

Exercise walk-through

11.4

Electric Power

AP Physics C: Electricity and Magnetism

You must be able to

- define **electric power** as $P = IV$
- express the power in a resistor as $P = I^2 R = \frac{V^2}{R}$
- describe **Joule heating** (electrical energy to thermal energy)
- find the total energy delivered, $E = Pt$

1

The method

Method — Power

$P = IV$, in watts. For a resistor, using $V = IR$:

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

Exercises 2.1-2.2

2.1 A device draws 2.5 A at 12 V. Find the power.

[2]

2.2 A $10\ \Omega$ resistor carries 3.0 A. Find the power dissipated.

[2]

Exercises 2.1-2.2

2.1 A device draws 2.5 A at 12 V. Find the power.

[2]

2.1

- electrical power:

$$P = IV = (2.5 \text{ A})(12 \text{ V})$$

- $P = \mathbf{30 \text{ W}}$

2.2 A 10Ω resistor carries 3.0 A. Find the power dissipated.

[2]

2.2

- power in a resistor:

$$P = I^2 R = (3.0 \text{ A})^2 (10 \Omega)$$

- $P = \mathbf{90 \text{ W}}$

Exercises 2.3-3.1

2.3 A 100 W device runs for 5.0 minutes. Find the energy it uses.

[2]

3.1 The power dissipated in a resistor is

[1]

☐

A I^2R

B IR^2

C I/R

D I^2/R

Exercises 2.3-3.1

2.3 A 100 W device runs for 5.0 minutes. Find the energy it uses.

[2]

2.3

- energy = power $\times$ time, with $t = 5.0 \times 60 = 300$ s:

$$E = Pt = (100 \text{ W})(300 \text{ s})$$

- $E = \mathbf{3.0 \times 10^4 \text{ J}}$

3.1 The power dissipated in a resistor is

[1]

☐

A I^2R

B IR^2

C I/R

D I^2/R

3.1 A

- I^2R .

Exercise 3.2

3.2 Joule heating converts electrical energy into

[1]

☐

A light

B thermal energy

C sound

D chemical energy

Exercise 3.2

3.2 Joule heating converts electrical energy into

[1]

☐

A light

B thermal energy

C sound

D chemical energy

3.2 B

- thermal energy.

Exercise 3.3 (a)

3.3 A resistor dissipates 48 W while carrying 4.0 A.

(a) Find its resistance.

[2]

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[2]

(a)

- $P = I^2 R$, rearranged for R :

$$R = \frac{P}{I^2} = \frac{48 \text{ W}}{(4.0 \text{ A})^2}$$

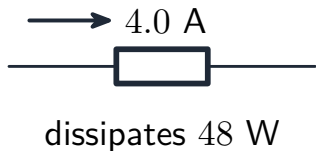
- $R = \mathbf{3.0 \, \Omega}$

Exercise 3.3 (b)

3.3 A resistor dissipates 48 W while carrying 4.0 A.

(b) Find the voltage across it.

[1]

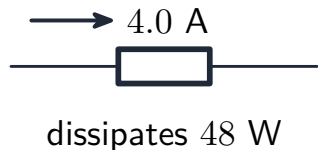


Exercise 3.3 (b)

3.3 A resistor dissipates 48 W while carrying 4.0 A.

(b) Find the voltage across it.

[1]



(b)

- $V = IR = (4.0 \text{ A})(3.0 \Omega) = \mathbf{12 \text{ V}}$

Exercise 3.4 (a)

3.4 A constant $2.0\ \Omega$ resistor carries a current $I(t) = t$ (in A, with t in s) from $t = 0$ to $t = 3.0$ s.

(a) Find $P(t)$ and the final power.

[2]

Exercise 3.4 (a)

3.4 A constant $2.0\ \Omega$ resistor carries a current $I(t) = t$ (in A, with t in s) from $t = 0$ to $t = 3.0$ s.

(a) Find $P(t)$ and the final power.

[2]

(a)

- power in a resistor, with $I = t$:

$$P(t) = I^2 R = t^2 (2.0\ \Omega) = \mathbf{2t^2\ W}$$

- at $t = 3.0$ s: $P = 2(3.0)^2 = \mathbf{18\ W}$

Exercise 3.4 (b)

3.4 A constant $2.0\ \Omega$ resistor carries a current $I(t) = t$ (in A, with t in s) from $t = 0$ to $t = 3.0$ s.

(b) Calculate the electrical energy transferred by integrating power. [2]

Exercise 3.4 (b)

3.4 A constant $2.0\ \Omega$ resistor carries a current $I(t) = t$ (in A, with t in s) from $t = 0$ to $t = 3.0$ s.

(b) Calculate the electrical energy transferred by integrating power. [2]

(b)

- the power varies, so integrate it over time:

$$E = \int_0^{3.0} P dt = \int_0^{3.0} 2t^2 dt = \left[\frac{2t^3}{3} \right]_0^{3.0}$$

- $E = 18\ \text{J}$