

2.3 Resistors and I-V characteristics

Name: _____ Class: _____ Date: _____

Total: 26 marks

KEY WORDS Ohmic conductor

• Filament lamp

• Diode

• Thermistor

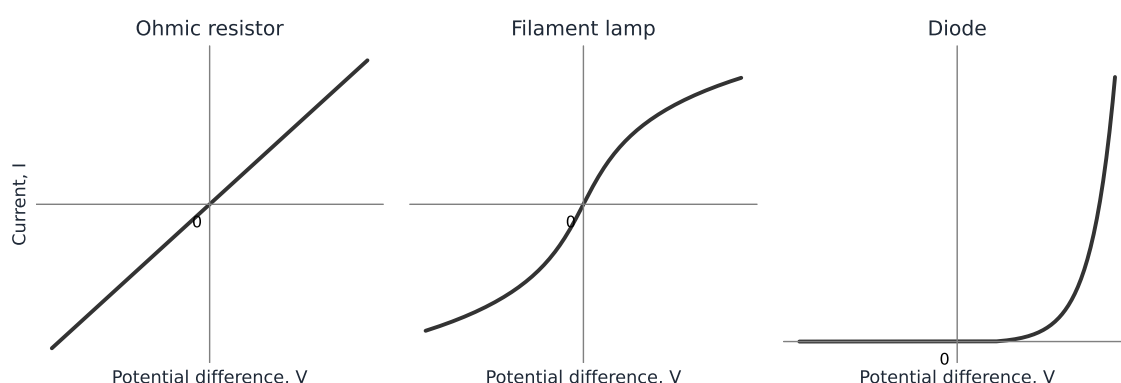
• LDR

Objective

Describe the I–V characteristic of a resistor, filament lamp and diode, explain the lamp's curve, state the thermistor and LDR rules with their applications, and describe RP4. Original questions for spec statement 4.2.1.4 and required practical 4.

1 Key knowledge and worked examples

An **I–V characteristic** is a graph of current against potential difference. **RP4** measures it: vary the potential difference with a variable resistor, record I and V , repeat with the supply reversed for negative values.

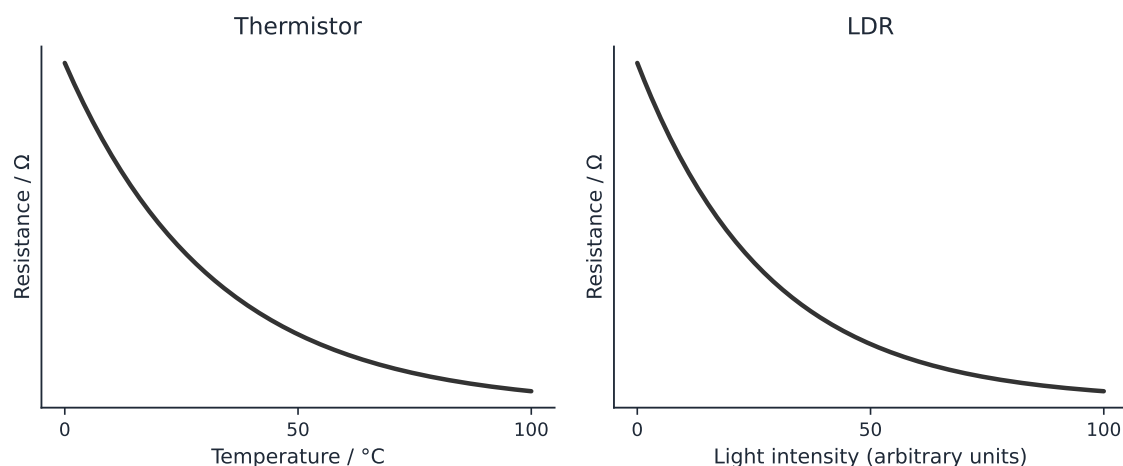


The shape names the component.

Component	Graph shape	Why
resistor (constant temperature)	straight line through origin	resistance constant: $I \propto V$
filament lamp	S-curve, flattening at large V	current heats the filament; resistance rises with temperature
diode	conducts forward only; no current in reverse	very high resistance in reverse

The lamp explanation in three linked steps:

1. A larger current makes the filament **hotter**.
2. The hotter filament has **higher resistance** (the moving electrons collide more with the vibrating lattice).
3. So current grows **less than proportionally** with potential difference – the curve bends over.



Sensors: resistance falls when their trigger rises.

- **Thermistor** : resistance **decreases** as temperature **increases**. Application: temperature sensor in a thermostat.
- **LDR** : resistance **decreases** as **light intensity increases**. Application: switching lights on when it gets dark.

RP4 method: ammeter in series, voltmeter in parallel; variable resistor changes the current; reverse the supply connections for negative potential differences; use a protective series resistor to limit diode current and a milliammeter to measure it; connect the voltmeter across the diode alone; keep the resistor's temperature constant (short bursts / low current); repeat and take means.

Worked example (reading an I–V graph). A lamp's graph shows 0.16 A at 2.0 V and 0.26 A at 6.0 V.

- Known: two points on the curve. Resistance changes, so compute each separately.

$$R_{2.0\text{V}} = \frac{2.0 \text{ V}}{0.16 \text{ A}} = 12.5 \, \Omega \quad R_{6.0\text{V}} = \frac{6.0 \text{ V}}{0.26 \text{ A}} = 23 \, \Omega$$

- The resistance rose with potential difference because the current heated the filament.

2 Practice

2.1 Sketch and label the I–V graph for (a) a fixed resistor at constant temperature and (b) a filament lamp. [4]

2.2 Explain why the filament lamp's graph is not a straight line. [3]

2.3 State what happens to the resistance of (a) a thermistor as temperature rises, (b) an LDR as it gets darker, and name one application of each. [4]

3 Exam-style questions

3.1 A student investigates the I–V characteristic of a diode.

- (a) Describe how the student obtains negative values of potential difference. [1]
- (b) The ammeter displays 0.0 A for all reverse values. Explain why. [2]
- (c) Give one reason a protective resistor is placed in series with the diode. [1]

3.2 A student plots the I–V graph of a resistor and of a filament lamp on the same axes. The lamp's curve lies **below** the resistor's line for all positive values.

Explain what this shows about the lamp's resistance compared with the resistor's at the same potential difference. [2]

3.3 A car's automatic headlight circuit uses an LDR in series with a $1000\ \Omega$ fixed resistor across a 12 V supply. The output is taken **across the LDR**; the lights switch on when it reaches 6.0 V. In daylight the LDR's resistance is $500\ \Omega$; after dark it rises to $5000\ \Omega$.

- (a) Calculate the output potential difference in daylight. [3]
- (b) Calculate the output potential difference after dark. [3]
- (c) Explain why the lights come on as it gets dark. [3]

