No.: Date:

第二十二章：恒定电流（2003年 - 2017年）

选择题

① L_1: $P = \frac{V^2}{R}$ L_2: $P = \frac{V^2}{R}$

$40 = \frac{110^2}{R}$ $100 = \frac{110^2}{R}$

$R = 302.5\Omega$ $R = 121\Omega$

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R} = \frac{1}{302.5} + \frac{1}{121}$

$R = 86.42\Omega$ #

B

② $I = nAve$

D

③ $R = \rho\frac{l}{A}$

$20 = 4.4\times10^{-7}\times\frac{l}{\pi(1\times10^{-4})^2}$

$l = 1.43\,m$ #

C

④ $V = IR$ $V = IR$

$= 2\times3$ $6 = I\times6$

$= 6V$ $I = 1A$ #

$V = IR$ $V = V_1 + V_2 + V_3$

$= (2+1)\times(2+1)$ $= 9V + 6V$

$= 9V$ $= 15V$ #

B

⑤ ① $V = IR$

$V = I(10+20)$

$I = \frac{V}{30}$

② $\frac{1}{R'} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R'} = \frac{1}{20} + \frac{1}{R}$

$R' = \frac{20R}{R+20}$

C

③ $V = IR$

$V = I'\left(\frac{20}{R+20} + 10\right)$

$\cancel{V} = \frac{\cancel{2}V}{30}\left(\frac{20R}{R+20} + 10\right)$

$15 = \frac{20R + 10R + 200}{R+20}$

$15R + 300 = 30R + 200$

$R = \frac{20}{3}\Omega$ #

⑥

⑦ $R_I = \rho\frac{l}{A}$ $R_{II} = \frac{\rho\times l/4}{\pi(r/2)^2}$

$= \rho\times\frac{l}{\pi r^2}$ $= \frac{\rho l}{\pi r^2}$

$= \frac{\rho l}{\pi r^2}$

$R_{III} = \frac{\rho\times l/2}{\pi(r/2)^2}$ $R_{IV} = \frac{\rho\times l}{\pi(\frac{r}{2})^2}$

$= \frac{2\rho l}{\pi r^2}$ $= \frac{4\rho l}{\pi r^2}$

$R_V = \frac{\rho\times5l}{\pi(2r)^2}$ $R_I = R_{II} < R_V < R_{III} < R_{IV}$

$= \frac{5\rho l}{4\pi r^2}$

C

⑧ $P = \frac{V^2}{R}$ $E = Pt$

$= \frac{120^2}{14}$ $= 1028.57\times5$

$= 1028.57\,W$ $= 5.14\,kW.h$

$5.14\,kW.h \times RM0.05 = RM0.26$ #

D

⑨ $R = \rho\frac{l}{A}$ $R' = \rho\frac{l/2}{A}$

$= \frac{1}{2}\frac{\rho l}{A}$

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_T} = \frac{2A}{\rho l} + \frac{2A}{\rho l}$

$R_T = \frac{1}{4}\frac{\rho l}{A}$

$= \frac{1}{4}R$ #

A

⑩ $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R} = \frac{1}{10} + \frac{1}{5} + \frac{1}{10}$

$R = 2.5\Omega$

A

(11) A

(12)
$$\frac{P_A}{P_B} = \frac{\frac{V}{R_A}}{\frac{V}{R_B}}$$
$$\frac{P_A}{P_B} = \frac{R_B}{R_A}$$
$$= \frac{\rho_B \frac{l_B}{A_B}}{\rho_A \frac{l_A}{A_A}} \qquad A_A = A_B$$
$$= 2 \times \frac{1}{4}$$
$$= \frac{1}{2} \#$$

C

(13)
$V = IR$
$2 = I(10+30)$
$I = 0.05\,A$

$V = IR$
$= 0.05 \times 30$
$= 1.5\,V$

$V_{CA} = 10\,V + 1.5\,V$
$= 11.5\,V \#$

C.

(14)
$R = \rho \frac{l}{A}$
$= \frac{\rho l}{nA}$

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$
$\frac{1}{R_T} = \frac{n}{R}$
$\frac{1}{R_T} = n \times \frac{nA}{\rho l}$
$R_T = \frac{\rho l}{n^2 A}$
$= \frac{1}{n^2} R_0 \#$

B

(15) C

(16)
$E = I(R+r)$
$4 = I(2.5+1+0.5)$
$4 = 4I$
$I = 1\,A$

B.

$V = IR$
$1.5 = 1\left(\frac{2.5}{100} l\right)$
$l = 60\,cm \#$

(17) A

(18)
$I = nAve$
$\frac{V}{R} = nAve$
$\frac{VA}{\rho l} = nAve$
$V = \frac{\rho}{ne} l$

C

(19)
$E = I(R+r)$
$= V + Ir$
$= 12 + (4 \times 0.4)$
$= 13.6\,V \#$

D.

(20) C

(21)
$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{R} = \frac{1}{6} + \frac{1}{12}$
$R = 4\,\Omega$

$E = I(R+r)$
$12 = I(4+2)$
$I = 2\,A$

$V = IR$
$12 - 2(2) = I \times 6$
$I = 1.33\,A$

C

(22) 并联
$E = I(R+r)$
$1.5 = I\left(10 + \frac{r}{10}\right)$
$I = \frac{15}{100+r}$

串联
$E = I(R+r)$
$1.5 \times 10 = I(10+10r)$
$I = \frac{15}{10+10r}$ (

① 带进 ②
$\frac{15}{100+r} = \frac{15}{10+10r}$
$100 + r = 10 + 10r$
$r = 10\,\Omega \#$

C

No.: .....

较好的输出。但用久了，r变大（3Ω或更大），I^2r即变大，而$V_R I$变小，小到没有可观的输出，这时干电池就要作废了。不能一直使用至V_R变为零，因为r越来越大，干电池的大部分输出功率都被内电阻消耗了。

(23) $E = I(R+r)$ $V = IR$

$24 = I(3+R'+1)$ $6 = I\left(\frac{30}{100}R'\right)$

$24 = \frac{20}{R'}(4+R')$ $I = \frac{20}{R'}$

$24 = \frac{80}{R'} + 20$

$R' = 20\Omega$ #

B

(24) $E_1 - E_2 + I_3r_2 + I_3R_3 - I_1R_1 - I_1r_1 = 0$

$E_1 - E_2 = I_1r_1 + I_1R_1 - I_3r_2 - I_3R_3$

D

作答题

(1) (a) 新的干电池的内阻很小（约0.1Ω），根据公式 $E = IR + Ir \Rightarrow EI = IV_R + I^2r$，其电功率$V_R I$相对来说就较大，也即它有

(b) (i) $E = I(R+r)$

$12 = I(5.5+0.5)$

$I = 2A$ #

(ii) $P = I^2R$

$= 2^2 \times 5.5$

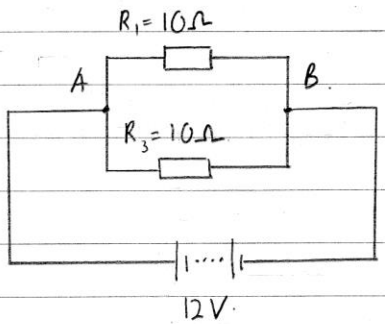
$= 22W$ #

(c) (i) $\frac{1}{R} = \frac{1}{10} + \frac{1}{10+10}$ $E = I(R+r)$

$R = 6\frac{2}{3}\Omega$ $12 = I\left(6\frac{2}{3}+0\right)$

$I = 1.8A$ #

(ii)



$\frac{1}{R} = \frac{1}{10} + \frac{1}{10}$ $E = I(R+r)$

$R = 5\Omega$ $12 = I(5+0)$

$I = 2.4A$ #

(2) (a) (i) $\rho_T = \rho_0(1+\alpha\Delta T)$

$= 100\times10^{-8}[1+0.0004\times(800-273)]$

$= 1.21\times10^{-6}\Omega m$ #

(ii) $P = \frac{V^2}{R}$

$600 = \frac{220^2}{R}$

$R = 80.67\Omega$ #

(iii) $R = \rho\frac{l}{A}$

$80.67 = 1.21\times10^{-6}\frac{l}{A}$

$\frac{l}{A} = 6.67\times10^7 m^{-1}$

$R = \rho\frac{l}{A}$

$= \rho_0(1+\alpha\Delta T)\frac{l}{A}$

$= 100\times10^{-8}(1+0.0004\times30)\times 6.67\times10^7$

$= 67.47\Omega$ #

(b) (i) $P = I^2R$ $P = VI$

$10-8 = I^2(1)$ $8 = V\sqrt{2}$

$I_{总} = \sqrt{2}$ $V = 4\sqrt{2}$

$V = I_R R$ $I_{总} = I_R + I_{R'}$

$4\sqrt{2} = I_R \times 40$ $\sqrt{2} = \frac{\sqrt{2}}{10} + I_{R'}$

$I_R = \frac{\sqrt{2}}{10}$ $I_{R'} = \frac{9\sqrt{2}}{10}$

$V = V_{P_0} + I_{R'}R'$ $P = V_{P_0} I_{R'}$

$4\sqrt{2} = V_{P_0} + \frac{9\sqrt{2}}{10}\times2.5$ $= 2.47\times\frac{9\sqrt{2}}{10}$

$V_{P_0} = 2.47$ $= 3.15W$ #

$P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

(ii) $P_{灯} = I_{灯}^2 R_{灯}$ $\quad P = EI$

$3.15 = \left(\frac{9\sqrt{2}}{10}\right)^2 R_{灯}$ $\quad 10 = E\sqrt{2}$

$R_{灯} = 1.94\,\Omega$ $\quad E = 5\sqrt{2}$

$E = I(R+r)$

$5\sqrt{2} = \frac{9\sqrt{2}}{10}(1.94 + R' + 1)$

$R' = 2.62\,\Omega$ #

③ (i) 看回 Graph paper.

(ii) $I = 1.42$; $V = 2.88$; $P = 4.09\,W$

$I = 1.25$; $V = 3.61$; $P = 4.51\,W$

$I = 1.13$; $V = 4.14$; $P = 4.68\,W$

$I = 1.05$; $V = 4.52$; $P = 4.75\,W$ Max.

$I = 0.97$; $V = 4.82$; $P = 4.68\,W$

$I = 0.86$; $V = 5.31$; $P = 4.57\,W$

$I = 0.79$; $V = 5.64$; $P = 4.46\,W$

$\therefore P_{max} = 4.75\,W$; $R = 4\,\Omega$

(iii) $\frac{1}{R} = \frac{1}{4} + \frac{1}{30}$ $\quad V = IR$

$R = 3\frac{9}{17}$ $\quad 4.52 = 1.05\left(3\frac{9}{17} + R_A\right)$

$R_A = 0.78\,\Omega$ #

④ (a)(i) $E = I(R+r)$

$12 = I(20+1)$

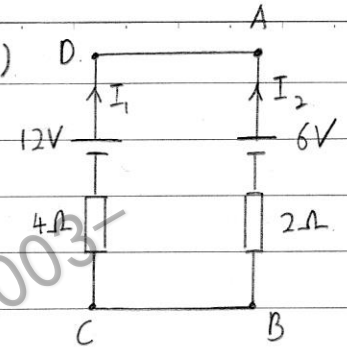
$I = 0.571\,A$ #

(ii) $E = I(R+r)$

$12+12 = I(20+2+2)$

$I = 1\,A$ #

(b)(i)

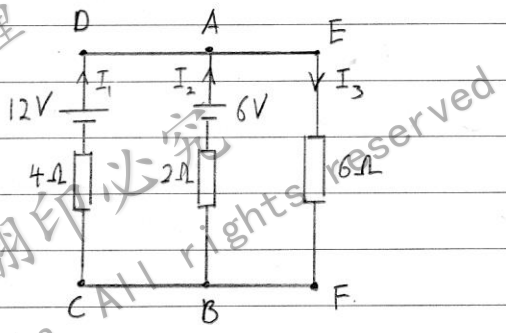


$V = IR$

$12 - 6 = I(4+2)$

$I = 1\,A$ #

$\therefore I_1 = 1A$; $I_2 = -1A$; $I_3 = 0A$



节点 A: $I_1 + I_2 = I_3$

回路 AEFBA: $6 - 6I_3 + 2I_2 = 0$

$6 - 6(I_1 + I_2) - 2I_2 = 0$

$6 - 6I_1 - 8I_2 = 0$ ①

回路 DABCD: $12 - 6 + 2I_2 - 4I_1 = 0$

$6 + 2I_2 - 4I_1 = 0$

$2I_2 = 4I_1 - 6$

$I_2 = 2I_1 - 3$ ②

② 带入 ①

$6 - 6I_1 - 8(2I_1 - 3) = 0$

$6 - 6I_1 - 16I_1 + 24 = 0$

$22I_1 = 30$

$I_1 = \frac{30}{22}\,A \,/\, 1.4\,A$ #

$I_2 = 2I_1 - 3$

$= 2\left(\frac{30}{22}\right) - 3$

$= -\frac{3}{11}\,A \,/\, -0.27\,A$ #

$I_3 = I_1 + I_2$

$= \frac{30}{22} - \frac{3}{11}$

$= \frac{12}{11}\,A \,/\, 1.09\,A$ #

⑤ (a) $V = IR$

$8.4 = 5R$

$R = 1.68\Omega$ #

(b) $R = \frac{\rho l}{A}$

$1.68 = \frac{\rho \times 1 \div 100}{\pi (0.01 \div 1000)^2}$

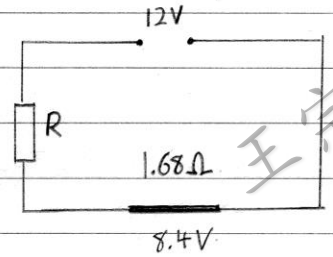
$\rho = 5.28 \times 10^{-8}\ \Omega m$ #

(c) $W = I^2 R t$

$= 5^2 \times 1.68 \times 60$

$= 2520\ J$ #

(d)



$V = IR$

$8.4 = I \times 1.68$

$I = 5A$

$V = IR$

$12 - 8.4 = 5R$

$R = 0.72\Omega$ #

⑥ (a) $\frac{1}{R} = \frac{1}{R_4} + \frac{1}{R_3}$

$\frac{1}{R} = \frac{1}{12} + \frac{1}{6}$

$R = 4\Omega$

$R_T = 10 + 6 + 4$

$= 20\Omega$ #

$V = IR$

$30 = I(20)$

$I = 1.5A$ #

(b) $V = IR$

$= 1.5 \times 6$

$= 9V$ #

$V_{ZY} = V_Z - V_Y$

$9 = V_Z - 0$

$V_Z = 9V$ #

∴电容器C两极板间的电势差 $= 9V$ #

(c) $\frac{1}{R} = \frac{1}{R_4} + \frac{1}{R_3}$

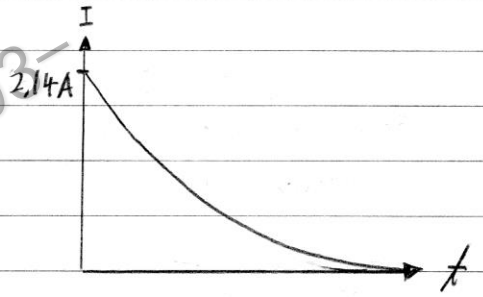
$\frac{1}{R} = \frac{1}{12} + \frac{1}{6}$

$R = 4\Omega$

$V = I_{max} R_T$

$30 = I_{max}(4 + 10)$

$I_{max} = 2.14\ A$ #

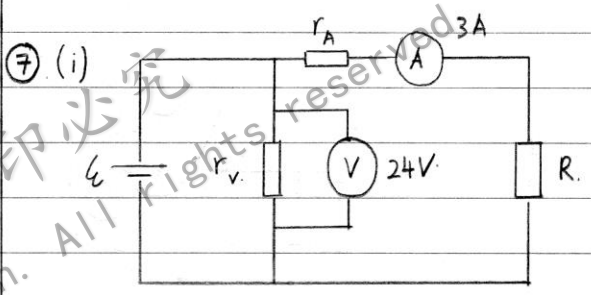


(d) $E = \frac{1}{2} C V^2$

$= \frac{1}{2} \times 10 \times 10^{-6} \times 9^2$

$= 4.05 \times 10^{-4}\ J$ #

⑦ (i)



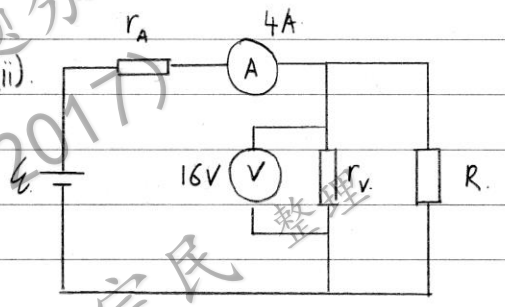
$\mathcal{E} = I(R + r)$

$\mathcal{E} = 3(R + r_A)$

$24 = 3(R + r_A)$

$8 = R + r_A$ ① #

(ii)



$V = IR$

$24 - 16 = 4 r_A$

$r_A = 2\Omega$ ②

$\frac{1}{R_T} = \frac{1}{r_V} + \frac{1}{R}$

$\frac{1}{R_T} = \frac{R + r_V}{R r_V}$

$R_T = \frac{R r_V}{R + r_V}$

② 带入 ①

$8 = R + 2$

$V = IR$

$16 = 4\left(\frac{Rr_V}{R+r_V}\right)$

$16 = 4\left(\frac{6r_V}{6+r_V}\right)$

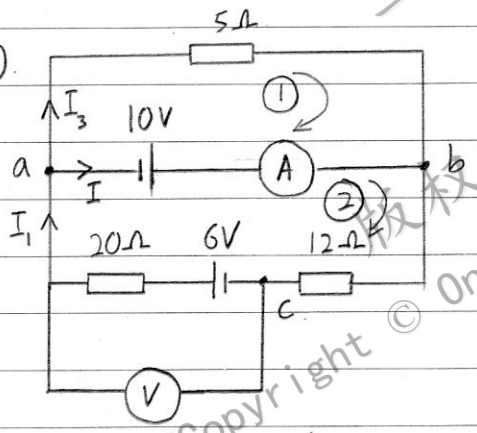
$4(6+r_V) = 6r_V$

$24 + 4r_V = 6r_V$

$r_V = 12\,\Omega$ #

(c) (a) 基尔霍夫定则包含节点电流定则及回路电压定则。在任一节点上的电流代数和为零，称为节点电流定则。在任一绕行方向上，整个回路的电势的总和为零，称称为回路电压定则。

(b)



(i) 节点 a： $I_1 = I + I_3$

$I = I_1 - I_3$

回路①： $-5I_3 - 10 = 0$

$I_3 = -2A$ # #

(负数代表与图显示的方向相反)

回路②： $10 - 12I_1 + 6 - 20I_1 = 0$

$-32I_1 = -16$

$I_1 = 0.5A$ #

(ii) $I = I_1 - I_3$

$= 0.5 - (-2)$

$= 2.5A$

∴ 安培表的读数为 2.5A。

$V = 6 - 20I_1$

$= 6 - 20 \times 0.5$

$= -4V$

∴ 伏特表的读数为 4V。

(iii) $W = \frac{1}{2}CV^2$

$= \frac{1}{2} \times 120 \times 10^{-6} \times 4^2$

$= 9.6 \times 10^{-4}\,J$ #

(9) (i) $\frac{1}{R'} = \frac{1}{10} + \frac{1}{5+10}$

$R' = 6\,\Omega$

$R_T = 6\,\Omega + 5\,\Omega$

$= 11\,\Omega$ #

$E = I(R+r)$

$12 = I(11+1)$

$I = 1\,A$

$I_1R_1 = I_2(R_2+R_3)$

$10I_1 = I_2(10+5)$

$10(1-I_2) = 15I_2$

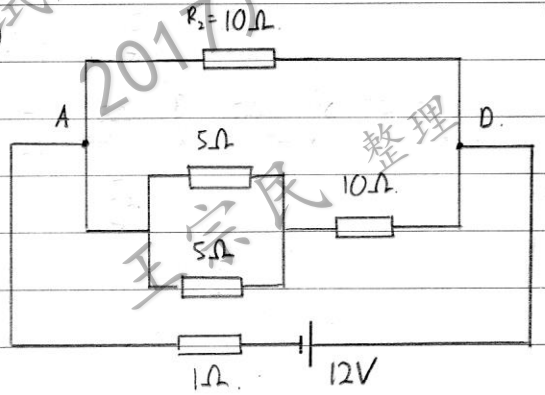
$I_2 = 0.4\,A$

$V_2 = I_2R_2$

$= 0.4 \times 10$

$= 4V$ #

(ii)



$\frac{1}{R_T} = \frac{1}{10} + \frac{1}{2.5+10}$

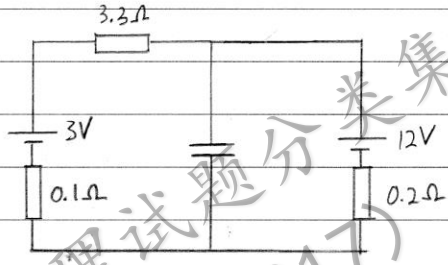
$R_T = 5\frac{5}{9}\,\Omega$ # / $5.56\,\Omega$ #

$E = I(R+r)$ $E = Ir + V_2$

$12 = I(5\frac{5}{9}+1)$ $12 = 1.83\times1 + V_2$

$I = 1.83\,A$ $V_2 = 10.17\,V$ #

(10) (a)



(i) $E = I(R+r)$

$12-3 = I(3.3+0.1+0.2)$

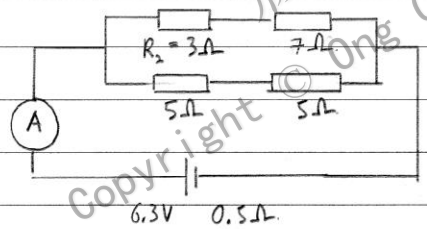
$I = 2.5\,A$ #

(ii) $V = IR$ $W = \frac{1}{2}CV^2$

$= 2.5\times0.2$ $= \frac{1}{2}\times8\times10^{-6}\times(12-0.5)^2$

$= 0.5\,V$ $= 5.29\times10^{-4}\,J$ #

(b) 滑动变阻器的触头在a端1cm处，电阻最大。

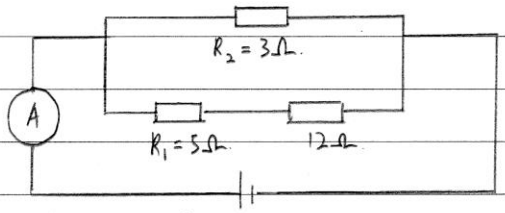


$\frac{1}{R_T} = \frac{1}{10} + \frac{1}{10}$ $E = I(R+r)$

$R_T = 5\,\Omega$ $6.3 = I(5+0.5)$

$I = 1.15\,A$ #

滑动变阻器的触头在b端时，电阻最小。



$\frac{1}{R_T} = \frac{1}{3} + \frac{1}{5+12}$ $E = I(R+r)$

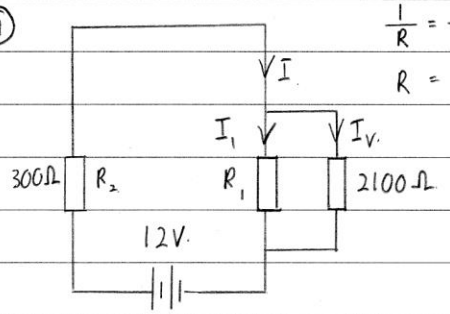
$R_T = 2.55\,\Omega$ $6.3 = I(2.55+0.5)$

$I = 2.07\,A$ #

(11)

$\frac{1}{R} = \frac{1}{2100} + \frac{1}{R_1}$

$R = \frac{2100R_1}{2100+R_1}$



(i) $V = IR$ $V = I_VR$

$12-8.4 = I\times300$ $8.4 = I_V\times2100$

$I = 0.012\,A$ $I_V = 0.004\,A$

$I = I_1 + I_V$ $V = I_1R_1$

$0.012 = I_1 - 0.004$ $8.4 = 8\times10^{-4}R_1$

$I_1 = 8\times10^{-4}$ $R_1 = 1050\,\Omega$ #

(ii) 随着量程扩大，伏特表的内阻也增大，因而分流变小，测量到的值变大，更接近PQ间的实际端电压。

(12) (a) ① 将可变电阻的触点C调至接近Q处，接通开关S，记下安培表及伏特表的读数。

② 将触点C逐步滑向P，使电阻变小，读取5组相应的安培表及伏特表读数。

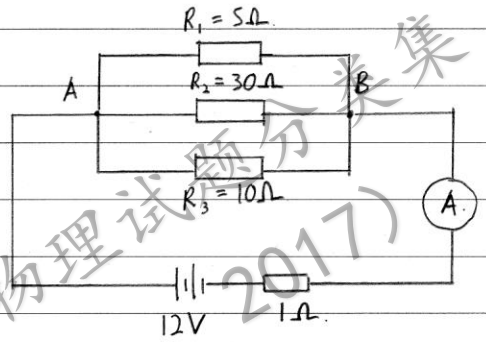
③ 用所得到的数据，绘出V-I座标图像，从所绘出的直线图像中，读取数据，求出r。

(b) (i) $E = I(R+r)$

$12 = I(5+1)$

$I = 2\,A$ #

(ii)



$\frac{1}{R'} = \frac{1}{5} + \frac{1}{30} + \frac{1}{10}$

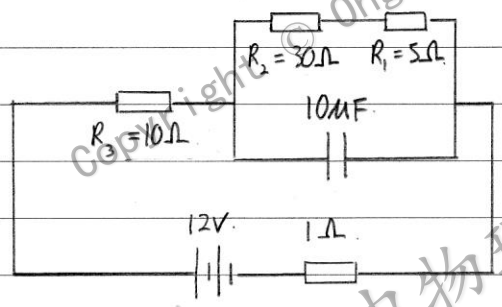
$R' = 3\Omega$

$E = I(R+r)$

$12 = I(3+1)$

$I = 3\,A$ #

(iii)



$E = I(R+r)$

$12 = I(10+30+5+1)$

$I = 0.261\,A$

$V_c = IR$

$= 0.261 \times 35$

$= 9.13\,V$

$E = \frac{1}{2}CV^2$

$= \frac{1}{2} \times 10 \times 10^{-6} \times 9.13^2$

$= 4.17 \times 10^{-4}\,J$ #

(13) $\frac{1}{C_T} = \frac{1}{1.5\mu + 4.5\mu} + \frac{1}{3\mu}$

$C = 2\mu F$

$C = \frac{Q}{V}$

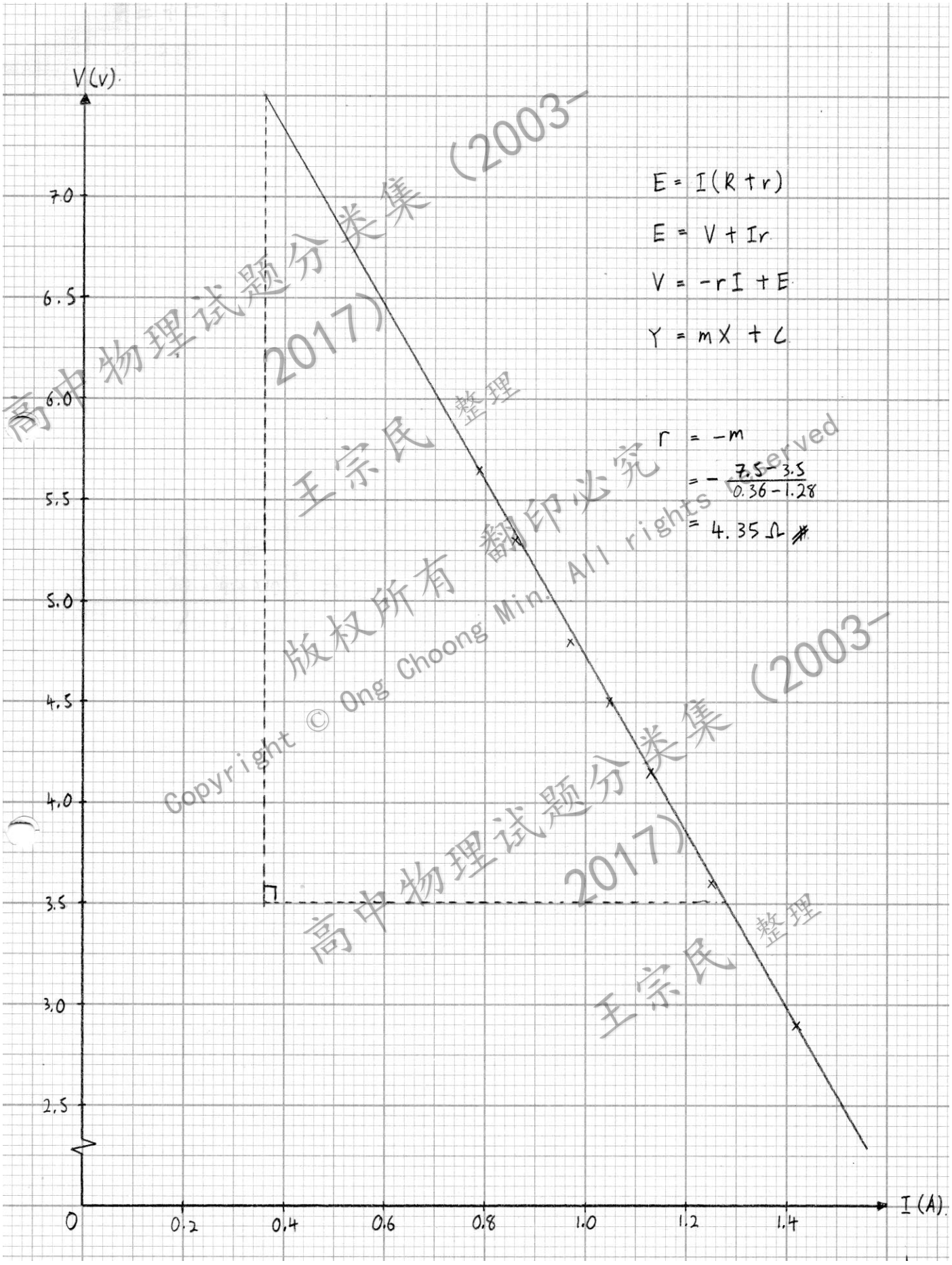
$2 \times 10^{-6} = \frac{Q}{10}$

$Q = 2 \times 10^{-5}\,C$

$E = \frac{1}{2}\frac{Q^2}{C}$

$= \frac{1}{2} \times \frac{(2 \times 10^{-5})^2}{3 \times 10^{-6}}$

$= 6.67 \times 10^{-5}\,J$ #



$E = I(R + r)$

$E = V + Ir$

$V = -rI + E$

$Y = mX + C$

$r = -m$

$= -\frac{7.5 - 3.5}{0.36 - 1.28}$

$= 4.35\ \Omega$ //