8 **(a)** The filament of a traditional lamp is made of tungsten that has a melting point of 3690 K. The resistivity ρ of tungsten at 300 K (27 °C) is $5.50 \times 10^{-8}\,\Omega\,m$.

(i) A tungsten filament is 0.178 m long and has a diameter of 5.72×10^{-5} m.

Show that its resistance is approximately 3.8 Ω at a temperature of 300 K.

[3]

(ii) The resistance of tungsten is approximately proportional to its temperature in kelvin. Calculate the approximate resistance of the filament at a working temperature of 2900 K.

resistance = ... Ω [2]

(b) Several students perform an experiment several times to determine the resistivity of a cold tungsten filament. Their calculated values of the resistivity in Ω m are given in Table 8.1.

Table 8.1

calculated values of resistivity / Ω m				
student A	student B	student C	student D	student E
6.00×10^{-8}	5.43×10^{-8}	2.23×10^{-7}	5.72×10^{-8}	5.51×10^{-8}
5.83×10^{-8}	5.71×10^{-8}	2.26×10^{-7}	5.68×10^{-8}	5.56×10^{-8}
5.47×10^{-8}	5.50×10^{-8}	2.19×10^{-7}	5.73×10^{-8}	5.48×10^{-8}
5.92×10^{-8}	5.27×10^{-8}	2.20×10^{-7}		5.48×10^{-8}
	5.81×10^{-8}	2.24×10^{-7}		5.50×10^{-8}

(i) Suggest the mistake that student C is making for all the readings.

.....

.....[2]

(ii) Describe the results of the students other than student C, using the terms *systematic error* and *random error*.

.....

.....

.....

.....[3]

(c) (I) Sketch the $I-V$ characteristic of a filament lamp on Fig. 8.1. [2]

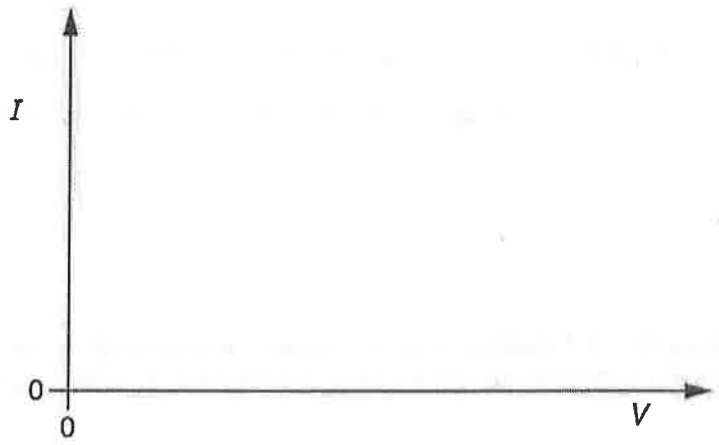

Fig. 8.1

(II) Describe the variation of the resistance of a filament lamp with current I.

.....

.....[1]

(III) Suggest the effect on the light emitted by a filament lamp when the supply potential difference is reduced from the normal operating voltage.

.....

.....[2]

(d) (I) The filament of a filament lamp is usually a coiled wire. As the lamp is used, the filament evaporates.

State and explain an advantage of a longer, thicker coiled filament rather than a shorter, thinner filament with the same resistance.

.....

.....

.....

.....

[2]

(II) Some filament lamps are designed to be extra bright, but they usually have a shorter lifespan.

Suggest why this is.

.....

.....

.....[1]

(III) Many modern households use LED lamps instead of filament lamps to reduce electricity bills.

A 100 W filament lamp has the same brightness as an 18 W LED lamp.

Suggest what this means about the efficiency of the LED lamp compared to the filament lamp. Explain your answer.

.....

.....

.....[2]

[Total: 20]