O Level Pure Physics Structured

Current and DC Circuits Test 2.0

Q1

Fig. 6.1 shows the print head for an inkjet printer. The inkjet from the ink gun is charged before it is ejected downwards.

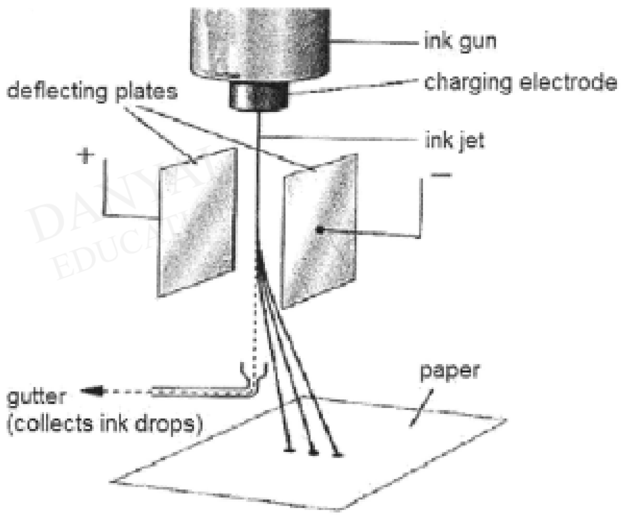

Fig. 6.1

The deflecting plates are maintained at a potential difference of 20 V. A charge of 1.5 μC is passed between the plates every second.

(i) State what is meant by potential difference.

....

....[1]

(ii) State the electric current passing through the plates.

current = ...[1]

(iii) Calculate the energy consumed by the plates in one minute.

energy =..............................[2]

Q2

Induction cookers work on the principle of electromagnetic induction. Fig 9.1 shows an induction cooker which consists of a copper coil connected to an alternating current (a.c.) supply and a ceramic plate. When a pot made of soft magnetic material is placed on top of the cooker and the a.c. supply is turned on, electromagnetic induction leads to the pot being heated. The ceramic plate remains relatively cool.

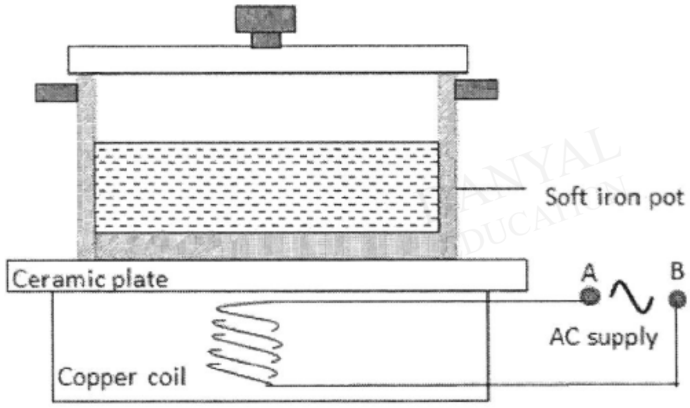

Fig. 9.1

(b) The manufacturer is exploring alternative materials for the pot. Fig. 9.2 shows how the resistivities of two alloys **A** and **B** change with temperature.

temperature / °C	resistivity of **A** (Ωm)	resistivity of **B** (Ωm)
20	1.5×10^{-7}	7.0×10^{-7}
70	2.3×10^{-7}	8.1×10^{-7}
120	3.1×10^{-7}	9.2×10^{-7}
170	3.9×10^{-7}	10.3×10^{-7}
220	5.3×10^{-7}	13.4×10^{-7}
270	8.7×10^{-7}	18.7×10^{-7}
320	12.7×10^{-7}	26.8×10^{-7}
370	18.9×10^{-7}	37.6×10^{-7}
420	26.2×10^{-7}	58.4×10^{-7}
470	35.4×10^{-7}	80.7×10^{-7}

Fig. 9.2

(i) Using data from Fig. 9.2, describe the relationship between temperature and resistivity of **A**

1. At low temperature, ...

....[1]

2. At high temperature, ...

....[1]

(ii) Fig 9.3 shows the chemical composition of alloys **A** and **B**.

Alloy	**A**	**B**
carbon (%)	2	3
iron (%)	88	78
chromium (%)	10	19

Fig. 9.3

The data in Fig. 9.2 and Fig. 9.3 provides some evidence of a relationship between chromium content and resistivity. State this possible relationship.

....

....[1]

Q3

(a) Figure 11.3 shows a lamp and two resistors connected to a battery of e.m.f. 6.0 V.

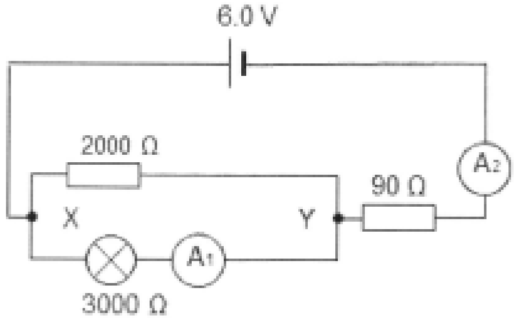

Fig. 11.3

(i) Calculate the total resistance of the circuit.

resistance = ... [2]

(ii) Calculate the ammeter reading A_2.

ammeter reading = ...[1]

(iii) Calculate the potential difference across XY.

potential difference = ...[1]

(iv) A 100 Ω resistor was connected in parallel across the 90 Ω resistor. The ammeter reading A_1 increased. Explain why.

....

....[1]

Q4

Fig 6.1 shows the experimental setup to obtain the fixed value of a resistor. Fig 6.2 shows how the ammeter reading varies with the voltmeter reading.

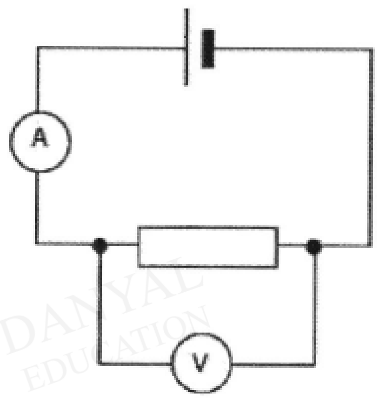

Fig 6.1

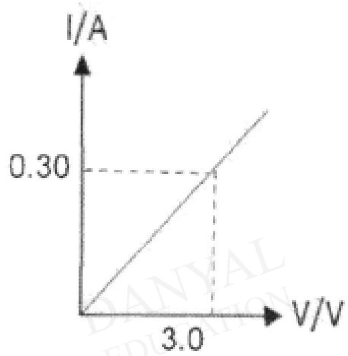

Fig 6.2

(a) Calculate the resistance of the fixed resistor.

resistance = ... [1]

(b) The resistor is a 2.0 m long constantan wire with a diameter of 0.20 mm. It is replaced with another constantan wire that is 1.0 m long with a diameter of 0.10 mm. The rest of the setup remains unchanged.

Predict the ammeter reading when the voltmeter reading is 3.0 V.

ammeter reading = ... [2]

Q5

Fig 7.1 shows a potential divider circuit with a fixed resistor and a thermistor connected to a 200 V supply. A cooling fan motor is connected across the fixed resistor.

Fig 7.2 shows the resistance behavior of the thermistor as the temperature increases.

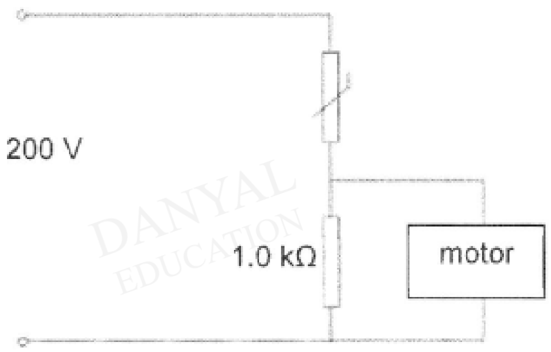

Fig 7.1

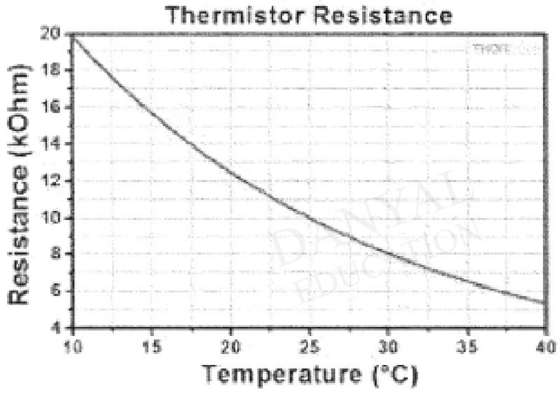

Fig 7.2

(a) Explain how a rise in the ambient temperature will switch on the fan.

....

....

....

.... [2]

(b) The fan is switched on when the ambient temperature rises to 32.5°C. Calculate the current in the resistors and hence the potential difference of the fan motor when this happens.

current = ...

potential difference = ... [3]

Answers

Current and DC Circuits Test 2.0

Q1

6di	Potential difference is the work done to drive a unit charge across a component.	B1
6dii	I = Q / t = 1.5 x 10^{-6} / 1 = 1.5 x 10^{-6} A	B1
6diii	E = VQ = 20 x 1.5 x 10^{-6} x 60 = 0.018 J *allow ecf from 6dii	M1 A1

Q2

bi	1. Low temperature: resistivity varies linearly with temperature / resistivity increases at a constant rate with temperature 2. High temperature: resistivity increases at an increasing rate with temperature	B1 B1
bii	As chromium content increases, the resistivity increases. *accept resistivity varies linearly with chromium content linearly with a positive gradient. **Do not accept resistivity is directly proportional to chromium content.	B1

Q3

1ai	Parallel resistance = $(1/2000 + 1/3000)^{-1}$ = 1200 Ω Total resistance = 1200 + 90 = 1290 Ω	M1 A1
1aii	I = V/R = 6 / 1290 = 4.65×10^{-3} A *allow ecf from 11ai	B1
1aiii	p.d. across XY + p.d. across 90 Ω = 6 V p.d. across XY + $4.65 \times 10^{-3} \times 90$ = 6 p.d. across XY = 5.58 V OR $R_{xy} = (1/2000 + 1/3000)^{-1}$ = 1200 Ω $V_{xy} = I R_{xy}$ = $4.65 \times 10^{-3} \times 1200$ = 5.58 V OR V_{xy} = (1200/1290) x 6 = 5.58 V	B1
aiv	Effective resistance will decrease. Main current in circuit will increase / A2 will Increase.	B1

Q4

a	R = V/I = 3.0 /0.30 = 10 Ω	1
b	New resistance = Old R X ½ X 4 = Old R X 2 = 20 Ω (½ L → ½ R and ½ diameter → ½ A → 4R) Ammeter reading = V/R = 3/ 20 = 0.15 A	1 1

Q5

'a	R_{therm} decreases as temperature increases V_{therm} decreases as <u>$V_{therm} = R_{therm}/R_{total}$ X emf</u> $V_{1k\Omega}$ and hence <u>V_{motor} increases</u> as V_{motor} = emf – V_{therm}.	1 1
'b	From graph, at 32.5°C, R_{therm} = 7.0 kΩ (accept up to 7.2 kΩ) I = emf / R_{total} = 200 / 8000 = 0.025 A $V_{motor} = IR_{1k\Omega}$ = (0.025)(1000) = 25 V	1 1 1