

11.4 Electric Power

Name: _____ Class: _____ Date: _____

Total: 15 marks

KEY WORDS joule heating • electric power • resistance

Objective

Build the skills to answer exam questions on **electric power**.

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 Key knowledge and worked examples

Study these first. Each one shows the method for a question type used later.

■ Power

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

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

■ Joule heating

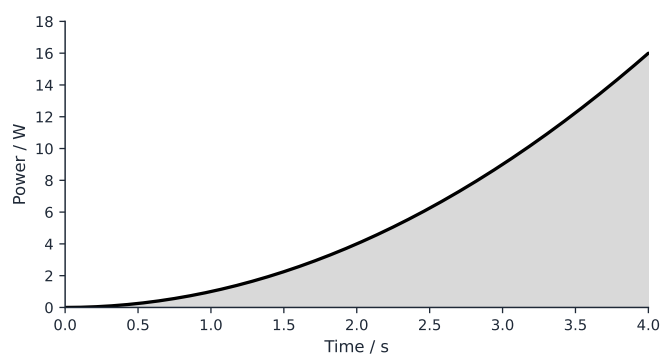
A resistor turns electrical energy into **thermal energy** at rate $I^2 R$.

■ Energy

 $E = Pt$ over a time interval.

■ Worked application: Energy is the time integral of power

A constant $4.0\ \Omega$ resistor carries a current $I(t) = 0.50t$ A, where t is in seconds, from 0 to 4.0 s. Instantaneous power is $P(t) = I(t)^2 R = t^2$ W, so final power is 16 W. Energy is $E = \int_0^4 P(t) dt = [t^3/3]_0^4 = 64/3$ J. Multiplying the final power by the full time would give 64 J and incorrectly treat the current as constant. The area under the power-time graph, rather than its endpoint alone, determines the energy.



2 Practice

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]

2.3 A 100 W device runs for 5.0 minutes. Find the energy it uses. [2]

3 Exam-style questions

3.1 The power dissipated in a resistor is [1]

- ☐ **A** $I^2 R$
☐ **B** IR^2
☐ **C** I/R
☐ **D** I^2/R

3.2 Joule heating converts electrical energy into [1]

- ☐ **A** light
☐ **B** thermal energy
☐ **C** sound
☐ **D** chemical energy

3.3 A resistor dissipates 48 W while carrying 4.0 A.

(a) Find its resistance. [2]

(b) Find the voltage across it. [1]

3.4 A constant $2.0\,\Omega$ resistor carries $I(t) = t$ A from 0 to 3.0 s. (a) Find $P(t)$ and the final power. [2]

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

Solutions

Each answer shows the steps, then the **result**.

2.1

- $P = IV = 2.5 \times 12 = 30 \text{ W}$

2.2

- $P = I^2 R = (3.0)^2 \times 10 = 90 \text{ W}$

2.3

- $E = Pt = 100 \times (5.0 \times 60) = 3.0 \times 10^4 \text{ J}$

3.1 A

- $I^2 R$.

3.2 B

- thermal energy.

3.3

(a)

- $R = \frac{P}{I^2} = \frac{48}{16} = 3.0 \text{ } \Omega$

(b)

- $V = IR = 4.0 \times 3.0 = 12 \text{ V}$

3.4

(a) $P(t) = I^2 R = 2t^2 \text{ W}; P(3) = 18 \text{ W}.$

(b) $E = \int_0^3 2t^2 dt = [2t^3/3]_0^3 = 18 \text{ J}.$