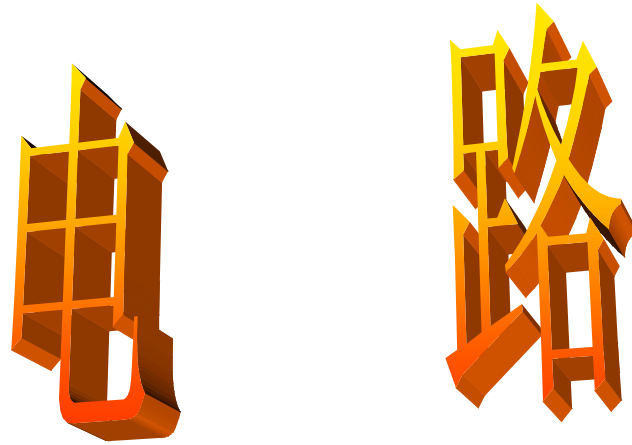




山东理工大学

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任课教师：魏佩瑜教授  
电工电子教研室

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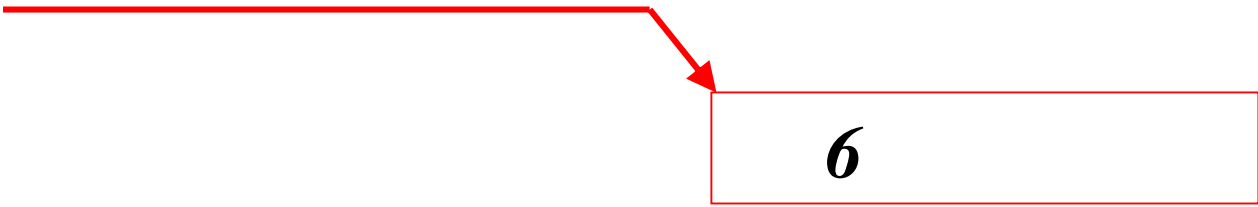
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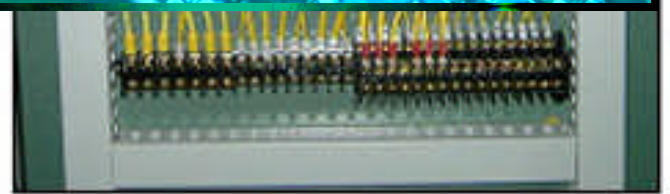
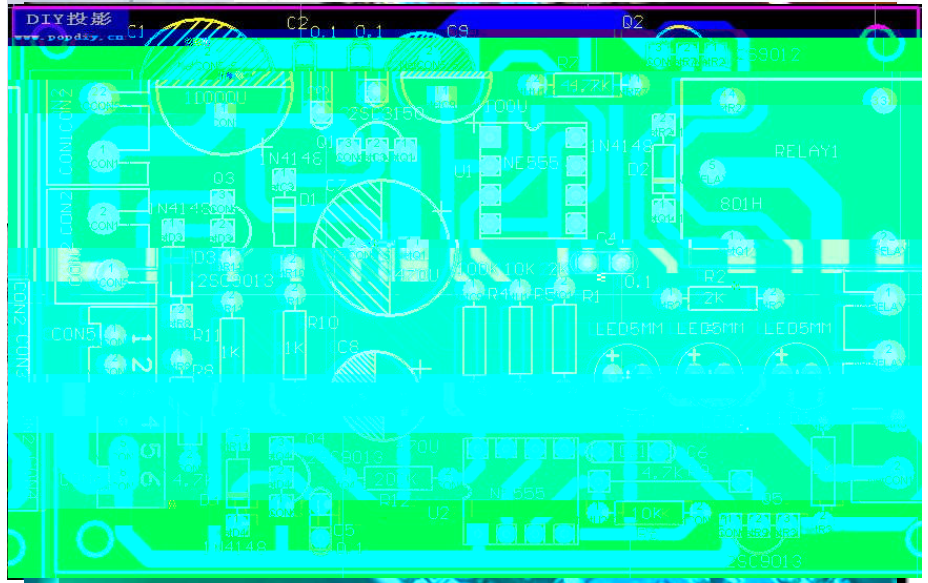


**6**

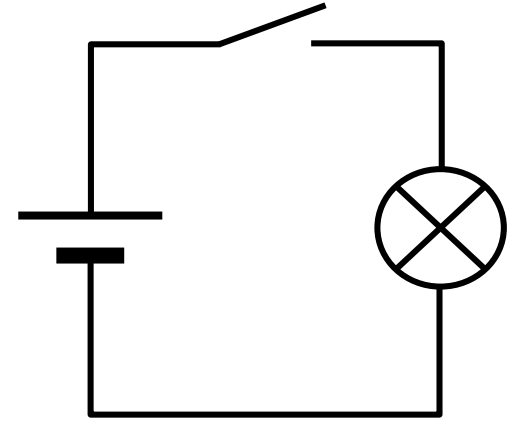
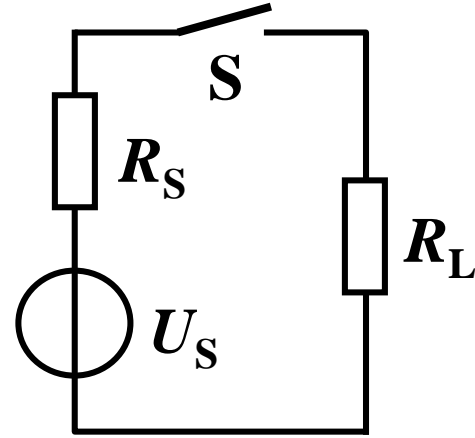
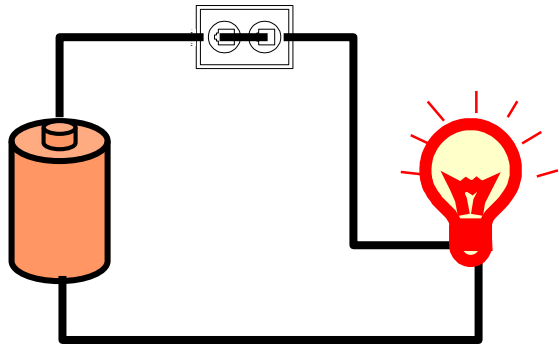




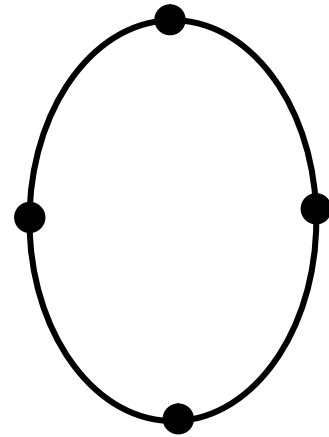
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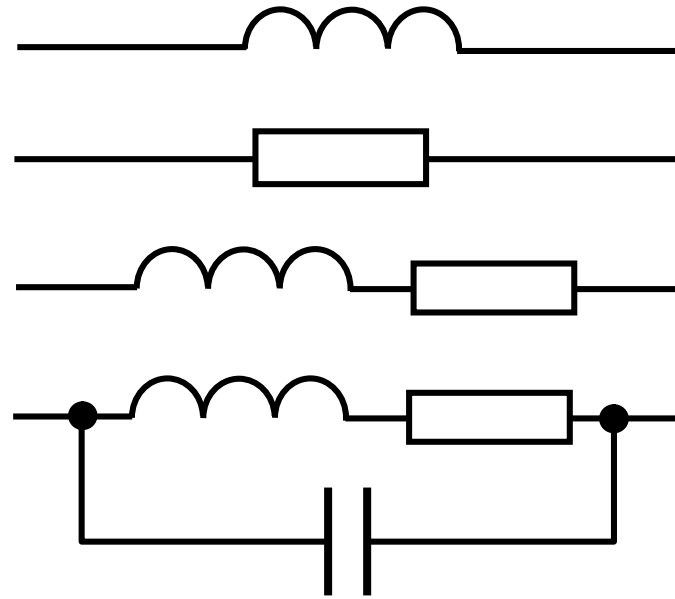
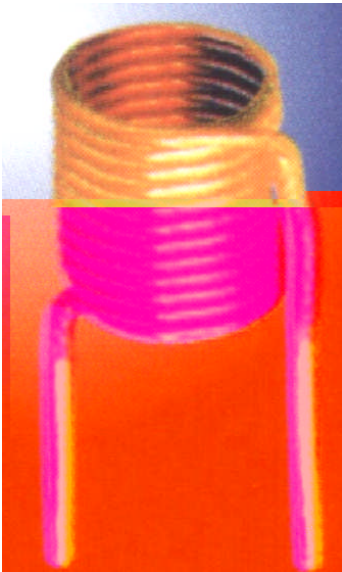






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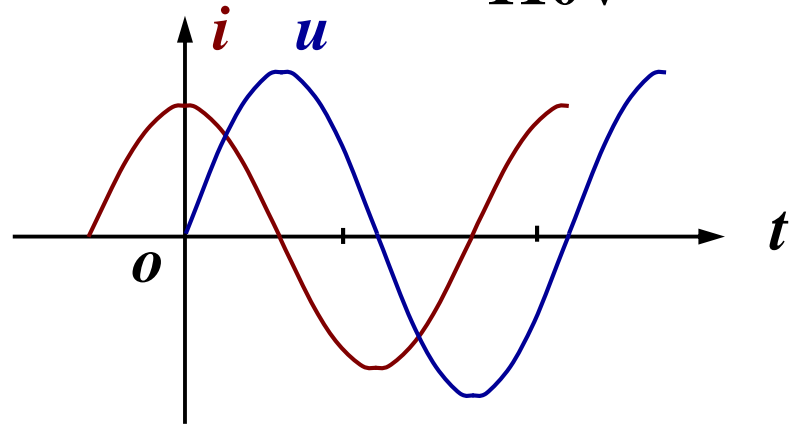
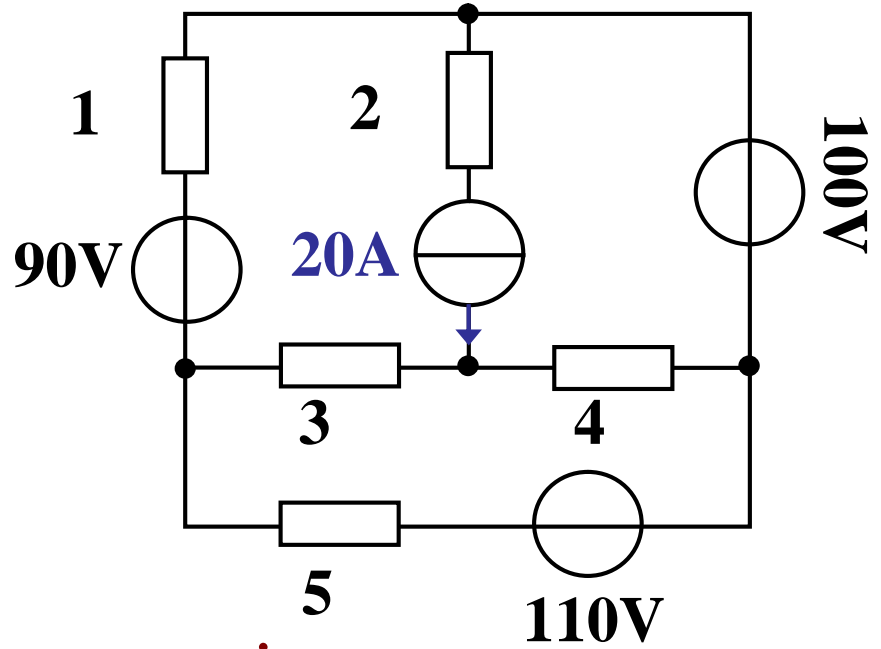
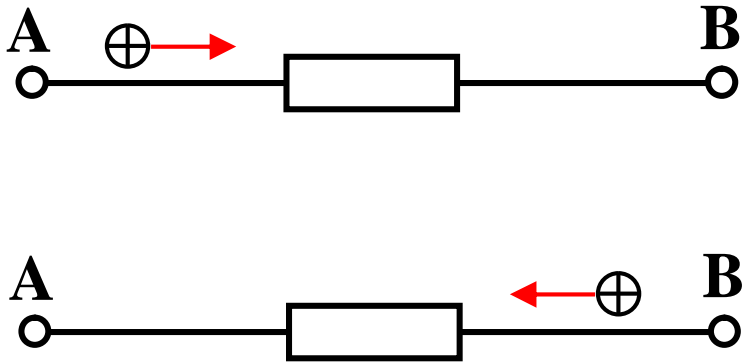
$$i(t) = \frac{dq(t)}{dt} = \lim_{\Delta t \rightarrow 0} \frac{q(t) - q(t - \Delta t)}{\Delta t}$$

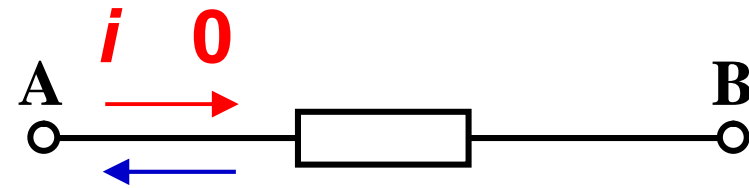
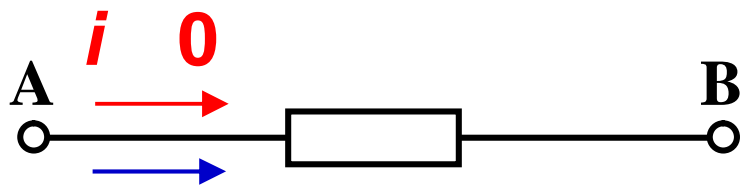
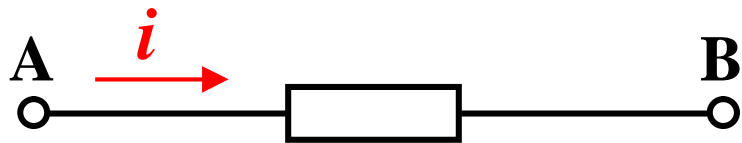
- **A ( ) kA mA A**

**1kA=10<sup>3</sup>A    1mA=10<sup>-3</sup>A    1 A=10<sup>0</sup> A**

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( )





( )

( )

A

B

$i_{AB}$

2.

•

( =0)

$q$

•

$U$

$q$

( $W$ )

$$U \underline{\underline{\frac{d}{dq} W}} \frac{dW}{dq}$$

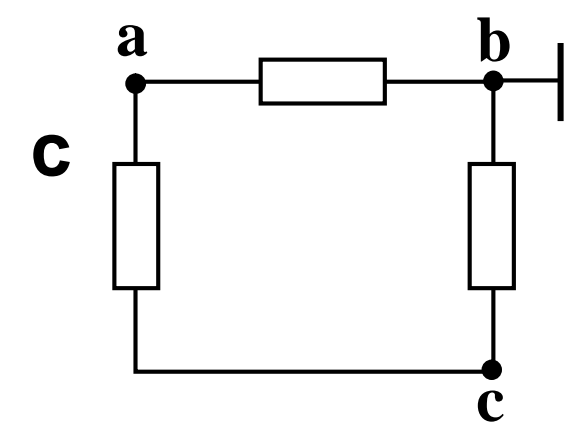
•

V ( ) kV mV V



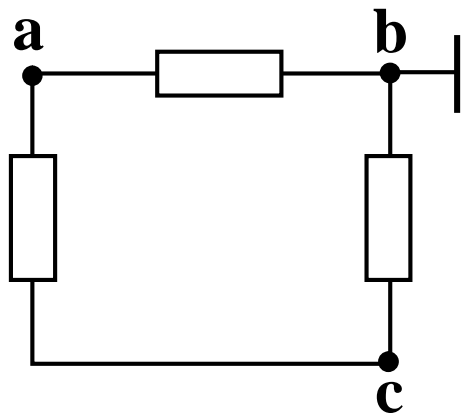
(1)  $4C$   $8J$   $12J$   
 $U_{ab}$   $U_{bc}$

(2)  $0$   
 $\frac{W_{ac}}{q} = \frac{(8 \ 12)}{4} = 5V$   
 $\frac{W_{bc}}{q} = \frac{12}{4} = 3V$



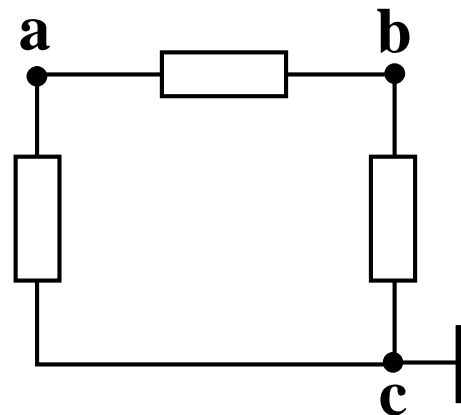
$U_{ab}$   $5$   $3$   $2V$   
 $U_{bc}$   $3$   $3V$





b **0**      a **2V**      c **3V**

$U_{ab}$  **2V**       $U_{bc}$  **3V**



c **0**      a **5V**      b **3V**

$U_{ab}$  **2V**       $U_{bc}$  **3V**





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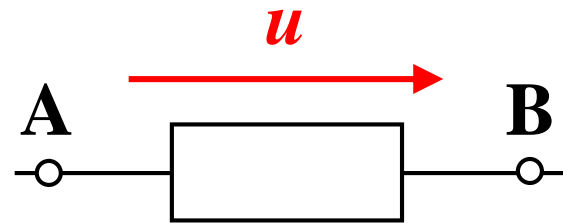
( )

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(1)



(2)



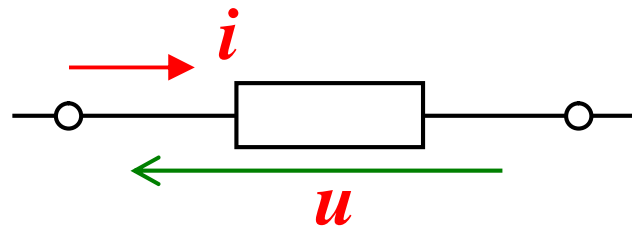
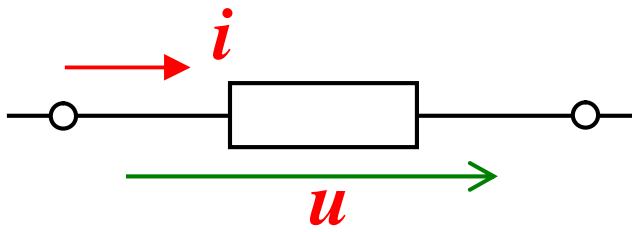
(3)



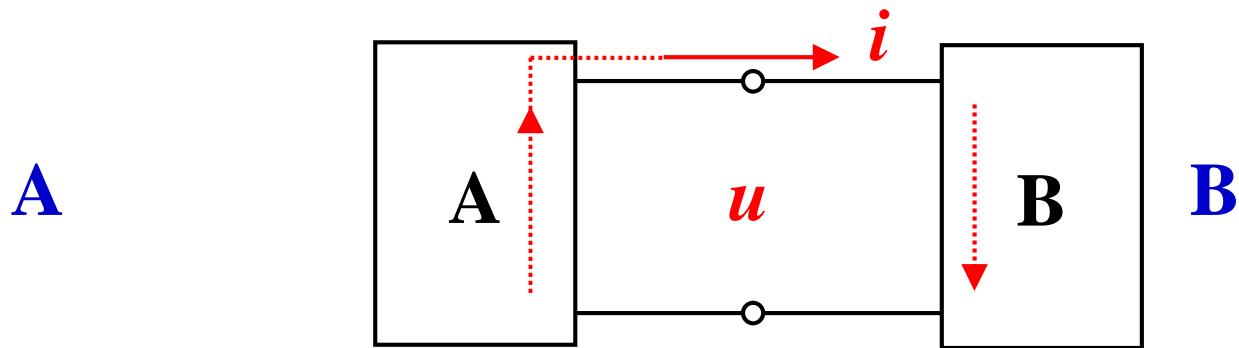
3.



$u$   $i$



**A** **B**





# 1 3



1.

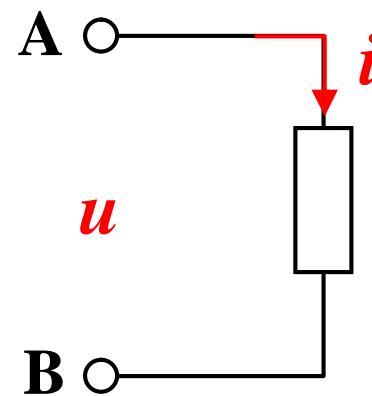
$$p \frac{dw}{dt} \quad u \frac{dw}{dq} \quad i \frac{dq}{dt}$$

$$p \frac{dw}{dt} \quad \frac{dw}{dq} \frac{dq}{dt} \quad ui \quad p \quad ui$$

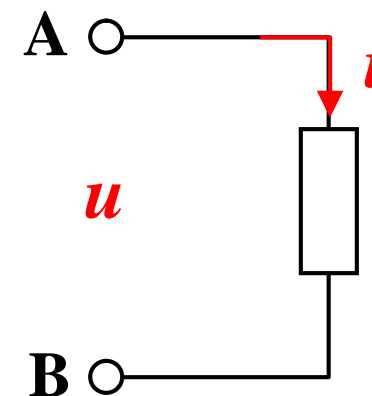
W ( ) (Watt ) kW mW

2.

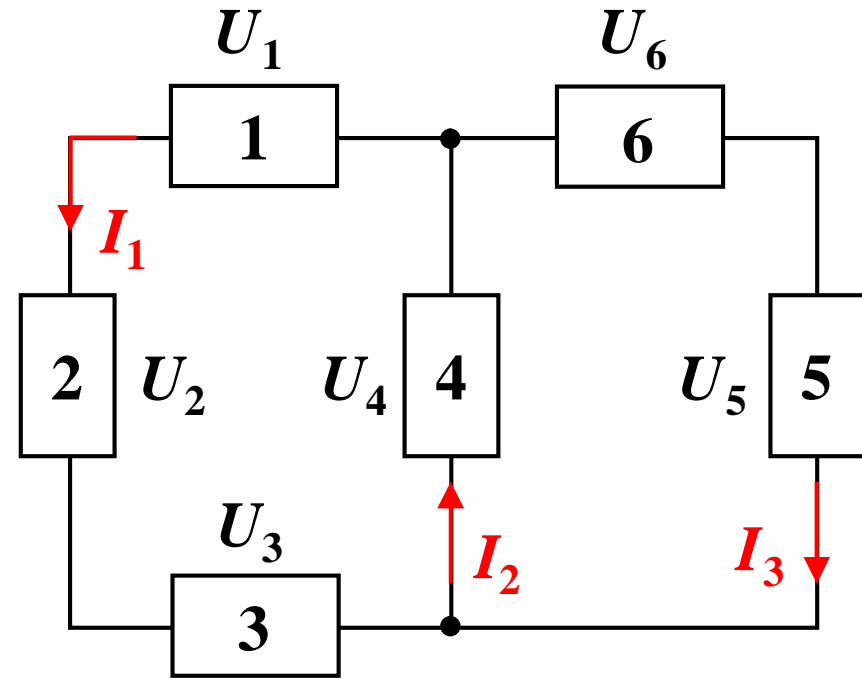
$$\begin{array}{l} \text{Ⓜ} \quad u \quad i \\ p \quad ui \\ p \quad 0 \\ p \quad 0 \end{array} \quad \begin{array}{l} ( \quad ) \\ ( \quad ) \end{array}$$



$$\begin{array}{l} \text{Ⓜ} \quad u \quad i \\ p \quad ui \\ p \quad 0 \\ p \quad 0 \end{array} \quad \begin{array}{l} ( \quad ) \\ ( \quad ) \end{array}$$



$U_1$  1V     $U_2$  3V  
 $U_3$  8V     $U_4$  4V  
 $U_5$  7V     $U_6$  3V  
 $I_1$  2A     $I_2$  1A     $I_3$  1A



$P_1$   $U_1 I_1$  1 2 2W

$P_2$   $U_2 I_1$  2 6W

$P_3$   $U_3 I_1$  2 6W

$P_4$   $U_4 I_2$  4W

$P_5$   $U_5 I_3$  7W

$P_6$   $U_6 I_3$  3W





3.

$$p = \frac{dw}{dt}$$

$$dw = p dt = u i dt$$

$$t_0 \quad t$$

$$w(t) = \int_{t_0}^t u(\tau) i(\tau) d\tau$$

**J ( ) (Joule )**

1 4

1.



5





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2.



$$d \ll$$



$$f = 20\text{kHz}$$

$$v = 3 \cdot 10^8 \text{ m/s}$$

$$\frac{v}{f} = 15\text{km}$$



“ ”

“ ”

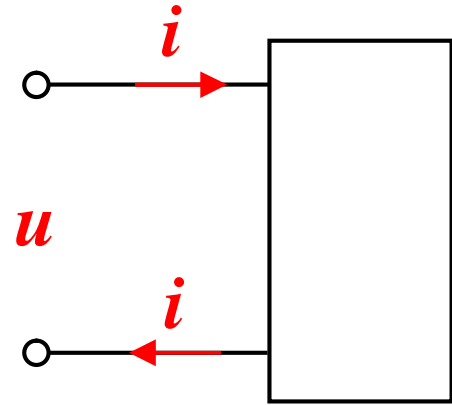
(

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( 18 )



$u$   $i$

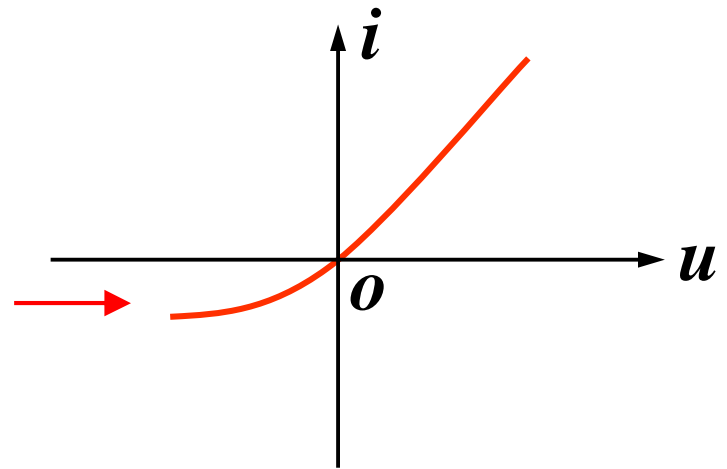


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1.

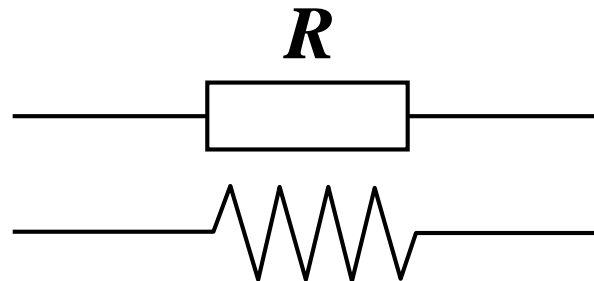
$u$   $i$

$f(u,i)$   $0$  ←



2.

• ( )



•  $u \quad i$

$$R \quad \begin{matrix} u & i \\ i & \frac{u}{R} \end{matrix} \quad u \quad Ri$$

•  $R$

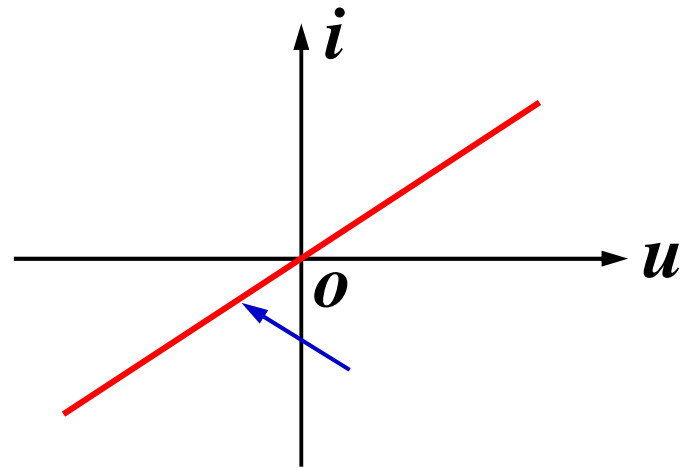
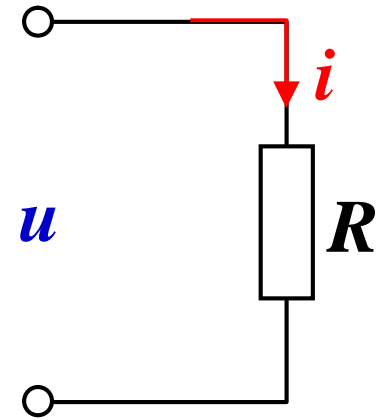
$$u \quad V \quad i \quad A \quad R$$

$$G \quad \frac{1}{R}$$

$$i \quad Gu$$

$G$

$S( \quad )$



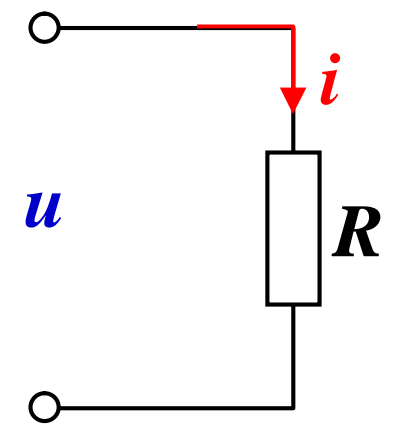


***R G***



***(R )***

***u Ri or i Gu***



3.

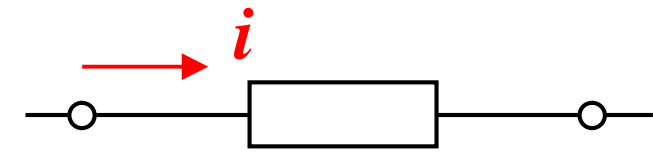
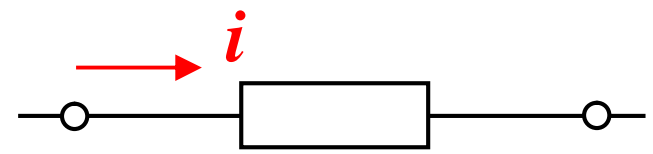
•

$u$   $i$

$$p \quad ui \quad Ri^2 \quad \frac{u^2}{R} \quad Gu^2 \quad \frac{i^2}{G}$$

$u$   $i$

$$p \quad ui \quad Ri^2 \quad Ri^2 \quad \frac{u^2}{R}$$



•

$t_0$   $t$

$$w(t) = \int_{t_0}^t p \, dt = \int_{t_0}^t u(\cdot) i(\cdot) \, dt$$

4.

/

/

①

$$u = f(i)$$

$$i = f(u)$$



②

$$u(t) = R(t) i(t)$$

$$i(t) = G(t) u(t)$$

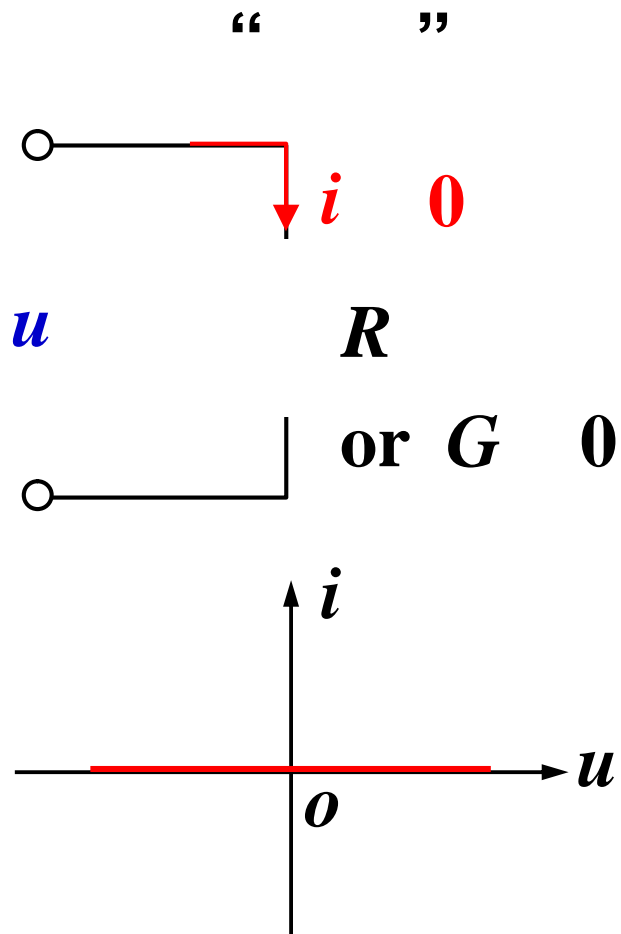
$$u = i$$

$$R(t)$$

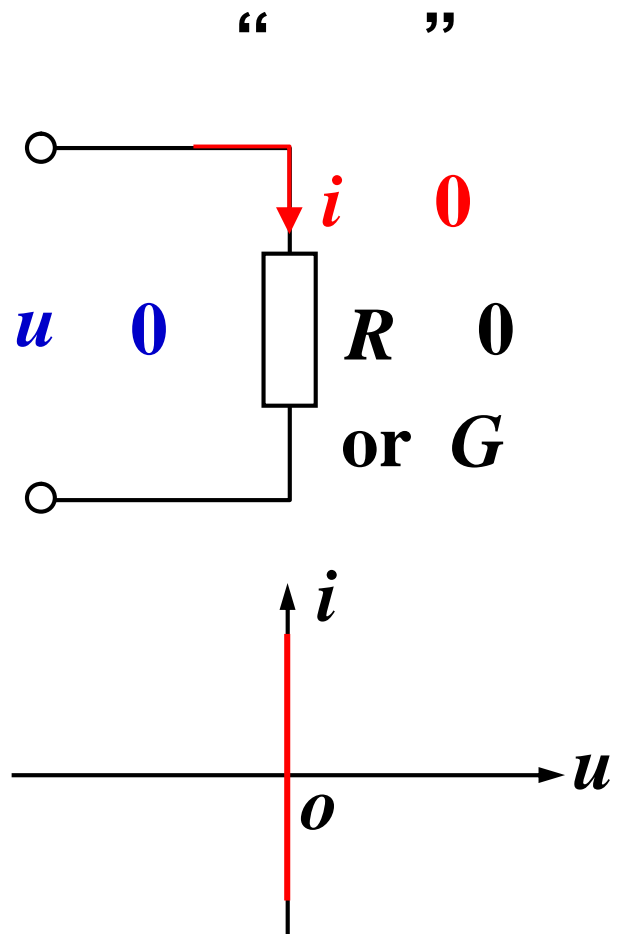
③

5. ( )

(1)



(2)



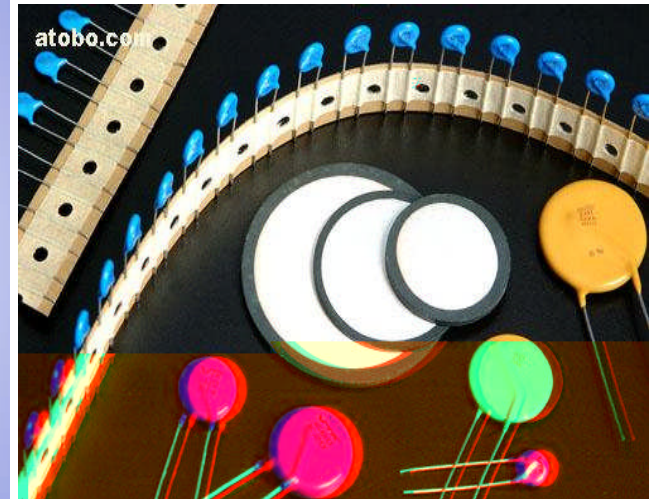
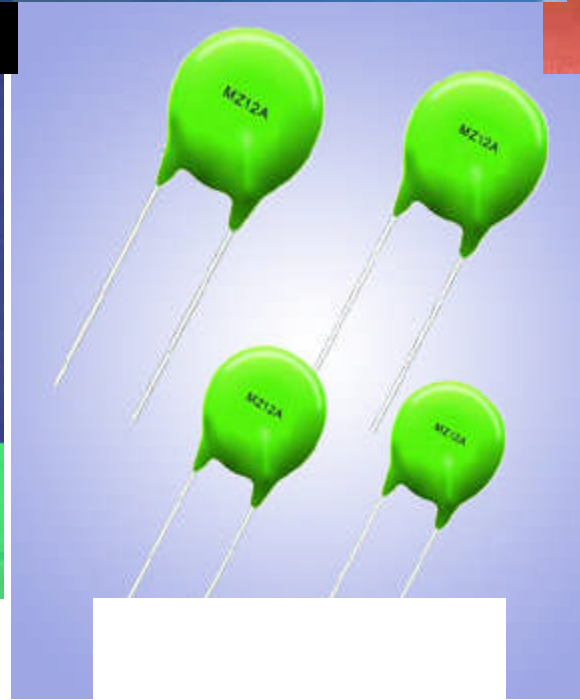
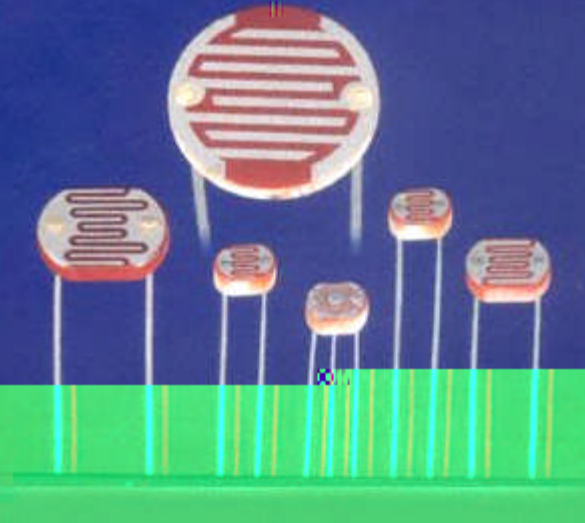
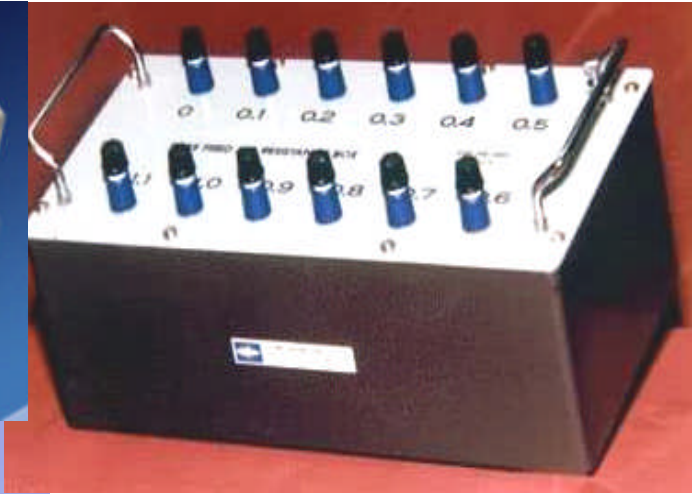
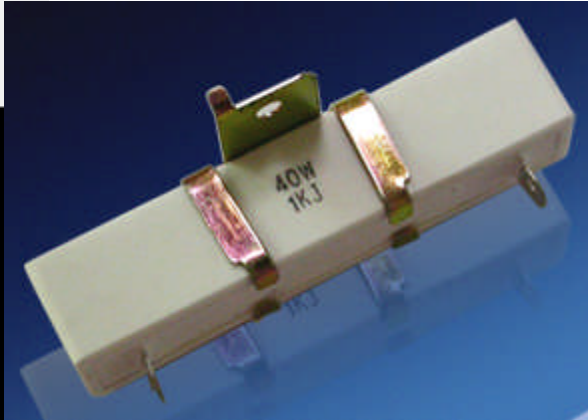
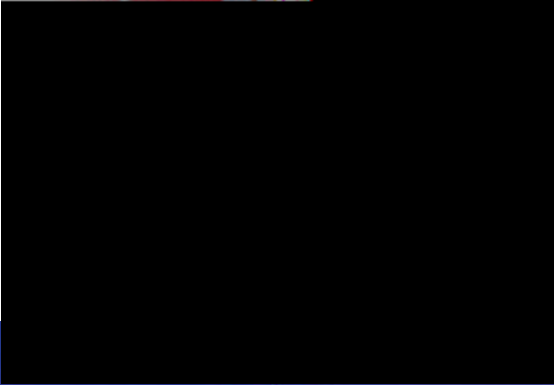


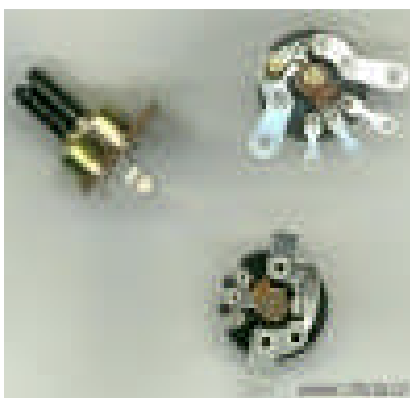
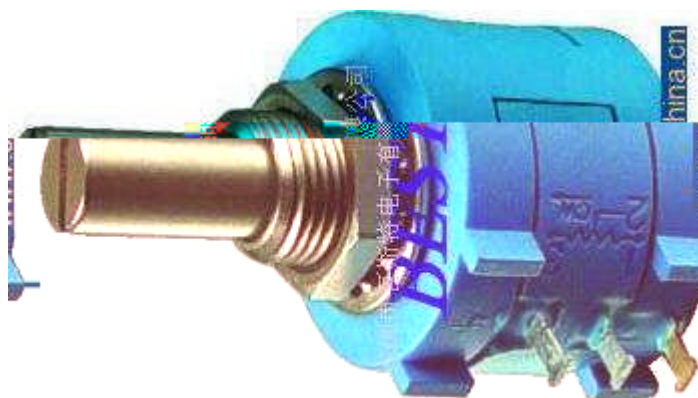
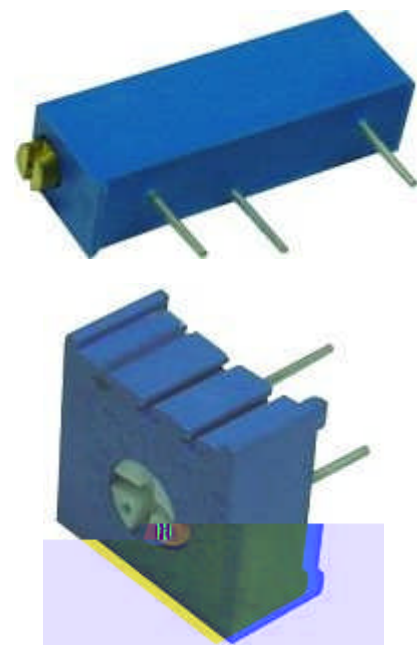
***R***   ***G***

*u*   *R i*   *i*   *G u*

***S***

*p*   *ui*   *i<sup>2</sup>R*    $\frac{u^2}{R}$

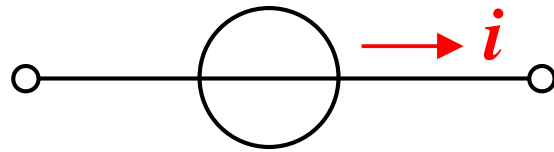




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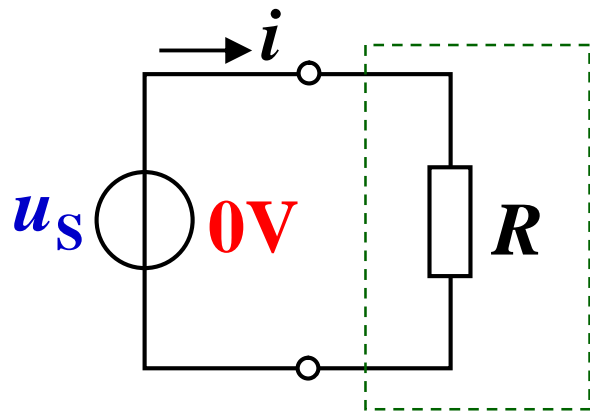
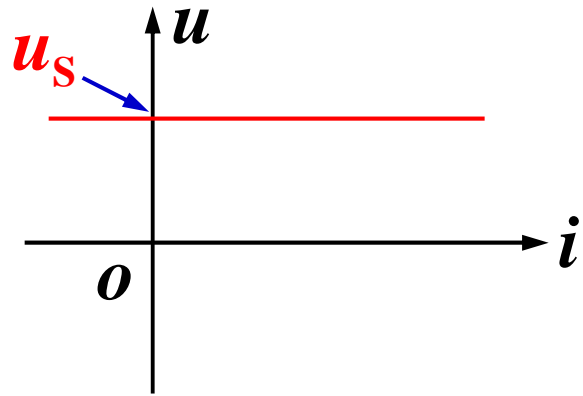
1.

*i*



•

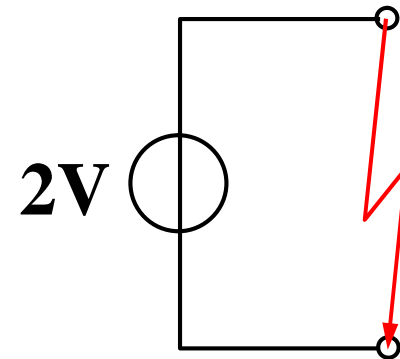




$$i = \frac{u_S}{R}$$

$$R = \left( \quad \right) i$$

$$R = \frac{u_S}{i}$$



0 ?

2V ?

$u_S$  0

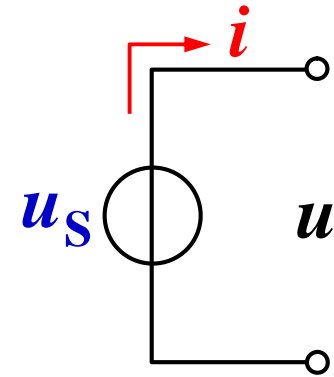
$u_S$  0

•

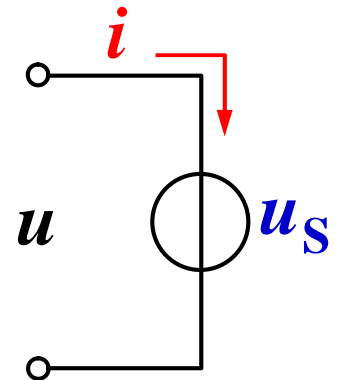
$$P = u_s i$$



( )



$$P = u_s i$$



$$P = u_s i$$

$$u_R \quad \text{V}$$

$$i = \frac{u_R}{R} = \frac{5}{5} \quad \text{A}$$

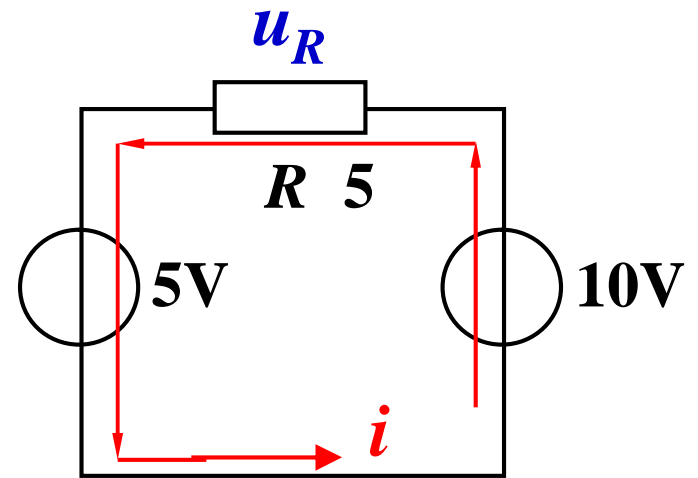
$$P_{10V} = u_s i \quad \text{W}$$

$$P_{5V} = u_s i \quad \text{W}$$

$$P_R = Ri^2 \quad \text{W}$$

$P$

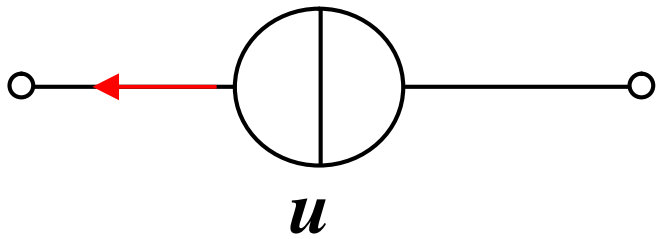
$P$



2.

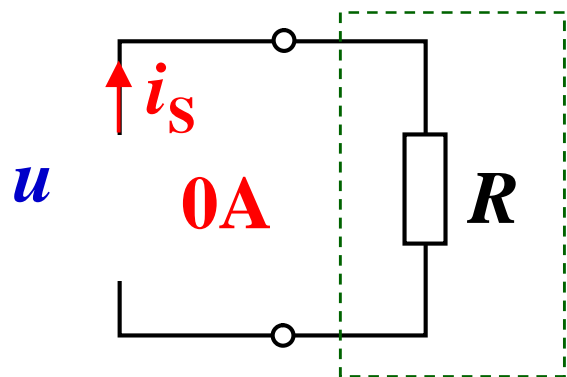
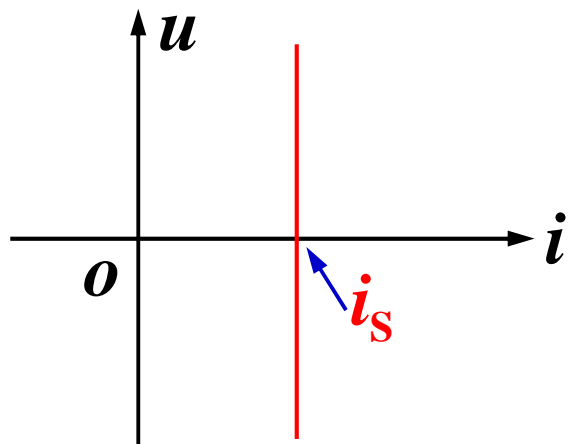
•

*u*



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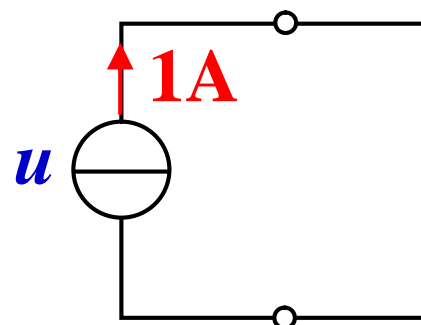
•



$$u \quad Ri_S$$

$$R \quad u \quad 0$$

$$R \quad u$$

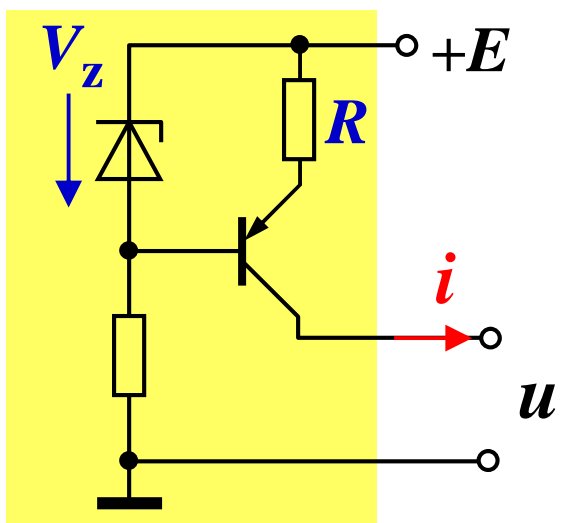


$$0 \quad ?$$

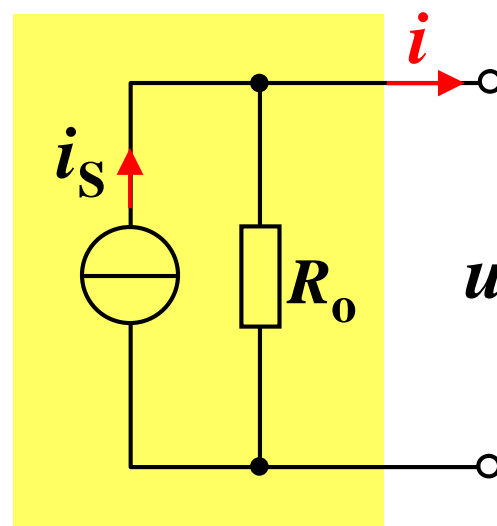
$$1A \quad ?$$

$$i_S \quad 0$$

$$i_S \quad 0$$



$$i \approx \frac{V_z}{R}$$

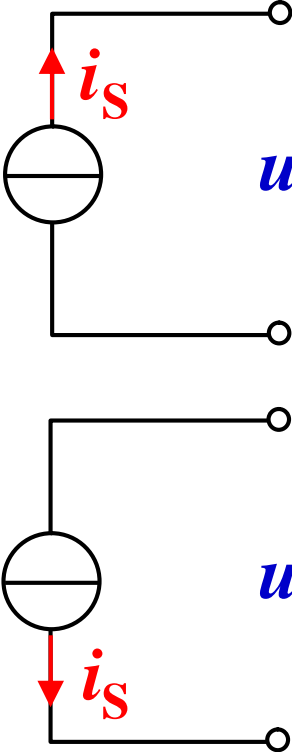


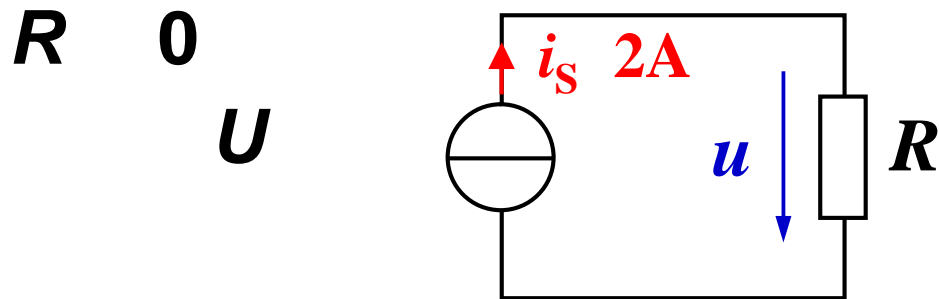
•

$$P = ui_s$$

$$P = ui_s$$

$$P = ui_s$$





(1)  $R \quad 0 \quad U$

$P \quad ui_s \quad i_s^2 R$



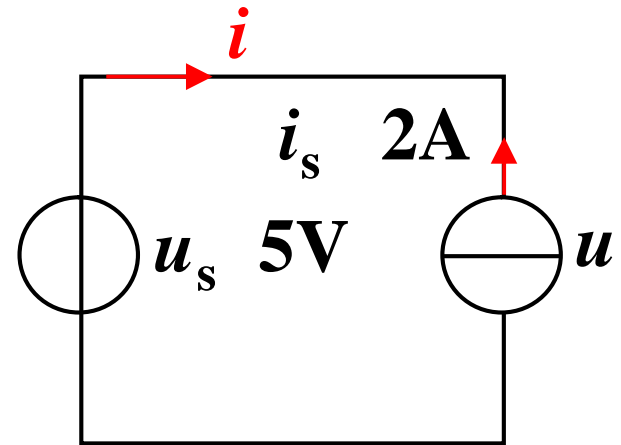
$R \quad u$

(2)  $R \quad 0 \quad u \quad 0 \quad P \quad ui_s \quad 0$

(3)  $R \quad u \quad P \quad ui_s$



$i$      $i_s$   
 $u$      $u_s$      $5V$



$P_{2A}$      $u i_s$      $W$

$P_{5V}$      $u_s i$      $W$

$5V$      $( 10 W$   
 $10W$

$P$      $P$

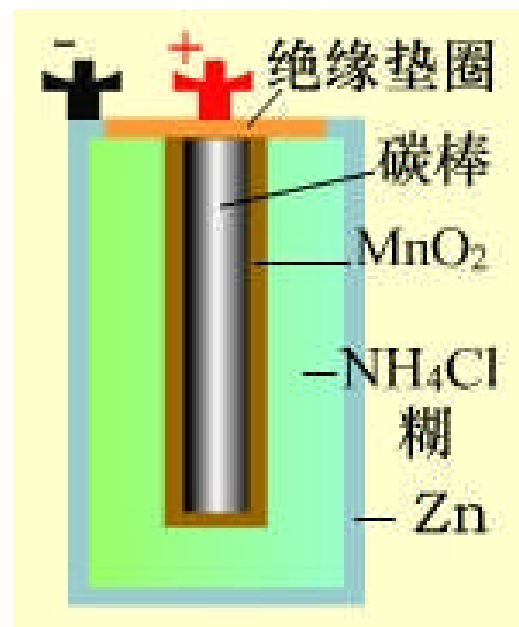
3.

(1) ( )



1.5V

( ) ( )

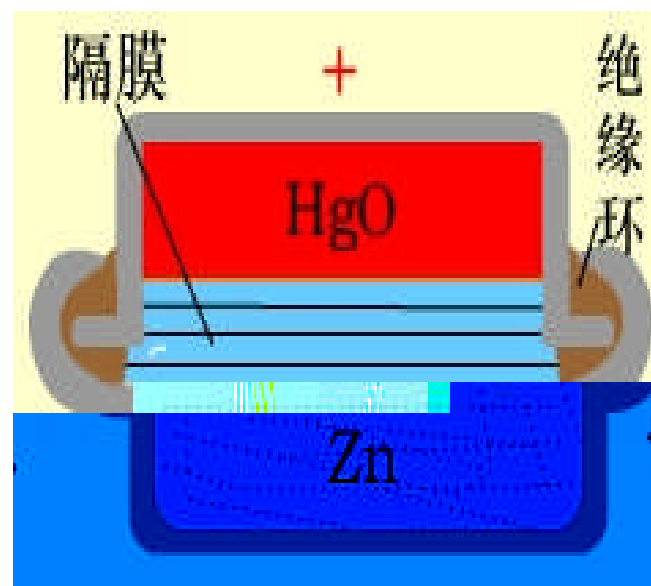


(2) ( )



1.35V

( )



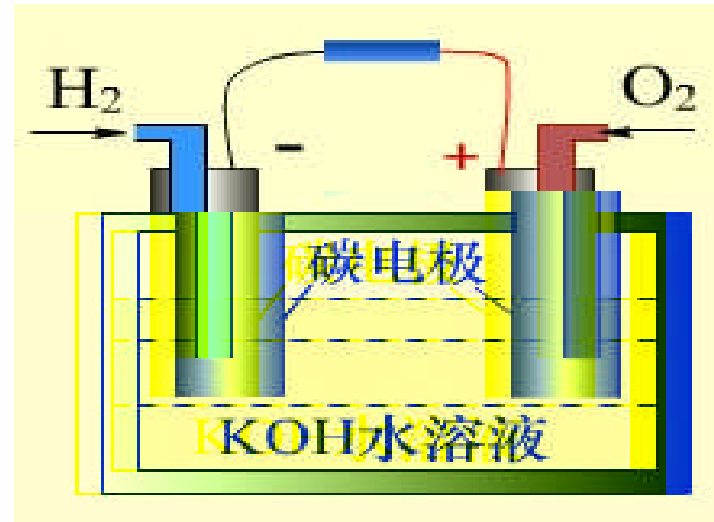
(3)

( )



1.23V

40 45%



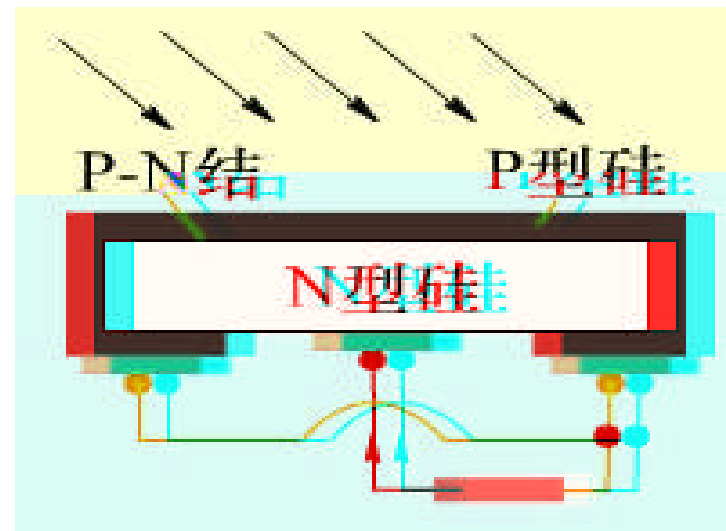
(4)

( )



P-N

N P  
11%



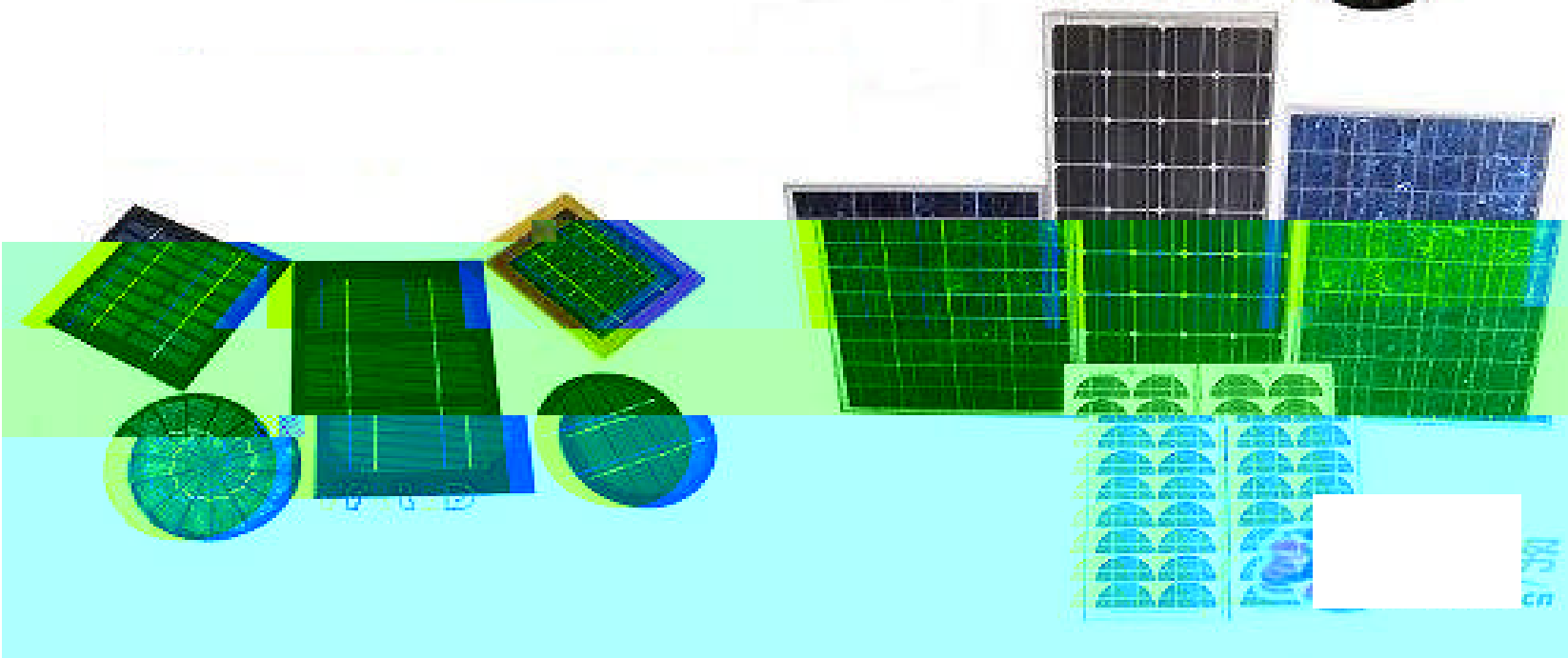
**$50\text{cm}^2$**

**$0.6\text{V}$**

**$0.1\text{A}$**



*F L D*



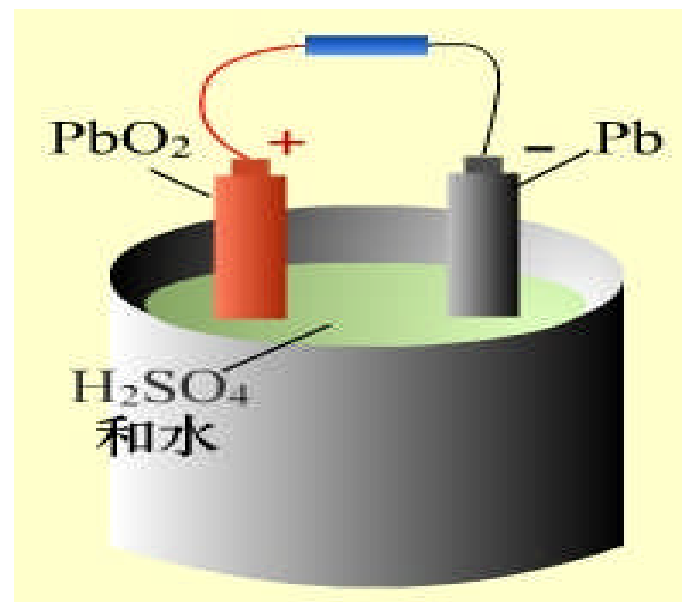
MP/5

(5) ( )

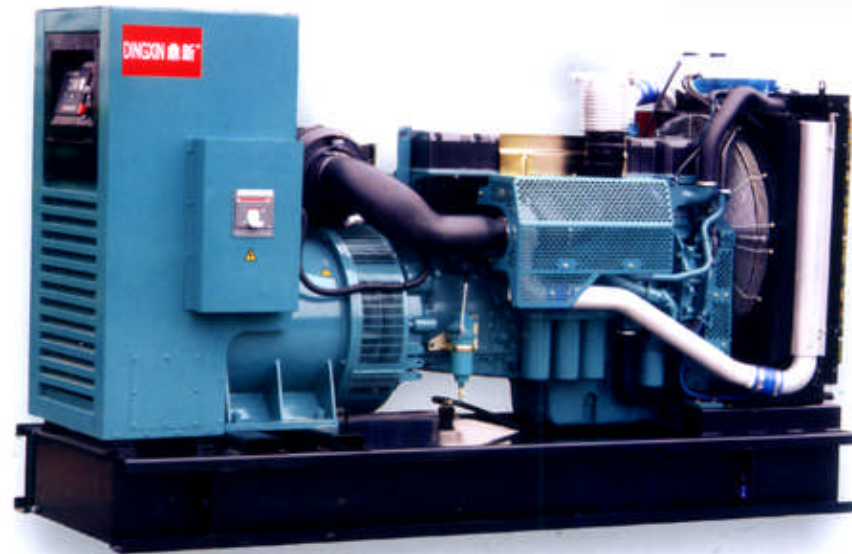
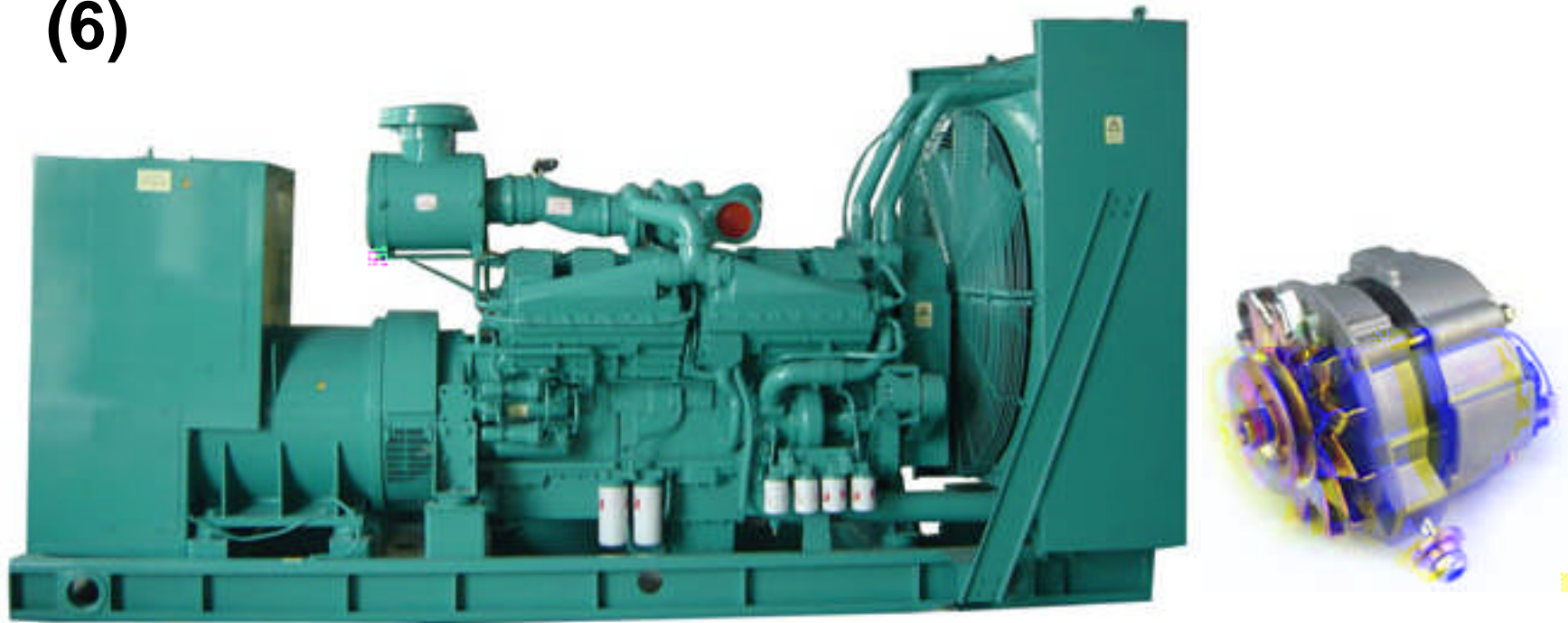


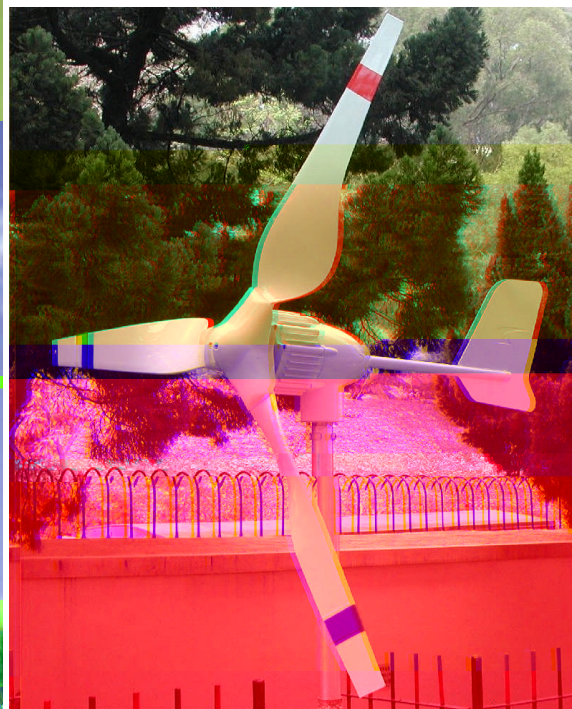
2V

2V



(6)





(7)





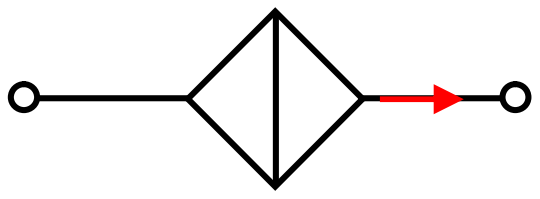
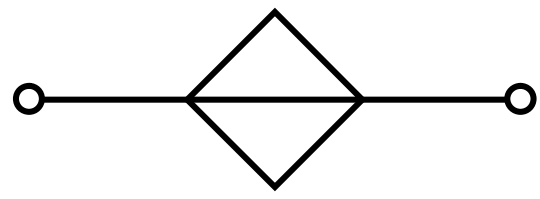
1 7 ( )

1.

)

(

•



2.



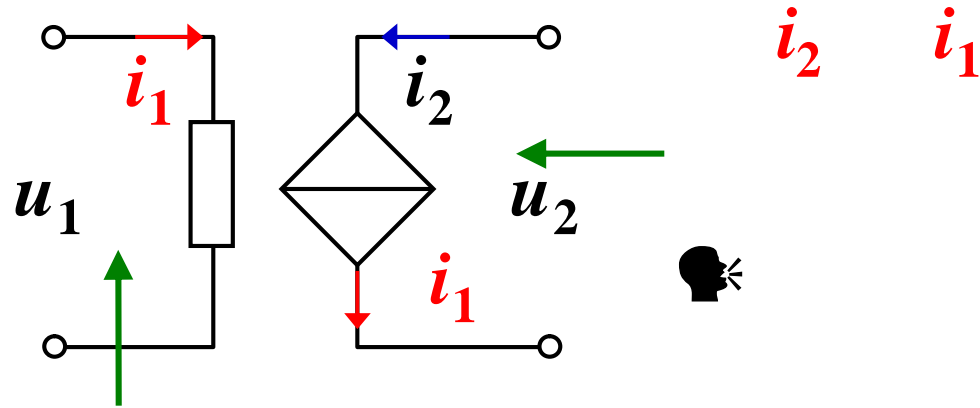
*u*

*i*



(1)

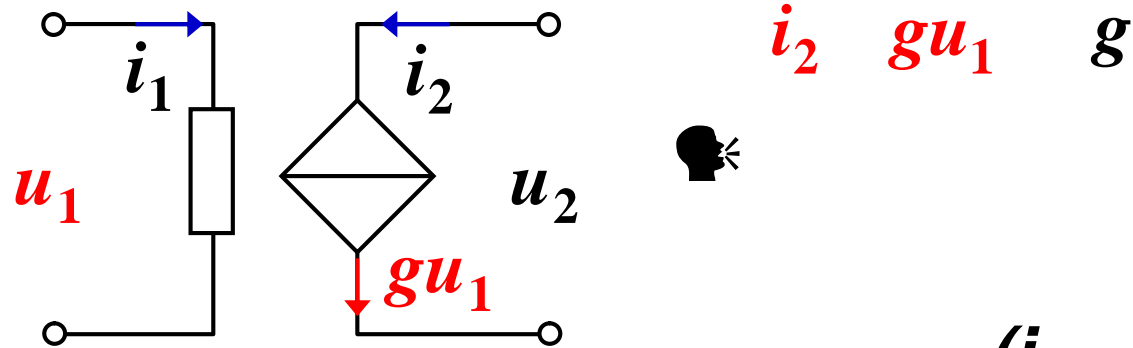
( CCCS )



$(i_c \quad i_b)$

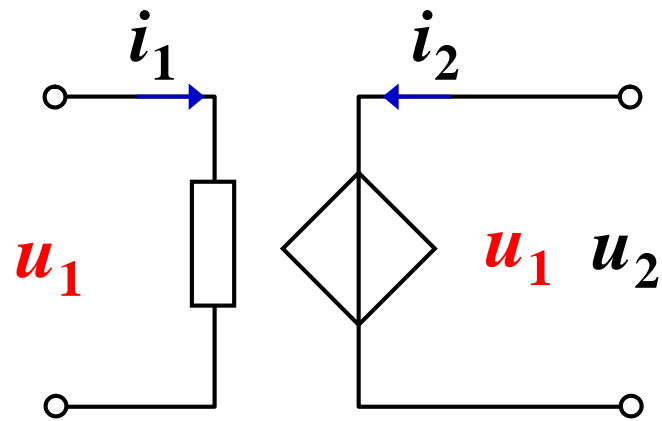
(2)

( VCCS )



$(i_d \quad gu_{gs})$

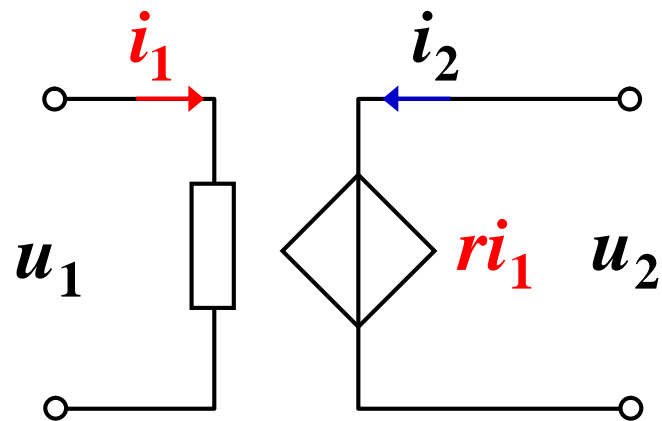
(3) (VCVS)



$u_2$   $u_1$

$(u_o \quad Au_d)$

(4) (CCVS)



$u_2$   $ri_1$

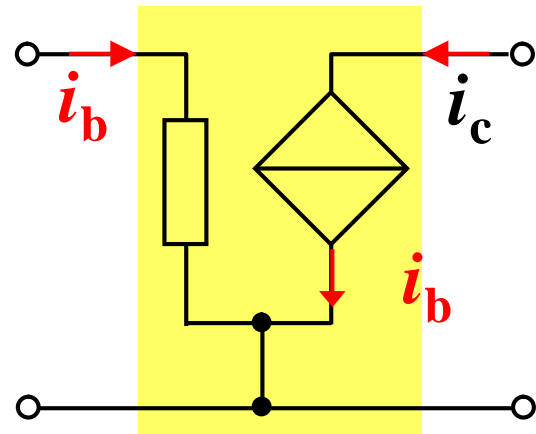
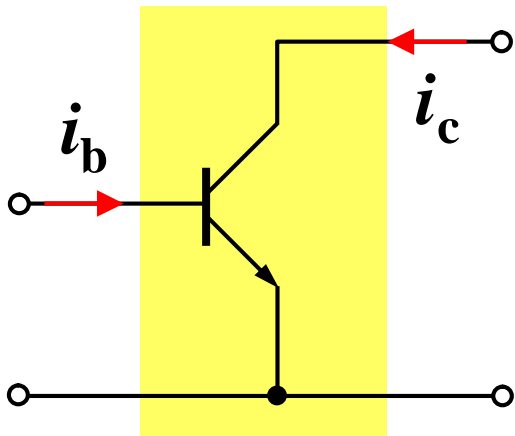
$r$

$(u_o \quad ri_f)$



*g r*

“ ”



**3.**

( )

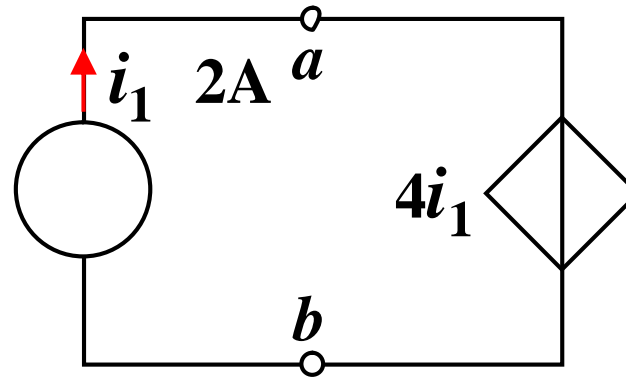
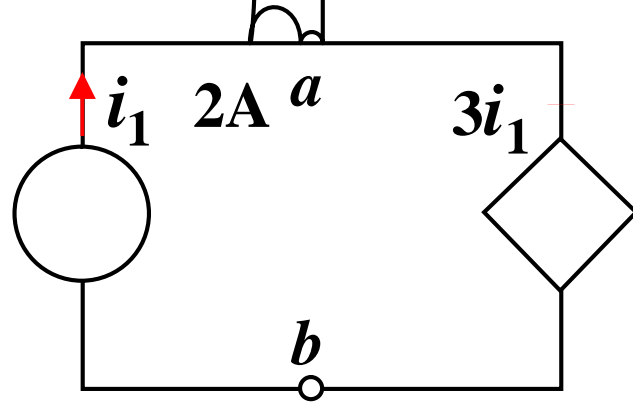
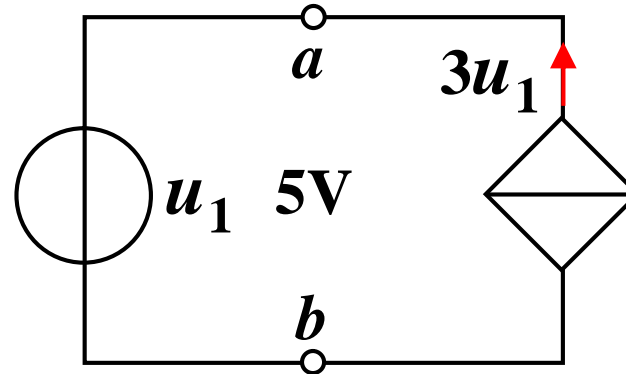
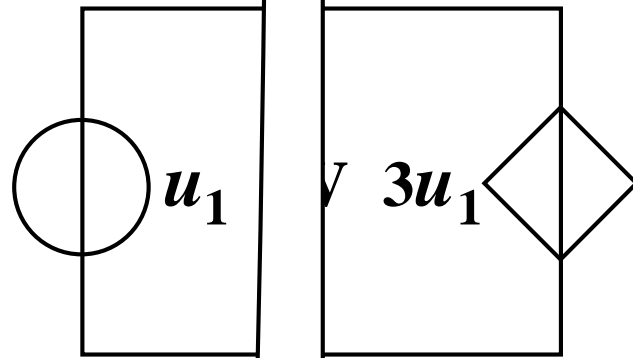
(

)

“ ”

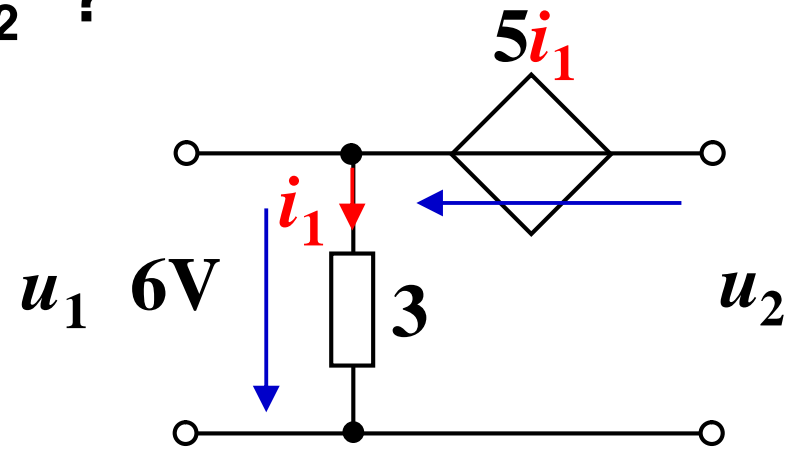
“ ”

( )



$$\begin{array}{rcl}
 i_1 & \frac{u_1}{3} & 2A \\
 u_2 & 5i_1 & u_1 \\
 & \times 2 & 6 \\
 & & V
 \end{array}$$

$u_2$  ?



1-9

(KL)



(KCL)

(KVL)



(VCR)

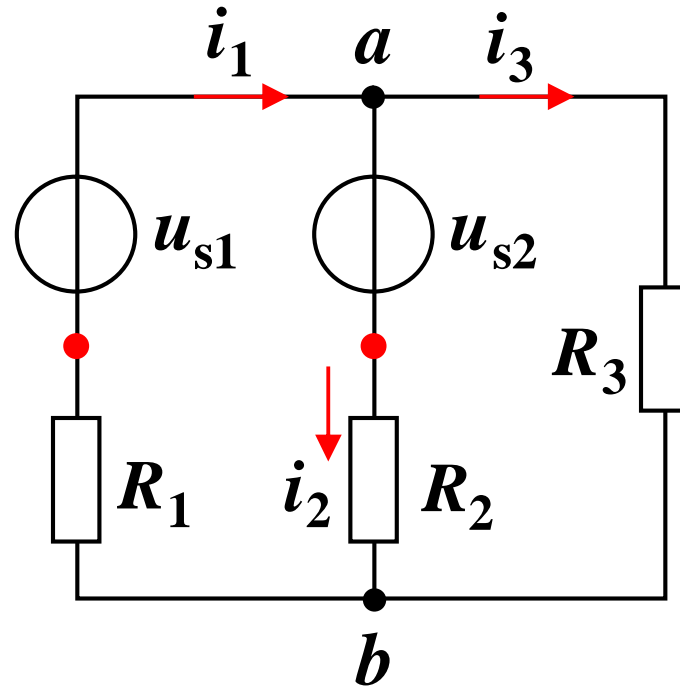
$u_R$   $Ri_R$

(KCL KVL)

KL VCR



1.  
(1)



$b$  5

$b$  3

(2)

$n$  4

$n$  2

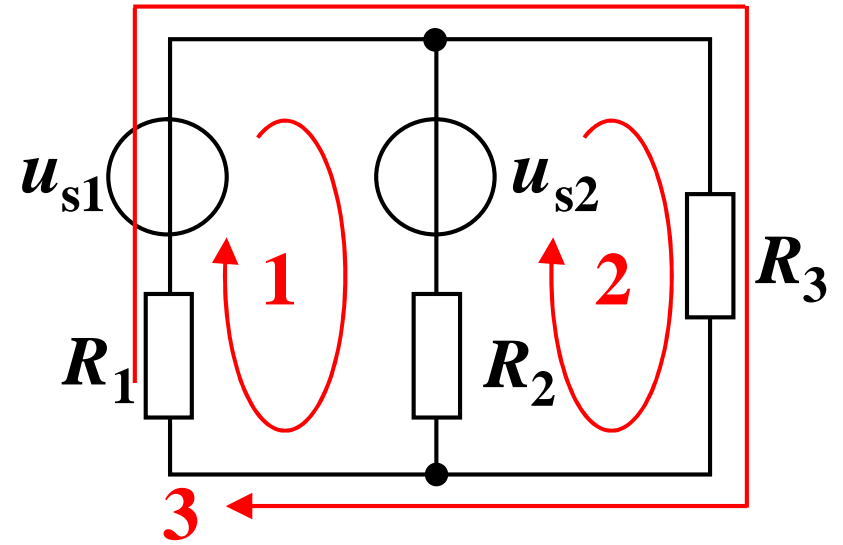


(3)

(4)

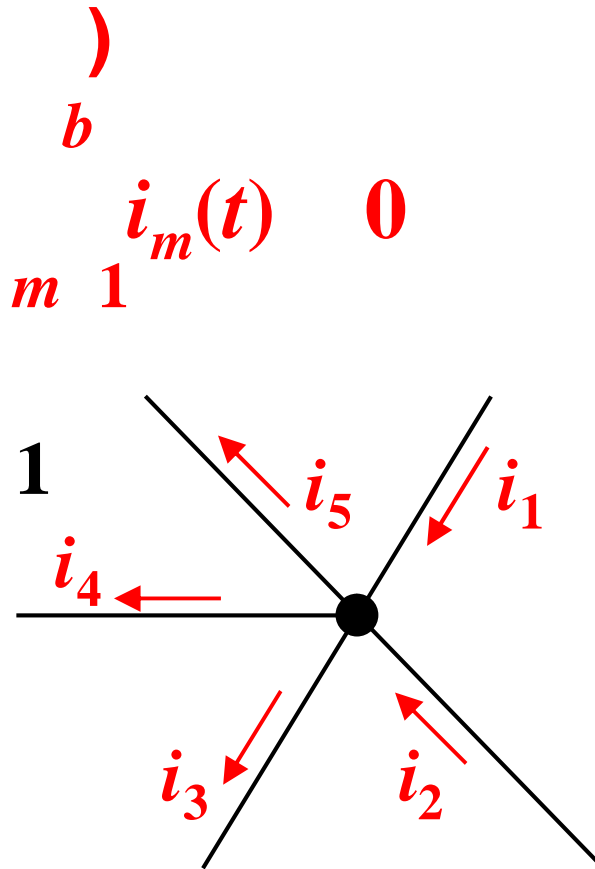
$l_3$

(5)



## 2. KCL ( )

💡 **KL 1845**



$$i_1 + i_2 + i_3 + i_4 + i_5 = 0$$

$$i_1 + i_2 + i_3 + i_4 + i_5$$

2

$$i_1 \quad i_2 \quad i_3 = 0$$

$$i_1 \quad \cancel{i_4} \quad \cancel{i_6} \quad 0$$

$$i_2 \quad \cancel{i_4} \quad \cancel{i_5} \quad 0$$

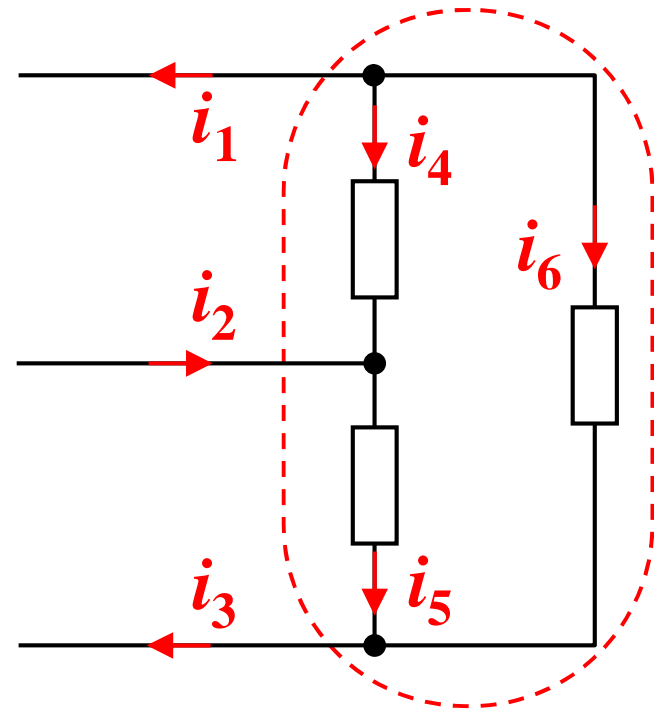
$$i_3 \quad \cancel{i_5} \quad \cancel{i_6} \quad 0$$

3

$$i_1 \quad i_2 \quad i_3 \quad 0$$



KCL





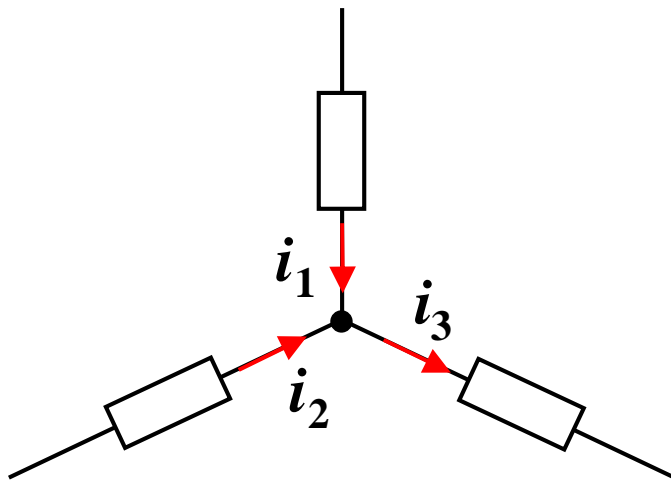
**KCL**

**KCL**

**KCL**



# KCL



$$\begin{array}{cccc} i_2 & 2A & i_3 & 3A \\ i_1 & & & \\ i_1 & i_2 & i_3 & 0 \\ i_1 & i_2 & i_3 & \end{array}$$

2)

3.



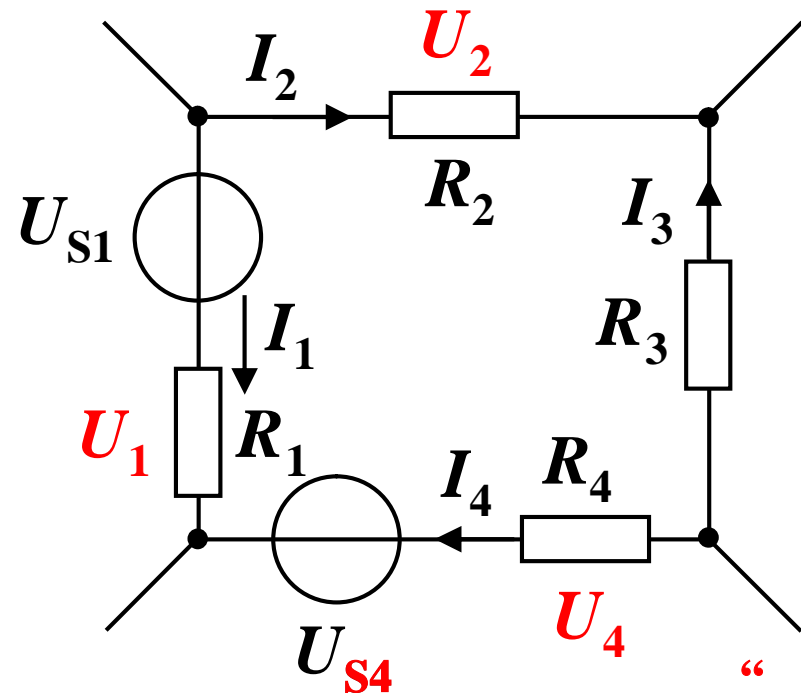
(KVL)

$$\sum_{m=1}^n u_m(t) = 0$$

$u$   $u$

(

)



“ 1

KVL

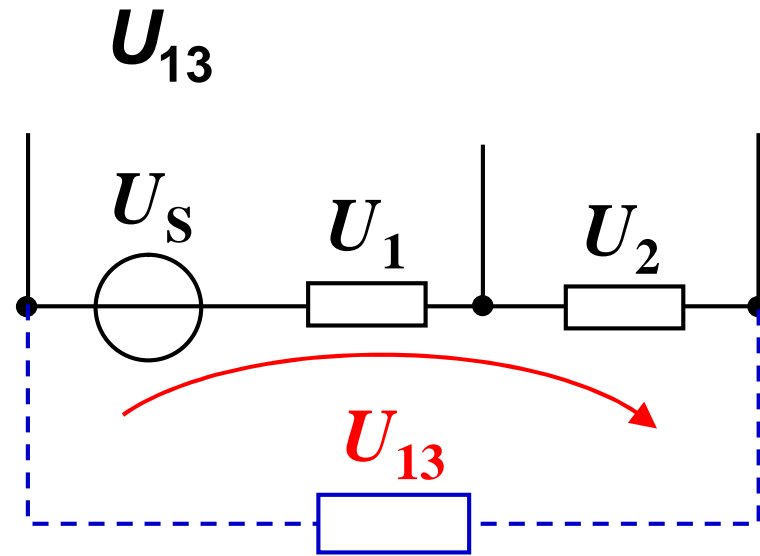
$U_{13}$   $U_S$   $U_1$   $U_2$



KVL

KVL

KVL





**4. KCL KVL**

**KCL**

**KVL**

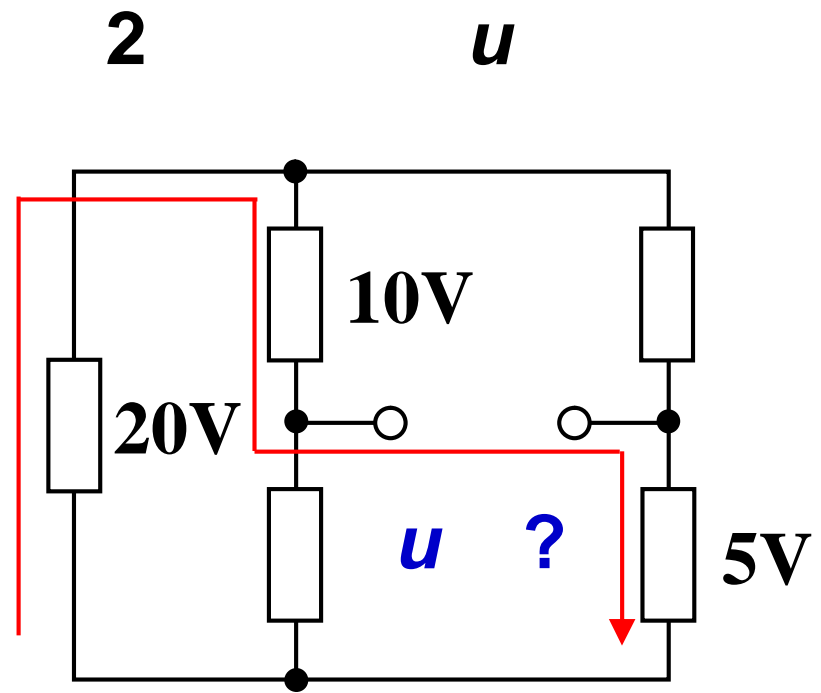
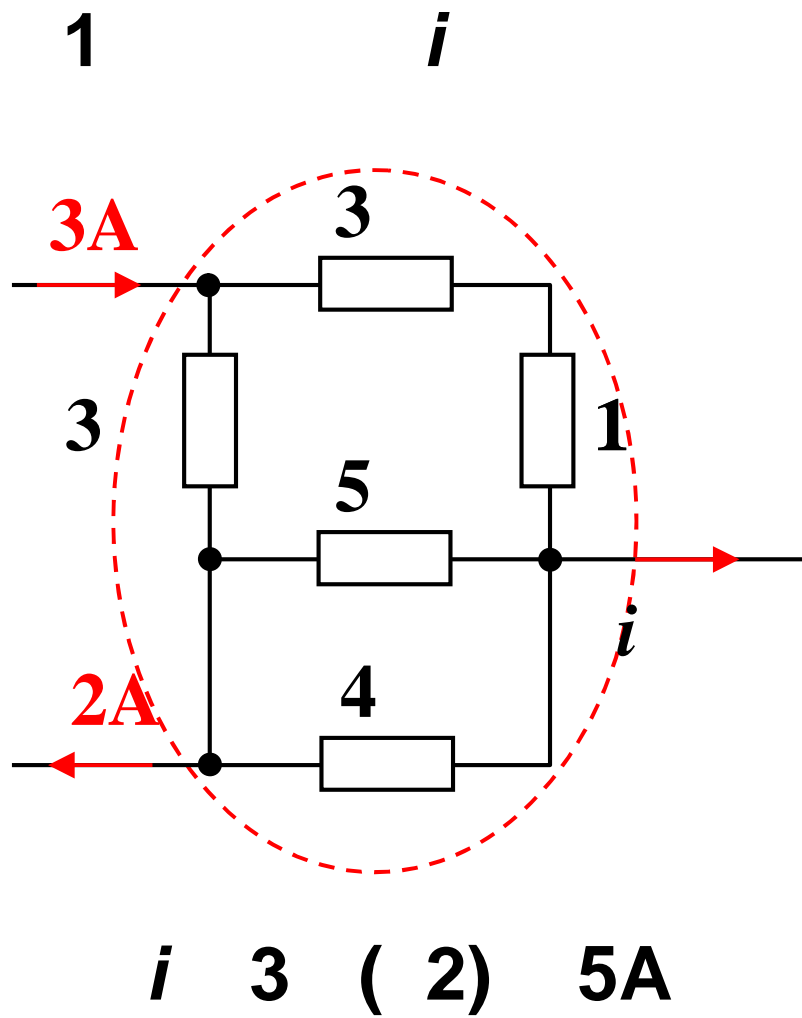
**KCL KVL**

**KCL**

**KVL**

**( )**

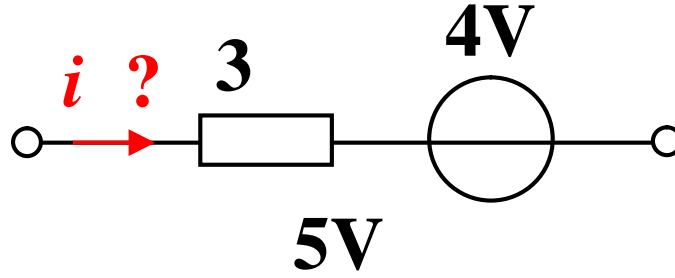
**KCL KVL**



$20$	$10$	$u$	$5$	$0$
$u$	$10$	$20$	$5$	
	$15V$			

3

$i$

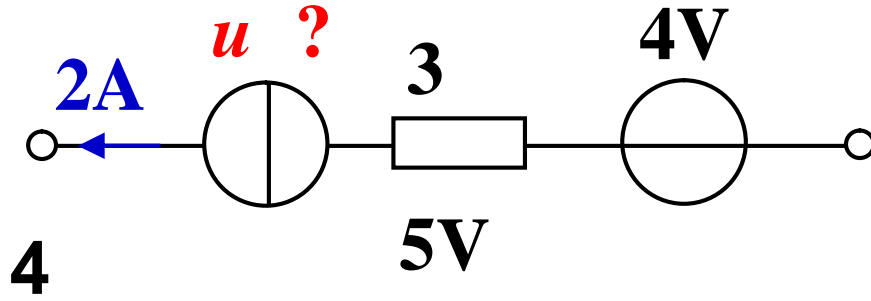


$3i$  4 5

$i$  3A

4

$u$

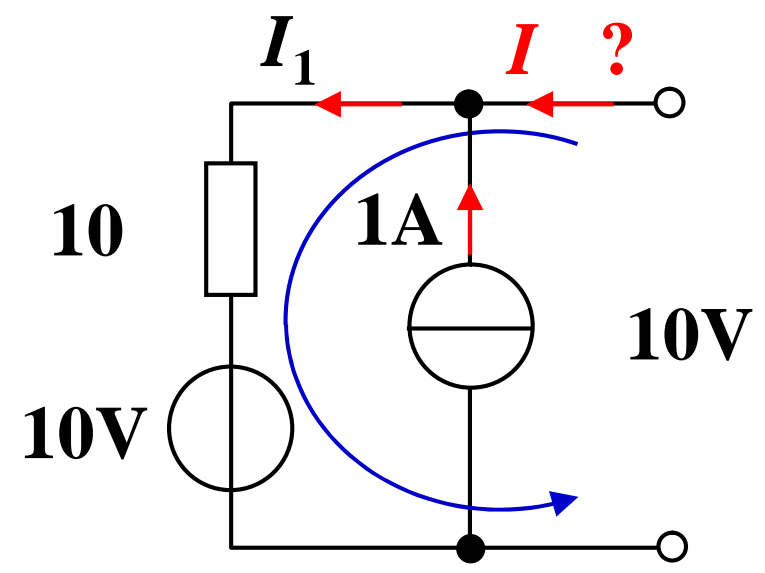


$u$  3 2 4

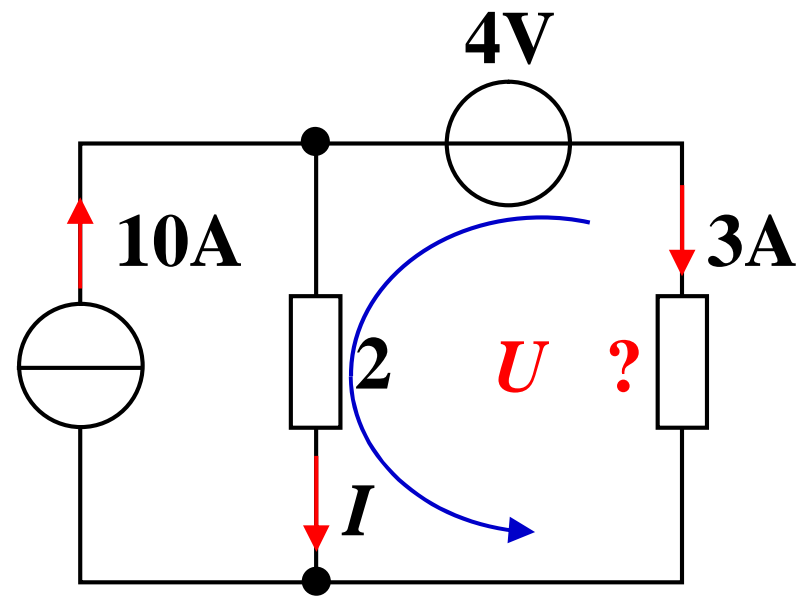
4



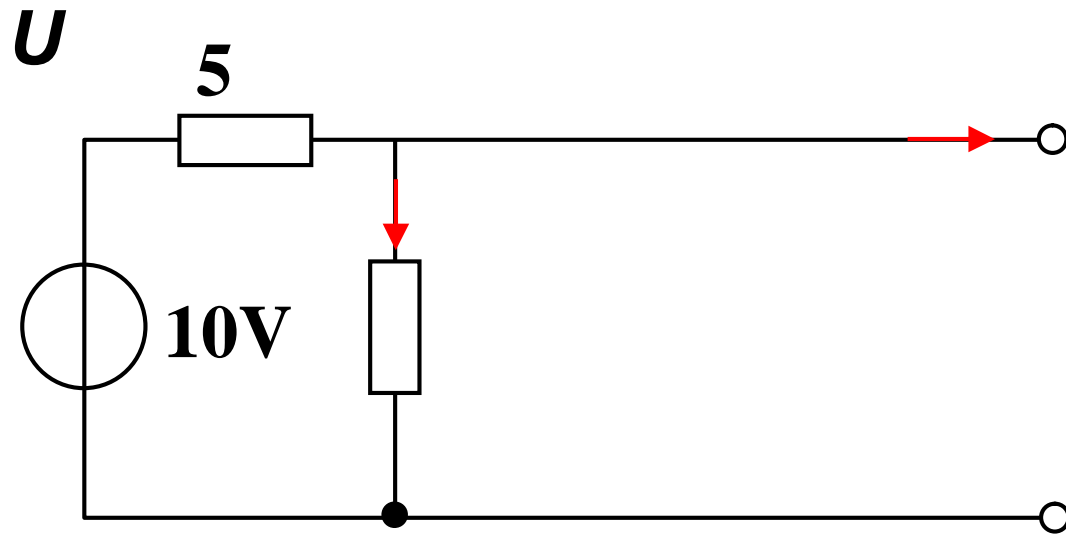
**5**  $I$   
 $10I_1$  10 10)  
 $I_1$  2A  
 $I$   $I_1$  1 2 1 3A



**6**  $U$   
 $I$  10 3 7A  
 $U$  4  $2I$  0  
 $U$   $2I$  4  
 14 4 10V



7



3T<sub>q</sub>

1/F12 27.96 Tf8 0 0 1 406 483 Tm166.268 0 Tc I T

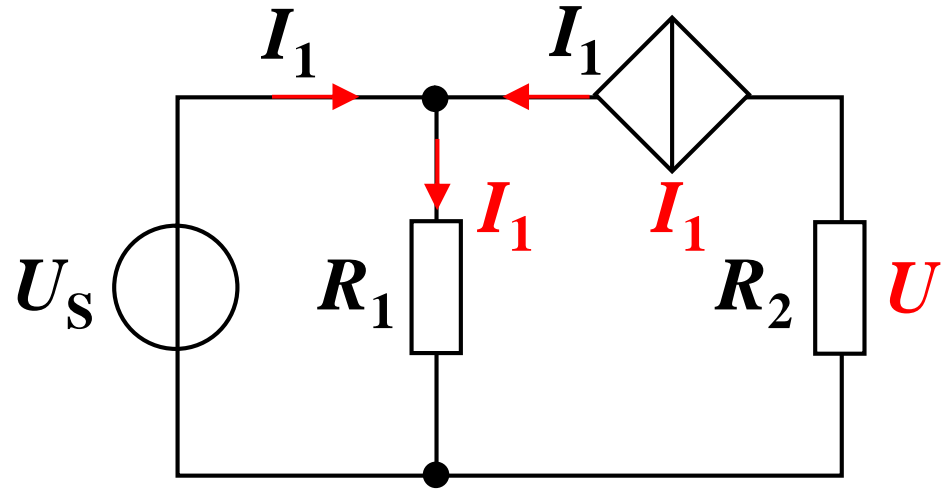
8

$U$

$$\begin{array}{l}
 U \\
 U_S \\
 I_1
 \end{array}
 \begin{array}{l}
 R_2 \\
 R_1(I_1 \\
 \frac{U_S}{R_1(1
 \end{array}
 \begin{array}{l}
 I_1 \\
 I_1) \\
 )
 \end{array}$$

$$U \quad R_2 \frac{U_S}{R_1(1$$

$$\left| \frac{U}{U_S} \right| = \frac{R_2}{R_1} \frac{1}{1$$



1.

2.

3.

*p ui*

4.

5.

(2 )

(4 )

6.

(VCR)

(KCL KVL)

