Homework Week 6

113-2 General Physics II

Due before 4:10 PM on March 31, 2025

Name 徐宛宇 110713556 資料四

1. [25 points] **Example 27.4 Find the Equivalent Resistance**

Four resistors are connected as shown in Figure 27.8a.

(a) [15 points] Find the equivalent resistance between points *a* and *c*. Write down every step.

(b) [10 points] What is the current in each resistor if a potential difference of 42 V is maintained between *a* and *c*?

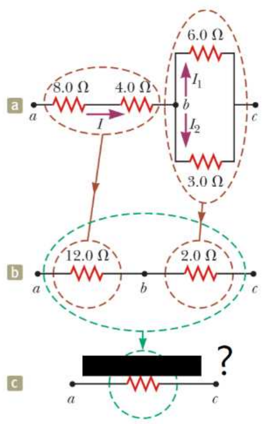


Figure 27.8

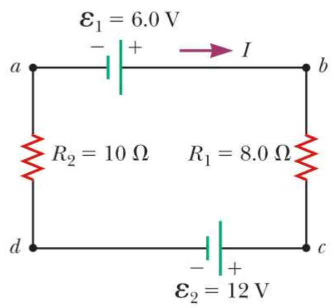


Figure 27.13 (Example 27.6)

2. [15 points] **Example 27.6 A Single-Loop Circuit**

A single-loop circuit contains two resistors and two batteries as shown in Figure 27.13. (Neglect the internal resistances of the batteries.) Find the current in the circuit.

3. [15 points] **Charging a Capacitor.**

Derive the expression from equation (27.15) to equation (27.18) for charging a capacitor.

$$\mathcal{E} - \frac{q}{C} - iR = 0 \qquad (27.15)$$

$$q(t) = C\mathcal{E}(1 - e^{-t/RC}) = Q_{\max}(1 - e^{-t/RC}) \qquad (27.18)$$

4. [10 points] **Discharging a Capacitor.**

Derive the expression from equation (27.21) to equation (27.22) for discharging a capacitor.

$$-\frac{q}{C} - iR = 0 \qquad (27.21)$$

$$q(t) = Q_i e^{-t/RC} \qquad (27.22)$$

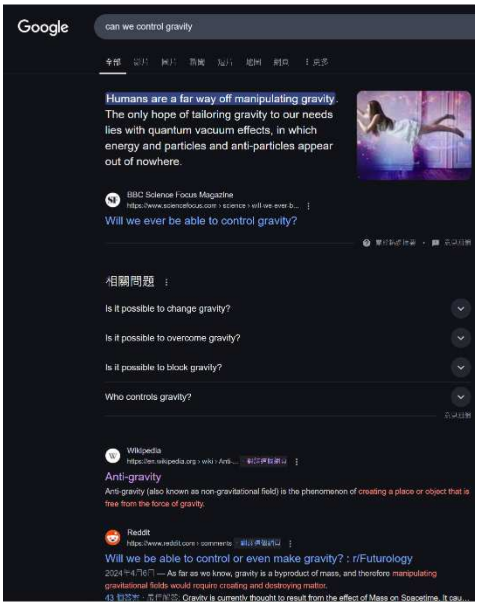
5. [10 points] According to our course schedule, what topics will be covered in the next lecture? ________ fields.

6. [25 points] (A) 重複 HW Week 3 最後一題的問題。[5 points] (B) Google 搜尋關鍵字 or 查閱維基有無文章 (注意維基不見得正確)。[20 points]

螢幕截圖或照相，線上繳交。如前面手寫，可分開繳交。

<u>答案範例</u>:

1. 庫侖力的形式與牛頓重力相似，我們可以打開和關閉電源，調控電力。而重力似乎一直存在，我們可以調控重力嗎，可能用什麼方式調控?
2. (中英皆可)



勇敢地提出笨的問題，

有一天就會問到對的問題

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1. (a)

$$8 + 4 + \frac{1}{\frac{1}{6} + \frac{1}{3}} = 14\ (\Omega)$$ *

(b)

$$V = IR \Rightarrow I = \frac{V}{R} = \frac{42}{14} = 3$$

$$I_2:\ 3 \times \frac{3}{6+3} = 1$$

$$I_3:\ 3 \times \frac{6}{6+3} = 2$$

$$\begin{cases} 8\Omega: & 3\ (A) \\ 4\Omega: & 3\ (A) \\ 6\Omega: & 1\ (A) \\ 3\Omega: & 2\ (A) \end{cases}$$ #

2. Kirchoff's Loop Rule :

$$6 - 8I - 12 - 10I = 0$$

$$\Rightarrow I = -0.33\ (A)$$ #

3.

$$\varepsilon - \frac{q}{C} - iR = 0$$

$$\Rightarrow i = \frac{C\varepsilon - q}{RC}$$

$$\Rightarrow \frac{dq}{dt} = -\frac{q - C\mathcal{E}}{RC}$$

$$\Rightarrow \frac{dq}{q - C\mathcal{E}} = \frac{-dt}{RC}$$

$$\Rightarrow \int_0^q \frac{dq}{q - C\mathcal{E}} = \int_0^t \frac{-dt}{RC}$$

method of separation of variables (1st order ODEs)

$$\int_0^q \frac{dq}{q - C\mathcal{E}}$$

Let $t = q - C\mathcal{E}$

$dt = dq$

$$= \int_{-C\mathcal{E}}^{q - C\mathcal{E}} \frac{dt}{t}$$

$$= \Big[\ln|t|\Big]_{-C\mathcal{E}}^{q - C\mathcal{E}}$$

$$= \ln\left(\frac{q - C\mathcal{E}}{-C\mathcal{E}}\right)$$

$q - C\mathcal{E} < 0$

$$\Rightarrow \frac{q - C\mathcal{E}}{-C\mathcal{E}} > 0$$

$$\Rightarrow q(t) = C\mathcal{E}\left(1 - e^{-t/RC}\right) = Q_{max}\left(1 - e^{-t/RC}\right)$$

(Q.E.D.)

4. $$-\frac{q}{C} - iR = 0$$

$$\Rightarrow i = \frac{-q}{RC}$$

$$\Rightarrow \frac{dq}{dt} = \frac{-q}{RC}$$

$$\Rightarrow \frac{dq}{q} = \frac{-dt}{RC}$$

method of separation of variables (1st order ODEs)

$$\Rightarrow \int_{C\varepsilon}^{q} \frac{dq}{q} = \int_0^t \frac{-dt}{RC}$$

$$\Rightarrow \ln \frac{q}{C\varepsilon} = \frac{-t}{RC}$$

$$\Rightarrow q = C\varepsilon\, e^{-\frac{t}{RC}} = Q_i\, e^{-\frac{t}{RC}}$$

5. magnetic fields

6. How does a capacitor help stabilize power supply in smartphones to prevent sudden shutdowns or glitches under heavy use?

截圖?