | | | | |
| $t = 4\tau = 4RC$ | | | | |
| $t = 5\tau = 5RC$ | | | | |
| $t = 6\tau = 6RC$ | | | | |

5. **In practice, if the potential difference across the resistor is equal to 0.674% $\varepsilon$, the capacitor could be considered as either completely charged or completely discharged. The completely charging time or completely discharging time is called *transient response time*. From the table in pre-lab question 4. What is the *transient response time* in terms on $RC$?**

   Transient response time: _____

6. **What is the unit of time constant? And complete the following table.**

   The unit of time constant is _____

| Capacitor | Resistor | Theoretical time constant | Transient response time (Definition: see Prelab Q.5) |
|---|---|---|---|
| 1.0F | 10 Ω | | |
| 1.0F | 33 Ω | | |
| 1.0F | 100 Ω | | |

**7. Label in the x-axis of the following graphs to indicate the *time constant* of a charging RC circuit**