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 $P = I^2R = \dfrac{V^2}{R}$
- 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 $V = IR$:

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

■ Joule heating

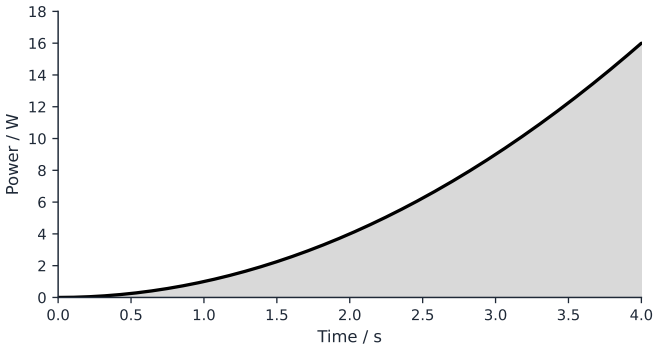
A resistor turns electrical energy into **thermal energy** at rate I^2R.

■ 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 $I(t) = 0.50t\,\text{A}$, where t is in seconds, from 0 to 4.0 s. Instantaneous power is $P(t) = I(t)^2R = t^2\,\text{W}$, so final power is 16 W. Energy is $E = \int_0^4 P(t)\,dt = [t^3/3]_0^4 = 64/3\,\text{J}$. 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 Ω 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^2R
- **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 $I(t) = t\,\mathrm{A}$ from 0 to $3.0\,\mathrm{s}$. (a) Find $P(t)$ and the final power. [2]

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