

Filament Bulbs - Hot + Cold

AS Physics

This assignment is about the working of a filament bulb - changes in temperature and how they affect its resistance. The bulb is a 12V interior car light bulb.

Here is a set of measurements of potential difference (p.d., or voltage) and current

p.d. (Volts)	0	2.0	4.0	6.0	8.0	10.0	12.0
Current (Amps)	0	0.210	0.320	0.353	0.372	0.385	0.414

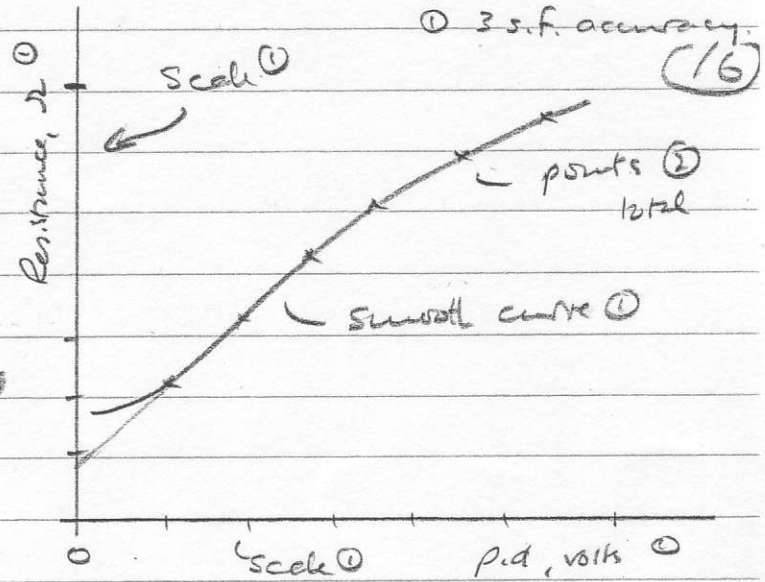
- Draw up a table showing p.d., current, and resistance for all voltages up to 12V.
(take care with headings, units and accuracy) (6)
- Plot a graph of bulb resistance against p.d.
Draw a smooth curve best fit. (7)
Use the graph to estimate the bulb's resistance when cold.
- When switched on from cold the bulb takes about 0.5 sec to become fully bright, working at its normal temperature. You can assume that the full 12V is applied from the instant of switching on.
Sketch a graph to show how the current varies in the first 0.5 seconds.
(Your sketch graph must have scales marked, and show the shape of the curve - but it need not be plotted in detail.). Explain the shape of your graph and any calculations you do. (10)
- Calculate the power of the bulb when (i) first switched on, and (ii) when working normally. (3)
- Explain why the bulb resistance increases with p.d.
Include... why the current heats the filament, and ... why the temperature affects the resistance. (7)

a)	P.D (Volts)	0	2.0	4.0	6.0	8.0	10.0	12.0	① lin
	Current (A)	0	0.210	0.320	0.352	0.372	0.385	0.414	① lin
	Resistance (Ω) ①	-	9.52	12.5	17.0	21.5	26.0	29.0	

② correct answers
① 3 s.f. accuracy

b) graph 17

Bulb $R_{cold} = 7.5 - 8.0 \Omega$ ②
 $7.0 - 8.5 \Omega$ ①

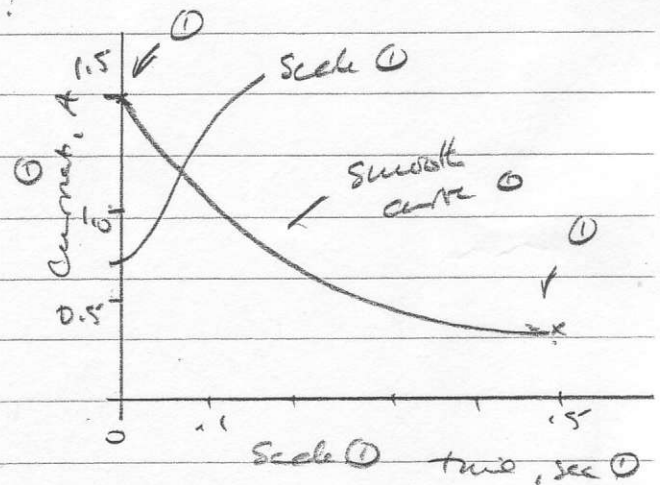


c) Current variation on switching on ...
do some sums ...

$R_{cold} = 8 \Omega$ so $I_{start} = \frac{V}{R} = 1.5 A$

When hot $I = 0.414 A$ - see the table!

Sketch graph



The current starts off large because of the small resistance ①. As the bulb heats up its resistance increases ① and current reduces ①

d) $P = IV = I^2 R = \frac{V^2}{R}$ ← more helpful version of the formula

So for the cold bulb when $R_{cold} = 8 \Omega$ $P_{cold} = \frac{V^2}{R} = \frac{12^2}{8} = 18 W$.

$P_{normal + hot} = IV = 0.414 \times 12 = 4.97 W$ (check $P = \frac{V^2}{R} = \frac{144}{29} = 4.97$)

e) Current heats filament...

moving electrons have k.e. ... collide with atoms ... pass on k.e. ... set the atoms vibrating ... make them HOT

Why temperature affects resistance ...

As temp. increases ... atoms vibrate more ... amplitude increases ... this impedes (slows down) electron movement ... R increases

a/6 b/7 c/10 d/3 e/7 Total/33