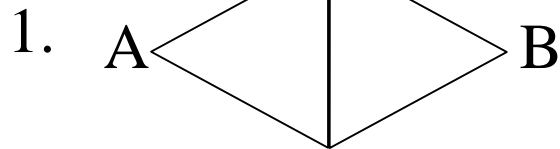


# 合成抵抗の計算



1辺の抵抗を $r$ とするときA-B間,A-C間およびA-D間の合成抵抗を求めよ。

ヒント 対称性を利用する。

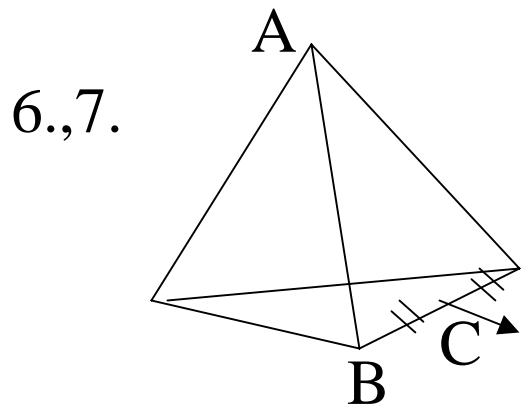
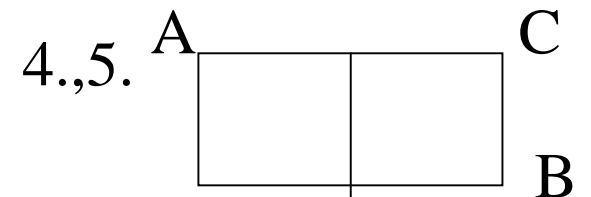
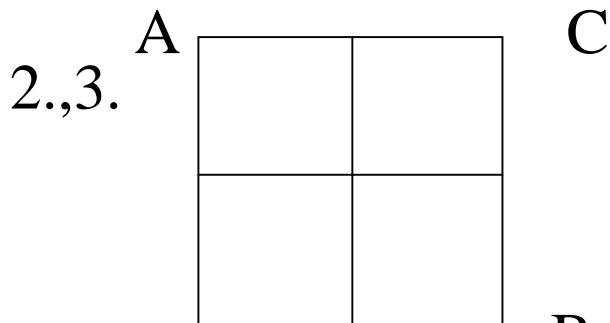
(1)電圧が等しい点同志は切り離しても、また接続しても電流分布は変わらない。

(2)電流分布の対称性を利用して未知数を減らす。

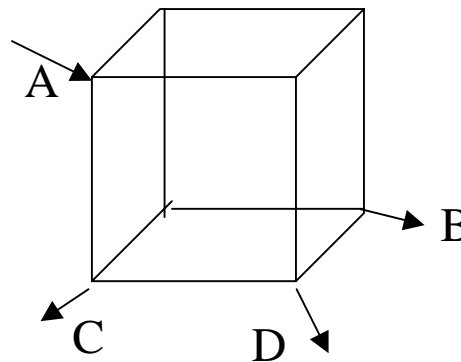
ポイントは始終点を含む「対称軸または面」、または始終点に垂直な「等分面」の発見です。

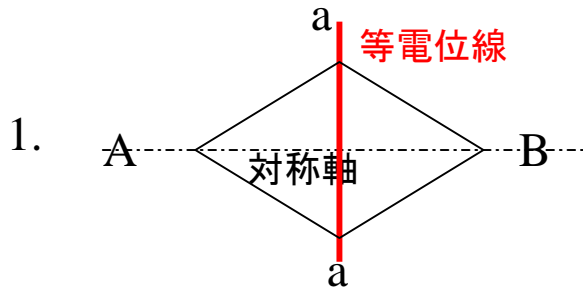
「対称軸」「対称面」に関し互いに鏡像関係にある点は同電位。

「等分面」上の点は同電位。

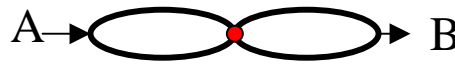


8. 9. 10.

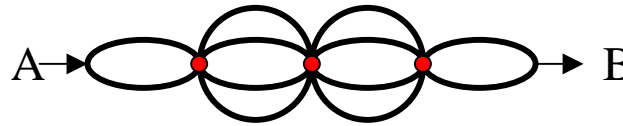
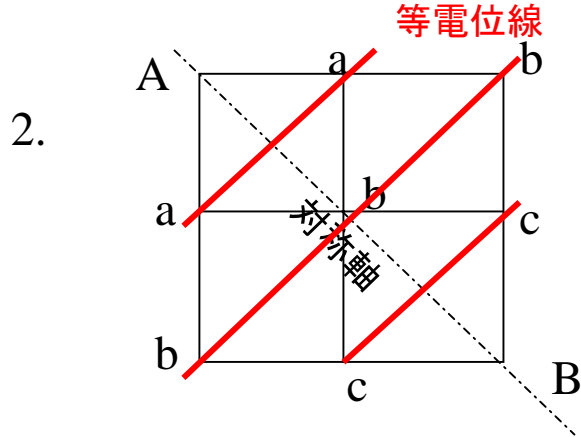




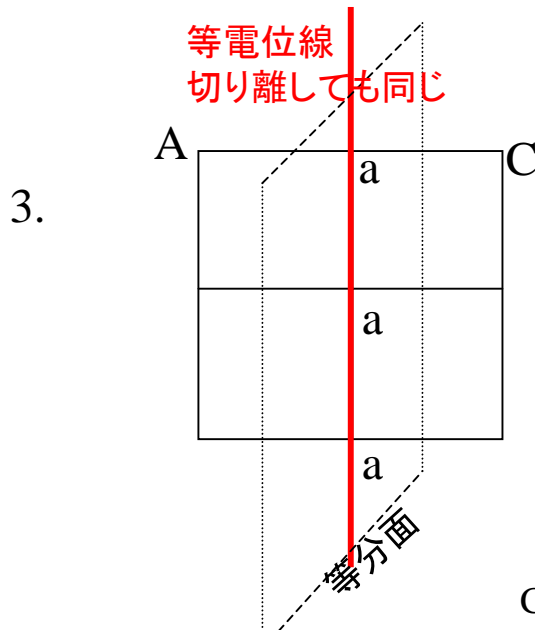
上下対称であるから a-a 線上の電圧は一定→  
a-a を結んでも電圧電流分布は不変



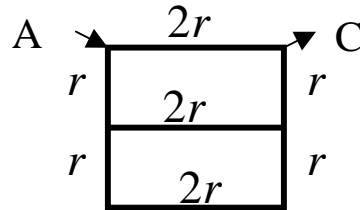
$$R = \frac{1}{2}r + \frac{1}{2}r = r$$



$$R = 2 \left( \frac{1}{2}r + \frac{1}{4}r \right) = \frac{3}{2}r$$

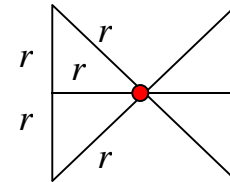


切り離した場合

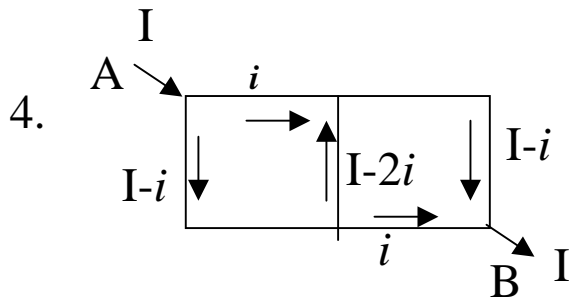


$$\begin{aligned} R &= (4r // 2r + 2r) // 2r \\ &= \left( \frac{1}{1/4r + 1/2r} + 2r \right) // 2r \\ &= \left( \frac{4r}{3} + 2r \right) // 2r = \frac{1}{3/10r + 1/2r} = \frac{4}{5}r \end{aligned}$$

結んだ場合



$$\begin{aligned} R &= (2r // r // 2r) * 2 \\ &= \frac{1}{1/2r + 1/r + 1/2r} * 2 \\ &= \frac{2r}{5} * 2 = \frac{4}{5}r \end{aligned}$$

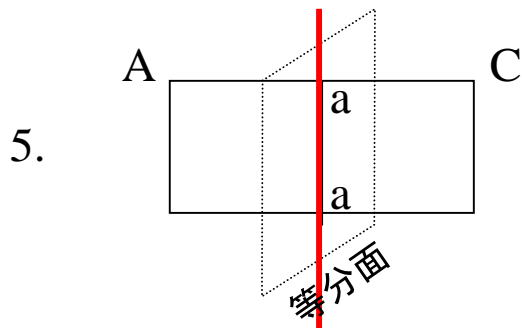


$$v = (I - i)2r + ir \dots \dots (1)$$

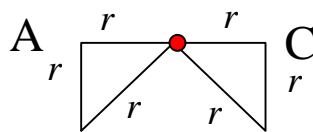
$$ir = (I - i)2r + (I - 2i)r \dots (2)$$

(2)から、 $3I = 5i \rightarrow i = 3/5I$

(1)に代入して、 $R = v/I = 7r/5$

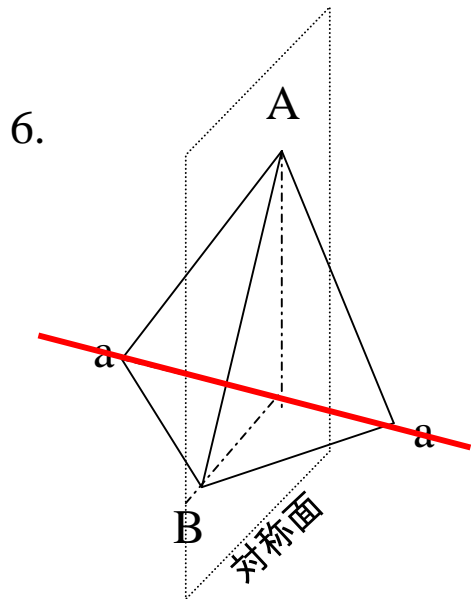


a-a を結ぶと

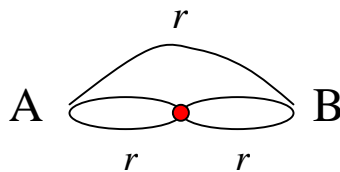


$$R = (r // 2r) * 2 = \frac{1}{1/r + 1/2r} * 2$$

$$= \frac{4}{3} r$$



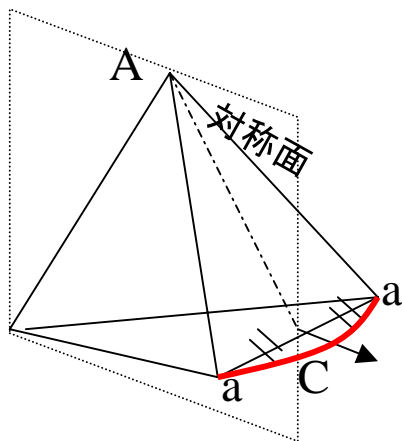
a-a を結ぶと



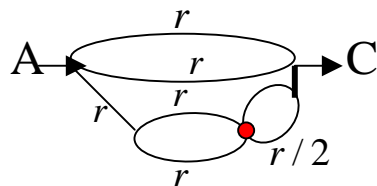
$$R = r // (r // r * 2) = \frac{1}{1/r + 1/r}$$

$$= \frac{1}{2} r$$

7.



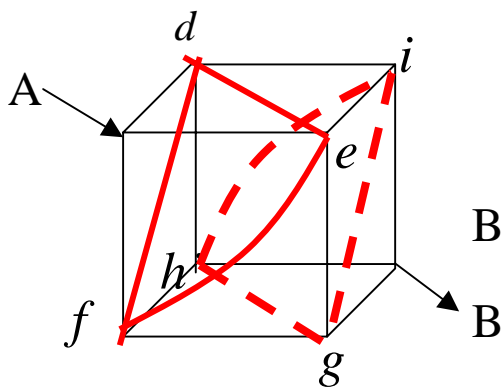
a-a を結ぶと



$$R = (r // r // (r + r/2)) + (r/2 // r/2)$$

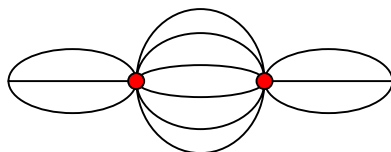
$$= \frac{1}{2/r + 2/3r} + r/4 = \frac{3}{8}r + \frac{r}{4} = \frac{5}{8}r$$

8.



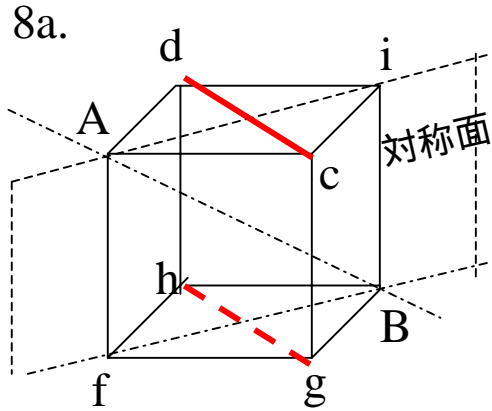
等電位点d-e-f およびg-h-i を結ぶ

AからBを見てd,e,fは対称点、BからAを見たときもg,h,iは対称点でそれぞれ電位が等しい。

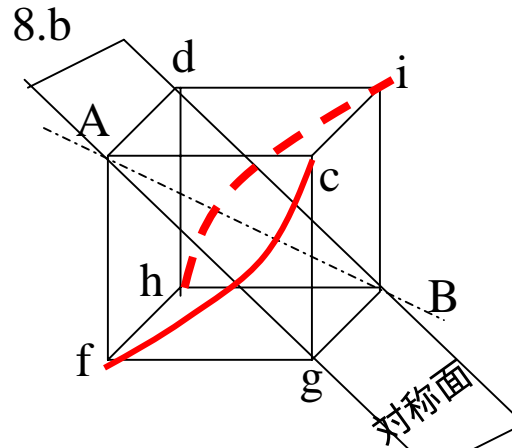


$$R = \frac{r}{3} + \frac{r}{6} + \frac{r}{3} = \frac{5}{6}r$$

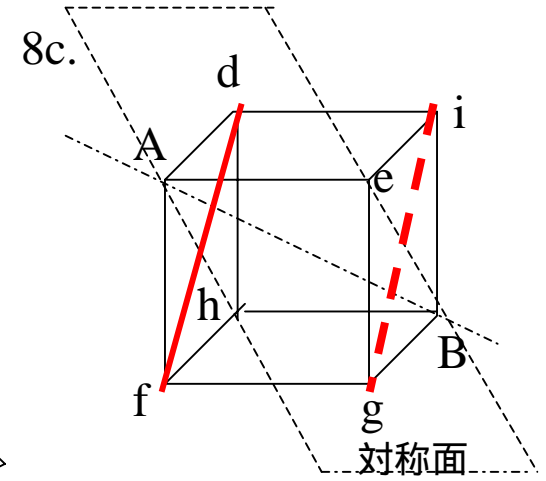
## 8. A-B を通る対称面は3つある



c-d, g-h が等電位

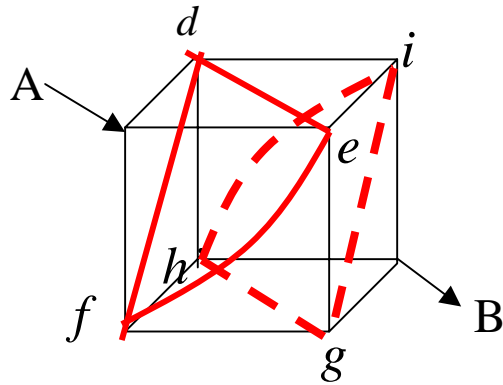


e-f, h-i が等電位 →  
d-e-f, g-h-i が等電位



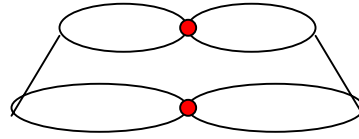
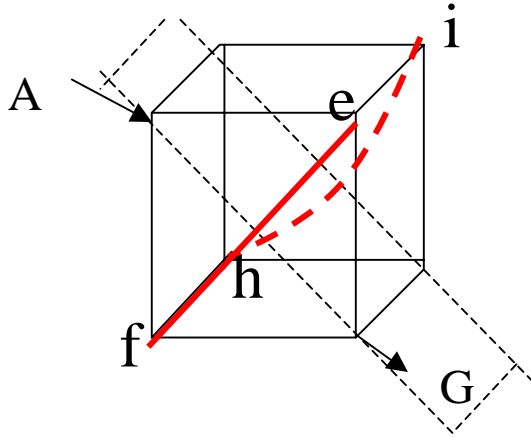
d-f, i-g が等電位 →  
d-e-f, g-h-i が等電位

## 8.総合



9.

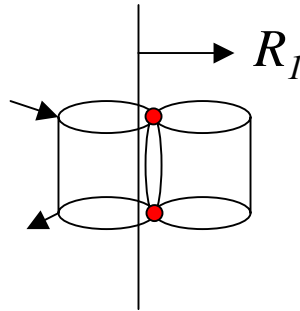
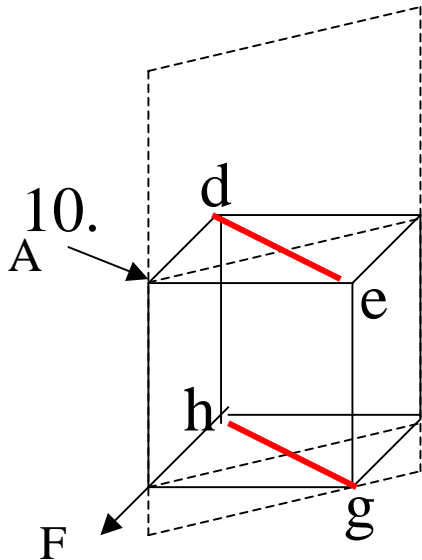
等電位点e-f, h-i 結ぶと



$$R = (r/2 + r/2) // (r + r/2 // r/2 + r)$$

$$= r // 3r = \frac{1}{1/r + 1/3r} = \frac{3}{4}r$$

等電位点d-e, g-h を結ぶ



$$R_1 = \left( \frac{r}{2} + r + \frac{r}{2} \right) // \frac{r}{2} = \frac{1}{1/2r + 2/r} = \frac{2r}{5}$$

$$R = \left( \frac{r}{2} + R_1 + \frac{r}{2} \right) // r = \frac{1}{5/7r + 1/r} = \frac{7r}{12}$$