Filament lamps and diodes: non-ohmic graphs

Student activity • investigation and reasoning

YEAR 10 / LESSON 46 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

Why are a filament lamp and a diode different from a cool fixed resistor?

Measure a small lamp and observe a current-limited diode demonstration. Plot actual component voltage against current.

Equipment

- 3 V filament lamp, low-voltage source, switch, ammeter, voltmeter and leads
- Staff silicon diode circuit with 1 kΩ resistor and suitable milliammeter

Never exceed the lamp rating. Staff set a current limit appropriate to that lamp. Disconnect before reversing polarity; let lamps cool before handling. Keep the diode's 1 kΩ resistor in series and source at or below 3 V. No diode breakdown test is performed.

Course coverage: Shared Physics / Double Award: 2.9, 2.13. Component current–voltage characteristics.

Plan, model or apparatus sketch

Draw a labelled setup or force diagram; include the measured quantities.

Method and reasoning

Read the whole sequence before starting

YEAR 10 / LESSON 46 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. In ten groups of three, build a checked circuit with a 3 V filament lamp, series ammeter and switch, and voltmeter across the lamp. Begin with the source at zero.

2. Record actual voltage and current at three positive settings up to the lamp's 3 V rating. Wait for each reading to settle, then open the switch.

3. Disconnect before reversing source polarity and record three negative pairs at comparable magnitudes. Do not touch the lamp while warm.

4. Observe staff measuring a silicon diode with a permanent 1 kΩ series resistor, a 0–3 V source and a 5 mA current limit. Record at least five forward operating points and one reverse-polarity point within the rated limits.

5. Plot I against actual voltage across each component, using separate scales where needed. For the diode, record results on an additional ruled table headed diode V / V and I / mA.

6. Explain the lamp's increasing resistance as its filament warms and the diode's asymmetric response. Do not describe every silicon diode as switching at one exact universal voltage.

Cleanup

- Switch off, disconnect and let lamps cool before collection.

Record your evidence

Blank spaces are for your own work

YEAR 10 / LESSON 46 / PHYSICS + SCIENCE (DOUBLE AWARD)

Reference and task data

Use the voltage across the component, not the whole diode-plus-resistor circuit. The diode's series resistor limits current. A reverse reading below the meter's resolution is not proof of mathematically zero current. Keep the lamp and diode current units explicit.

Lamp setting	Actual V / V	Current / A
Positive low		
Positive middle		
Positive high		
Negative low		
Negative middle		
Negative high		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 10 / LESSON 46 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Why does the lamp graph curve?

2. Why is a resistor essential in the diode circuit?

3. Where is the diode voltage measured?

4. How does a diode respond to reversed polarity in this range?

5. Can one fixed resistance describe the whole lamp curve?

6. Why use separate current scales?