Physics – Grade 10

Unit One – Electricity

Chapter 5
Generator and Receiver

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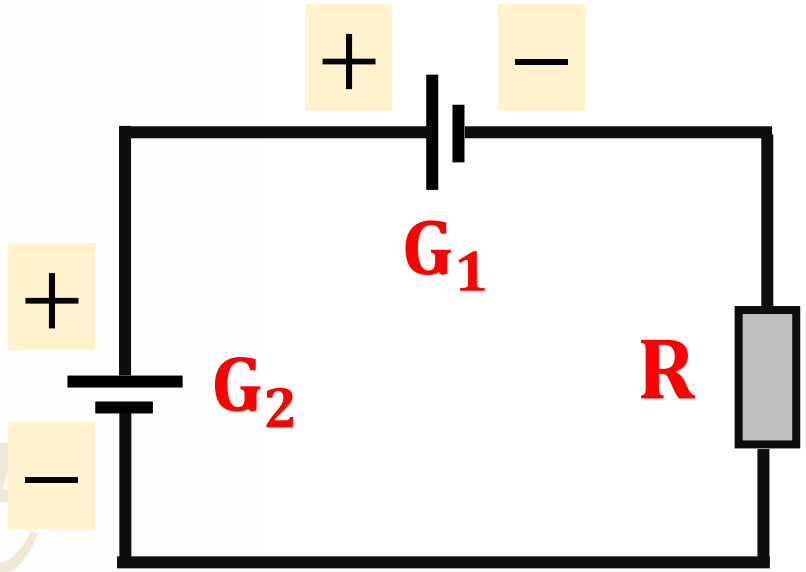
Think then Solve

Exercise 1:

Two generators $G_1(6V, 2\Omega)$, $G_2(18V, 1\Omega)$ are connected with a resistor of resistance $R = 20\Omega$ as shown in the adjacent figure.



1. Specify the role of G_1 and G_2.
2. Draw the direction of the current in this circuit.
3. The current sent by the generator is $I = 0.5\ A$.

a. Calculate the voltage across G_1.

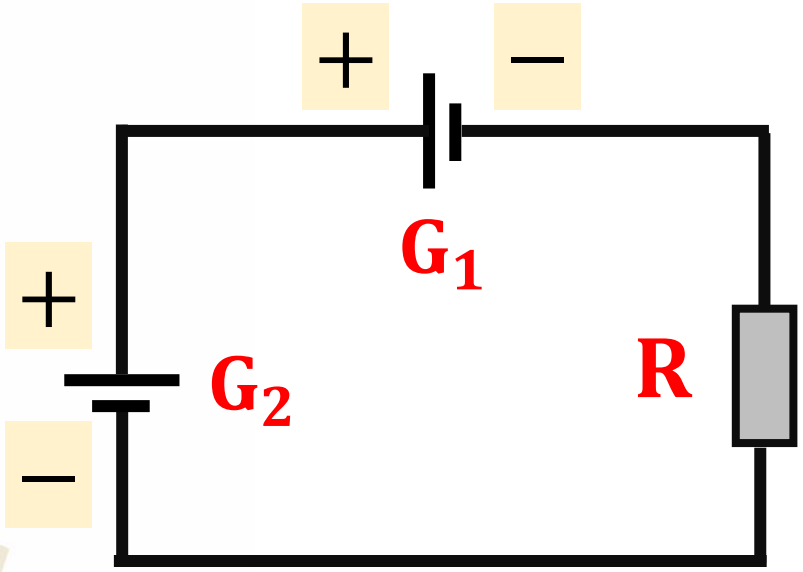
b. Calculate the voltage across G_2.

c. Calculate the voltage across R

Exercise 1:

$G_1(6V, 2\Omega)$; $G_2(18V, 1\Omega)$ and $R = 20\Omega$.

1.Specify the role of G_1 and G_2.



The positive pole of G_1 is connected to positive pole of G_2 then:

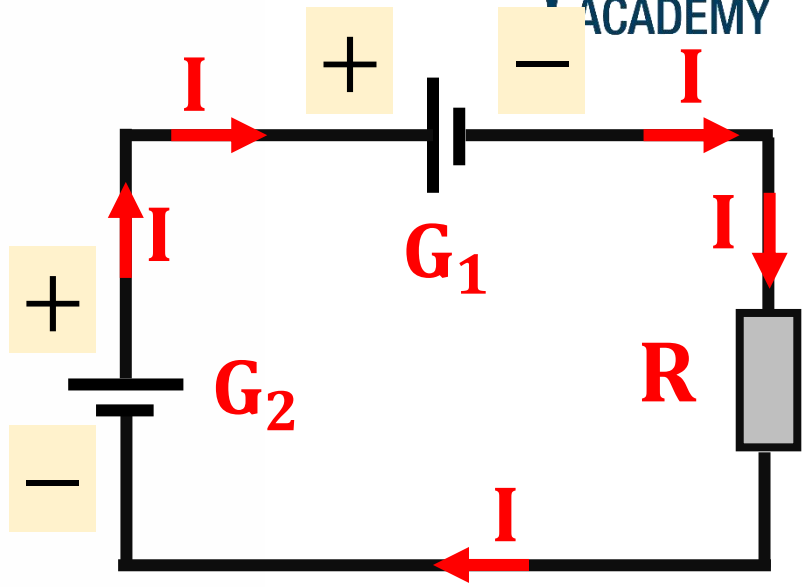
The two generators are connected in opposition then:

The one with higher electromotive force is the generator and the other is receiver:

G_2 is generator and G_1 is a receiver

Exercise 1:

$G_1(6V, 2\Omega)$; $G_2(18V, 1\Omega)$ and $R = 20\Omega$.



2. Draw the direction of the current in this circuit.

The current leaves from positive pole of the generator.

3. The current send by the generator is $I = 0.5\ A$

a. Calculate the voltage across G_1.

$$U = r'I + E'$$

$$U = (2 \times 0.5) + 6$$

$$U = (1) + 6$$

$$U = 7V$$

Exercise 1:

$G_1(6V, 2\Omega)$; $G_2(18V, 1\Omega)$ and $R = 20\Omega$.

b.Calculate the voltage across G_2.

$$V = -rI + E$$

$$V = (-2 \times 0.5) + 18$$

$$V = (-1) + 18$$

$$V = 17V$$

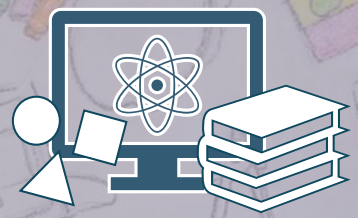
c. Calculate the voltage across the resistor R.

$$V = RI$$

$$V = 20 \times 0.5$$

$$V = 10V$$

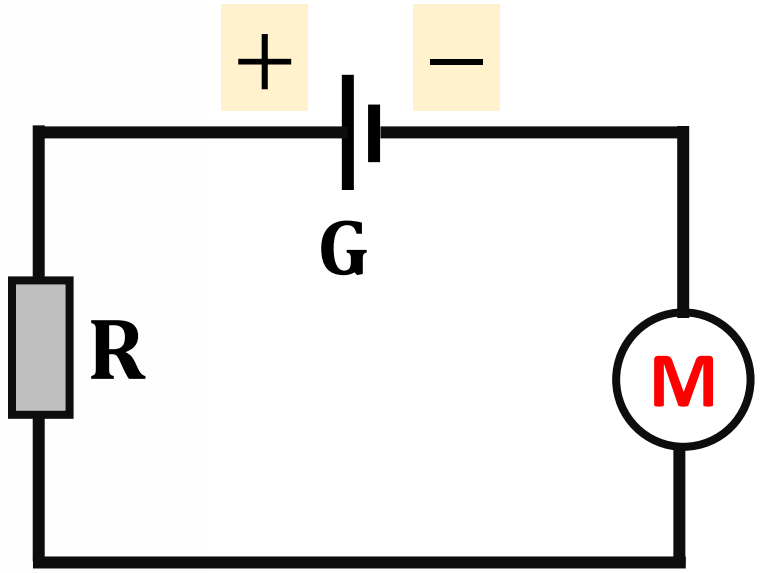
The End



Think then Solve

Exercise 2:

A generator of characteristics (E; r) is connected in series to an electric motor of ($E' = 6V$; $r' = 2\Omega$) and to a resistor of resistance $R = 8\Omega$ as shown in the adjacent figure.



1. **The motor functions normally and the power dissipated by the resistor is 2 W.**
   a. **Calculate the current I_1 flowing in the circuit.**
   b. **Determine the voltage across the generator.**
   c. **Deduce a relation between E, and r.**

Exercise 2:

2. The motor is blocked; the power dissipated in R becomes 8W.
   a. Calculate the current I_2 flowing in the circuit.
   b. Determine the voltage across the generator.
   c. Deduce a new relation between E and r.
3. Using the relations in parts 2.c and 3.c, determine the values of E and r.

Exercise 2:

$G(E; r); M(E' = 6V; r' = 2\Omega); R = 8\Omega$

1. The motor functions normally and the power dissipated in R is 2 W.

a. Calculate the current I_1 flowing in the circuit.

$$P = RI^2$$

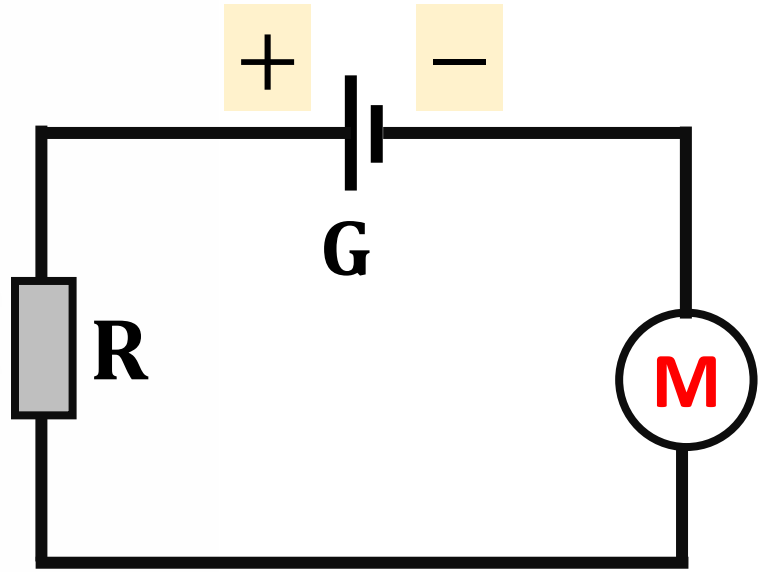
$$I^2 = \frac{P}{R}$$

$$I^2 = \frac{P}{R} = \frac{2}{8}$$

$$I^2 = 0.25$$

$$I = \sqrt{0.25}$$

$$I = 0.5A$$

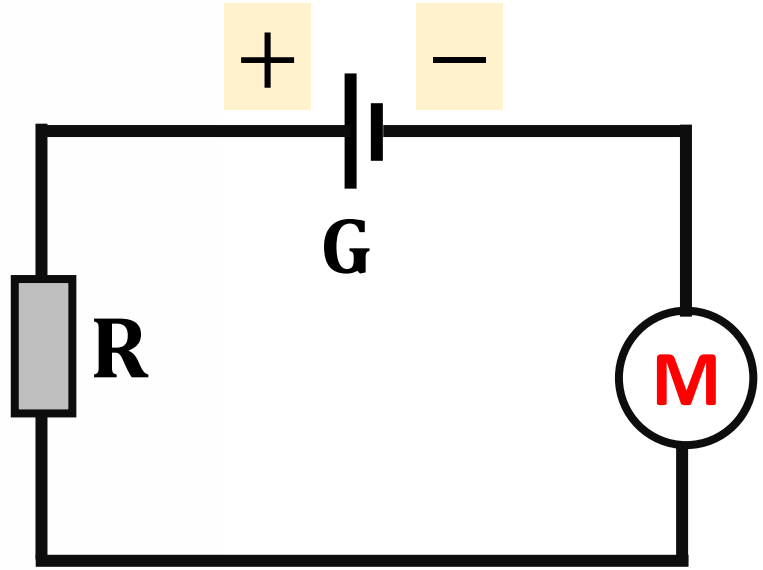


Exercise 2:

$G(E; r); M(E' = 6V; r' = 2\Omega); R = 8\Omega$

b. Determine the voltage across the generator.

Applying law of addition of voltage:



$$U_G = U_R + U_M$$

$$U_G = RI + r'I + E'$$

$$U_G = 8 \times 0.5 + 2 \times 0.5 + 6$$

$$U_G = 11V$$

Exercise 2:

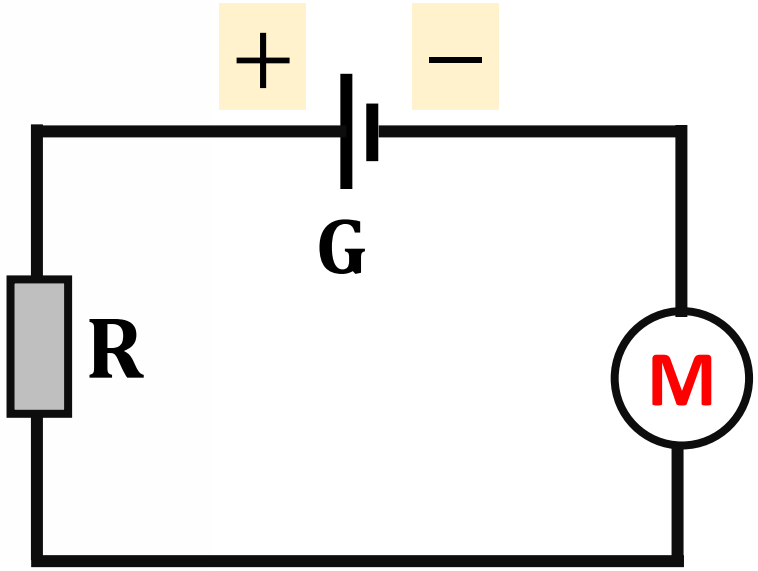
$\mathbf{G(E; r); M(E' = 6V; r' = 2\Omega); R = 8\Omega}$

c. Deduce a relation between E, and r.

Using ohm's law of generator:

$$U_G = -rI + E$$

$$11 = -0.5r + E \ldots\ldots (1)$$



Exercise 2:

$\mathbf{G(E; r); M(E' = 0V; r' = 2\Omega); R = 8\Omega}$

2. The motor is blocked; the power dissipated by R becomes 8W.

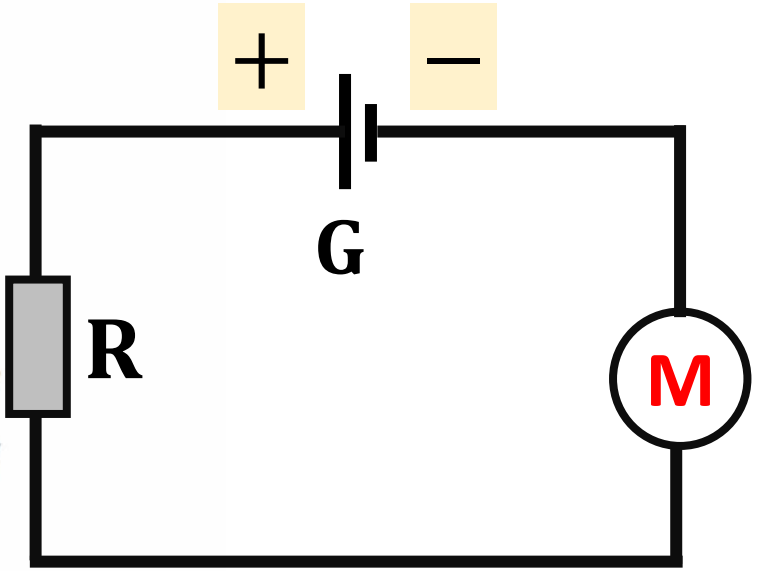
a.Calculate the current I_2 flowing in the circuit.

$$P = RI^2$$

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

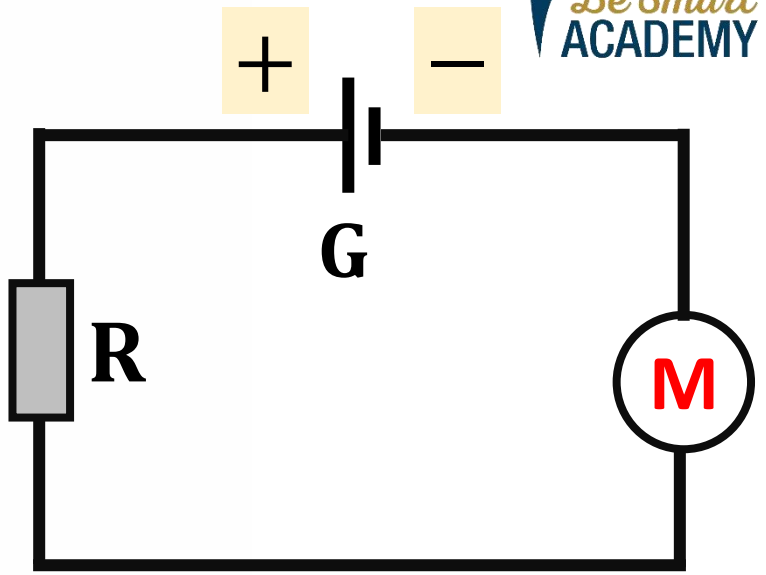
$$I^2 = \frac{8}{8} = 1$$

$$I = 1A$$



Exercise 2:

$G(E; r); M(E' = 0; r' = 2\Omega); R = 8\Omega$



b. Determine the voltage the generator.

Applying law of addition of voltage:

$$U_G = U_R + U_M$$

$$U_G = RI + r'I + E'$$

$$U_G = 8 \times 1 + 2 \times 1 + 0$$

$$U_G = 10V$$

Exercise 2:

c. Deduce a new relation between E and r.

$U_G = rI + E$ ⇒ $10 = -r + E$ ..... (2)

4. Using the relations in parts 2.c and 3.c, determine the values of E and r.

$$\begin{cases} 11 = -0.5r + E \quad \ldots\ldots (1) \\ 10 = -r + E \quad \ldots\ldots (2) \end{cases}$$

Solving the system, we get:

$$\begin{cases} 11 = -0.5r + E \quad \ldots\ldots \\ 10 = -r + E \quad \ldots\ldots \times(-1) \end{cases}$$

Exercise 2:

$$\begin{cases} 11 = -0.5r + E \\ -10 = +r - E \end{cases}$$

Add the two equations:

$$11 - 10 = -0.5r + E + r - E$$

$$1 = +0.5r$$

$$r = \frac{1}{0.5}$$

$$r = 2\Omega$$

Substitute $r = 2\Omega$ in any equation:

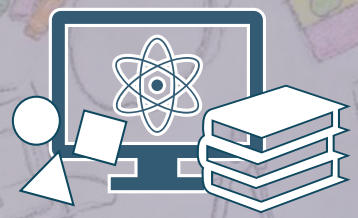
$$11 = -0.5r + E$$

$$11 = -0.5(2) + E$$

$$11 = -1 + E$$

$$E = 12V$$

The End

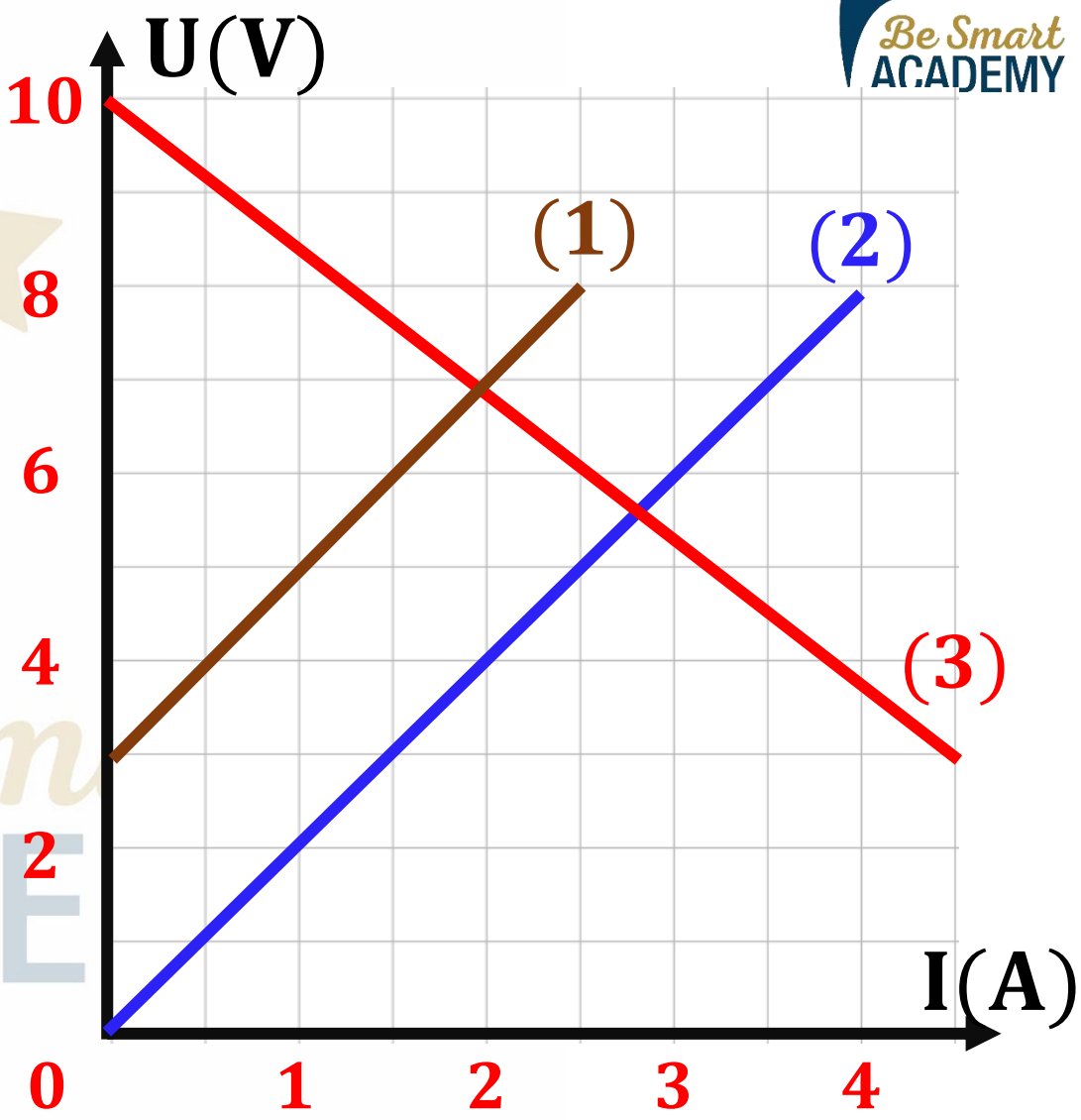


Think then Solve

Exercise 3:

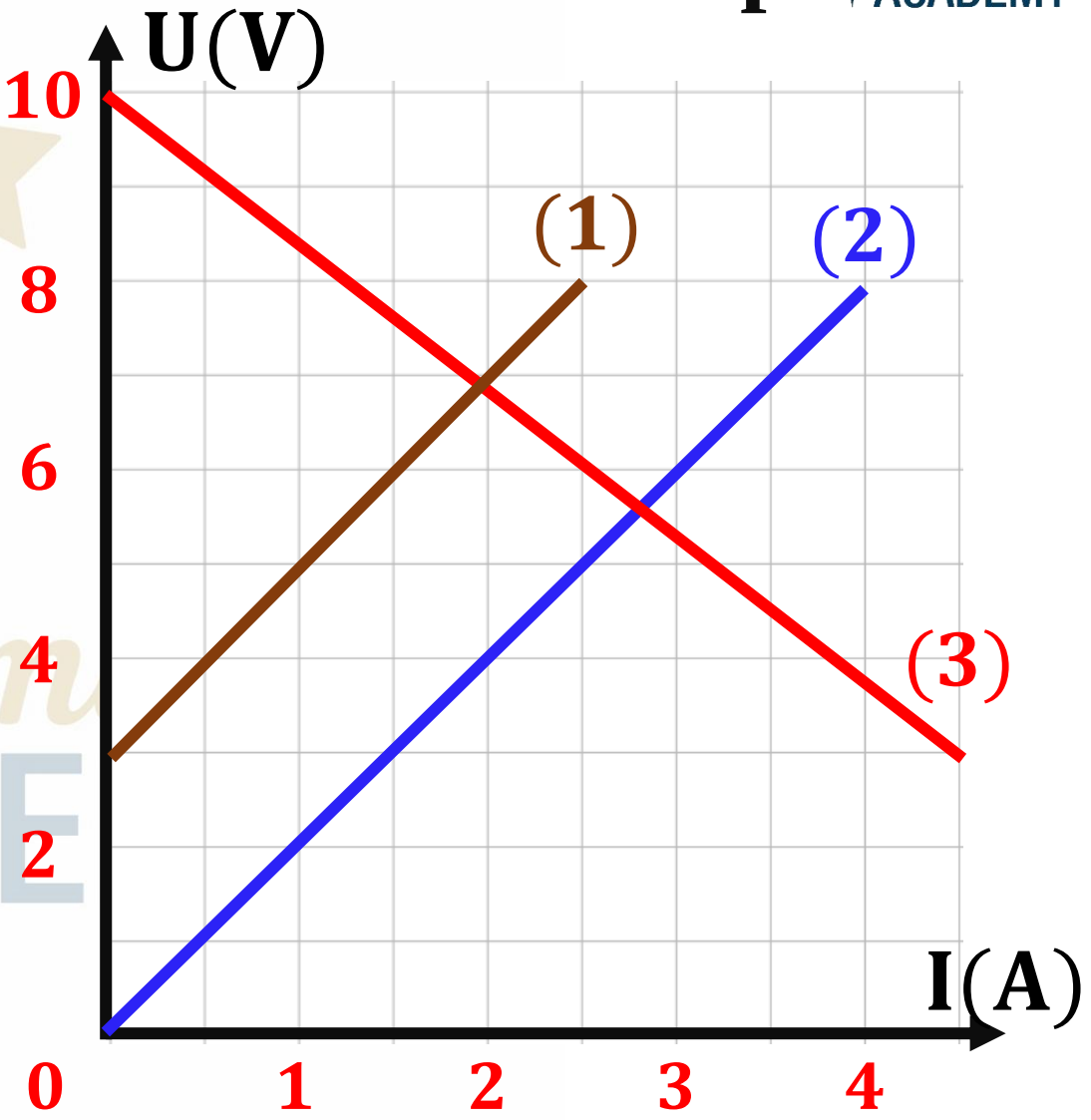
The adjacent graph represents the curves of three electric dipoles: a motor M (E′; r′), a generator G (E, r) and a resistor R.

1. **Referring to the figure, associate to each dipole its corresponding graph.**
2. **Using the figure, determine the characteristic constants of each dipole.**



Exercise 3:

1. Referring to graph, associate to each dipole its corresponding graph.

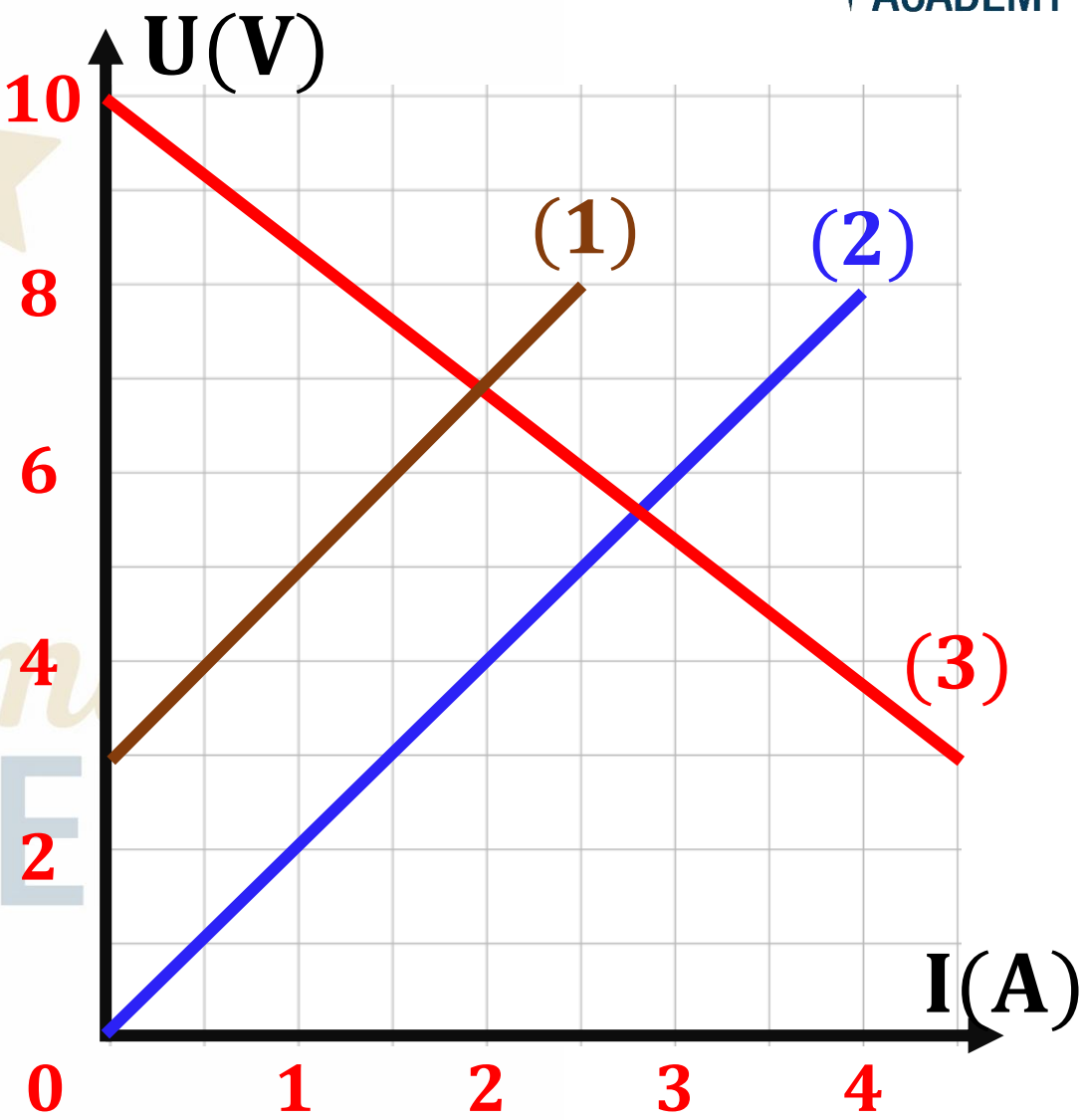


Curve (1): refers to the motor M; because its curve is a straight line of positive slope and NOT passing through origin.

Curve (2): refers to the Resistor; because its curve is a straight line passing through origin.

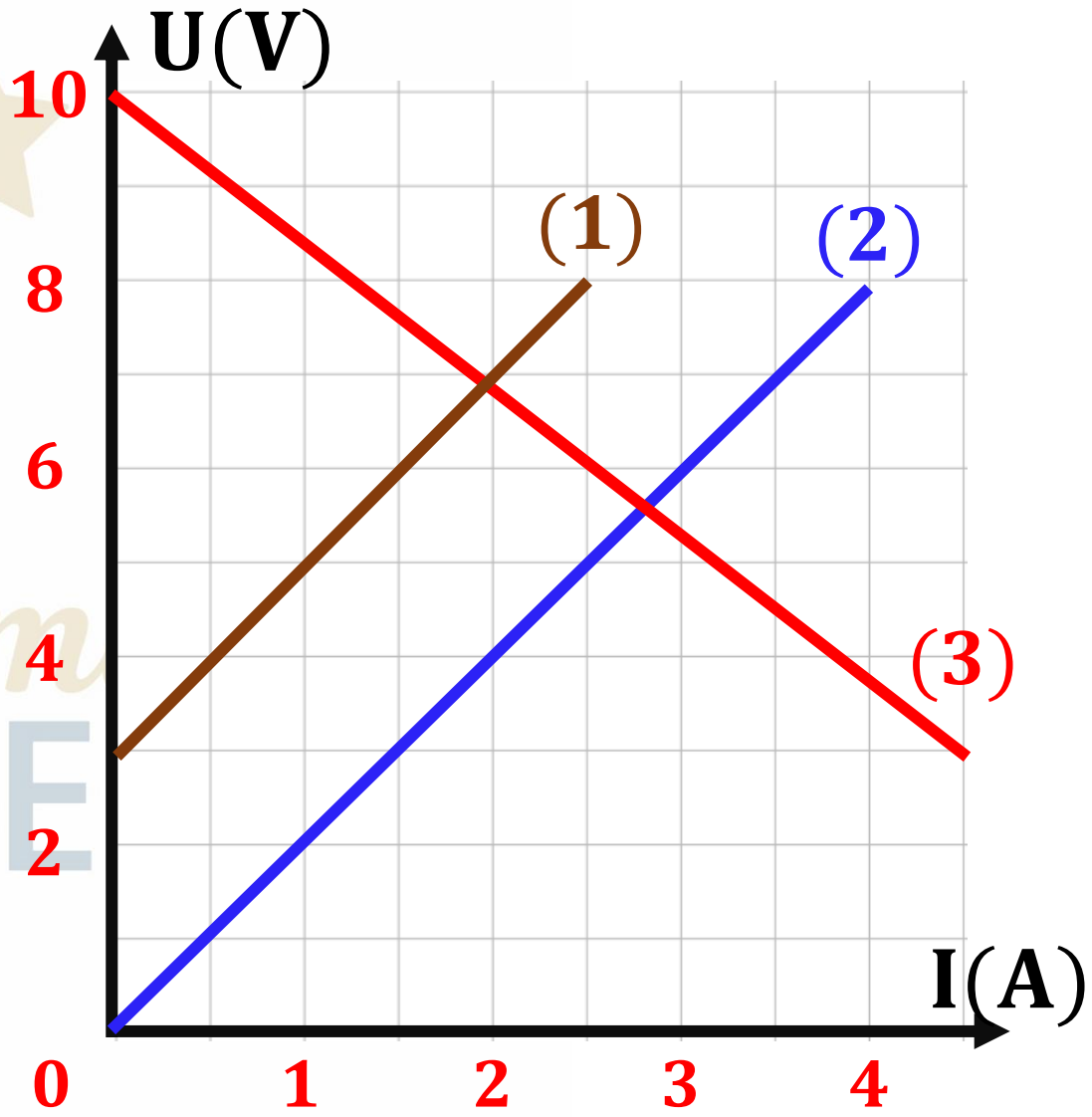
Exercise 3:

Curve (3): refers to the generator G; because its curve is a straight line of negative slope and NOT passing through origin.



Exercise 3:

2.Using the graph, determine the characteristic constants of each dipole.



Curve (1) is for receiver:

Its equation is $U_M = a.I + b$

Where a is slope ($a = r'$ and b $= E'$ is y-intercept

$$r' = a = \frac{U_2 - U_1}{I_2 - I_1} = \frac{8 - 4}{2.5 - 0.5}$$

$$r' = 2\Omega$$

Exercise 3:

b: is y-intercept

$$b = E' = 3V$$

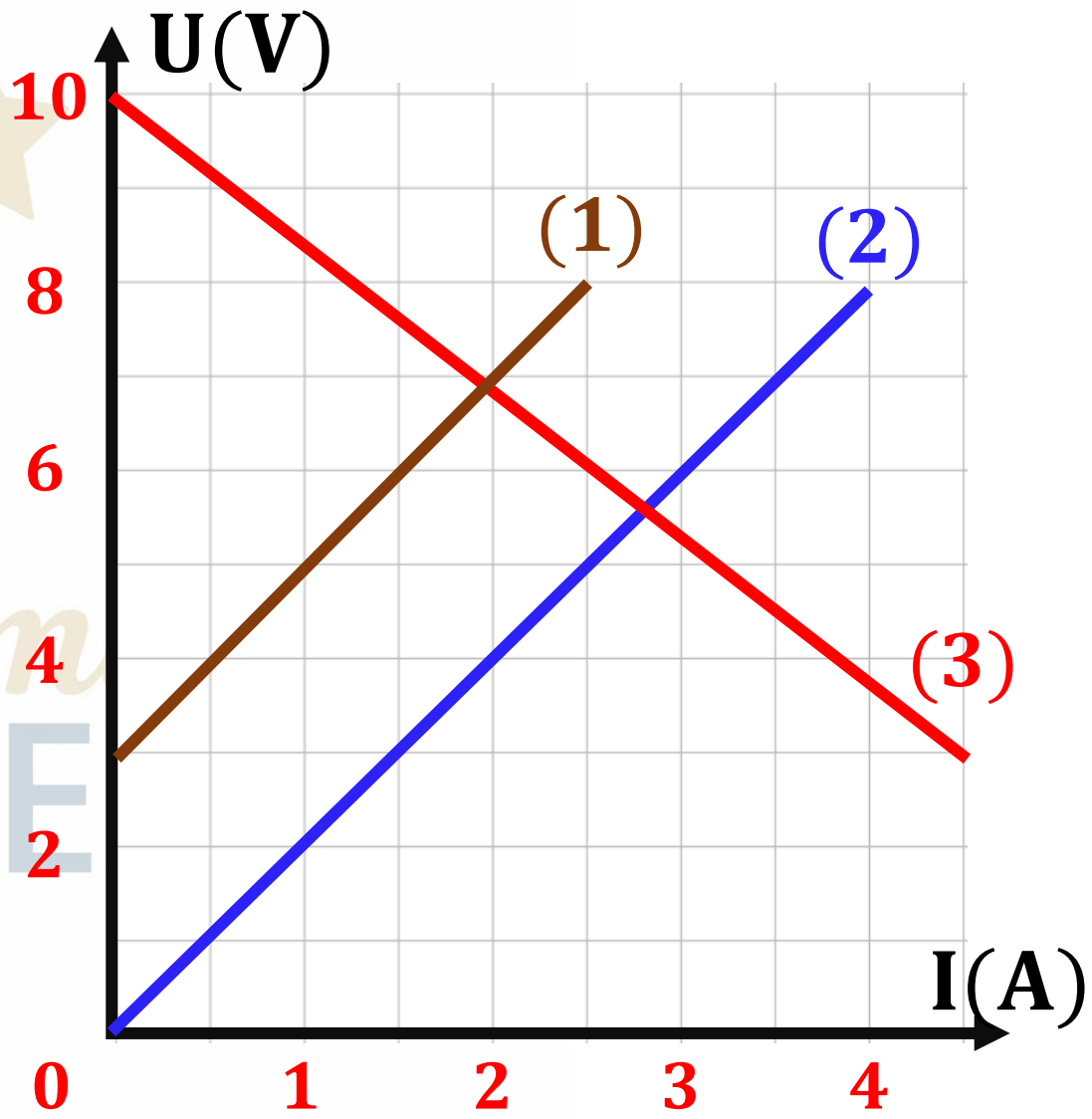
Curve (2) is for resistor:

Its equation is $U_R = R.I$

Where a is slope ($a = R$):

$$R = a = \frac{U_2 - U_1}{I_2 - I_1} = \frac{8 - 0}{4 - 0}$$

$$R = 2\Omega$$



Exercise 3:

Curve (3) is for generator:

Its equation is $U_G = a.I + b$

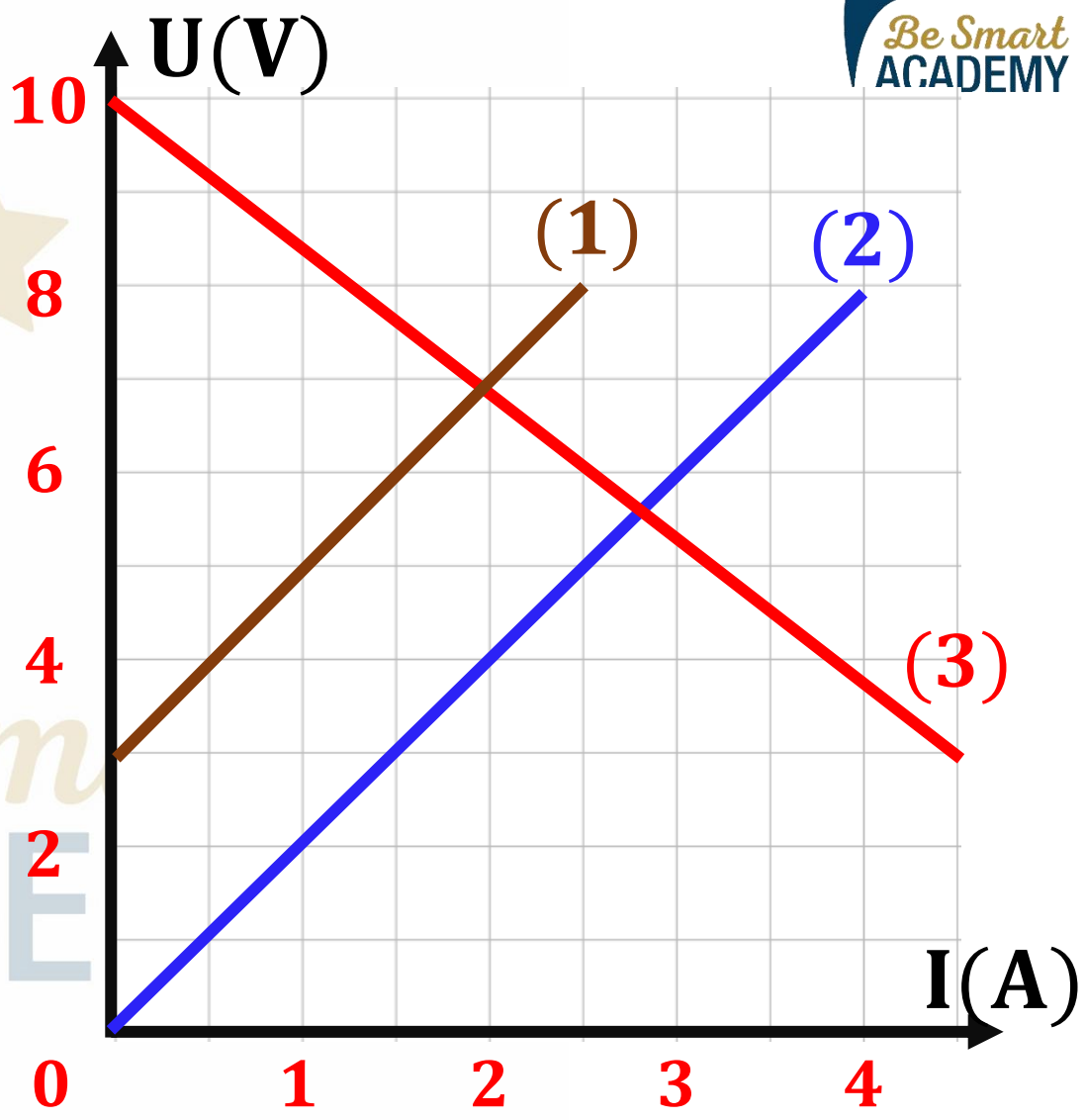
Where a is slope ($r = a$, and $b = E$ is y-intercept):

$$r = a = \frac{U_2 - U_1}{I_2 - I_1} = \frac{10 - 3}{0 - 4.5}$$

$$r = 1.55\Omega$$

$b = E$ is y-intercept

$$b = E = 10V$$



Exercise 3:

M ($E' = 3V$; $r' = 2\Omega$); G ($E = 10V$, $r = 1.55\Omega$); $R = 2\Omega$.

3. The motor M is connected across the generator G as shown. in the figure.

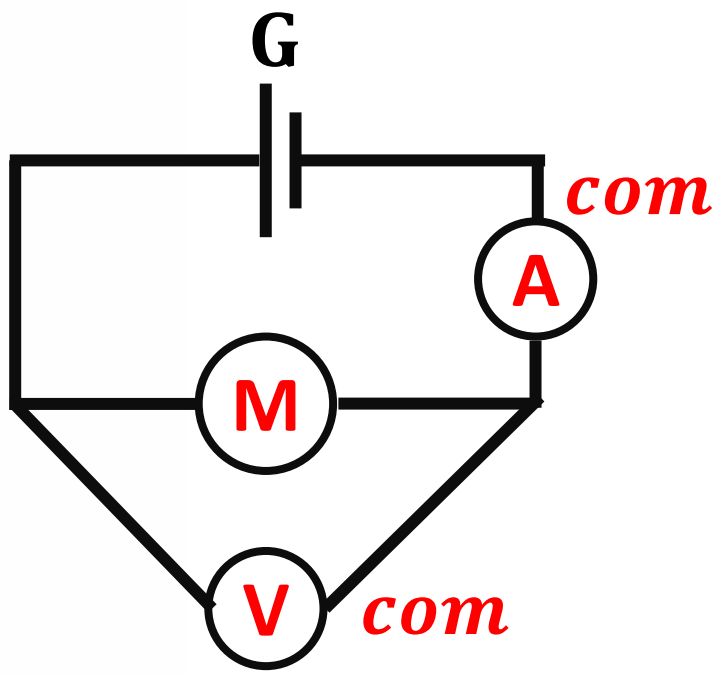
Determine, when possible, the current through the circuit, and the voltage across the motor.

$$U_G = U_M$$

$$-r.I + E = r'I + E'$$

$$-1.55 \times I + 10 = 2 \times I + 3$$

$$10 - 3 = 2 \times I + 1.55 \times I$$



Exercise 3:

$$10 - 3 = 2 \times I + 1.55 \times I$$

$$7 = 3.55 \times I$$

$$I = \frac{7}{3.55} \Rightarrow I = 1.97A$$

$$U_M = r'\mathrm{I} + E' \Rightarrow U_M = 2 \times 1.97 + 3$$

$$U_M = 6.94\mathrm{V}$$

The End