

講義中の注意



- 講義中は、参加者のマイク・カメラの機能はミュート状態になります。
- 進行はスタッフ及び講師が行いますので、指示に従ってください。
- 質疑応答の時間は、参加者のマイクをオンにして質問を受け付けることもあります。希望される方は「チャット欄」で申し出てください。

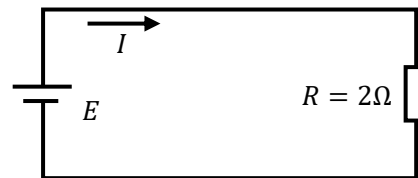
電験三種 ライブ講義

第4回 比例と反比例

比例と反比例

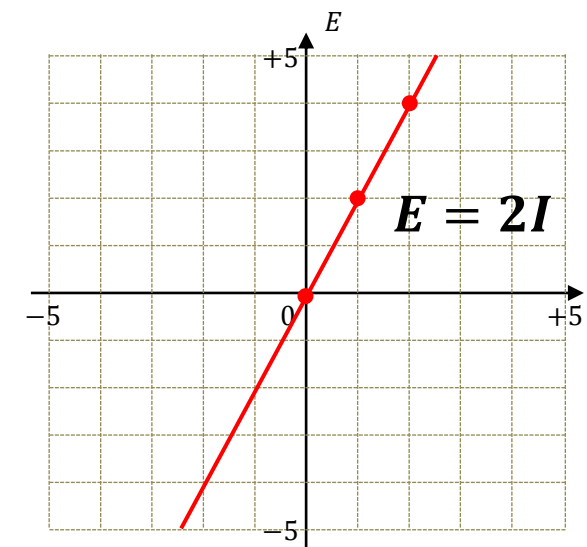
比例とは、 x の値が2倍、3倍・・・になると、
 y の値が2倍、3倍・・・になる。
このとき、 y は x に比例するという。

$$y = ax$$



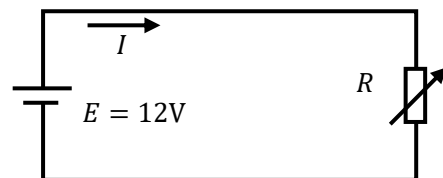
$$E = 2I$$

I	0	1	2	3	4	5
E	0	2	4	6	8	10



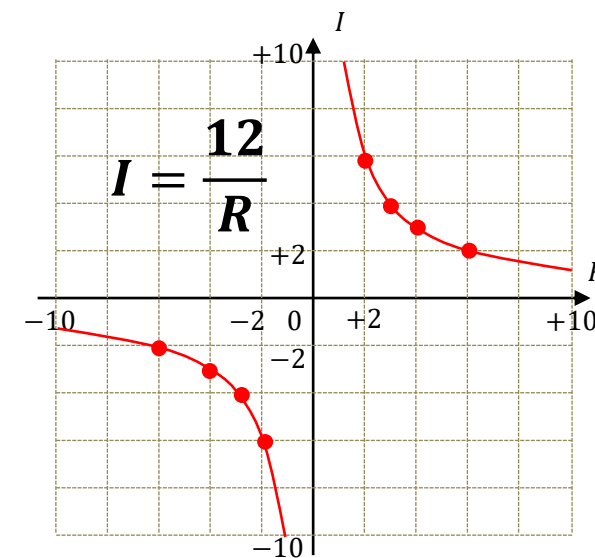
反比例とは、 x の値が2倍、3倍・・・になると、
 y の値が1/2倍、1/3倍・・・になる。
このとき、 y は x に反比例するという。

$$y = \frac{a}{x}$$



$$I = \frac{12}{R}$$

R	1	2	3	4	6	12
I	12	6	4	3	2	1

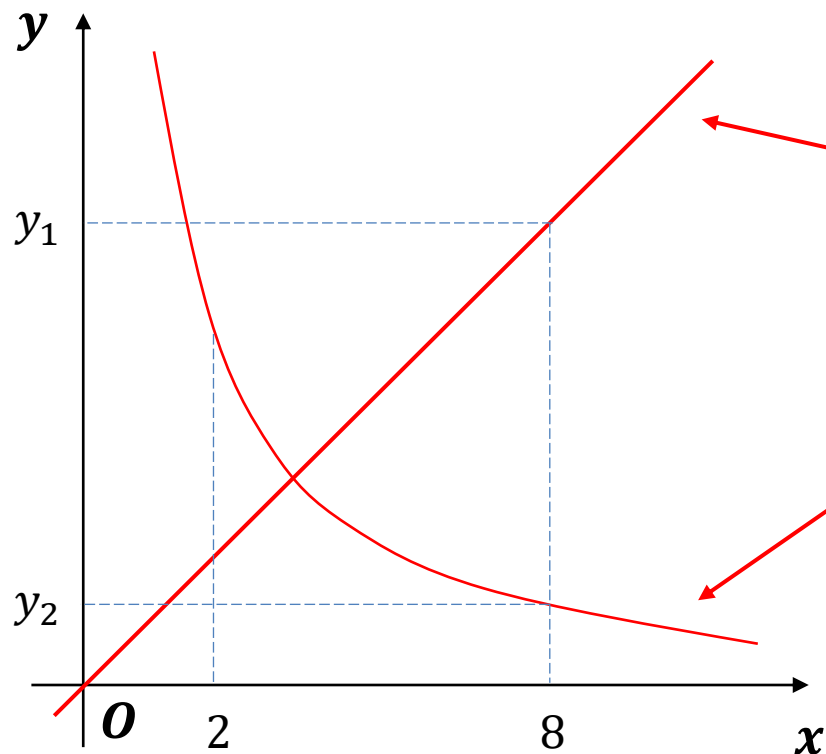


比例と反比例

実際の計算では比例定数 a の導出がめんどくさいことが多い

$$y = \textcircled{a}x$$

$$y = \frac{\textcircled{a}}{x}$$



x	0	2			8
y	0	4			

x	0	2			8
y	0	6			

$$2 : 8 = 4 : y_1$$
$$y_1 = \frac{4 \times 8}{2} = 16$$

$$2 : 8 = \frac{1}{6} : \frac{1}{y_2}$$
$$\frac{2}{y_2} = \frac{8}{6} \rightarrow y_2 = \frac{2 \times 6}{8} = \frac{3}{2}$$

例題 I

直流分巻電動機があり、電機子回路の全抵抗（ブラシの接触抵抗も含む）は 0.098Ω である。この電動機を端子電圧の電源 220 V を接続して、ある負荷で回転すると、回転速度は 1480 min^{-1} 、電機子電流は 120 A 、電動機で発生する誘導起電力は 208 V であった。同一端子電圧でこの電動機を無負荷運転したときの回転速度 $N_0 [\text{min}^{-1}]$ を求めよ。ただし、無負荷運転では、電機子電流は非常に小さく、電機子回路の全抵抗による電圧降下は無視できるものとする。

Ans. $N_0 =$ _____

例題 I

直流分巻電動機があり、電機子回路の全抵抗（ブラシの接触抵抗も含む）は 0.098Ω である。この電動機を端子電圧の電源 220 V を接続して、ある負荷で回転すると、回転速度は 1480 min^{-1} 、電機子電流は 120 A 、電動機で発生する誘導起電力は 208 V であった。同一端子電圧でこの電動機を無負荷運転したときの回転速度 $N_0 [\text{min}^{-1}]$ を求めよ。ただし、無負荷運転では、電機子電流は非常に小さく、電機子回路の全抵抗による電圧降下は無視できるものとする。

(ポイント)

直流電動機の回転速度は電動機の誘導起電力に比例する。

$$\begin{aligned} 220 : 208 &= N_0 : 1480 \\ 208N_0 &= 220 \times 1480 \\ N_0 &= \frac{220}{208} \times 1480 = 1565 \text{ min}^{-1} \end{aligned}$$

(別解)

電動機の回転速度は以下の式で表せる。

$$N = \frac{V - I_a r_a}{K_v \phi} = \frac{220 - 120 \times 0.098}{K_v \phi} = 1480$$
$$K_v \phi = 0.1405$$

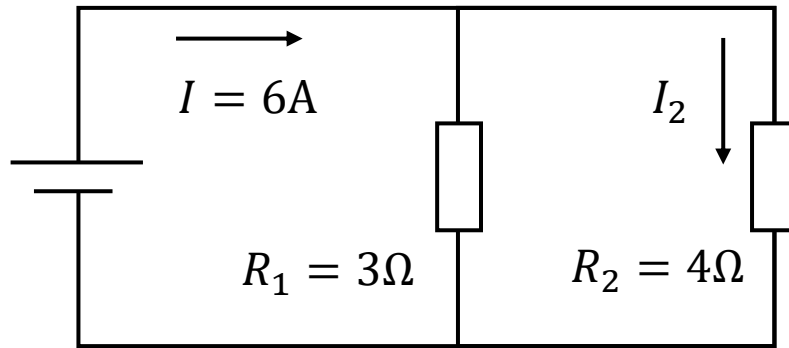
無負荷運転では電機子回路の電圧降下は無視できるので、

$$N_0 = \frac{220 - 0}{0.1405} = 1565$$

Ans. $N_0 = 1565 \text{ min}^{-1}$

例題2

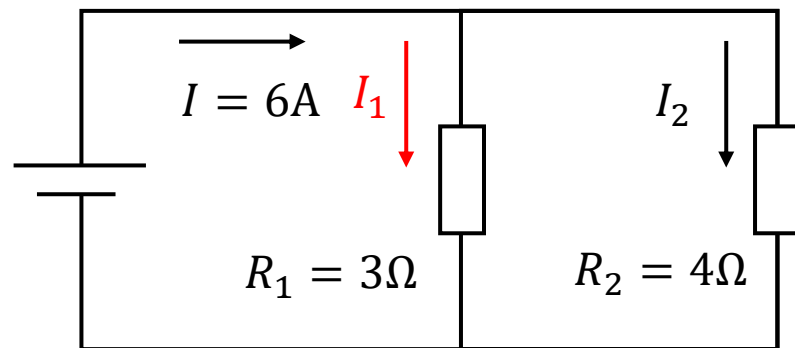
以下の回路の電流 I_2 を求めよ。



Ans. $I_2 =$ _____

例題2

以下の回路の電流 I_2 を求めよ。



$$I_1 : I_2 = \frac{1}{R_1} : \frac{1}{R_2} = R_2 : R_1$$
$$I_1 : I_2 = 4 : 3$$

$$I_2 = \frac{3}{7} \times 6 = \frac{18}{7} \text{ A}$$

(別解)

合成抵抗 R を求める

$$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{3 \times 4}{3 + 4} = \frac{12}{7}$$

電源電圧を求める

$$E = RI = \frac{12}{7} \times 6 = \frac{72}{7}$$

I_2 を求める

$$I_2 = \frac{E}{R_2} = \frac{72}{7} \div 4 = \frac{18}{7}$$

Ans. $I_2 = \frac{18}{7} \text{ A}$

練習問題 I

(1) $1 : 2 = x : 10$

(2) $3 : 5 = x : 25$

(3) $11 : 12 = x : 144$

(4) $1 : 4 = x : 2$

Ans. $x =$ _____

Ans. $x =$ _____

Ans. $x =$ _____

Ans. $x =$ _____

(5) $1 : 2 = 8 : x$

(6) $3 : 7 = 21 : x$

(7) $13 : 15 = 169 : x$

(8) $4 : 7 = 6 : x$

Ans. $x =$ _____

Ans. $x =$ _____

Ans. $x =$ _____

Ans. $x =$ _____

練習問題 I

(1) $1 : 2 = x : 10$

$$\begin{aligned} 2x &= 10 \\ x &= 5 \end{aligned}$$

Ans. $x = 5$

(2) $3 : 5 = x : 25$

$$\begin{aligned} 5x &= 3 \times 25 \\ x &= 15 \end{aligned}$$

Ans. $x = 15$

(3) $11 : 12 = x : 144$

$$\begin{aligned} 12x &= 11 \times 144 \\ 12x &= 11 \times 12 \times 12 \\ x &= 132 \end{aligned}$$

Ans. $x = 132$

(4) $1 : 4 = x : 2$

$$\begin{aligned} 4x &= 2 \\ x &= \frac{2}{4} = \frac{1}{2} \end{aligned}$$

Ans. $x = \frac{1}{2}$

(5) $1 : 2 = 8 : x$

Ans. $x =$

(6) $3 : 7 = 21 : x$

Ans. $x =$

(7) $13 : 15 = 169 : x$

Ans. $x =$

(8) $4 : 7 = 6 : x$

Ans. $x =$

練習問題 I

(1) $1 : 2 = x : 10$

$$\begin{aligned} 2x &= 10 \\ x &= 5 \end{aligned}$$

Ans. $x = 5$

(2) $3 : 5 = x : 25$

$$\begin{aligned} 5x &= 3 \times 25 \\ x &= 15 \end{aligned}$$

Ans. $x = 15$

(3) $11 : 12 = x : 144$

$$\begin{aligned} 12x &= 11 \times 144 \\ 12x &= 11 \times 12 \times 12 \\ x &= 132 \end{aligned}$$

Ans. $x = 132$

(4) $1 : 4 = x : 2$

$$\begin{aligned} 4x &= 2 \\ x &= \frac{2}{4} = \frac{1}{2} \end{aligned}$$

Ans. $x = \frac{1}{2}$

(5) $1 : 2 = 8 : x$

$$\begin{aligned} x &= 2 \times 8 \\ x &= 16 \end{aligned}$$

Ans. $x = 16$

(6) $3 : 7 = 21 : x$

$$\begin{aligned} 3x &= 7 \times 21 \\ x &= 49 \end{aligned}$$

Ans. $x = 49$

(7) $13 : 15 = 169 : x$

$$\begin{aligned} 13x &= 15 \times 169 \\ 13x &= 15 \times 13 \times 13 \\ x &= 195 \end{aligned}$$

Ans. $x = 195$

(8) $4 : 7 = 6 : x$

$$\begin{aligned} 4x &= 7 \times 6 \\ x &= \frac{42}{4} = \frac{21}{2} \end{aligned}$$

Ans. $x = \frac{21}{2}$

練習問題2

$$(1) 1:2 = \frac{1}{x} : \frac{1}{10}$$

Ans. $x =$ _____

$$(2) 3:7 = \frac{1}{x} : \frac{1}{2}$$

Ans. $x =$ _____

$$(3) 12:15 = \frac{1}{x} : \frac{1}{144}$$

Ans. $x =$ _____

$$(4) 14:5 = \frac{1}{x} : \frac{1}{2}$$

Ans. $x =$ _____

$$(5) 3:8 = \frac{1}{32} : \frac{1}{x}$$

Ans. $x =$ _____

$$(6) 5:11 = \frac{1}{9} : \frac{1}{x}$$

Ans. $x =$ _____

$$(7) 8:15 = \frac{1}{30} : \frac{1}{x}$$

Ans. $x =$ _____

$$(8) \frac{4}{5} : \frac{13}{2} = \frac{1}{5} : \frac{1}{x}$$

Ans. $x =$ _____

練習問題2

$$(1) 1:2 = \frac{1}{x}:\frac{1}{10}$$

× 10x

$$1:2 = 10:x$$
$$x = 20$$

Ans. $x = 20$

$$(2) 3:7 = \frac{1}{x}:\frac{1}{2}$$
$$3:7 = 2:x$$
$$3x = 14$$
$$x = \frac{14}{3}$$

Ans. $x = \frac{14}{3}$

$$(3) 12:15 = \frac{1}{x}:\frac{1}{144}$$
$$12:15 = 144:x$$
$$12x = 15 \times 144$$
$$12x = 15 \times 12 \times 12$$
$$x = 180$$

Ans. $x = 180$

$$(4) 14:5 = \frac{1}{x}:\frac{1}{2}$$
$$14:5 = 2:x$$
$$14x = 10$$
$$x = \frac{10}{14} = \frac{5}{7}$$

Ans. $x = \frac{5}{7}$

$$(5) 3:8 = \frac{1}{32}:\frac{1}{x}$$

Ans. $x =$

$$(6) 5:11 = \frac{1}{9}:\frac{1}{x}$$

Ans. $x =$

$$(7) 8:15 = \frac{1}{30}:\frac{1}{x}$$

Ans. $x =$

$$(8) \frac{4}{5}:\frac{13}{2} = \frac{1}{5}:\frac{1}{x}$$

Ans. $x =$

練習問題2

$$(1) 1:2 = \frac{1}{x} : \frac{1}{10}$$

× 10x

$$1:2 = 10:x$$
$$x = 20$$

Ans. $x = 20$

$$(2) 3:7 = \frac{1}{x} : \frac{1}{2}$$
$$3:7 = 2:x$$
$$3x = 14$$
$$x = \frac{14}{3}$$

Ans. $x = \frac{14}{3}$

$$(3) 12:15 = \frac{1}{x} : \frac{1}{144}$$
$$12:15 = 144:x$$
$$12x = 15 \times 144$$
$$12x = 15 \times 12 \times 12$$
$$x = 180$$

Ans. $x = 180$

$$(4) 14:5 = \frac{1}{x} : \frac{1}{2}$$
$$14:5 = 2:x$$
$$14x = 10$$
$$x = \frac{10}{14} = \frac{5}{7}$$

Ans. $x = \frac{5}{7}$

$$(5) 3:8 = \frac{1}{32} : \frac{1}{x}$$
$$3:8 = x:32$$
$$8x = 3 \times 32$$
$$x = 12$$

Ans. $x = 12$

$$(6) 5:11 = \frac{1}{9} : \frac{1}{x}$$
$$5:11 = x:9$$
$$11x = 5 \times 9$$
$$x = \frac{45}{11}$$

Ans. $x = \frac{45}{11}$

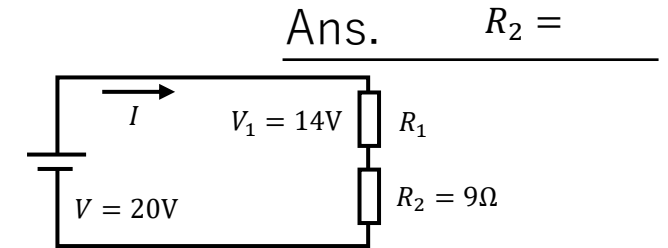
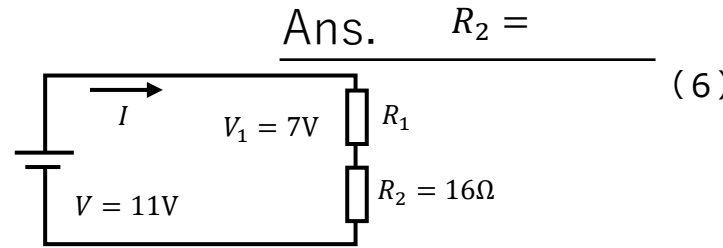
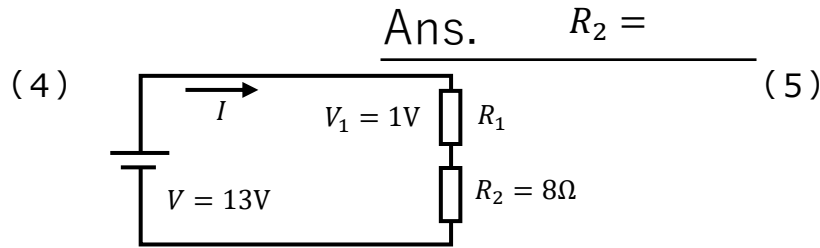
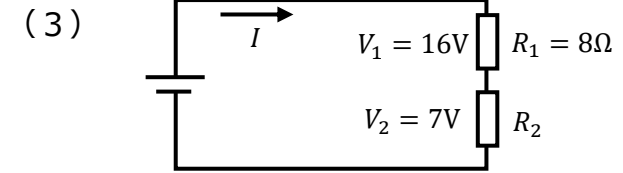
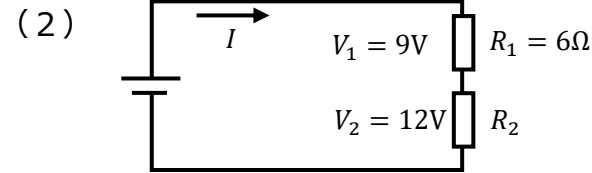
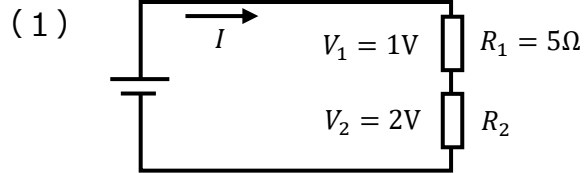
$$(7) 8:15 = \frac{1}{30} : \frac{1}{x}$$
$$8:15 = x:30$$
$$15x = 8 \times 30$$
$$x = 16$$

Ans. $x = 16$

$$(8) \frac{4}{5} : \frac{13}{2} = \frac{1}{5} : \frac{1}{x}$$
$$\frac{4}{5} : \frac{13}{2} = x:5$$
$$\frac{13}{2}x = \frac{4}{5} \times 5$$
$$x = 4 \times \frac{2}{13} = \frac{8}{13}$$

Ans. $x = \frac{8}{13}$

練習問題3



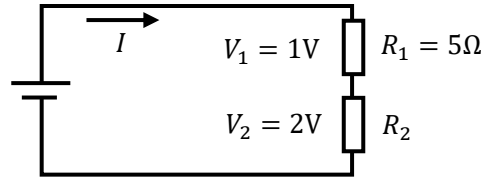
Ans. $R_1 =$ _____

Ans. $R_1 =$ _____

Ans. $R_1 =$ _____

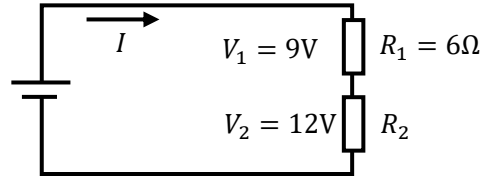
練習問題3

(1)



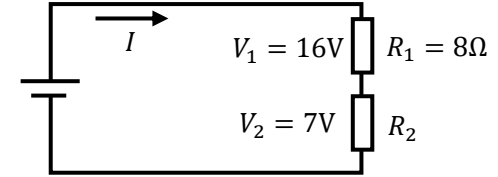
$$\begin{aligned} V_1:V_2 &= R_1:R_2 \\ 1:2 &= 5:R_2 \\ R_2 &= 10 \end{aligned}$$

(2)



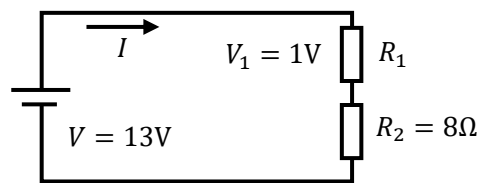
$$\begin{aligned} V_1:V_2 &= R_1:R_2 \\ 9:12 &= 6:R_2 \\ 9R_2 &= 12 \cdot 6 \\ R_2 &= \frac{12 \cdot 6}{9} = 8 \end{aligned}$$

(3)



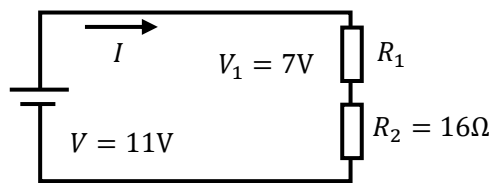
$$\begin{aligned} V_1:V_2 &= R_1:R_2 \\ 16:7 &= 8:R_2 \\ 16R_2 &= 7 \cdot 8 \\ R_2 &= \frac{7 \cdot 8}{16} = \frac{7}{2} \end{aligned}$$

(4)



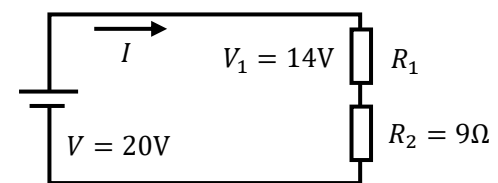
Ans. $R_2 = 10\Omega$

(5)



Ans. $R_2 = 8\Omega$

(6)



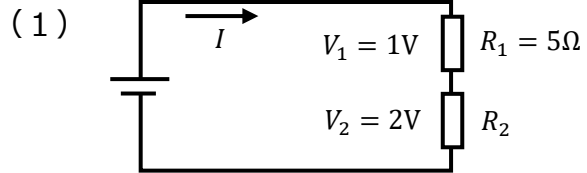
Ans. $R_2 = \frac{7}{2}\Omega$

Ans. $R_1 =$ _____

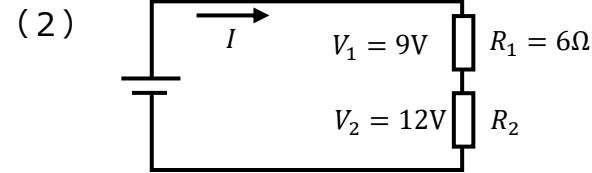
Ans. $R_1 =$ _____

Ans. $R_1 =$ _____

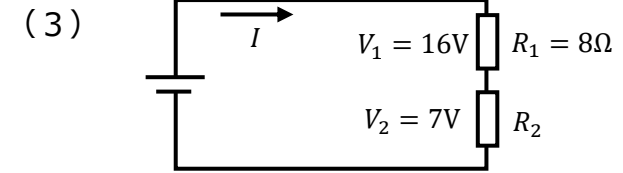
練習問題3



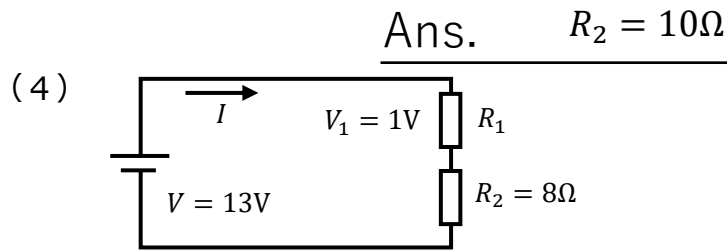
$$\begin{aligned} V_1:V_2 &= R_1:R_2 \\ 1:2 &= 5:R_2 \\ R_2 &= 10 \end{aligned}$$



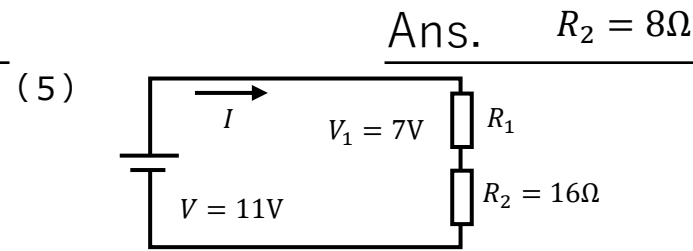
$$\begin{aligned} V_1:V_2 &= R_1:R_2 \\ 9:12 &= 6:R_2 \\ 9R_2 &= 12 \cdot 6 \\ R_2 &= \frac{12 \cdot 6}{9} = 8 \end{aligned}$$



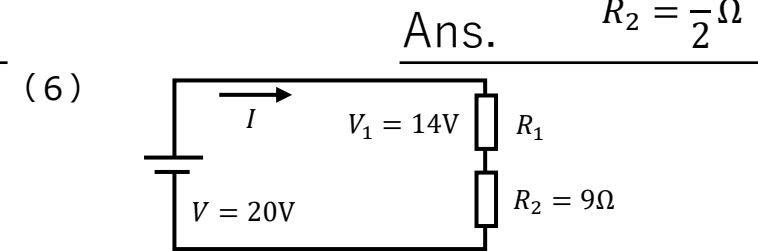
$$\begin{aligned} V_1:V_2 &= R_1:R_2 \\ 16:7 &= 8:R_2 \\ 16R_2 &= 7 \cdot 8 \\ R_2 &= \frac{7 \cdot 8}{16} = \frac{7}{2} \end{aligned}$$



$$\begin{aligned} V_1:V - V_1 &= R_1:R_2 \\ 1:13 - 1 &= R_1:8 \\ 12R_1 &= 8 \\ R_1 &= \frac{8}{12} = \frac{2}{3} \end{aligned}$$



$$\begin{aligned} V_1:V - V_1 &= R_1:R_2 \\ 7:11 - 7 &= R_1:16 \\ 4R_1 &= 7 \cdot 16 \\ R_1 &= \frac{7 \cdot 16}{4} = 28 \end{aligned}$$



$$\begin{aligned} V_1:V - V_2 &= R_1:R_2 \\ 14:20 - 14 &= R_1:9 \\ 6R_1 &= 14 \cdot 9 \\ R_2 &= \frac{14 \cdot 9}{6} = 21 \end{aligned}$$

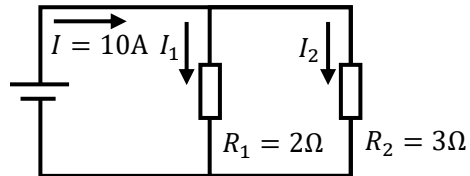
Ans. $R_1 = \frac{2}{3}\Omega$

Ans. $R_1 = 28\Omega$

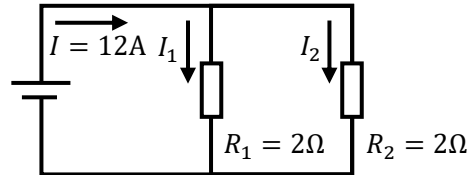
Ans. $R_1 = 21\Omega$

練習問題4

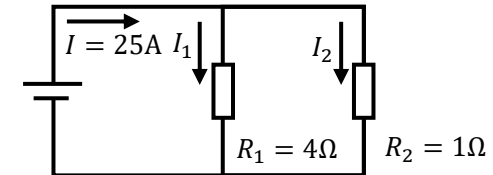
(1)



(2)

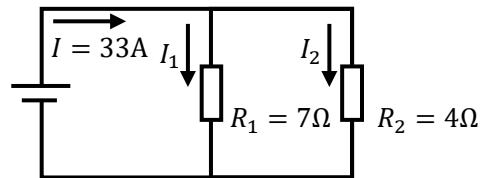


(3)



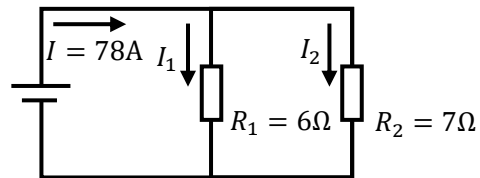
Ans. $I_1 =$ $I_2 =$

(4)



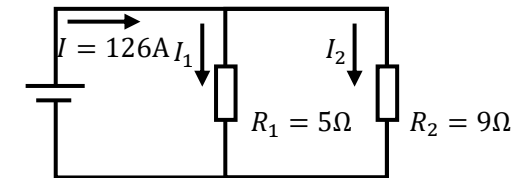
Ans. $I_1 =$ $I_2 =$

(5)



Ans. $I_1 =$ $I_2 =$

(6)

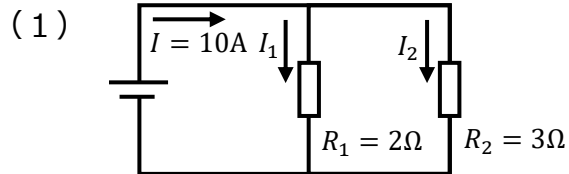


Ans. $I_1 =$ $I_2 =$

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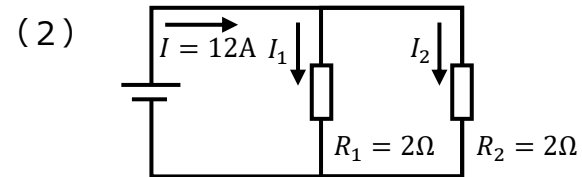
練習問題4



$$I_1:I_2 = \frac{V}{R_1}:\frac{V}{R_2} = \frac{1}{R_1}:\frac{1}{R_2} = R_2:R_1$$

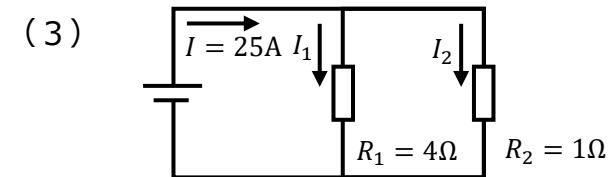
$$I_1:I_2 = R_2:R_1 = 3:2 = 6:4$$

Ans. $I_1 = 6A$ $I_2 = 4A$



$$I_1:I_2 = R_2:R_1 = 2:2 = 6:6$$

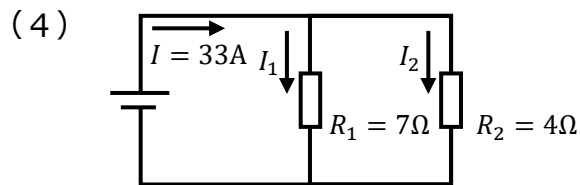
Ans. $I_1 = 6A$ $I_2 = 6A$



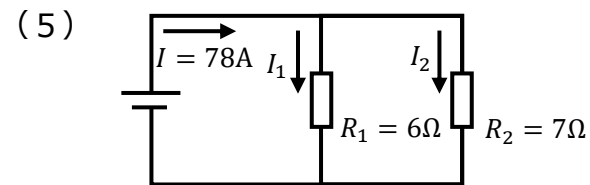
$$I_1:I_2 = R_2:R_1 = 1:4 = 5:20$$

$$\frac{25}{4+1} = 5 \quad \nearrow \quad \times 5$$

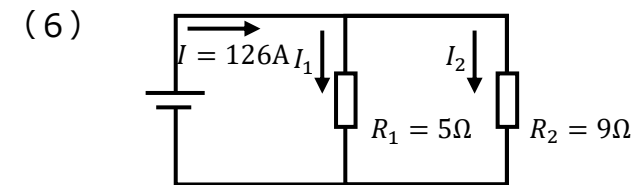
Ans. $I_1 = 5A$ $I_2 = 20A$



Ans. $I_1 =$ $I_2 =$

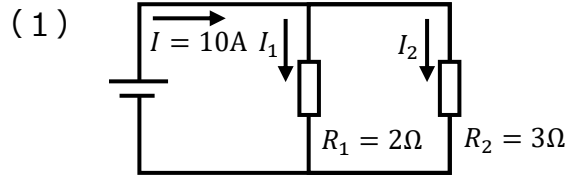


Ans. $I_1 =$ $I_2 =$



Ans. $I_1 =$ $I_2 =$

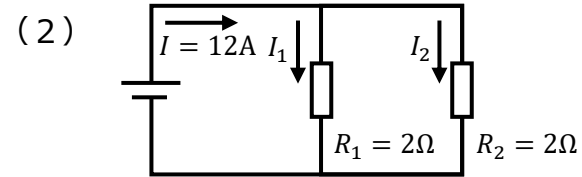
練習問題4



$$I_1:I_2 = \frac{V}{R_1}:\frac{V}{R_2} = \frac{1}{R_1}:\frac{1}{R_2} = R_2:R_1$$

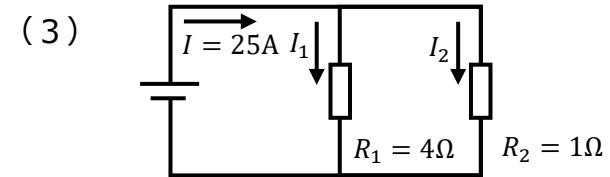
$$I_1:I_2 = R_2:R_1 = 3:2 = 6:4$$

Ans. $I_1 = 6A$ $I_2 = 4A$



$$I_1:I_2 = R_2:R_1 = 2:2 = 6:6$$

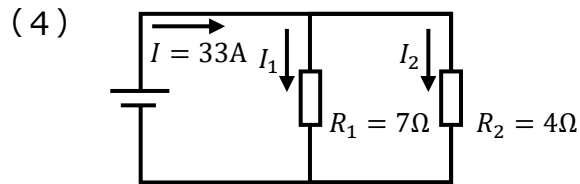
Ans. $I_1 = 6A$ $I_2 = 6A$



$$I_1:I_2 = R_2:R_1 = 1:4 = 5:20$$

$$\frac{25}{4+1} = 5 \quad \nearrow \times 5$$

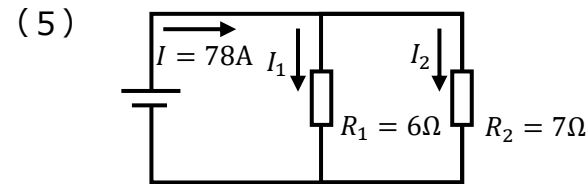
Ans. $I_1 = 5A$ $I_2 = 20A$



$$I_1:I_2 = R_2:R_1 = 4:7 = 12:21$$

$$\frac{33}{7+4} = 3 \quad \nearrow \times 3$$

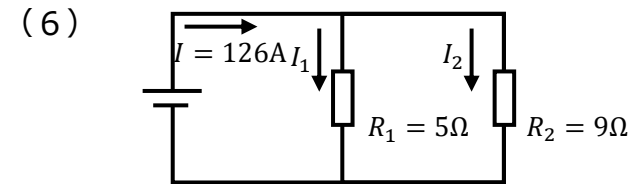
Ans. $I_1 = 12A$ $I_2 = 21A$



$$I_1:I_2 = R_2:R_1 = 7:6 = 42:36$$

$$\frac{78}{7+6} = 6 \quad \nearrow \times 6$$

Ans. $I_1 = 42A$ $I_2 = 36A$

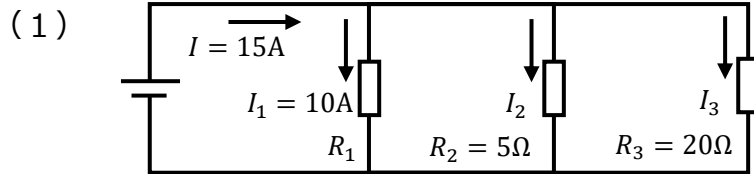


$$I_1:I_2 = R_2:R_1 = 9:5 = 81:45$$

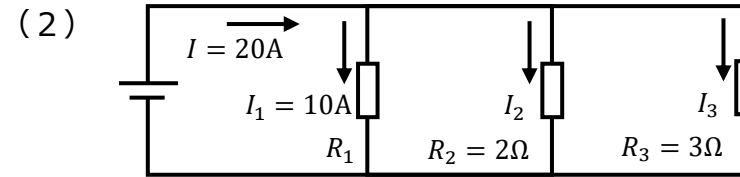
$$\frac{126}{5+9} = 9 \quad \nearrow \times 9$$

Ans. $I_1 = 81A$ $I_2 = 45A$

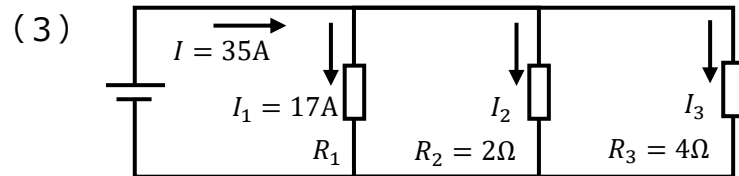
練習問題5



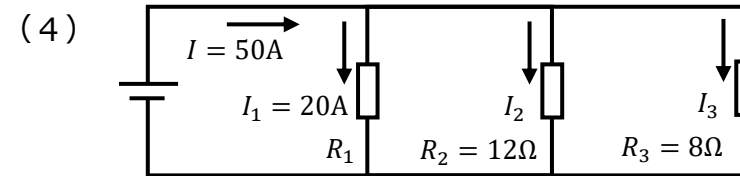
Ans. $I_2 =$ $I_3 =$



Ans. $I_2 =$ $I_3 =$

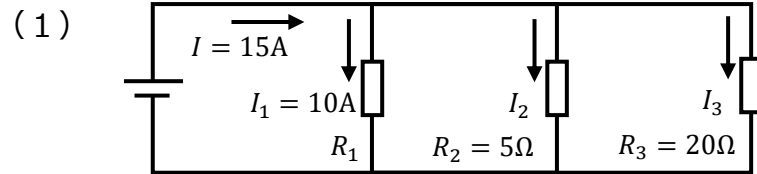


Ans. $I_2 =$ $I_3 =$



Ans. $I_2 =$ $I_3 =$

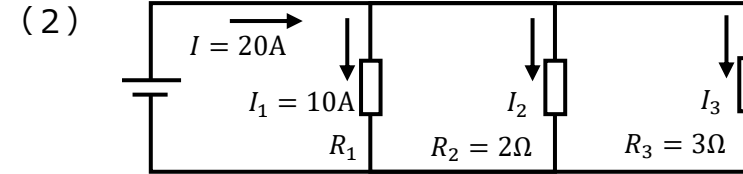
練習問題5



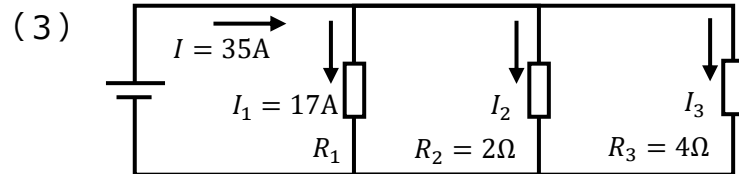
$$I_2 + I_3 = I - I_1 = 10 - 5 = 5$$

$$I_2 : I_3 = R_3 : R_2 = 20 : 5 = 4 : 1$$

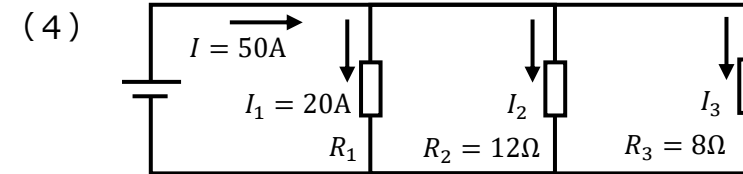
Ans. $I_2 = 4A$ $I_3 = 1A$



Ans. $I_2 =$ $I_3 =$

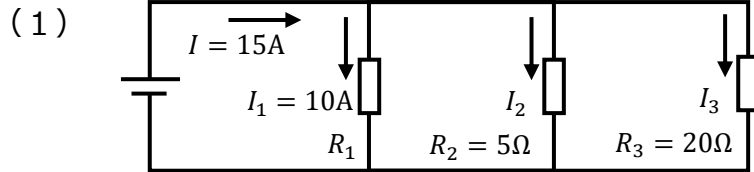


Ans. $I_2 =$ $I_3 =$



Ans. $I_2 =$ $I_3 =$

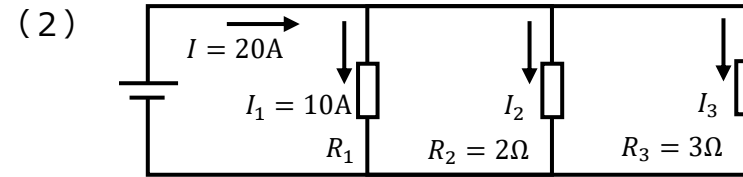
練習問題5



$$I_2 + I_3 = I - I_1 = 15 - 10 = 5$$

$$I_2 : I_3 = R_3 : R_2 = 20 : 5 = 4 : 1$$

Ans. $I_2 = 4A$ $I_3 = 1A$

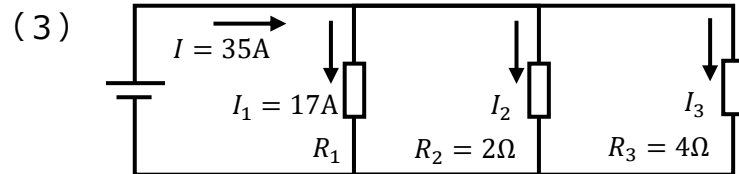


$$I_2 + I_3 = I - I_1 = 20 - 10 = 10$$

$$I_2 : I_3 = R_3 : R_2 = 3 : 2 = 6 : 4$$

$$\frac{10}{3 + 2} = 2 \quad \times 2$$

Ans. $I_2 = 6A$ $I_3 = 4A$

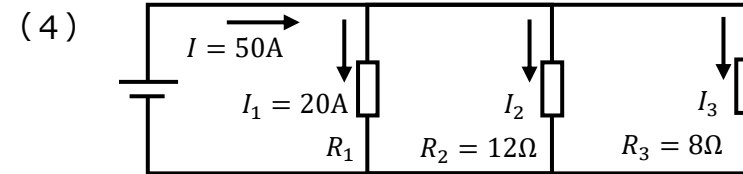


$$I_2 + I_3 = I - I_1 = 35 - 17 = 18$$

$$I_2 : I_3 = R_3 : R_2 = 4 : 2 = 12 : 6$$

$$\frac{18}{4 + 2} = \frac{18}{6} = 3 \quad \times 3$$

Ans. $I_2 = 12A$ $I_3 = 6A$



$$I_2 + I_3 = I - I_1 = 50 - 20 = 30$$

$$I_2 : I_3 = R_3 : R_2 = 8 : 12 = 8 \times \frac{3}{2} : 12 \times \frac{3}{2} = 12 : 18$$

$$\frac{30}{8 + 12} = \frac{30}{20} = \frac{3}{2} \quad \times \frac{3}{2}$$

Ans. $I_2 = 12A$ $I_3 = 18A$



ご聴講ありがとうございました!!