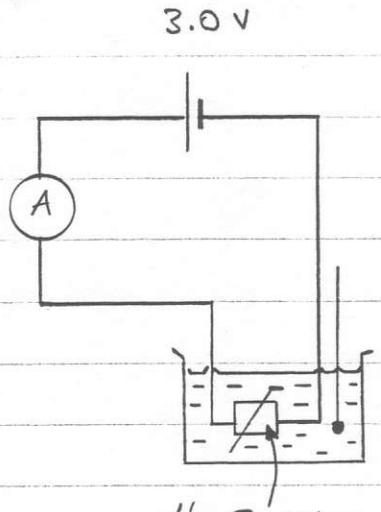
Thermistors and Resistance

AS Physics

The current flowing through a thermistor at different temperatures is measured with this circuit →



The results are:—

Temp, °C	0	10	25	40	54	76	100
Current, mA	7.4	9.0	11.9	15.6	20.2	28.8	41.7

a). Calculate the resistance at each temperature. Put all values of temperature, current and resistance in a table. Plot a graph of resistance against temperature over the range 0 – 100 °C (table: 6, graph: 7)

b) Why does the resistance of the thermistor decrease as its temperature rises? (3)

c) You want to use the circuit to measure temperature over the range 20 - 80 °C to an accuracy of ± 1°C. You have 4 different types of meters, with ranges.... 0 - 10 mA, 0 - 50 mA, 0 - 100 mA, and 0 - 500 mA. which one should you use, and why? (2)

d) What is the change in current for a 1°C change in temperature at .... 20 °C ? .... 80 °C ? (4)

e) Sketch a suitable scale for the current meter in (c) that will enable you to measure temperature to the required accuracy. (3)

f) Where on the temperature range 20 – 80 °C is your electronic thermometer most accurate? Explain your answer. (2)

g) You want to use the circuit in a thermostat to control the temperature of water at 37 ± 2 °C. What are the maximum and minimum currents for this range? (2)

h) The current flowing through the thermistor generates heat. What heating power is produced at 60 °C ? (4)

i) Can you suggest how the system in the diagram can be used to measure the temperature of water in a car engine? If the normal temperature is 90 °C what would the current be? (4)

TJN
10.00

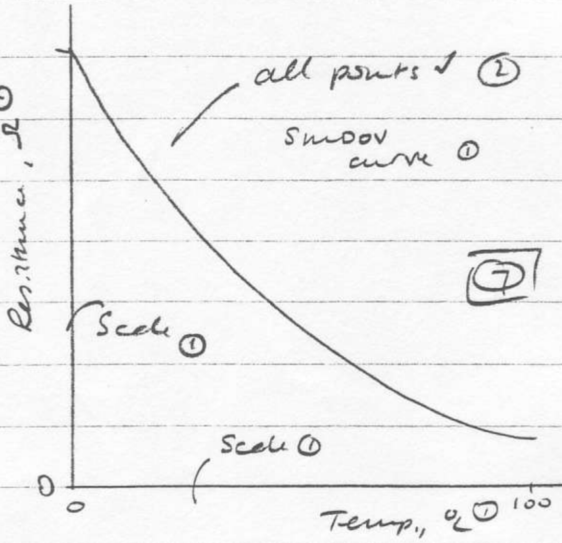
Thermistor — Answers

AS Physics

(a)

T, °C	0	10	25	40	54	76	100
I mA	7.4	9.0	11.9	15.6	20.2	28.8	41.7
R, Ω	405	333	252	192	149	104	71.9

all answers (2)
3 s.f. accuracy (1)
[6]



(b) Why R↓ as T↑

- as Temp. increases the atoms have more thermal energy (1) (vibrate more E)…. this releases some electrons from their atoms (1)…. so there are more electrons free to carry charge (1) /3

Total /38

c) the best meter

at 20°C R = 280 Ω $I_{20} = V/R$ = 0.0107 A = 10.7 mA (1)

at 80°C R = 96 Ω I_{80} = 0.0312 A = 31.2 mA (1)

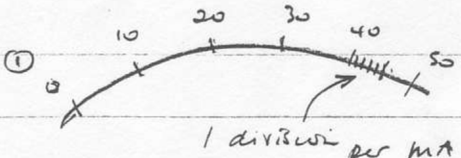
So the max. current is 31 mA … best meter is the 0–50 mA one (1)

d) R at 21 = 272 Ω, I_{21} = 0.011 A = 11.0 mA (1)

R at 81 = 94 Ω, I_{81} = 0.0319 = 31.9 mA (1)

So change in I for 1°C temp change

at 20° is 11.0 − 10.7 = 0.3 mA (1) at 80°C is 31.9 − 31.2 = 0.7 mA (1)



e) See sketch. any scale (1) shows 10s of mA (1) shows 1 mA divisions (1)

f) The thermometer is most accurate at high temps (around 80°C) because at that end a 1°C change gives the biggest current change (1)

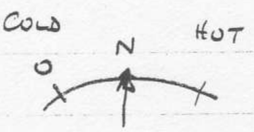
g) Thermostat…. T = … 37 − 2 = 35°C R = 208 I = 0.0144 A = 14.4 mA (1)

37 + 2 = 39°C R = 194 I = 0.0155 A = 15.5 mA (1)

h) heat production … Heating power P = IV (1) = I^2R = V^2/R (1) ← the most useful

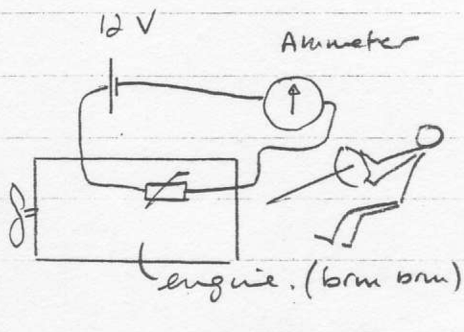
at 60°C R = 136 Ω (1) So Power P = $3^2/136$ = 0.066 Watts (1)

i) Car engine…. put thermistor in the engine's water system (1)…. Mark the ammeter scale as cold … hot (1)



at 90°C R = 84 Ω for 3 V I = 36 mA (1)

So for 4×3 = 12 V I = 4 × 36 = 144 mA (1)



Marks: (c) /4, (h) /4, (b) /2 [?], (J) /2, (F) /2, (e) /3, (d) /4, (c) /3 (+ method), (b) /3, /7, /6, (a)

JRN 11.00