Revision for Exams : Graphical analysis

1. Conduction of heat in a solid is given by the equation:

$\frac{Q}{t} = kA\frac{\Delta T}{l}$ where : k = thermal conductivity of a material

A = cross-sectional area

l = length of solid/thickness.

A group of students carried out an experiment to determine how the energy transferred was affected by the length of an Aluminium rod that was 2.00 cm in diameter. The difference in temperature between the two ends of the rod was kept at 75.0°C and the heat transferred was measure after 1 minute.

Their results were as follows:

Length (cm)	Heat (J)	1/length (m^{-1})	
5.0	6 700	20	
10	3 350	10	
15	2 230	6.7	
20	1 700	5	
25	1350	4	

a) Find the cross sectional area of the aluminium rod

$A = \pi(1\times10^{-2})^2 = 3.14\times10^{-4}m^2$

b) List the variables:

i) Independent: length of Rod

ii) Dependent: heat transmitted

iii) Controlled: A, t, ΔT, Aluminium Rod

c) Plot a graph of heat vs length.

d) Plot a graph of heat vs 1/length.

e) Explain why the second graph is necessary.

To obtain straight line graph to determine eqn

f) Find the gradient of the second graph.

$grad = \frac{6700\,J}{20\,m^{-1}} = 335\,Jm$

g) HENCE, determine the value of the thermal conductivity of aluminium with units.

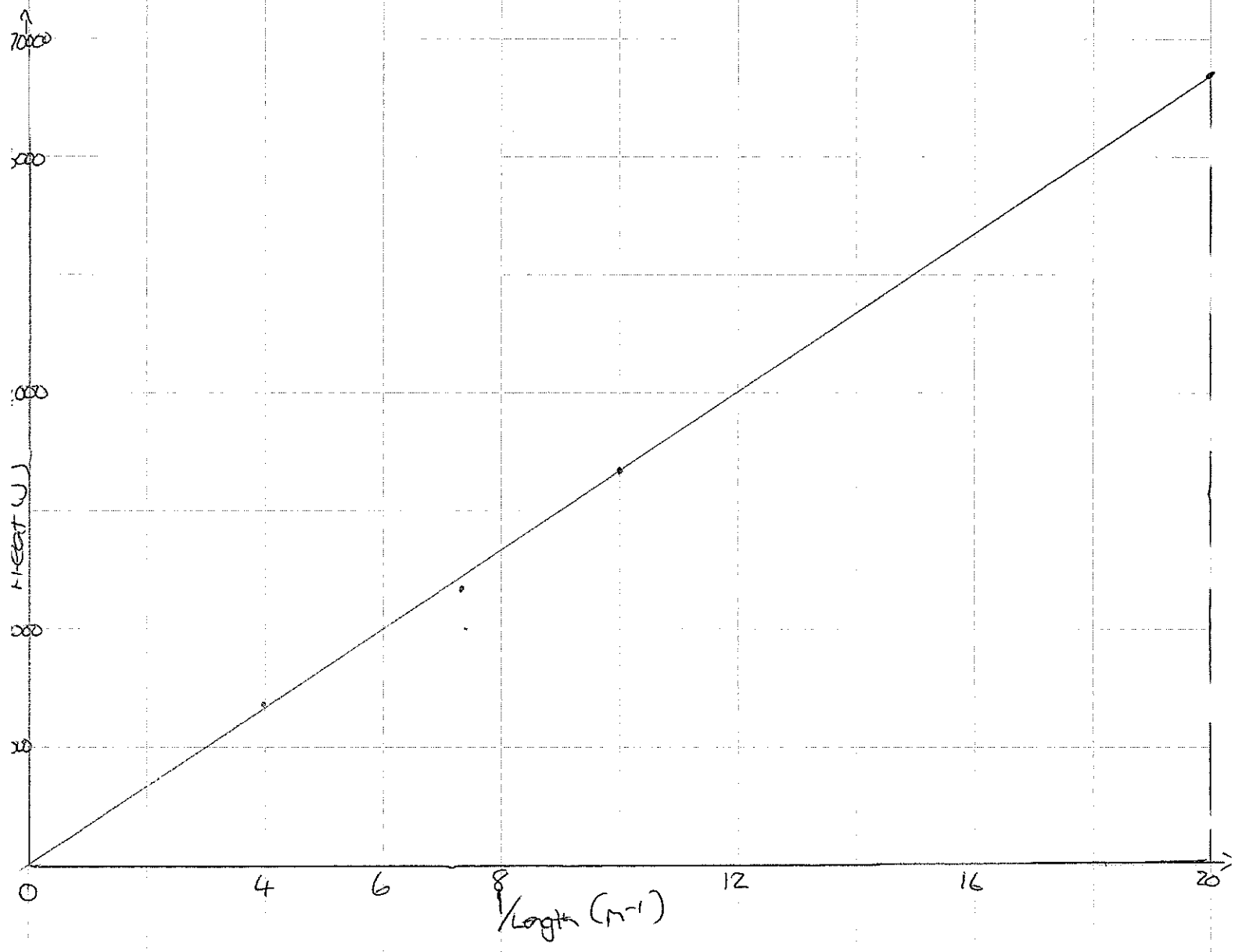
$Q = kA\Delta Tt \times \frac{1}{l}$

$335\,Jm = kA\Delta Tt$

$K = \frac{335\,Jm}{3.14\times10^{-4}m^2 \times 75K \times 60s} = 237.08\,JK^{-1}s^{-1}m^{-1}$

$= 237.\,WK^{-1}m^{-1}$

$= 240\,WK^{-1}m^{-1}$



2. The resistivity of a piece of wire is given by :

$$R = \frac{\rho l}{A}$$

where R = resistance

ρ = resistivity

l = length of wire

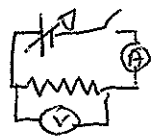
A = cross sectional area of wire

A group of scientists submit the following measurements when the length of the new metal they have discovered is changed and the voltage across the wire and current through it are varied.

Length (m)	Voltage (V)	Current (A)	Resistance(Ω)
0.1	2.00	3.02	0.662
0.5	2.00	0.60	3.33
0.8	2.00	0.38	5.26
1.0	2.00	0.31	6.45
1.2	2.00	0.25	8.00

They have used a wire that is 5 mm in diameter.

a) Draw the circuit diagram.
b) Complete the table.
c) Plot a graph of resistance vs length.
d) Find the gradient.
e) Hence determine the resistivity of the metal with units.
f) From your graph determine the current that would flow with a 0.6m length of wire.
g) If the cross sectional area of the metal was compared to the resistance, what would you graph to obtain a straight line graph?

a) 

$A = \pi r^2$
$= \pi \left(\frac{5\times10^{-3}}{2}\right)^2$
$= 1.963\times10^{-5} m^2$

d) Grad $= \frac{6.75}{1} = 6.75\ \Omega m^{-1}$

e) $R = \frac{\rho l}{A}$ $\quad y = mx$

grad $= \frac{\rho}{A}$

$6.75\ \Omega m^{-1} = \frac{\rho}{1.963\times10^{-5} m^2}$

$\rho = 6.75 \times 1.963\times10^{-5}$
$= 1.33\times10^{-4}\ \Omega m$

f) $R = 3.9\ \Omega$ $\quad I = \frac{V}{R} = \frac{2}{3.9} = 0.513A$ (Range)

g) R vs $\frac{1}{A}$

Graph of Resistance vs length