회로 이론/실습

2. 직렬로 연결된 저항 회로의 전류, 전압 및 전력

2. 직렬로 연결된 저항 회로의 전류, 전압 및 전력

2-1. 목적 및 배경

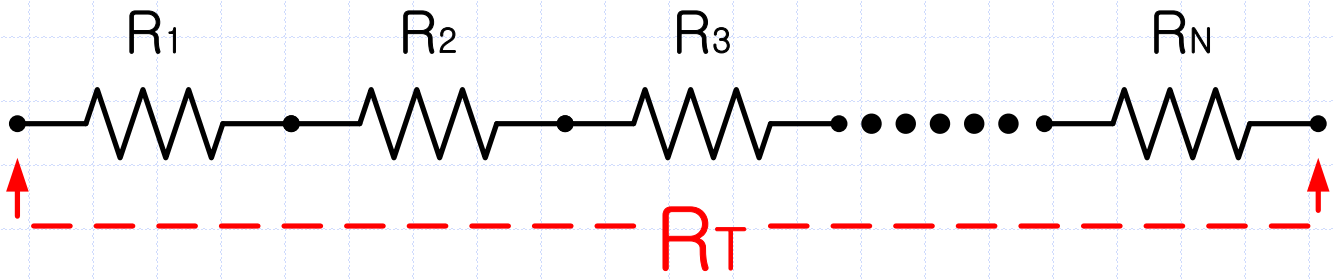
- ✓ 저항이 직렬로 연결될 때 총저항의 값을 계산한다.
- ✓ 디지털 멀티미터 (Digital Multi-Meter : DMM) 를 이용하여 직렬로 연결된 저항값을 측정한다.
- ✓ 디지털 멀티미터 (Digital Multi-Meter : DMM) 를 이용하여 직렬로 연결된 회로의 전압과 전류를 측정한다.
- ✓ 측정된 전압과 전류를 이용하여 전력을 계산한다.

2-2. 소요 부품 및 장비

- 부품
  - 저항 (1/4W) : 100Ω, 200Ω, 1kΩ, 3kΩ, 4.7kΩ, 1MΩ
- 장비
  - 브레드 보드
  - 디지털 멀티미터 (Digital Multi-Meter)
  - 직류전원장치 (DC Power Supply)

2-3. 유용한 공식

✓ 저항의 직렬 연결



$$R_T = R_1 + R_2 + R_3 + \cdots\cdots + R_N$$

2-3. 유용한 공식

✓ 옴의 법칙 (Ohm's Law)

$$V = IR, \quad I = \frac{V}{R}, \quad R = \frac{V}{I}$$

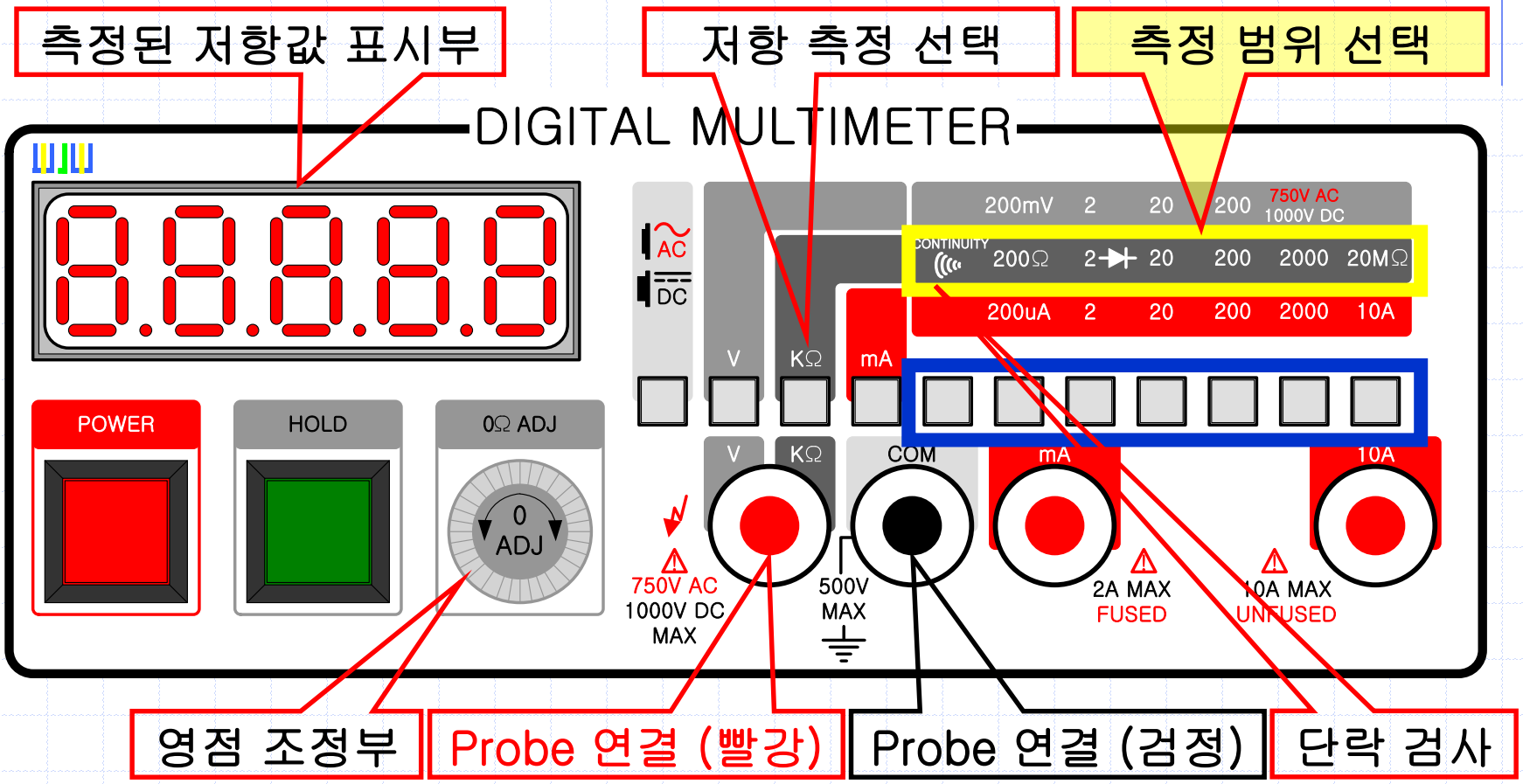
V : 전압 (Voltage, V), I : 전류 (Currents, A), R : 저항 (Resistor, Ω)

✓ 전력 (Power), P, W, Watt

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

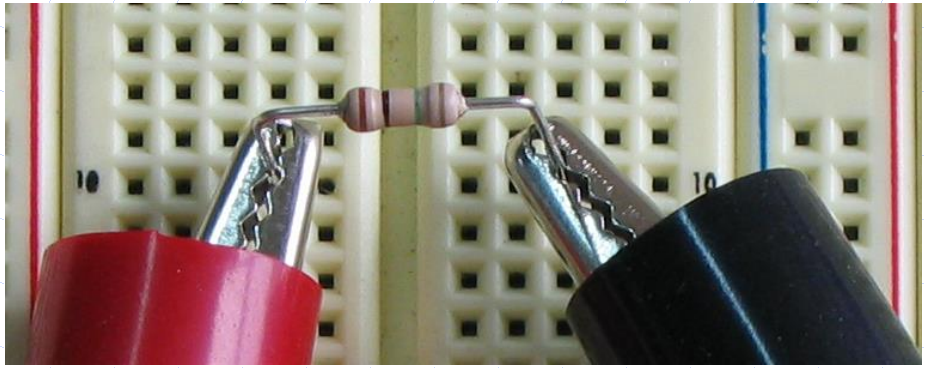
2-4. 디지털 멀티미터 (DMM)-저항 측정

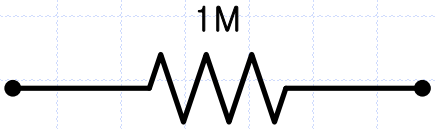
✓ Digital Multi Meter 사용하기 (저항 측정)



2-5A. 저항 측정

✓ 저항 측정



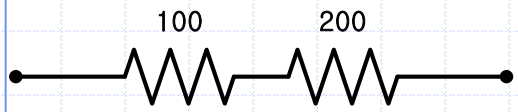


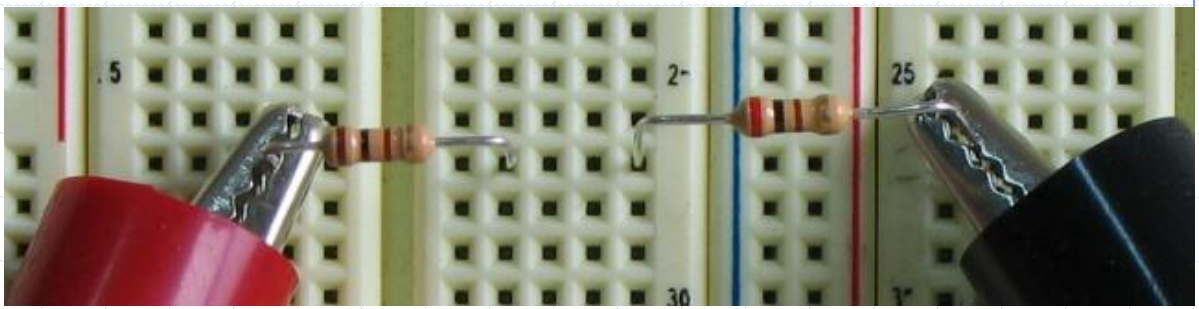
갈 검 녹

1 0 X 100,000 = 1 MΩ

2-5B. 저항 측정

✓ 직렬 저항 측정

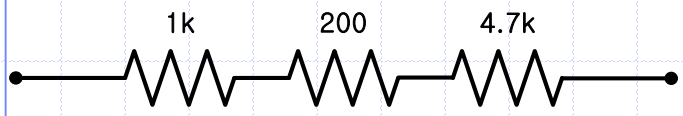


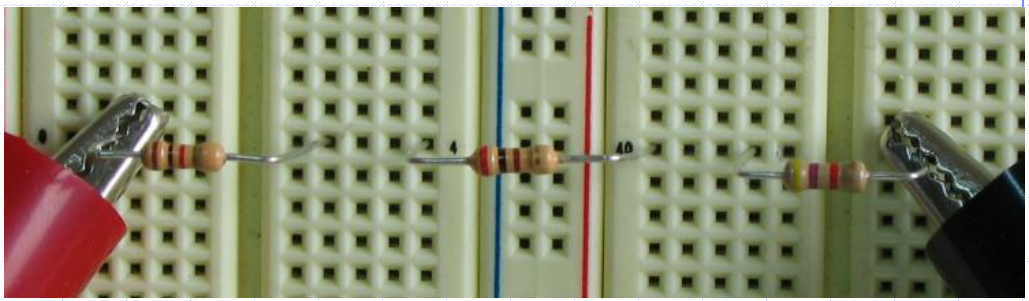


$$R_T = R_1 + R_2 = 100\Omega + 200\Omega = 300\Omega$$

2-5C. 저항 측정

✓ 직렬 저항 측정

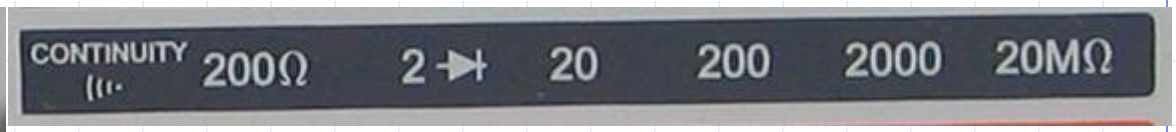




$$R_T = R_1 + R_2 + R_3 = 1k\Omega + 200\Omega + 4.7k\Omega = 5900\Omega = 5.9k\Omega$$

2-6. 저항 측정과 측정 범위 선택

✓ 저항값 1kΩ을 여러 가지 측정 범위로 측정



0~200Ω, 0~2kΩ, 0~20kΩ, 0~200kΩ, 0~2000kΩ, 0~20MΩ

측정 범위 : 0 ~ 200Ω
측 정 값 : 측정 불가 (OL)
측정 범위 넘음

측정 범위 : 0 ~ 2kΩ
측 정 값 : 0.9996kΩ=999.6Ω
오차 : 0.04%

측정 범위 : 0 ~ 20kΩ
측 정 값 : 0.998kΩ=998Ω
오차 : 0.2%

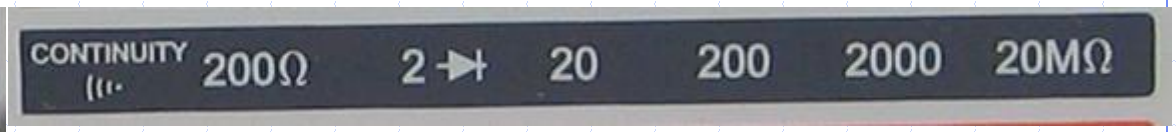
측정 범위 : 0 ~ 200kΩ
측 정 값 : 0.97kΩ=970Ω
오차 : 3%

측정 범위 : 0 ~ 2000kΩ
측 정 값 : 0.7kΩ=700Ω
오차 : 30%

측정 범위 : 0 ~ 20MΩ
측 정 값 : 0.003MΩ=300Ω
오차 : 200%

2-6. 저항 측정과 측정 범위 선택

✓ 저항값 200Ω을 여러 가지 측정 범위로 측정



0~200Ω, 0~2kΩ, 0~20kΩ, 0~200kΩ, 0~2000kΩ, 0~20MΩ

측정 범위 : 0 ~ 200Ω
측 정 값 : 199.05Ω
오차 : 0.475%

측정 범위 : 0 ~ 2kΩ
측 정 값 : 0.2004kΩ=200.4Ω
오차 : 0.2%

측정 범위 : 0 ~ 20kΩ
측 정 값 : 0.197kΩ=197Ω
오차 : 1.5%

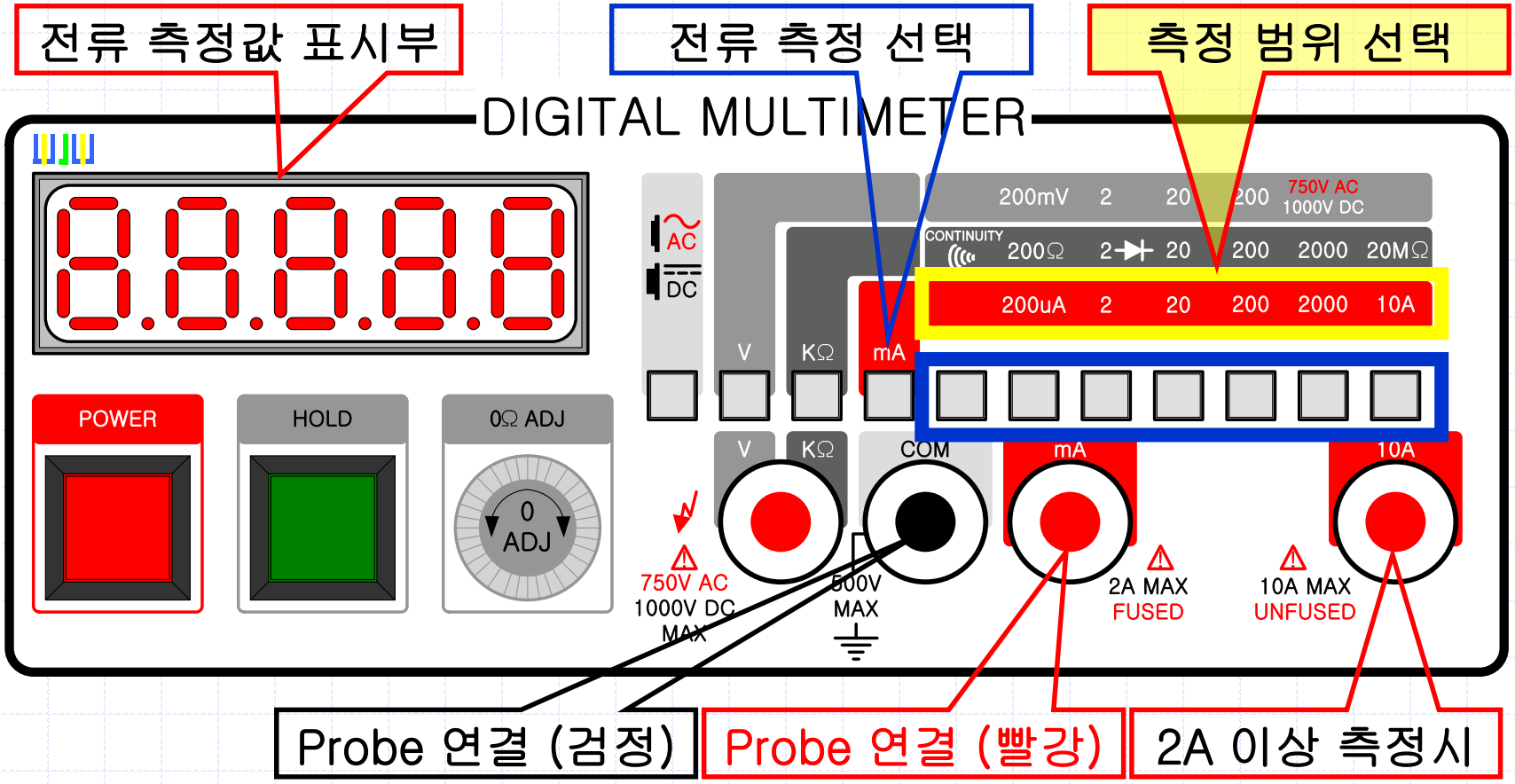
측정 범위 : 0 ~ 200kΩ
측 정 값 : 0.21kΩ=210Ω
오차 : 5%

측정 범위 : 0 ~ 2000kΩ
측 정 값 : 0.3kΩ=300Ω
오차 : 50%

측정 범위 : 0 ~ 20MΩ
측 정 값 : 0.011MΩ
오차 : 45%

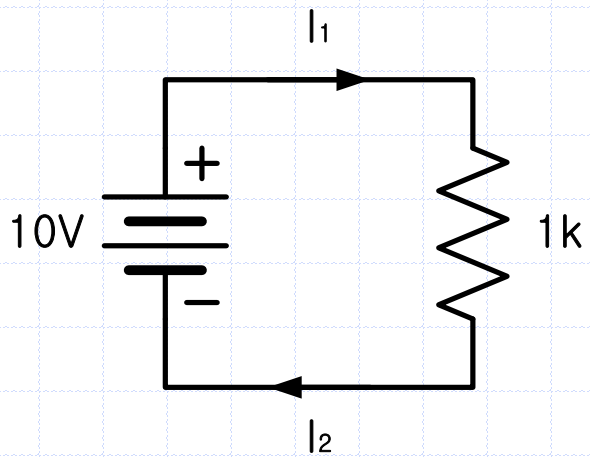
2-7. 디지털 멀티미터 (DMM)-전류 측정

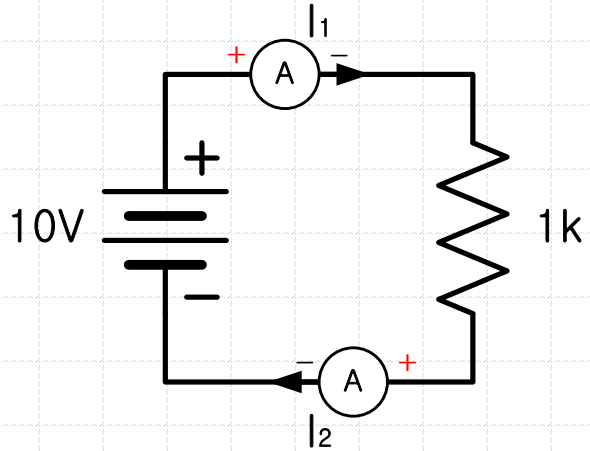
✓ Digital Multi Meter 사용하기 (전류 측정)

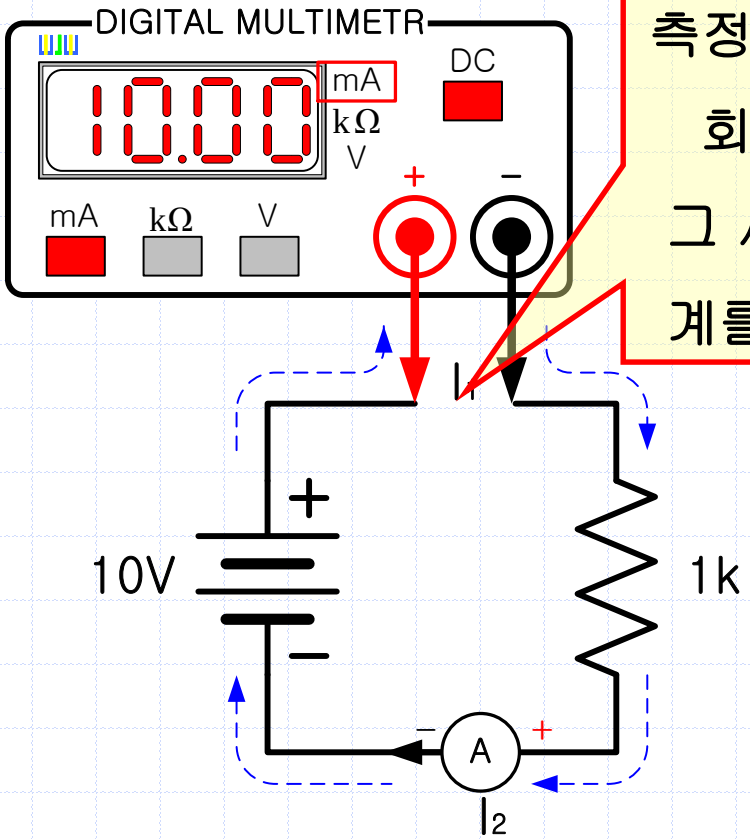


2-8A. 전류 측정

✓ 전류의 측정 방법 : 회로와 직렬로 연결하여 측정

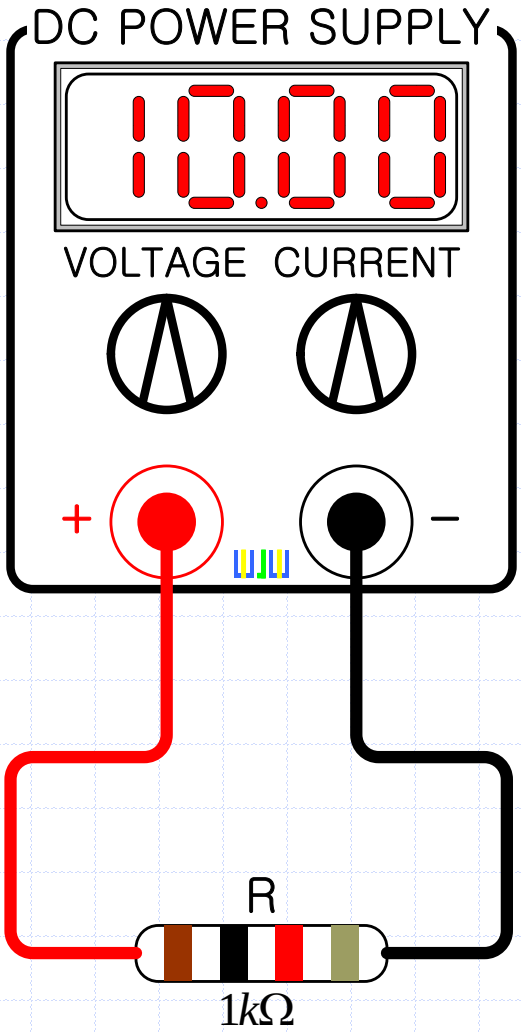


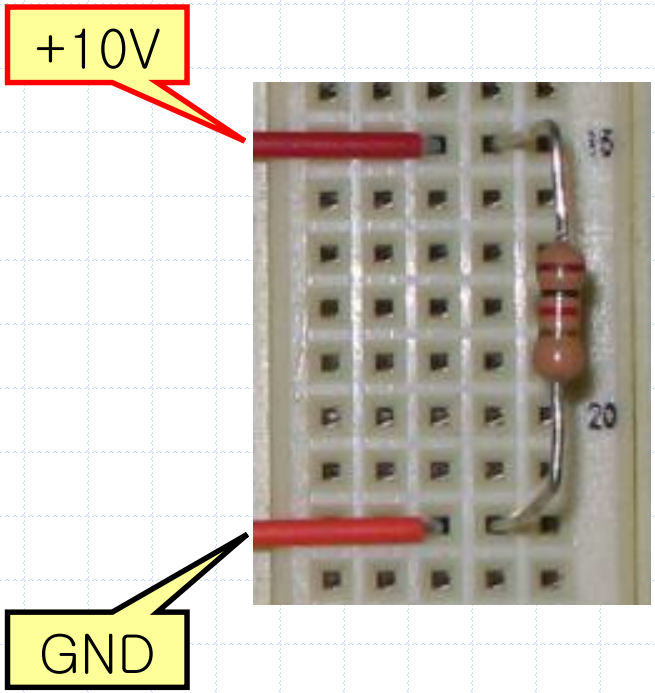




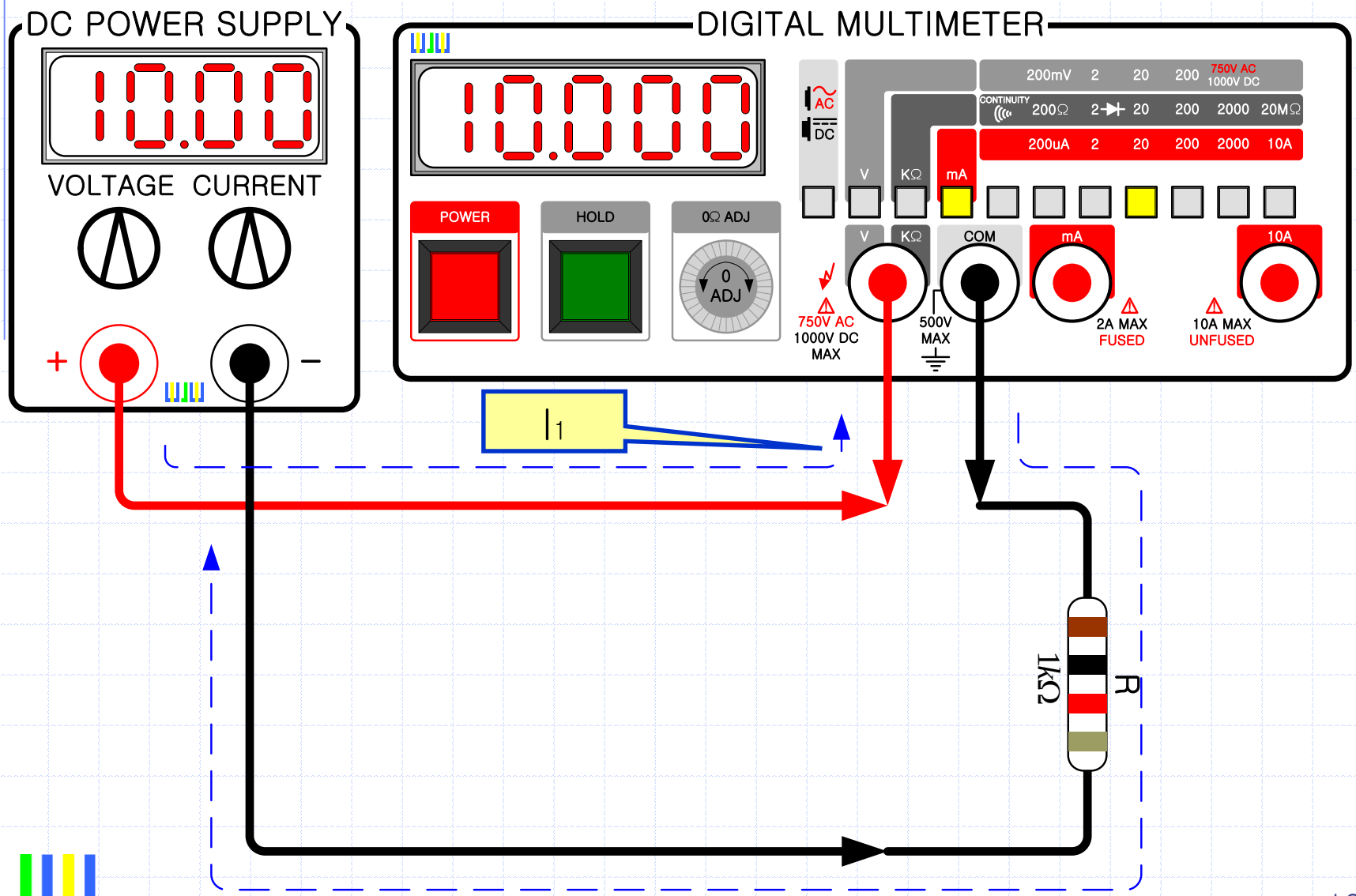
전류의 흐름을 측정하기 위하여 회로를 끊고 그 사이에 전류계를 넣어 측정

2-8A. 전류 측정

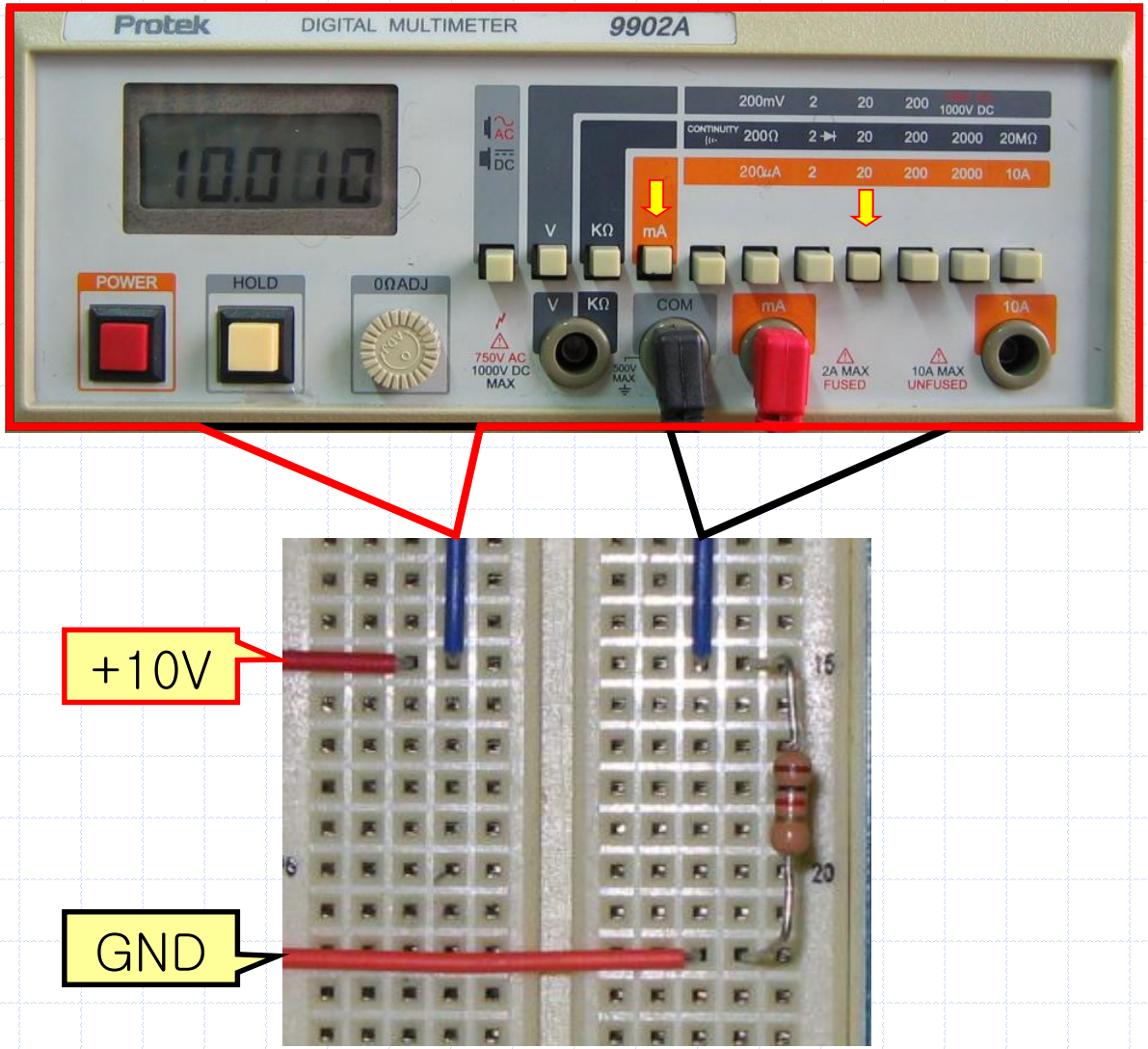




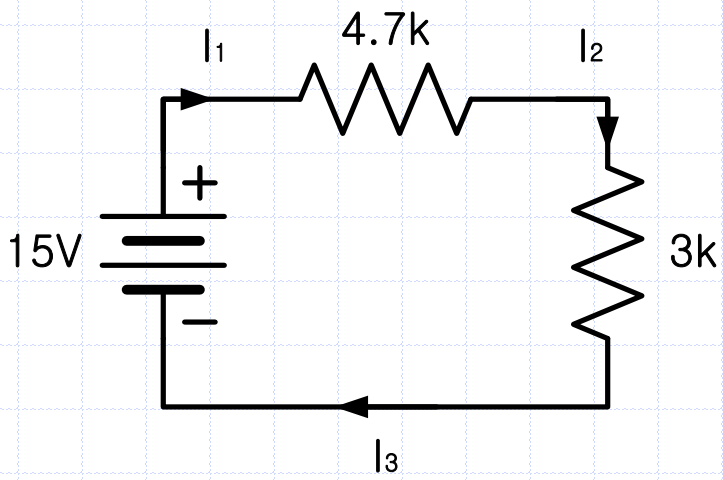
2-8A. 전류 측정

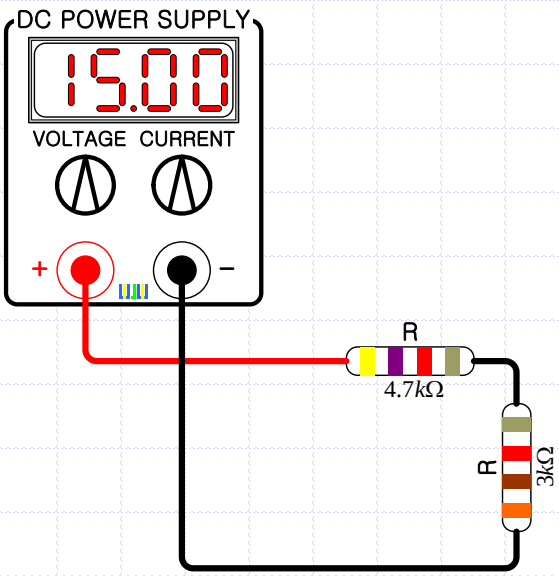

DC POWER SUPPLY
10.00
VOLTAGE
CURRENT
+
−
DIGITAL MULTIMETER
10.000
POWER
HOLD
0Ω ADJ
0
ADJ
AC
DC
200mV 2 20 200 750V AC 1000V DC
CONTINUITY 200Ω 2 20 200 2000 20MΩ
200uA 2 20 200 2000 10A
V
KΩ
mA
COM
10A
750V AC
1000V DC
MAX
500V
MAX
2A MAX
FUSED
10A MAX
UNFUSED
I1
1kΩ
R

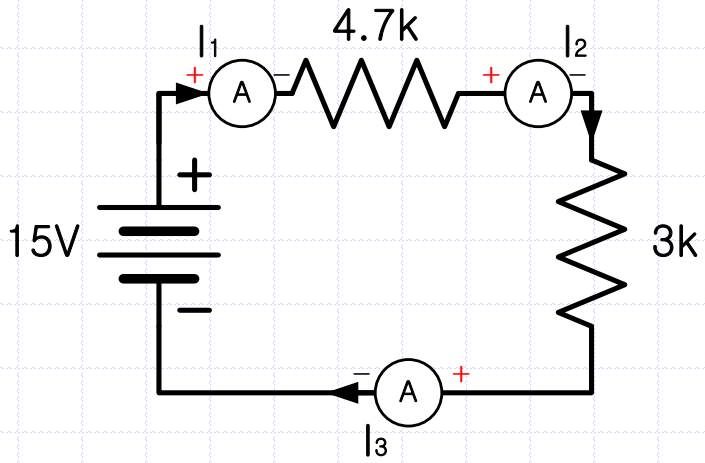
2-8A. 전류 측정

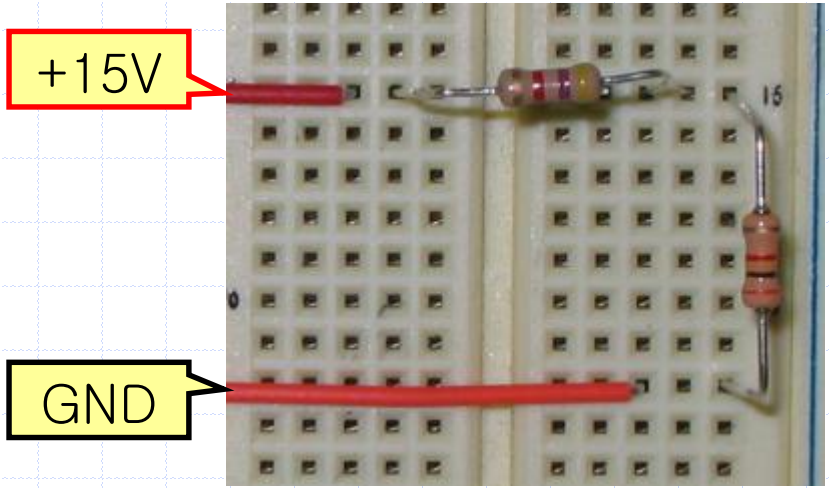

Protek
DIGITAL MULTIMETER
9902A
10.010
AC
DC
200mV
2
20
200
1000V DC
CONTINUITY
200Ω
2
20
200
2000
20MΩ
200μA
2
20
200
2000
10A
V
KΩ
mA
POWER
HOLD
0ΩADJ
V
KΩ
COM
mA
10A
750V AC
1000V DC
MAX
500V
MAX
2A MAX
FUSED
10A MAX
UNFUSED
+10V
GND
15
20

2-8B. 전류 측정

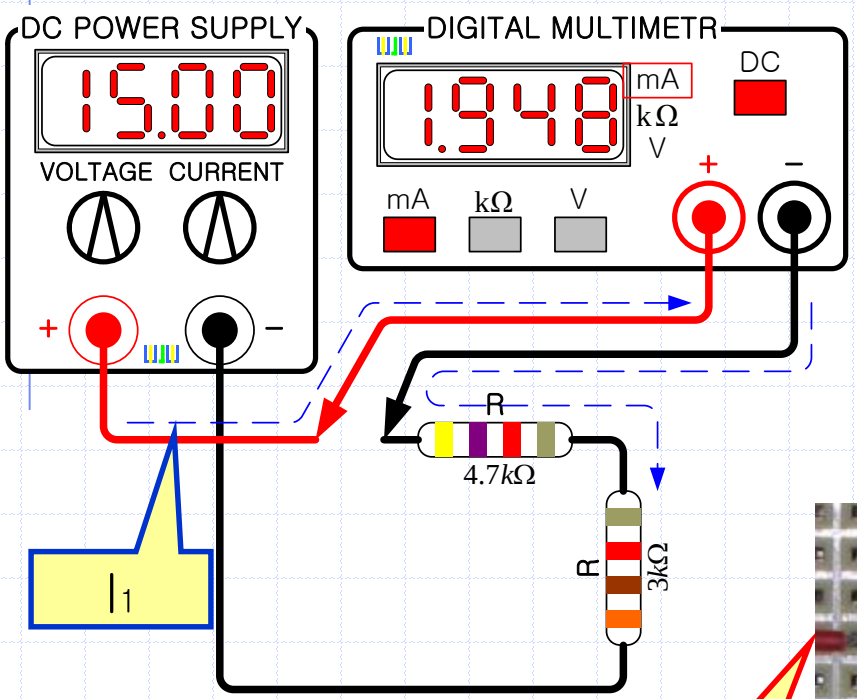

I1
4.7k
I2
+
15V
−
3k
I3


DC POWER SUPPLY
15.00
VOLTAGE
CURRENT
+
−
R
4.7kΩ
R
3kΩ

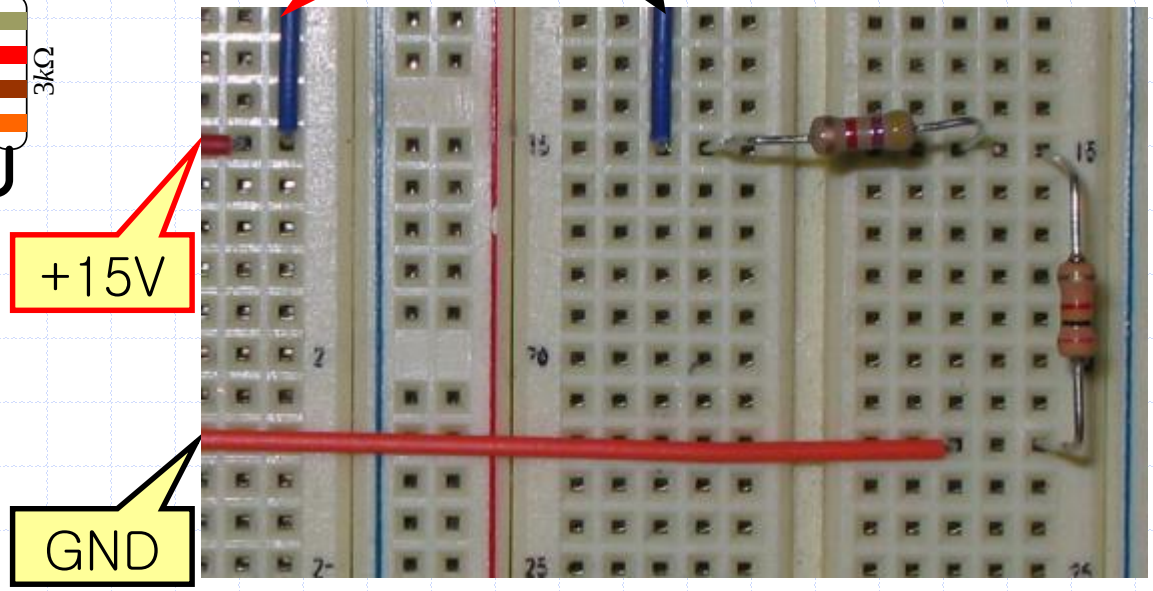

I1
4.7k
I2
A
A
+
15V
−
3k
A
I3


+15V
GND

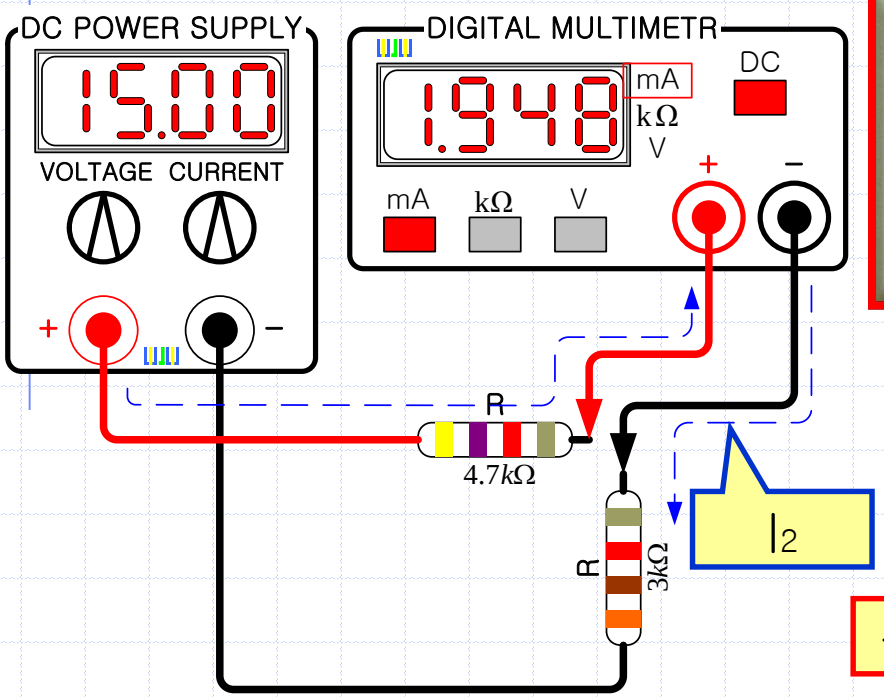
2-8B. 전류 측정

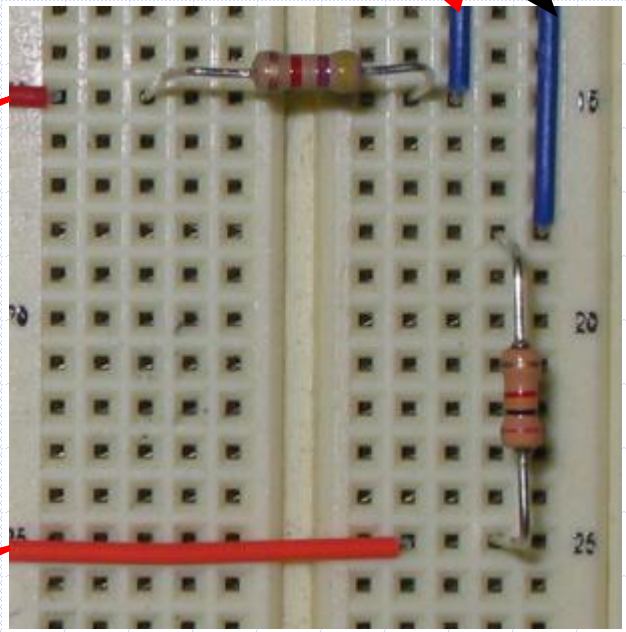

DC POWER SUPPLY
15.00
VOLTAGE CURRENT
+
−
DIGITAL MULTIMETR
1.948
mA
kΩ
V
DC
mA
kΩ
V
+
−
R
4.7kΩ
R
3kΩ
I1


Protek
DIGITAL MULTIMETER
9902A
1.970
POWER
HOLD
0ΩADJ
V
KΩ
COM
mA
10A


+15V
GND

2-8B. 전류 측정

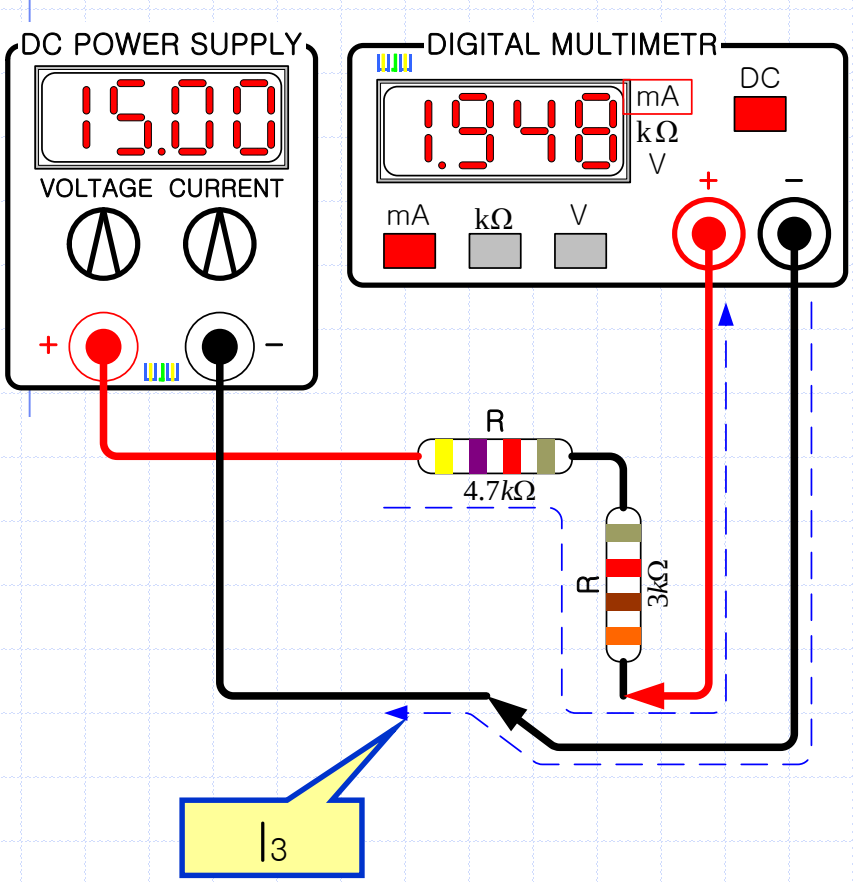


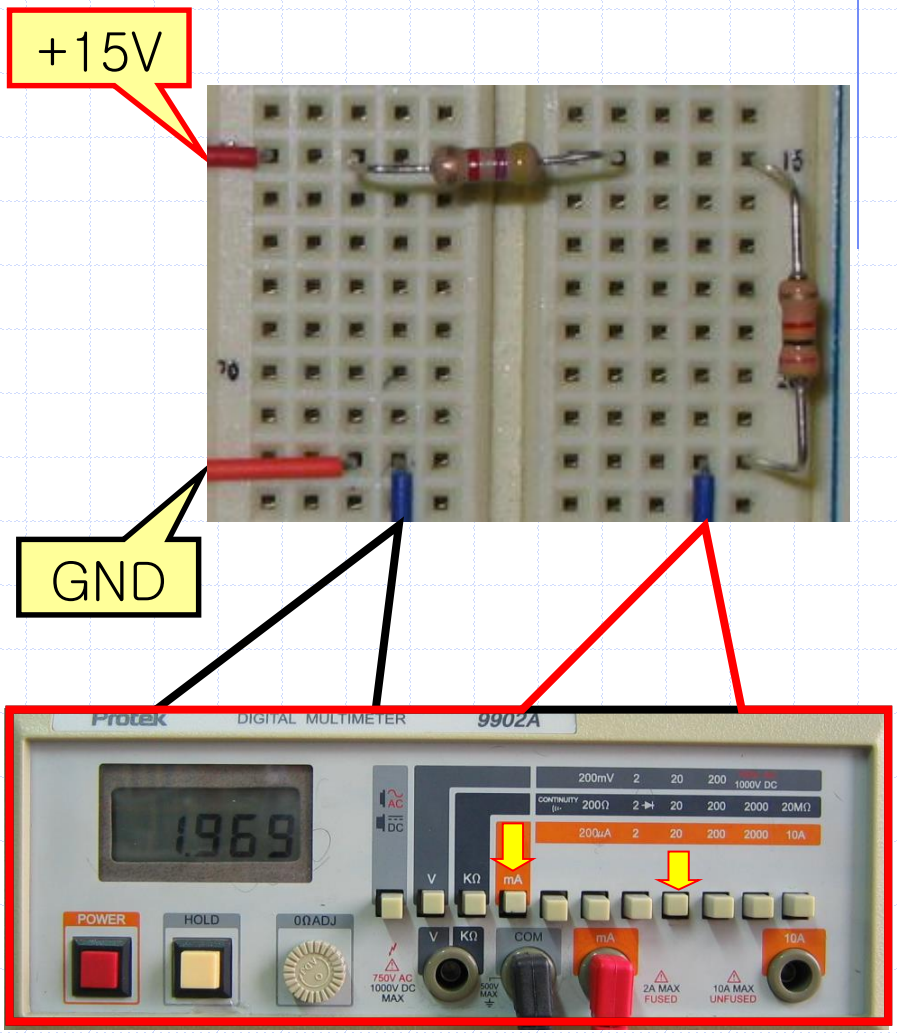


+15V

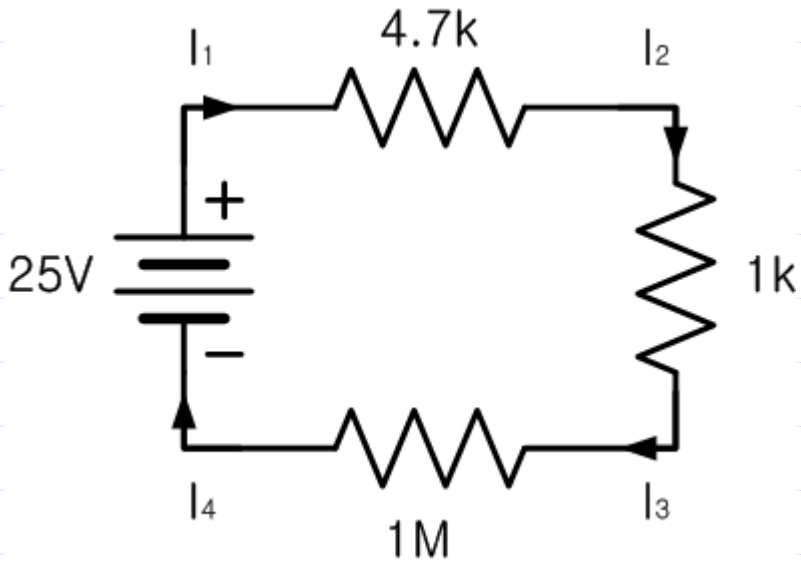
GND

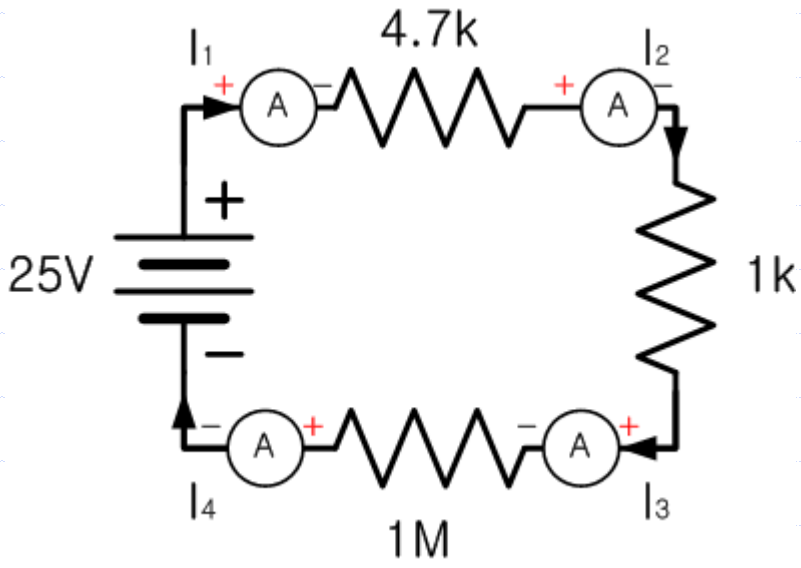
2-8B. 전류 측정

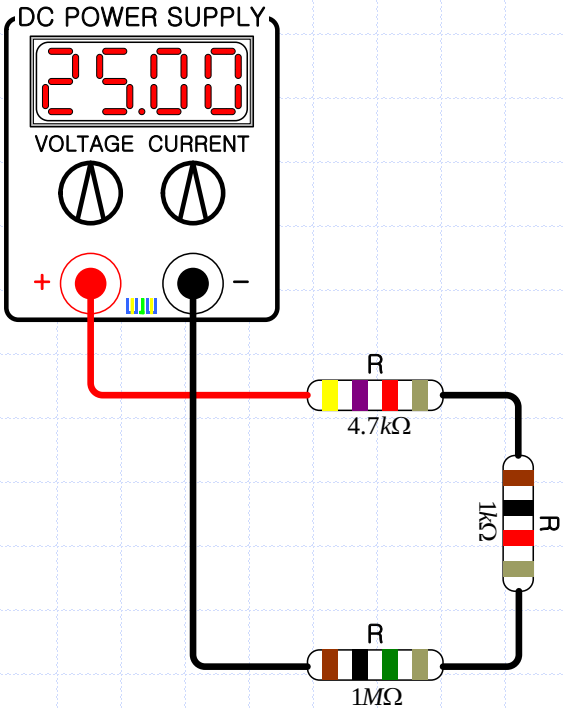

DC POWER SUPPLY
15.00
VOLTAGE
CURRENT
+
−
DIGITAL MULTIMETR
1.948
mA
kΩ
V
DC
mA
kΩ
V
+
−
R
4.7kΩ
R
3kΩ
I3

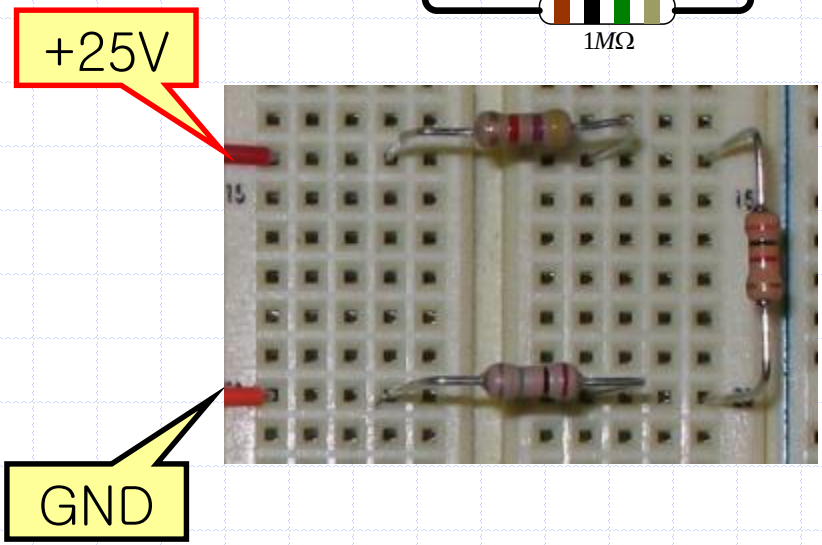

+15V
GND
Protek
DIGITAL MULTIMETER
9902A
1.969
POWER
HOLD
0ΩADJ
V
KΩ
COM
mA
10A

2-8C. 전류 측정

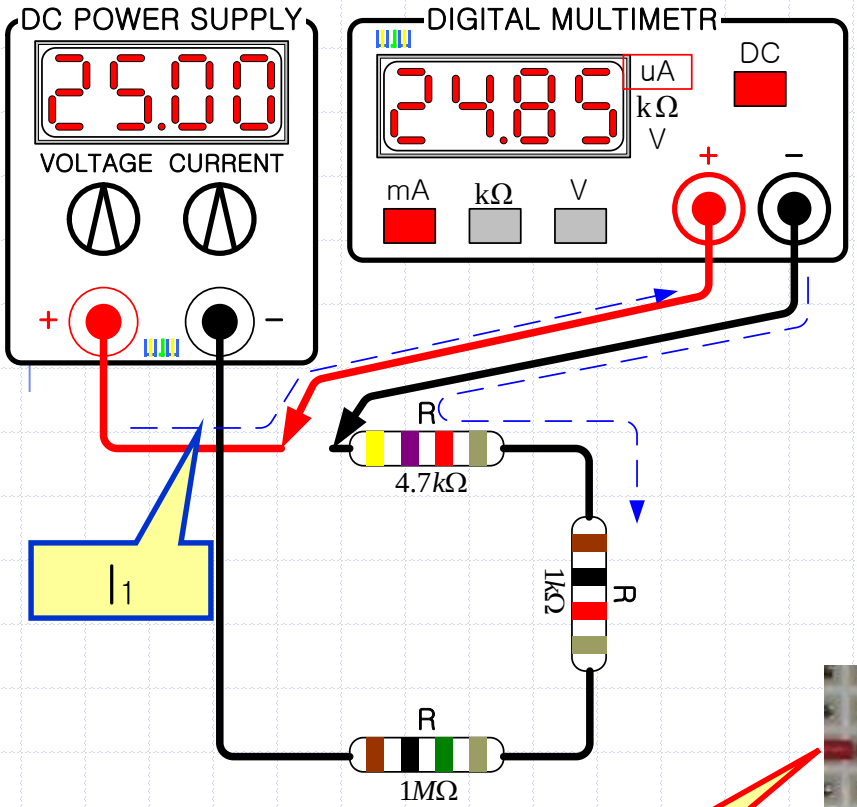

I1
4.7k
I2
+
25V
−
1k
I4
1M
I3

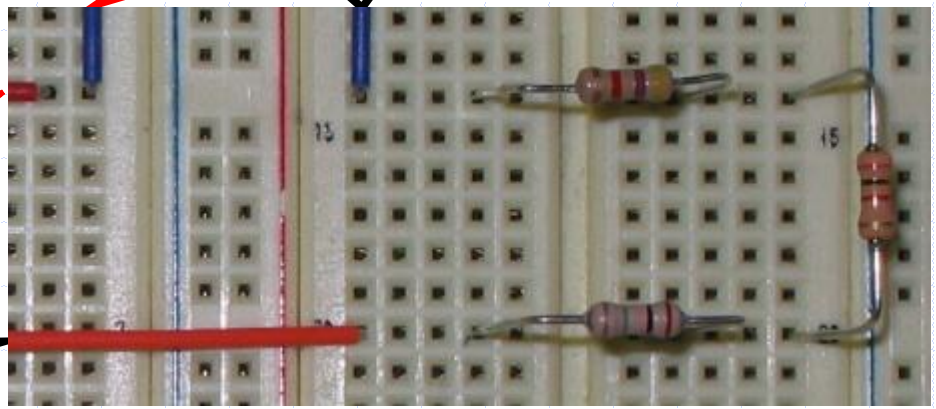

I1
4.7k
I2
A
A
+
25V
−
1k
A
A
I4
1M
I3


DC POWER SUPPLY
25.00
VOLTAGE
CURRENT
+
−
R
4.7kΩ
1kΩ
R
R
1MΩ


+25V
GND

2-8C. 전류 측정

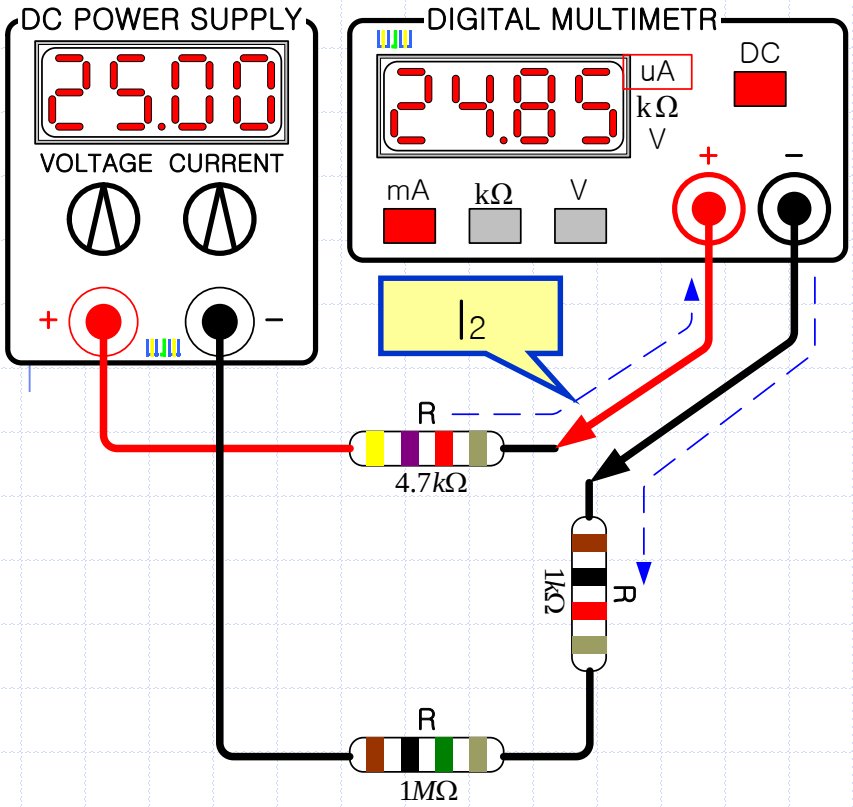




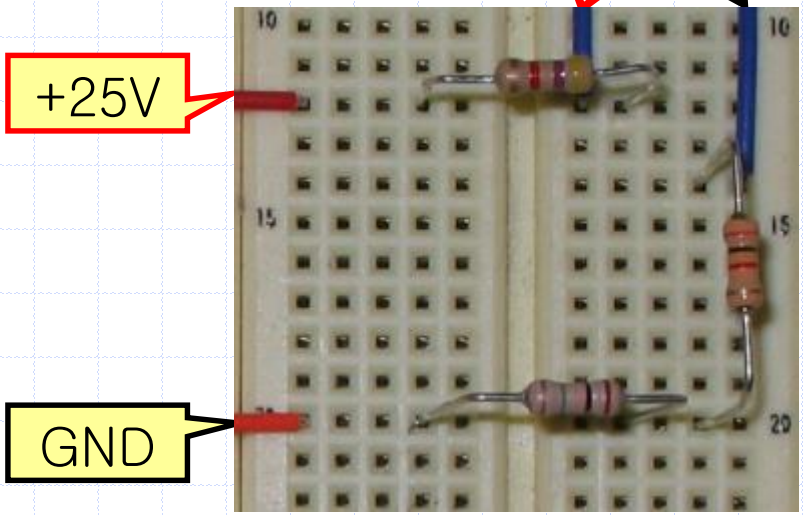
+25V

GND

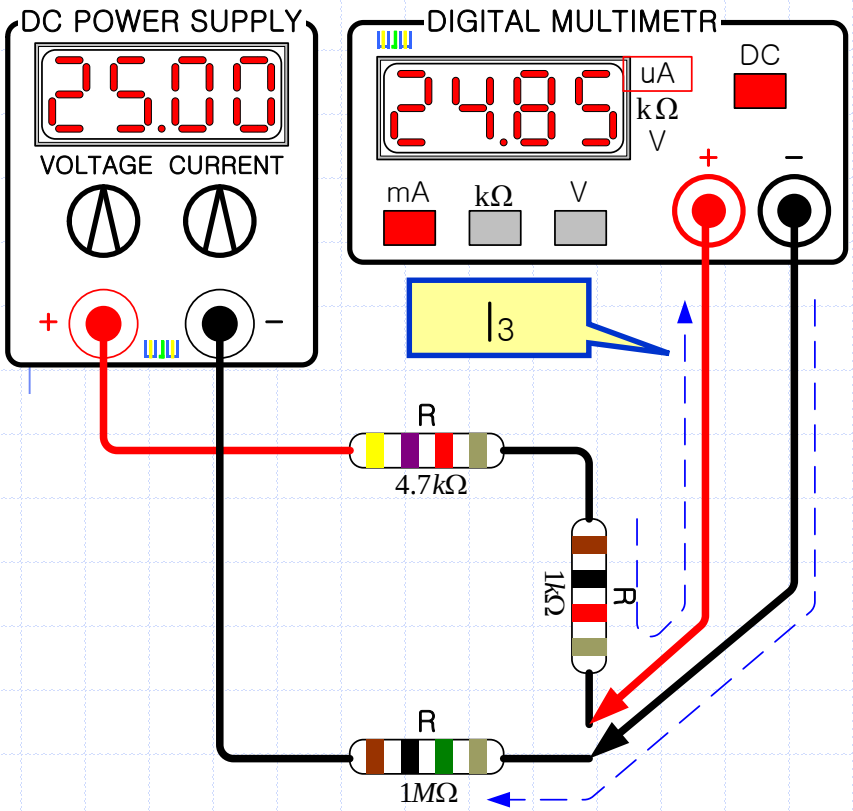
2-8C. 전류 측정

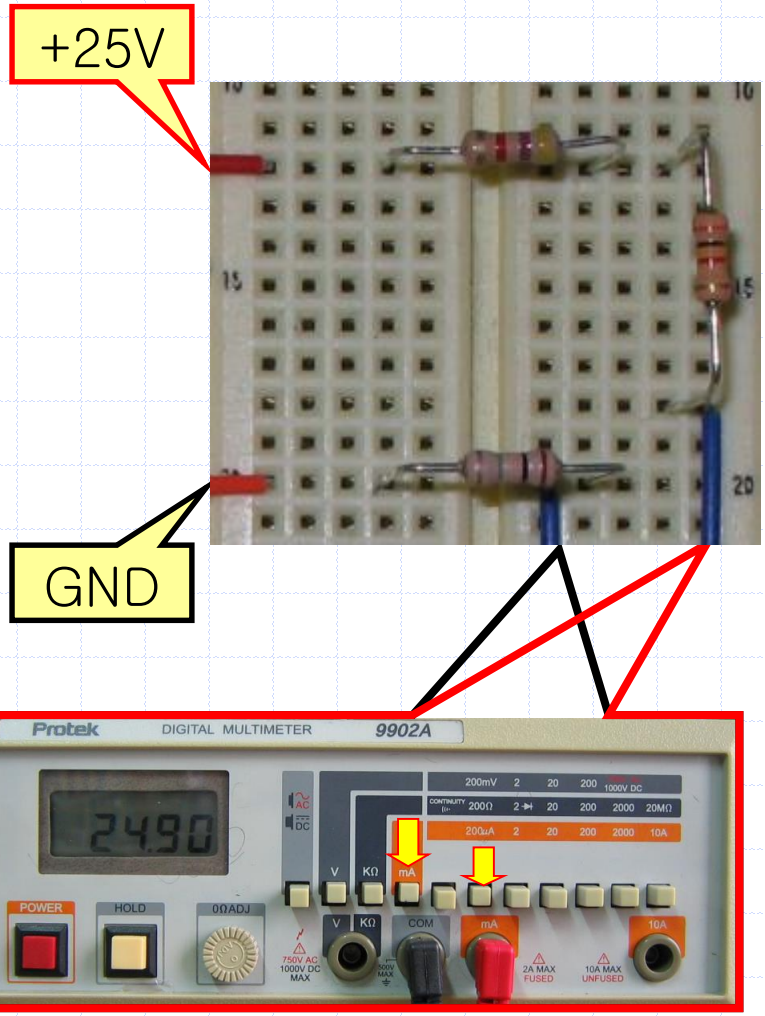

DC POWER SUPPLY
25.00
VOLTAGE CURRENT
+
−
DIGITAL MULTIMETR
24.85
uA
kΩ
V
DC
mA
kΩ
V
+
−
I2
R
4.7kΩ
1kΩ
R
R
1MΩ


Protek
DIGITAL MULTIMETER
9902A
24.89
POWER
HOLD
0ΩADJ
V
KΩ
COM
mA
10A

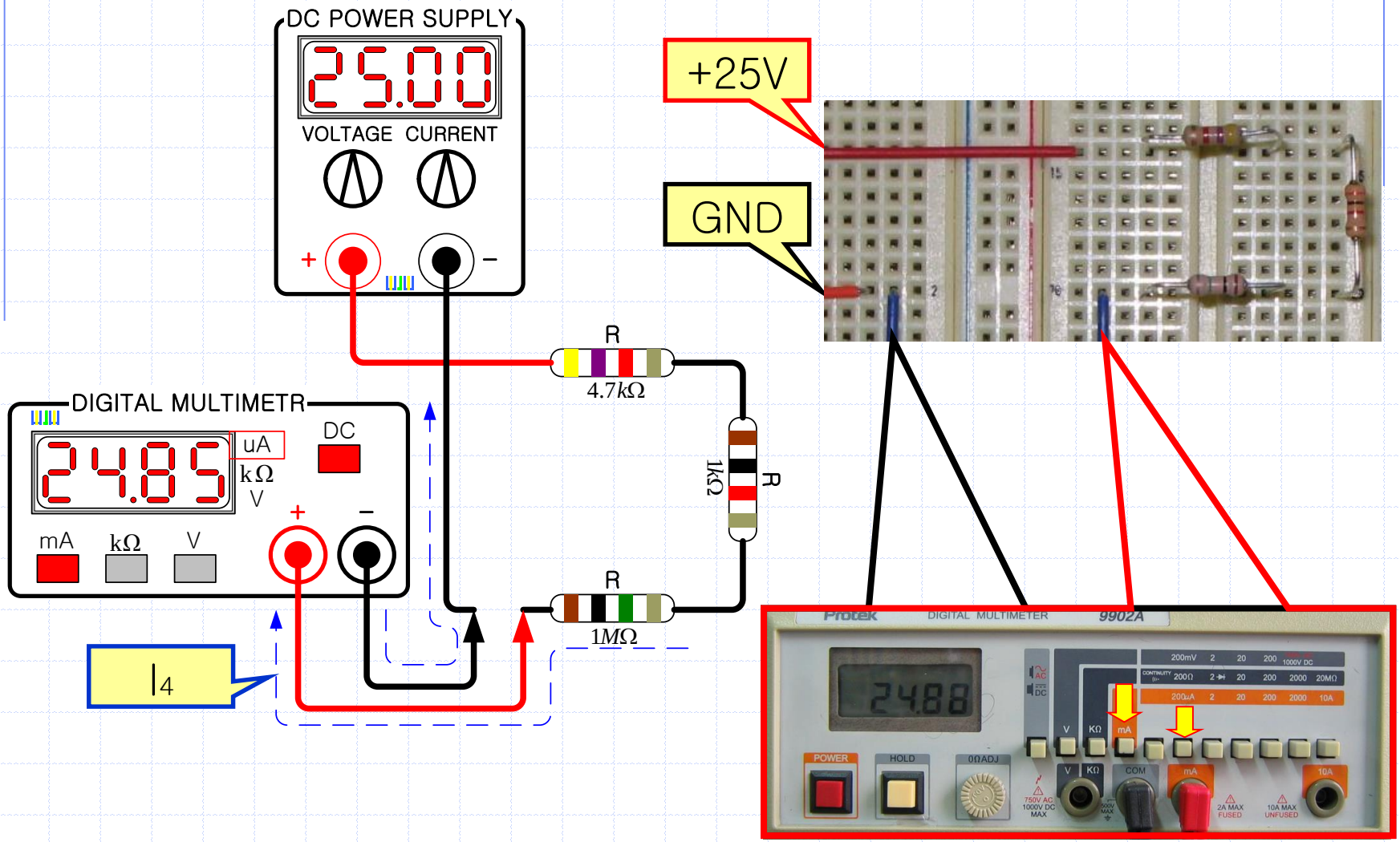

+25V
GND

2-8C. 전류 측정


DC POWER SUPPLY
25.00
VOLTAGE
CURRENT
+
−
DIGITAL MULTIMETR
24.85
uA
kΩ
V
DC
mA
kΩ
V
+
−
I3
R
4.7kΩ
R
1kΩ
R
1MΩ

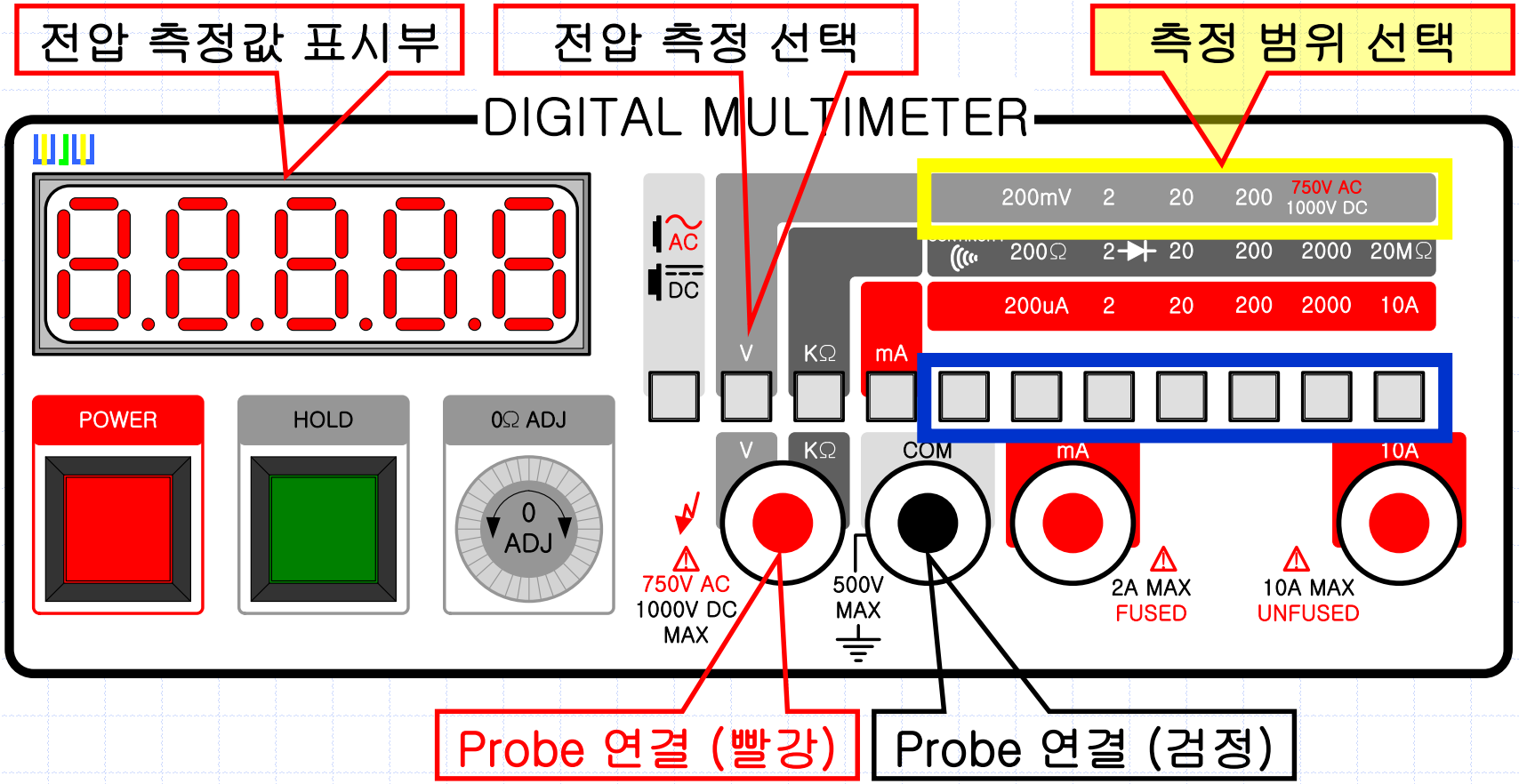

+25V
GND
Protek
DIGITAL MULTIMETER
9902A
24.90
POWER
HOLD
0ΩADJ
V
KΩ
COM
mA
10A

2-8C. 전류 측정


DC POWER SUPPLY
25.00
VOLTAGE CURRENT
+
−
+25V
GND
R
4.7kΩ
R
1kΩ
R
1MΩ
DIGITAL MULTIMETR
24.85
uA
kΩ
V
DC
mA
kΩ
V
+
−
I4
Protek
DIGITAL MULTIMETER
9902A
24.88
POWER
HOLD
0ΩADJ
V
KΩ
COM
mA
10A

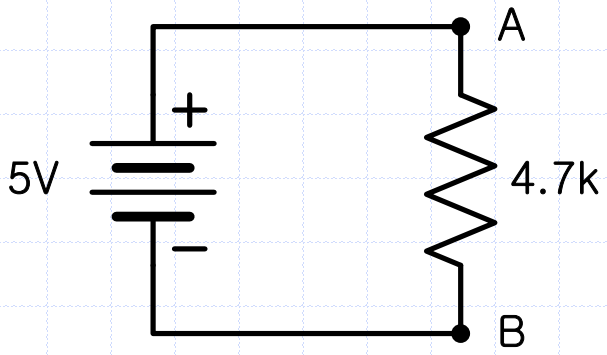
2-9. 디지털 멀티미터 (DMM)-전압 측정

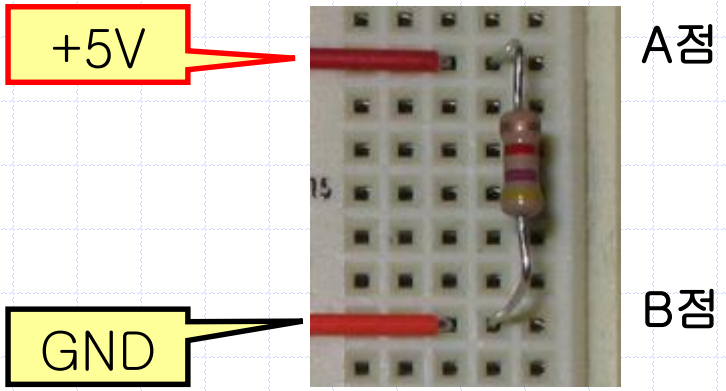
✓ Digital Multi Meter 사용하기 (전압 측정)

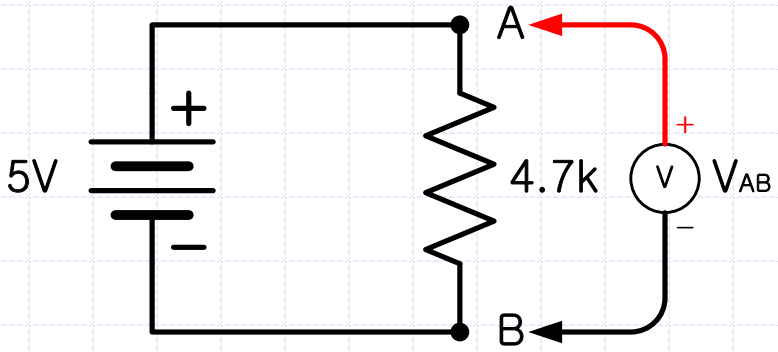


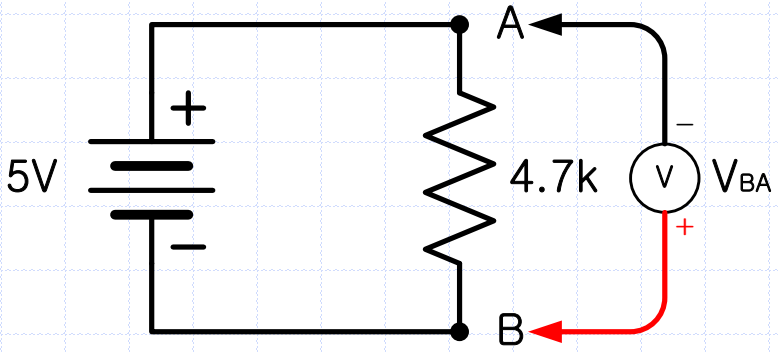
2-10A. 전압 측정

✓ 전압의 측정 방법 : 회로와 병렬로 연결하여 측정

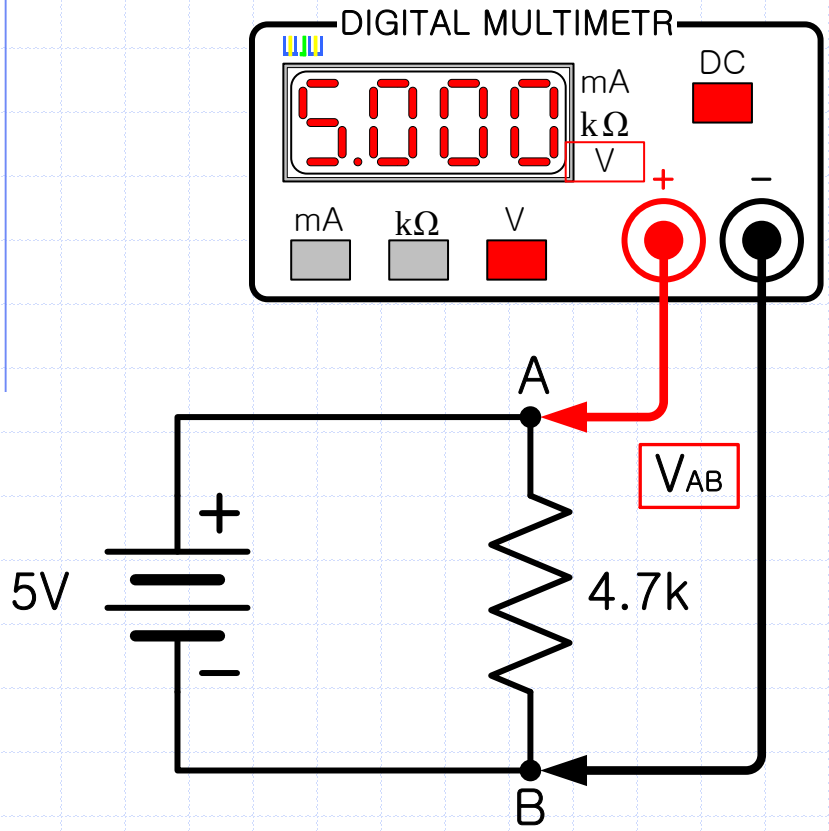


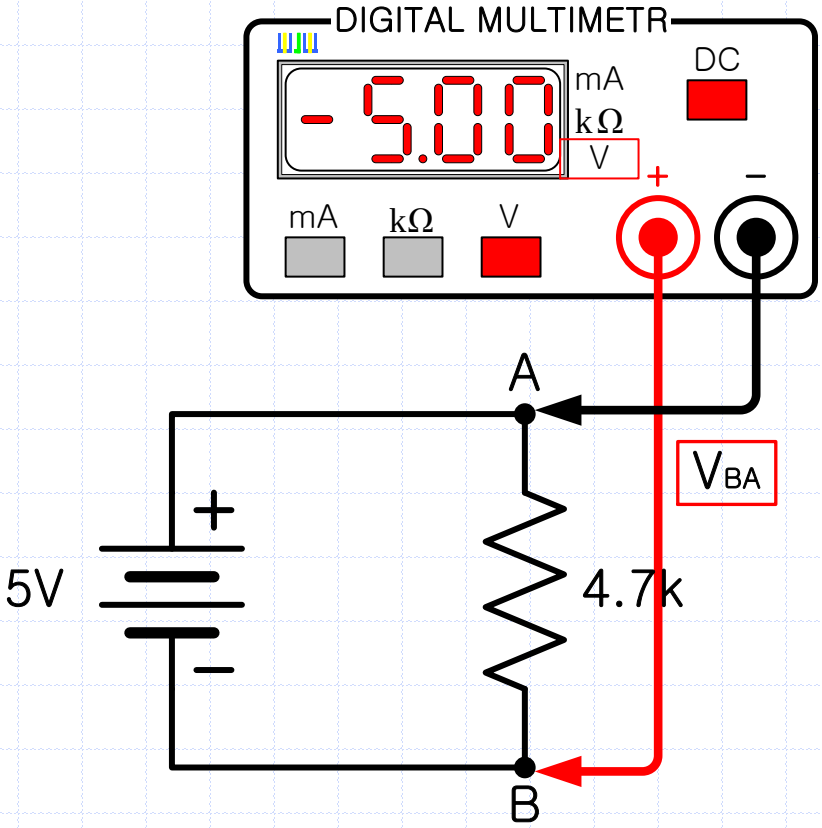




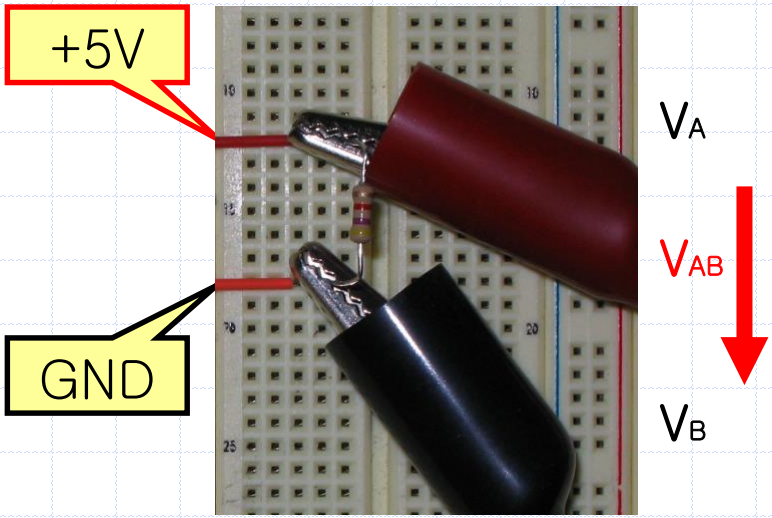


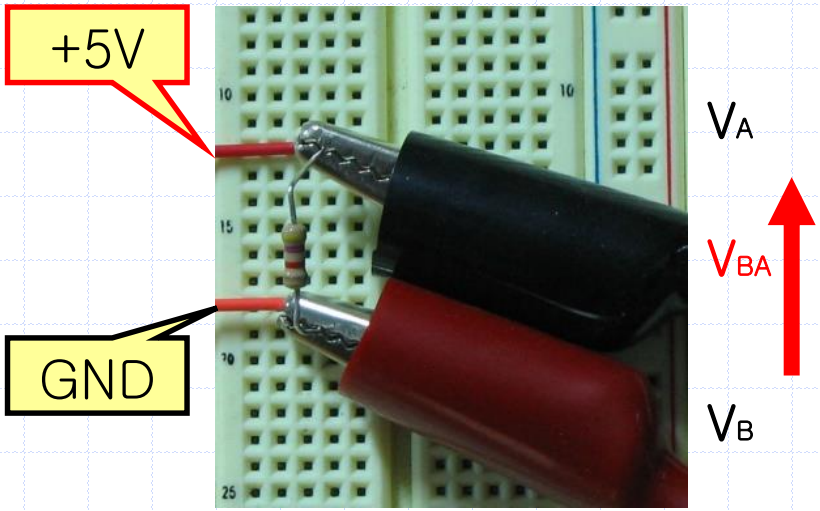
2-10A. 전압 측정

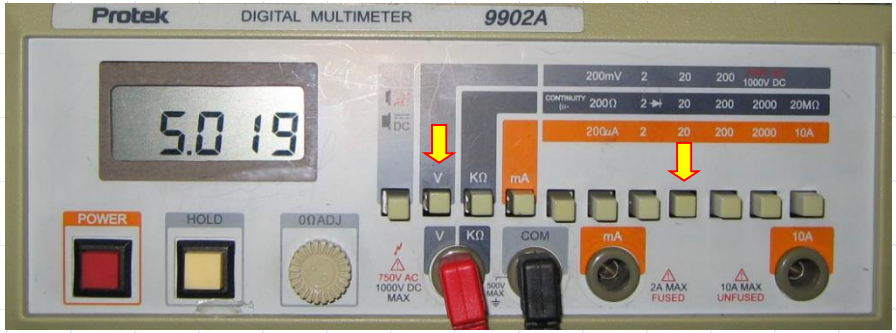

DIGITAL MULTIMETR
5.000
mA
kΩ
V
DC
mA
kΩ
V
+
−
A
B
V_{AB}
5V
+
−
4.7k


DIGITAL MULTIMETR
-5.00
mA
kΩ
V
DC
mA
kΩ
V
+
−
A
B
V_{BA}
5V
+
−
4.7k

2-10A. 전압 측정

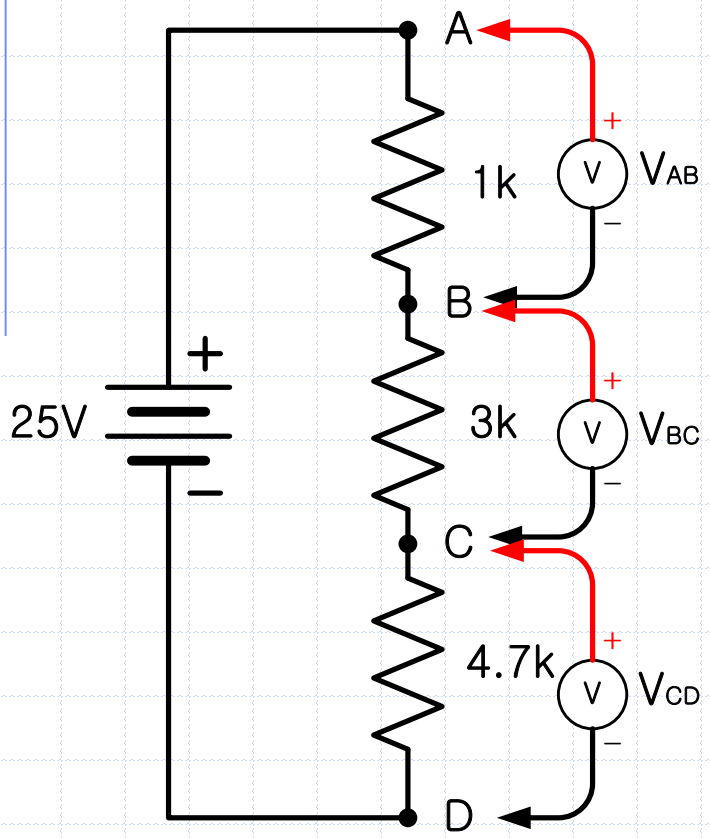

+5V
GND
VA
VAB
VB

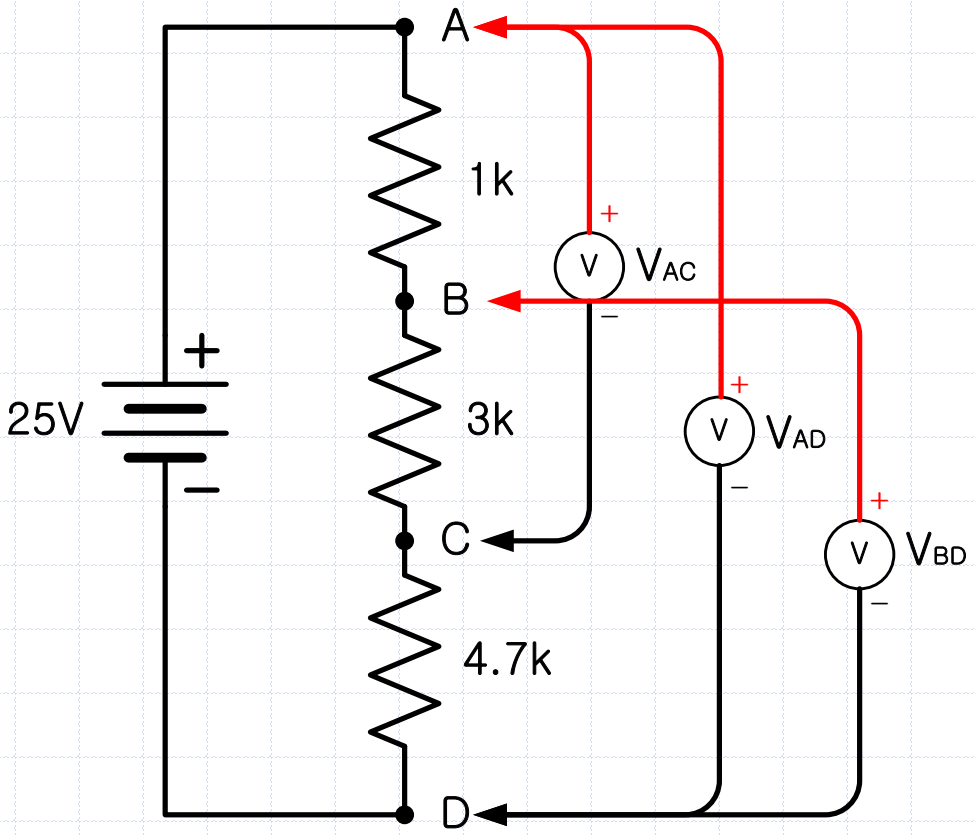

+5V
GND
VA
VBA
VB


Protek
DIGITAL MULTIMETER
9902A
5.019
POWER
HOLD
0ΩADJ
V
KΩ
mA
COM
10A

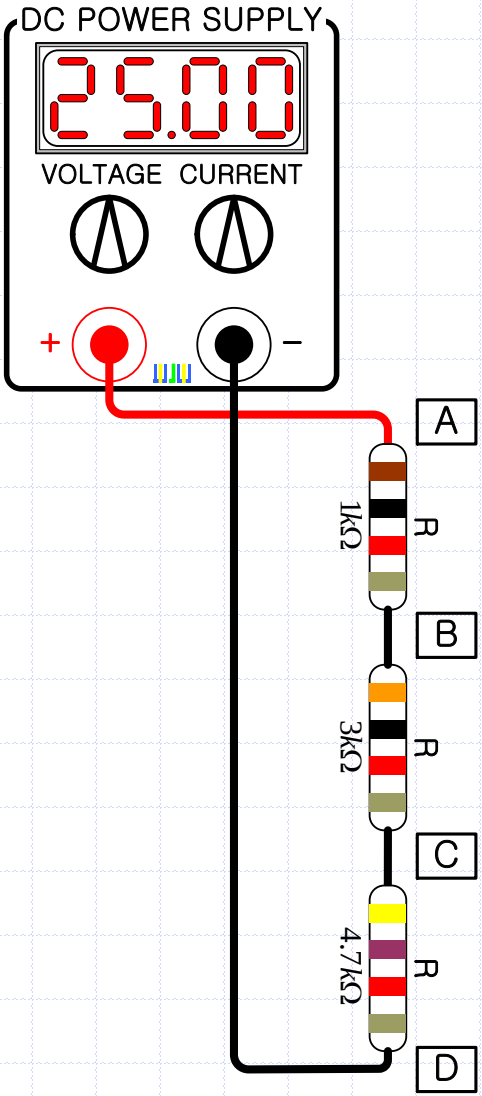

Protek
DIGITAL MULTIMETER
9902A
-5.020
POWER
HOLD
0ΩADJ
V
KΩ
mA
COM
10A

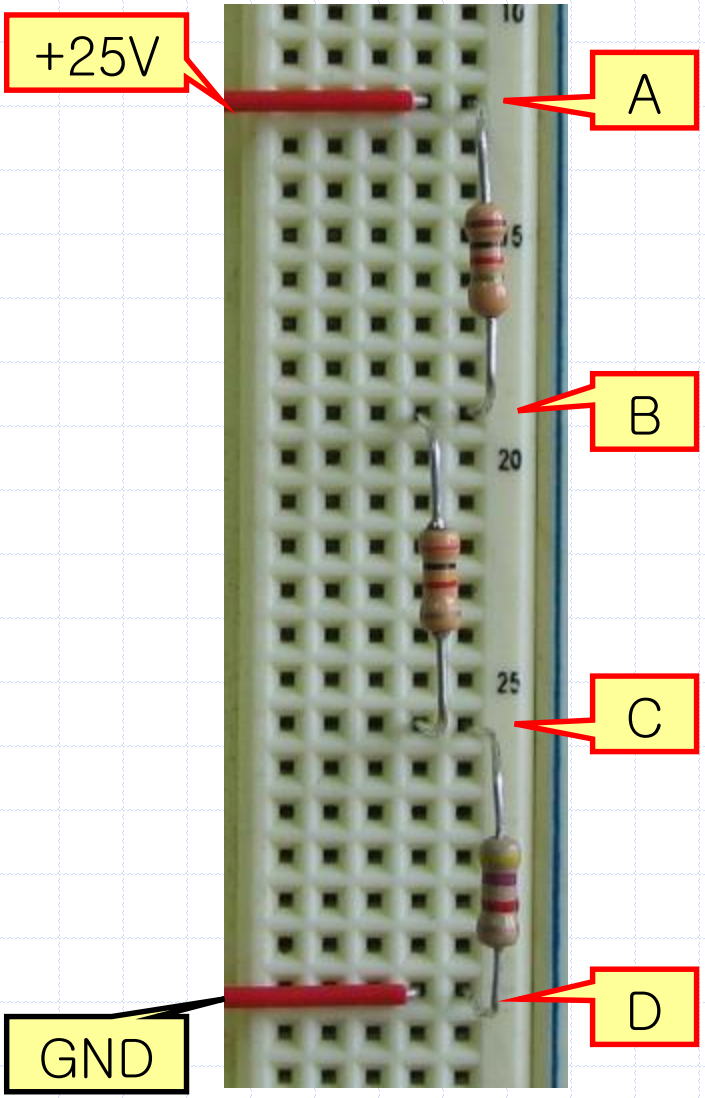
2-10B. 전압 측정



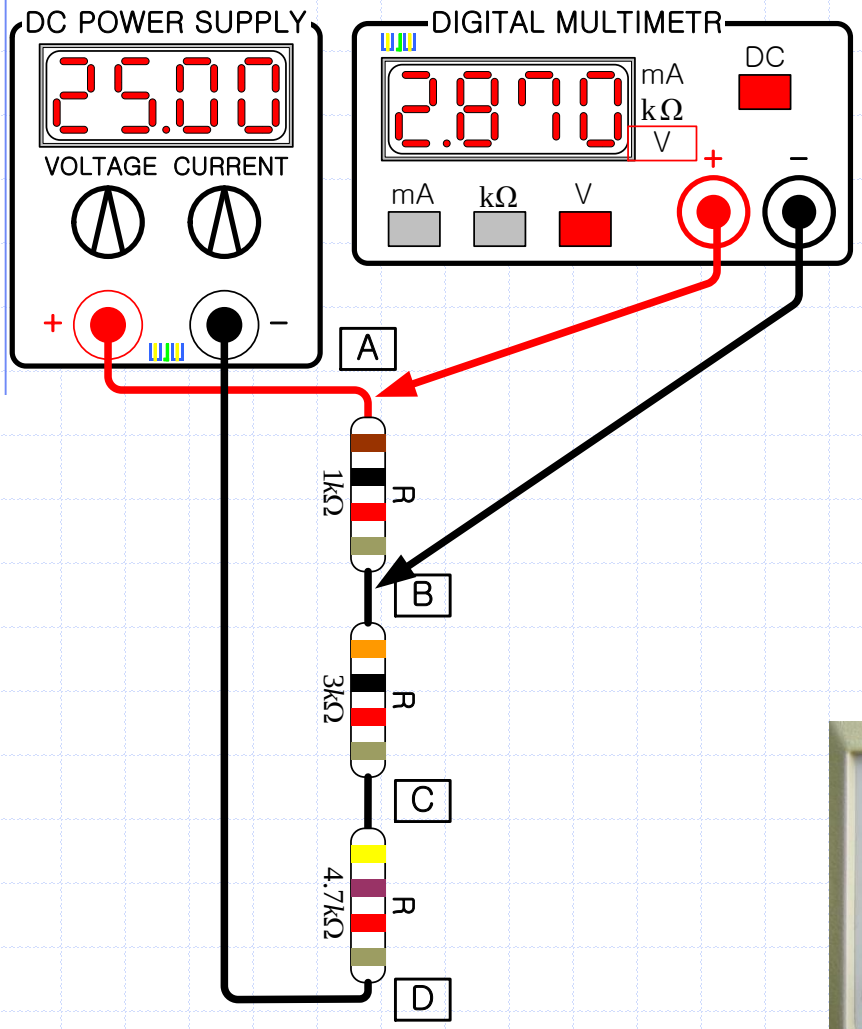


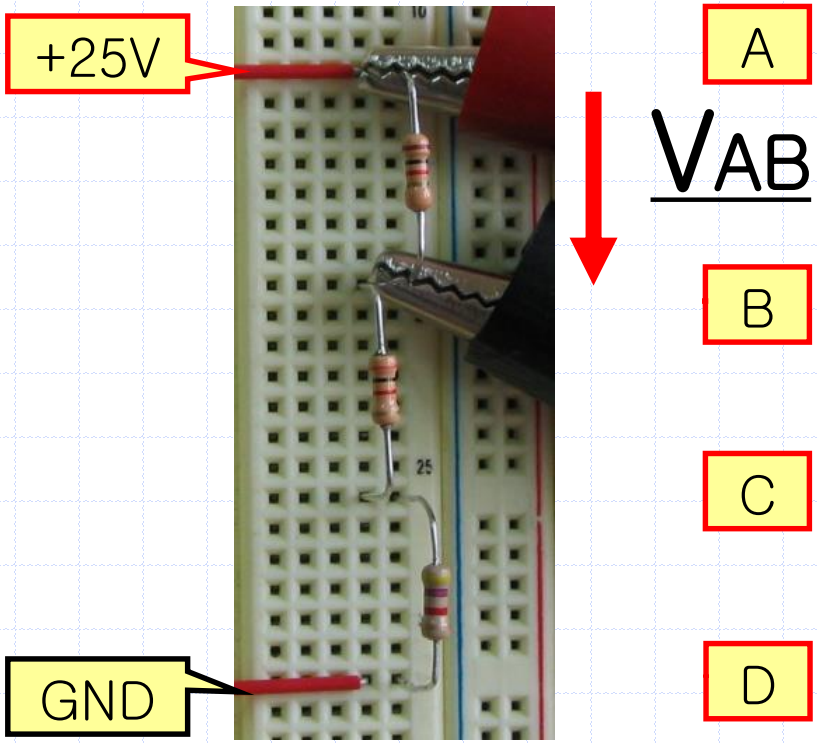
2-10B. 전압 측정


DC POWER SUPPLY
25.00
VOLTAGE
CURRENT
+
−
A
1kΩ
R
B
3kΩ
R
C
4.7kΩ
R
D


+25V
A
B
C
D
GND

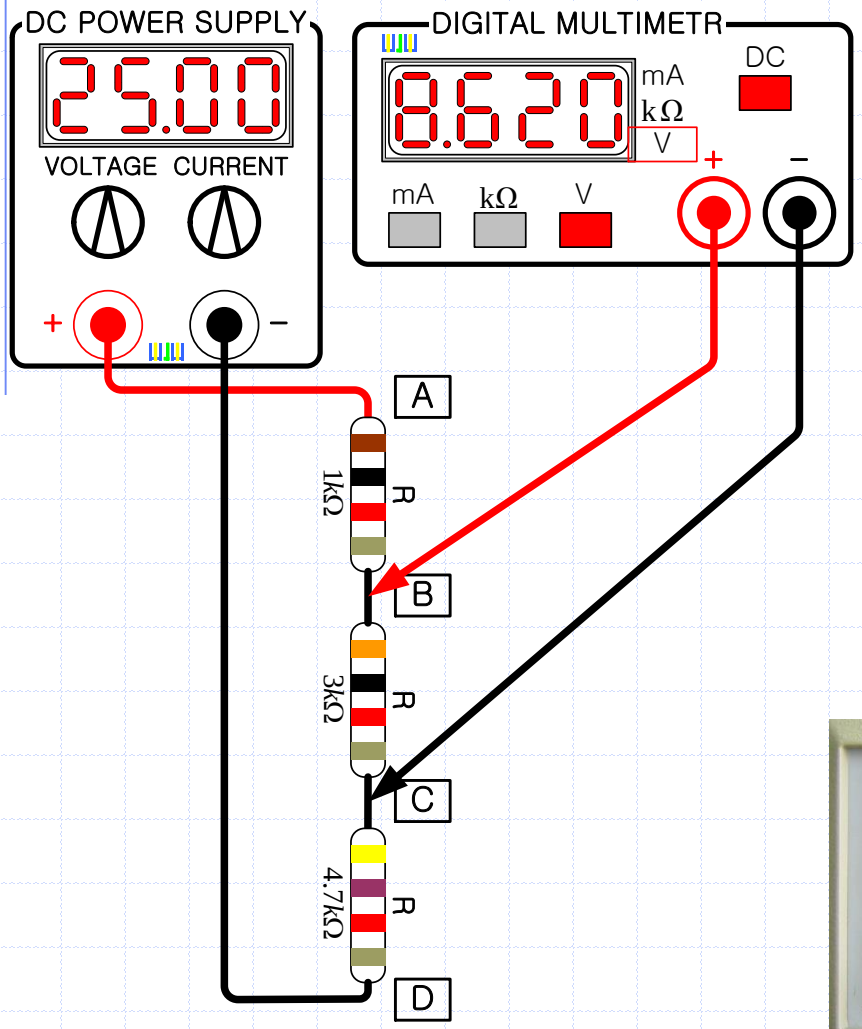
2-10B. 전압 측정

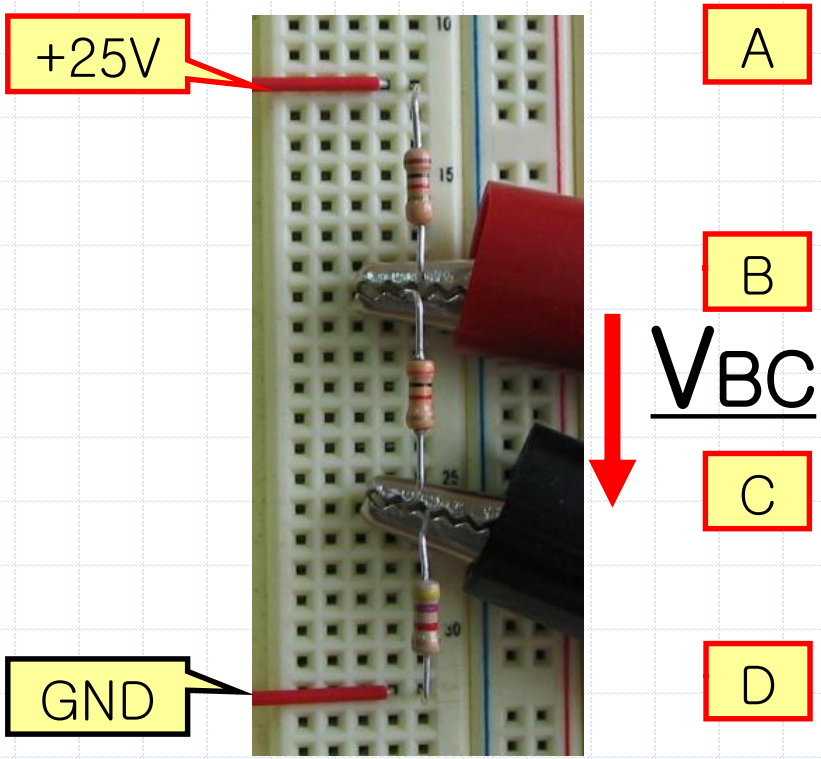

DC POWER SUPPLY
25.00
VOLTAGE
CURRENT
+
−
DIGITAL MULTIMETR
2.870
mA
kΩ
V
DC
mA
kΩ
V
+
−
A
1kΩ
R
B
3kΩ
R
C
4.7kΩ
R
D


+25V
GND
A
VAB
B
C
D


Protek
DIGITAL MULTIMETER
9902A
2.898
POWER
HOLD
0ΩADJ
V
KΩ
mA
COM
10A

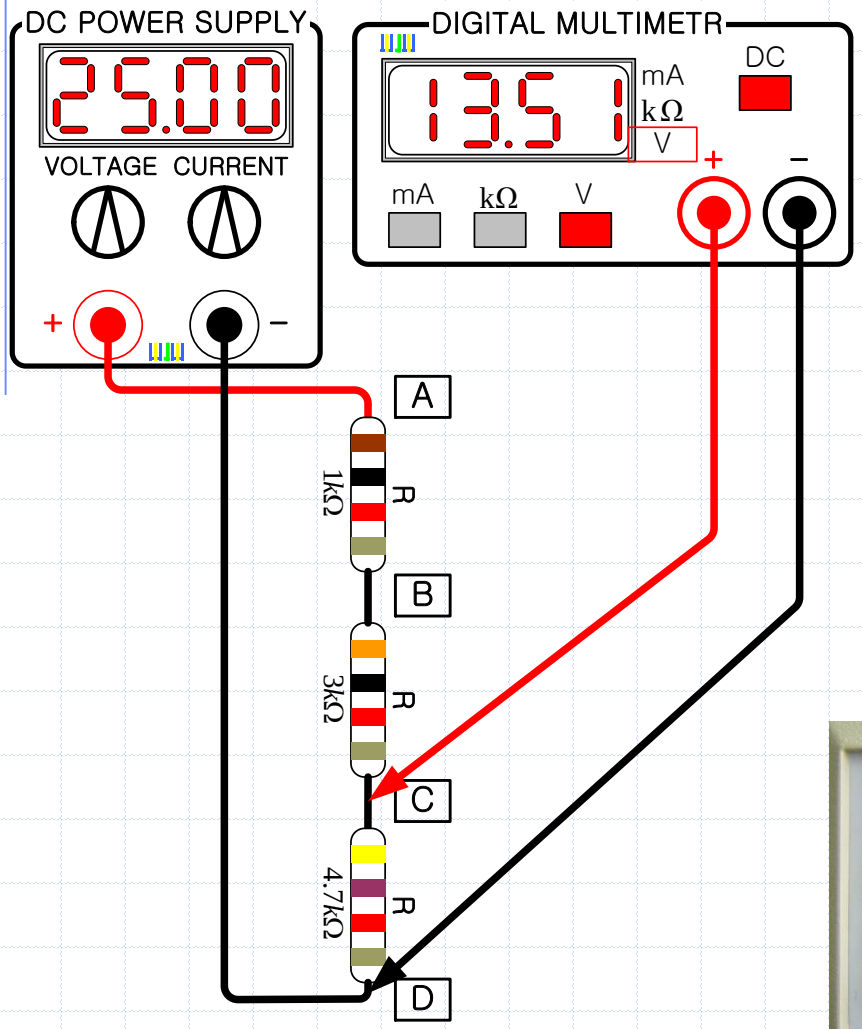
2-10B. 전압 측정

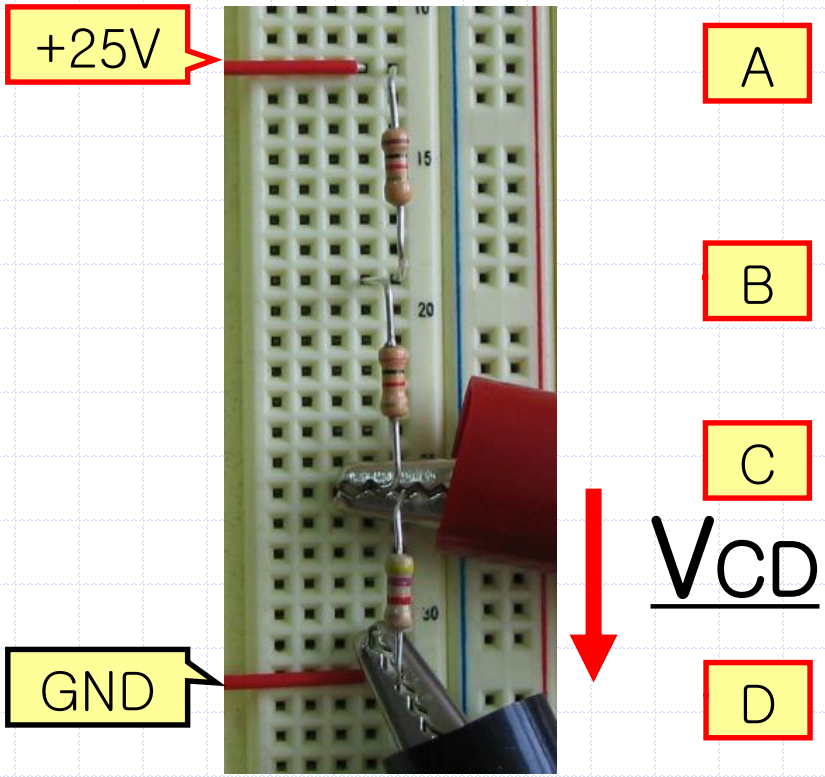

DC POWER SUPPLY
25.00
VOLTAGE
CURRENT
+
−
DIGITAL MULTIMETR
8.620
mA
kΩ
V
DC
mA
kΩ
V
+
−
A
1kΩ
R
B
3kΩ
R
C
4.7kΩ
R
D


+25V
GND
A
B
VBC
C
D


Protek
DIGITAL MULTIMETER
9902A
8.749
POWER
HOLD
0ΩADJ
V
KΩ
mA
COM
10A

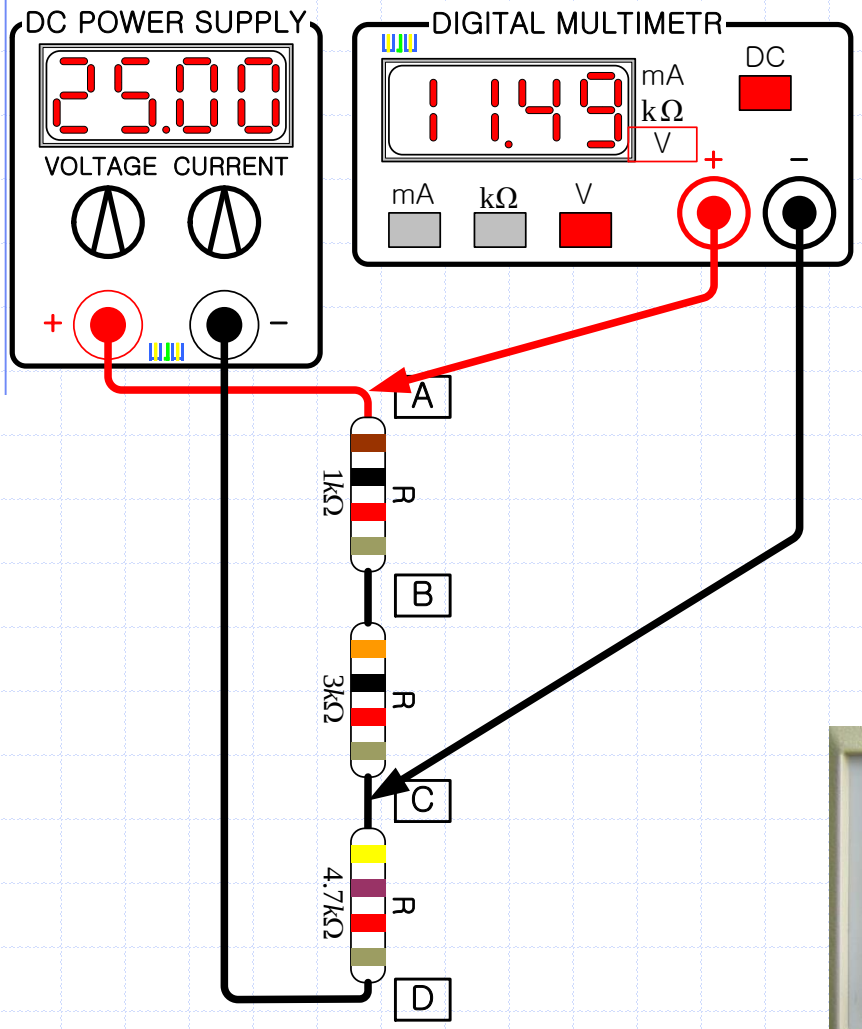
2-10B. 전압 측정

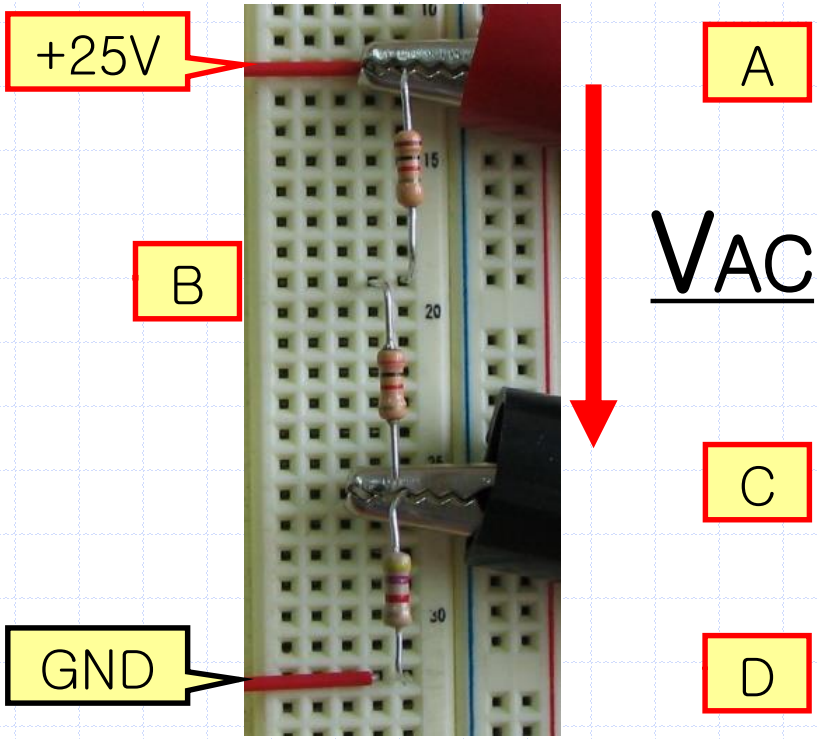

DC POWER SUPPLY
25.00
VOLTAGE
CURRENT
+
−
DIGITAL MULTIMETR
13.5
mA
kΩ
V
DC
mA
kΩ
V
+
−
A
1kΩ
R
B
3kΩ
R
C
4.7kΩ
R
D


+25V
GND
A
B
C
D
VCD


Protek
DIGITAL MULTIMETER
9902A
13.415
POWER
HOLD
0ΩADJ
V
KΩ
mA
COM
10A

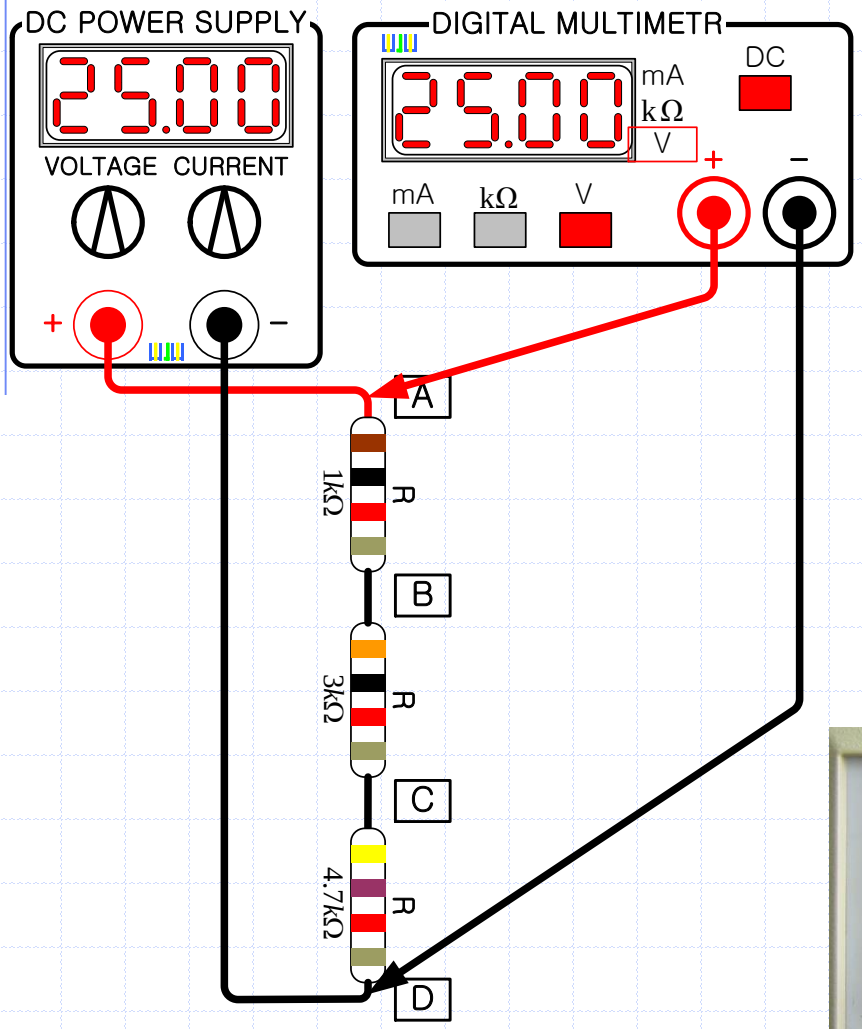
2-10B. 전압 측정

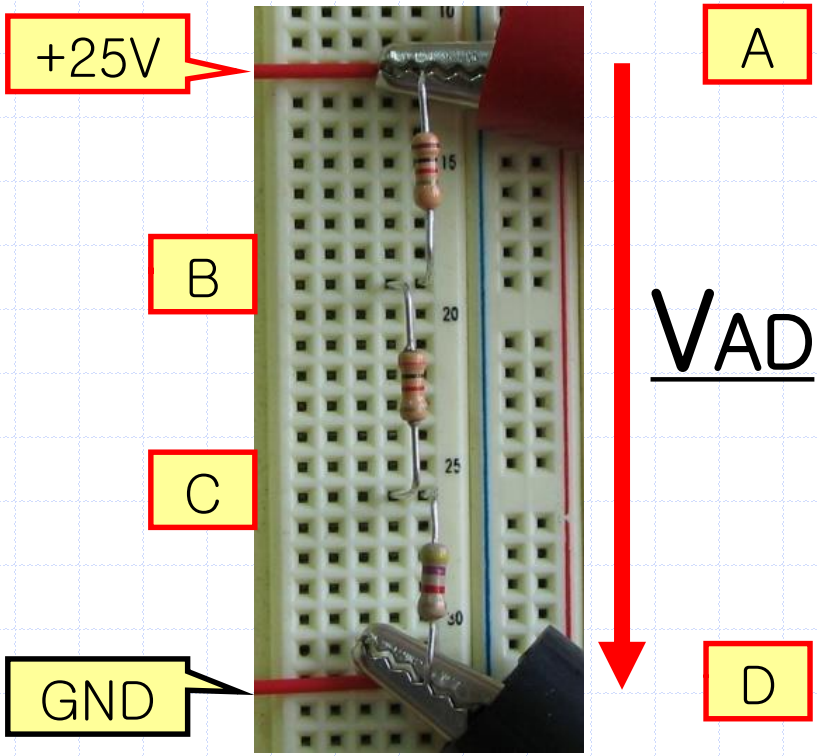

DC POWER SUPPLY
25.00
VOLTAGE CURRENT
+
−
DIGITAL MULTIMETR
11.49
mA
kΩ
V
DC
mA
kΩ
V
+
−
A
1kΩ
R
B
3kΩ
R
C
4.7kΩ
R
D


+25V
A
B
VAC
C
GND
D


Protek
DIGITAL MULTIMETER
9902A
11.651
POWER
HOLD
0ΩADJ
V
KΩ
mA
COM
10A

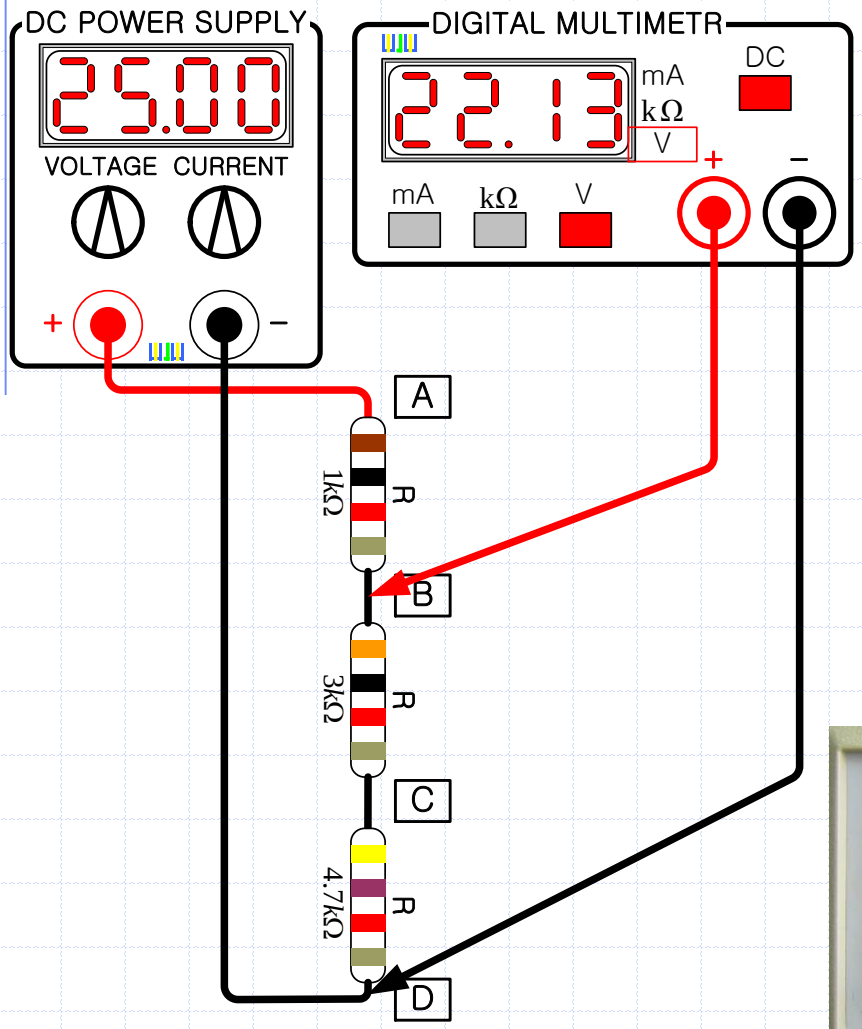
2-10B. 전압 측정

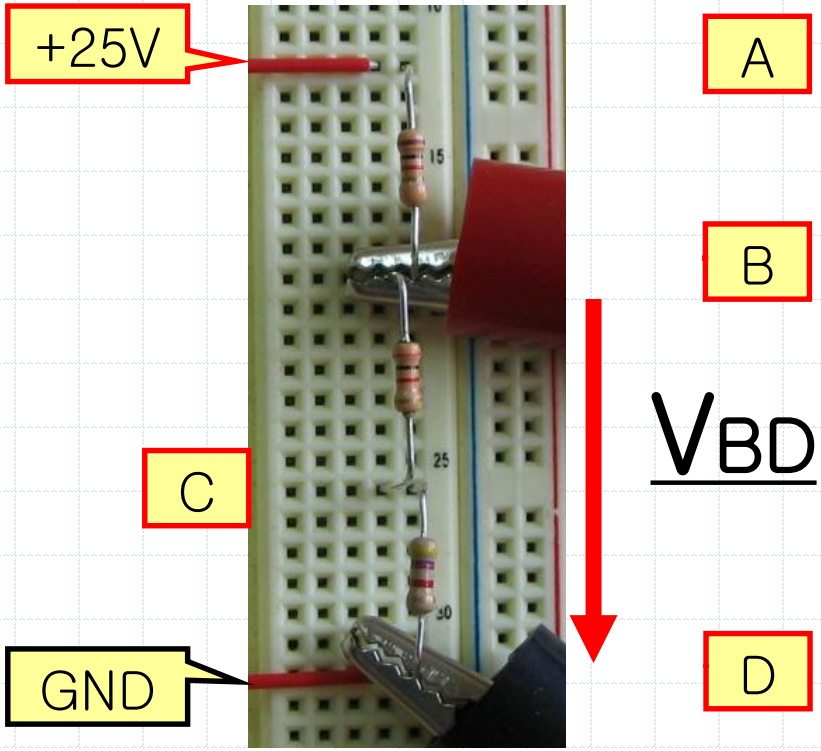

DC POWER SUPPLY
25.00
VOLTAGE CURRENT
+
−
DIGITAL MULTIMETR
25.00
mA
kΩ
V
DC
mA
kΩ
V
+
−
A
1kΩ
R
B
3kΩ
R
C
4.7kΩ
R
D


+25V
A
B
VAD
C
GND
D


Protek
DIGITAL MULTIMETER
9902A
25.04
POWER
HOLD
0ΩADJ
V
KΩ
mA
COM
10A

2-10B. 전압 측정


DC POWER SUPPLY
25.00
VOLTAGE
CURRENT
+
−
DIGITAL MULTIMETR
22.13
mA
kΩ
V
DC
mA
kΩ
V
+
−
A
1kΩ
R
B
3kΩ
R
C
4.7kΩ
R
D

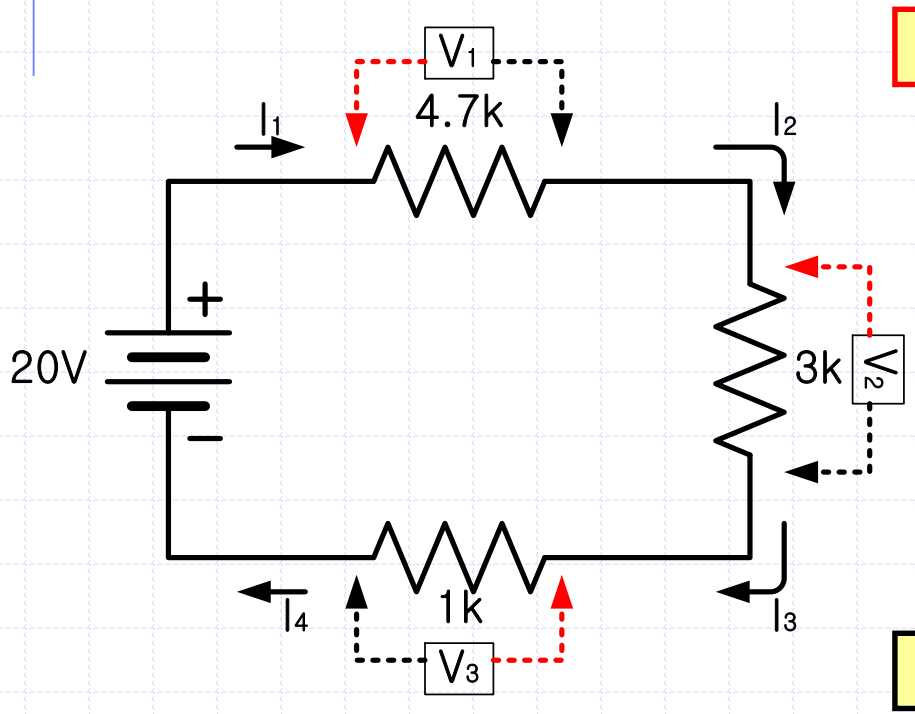

+25V
A
B
VBD
C
GND
D

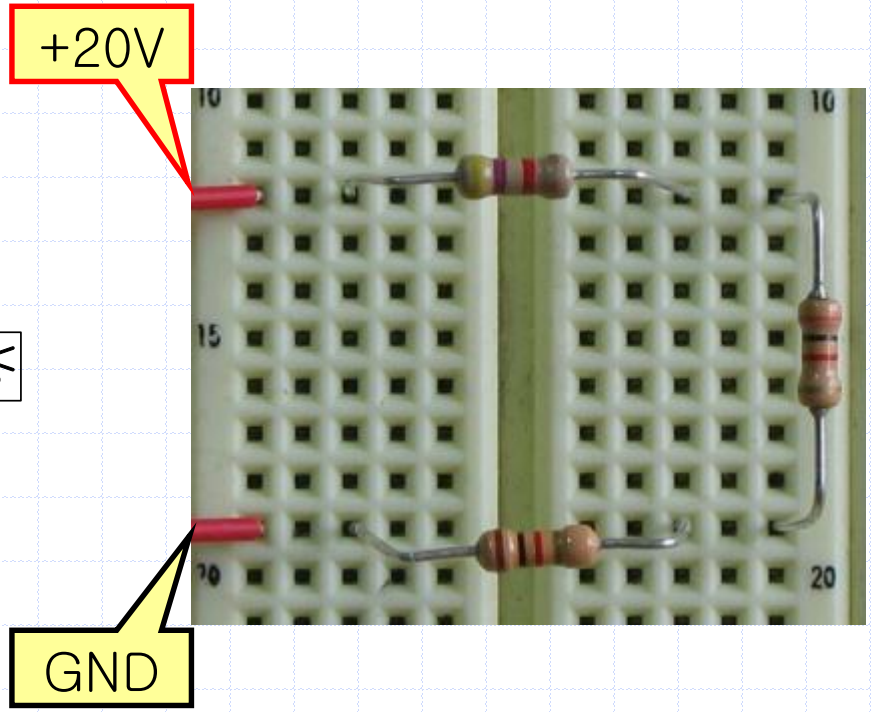

Protek
DIGITAL MULTIMETER
9902A
22.19
POWER
HOLD
0ΩADJ
V
KΩ
mA
COM
10A

2-11A. 전류, 전압 측정 및 전력 계산

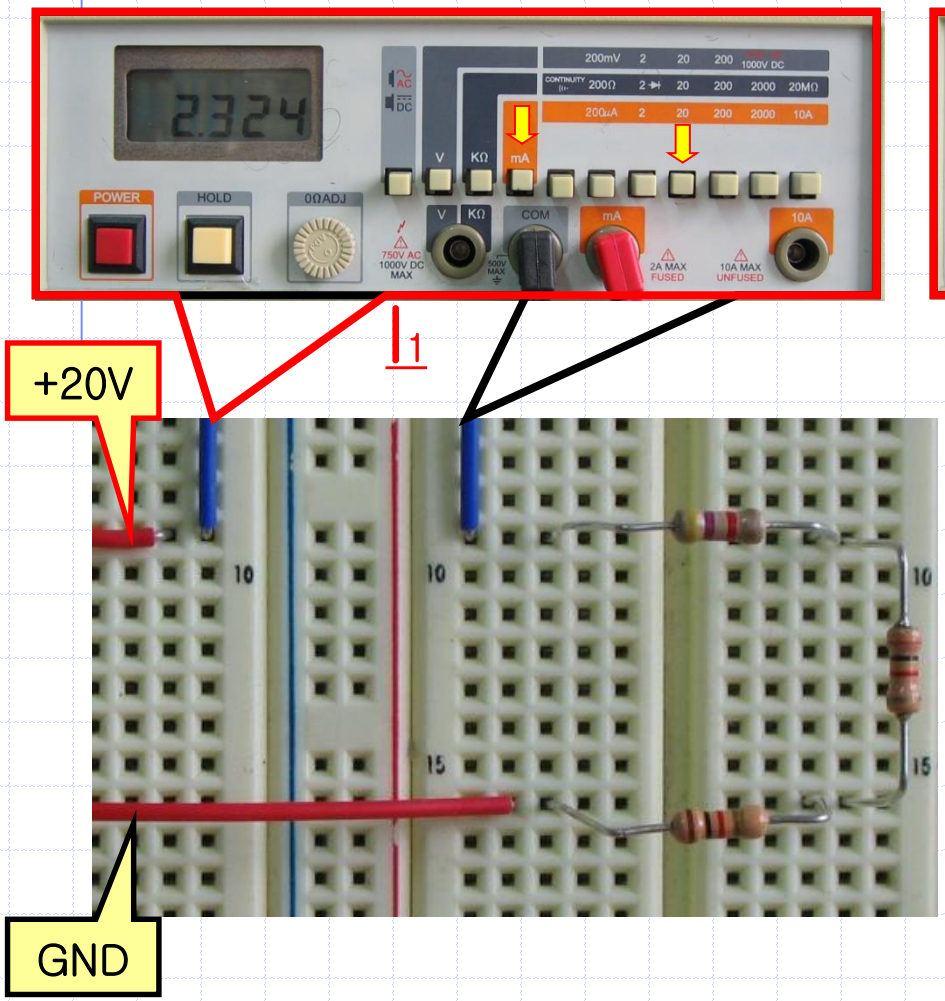
✓ 전력 계산 : 각 단의 전류와 전압을 측정하여 계산

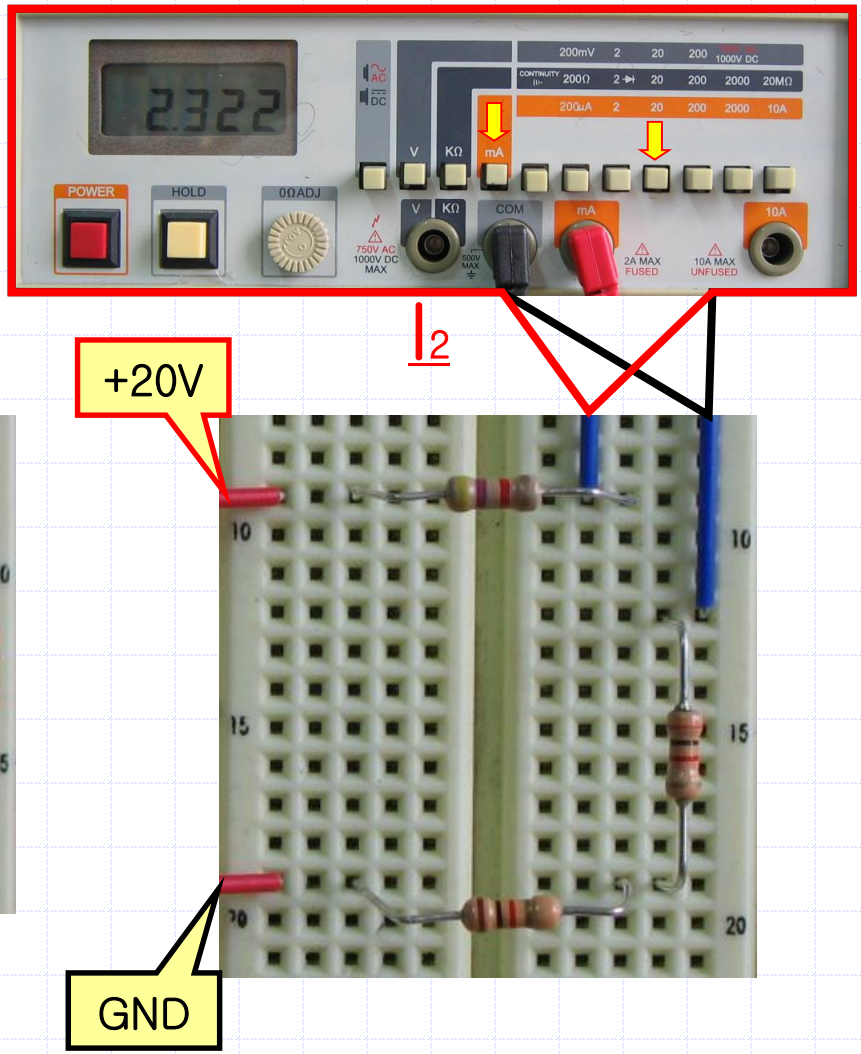
$$P = VI = I^2R = \frac{V^2}{R}$$



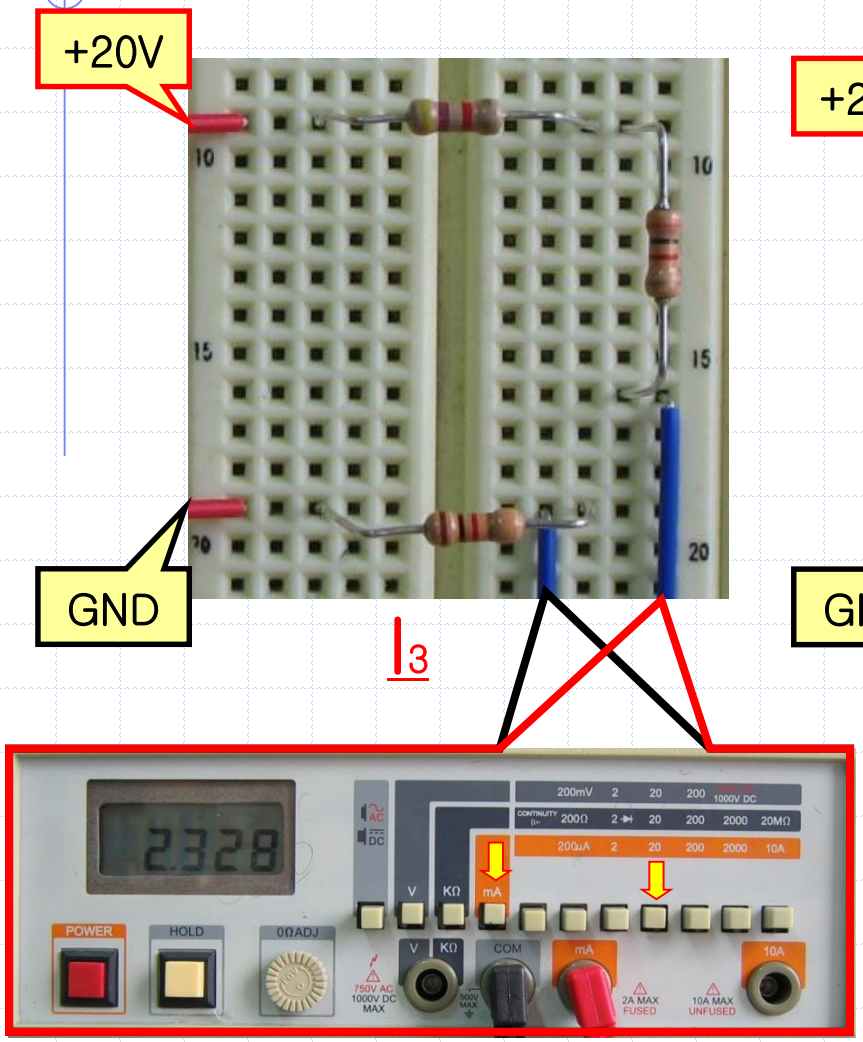


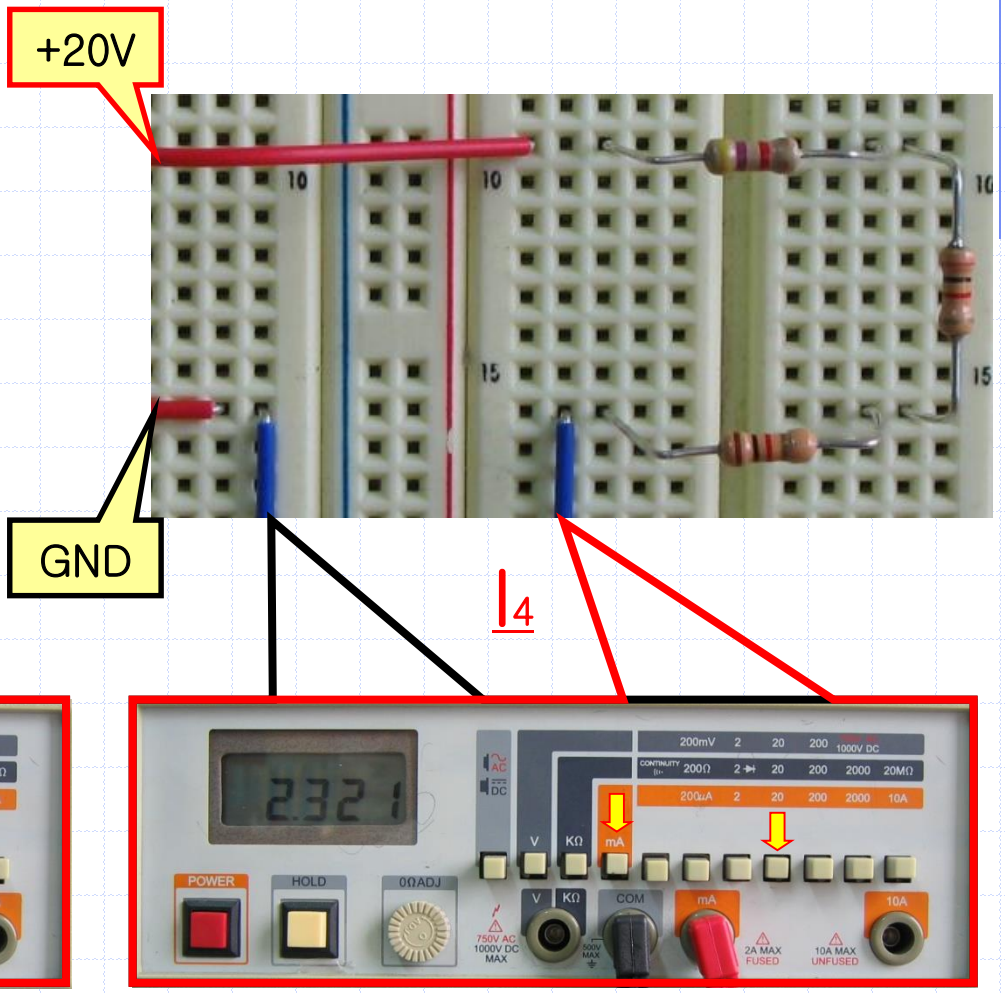
2-11A. 전류, 전압 측정 및 전력 계산



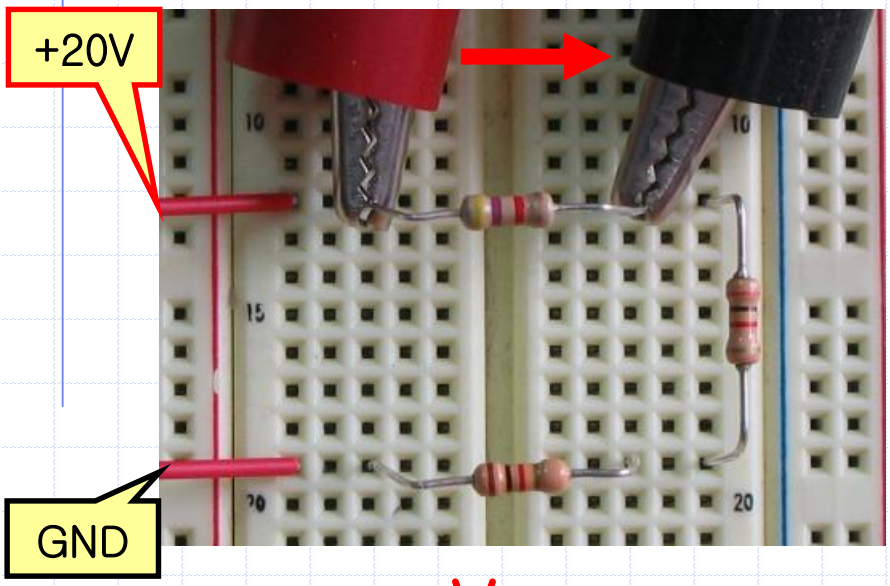


2-11A. 전류, 전압 측정 및 전력 계산

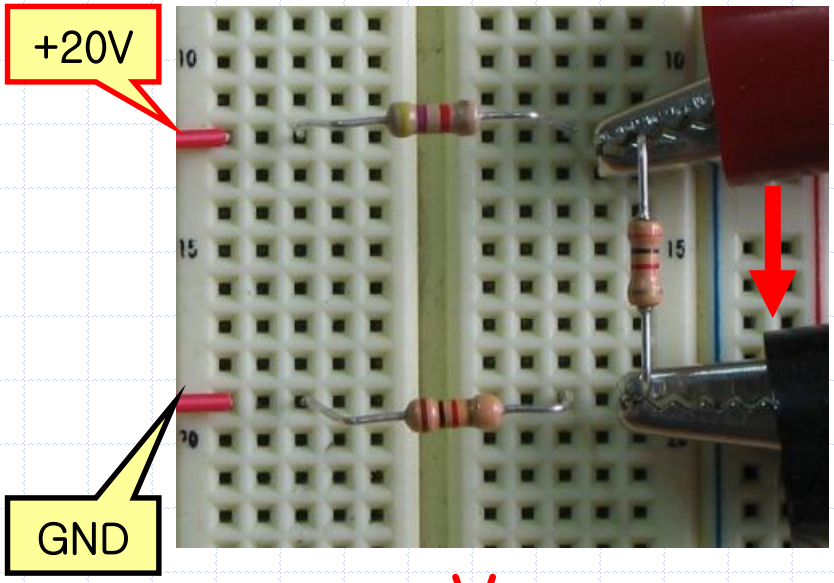




2-11A. 전류, 전압 측정 및 전력 계산

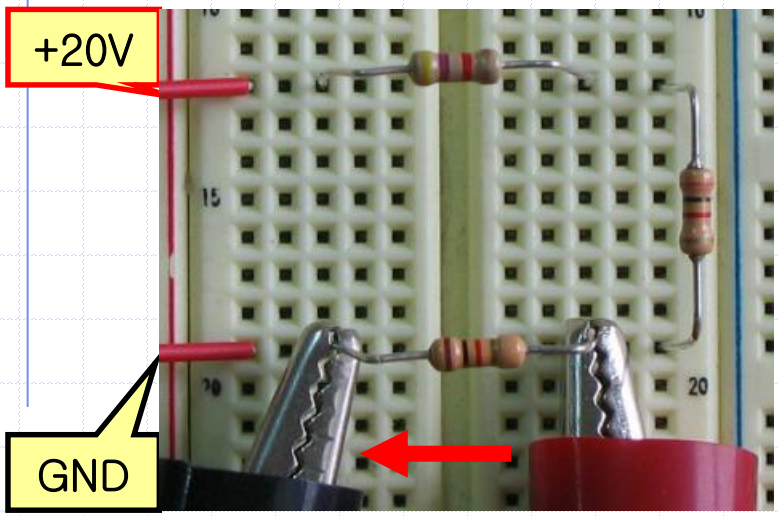


V_1



V_2

2-11A. 전류, 전압 측정 및 전력 계산



V_3

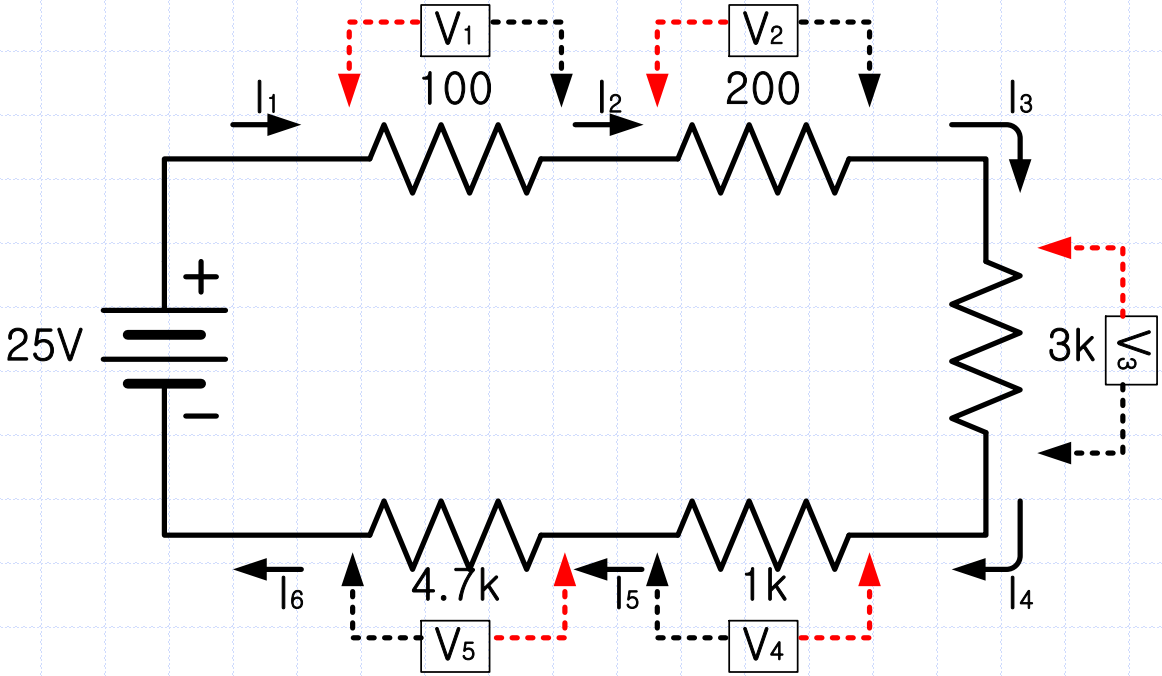
전력 계산

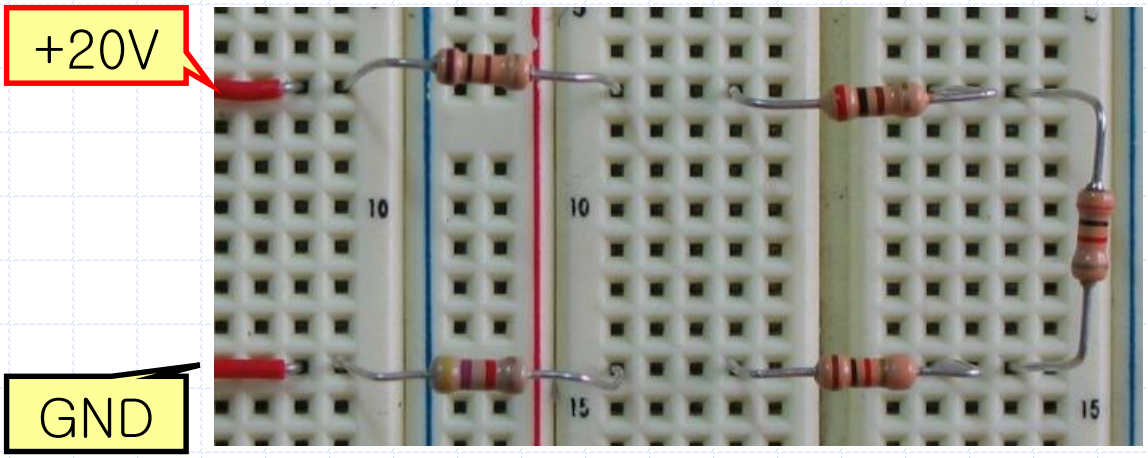
I_1	2.3 mA	V_1	10.8 V
P_1	$= I_1 \times V_1 = 24.84$ mW		

I_2	2.3 mA	V_2	6.9 V
P_2	$= I_2 \times V_2 = 15.87$ mW		

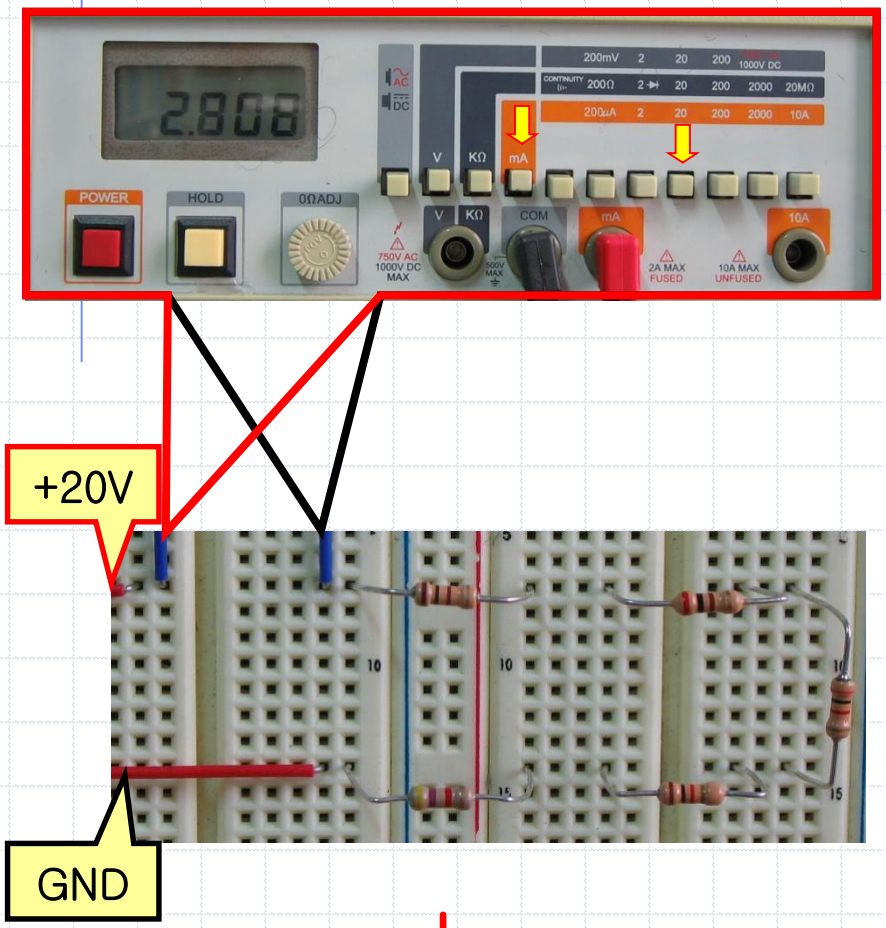
I_3	2.3 mA	V_3	2.3 V
P_3	$= I_3 \times V_3 = 5.29$ mW		

2-11B. 전류, 전압 측정 및 전력 계산

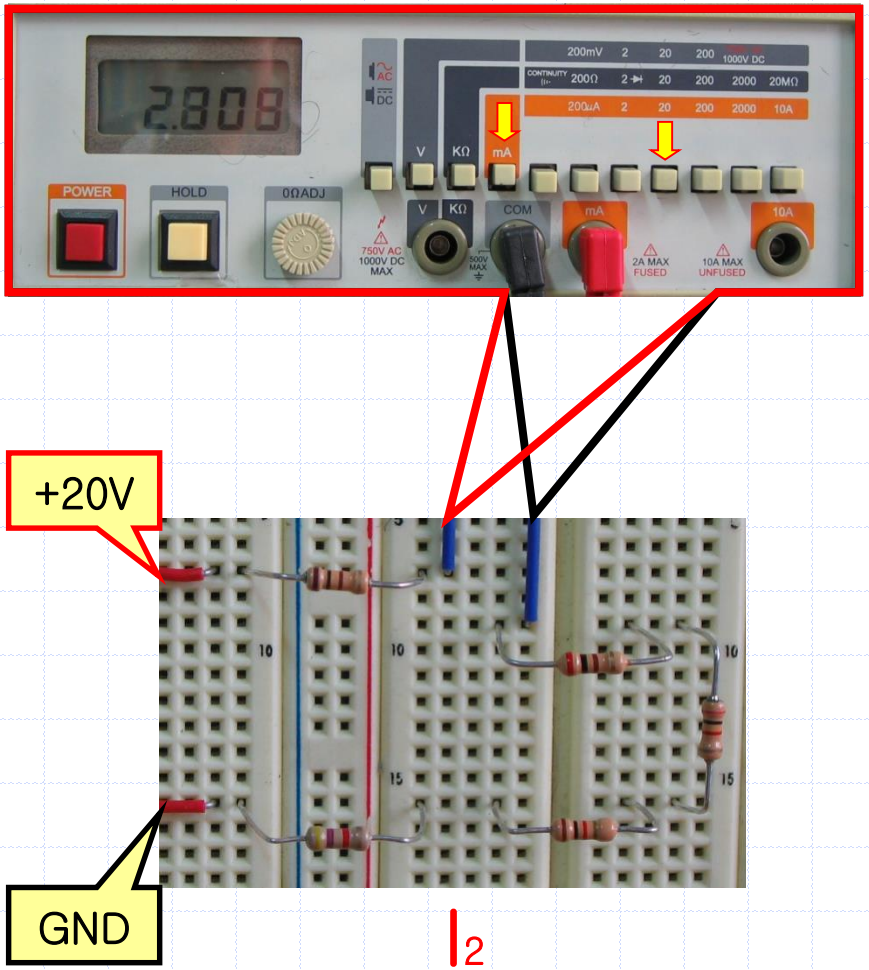




2-11B. 전류, 전압 측정 및 전력 계산

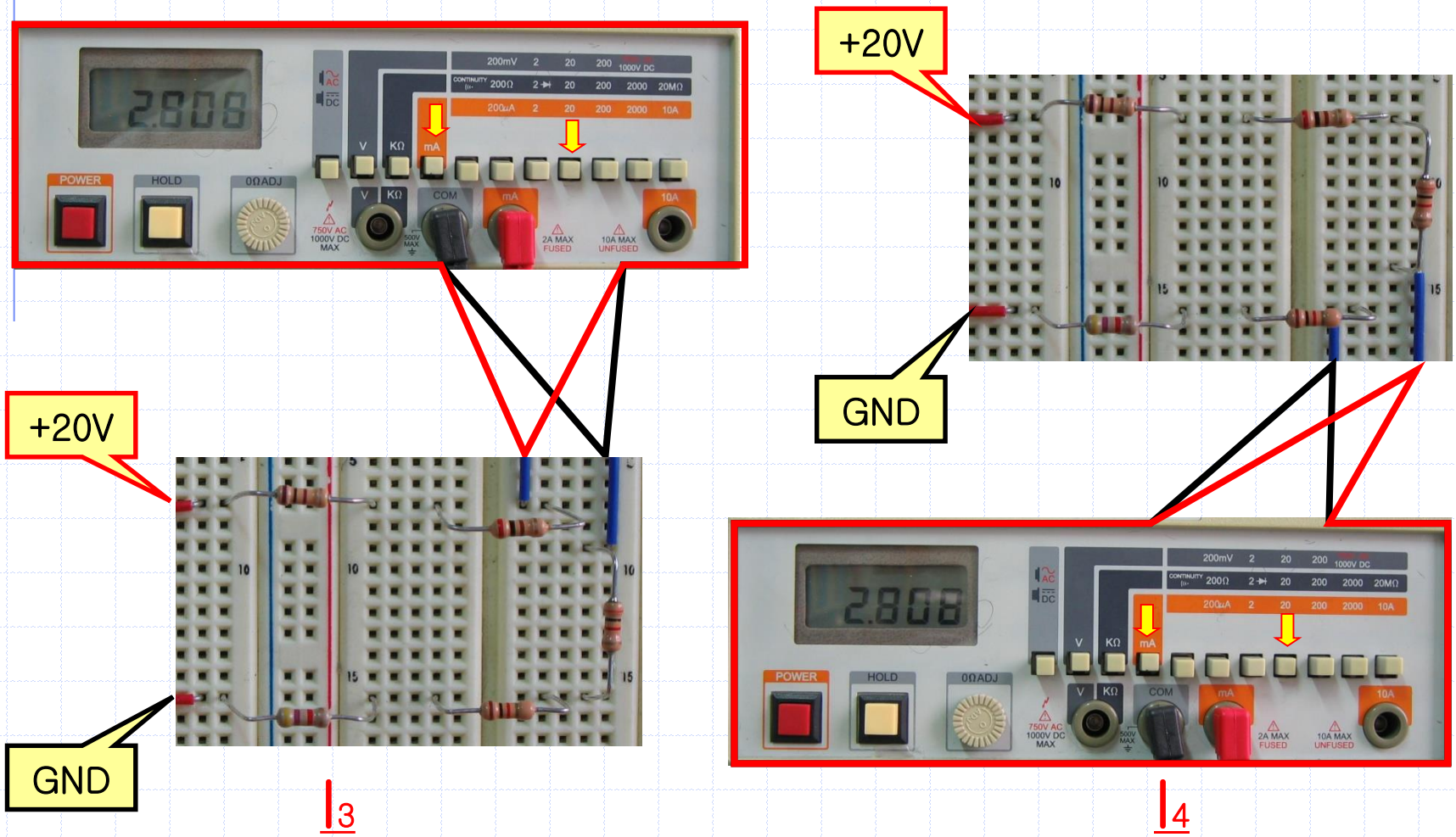


I_1



I_2

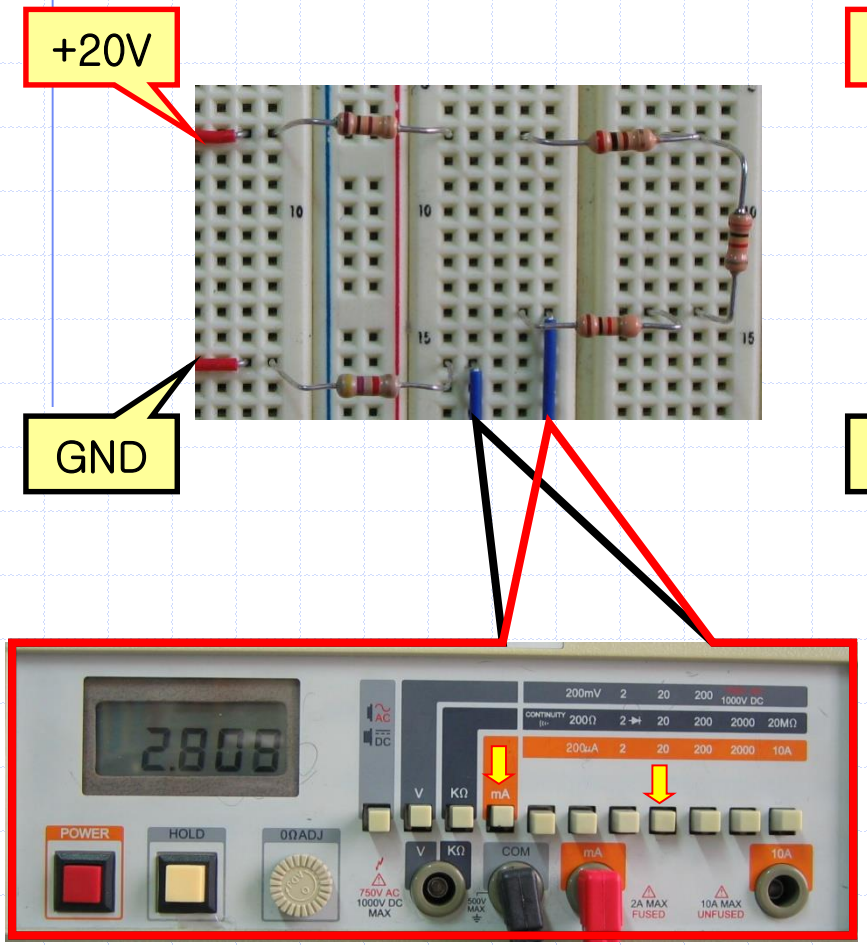
2-11B. 전류, 전압 측정 및 전력 계산



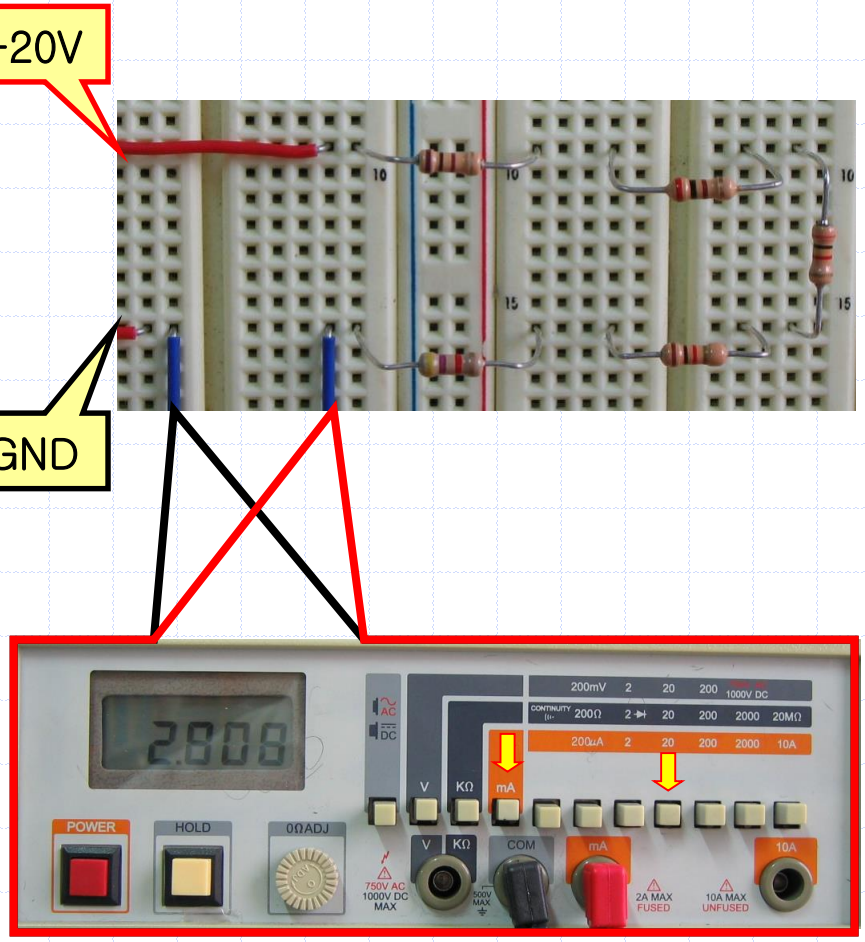
I_3

I_4

2-11B. 전류, 전압 측정 및 전력 계산

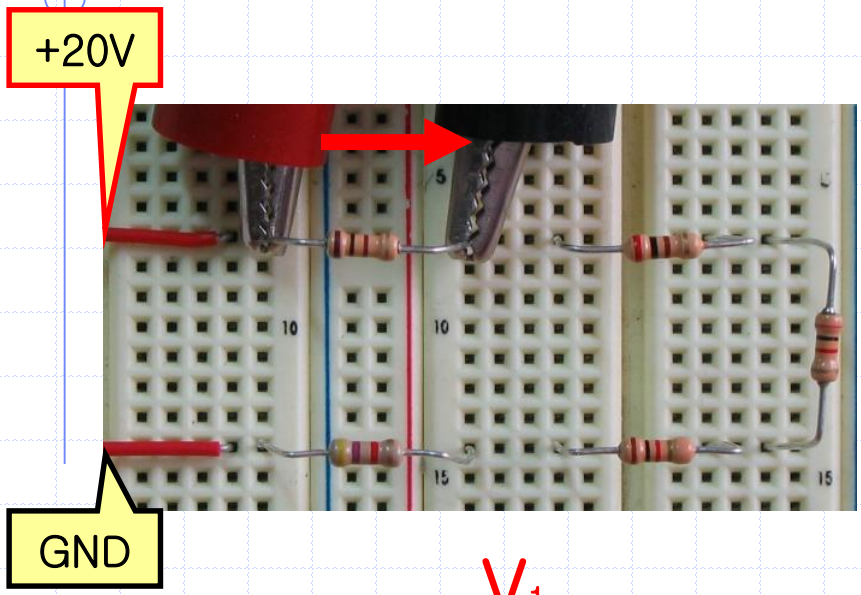


I_5

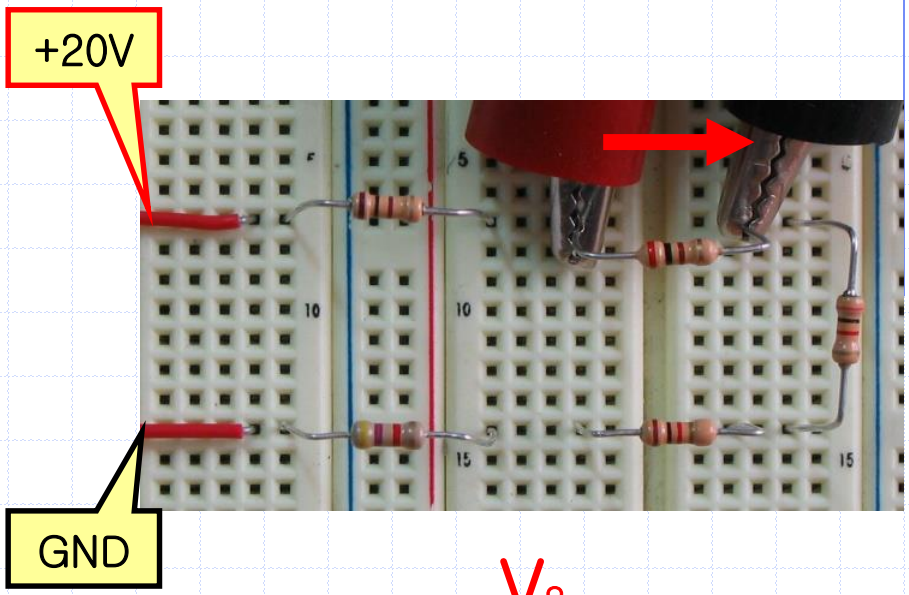


I_6

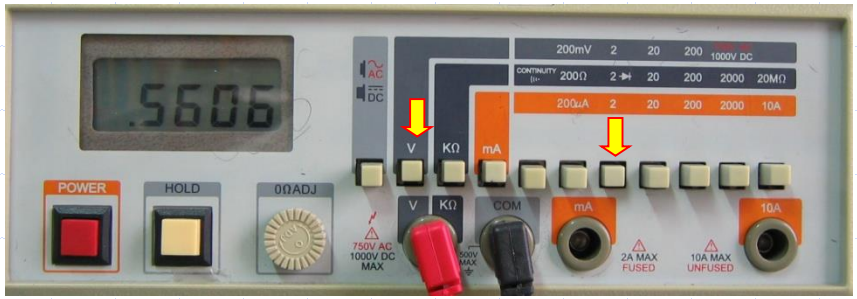
2-11B. 전류, 전압 측정 및 전력 계산



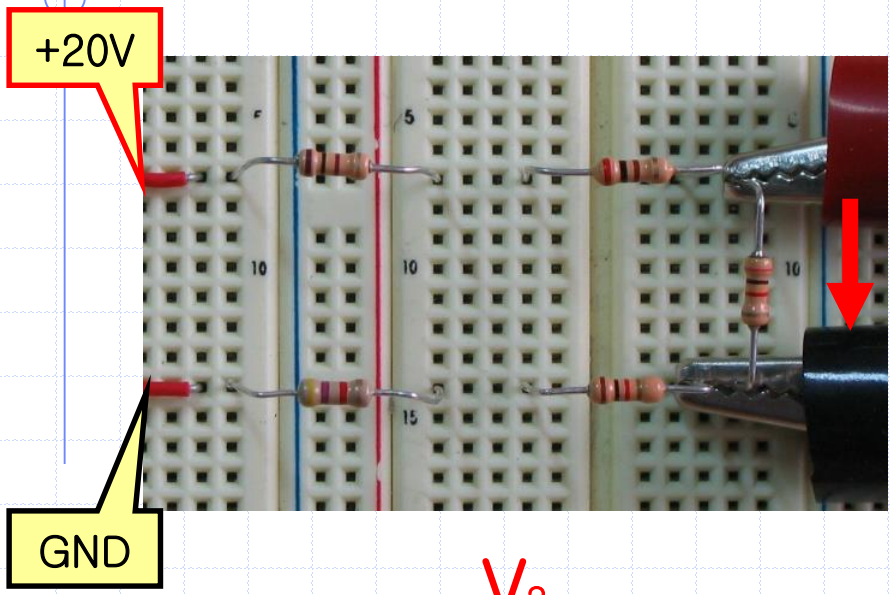
V_1



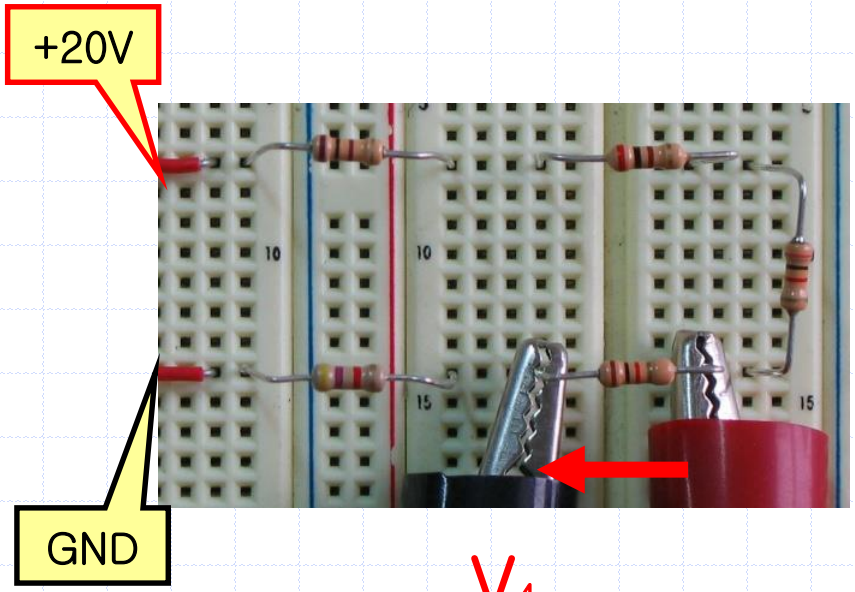
V_2



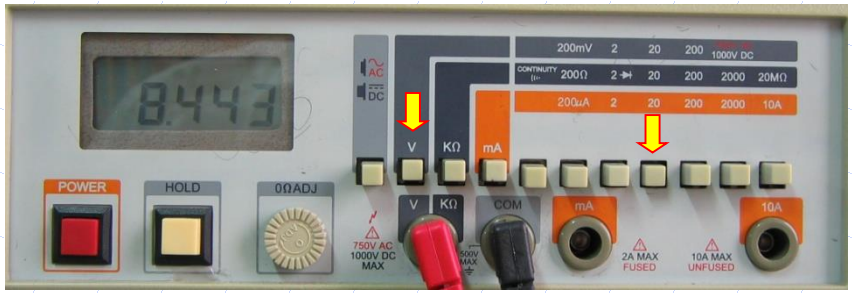
2-11B. 전류, 전압 측정 및 전력 계산

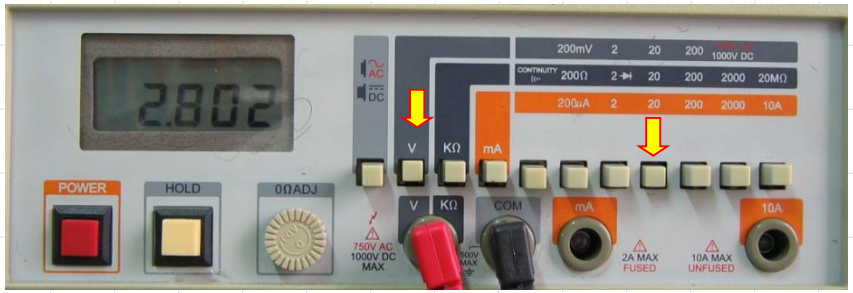


V_3

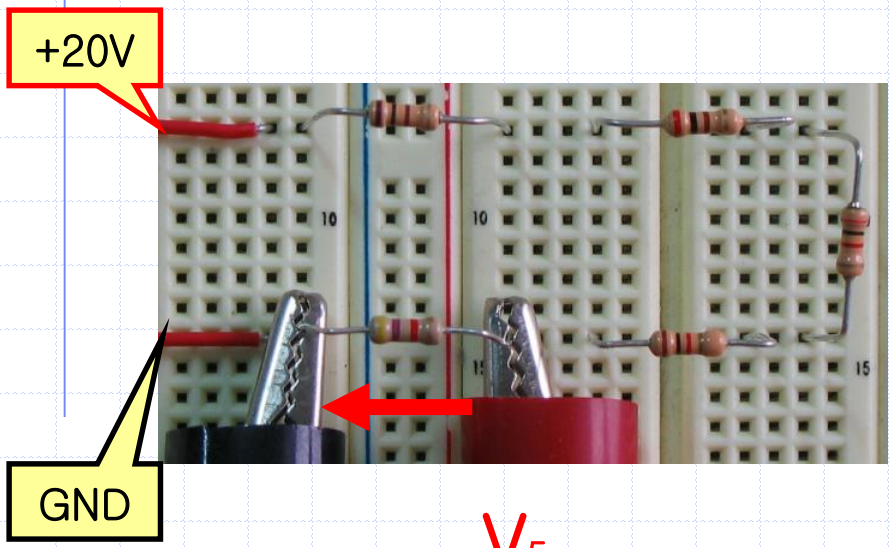


V_4





2-11B. 전류, 전압 측정 및 전력 계산



V_5

전력 계산

I_1	2.78 mA	V_1	0.28 V
P_1	$= I_1 \times V_1 = 0.7784$ mW		

I_2	2.78 mA	V_2	0.56 V
P_1	$= I_2 \times V_2 = 1.5568$ mW		

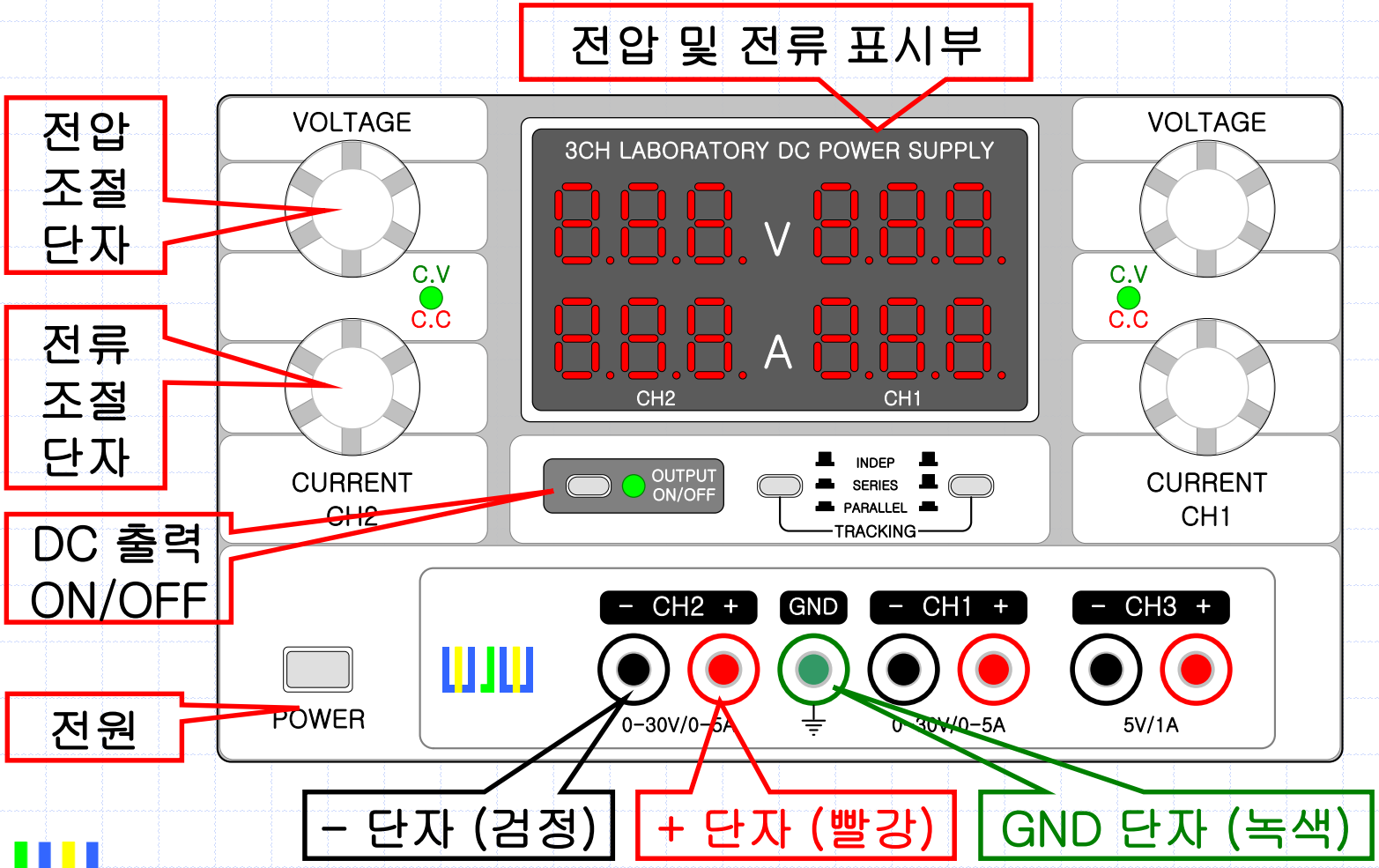
I_3	2.78 mA	V_3	8.33 V
P_3	$= I_3 \times V_3 = 24.84$mW		

I_4	2.78 mA	V_4	2.78 V
P_4	$= I_4 \times V_4 = 23.1574$ mW		

I_5	2.78 mA	V_5	13.06 V
P_5	$= I_5 \times V_5 = 36.3068$ mW		

2-12. 직류전원장치 (DC Power Supply)

✓ DC Power Supply 사용하기



2-12. 직류전원장치 (DC Power Supply)

✓ DC Power Supply 사용하기

2-12. 직류전원장치 (DC Power Supply)

✓ DC Power Supply 사용하기